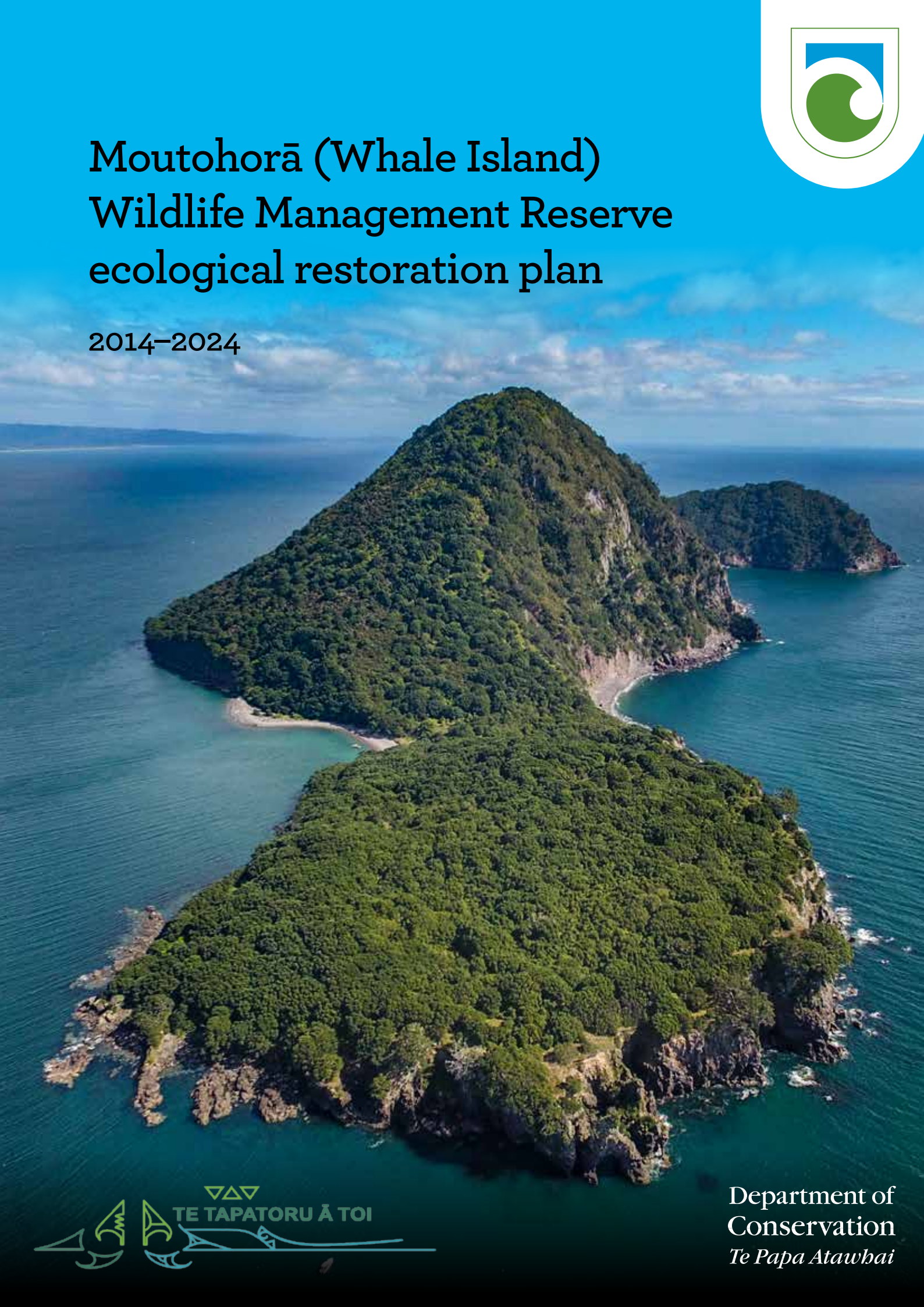
# Moutohorā (Whale Island) Wildlife Management Reserve ecological restoration plan

2014–2024



TE TAPATORU Ā TOI

Department of Conservation
*Te Papa Atawhai*

Cover: Moutohorā (Whale Island) Wildlife Management Reserve. *Photo: David Finn.*



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2014–2024

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## Vision

Mā te ngaruru ō te Tāpui Tokotoru ka noho momoho nga taonga tukuiho - taonga koiora hei painga huarahi mō ngā whakatipuranga ō ināianei ō ake tonu ake.

As Te Tāpui Tokotoru Conservation Management Plan flourishes, opportunities abound for the enjoyment by present and future generations of its unique ecological, historical, cultural, recreational and educational dynamics.

# 1. Introduction

Moutohora (Whale Island) Wildlife Management Reserve[1,2] (known to Ngāti Awa as Moutohorā, which will be used hereafter in this report) was gazetted as a Government purpose reserve in 1991, pursuant to the Reserves Act 1977. The foreshore boundary was subsequently changed to include the mean low water spring level in 2009. Moutohorā was also gazetted as a Wildlife Refuge in 1984, pursuant to the Wildlife Act 1953; however, this classification was revoked on 27 April 2012.

Although the island is vested in the Crown, it is administered by Te Tapatoru ā Toi, a joint management committee established under subpart 5 of the Ngāti Awa Claims Settlement Act 2005. This committee has six members, who are appointed by the Minister of Conservation and jointly manage Moutohorā alongside Ohope Scenic Reserve and Tauwhare Pa Scenic Reserve, as set out in Te Tāpui Tokotoru Conservation Management Plan (CMP) 2008–2018 (DOC 2008b).

Historically, the Department of Conservation (DOC) had three approaches for the ecological management of New Zealand's offshore islands: restore ecological communities, manage specific species or 'do nothing' (Smale & Owen 1990). Following consideration of these approaches, DOC and Ngāti Awa agreed that ecological restoration was the preferred option for Moutohorā, making this the first New Zealand offshore island to be primarily managed for the restoration of ecological communities (DOC 1999).

[1] The official name of the reserve was confirmed as 'Moutohora (Whale Island) Wildlife Management Reserve on 17 December 2009, replacing the former reserve name of Moutohora (Whale) Island Wildlife Management Reserve.

[2] The official spelling of the island was confirmed as 'Moutohora Island' by the New Zealand Geographic Board on 10 April 1992, replacing the formerly mapped name of 'Motuhora Island'. The island is also known as Whale Island.

Presently, DOC's Island Strategy (DOC 2010) provides nationally consistent guidelines for managing islands administered by DOC and those under co-management agreements with iwi. Within this strategy, the management of Moutohorā is further classified under the Ecosystem Restoration category, the objective of which is to restore ecosystems to high levels of ecological integrity by assisting their recovery from multiple disturbances. The outcomes, objectives and policies specifically relating to the ecological restoration of Moutohorā are guided by Te Tāpui Tokotoru CMP, however, which are as follows (DOC 2008b):

**Outcomes:**

1. Moutohorā's natural, historical and cultural heritage is protected and enhanced

**Objectives:**

1. To protect and enhance the recovery of the island ecosystem, including fauna and habitats
2. To provide a haven for compatible threatened species that can be safely introduced to the island
3. To maintain Moutohorā's pest-free status
4. To increase scientific knowledge of the island's ecosystem

**Policies:**

1. Should allow natural processes to largely proceed without undue intervention
2. Will assess any introduction of indigenous flora and fauna for compatibility with the island's existing and previous flora and fauna communities
3. Will actively manage natural processes where they threaten the integrity of cultural and historical heritage
4. Will enhance and maintain biosecurity measures, and should maintain a presence on the island for compliance during the peak summer season
5. Will develop an appropriate research strategy and methodology

This ecological restoration plan has been produced by biodiversity staff from DOC's former East Coast Bay of Plenty Conservancy with agreement from Te Tapatoru ā Toi to implement the relevant policies of Te Tāpui Tokotoru CMP. DOC has also designed and is progressively implementing an outcome-based programme to prioritise, plan, manage, monitor and report on natural heritage activity. In the most current exercise to rank representative cost-effective ecosystems (September 2013), Moutohorā ranked 19th out of over 700 ecosystems that were assessed nationally. The ecosystem management prescription developed for Moutohorā through this exercise complements this restoration plan.

This restoration plan begins with a description of the island, and then provides background information, progress and proposed future activities for the key indigenous flora and fauna on the island, as well as the control of plant and avian pest species. A list of contingencies for the island in terms of fire and biosecurity are also included. The plan then ends with a table summarising the key tasks that need to be implemented to further progress the policies outlined above.

It should be noted that all restoration activity referred to within this document should be conducted in accordance with the Moutohorā historic heritage guidelines (DOC & Te Tapatoru ā Toi 2011). Furthermore, any ecological restoration activity should also take into consideration the historic and cultural assessment that is prepared in accordance with milestone 3 for Moutohorā Wildlife Management Reserve in Te Tāpui Tokotoru CMP (DOC 2008). External researchers wishing to undertake study on Moutohorā should refer to the Moutohorā research strategy (Christensen 2012), which outlines the permit application process.

# 2. Moutohorā (Whale Island) Wildlife Management Reserve

## 2.1 Geography

Moutohorā is a steep remnant volcano, located in the Bay of Plenty (Fig. 1). This 143-ha island is situated 9.55 km northwest of Whakatāne and 7.20 km from the mainland at its closest point. The nearest island to Moutohorā is Moutoki Island, which is part of Ngā Moutere o Rūrima (the Rūrima Islands) and is located 7.15 km to the west (DOC 2008b).


Figure 1. Map of Moutohorā (Whale Island) Wildlife Management Reserve.

Moutohorā, Whakaari/White Island, Te Paepae o Aotea (Volkner Rocks) and Ngā Moutere o Rūrima all fall within the White Island Ecological District—and this district, along with the neighbouring Ecological Districts of Rotorua, Ōtanewainuku, Tauranga and Motiti, form the Northern Volcanic Plateau Ecological region, grouped as such due to their closely related characteristics (McEwen 1987).

## 2.2 Climate

The MetService has an automatic weather station at Whakatāne Airport, which recorded a mean annual temperature of 14.8°C and 2792 hours of sunshine (the highest national sunshine hours) in 2013 (NIWA 2014). The climate on Moutohorā is likely to be 1–2°C warmer than this (DOC 1999).

The MetService also recorded 909 mm of rain at Whakatāne Airport in 2013 (NIWA 2014). A rainfall gauge was installed on Moutohorā in 2012 at the lower helicopter pad, which is checked by field staff during each visit. To date, this indicates that Moutohorā has an average of 14% less rainfall than the neighbouring mainland.

The prevailing winds are northwesterly, with northeasterly storms occasionally sweeping the island. Frosts are seldom recorded on Moutohorā (DOC 1999).

## 2.3 Geology and landscape

Moutohorā is located in the northern zone of the Taupō-White Island Marine Depression, an area of frequent volcanic activity (Ramsay & Hayward 1971). The island is a remnant volcanic cone that has been severely eroded over time, particularly on the northern sides, with contiguous bluffs found on the west through to the lower-lying eastern plateau. The island has two peaks: the higher central Motuharapaki (323 m) and western Raetihi Pā (Pā Hill, 189 m) (Fig. 1).

Large areas of sedimentary rock are present at Oneroa (formerly Boulder Bay or Camp Bay) and north of the eastern terraces behind Te Rātahi (formerly McEwan's Bay). Filled valleys containing windblown sand also occur behind Te Rātahi and at Oneroa, where this has resulted in the creation of a wetland area. No natural streams occur. Large boulder banks can be found at sea level at the western ends of both Oneroa and Te Rātahi bays, impounding wind-created dunes. The boulder banks comprise variable-sized rounded blocks and boulders of andesite material that originated from debris fans off the escarpments.

There are only three sandy bays on Moutohorā (Oneroa, Onepū (formerly Sulphur Bay) and Te Rātahi), all of which are located on the southern coast.

Geothermal activity occurs at five main sites, particularly in and above Onepū in an area known as Waiariki (Sulphur Valley). Numerous hot springs and vents are present in the toe of the slump field, with hot water springs visible at mean low tide (Moore 1990). Occasional vents are also visible on the southern slopes of the central cone below Motuharapaki, and in the sand and water at Te Rātahi during mean low tide.

## 2.4 Soils

The soils of Moutohorā are volcanic in origin, ranging from a thin layer of ash, through to pumice or tephra over weathered andesite that takes the form of fractured, variably-sloped outcrops or debris fans (Rijkse 1980). The soils vary greatly in depth, particularly along the lower slopes around Oneroa and Te Rātahi, with patchy layers of underlying sandy soils found elsewhere on the island.

Soil fertility is generally low, apart from the colluvial soils at Oneroa, which have relatively high phosphorus levels. The soils do contain some organic matter from humus accumulation, however, which is represented by variable duff layers over sand or ash, and further nutrient enrichment occurs through guano deposits from nesting seabirds. The soils also have good physical properties for plant growth, with the exception of those found on the northern seaward cliffs. Neither water nor wind cause severe erosion on the island due to a good level of ground cover.

## 2.5 Mammalian pest eradication

Rabbits (*Oryctolagus cuniculus*), goats (*Capra hircus*), sheep (*Ovis aries*), cats (*Felis catus*) and Norway rats (*Rattus norvegicus*) were all once present on Moutohorā and had severe impacts on the island. In its most degraded state, the island was described as being bare soil and rock due to habitat degradation, which was mainly the result of extensive browsing by goats and rabbits (Smale & Owen 1990).

Rabbits were first observed on the island in 1968, having been illegally released by fishermen to use as bait for the crayfishing industry. At their peak in 1973, rabbits numbered 375 individuals per hectare (Pedersen & Roche 1973). Several poison operations (aerial drops of 1080 carrot baits, 1080 paste and hand-broadcast brodifacoum) took place from 1973 until 1987, when this species was finally eradicated from the island.

Goats were released onto the island during the mid- to late-1800s as a source of food for shipwrecked sailors (Smale & Owen 1990) and were later killed for use as crayfish bait by local fishermen. Over 1000 goats were shot by hunters from the New Zealand Wildlife Service in 1964 and eradication was achieved in 1977 (Ogle 1990a).

Sheep also once grazed the island, having been taken there for a small-scale farming operation in 1915. However, these were removed in 1943.

Cats were once present in sufficiently large number for camping parties to shoot them during their stay, resulting in their eradication from the island.

Norway rats were noted as being present on the island between 1910 and 1920, possibly having arrived on barges bringing stock to the island. By 1956, they were reportedly present in large numbers (Imber 1971). This led to a rāhui on the harvest of kuia (grey-faced petrel, *Pterodroma macroptera gouldi*) chicks, as the population showed signs of decline in the early 1960s, almost certainly due to rat predation of chicks and eggs. There is no record of ship rats (*Rattus rattus*) or kiore (*Rattus exulans*) having been present on Moutohorā, although the latter did inhabit the neighbouring Ngā Moutere o Rūrima. From 1969, Norway rats were trapped and poisoned with warfarin on a small scale, as part of an investigation into the effect of rats on breeding petrels. Over the following years, various other poison baits were hand laid on the island, including EPIBLOC® (a chemisterilant) in 1977; Racumen in 1978; brodifacoum (as part of a Ministry of Agriculture and Fisheries field trial), 1080 and Talon® (the latter a trial for ICI New Zealand) in 1980; and brodifacoum in 1982. From 1985 to 1987, 1080-infused carrots, Talon® 20P or bromodialone baits were either hand laid or spread aerially, leading to the eventual eradication of rats from the island in 1986. This poison operation continued until 1987, when the island was declared pest free.

As at June 2014, no incursion of introduced mammalian pests has occurred on Moutohorā—and the eradication of these pest species has had many beneficial effects on the island ecosystem. For example, Imber et al. (2003) determined that 13 years following the eradication of mammalian pests, the kuia population had doubled in size. In addition, vegetation monitoring using photopoints has also documented significant changes in the density and diversity of vascular plants (Shaw et al. 2003), with the island being transformed from one that was dominated by grass swards to one that is now predominantly covered with regenerating pōhutukawa-māhoe-kānuka (*Metrosideros excelsa–Melicytus ramiflorus–Kunzea* spp.) forest.

# 3. Flora

## 3.1 Forest structure and revegetation

### Background

Moutohorā has been recognised as having a high restoration value due to its varied assemblage of ecosystems and habitats. When the island was purchased by the Crown in 1984, the vegetation was in a highly modified state, with most of the island covered in rank grass, and forest and shrub hardwood remnants in the gullies and on steeper sites (Regnier 1985). At this time, the native plant communities that were present on the island included areas of rarauhe (bracken, *Pteridium esculentum*), kānuka scrubland, scattered pōhutukawa, and coastal forest containing māhoe, ngaio (*Myoporum laetum*), kōtukutuku (tree fuchsia, *Fuchsia excorticata*), whau (*Entelea arborescens*), tutu (*Coriaria arborea*) and mānuka (*Leptospermum scoparium*). A number of other species were also present in low numbers, including patē (seven-finger, *Schefflera digitata*), tī kōuka (cabbage tree, *Cordyline australis*), harakeke (flax, *Phormium tenax*), houpara (coastal five-finger, *Pseudopanax lessonii*), kohekohe (*Dysoxylum spectabile*), karaka (*Corynocarpus laevigatus*), kawakawa (*Piper excelsum* subsp. *excelsum*), mangeao (*Litsea calicaris*) and karo (*Pittosporum crassifolium*) (McGlynn 1990).

Based on the composition of remnant stands on the island and the vegetation of adjacent mainland areas, it is likely that pōhutukawa forest was once the dominant vegetation, with a component of mangeao (Parris 1971) and Podocarpaceae (Rijkse 1980). Coastal vegetation on the adjacent mainland also provides some indication of the species that were once present—for example, Kohi Point Reserve has a pōhutukawa-mangeao canopy with pūriri (*Vitex lucens*), mamaku (*Cyathea medullaris*), kohekohe, and an understorey of hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*), kawakawa and nīkau (*Rhopalostylis sapida*) (Beadel & Shaw 1988). It has been suggested that pollen analysis would be a viable approach to better determine historical vegetation patterns on Moutohorā (Wilmshurst 1998), as this can help to ascertain past species, at least to family level.

A planting programme was started in 1984 by the New Zealand Wildlife Service and completed in 1989 by DOC, with assistance from the Whakatāne Branch of Forest & Bird and other volunteers (McGlynn 1990). This programme aimed to:

- Accelerate rates of natural succession by re-introducing previously lost species
- Enlarge the population size of existing species
- Create buffer zones of fire-resistant vegetation (e.g. harakeke) to minimise the risk of fire
- Expand the food resources and habitats for indigenous animals

The planting programme aimed to select key areas for replanting and to establish viable seed sources for the rest of the island. Seed and cutting material was collected within a 25-km radius of the island, with a preference for sourcing plants from the island itself and, where possible, growing plants from seed (McGlynn 1990). Species such as harakeke, *Coprosma* spp. and ngaio were also used to create protective 'fire tolerant' plantings in certain vulnerable areas, which included landing sites traditionally used by the public and open sites with grassland (McGlynn 1990). These fire tolerant plantings no longer dominate these areas, however.

The planting programme resulted in over 11 000 plants representing 45 species being established on Moutohorā (Appendix 1). Most of these were broadleaved shrubs or small trees, but the plantings also included large broadleaved trees, climbers, harakeke and dune plants. At Oneroa, a considerable area of low kānuka was interplanted with canopy species including karaka, kohekohe and pūriri, and sub-canopy karo and houpara (McGlynn 1990).

Since the elimination of browsing animals and rodents from the island (see section 2.5), and the implementation of this planting programme (McGlynn 1990), the vegetation on Moutohorā has changed dramatically, with a flora of greater diversity, vigorous growth, regeneration and the recruitment of seedlings. The vegetation on the island is most accurately mapped by Chakraborty (unpubl. data 2007) and adapted by B. Christensen (see Appendix 2).

Moutohorā is presently covered by a mosaic of pōhutukawa forest, māhoe forest, kānuka scrubland, rarauhe and pasture grasses, comprising 190 indigenous and 110 exotic plant species (Ogle 1990a; Appendix 1). There is natural regeneration of canopy species such as pōhutukawa, māhoe and kānuka, and understorey vegetation shrubs such as karamu (*Coprosma* spp.), koromiko (*Hebe elliptica*), hangehange and taupata (*Coprosma repens*) are also present. Fern species in the understorey include rasp fern (*Blechnum parrisiae*), mākaka (common maiden hair, *Adiantum cunninghamii)* and huruhuru whenua (shining spleenwort, *Asplenium oblongifolium*).

New grasslands are also now covering areas that were previously bare, and existing grasslands are being replaced by kānuka, rarauhe and club sedges. For example, the most ecologically important stands of a recently recognised new species of kānuka (de Lange 2014) are located on the sand dunes at Oneroa, where they occupy an area of c. 3 ha (Smale & Owen 1990); kōwhangatara (spinifex, *Spinifex sericeus*) is predominantly found on the ridges of the sand dunes in Oneroa Bay, along with small remnant areas of pīngao (*Ficinia spiralis*); and areas of ongaonga (stinging nettle, *Urtica ferox*) occur near Motuharapaki and extending down the sides.

The small wetland area that is impounded behind the sand dunes at Oneroa comprises a variety of species, with the most abundant being *Cyperus* spp. Sea rush (*Juncus kraussii* var. *australiensis*) also occurs in clumps, indicating the saline nature of this wetland. Scattered wīwī rushes (knobby clubrush, *Ficinia nodosa*; sea rush) and kānuka contribute to a dense cover interspersed with open areas of water and mud.

### Progress to date

Unfortunately, no formal monitoring of the planting programme was undertaken. However, general observations suggest that the programme has been very successful given the dense shrub and tree layer that is now evident across the entire island, as confirmed by the network of permanent photopoints that was established in 1990 to monitor regeneration of native vegetation on the island. The most obvious changes to the vegetation on the island have been the reduction in areas of grassland and the increase in kānuka and pōhutukawa (Shaw et al. 2003). In 1991, two 20 × 20 m plots were set up, one located in Oneroa and the other in Te Rātahi (Appendix 3), and in 2003, the Oneroa plot was remeasured and standardised to fit the standard permanent plot method (Hurst & Allen 2007). Additionally, 14 grassland plots were established in 1991, however these have not been re-measured since their establishment.

Three pōhutukawa plots were also established on Moutohorā as part of a wider study of pōhutukawa forest structure, composition and dynamics in the Bay of Plenty. This study noted that Moutohorā was only one of two sites sampled in which successful pōhutukawa regeneration was occurring (Bylsma 2012).

### Discussion

Following completion of the revegetation planting programme in 1989, no further planting was carried out, as all four objectives had been achieved. Further revegetation will not be necessary in the future, as a range of plant species have successfully been established on the island, the majority of which is now covered by native vegetation.

Recent revision of the taxonomy of kānuka has revealed the existence of an endemic species to Moutohorā (*K. salterae*), which differs from *K. robusta* as it favours frequent disturbance and can be found in geothermally active areas of the island (de Lange 2014). The origin of this species is

currently unknown. This species has been classified as At Risk—Naturally Uncommon under the New Zealand Threat Classification System (de Lange et al. 2013), indicating that it may require further consideration for future management.

### Proposed future activities

- Determine whether any management actions are needed for *K. salterae*.

## 3.2 Threatened plant reintroductions

### Background

The value of Moutohorā as a haven for threatened species was first raised at the conclusion of the planting programme in 1989 (McGlynn 1990). In 1997, a strategy for threatened plant reintroduction to Moutohorā was prepared (Shaw 1997), which was followed by a transfer proposal (Gosling 1999). In August 1999, a 3-year programme for threatened plant reintroductions commenced that involved 13 species. However, at the beginning of this programme, not all species of threatened plants were available and further trialling of sites was required, resulting in the continuation of this programme for a further 6 years, which allowed more data to be gathered by monitoring the plantings across a range of sites (P. Cashmore, DOC, pers. comm.). The two key objectives for the programme, as described by Gosling (1999), were to:

1. Establish self-sustaining populations of some Bay of Plenty threatened plant species:
   - Mawhai (native cucumber, *Sicyos mawhai*)
   - Pīngao (*Ficinia spiralis*)
   - Scrub daphne (*Pimelea tomentosa*)
   - Parapara (*Pisonia brunoniana*)
   - Waiu-atua (shore spurge, *Euphorbia glauca*)
   - Autetaranga (sand daphne, *Pimelea villosa* ssp. *villosa*)
   - Hinarepe (sand tussock, *Poa billardierei*)
   - Matangoa (New Zealand cress, *Rorippa divaricata*)
   - Tawāpou (*Planchonella costata*)
   - Nau (Cook's scurvy grass, *Lepidium oleraceum*)
   - Coastal māhoe (*Melicytus novae-zelandiae*)
   - Holloway's crystalwort (*Atriplex hollowayi*)
   - New Zealand spinach (*Tetragonia tetragonoides*)
2. Restore those elements to the Moutohorā ecosystem that will give it a more diverse ecological character that is closer to that which likely occurred prior to vegetation clearance by humans and the liberation or escape of various introduced animals.

### Progress to date

The threatened plant reintroduction programme was carried out annually until 2010. Individual plants or groupings were demarcated with numbered stakes, allowing the presence/absence and height of previous plantings to be recorded during annual planting sessions. At its conclusion in 2010, all numbered stakes were removed.

### Discussion

The threatened plant species reintroductions had varying success. Only 11 of the 13 proposed species were actually reintroduced to the island—the reintroduction of Holloway's crystalwort did not occur due to an inability to source plants from Northland, and coastal māhoe, which was already established on the island, was not further supplemented due to a lack of nursery stock.

Of the 11 remaining species, only six (mawhai, pīngao, scrub daphne, parapara, tawāpou and waiu-atua) successfully established self-sustaining populations. One species that struggled

to establish a self-sustaining population was nau. This perennial herb requires high rates of recruitment to enable the plant to persist, and monitoring showed that individuals survived for 3 years and then perished—and although plants set seed, no recruitment was evident. The reintroduction of matangoa was also not successful.

In the early stages of the planting programme, a few threatened plant species were planted on archaeological sites. However, this was discontinued.

### Proposed future activities

- Reintroduce Holloway's crystalwort, William's broom (*Carmichaelia williamsii*) and thick-leaved tree daisy (*Olearia pachyphylla*), as outlined in the former CMP (DOC 1999).
- Publish the results of the 12 years of threatened plant reintroduction work.
- Determine why nau failed to establish on the island, despite the presence of suitable growing conditions.

# 4. Invertebrates

## Background

Invertebrate surveys on Moutohorā were undertaken as early as 1970, prior to the island becoming free of mammalian pests. The most comprehensive survey of invertebrates was undertaken by Patrick (1996), whose species list has since been supplemented by additional surveys for spiders, land snails and most recently ants.

Collections of invertebrates taken from Moutohorā now reside at:

- Auckland War Memorial Museum, Auckland (Quilter 1971)
- Otago Museum, Dunedin (Patrick 1996; Fitzgerald 2006)
- University of Otago, Dunedin (Patrick 1996)
- University of Canterbury, Christchurch (Patrick 1996)
- Museum of New Zealand Te Papa Tongarewa (Ogle 1990b; Fitzgerald 2006)
- New Zealand Arthropod Collection, Landcare Research, Auckland (Kirk 2013)
- Private collections—B. Barratt & B. Patrick (Patrick 1996)

## Progress to date

The first documented records of insects on Moutohorā were made by Quilter (1971), following the Auckland University Field Club trip in 1970. During this trip, a comprehensive collection of insects was collected, from which 26 species from seven orders were identified.

In 1995, Patrick (1996) conducted a week-long survey of the island, during which 285 invertebrate species were identified. The main objectives of this survey included identifying invertebrate fauna prior to the proposed introduction of tuatara (*Sphenodon punctatus*) to Moutohorā; identifying species of regional or national significance; and identifying key invertebrate habitats. Various survey methods were used, including pitfall, malaise and light traps, hand-searching, sweeping, netting, beating larvae from their host, and searching under rocks and wood during the day. Of the 285 species found on Moutohorā, 264 were insect species. Four species noted by Quilter (1971) were not recorded during this survey.

Patrick's (1996) results also included 14 species of spiders; however, a more extensive collection had previously been made by David Court during the Auckland University Field Club trip in 1970 and the Offshore Island Research Group (ORIG) trip in 1985/86. Although not all of his findings were reported, Court recorded over 60 species of spiders in leaf litter samples from Moutohorā (Fitzgerald 2006), the majority of which are also found on other northern offshore islands. Significantly, a lone male katipō (*Latrodectus katipo*), an endangered endemic spider, was found during this trip following extensive searching—the only known record of this species on Moutohorā (Wright 1986; Fitzgerald 2006).

More recently, two additional spider surveys have been conducted by Fitzgerald (one in 1999 prior to the translocation of tīeke (North Island saddleback, *Philesturnus rufusater*) and a follow-up survey in 2005 post-translocation of tīeke) to ascertain whether any change in the spider fauna on Moutohorā could be attributed to the presence of tīeke on the island. A total of 53 species were recorded during these surveys (Fitzgerald 2006), of which nine had not been previously documented, bringing the total known species of spiders on Moutohorā to 96. However, it was difficult to conclude whether spider abundance had been affected by the well-established tīeke population on Moutohorā due to the considerable changes in vegetation over this time period which may also have affected spider populations.

Land snails have also been collected on Moutohorā: two specimens initially in 1984 by Ogle (1990b), followed by a survey during the ORIG trip in 1985/86. Collections taken from leaf litter

samples and off tree bark yielded a total of 15 species, of which 14 were indigenous. All but one of these species are typical of those existing in dry or well-drained habitats elsewhere (Ogle 1990b).

Wasps have not posed a significant problem on Moutohorā, although an invasive yellow flower wasp (*Radumeris tasmaniensis*) was discovered on the beach at Te Rātahi in 2011.

In 2013, during a routine biosecurity survey for invasive Argentine ants (*Linepithema humile*), six ant species were identified, including one endemic species (southern ant, M*onomorium antarcticum*) (Kirk 2013).

## Discussion

The invertebrates of Moutohorā are considered to be diverse. They comprise insect species that are commonly found throughout New Zealand, the majority of which are representative of northern New Zealand. This supports geological evidence that Moutohorā has become isolated from the mainland relatively recently. The discovery of a primitive and fairly immobile moth fauna also indicates a recent mainland connection (Patrick 1996), as does the fact that although three-quarters of the spider species identified on Moutohorā are considered endemic to New Zealand, there is an absence of island endemic species (Fitzgerald 2006).

The general abundance of insect life on Moutohorā is credited to the rapid regeneration of vegetation following the eradication of mammalian pests in 1986/87. As such, Patrick (1996) concluded that there would be no sizeable impact or conservation implications for the insect fauna on Moutohorā if tuatara were returned to the island.

It is possible that ongoing vegetation regeneration may result in further changes to the invertebrate fauna on Moutohorā, as shown by Fitzgerald's (2006) study on the effects of tīeke on spiders. Whilst spiders that inhabit forests may broaden their range across the island, those that inhabit grassland and open scrub are likely to become more localised or transient, cycling irregularly through colonisation and extinction events (Wright 1986; Fitzgerald 2006).

Although the 2013 biosecurity survey found that Moutohorā was clear of Argentine ants, pest invertebrates would pose a very real threat if they did colonise the island, and so vigilant biosecurity measures should continue to remain a priority.

## Proposed future activities

- Review the lists of invertebrate species recorded on Moutohorā during past surveys and compile into one updated list, ensuring that current taxonomic classifications are used.
- Encourage further surveys by researchers and students to create a current record of invertebrate species present on Moutohorā, as well as more extensive studies into currently known species. This will help with the detection of any changes to species presence and composition that may result from continued forest regeneration.
- Ensure that DOC staff, visitors and concessionaires are made aware of the risks posed by invertebrate pests to the island and adhere to the strict biosecurity measures in place to avoid introduction of these pests when on Moutohorā (see section 11.2—Biosecurity).

# 5. Reptiles

## 5.1 Tuatara

### Background

Tuatara (*Sphenodon punctatus*) were reported to have occurred on Moutohorā until the early 1900s, when they succumbed to extinction as a result of habitat degradation and predation by Norway rats (K. Merito, Te Tapatoru ā Toi, pers. comm.). A plan to reintroduce tuatara to Moutohorā was developed in the mid-1990s, not only to return them to their former home range and restore a significant missing component of the Moutohorā ecosystem, but also to act as a safeguard for the neighbouring Ngā Moutere o Rūrima population, which is vulnerable to rodent incursion, poaching and fire (Owen & Newman 1996). This reintroduction was in alignment with Objective 12 of the Tuatara Recovery Plan, which included the establishment of translocation survivorship techniques (Cree & Butler 1993), and the translocation had the full support of Ngāti Awa.

In October 1996, 32 tuatara (12 males, 20 females) were transferred from Moutoki Island (a 0.9-ha island c. 8 km northwest of Moutohorā, within Ngā Moutere o Rūrima) and released at four sites: Oneroa, Hut Valley, Onepū and Te Rātahi (5 females, 3 males per site). Two of these sites were situated in mid-successional kānuka-māhoe forest, while two were in early successional kānuka forest—and within each habitat type, one site had a low density of kuia burrows while the other had a high density. Twenty tuatara were placed into artificial burrows constructed from a plastic bucket and novacoil, while the remaining 12 were released into petrel burrows or placed on open ground. A pre-translocation survey of invertebrates by Patrick (1996) confirmed that there was sufficient food supply for tuatara and that the reintroduction was not likely to have an adverse impact on the invertebrate population.

Concern that the small number of tuatara transferred could lead to genetic inbreeding led to a decision to release more females than males. The risk of inbreeding was further reduced by translocating gravid females, whose mate had hopefully not been transferred to the island at the same time (K.L. Owen 1998). It was considered that the translocation would be deemed a success if 5 years following the translocation, 50% of tuatara had survived and at least five island-born juveniles were found, indicating that recruitment was occurring. This objective was later revised to 2–3 island-bred individuals by the newly formed Tuatara Recovery Group (TRG)[3].

### Progress to date

Post-translocation monitoring was undertaken by Graham Ussher, University of Auckland, as part of a PhD study to assess population responses to recent habitat disturbance and the success of establishing a new tuatara population under varied environmental conditions. This involved six 2-week-long surveys of 20 tuatara that had transmitters attached by a harness, which were carried out every 3 months between October 1996 and December 1997. Monitoring techniques included day and night searches, during which observers walked 5–10 m apart along a transect or grid network looking for sign of scats, tuatara burrows (commonly oval shaped and smaller than petrel burrows), burrow disturbance and sloughed skin. All captured tuatara were weighed, measured (snout-vent length, new and old tail) and temporarily marked with a xylene-free pen. The most suitable period for monitoring was considered to be between mid-summer and early autumn (December to March/early April), as kuia were not present at this time. This also coincides with the tuatara breeding period, during which males display and approach females in order to mate. The absence of petrel background activity and noise during this time meant

[3] These TRG guidelines were formulated in the early days of tuatara translocation, at which time the measurement of a successful translocation was yet to be determined conclusively (Ussher 2002a).

that tuatara could be heard more readily as they moved through the understorey, and any soil disturbance at burrow entrances could be attributed to reptile movement rather than petrel activity. Monitoring effort has been focussed on three of the four original release sites, as this was considered to be of greater benefit than undertaking a superficial survey across the entire island—however, this does mean that the Onepū population has not been monitored.

Nine months post-translocation, 88% of the tuatara population survived and only two of the 20 tuatara were still utilising artificial burrows. The majority of tuatara had remained close to their original release site and had gained weight, indicating that there was suitable food and habitat availability.

Further monitoring was carried out in November 2000 and November 2001 by University of Auckland students, during which 28 of the original founder population of 32 was observed. No juvenile tuatara were found during extensive day and night searches in the Te Rātahi and Hut Valley sites.

In February 2002, Ussher re-monitored the population, and observed eight of the original founders and three island-born juveniles. The collation of all recaptured tuatara weights indicated that the tuatara were in good body condition, with some weight loss over the summer period that was regained in the autumn. Dispersal was highly variable and included an observation of one tuatara at Motuharapaki. However, a core population of 3–6 founders remained at each of the four release sites. Although the initial TRG target (50% of founder population recaptured after 5 years with evidence of 2–3 wild-born juveniles) was not achieved on this occasion, combined observations from several monitoring trips would be more likely to provide evidence for this, rather than a one-off monitoring trip—and Ussher (2002a) believed that the Moutohorā population was likely to become self-sustaining in the long term.

Due to the scattered nature of the original four release sites, there was concern that the long-term self-sustainability of the tuatara might be compromised by reproductive isolation and the slow breeding rate of this species. Consequently, Ussher (2002a) suggested securing the population of at least one of the release sites through a second translocation of young tuatara from Moutoki. Te Rātahi was the best candidate for this translocation, as it had provided the most evidence of a breeding population (two wild young tuatara had been found there) and contained a large area of suitable habitat for tuatara dispersal. The Hut Valley and Oneroa areas would remain important sites for continued research into the reestablishment of tuatara and could also be used in the future as comparison sites with Te Rātahi, with a focus on population growth, dispersal and behaviour (Ussher 2002a).

In October 2008, 30 tuatara (16 females, 14 males) were translocated from Moutoki to Te Rātahi. Only juvenile tuatara ranging in body length from 140 mm to 170 mm were selected for this second translocation to Moutohorā, partly because a larger number of juveniles had been noted on Moutoki following the first translocation and partly to ensure that the adult breeding population remained intact (Ussher 2002a). All animals were inserted with a Passive Integrated Transponder (PIT) tag and placed into artificial burrows within a 10 × 10 m grid. One month following the translocation, three people searched for 3 hours and located five of the newly released tuatara, each of which had lost 5–10% of its body weight (S. King, DOC, unpubl. data 2009). Given the minimal search effort of this monitoring trip, it was not conclusively proven that the second translocation had been successful (where 30% of released individuals can be found). Monitoring of the population 5 years following the translocation has not yet occurred.

## Discussion

The TRG determined that Moutohorā could support a population of c. 8500 animals (100 tuatara per hectare) (Gaze 2001). More recent guidance on holding capacity suggests that the island could actually only support this density of tuatara over half its area (taking into account unsuitable habitat such as cliffs or dense seabird populations; N. Nelson, Victoria University of Wellington, pers. comm.). However, the current population estimate falls well within this.

To determine whether the 2008 translocation has successfully supplemented the earlier release, it is recommended that post-translocation monitoring occurs as soon as resources allow. Ussher (2002a) also recommended long-term monitoring of the founder population to determine resource limitation and inter-specific competition. The opportunity to undertake this research could be offered to a suitable tertiary institute such as Victoria University of Wellington, which specialises in reptile ecology and conservation. Sufficient temporal monitoring periods (potentially on a decadal basis) will be required to witness a self-sustaining population, to account for the long lifespan and slow reproductive rate of tuatara.

The harvest of kuia was resumed in 2012 under permit to Ngāti Awa. Disturbance to known tuatara territories should be limited, with harvesters being made aware of sensitive areas. In addition, harvesting tools should not include fish hooks or barbed wire to limit damage to tuatara, as tuatara have been found with missing eyes and limbs on Motunau, where harvesting has occurred (J. Heaphy, DOC, pers. comm.). With training, the monitoring of tuatara could be undertaken jointly with the kuia harvest.

### Proposed future activities

- Ensure that future monitoring encompasses the entire island, where access allows, as the tuatara are likely to be widely dispersed since their initial release.
- Carry out post-translocation monitoring of the 2008 population to determine the success of that second translocation. Particular emphasis should be placed on checking that the island founders are in good condition and finding any island-hatched young. If no young are evident, research should be undertaken to determine which factors are limiting the success of the new population.
- PIT tag all recaptured founder and island-hatched tuatara to deter wildlife smugglers and to trace the individuals back to the island in the event that they are illegally removed. This would also allow the founder population to be identified and contribute to the knowledge base of translocated populations.
- Reduce habitat disturbance around known tuatara territories.
- Undertake monitoring of the Moutoki population to ensure that the two translocations have not significantly impacted on the remaining population. This is essential if any further translocations to Moutohorā or elsewhere are planned in the future.
- Adopt new monitoring techniques for determining population trends, as directed by the Reptile Technical Specialist Group.
- If further translocations from Moutoki do occur, reduce their impact on this population by only transferring juveniles, only selecting every 2nd or 3rd animal found, only removing individuals from discrete areas and leaving at least 10–15 years between each transfer.
- Before considering any future translocations, conduct research into limiting factors for the tuatara population on Moutohorā, such as the possibility of a genetic bottleneck or a change in environmental conditions. Also, adhere to a long-term recovery goal that is in alignment with the Tuatara Recovery Plan (Gaze 2001) to ensure that genetic diversity is maintained by increasing population levels.

## 5.2 Lizards

### Background

Three lizard species are found on Moutohorā: common gecko (*Woodworthia maculata*), copper skink (*Oligosoma aeneum*) and a 'taxonomically indeterminate' species *Oligosoma* aff. *infrapunctatum* "crenulate" or the crenulate skink (Hitchmough et al. 2013). This latter species was formerly classified as the speckled skink (*Oligosoma infrapunctatum*) (Towns 1987). However, preliminary genetic work that is currently being undertaken indicates that *O.* aff. *infrapunctatum*

"crenulate" is likely to be a distinct species (R. Hitchmough, DOC, pers. comm.). Therefore, any former reference made to the speckled skink will hereby be changed to its current impending title of crenulate skink.

Whilst both the common gecko and copper skink are classified as Not Threatened, the crenulate skink species has been classified as At Risk—Relict (Hitchmough et al. 2013). Moutohorā is believed to be the stronghold of the crenulate skink, which is also found on Mokoia Island in Lake Rotorua/Te Rotorua nui ā Kahumatamomoe, at a scattering of central North Island mainland sites and at a couple of Westland mainland sites (R. Hitchmough, DOC, pers. comm.).

Collections of lizards taken from Moutohorā now reside at:

- Auckland War Memorial Museum, Auckland (Towns & Hayward 1973)
- Victoria University of Wellington, Wellington (Owen 1992)

### Progress to date

Lizard surveys have been carried out on Moutohorā since 1970, during visits by the Auckland University Field Club. In 1971, a density estimate of 645 lizards per hectare was calculated for Moutohorā using a 50 × 50 ft quadrat (Towns 1971). By 1992, a dramatic increase in lizard numbers had been noted following an intensive search for them, which was largely attributed to the removal of rats from the island (Owen 1992).

The earliest survey recorded a skink species (*Leiolopisma* sp.) as being the most abundant on Moutohorā, with the common gecko not believed to be very 'common' (Towns 1971). However, anecdotal evidence suggests that the distribution and density of common geckos has changed dramatically since then, with the population considered to be widespread and in great abundance on Moutohorā today. This was reflected in results from an Auckland University Field Club trip over 2000/01, during which only five skinks were caught in grassland habitat and none were caught in kānuka regenerating forest over a total of 125 trap nights, whereas a minimum density of 600 common geckos per hectare was measured in forested areas (Ussher 2002b). This difference can be attributed to a change in vegetation cover, which was considerably affected by goats and rabbits in the 1970s. Since then there has been considerable regeneration, providing greater cover and leading to less suitable habitat for skinks (Ussher 2002b). During the same trip, gecko utilisation of pōhutukawa flowers was also measured, yielding a density of 115 geckos/$m^3$ over 2.5 $m^3$ and 25 geckos/$m^3$ over 1.3 $m^3$. These gecko densities are markedly greater than those recorded or observed elsewhere (Ussher 2002b).

The habitat use of crenulate skinks was studied during the Offshore Island Research Group trip in 1985/86. Snout-vent length measurements of individuals collected in pitfall traps suggested that maturity is reached at 65–70 mm when they are approximately 2 years of age (Wright 1986).

In 1992, authority was granted to Dr C. Daugherty of Victoria University of Wellington to collect two crenulate skink specimens from Moutohorā for taxonomic review purposes of New Zealand lizards (Owen 1992). Current taxonomic work of this species is using genetic material gathered from these specimens. In 2002, a further three crenulate skinks were obtained from Moutohorā for the purpose of comparing evaporative water loss in endemic skinks. These three lizards were released back to the island once the study was completed (Nielson 2002).

Searches specifically targeting shore skinks (*Oligosoma smithi*) have also been conducted on Moutohorā, the presence of which is as yet unconfirmed on the island—although past records indicate that they may have once been present (Towns 1987; Owen 1992). No shore skinks were found following intensive searching for 620 minutes at six locations across the island (Owen 1992) or by setting eight pitfall traps for 24 hours along the driftwood line at Oneroa (Garrick 1992). More recently, a total of 10 person hours were spent searching the northern boulder beaches of Moutohorā; however, this was again unsuccessful. The absence of shore skinks despite the availability of suitable habitat is considered puzzling (Ussher 2002b), particularly as nearby Moutoki Island holds a generous population of this species and shore skinks have recently been confirmed present on Rurima Island (Baling 2014).

## Discussion

In 1987, a management plan for reptiles on Moutohorā was written by Towns (1987). Within this, it was stated that Moutohorā was considered to be a 'significant location for rare species of northern reptiles' due to the absence of rats (Towns 1987: 3). Since the publication of this document, tuatara have been successfully translocated to Moutohorā.

In 1992, it was recommended that a monitoring plan be established for lizards on Moutohorā (Owen 1992). Continued changes to the vegetation are expected to result in changes in population numbers, with the potential for new species that were previously present in low numbers to be discovered. Furthermore, whilst common geckos are abundant throughout most of the island, little is known about the current range and distribution of the two skink species on Moutohorā.

As indicated by Towns (1987), the pest-free status of Moutohorā makes it a potentially significant location and sanctuary for some of New Zealand's lizards. The reintroduction of new lizard species to Moutohorā would allow the lizard population to continue to contribute to ecosystem restoration through an increase in seed dispersal and pollination of native flora. Furthermore, the restoration of appropriate lizard species to the island will increase the security of rare species and enable certain lizard populations to be returned to their former ecological range (L. Adams, DOC, pers. comm.).

It has previously been considered that McGregor's skink (*Oligosoma macgregori*), Whitaker's skink (*Oligosoma whitakeri*) and Duvaucel's gecko (*Hoplodactylus duvaucellii*) would all be suitable for transfer, as the island falls within their ecological range (Towns 1987; K. Owen, DOC, pers. comm.). Moutohorā is also the southernmost range for the moko skink (*Oligosoma moco*) (McEwen 1987); however, the introduction of this species may be difficult due to competition pressures exhibited by the crenulate skink (R. Hitchmough, pers. comm.).

Based on recent advice from the Lizard Technical Advisory Group, a list of candidate species for transfer has been established (Table 1). The skink species selected are indicative of those that would suitably co-exist with the crenulate skink, which is viewed as a priority species on the island. Other species may also become likely candidates in the future.

Table 1. Candidate lizard species for translocation to Moutohorā (Whale Island) Wildlife Management Reserve.

| | SPECIES | SOURCE POPULATION |
|---|---|---|
| Skinks: | Shore skink (*Oligosoma smithi*) | Ngā Moutere o Rūrima |
| | Striped skink (*O. striatum*) | No source population at present |
| | Whirinaki skink (*O. "Whirinaki"* ) | No source population at present |
| Geckos: | Duvaucel's gecko (*Hoplodactylus duvaucellii*) | Alderman Islands |
| | Pacific gecko (*Dactylocnemis pacificus*) | Sites within Bay of Plenty |
| | Forest gecko (*Mokopirirakau granulatus*) | Sites within Bay of Plenty |
| | Auckland green gecko (*Naultinus elegans elegans*) | Sites within Bay of Plenty |

## Proposed future activities

- Install a pitfall trapping grid on Moutohorā to enable monitoring and the compilation of an inventory of lizard species on the island. This methodology allows the capture of terrestrial lizards, especially skinks, which are more difficult to monitor than the widely abundant common gecko on the island. Monitoring should occur every 4–5 years to detect any changes in the abundance and distribution of terrestrial lizards.
- Complement the use of pitfall traps for inventory and monitoring with the use of G-minnow traps, artificial cover objects, and active day and night searches, especially in areas where pitfall trapping is less feasible. Lizard indicator dogs and species identification from DNA sampling of droppings in the soil could also be applied.

- If lizard surveys uncover the presence of a new species on Moutohorā, conduct further monitoring to ascertain the abundance and distribution of this species.
- Investigate the transfer of appropriate lizard species to Moutohorā as listed in Table 1. Those species of greater priority should be considered first.
- Update the list for potential candidate lizard species for transfer to Moutohorā on a regular basis, following recommendations from the Lizard Technical Advisory Group.

# 6. Avifauna

The avifauna of Moutohorā comprises a mixture of shorebirds and seabirds on or around the shores of the island (section 6.1), as well as an assortment of passerines, forest birds and raptors. A comprehensive list of the bird species that were historically and are currently present, including those known to be breeding on Moutohorā, can be found in Appendix 5.

Three bird species have been introduced to Moutohorā since it became pest-free, the statuses of which are described in sections 6.2–6.4 below. Before any further introductions of avian species are made to the island, it is important to consider:

- Which species were historically present on Moutohorā
- Which species were historically present in the White Island Ecological District
- The suitability of the habitat available
- The species' suitability to co-exist with other species that are currently present
- National or Recovery Plan priorities

Careful consideration should also be given to the order in which species are introduced to the island.

## 6.1 Seabirds

### Background

A wide variety of seabirds are evident in the waters surrounding Moutohorā, including Campbell black-browed mollymawk (*Thalassarche impavida*), Salvin's mollymawk (*Thalassarche salvini*), New Zealand white-capped mollymawk (*Thalassarche cauta steadi*) northern giant petrel (pāngurunguru, *Macronectes halli*) and Cape petrel (*Daption capense*) which visit in winter months. Prion species (*Phachyptila* spp.), flesh-footed shearwater (toanui, *Puffinus carneipes*) and Buller's shearwater (*Puffinus bulleri*) are common offshore in the summer, whilst fluttering shearwater (pakahā, *Puffinus gavia*), northern diving petrel (*Pelecanoides urinatrix urinatrix*) and Australasian gannet (tākapu, *Morus serrator*) are common throughout the year (Croxall & Millener 1971; G. Taylor, DOC, pers. comm.). Sooty shearwater (tītī, *Puffinus griseus*), short-tailed shearwater (*Puffinus tenuirostris*), Caspian tern (taranui, *Hydroprogne caspia*) and Arctic skua (*Stercorarius parasiticus*) also visit this area in smaller numbers.

As a result of the early introduction of feral cats and Norway rats to Moutohorā, the only seabirds that are breeding on the island today are kuia (grey-faced petrel, *Pterodroma macroptera gouldi*), little blue penguin (kororā, *Eudyptula minor*) and white-fronted tern (tara, *Sterna striata*) (Smale & Owen 1990). In addition, a population of 500 pairs of sooty shearwaters was referred to by Owen & Newman (1996) and Imber (1969), whilst Butts & Potter (1993) documented a breeding population; however, the location of the breeding colony is not specified and there is no recent evidence to suggest that this species returns to Moutohorā to breed annually (C. Jones, Landcare Research, pers. comm.).

A large-scale banding programme for kuia was undertaken from 1969 to 1971 by the New Zealand Wildlife Service (resulting in 9726 chicks and 719 adults being banded). At the start of this programme, the breeding population of kuia was estimated at 40 000 pairs (Imber 1969); however, predation of eggs and chicks by Norway rats led to a 10–35% decline in breeding success between 1969 and 1971 (Imber et al. 2000). Ngāti Awa had similarly observed a decline in petrel numbers in the late 1950s, and for this reason placed a rāhui on the harvesting of chicks in 1962. By 1998–2000, the estimated number of breeding pairs had increased to 95 000 pairs (Imber et al. 2003), representing a doubling of the population since the eradication of mammalian pests was declared in 1987.

### Progress to date

The poisoning of rats and rabbits on Moutohorā between 1977 and 1985 led to their complete eradication in 1986, which, in turn, resulted in an improvement in the breeding success of kuia between 1985–88 and 1990–94 (no research was undertaken in the years in between) (Imber et al. 2000; Imber et al. 2003). In 2006, Te Rūnanga o Ngāti Awa collaborated with Landcare Research to undertake a 6-year study to estimate the breeding population size, breeding success and adult survivorship of kuia on Moutohorā. Using kuia mark-recapture data from Mauao (Mt Maunganui) and Motuotau Island (Rabbit Island), adult survival was estimated to be 0.89 after accounting for transience effects (Jones et al. 2011). It was also found that around 50% of fledglings that returned to their natal colony did so by 4 years of age and that by age 6 the probability of a fledgling returning was approximately 1.0. Based on surveys of 1194 burrows on Moutohorā, a breeding occupancy rate of 0.523 (95% credible interval 0.126–0.869) was estimated on the island. Kuia burrow densities were found to increase with altitude, but were lower in gullies and on terraces. Based on predicted breeding pair densities, a population estimate of 69 330 (95% credible interval 10 590–128 300) breeding pairs was calculated for the island (Whitehead et al. 2014). In this study, burrow densities were estimated using habitat characteristics, providing greater precision and accuracy to the estimates than earlier approaches that simply extrapolated limited sampling data over larger areas.

One goal of this research was to determine the effect that the resumption of customary harvest of kuia might have on the population's growth rates. Based on the study's findings, it was recommended that harvesting could resume if a conservative fixed quota was established, or alternatively a proportion of the population was harvested (Jones et al. 2015). The latter would require breeding population size estimates to be made every 2–3 years using an index such as burrow entrance counts to determine what proportion of the population could be safely harvested to ensure that a self-sustaining population remained. In 2012, the harvest rāhui was lifted and 130 kuia chicks were harvested by Te Rūnanga o Ngāti Awa under the guidance of an appointed Manu Kuia Kaitiaki o Ngāti Awa. Under permit, 200 kuia chicks may be harvested between the second Saturday in November to 7 December between 08:00 and 16:00 h until 2015, when the permit will be reassessed.

Between 2008 and 2012, 276 kuia chicks were translocated from Moutohorā to Cape Sanctuary at Cape Kidnappers, Hawke's Bay. Fledglings were selected from two main catching areas at Hut Valley and just east of Onepū, well away from previous Landcare Research study sites. Of 75 fledglings translocated in 2012, 85% fledged successfully. A further 125 juveniles were planned to be collected for translocation to Cape Sanctuary in 2013/14. By 2014, the first of the translocated chicks should have started returning as adults to Cape Kidnappers to breed for the first time.

A study to determine whether kuia are attracted to auditory social cues has been conducted on the island (Buxton et al. 2015). Kuia were found to be attracted to conspecific vocalisation playbacks of their own calls and also those of flesh-footed and fluttering shearwaters. Response to call-playback increased with increasing densities of nearby breeding conspecifics, suggesting there may be a relationship between attraction and the size of nearby potential source populations. This suggests that, for some procellaniid species, call-playback represents a cost-effective alternative to other active restoration approaches, such as translocation.

Samples collected from Moutohorā have also been used to examine kuia population genetic structure at 13 colonies across their New Zealand breeding range (Lawrence et al. 2014). The research found no genetically distinct populations and concluded that conservation and restoration efforts can occur freely across the full range of the petrel.

### Discussion

The guano of nesting seabirds supplies essential minerals and nutrients to the soil, enriching the habitat for ground-dwelling invertebrates, and thus providing the primary food source for tuatara, skinks, geckos and ground-feeding birds such as tīeke. Kuia are the only large seabird species known to currently breed on Moutohorā. They are present at two separate times of the year: in April/May (when they prepare burrows and mate) and then from late June (when incubation commences) to December/January (when chicks fledge). Soil condition, nutrient levels and habitat diversity could be improved further on Moutohorā by establishing smaller species of burrowing seabirds, which may lead to further increases in the abundance of invertebrates and lizards. The abundance of these taxa has been shown to be greater on islands containing dense and diverse nesting seabird populations (Markwell & Daugherty 2002; G. Taylor, DOC, pers. comm).

Seabirds such as Australasian gannets, common diving petrels and kuia have been successfully translocated to various locations in New Zealand (including Young Nicks Head and Cape Kidnappers, Hawke's Bay) using various methods, including chick translocation, acoustic attraction and decoys. Species that nest on nearby islands in the eastern Bay of Plenty and which could be considered for reintroduction to Moutohorā include common diving petrels, fluttering shearwaters and white-faced storm petrels—although potential inter-specific disturbance or competition of introduced species with kuia should be considered before any such reintroductions are made. Flesh-footed and sooty shearwaters would not be suitable candidates, as the chicks of these species are often killed by returning kuia when large colonies are present. Acoustic attraction should be attempted initially, following which chick translocation could be considered if this is unsuccessful. The use of these two techniques simultaneously was recommended by Miskelly & Taylor (2004) and Miskelly et al. (2009). The translocation of chicks requires significant resources, as chicks need to be fed 1–2 times daily for up to a month and monitored until they fledge, and then burrows need to be checked for a number of years until they return to the site to breed. Decoys are suitable for ground-nesting birds such as gannets, gulls and terns, but have the potential to impact on petrel colonies (G. Taylor, DOC, pers. comm.)—plus these species would not be suitable for reintroduction on Moutohorā due to a lack of suitable habitat, i.e. large open turf or grass areas.

### Proposed future activities

- Determine whether seabird species other than kuia are currently breeding on Moutohorā by installing acoustic monitoring equipment at potential breeding sites across the island during Oct–Nov and Jan–Feb. Species that may be prospecting at Moutohorā include fluttering, flesh-footed, little and sooty shearwaters, black-winged petrels (*Pterodroma nigripennis*), northern diving and white-faced storm petrels.
- Estimate the population size of any new species that is found to be breeding on the island.
- Consider the use of the acoustic anchoring technique to attract desirable seabird species to the island to establish new breeding colonies. Potential candidates include fluttering shearwaters, northern diving petrels and white-faced storm petrels, all of which breed on nearby Motunau (Plate Island). If resources allow, chick translocation could occur simultaneously with acoustic attraction.
- Develop an annual monitoring programme with Landcare Research and Ngāti Awa to detect changes in breeding grey-faced petrel abundance on Moutohorā. It is recommended that under the most monitoring conditions, at least 45 randomly assigned 5-m-radius plots surveyed annually during the incubation period for at least 20 years will be required to detect the smallest (1%) annual change in breeding bird abundance (Buxton et al. in press).

- Review the kuia harvest permit in 2015. Continue research into the population size and recruitment of this species to ensure that the kuia population has not been adversely affected by an annual harvest and is not in decline due to a catastrophic event, such as disease or a reduction in food availability.
- Conduct further research into the impacts on population size and recruitment in kuia. This could include investigating links with climate change, commercial fishing, recreational fishing or land-based nutrient run-off.

## 6.2 Kiwi

### Background

A population of North Island brown kiwi (*Apteryx mantelli*) was established on Moutohorā to provide a 'back up' population in case a catastrophic event (e.g. dog incursion, fire, disease) should threaten the survival of kiwi within the mainland core area of Ohope Scenic Reserve and the immediate surrounding areas (Whakatāne Kiwi Trust 2007).

A total of 25 young kiwi have been released on Moutohorā since 2001, all of which originated from eggs sourced within the Whakatane area and raised at Kiwi Encounter, Rotorua, under the Operation Nest Egg (ONE) programme. In addition, a rehabilitated kiwi was released on the island in 2008, after being found injured in Te Urewera National Park. This was the last kiwi to be transferred to the island.

The Whakatāne Kiwi Management Plan (2005–15) (Whakatāne Kiwi Trust 2007), which was produced by DOC and the Bay of Plenty Regional Council, guides the management of kiwi on Moutohorā. A performance measure of this plan was to have ten successfully breeding pairs established on the island by 2010. Moutohorā is believed to have an estimated carrying capacity of 12 pairs of kiwi (Llewellyn 2010). However, such low numbers are unlikely to lead to a viable, self-sustaining population of kiwi establishing on the island. A former goal of the plan (see later in this section) was that once the target breeding population size or carrying capacity was reached, sub-adults would be harvested and moved to mainland sites throughout the Bay of Plenty each year to supplement recovering populations; and from time to time, sub-adults from other Bay of Plenty sites, such as the Waiotahe, Omataroa and the Whirinaki Valleys, would also be swapped for Whakatane kiwi and introduced to Moutohorā (and the mainland core area) to maintain genetic vigour (Whakatāne Kiwi Trust 2007).

Transmitters were attached to the kiwi released onto Moutohorā to allow initial monitoring to confirm that they were successfully breeding and surviving. Once confirmed, all transmitters were to be removed from monitored birds and annual call count surveys were to be undertaken to detect trends in the Moutohorā kiwi population. Monitoring showed that ONE birds released on Moutohorā had low mortality which, together with a good food supply and habitat, meant that successful establishment on the island was likely. Therefore, the majority of birds released since 2007 have had their transmitters removed.

### Progress to date

Since release, five monitored males are known to have died from unknown causes. Following the loss of one male and the loss of transmitters from two birds, only one breeding male was monitored during the 2009/10 season. However, a further four birds were located using kiwi dogs in 2012 to increase monitoring activity.

Monitoring results since 2005 have shown that breeding has been largely unsuccessful on Moutohorā, despite monitored birds being found to be in good condition. Aside from two chicks that are known to have hatched and a sub-adult that was caught during the 2013 survey, there has been a confirmed total of 21 failed nesting attempts. Twelve of these nests were abandoned and only rotten eggs were found in the remaining nine nests when they were visited 90 days after the commencement of egg incubation.

Three call count surveys have been undertaken in April 2011, June 2012 and May 2013, during which 11, 9 and 11 individual kiwi, respectively, were heard. However, not all parts of the island were surveyed due to inaccessibility and listening may have been compromised by noise disturbance from kuia returning to their burrows. For this reason, the call counts have occurred over a range of months to establish the best time to undertake kiwi listening surveys on Moutohorā.

### Discussion

The limited breeding success of kiwi on Moutohorā could be investigated in a master's-level study. To date, the following theories have been proposed for the high nesting failure rate:

1. The environment is too dry to allow eggs to develop through to hatching
2. Burrow temperatures could be too high as a result of geothermal heat in some areas affecting egg production and incubation
3. Burrow disturbance or competition from kuia, whose numbers are estimated at 69 330 breeding pairs (Whitehead et al. 2014), may be affecting incubating kiwi
4. Geological environmental factors such as soil mineral deficiency and geothermal properties may be affecting the nesting process
5. A combination of two or more of the above factors

To determine which stage in the breeding cycle was causing problems for kiwi on the island, the first clutch of eggs from a monitored male with a history of failed nesting attempts was removed from Moutohorā at day 41 of the incubation cycle in 2011. Both the eggs were incubated ex situ at Kiwi Encounter, and one chick was successfully hatched and later released into Ohope Scenic Reserve. This confirmed that at least one of the eggs was viable. The second clutch of eggs was to be used as an in situ control, but this failed when the nest was abandoned before it could be located. Consequently, neither the cause of abandonment nor the stage of incubation at which the nest was abandoned could be determined (B. Palmer, DOC, pers. comm.).

Due to the low breeding success of kiwi on Moutohorā, and the success of kiwi chick recruitment and survival in the mainland core area, the former goal of using Moutohorā as a 'back-up' population is no longer valid. Therefore, harvesting sub-adults to supplement the mainland population is unlikely to occur. Consequently, a review of the Whakatāne Kiwi Management Plan in 2010 recommended that active management of kiwi on Moutohorā ceases on the island, with logistical support instead being provided to researchers to conduct relevant studies on kiwi when the opportunities present themselves (Llewellyn 2010).

### Proposed future activities

- Engage with tertiary education providers to investigate the causes of kiwi nesting failure on Moutohorā.
- Continue call count surveys once every 5 years on Moutohorā to obtain population estimates and map bird territories. This information may be useful for any external researchers.
- Carry out call counts in late March/early April when fewer kuia are present on the island, to prevent excessive noise disturbance from kuia from impacting on kiwi listening surveys.

## 6.3 Tīeke

### Background

In March 1999, 40 tīeke (North Island saddleback, *Philesturnus rufusater*) were translocated to Moutohorā from Repanga (Cuvier Island). Tīeke were considered a suitable candidate for reintroduction to Moutohorā due to their cultural significance to Ngāti Awa and their threat status at the time (Owen & Blick 2000). Historically, tīeke are thought to have been present in the Whakatane District and therefore linked to Moutohorā when the island was connected to

the mainland. Ngāti Awa believes that when Mataatua waka travelled from Repanga south to Whakatane it was accompanied by two tīeke, who settled briefly on Moutohorā before returning north to Repanga. As such, Repanga was considered a culturally appropriate site to source the population from. Initial proposals to transfer tīeke were discussed in 1989 by Te Komiti Taiaio (the Environmental and Cultural Committee of Ngāti Awa), in consultation with Ngāti Hei, tangata whenua of Repanga. However, it was only in 1998 that the habitat on the island was considered suitable for the reintroduction of tīeke, following an increase in forest regeneration.

### Progress to date

Forty banded tīeke (20 males, 20 females) were released on the southern side of Raetihi near Te Puna Wai on Moutohorā in March 1999 (Owen & Blick 2000). Following this translocation, three monitoring trips were undertaken in March, July and November 1999 by researchers from the University of Auckland for the equivalent of 150 person hours total effort. This monitoring consisted of recording confirmed sightings of individuals and unconfirmed sightings of birds seen and/or heard in the area. Thirty-seven of the 40 birds were re-sighted at least once during this time, with eight established pairs recognised, of which seven were believed to have successfully bred (Brunton 2000).

In November 2005, Massey University PhD student Kevin Parker conducted strip transect surveys of tīeke on Moutohorā over a period of a week. This consisted of walking five different transects of varying length, and counting all birds seen and heard within 10 m either side of the line (Appendix 6). Each transect was repeated several times and the results were averaged to provide an estimate of the number of birds per hectare. From this, it was estimated that approximately 1000 birds were present on the island, although confidence intervals for this methodology were large due to the small number of transects (K. Parker, pers. comm.).

### Discussion

The work of Armstrong (2005) on Mokoia Island, Bay of Plenty, suggested that the breeding of tīeke on islands is density-dependent, i.e. reproduction and juvenile survival decrease as population density increases. The Moutohorā population is considered to be similar to many long-established, high-density populations, such as that of Mokoia Island. As such, a similar trend is predicted to be exhibited given the high density of tīeke observed in 2005 (K. Parker, pers. comm.).

The determination of population parameters over time would allow for greater understanding of the tīeke population and help to guide future management of these birds on Moutohorā. Whilst tīeke appear to be abundant on the island, regular monitoring of the population should be undertaken to provide reliable population statistics. To increase the confidence level of future population estimates, a larger number of transect lines should be used, and further accuracy could be obtained by carrying out distance sampling alongside the transects—although this would require greater effort as a minimum of 20 transects would be required (K. Parker, pers. comm.).

In 2013, a survey methodology was developed for tīeke on Moutohorā following the same protocols as Parker (2005). Twelve parallel transects, each of 400 m in length, were randomly created, with permanently marked start and end points to allow the population to be monitored over time (Appendix 7).

### Proposed future activities

- Estimate the abundance and density of tīeke on Moutohorā using line transect surveys.
- Identify population trends of tīeke over time on Moutohorā by repeating surveys every 3–5 years.
- Determine whether the tīeke population on Moutohorā has reached carrying capacity. This information may guide the future management of this species in New Zealand.

- If monitoring reveals a large population base, consider translocating tīeke from Moutohorā to other pest-free sites. An assessment of the genetic diversity of the population should first be undertaken, however, as there is evidence that second-order translocations or above can result in significant bottlenecking (R. Burns, DOC, pers.comm.).
- Carry out additional surveys and further investigations on the tīeke population on Moutohorā if any threats are detected (e.g. disease, predator incursion), or a sudden change in the population is suspected.

## 6.4 Kākāriki

### Background

In 1986, 35 captive-bred kākāriki (red-crowned parakeet, *Cyanoramphus novaezelandiae*) were introduced to Moutohorā (McHalick 1998; DOC 1999), which were sourced from private and Wildlife Service aviaries in Rotorua and Whakatane (A. Bassett, DOC, pers. comm.). This introduction was noted by Smale & Owen (1990) as occurring not as a result of a clear strategy, but due to the availability of these birds at the time. However, the captive stock of kākāriki in NewZealand was later documented to be red-crowned × yellow-crowned (*C. auriceps*) hybrids (Triggs & Daugherty 1988; Towns et al. 1990), raising concern about the level of hybridisation present in the parent stock transferred to Moutohorā.

### Progress to date

To determine the level of hybridisation, genetic analysis using protein (allozyme) electrophoresis analysis was conducted on 11 birds from the translocated population in 1989 (Triggs & Daugherty 1996). Following analysis, these birds were not returned to the island (A. Bassett & K. Owen, pers. comm.). Results showed that the captive population was more genetically representative of wild red-crowned kākāriki (average genetic distance of 0.005) than of wild yellow-crowned kākāriki (average genetic distance = 0.025). In comparison, the average genetic distance of wild red-crowned kākāriki to wild yellow-crowned kākāriki is 0.033 (Triggs & Daugherty 1989).

In light of these genetic findings, the decision was made to leave the establishing population of kākāriki on the island. The time, expense and public relations costs to remove the birds further contributed towards this decision (Smale & Owen 1990).

The population present on Moutohorā is known to be successfully breeding (DOC 1999).

### Discussion

It is recommended that no future translocations of kākāriki be made to Moutohorā and that the current population should not be used as a source population for translocation elsewhere due to the level of hybridisation in the founder population (Triggs & Daugherty 1996).

### Proposed future activities

- Do not conduct any further monitoring or management techniques for kākāriki on Moutohorā, as this hybridised population is deemed of little value to the management of natural populations of kākāriki throughout New Zealand.
- Continue to make general observations of the kākāriki population if this is considered of value, e.g. if an outbreak of Psittacine beak and feather disease occurs within the population.

# 7. Marine mammals

Marine mammals such as whales, dolphins and seals are known to frequent the waters around Moutohorā. The island lies on the migration route of many marine mammal species, so sightings of whales and dolphins are commonly recorded.

Few live marine mammal strandings have been documented on Moutohorā. Most beach-cast animals historically observed on the island were either beaked whale species or aihe (common dolphins, *Delphinus* spp.). In 2010, however, an 18-m-long Sei whale (*Balaenoptera borealis*) was cast up below the western bluffs of the island.

In the event of a marine mammal stranding, the Ōpōtiki-Whakatāne Area operational plan for marine mammal incidents (DOC 2014) should be followed to ensure that correct procedures are adhered to. Animals are generally left to decompose naturally, as burial is not feasible in most cases and nor is it warranted, as the carcass does not pose a health risk to the general public.

Other marine mammal species that have been recorded on or around Moutohorā include:

- Orca (maki, *Orcinus orca*)
- Blue whale (tohorā pounamu, *Balaenoptera musculus*)
- Southern right whale (tohorā/kewa, *Eubalaena australis*)
- Leopard seal (popoiangore, *Hydrurga leptonyx*)—a vagrant species with few recorded observations
- New Zealand sea lion (rāpoka, *Phocarctos hookeri*)—a vagrant species with few recorded observations
- New Zealand fur seal (kekeno, *Arctocephalus forsteri*)

Additional information about the New Zealand fur seal is provided below as this is the most common marine mammal found on and around Moutohorā.

## 7.1 New Zealand fur seal

### Background

New Zealand fur seals are present all year round on both Moutohorā and Ngā Moutere o Rūrima, but numbers peak in early summer when breeding commences and during winter when haul-out occurs.

Moutohorā and Rūrima are two of the very few sites where fur seals breed in the North Island (Cowling et al. 2014). Pupping and weaning occurs at Te Rātahi; however, a small breeding group of up to seven females is also present alongside dominant males in more discrete locations on the island (P. Livingstone, pers. obs.).

Moutohorā provides one of the few sanctuaries in the eastern Bay of Plenty for New Zealand fur seals to haul out and rest, with up to 140 mixed aged, non-breeding seals seen during periodic surveys (P. Livingstone, pers. obs.). Based on tags recovered from Moutohorā residents, the origin of some of these seals can be traced to Nelson and Kaikoura, indicating that Moutohorā seals have originated from a wider New Zealand population.

### Progress to date

It has only been in recent years that New Zealand fur seal pups have been observed on Moutohorā, with seven seen in 2013 (R. Cooper, DOC, pers. comm.). Since females tend to return to natal areas to breed (Boren 2005), it is predicted that there will be an increase in the breeding population on Moutohorā over time.

Between 2011 and 2012, a study monitoring the interactions between swimmers and seals was undertaken. This found that swimmers had minimal impacts on fur seal behaviour in the water. However, it also recommended that as the local seal population and/or marine tourism industry grows, monitoring should occur to ensure that seal avoidance behaviours do not increase (Cowling et al. 2014).

### Proposed future activities

- Continue seasonal counts of New Zealand fur seals during periodic field trips to Moutohorā by DOC staff. This will help to determine trends in migration, breeding and seasonal patterns for this population.
- Collect any available tags from deceased animals and return to DOC's Science and Policy Group, Wellington. This information will contribute towards knowledge of fur seal activity in New Zealand waters.
- Follow the guidelines provided in the Ōpōtiki-Whakatāne Area operational plan for marine mammal incidents (DOC 2014) by recording any unusual sightings of New Zealand fur seals /sea lions, fur seal entanglements or suspicious deaths.
- Minimise disturbance from both visitor and management interactions during pupping (December – January), as females are more prone to fleeing at this time, and around pupping and haul-out sites in general.
- Monitor the risk for potential disturbance from concessionaires adjacent to New Zealand fur seal breeding areas.
- Ensure that all conservation dogs used for kiwi monitoring and rodent contingency operations on Moutohorā have up-to-date vaccinations for canine parvovirus and distemper.
- Encourage and support research into New Zealand fur seals on Moutohorā by tertiary institutes and other interested parties.
- Provide education for all groups (iwi, researchers, annual school and conservation groups, and particularly concessionaires) to increase awareness of New Zealand fur seals.

# 8. Control of pest plants

## Background

Pest plants have the ability to change the structure and function of plant ecosystems, by outcompeting native species, changing soil nutrient levels and altering canopy composition. The majority of weed species present on Moutohorā have arrived via airborne capsules from plants on the adjacent mainland, seed pods that have washed ashore and seed deposited in the guano of birds, including feral pigeons. Human carriage has also been identified as one of the major pathways of weeds reaching islands (Atkinson 1997); however, effective quarantine procedures performed on all personnel and equipment before departure from the mainland have prevented many unwanted species from reaching and establishing on Moutohorā.

Little information on the management of pest plants on Moutohorā has been documented in previous reports of restoration work on the island. DOC's weed reporting system repository, BioWeb, contains the location of weeds that have been detected on the island in the last decade, as well as the density of weeds of serious concern and any control methods applied.

## Progress to date

Introduced plants generally have not been a problem on Moutohorā, with the exception of localised areas of pampas (*Cortaderia selloana*), tree lucerne (*Chamaecytisus palmensis*), ladder fern (*Nephrolepis cordifolia*) and buddleia (*Buddleja davidii*). Formosan lily (*Lilium formosanum*) is also widespread throughout Te Rātahi and Oneroa. However, several species could become a problem in the future if they are not kept in check by indigenous vegetation or managed. These include boxthorn (*Lycium ferocissimum*), common asparagus (*Asparagus officinalis*), bushy asparagus (*Asparagus aethiopicus*), gorse (*Ulex europaeus*), tree lupin (*Lupinus arboreus*), Japanese walnut (*Juglans ailantifolia*) and beggars' ticks (*Bidens frondosa*). Tree lucerne and lupin both fix nitrogen in the soil, which can have a detrimental effect on native species and alter natural ecological restoration trajectories when present in high levels.

In the previous decade, regular weed surveillance and control activity has occurred on the island, usually during a week between late February and early March. This control programme has focussed on the containment of Formosan lily at Te Rātahi and Oneroa, tree lucerne in a localised area at Te Rātahi, and tree lupin in the Oneroa area, and the control of ladder fern at Onepū, as well as the surveillance and control of other occasionally found weeds. Methods of control include knapsack foliar spraying, aerial spraying in areas that cannot be accessed by foot and hand weeding around threatened plant species. A variety of herbicides are applied according to current best practice at recommended label rates. The choice of herbicide is determined by the weed species being targeted and the habitat in which they occur.

The current objectives of this pest plant control programme are to:

- Contain those weed species that have a limited range and do not yet cover the entire island
- Reduce to zero density high-priority weed species that currently exists in low numbers, including bushy asparagus and Japanese walnut
- Eradicate any new populations of weed species not previously found on the island

Moth plant (*Araujia sericifera*) and tree privet (*Ligustrum lucidum*) have been successfully eradicated from the island. However, annual surveillance needs to continue to ensure that any newly emergent plants in areas where these species have historically occurred can be detected and destroyed.

There have been several years of debate to verify the correct identification of exotic tuber ladder fern (*N. cordifolia*), which has similar characteristics to the native ladder fern (*N. flexuosa*). DNA analysis by Peter de Lange (DOC, pers. comm.) has now confirmed that both species are likely

to be present in the Onepū area. This area is particularly fragile as the top vegetation layer is predominantly moss, which can easily become damaged by trampling in dry conditions.

### Discussion

Established weed control, surveillance and reporting programmes should continue following DOC standard operating procedures (SOPs), including the weed surveillance SOP (DOC 2008a), weed control reporting and reviewing SOP (DOC 2009a) and weed planner SOP (DOC 2009b), as well as DOC's strategic plan for managing invasive weeds (Owen 1998).

Increased visitor numbers has been associated with increased levels of pest plant invasion (Atkinson 1997). Therefore, as the number of tourists visiting the island increases in the future, a greater degree of weed control and subsequent surveillance may be required. It is also essential that concessionaire quarantine practices are frequently audited to ensure that required standards in their concession are being met.

Common starlings (*Sternus vulgaris*) are known to spread weed seeds, particularly where roosts are established. Therefore, the control of starlings on Moutohorā may need to be considered if their numbers increase substantially. The resident population of feral rock pigeons (*Columba livia*) is also a continued source of new weed seed introduction to the island, and so a programme to reduce or eradicate the current population should be implemented.

### Proposed future activities

- Undertake annual surveillance to determine whether any new unwanted pest plants have established on the island.
- Make any new species that are detected a high priority for control. The cost of removing invasive plants is reduced if early detection occurs and the species is controlled before it becomes fully established (Timmins & Braithwaite 2000). Searches should focus on recently disturbed areas such as slips (as adventive weeds generally favour disturbed sites) and public entry sites to the island.
- Consider reviewing quarantine practices if annual weed surveillance indicates an increase in new weed species.
- Review control methods to ensure that best practice methods continue to be applied.
- Consider the use of biocontrol for some species, provided the appropriate permit can be obtained.
- Investigate the control of starlings and feral rock pigeons (see section 9) on Moutohorā to reduce any potential spread of weeds from the mainland.

# 9. Control of avian pests

Avian pest species are capable of becoming established on Moutohorā. If their presence is detected, this should be investigated and immediate measures taken to prevent the establishment of breeding populations. Species of particular concern are:

- Eastern rosella (*Platycercus eximius*)
- Australian magpie (*Gymnorhina tibicen*)—a vagrant species with recent records
- Common myna (*Acridotheres tristis*)—a vagrant species with few recorded observations
- Common starling (*Sternus vulgaris*)—a vagrant species with few recorded observations

Both southern black-backed gulls (karoro, *Larus dominicanus*) and rock pigeons (*Columbia livia*) are avian pests that are already established and breeding on Moutohorā. The management of these species' is outlined in further detail below.

## 9.1 Southern black-backed gulls

### Background

Southern black-backed gulls are widely recognised as opportunistic scavengers and predators of any suitable wildlife or carrion. As such, they are one of two native bird species in New Zealand that are not afforded any protection under the Wildlife Act 1953.

The black-backed gull population in the eastern Bay of Plenty has benefited from the greater food availability at open landfill sites over many years. This, coupled with high breeding success on Moutohorā due to a lack of mammalian predators, has resulted in a large resident population on the island, which increases significantly over the breeding season. Currently, there are approximately 90–100 black-backed gulls, including juveniles, present around the island's shoreline (P. Livingstone, pers. obs.).

Historically, Moutohorā was a breeding site for banded dotterel (*Charadrius bicintus bicintus*) and northern New Zealand dotterel (tūturiwhatu, *Charadrius obscurus aquilonuis*). Three pairs and chicks of the New Zealand dotterel were first seen in the mid-1980s (Butts & Potter 1993), and fledged chicks were observed annually until 2009/10 at Oneroa. However, a decrease in breeding pairs was observed over time and only a single adult New Zealand dotterel has been observed on several occasions since.

The decline of these dotterel species has been largely attributed to the increased presence of black-backed gulls on Moutohorā, as they are known to predate on the eggs and chicks of shorebirds such as northern New Zealand dotterel, variable oystercatcher (tōrea tai, *Haematopus unicolor*), white-fronted tern and Caspian tern. They are also known to be predators of reptiles (K. Owen, pers. comm.).

Black-backed gull control is undertaken along the coastline of the eastern Bay of Plenty mainland to reduce numbers, specifically at breeding sites of threatened native shorebirds.

Management actions for controlling black-backed gulls include alphachlorose poisoning, shooting birds, destroying eggs, pricking eggs and pricking eggs with formalin—although the latter has been discarded as an option due to the inherent risks to human health from formaldehyde (formalin) use. The preferred method of control on Moutohorā is the pricking of eggs using a sharp, fine point. Pricking is a more sustainable option than destroying eggs, as birds often continue to incubate unviable eggs instead of re-clutching, and so this limits the work for field staff and reduces the breeding rate of the birds. The pricking of black-backed gull eggs now occurs simultaneously with rodent monitoring trips for greater efficiency.

### Progress to date

Management of southern black-backed gulls on Moutohorā commenced in 2011. Eggs were pricked from October to early February at 3–4 week intervals to include any additional clutches laid. All nests from Oneroa bluffs east to Te Rātahi were targeted during this time.

In 2011/12, 81 eggs and seven juveniles were euthanised on Moutohorā (J. Barsdell, DOC, unpubl. data 2011); over the 2012/13 season, approximately 230 eggs were pricked and 13 chicks euthanised from 108 nests found on Moutohorā, Rūrima and Moutoki; and during the 2013/14 season, a total of 100 eggs were pricked and one juvenile euthanised on Moutohorā alone. Reductions in juvenile black-backed gulls have been observed on Moutohorā (P. Livingstone, pers. obs.).

### Discussion

A decrease in the black-backed gull population on Moutohorā will likely lead to a reduction in the predation of lizards, tuatara, and the eggs and chicks of threatened shorebirds. However, the current practice of pricking black-backed gull eggs could be refined to increase the effectiveness of the control method, e.g. by adjusting the frequency of pricking between clutches.

Management could also include the control of adult and juvenile birds to reduce the population to a level that enables successful shorebird breeding. Such control has been conducted on mainland sites by shooting adults and juveniles during the breeding season (M. Sothieson, unpubl. data 2012).

### Proposed future activities

- Continue efforts to reduce the population of black-backed gulls and thereby reduce the risk of predation to ground-nesting shorebirds and reptiles
- Conduct black-backed gull population counts at the beginning and end of each operational year to measure the efficacy of any black-backed gull control administered
- Review the effectiveness of management every 3 years through comparison of annual shorebird census results

## 9.2 Rock pigeons

### Background

Rock pigeons have been present on Moutohorā for approximately 45 years. These birds are a hybrid of various Columbia species and display varying plumage patterns. The original flock of ten birds was transient, moving between the island and the mainland (R. Cooper, DOC, pers. comm.).

The original roosting population was observed at the bluffs west of Oneroa in the early 1980s (R. Cooper, DOC, pers. comm.). Bird surveys conducted by Massey University in 1985/86 found that a small breeding population had established on the northern bluffs (Butts & Potter 1993). Since then, the population has increased rapidly to approximately 300–350 birds that are now predominantly found on the rugged northern bluffs of Moutohorā.

Feral pigeons compete with native passerines and seabirds for nesting sites. They also compete for food with species such as red-crowned kākāriki, tūī (*Prosthemadera novaeseelandiae*) and korimako (bellbird, *Anthornis melanura*), which feed on seed and berries.

Since this pigeon population is semi-transient, there is the potential for new pest plants to be introduced to Moutohorā by birds travelling from mainland sites such as Matahina, Matata and urban areas of Whakatane. Pest plant species that are not currently established on the island but could be introduced include cotoneaster (*Cotoneaster* spp.), phoenix palm (*Phoenix canariensis*), woolly nightshade (*Solanum mauritianum*) and tree privet. There is also a risk of these pigeons transferring avian diseases from the mainland.

### Progress to date

The main roosting and nesting areas of feral pigeons on Moutohorā have been identified. One trial cull of adults from the island occurred in 2013 using 12-gauge shotguns, during which 23 birds were shot from bluffs on the northern side of Te Rātahi headland. A further 160 birds were destroyed in 2014 over three operations.

### Discussion

Management options for the control of feral pigeons include shooting and/or the application of an avicide such as alphachloralose gel or grain. However, the use of alphachloralose is considered unsuitable due to the risk it poses to protected species such as tīeke, tūī, korimako and red-crowned kākāriki through unintentional eating of the bait. No other toxins are currently available that are approved for use on Public Conservation Land.

Due to the transient nature of feral pigeons, total eradication is unlikely to be achieved. However, the population could be managed to low densities through sustained ground control using firearms (0.22 rimfire or 12-gauge shotguns) from safe vantage points on the island. To achieve very low density outcomes, an aerial component could also be considered to target inaccessible areas and it may be possible to shoot in towards the island from a boat to target cliff faces.

### Proposed future activities

- Reduce and maintain the feral pigeon population to low densities using skilled firearm operators
- Monitor the feral pigeon population annually and plan actions accordingly to achieve sustained control
- Review management gains every 2 years, commencing 2015/16
- Investigate other methods of pigeon control such as trapping or using nets
- Regularly review DOC's pesticides status list (DOC 2013b) for any new approved avicide methods

# 10. Contingencies

## 10.1 Fire

Fire poses a significant threat to the integrity and biodiversity values of island ecosystems. A combination of low rainfall and high temperatures puts Moutohorā at risk of fire for the majority of the year, but particularly during the summer months. Therefore, the priority here is to maintain a system of readiness and response.

**Open fires, smoking and camping are all prohibited activities on Moutohorā for fire prevention purposes.**

The last significant fire on the island was c. 1939, during which a large proportion of the southern slope was affected. In addition, Ogle (1990a) described two fires that took place in 1975 and 1978, originating from picnic fires at Onepū. The first of these was described as being extensive, burning the valleys and ridge between Onepū and Oneroa, and extending to the southern and eastern faces of Raetihi. Less detail is known about the extent of the latter fire, which is believed to have burnt the lower slopes at Onepū.

Given the high ecological value of the island ecosystem, and DOC's responsibilities under the Forest and Rural Fires Act 1977, a High Initial Threat (HIT) Plan known as the Moutohorā Fire Response Plan is in place to manage the fire response on the island (DOC 2012b). This plan is updated annually, and is linked to the joint fire response agreement between DOC and Whakatāne District Council and found within the Whakatāne District Council Rural Fire Plan.

Moutohorā is also equipped with a designated fire kit that includes a high-pressure pump and hose packs to suppress and contain small fires in the immediate area surrounding the hut, for the protection of this asset. This fire equipment should be maintained through current fire maintenance and running checks, as specified in DOC's national fire plan SOP (DOC 2013a). Vegetation clearance around existing infrastructure (the hut, radio towers and helicopter pads) should also be maintained to minimise fire risk by acting as a small fire break from likely sources of ignition.

Four tanks with the capacity to hold approximately 12 000 litres of water are available at the hut. A sprinkler system was also installed on Moutohorā in 2012, which consists of a self-collecting tank on the spur above the hut and a series of sprinklers. This provides the ability to dampen the hut and surrounding vegetation in the event of a vegetation or structural fire. The operational function of the sprinkler system is included in the monthly fire readiness schedule checks.

Fire training should be conducted once every 2 years to ensure a timely and effective response to fire in accordance with the Moutohorā Fire Response HIT Plan. This training should be conducted in conjunction with the Whakatāne District Council to ensure a fire ready, cohesive working relationship between the two agencies.

The closure of Moutohorā to all activities (management, concessionaires, cultural and educational) should be enforced if the fire risk is considered to be unacceptably high, as indicated by Fire Weather Code Indices. The threshold for this should be a Fire Weather Index >29 (Extreme), a Build up Index (BUI) code >60 (Extreme) or a grass curing value of 100%. When these indices reach these levels, there is greater potential for ignition, and difficulty in fire containment and mop-up, in which case closure of the island helps to minimise all risks. This occurred during the drought of 2012/13, when the island was closed from late February to late April until sufficient rain eased conditions for normal activity to resume.

Continued advocacy with public, iwi, research groups and concessionaires should be maintained to increase awareness about the risk of fire to the island, particularly during the peak fire season.

## 10.2 Biosecurity

The most significant threat to Moutohorā is the accidental or deliberate introduction of unwanted mammalian or invasive invertebrate pests onto the island. These could arrive via boats moored close to shore, unquarantined goods and vessels, deliberate release, or shipwreck. All concessionaires, visitors, researchers and staff are required to remain vigilant whilst in transit to and when on the island, and to report any suspected incursions as soon as possible to DOC. Rodent monitoring, which consists of monthly checks of tracking cards, gnaw sticks and bait stations, as well as annual surveillance by predator dogs, helps to ensure that these pests (if they arrive) are detected promptly.

Argentine ants pose a significant threat to the island, so similar measures to those for rodents should remain in place, including at least biennial monitoring at all main entry points to the island. Rainbow skinks (*Lampropholis delicata*) are also becoming more common in the Whakatāne area. A preferred habitat of both rainbow skinks and Argentine ants is potted plant material. Therefore, it is recommended that no potted plants are transported to the island to reduce the risk of transferring these highly invasive species. Consequently, as is frequently occurring on other islands, including the Hen and Chickens, all propagation of plants occurs on the island itself. If any plants do need to be transferred in the future, they will require strict quarantine checks, including full submergence of plant material and their containers in water for at least 48 hours before transfer to the island. Any seed material may only be introduced following rigorous testing of its provenance, to ensure that it is sourced from the appropriate Ecological District.

To reduce the risk of a pest animal incursion, a high standard of quarantine of all personnel and equipment is required prior to departure to the island. The fumigation of quarantine facilities for invertebrate pests should occur quarterly. Quarantine staff should be aware of any new local and national pest organisms, as directed by the Ministry for Primary Industries and Regional Councils. Bait stations and trap networks established in the quarantine facilities and surrounds, including on-board the DOC vessel Maataariki, should be checked on a monthly basis and prior to all trips. A series of bait stations that are maintained by volunteers from the Whakatāne Harbour Care Group are checked and rebaited monthly. Full details of the quarantine standards in place can be found in the quarantine and contingency plan for Moutohorā and the Rūrima group (DOC 2003). Concessionaire quarantine facilities and practices, including raising the awareness of travelling customers around the importance of biosecurity, should also be audited regularly. Special conditions within the concession are included in the biosecurity standards for concessionaires and boat operators ferrying passengers to and from Moutohorā (DOC 2012a).

The transfer of disease to wildlife on Moutohorā also poses a threat, but a high standard of quarantine should reduce this risk. Staff should remain vigilant and kept informed of any new and potential wildlife health outbreaks, however. If any such outbreak were to occur on Moutohorā, this would be managed under the guidance of DOC's Banding and Wildlife Health Office, Science and Capability Group, National Office.

Fire and poaching remain serious threats to wildlife on the island. The boundary definition of the island was changed in 2011, prohibiting any member of the public from landing above the mean low spring mark. Illegal landing penalties under the Reserves Act 1977 include fines of up to $500 and imprisonment of up to 1 month. However, despite large instructive notices at all boat departure points from the mainland (Thornton, Whakatāne Wharf, Matata, Ohiwa Harbour and boat ramps) and a radio awareness campaign during the summer months that coincides with concessionaire advertising, illegal entry onto the island continues to occur. The majority of the public found illegally on the island are local residents, and most incursions occur in the Onepū area, which is favoured for its 'hot water beach', and occasionally at Oneroa and Te Rātahi. Therefore, at peak holiday times, DOC staff should undertake surveillance trips to the island to deter would-be illegal landers and promote good biosecurity practices of vessels moored

near the island. Where an illegal landing has occurred, prompt follow-up action with assistance from regional compliance staff is vital. This is of particular importance when suspected wildlife poaching has occurred, in which case DOC's National Compliance Team and Reptile Technical Specialist Group should be contacted as a matter of urgency.

# 11. Summary of tasks

Table 2 provides a timeline for the key tasks outlined in this report.

Table 2. Timeline for the key tasks required on Moutohora Island and an indication of their priority (L = low; M = medium; H = high).

| SPECIES | METHOD | 2014/ 2015 | 2015/ 2016 | 2016/ 2017 | 2017/ 2018 | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 | 2021/ 2022 | 2022/ 2023 | 2023/ 2024 | REQUIRES FURTHER INVESTIGATION | PRIORITY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| General vegetation | | | | | | | | | | | | | |
| | Monitoring – photopoints | | | | | √ | | | | | √ | | M |
| | Monitoring – 20 × 20 m plots | | √ | | | | √ | | | √ | | | L |
| | Monitoring - pōhutukawa plots | | | | | | | | | | √ | | L |
| Threatened plants | | | | | | | | | | | | | |
| | Translocation of *Atriplex billardieri* | | | | | | | | | | | √ | L |
| | Translocation of *Carmichaelia williamsii* | | | √ | | | | | | | | | L |
| | Translocation of *Olearia pachyphylla* | | | | | √ | | | | | | | M |
| | Monitoring of *Olearia pachyphylla* | | √ | | √ | | √ | | | | | | H |
| | Reasons for recruitment failure of *Lepidium oleraceum* | | | | | | | | | | | √ | M |
| | Consider potential plant candidates for reintroduction | | | | | √ | | | | | √ | | L |
| Invertebrates | | | | | | | | | | | | | |
| | Review invertebrate species list | | | √ | | | | | | | | √ | L |
| Reptiles | | | | | | | | | | | | | |
| Tuatara | Monitoring – night and day search | √ | | | | | | | | | √ | | H |
| | PIT tag island born individuals and untagged founder adults | √ | | | | | | | | | √ | | H |
| | Assess the need for further reintroduction | | √ | | | | | | | | | | H |
| Lizards | Inventory and monitoring – pitfall traps | | √ | | | | | √ | | | | | H |
| | Inventory and monitoring – active searches | | √ | | | | | √ | | | | | H |
| | Reintroduce Duvaucel's gecko | | √ | | | | | | | | | | H |
| | Reintroduce shore skink | | | | | | | | | | | √ | M |
| Avifauna | | | | | | | | | | | | | |
| General | Review bird species list | | | | | | | | | | | √ | L |
| Seabirds | Inventory – acoustic monitoring of breeding seabird populations | √ | | | √ | | | √ | | | √ | | H |
| | Population study of new found breeding species | | | | | | | | | | | √ | L |
| | Vocal anchoring of white-faced storm petrel, fluttering and common diving petrel if not already breeding on the island | | | √ | | | | | | | | | H |
| | Reasons into nest failure | | | | | | | | | | | √ | H |

*Continued on next page*

*Table 2 continued*

| SPECIES | METHOD | 2014/ 2015 | 2015/ 2016 | 2016/ 2017 | 2017/ 2018 | 2018/ 2019 | 2019/ 2020 | 2020/ 2021 | 2021/ 2022 | 2022/ 2023 | 2023/ 2024 | REQUIRES FURTHER INVESTIGATION | PRIORITY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Translocation of common diving petrel | | | | | √ | | | | | | | H |
| | Translocation of fluttering shearwater | | | | | √ | | | | | | | H |
| Kiwi | Call count survey | | | √ | | | | | √ | | | | L |
| | Reasons into nest failure | | | | | | | | | | | √ | H |
| Tieke | Monitoring – line transect | √ | | | √ | | | √ | | | √ | | H |
| | Determine population statistics and status of the population | | √ | | | | | | | | | √ | M |
| Marine | | | | | | | | | | | | | |
| | Dive surveys | | | | | | | | | | | √ | |
| | Seal population monitoring | | | | | | | | | | | √ | L |
| Pest plants | | | | | | | | | | | | | |
| | Surveillance | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | H |
| | Weed control | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | H |
| Pest animals | | | | | | | | | | | | | |
| | Feral Pigeons | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | H |
| | Black back gull control | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | H |
| Overall | | | | | | | | | | | | | |
| | Update species lists in appendices | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | | L |

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# Appendix 1

## Vascular flora of Moutohorā (Whale Island) Wildlife Management Reserve

(Ogle 1990a with additions by P. Cashmore and J. Hobbs 2002–09)

The following table lists the vascular plant species that are found on Motouhora Island. Exotic species are marked with an asterisk (*).

Table A1.1. Moutohorā (Whale Island) Wildlife Management Reserve vascular plant species list.

| Fern Allies | |
|---|---|
| *Lycopodium cernuum* | arching clubmoss |
| *Lycopodium varium* | hanging clubmoss |
| *Lycopodium volubile* | climbing clubmoss |
| *Psilotum nudum* | |
| Ferns | |
| *Adiantum cunninghamii* | mākaka; common maidenhair |
| *Adiantum hispidulum* | rosy maidenhair |
| *Asplenium appendiculatum* subsp. *maritimum* | shore spleenwort |
| *Asplenium bulbiferum* subsp. *bulbiferum* | hen and chickens fern |
| *Asplenium flabellifolium* | necklace fern |
| *Asplenium flaccidum* subsp. *flaccidum* | hanging spleenwort |
| *Asplenium flaccidum* subsp. *haurakiense* | |
| *Asplenium flaccidum* subsp. *haurakiense* x *A. oblongifoilium* | |
| *Asplenium gracillimum* | |
| *Asplenium gracillimum* x *A. hookerianum* | |
| *Asplenium hookerianum* | |
| *Asplenium northlandicum* (*obtusatum*) subsp. *northlandicum* | northern shore spleenwort |
| *Asplenium oblongifolium* | huruhuruwhenua; shining spleenwort |
| *Asplenium polyodon* | sickle spleenwort |
| *Asplenium terrestre* subsp. *maritimum* | shore spleenwort |
| *Blechnum chambersii* | nini |
| *Blechnum discolor* | crown fern |
| *Blechnum filiforme* | thread fern |
| *Blechnum membranaceum* | |
| *Blechnum minus* | |
| *Blechnum novae-zelandiae* | kiokio; palm leaf fern |
| *Blechnum parrisiae* | rasp fern |
| *Blechnum zeelandicum* | rasp fern |
| *Cheilanthes distans* | woolly cloak fern |
| *Cheilanthes sieberi* | rock fern |
| *Cyathea dealbata* | ponga; silver fern |
| *Cyathea medullaris* | mamaku; black tree fern |
| *Deparia petersenii* ssp. *congrua* | |
| *Dicksonia fibrosa* | wheki-ponga; golden tree fern |
| *Dicksonia squarrosa* | wheki; rough tree fern |
| *Diplazium australe* | |
| *Histiopteris incisa* | water fern |
| *Hymenophyllum bivalve* | filmy fern |
| *Hymenophyllum flabellatum* | filmy fern |
| *Hymenophyllum rarum* | filmy fern |

*Continued on next page*

*Table A1.1 continued*

| | |
|---|---|
| *Hymenophyllum sanguinolentum* | piripiri; filmy fern |
| *Hypolepis ambigua* | |
| *Hypolepis dicksonioides* | giant hypolepis |
| *Lastreopsis glabella* | felted fern |
| *Leptopteris hymenophylloides* | heruheru; crape fern |
| *Microsorum pustulatum* ssp. *pustulatum* | kōwaowao; hound's tongue |
| *Microsorum scandens* | mokimoki; fragrant fern |
| *Nephrolepis cordifolia** | tuber ladder fern |
| *Nephrolepis flexuosa* | native ladder fern |
| *Paesia scaberula* | lace fern |
| *Pellaea rotundifolia* | tarawera; button fern |
| *Phymatosorus scandens* | fragrant fern |
| *Pneumatopteris pennigera* | gulley fern |
| *Polystichum wawranum* | common shield fern |
| *Pteridium esculentum* | rarauhe; bracken |
| *Pteris macilenta* | sweet fern |
| *Pteris saxitilis* x *P. comans* | |
| *Pteris tremula* | shaking brake |
| *Pyrrosia eleagnifolia* | leather-leaf fern |
| *Rumohra adiantiformis* | leathery shield fern |
| *Schizaea bifida* | forked comb fern |
| *Trichomanes venosum* | veined filmy fern |
| Gymnosperms | |
| | |
| Dicotyledonous trees and shrubs | |
| *Acacia paradoxa** | kangaroo acacia |
| *Berberis glaucocarpa** | barberry |
| *Brachyglottis repanda* | rangiora; bushman's friend |
| *Buddleja davidii** | buddleia |
| *Chaemacyperus palmensis** | tree lucerne |
| *Coprosma propinqua* x *C. robusta* | |
| *Coprosma macrocarpa* x *C. robusta* | |
| *Coprosma macrocarpa* subsp. *minor* | |
| *Coprosma spathulata* subsp. *spathulata* | |
| *Coprosma repens* | taupata; looking glass plant |
| *Coprosma robusta* | karamu |
| *Coriaria arborea* | tutu |
| *Corynocarpus laevigatus* | karaka |
| *Crataegus monogyna** | hawthorn |
| *Dysoxylum spectabile* | kohekohe; New Zealand mahogany |
| *Entelea arborescens* | whau |
| *Fuchsia excorticata* | kōtukutuku; tree fuchsia |
| *Geniostoma ligustrifolium* var. *ligustrifolium* | hangehange |
| *Griselinia lucida* | puka |
| *Hebe stricta* var. *stricta* | koromiko |
| *Juglans ailantifolia** | Japanese walnut |
| *Knightia excelsa* | rewarewa; New Zealand honeysuckle |
| *Kunzea robusta* | kānuka |
| *Kunzea salterae* | Moutohorā kānuka |
| *Leptospermum scoparium* | mānuka |
| *Leptecophylla juniperina* ssp. *juniperina* | mingimingi |
| *Leucopogon fasciculatus* | soft mingimingi |

*Continued on next page*

*Table A1.1 continued*

| | |
|---|---|
| *Leucopogon fraseri* | patotara; dwarf mingimingi |
| *Ligustrum lucidum** | tree privet |
| *Ligustrum sinense** | Chinese privet |
| *Litsea calicaris* | mangeao |
| *Lupinus arboreus** | tree lupin |
| *Lycium ferocissimum** | boxthorn |
| *Macropiper excelsum* var. *excelsum* | kawakawa |
| *Melicytus ramiflorus* | māhoe |
| *Metrosideros excelsa* | pōhutukawa |
| *Myoporum laetum* | ngaio |
| *Ozothamnus leptophyllus* | tauhinu |
| *Pimelea orthia* ssp. *orthia* | |
| *Pittosporum crassifolium* | karo |
| *Pomaderris amoena* | tauhinu |
| *Pseudopanax arboreus* | whauwhaupaku; five-finger |
| *Pseudopanax lessonii* | houpara; coastal five-finger |
| *Rosa rubiginosa** | sweet briar |
| *Schefflera digitata* | pate; seven-finger |
| *Ulex europaeus** | gorse |
| *Urtica ferox* | ongaonga; stinging nettle |
| Dicotyledonous Lianes | |
| *Araujia hortorum** | moth plant |
| *Calystegia sepium* subsp. *roseata* | |
| *Calystegia soldanella* | nihinihi; shore bindweed |
| *Calystegia soldanella* x *C. tuguriorum* | |
| *Calystegia tuguriorum* | powhiwhi; New Zealand bidweed |
| *Clematis cunninghamii* | clematis |
| *Metrosideros carminea* | carmine rātā |
| *Metrosideros perforata* | rātā vine |
| *Muehlenbeckia australis* | pohuehue |
| *Muehlenbeckia complexa* | scrub pohuehue |
| *Parsonsia capsularis* | New Zealand jasmine |
| Dicotyledonous herbs | |
| *Acaena anserinifolia* | piripiri; bidibid |
| *Acaena novae-zelandiae* | red bidibid |
| *Amaranthus powellii** | redroot |
| *Anagallis arvensis** | scarlet pimpernel |
| *Apium prostratum* | native celery |
| *Atriplex prostrata** | orache |
| *Bellis perennis** | daisy |
| *Bidens frondosa** | Beggars ticks |
| *Brassica oleracea** | wild cabbage |
| *Cakile edentula** | sea rocket |
| *Callitriche muelleri* | starwort |
| *Calystegia sepium* agg. | pink bindweed |
| *Cardamine debilis* | bitter cress |
| *Carduus nutans** | nodding thistle |
| *Carduus pycnocephalus** | winged thistle |
| *Centella uniflora* | centella |
| *Cerastium fontanum* subsp. *vulgare** | mouse-ear chickweed |
| *Cerastium glomeratum** | annual mouse-ear chickweed |
| *Chenopodium album* agg.* | fathen |

*Continued on next page*

*Table A1.1 continued*

| | |
|---|---|
| *Chenopodium murale** | nettle-leaved fathen |
| *Cersium arvense** | Californian thistle |
| *Cersium vulgare** | Scotch thistle |
| *Conyza parva** | smooth fleabane |
| *Conyza sumatrensis** | broad-leaved fleabane |
| *Cotula australis** | soldier's button |
| *Crassula colligata* subsp. *colligata* | |
| *Crassula sieberiana* | |
| *Crepis capillaris** | hawksbeard |
| *Dichondra repens* | Mercury Bay weed |
| *Disphyma australe* | ice-plant |
| *Drosera auriculata* | sundew |
| *Epilobium ciliatum** | tall willowherb |
| *Epilobium cinereum* | willowherb |
| *Epilobium nummularifolium* | creeping willowherb |
| *Erechtites hieraciifolia** | American fireweed |
| *Erodium moschatum** | musky storksbill |
| *Euphorbia peplus** | milkweed |
| *Fumaria muralis** | scrambling fumitory |
| *Galium aparine** | cleavers |
| *Galium propinquum* | marsh bedstraw |
| *Gamochaeta coarctata** | purple cudweed |
| *Geranium maderense** | |
| *Geranium molle* | dove's foot cranesbill |
| *Geranium solanderi* | Solander's geranium |
| *Haloragis erecta* var. *erecta* | shrubby haloragis |
| *Hydocotyle heteromeria** | waxweed |
| *Hypochaeris glabra* | smooth catsear |
| *Hypochaeris radicata** | catsear |
| *Jacobaea vulgaris** | ragwort |
| *Lactuca virosa** | arid lettuce |
| *Lagenophora pumila* | papatāniwhaniwha |
| *Lampranthus glaucus** | |
| *Lavatera arborea** | tree mallow |
| *Leontodon taraxacoides** | hawkbit |
| *Lepidium pseudotasmanicum** | narrow-leaved cress |
| *Linum monogynum* | linen flax |
| *Lobelia anceps** | shore lobelia |
| *Lotus angustissimus** | slender birdsfoot trefoil |
| *Lotus pedunculatus** | lotus |
| *Lotus suaveolens** | hairy birdsfoot trefoil |
| *Modiola caroliniana** | creeping mallow |
| *Mycelis muralis** | wall lettuce |
| *Myosotis laxa* var. *caespitosa** | water forget-me-not |
| *Myosotis spathulata* | |
| *Nertera depressa** | nertera |
| *Nicandra physalodes** | apple of Peru |
| *Ornithopus perpusillus** | wild seradella |
| *Orobanche minor** | broomrape |
| *Oxalis exilis** | creeping oxalis |
| *Oxalis rubens** | dune oxalis |
| *Oxybasis glauca* subsp. *ambigua* | |

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*Table A1.1 continued*

| | |
|---|---|
| *Parietaria debilis** | New Zealand pellotory |
| *Pelargonium inodorum* | kōpata |
| *Peperomia urvilleana** | |
| *Persicaria maculosa** | willow weed |
| *Physalis peruviana** | Cape gooseberry |
| *Phytolacca octandra** | inkweed |
| *Plantago australis** | swamp plantain |
| *Plantago coronopus** | buck's horn plantain |
| *Plantago lanceolata* | ribwort |
| *Plantago raoulia* | native plantain |
| *Polycarpon tetraphyllum** | allseed |
| *Polygonum persicaria** | willow weed |
| *Portulaca oleracea** | purslane |
| *Pseudongaphalium* 'coast' | |
| *Ranunculus repens** | creeping buttercup |
| *Ranunculus sardous** | hairy buttercup |
| *Rumex acetosella** | sheep's sorrel |
| *Rumex conglomeratus** | clustered dock |
| *Rumex crispus** | curled dock |
| *Rumex obtusifolius** | broad-leaved dock |
| *Sagina procumbens** | procumbent pearlwort |
| *Sarcocornia quinqueflora* | glasswort |
| *Senecio bipinnatisectus** | Australian fireweed |
| *Senecio hispidulus* | fireweed |
| *Senecio lautus* | shore groundsel |
| *Senecio minimus* | fireweed |
| *Senecio quadridentatus* | cotton fireweed |
| *Senecio sylvaticus** | wood groundsel |
| *Silene gallica** | catchfly |
| *Solanum nigrum** | black nightshade |
| *Solanum nodiflorum* | small-flowered nightshade |
| *Sonchus asper** | prickly sow thistle |
| *Sonchus oleraceus** | sow thistle |
| *Stellaria media* | chickweed |
| *Stellaria parviflora* | native chickweed |
| *Taraxacum officinale** | dandelion |
| *Tetragonia tetragonoides* | kōkihi; New Zealand spinnach |
| *Trifolium dubium** | suckling clover |
| *Trifolium glomeratum** | clustered clover |
| *Trifolium repens** | white clover |
| *Trifolium subterraneum** | subclover |
| *Verbena bonariensis** | purple-top |
| *Veronica plebia** | Australian speedwell |
| *Vicia sativa** | vetch |
| *Wahlenbergia littoricola* subsp. *vernicosa* | |
| *Wahlenbergia violacea* | violet harebell |
| *Xanthium spinosum** | Bathhurst bur |
| Monocotyledonous trees, shrubs and lianes | |
| *Cordyline australis* | tī kōuka; cabbage tree |
| Orchids | |
| *Acianthus sinclairii* | pixie cap |
| *Caladenia lyallii* | |

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*Table A1.1 continued*

| | |
|---|---|
| *Corybas cheesemanii* | helmet orchid |
| *Diplodium alobulum* | |
| *Drymoanthus adversus* | green fleshy orchid |
| *Earina autumnalis* | ruapeka; Easter orchid |
| *Earina mucronata* | peka-a-waka; bamboo orchid |
| *Gastrodia cunninghamii* | black orchid |
| *Gastrodia sesamoides* | potato orchid |
| *Microtis parviflora* | onion-leaved orchid |
| *Microtis unifolia* | common onion orchid |
| *Orthoceras novae-zeelandiae* | mamaika; horned orchid |
| *Petalochilus bartlettii* | greenhood |
| *Thelymitra longifolia* | white sun orchid |
| *Winika cunninghamii* | winika; Christmas orchid |
| Grasses | |
| *Aira caryophyllea** | silvery hair grass |
| *Anthosachne kingiana* subsp. *multiflora* | blue wheat grass |
| *Anthosachne scabra** | blue wheat grass |
| *Anthoxanthum odoratum** | sweet vernal |
| *Briza minor** | shivery grass |
| *Bromus diandrus** | ripgut brome |
| *Bromus willdenowii** | prairie grass |
| *Cortaderia selloana** | pampas |
| *Cynodon dactylon** | Indian doab |
| *Dactylis glometata** | cocksfoot |
| *Deyeuxia avenoides* | mountain oat grass |
| *Dichelachne crinata* | plume grass |
| *Digitaria sanguinalis** | summer grass |
| *Echinopogon ovatus* | hedgehog grass |
| *Eleusine indica** | crowfoot grass |
| *Eragrostis brownii* | bay grass |
| *Holcus lanatus** | Yorkshire fog |
| *Lachnagrostis billardierei* | sand wind grass |
| *Lachnagrostis filiformis* | New Zealand wind grass |
| *Lagurus ovatus** | harestail |
| *Lolium perene* | ryegrass |
| *Microlaena stipoides* | meadow rice grass |
| *Oplismenus hirtellus* subsp. *imbecillis** | |
| *Panicum dichotomiflorum** | smooth witch grass |
| *Paspalum dilatatum** | paspalum |
| *Paspalum orbiculare* | native paspalum |
| *Pennisetum clandistinum** | kikuyu |
| *Poa anceps* | broad-leaved poa |
| *Poa annua** | annual poa |
| *Poa billardiere*i | sand wind grass |
| *Poa imbecilla** | weak poa |
| *Poa pratensis** | smooth meadow grass |
| *Poa pusilla* | |
| *Poa trivialis** | rough meadow grass |
| *Polypogon monspeliensis** | beard grass |
| *Rytidosperma penicillatum** | danthonia |
| *Rytidosperma racemosum** | danthonia |
| *Rytidosperma unarede* | bristle grass |

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*Table A1.1 continued*

| | |
|---|---|
| *Spinifex sericeus* | kōwhangatara; spinifex |
| *Sporobolus africanus** | ratstail |
| *Vulpia bromoides** | vulpia hair grass |
| *Zoysia minima* | prickly couch |
| *Zoysia pauciflora* | |
| Sedges | |
| *Carex* "geminata large" | |
| *Carex breviculmis* | grassland sedge |
| *Carex dissita* | forest sedge |
| *Carex flagellifera* | Glen Murray tussock |
| *Carex pumila* | sand sedge |
| *Carex raoulii* | swamp sedge |
| *Carex* sp. *(C. "*raotest*")* | |
| *Carex testacea* | speckled sedge |
| *Carex virgata* | swamp sedge |
| *Cyperus insularis* | |
| *Cyperus ustulatus* | giant umbrella sedge |
| *Ficinia nodosa* | knobby clubrush |
| *Ficinia spiralis* | |
| *Isolepis cernua* var. *cernua* | slender clubrush |
| *Lepidosperma australe* | square-stemmed sedge |
| *Machaerina juncea* | swamp twig rush |
| *Morelotia affinis* | |
| *Uncinia uncinata* | kamu; hook sedge |
| Rushes | |
| *Apodasmia similis* | oioi; jointed wire rush |
| *Juncus edgariae* | Edgars rush |
| *Juncus kraussii* subsp. *australiensis* | sea rush |
| *Juncus pallidus* | giant rush |
| *Juncus planifolius* | flat-leaved rush |
| *Luzula picta* | woodrush |
| Other monocotyledonous herbs | |
| *Amaryllis belladonna** | belladona lilly |
| *Arthropodium candidum* | small renga lily |
| *Arthropodium cirratum* | rengarenga; rock lily |
| *Asparagus aethiopicus** | bushy asparagus |
| *Asparagus officinalis** | common asparagus |
| *Astelia solandri* | kahakaha; perching lily |
| *Dianella nigra* | blue berry |
| *Lilium formosanum** | Formosan lily |
| *Phormium cookianum* | mountain flax |
| *Phormium tenax* | harakeke; flax |
| *Typha orientalis* | raupo; bullrush |
| Species planted 1984–1989 | |
| *Alectryon excelsus* | tītoki |
| *Beilschmedia tawa* | tawa |
| *Calystegia soldanella* | shore convolvulus |
| *Carmichaelia australis* | New Zealand broom |
| *Carpodetus serratus* | putaputawētā; marbleleaf |
| *Cassinia leptophylla* | tauhinu |
| *Coprosma acerosa* | sand coprosma |
| *Coprosma lucida* | shinning karamu |

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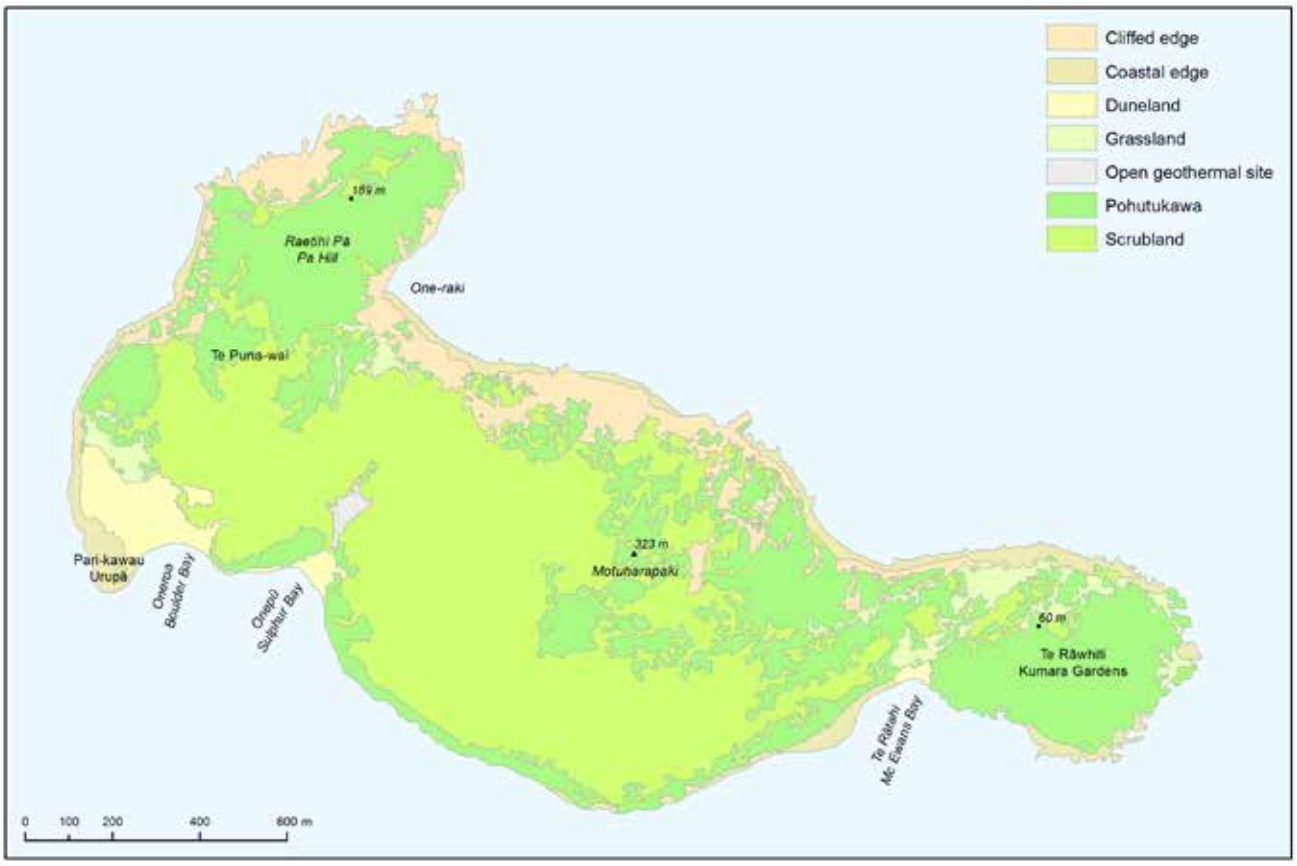
*Table A1.1 continued*

| | |
|---|---|
| *Coprosma macrocarpa* x *C. robusta* | |
| *Coprosma propinqua* | mingimingi |
| *Coprosma propinqua* x *C. robusta* | |
| *Coprosma repens* | taupata |
| *Coprosma robusta* | karamū |
| *Coprosma spathulata* | |
| *Cordyline australis* | tī kōuka; cabbage tree |
| *Corynocarpus laevigatus* | karaka |
| *Dacrycarpus dacrydioides* | kahikatea |
| *Dodonea viscosa* | akeake |
| *Entelea arborescens* | whau |
| *Ficinia spiralis* | pīngao |
| *Freycinetia banksii* | kiekie |
| *Fuchsia excorticata* | kōtukutuku; tree fuchsia |
| *Hebe parviflora* | kōkōmuka tāranga |
| *Hebe stricta* | koromiko |
| *Hedycarya arborea* | porokaiwhiri; pigeonwood |
| *Knightia excelsa* | rewarewa; New Zealand honeysuckle |
| *Litsea calicaris* | mangaeo |
| *Lobelia angulata* | pratia |
| *Machaerina sinclairii* | |
| *Melicope ternata* | wharangi |
| *Melicytus novae-zelandiae* | coastal māhoe |
| *Metrosideros carminea* | |
| *Muehlenbeckia complexa* | pohuehue |
| *Myoporum laetum* | ngaio |
| *Myrsine australis* | mapou |
| *Ozothamnus leptophylla* | tauhinu; cottonwood |
| *Phormium tenax* | harakeke; flax |
| *Piper excelsum* subsp. *excelsum* | kawakawa; pepper tree |
| *Pittosporum tenuifolium* | kōhūhū |
| *Pseudopanax arboreus* | whauwhaupaku; five-finger |
| *Pseudopanax lessonii* | houpara; coastal five-finger |
| *Rhapalostylis sapida* | nīkau |
| *Schefflera digitata* | pate; seven-finger |
| *Vitex lucens* | pūriri |
| *Weinmannia racemosa* | kāmahi |
| Species planted 1999-onwards | |
| *Euphorbia glauca* | waiu-atua; shore spurge |
| *Ficinia spiralis* | pīngao |
| *Lepidium oleraceum* | nau; Cook's scurvy grass |
| *Pimelea tomentosa* | scrub daphne |
| *Pimelea villosa* subsp. *villosa* | auteteranga; sand daphne |
| *Pisonia brunoniana* | parapara |
| *Planchonella costata* | tawāpou |
| *Poa billardierei* | hinarepe; sand tussock |
| *Rorippa divaricata* | matangaoa; New Zealand watercress |
| *Sicyos mawhai* | mawhai; New Zealand cucumber |
| *Tetragonia tetragonoides* | kōkihi; New Zealand spinach |

# Appendix 2

## Vegetation and cover class map of Moutohorā (Whale Island) Wildlife Management Reserve

(Chakraborty (unpubl. data 2007) adapted by B. Christensen)



# Appendix 3

## Map and table of vegetation monitoring plot sites in Moutohorā (Whale Island) Wildlife Management Reserve

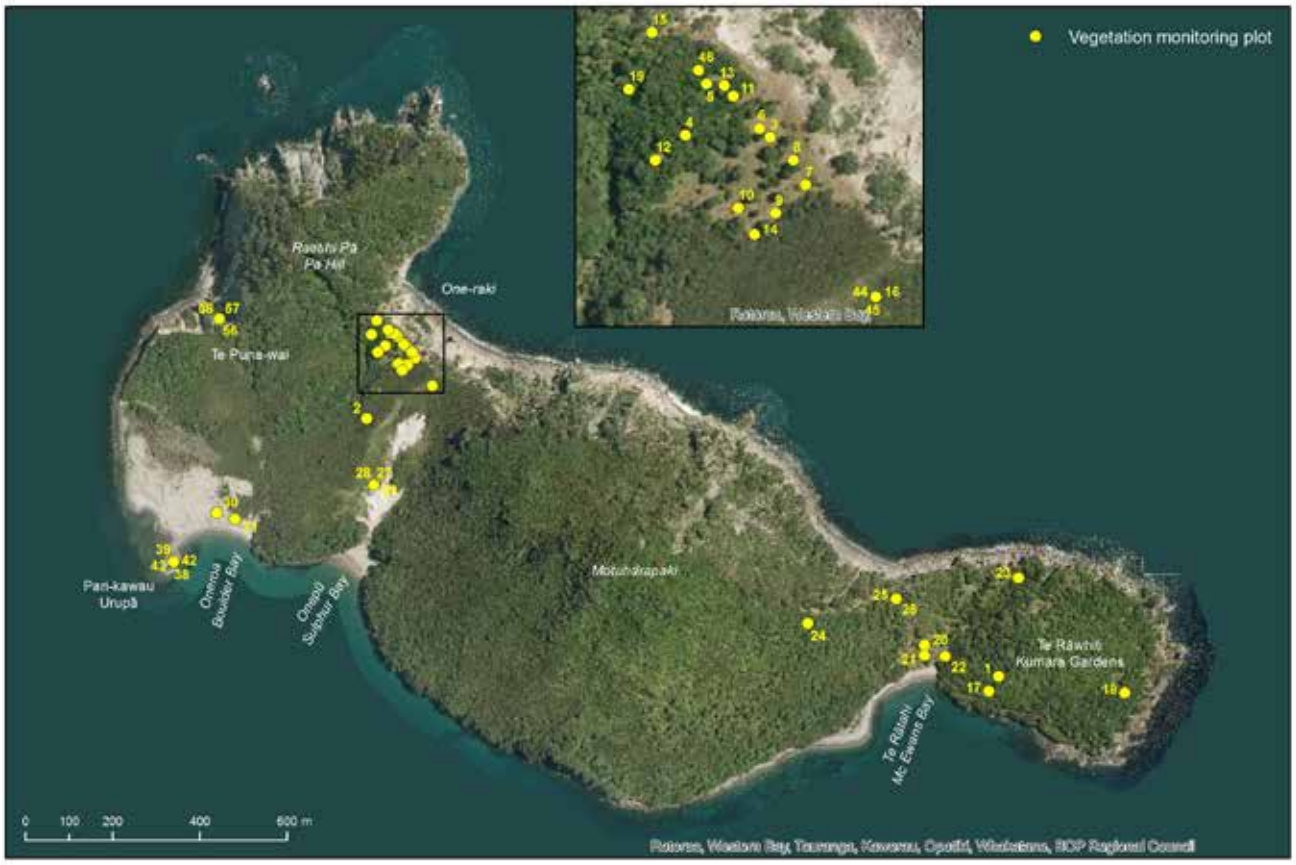



Table A3.1. Details of vegetation monitoring plot sites, Moutohorā (Whale Island) Wildlife Management Reserve.

| MAP ID | EASTING | NORTHING | PLOT LABEL | DESCRIPTION 1 | DESCRIPTION 2 |
|---|---|---|---|---|---|
| 1 | 1950547 | 5802484 | McEwans_Bay | 20x20 plot | |
| 2 | 1949096 | 5803075 | Boulder_Bay | 20x20 plot | |
| 3 | 1949187 | 5803240 | G | Grassland plot | |
| 4 | 1949139 | 5803241 | G1 | Grassland plot | |
| 5 | 1949151 | 5803270 | G2 | Grassland plot | |
| 6 | 1949181 | 5803245 | G3 | Grassland plot | |
| 7 | 1949207 | 5803213 | G13 | Grassland plot | |
| 8 | 1949200 | 5803227 | G14 | Grassland plot | |
| 9 | 1949190 | 5803197 | G16 | Grassland plot | |
| 10 | 1949169 | 5803200 | G17 | Grassland plot | |
| 11 | 1949166 | 5803263 | G19 | Grassland plot | |
| 12 | 1949122 | 5803227 | G20 | Grassland plot | |
| 13 | 1949161 | 5803269 | G19 | Grassland plot | |
| 14 | 1949178 | 5803185 | P13 | Grassland plot | |
| 15 | 1949120 | 5803299 | P15 | Grassland plot | |
| 16 | 1949247 | 5803150 | P11_12 | Grassland plot | |

*Continued on next page*

*Table A3.1 continued*

| MAP ID | EASTING | NORTHING | PLOT LABEL | DESCRIPTION 1 | DESCRIPTION 2 |
|---|---|---|---|---|---|
| 17 | 1950525 | 5802450 | Whale1 | Pōhutukawa plot | |
| 18 | 1950837 | 5802446 | Whale2 | Pōhutukawa plot | |
| 19 | 1949107 | 5803267 | Whale3 | Pōhutukawa plot | |
| 20 | 1950377 | 5802556 | PhotoPoint (PP) 1 | Te Rātahi | Rear dune |
| 21 | 1950377 | 5802532 | PP_2 | Te Rātahi | East side of main hill |
| 22 | 1950425 | 5802530 | PP_2A | Te Rātahi | Rear dune |
| 23 | 1950593 | 5802709 | PP_2B | Te Rātahi | Rear dune |
| 24 | 1950109 | 5802606 | PP_3 | Slopes of Main Hill (east side) | Te Rātahi east end of island |
| 25 | 1950312 | 5802662 | PP_3A | | Looking onto cliffs |
| | 1950312 | 5802662 | PP_3B | Slopes of Main Hill (east side) | East end of island looking on to lower cliffs and beach |
| 26 | 1949113 | 5802922 | PP_4 | Onepū valley (west side) | West side of main hill |
| | 1949113 | 5802922 | PP_5 | Onepū valley (west side) | West side of main hill |
| | 1949113 | 5802922 | PP_6 | Onepū valley (west side) | West side of main hill |
| 27 | 1948753 | 5802859 | PP_7 | Oneroa dunes | Across foredune |
| 28 | 1948795 | 5802845 | PP_8 | Oneroa dunes | Up Hut Valley |
| 29 | 1948654 | 5802746 | PP_9A | Oneroa (adj. to Boulder Bank) | West half Raetihi (Pā Hill) |
| | 1948654 | 5802746 | PP_9B | Oneroa (adj. to Boulder Bank) | East half Raetihi (Pā Hill) |
| | 1948654 | 5802746 | PP_9C | Oneroa (adj. to Boulder Bank) | West lower slopes Raetihi (Pā Hill) |
| | 1948654 | 5802746 | PP_9D | Boulder Bank | West-middle lower slopes Raetihi (Pā Hill) |
| | 1948654 | 5802746 | PP_9E | Boulder Bank | Mid-lower slopes Raetihi (Pā Hill) |
| | 1948654 | 5802746 | PP_9F | Boulder Bank | Mid-lower slopes Raetihi (Pā Hill) |
| | 1948654 | 5802746 | PP_9G | Boulder Bank | Mid-eastern slopes Raetihi (Pā Hill) |
| | 1948654 | 5802746 | PP_9H | Boulder Bank | Eastern slopes Raetihi |
| | 1948654 | 5802746 | PP_9T | Boulder Bank | Eastern slopes Raetihi |
| | 1948654 | 5802746 | PP_10 | Oneroa | Main Hill |
| | 1948654 | 5802746 | PP_10A | Oneroa | Main Hill |
| | 1948654 | 5802746 | PP_10B | Oneroa | Main Hill |
| 30 | 1949247 | 5803150 | PP_11 | Onepū Saddle | Onepū Saddle |
| | 1949247 | 5803150 | PP_12 | Onepū Ridge | Raetihi |
| 31 | 1949178 | 5803185 | PP_13 | Hut Valley Saddle | Upper Hut Valley |
| 32 | 1949077 | 5803582 | PP_14 | Raetihi Summit | Cliffs on main hill |
| 33 | 1949146 | 5803278 | PP_15 | Raetihi | East side Hut Valley |
| 34 | 1985143 | 5802998 | PP_16 | Ridge between Onepū and Hut Valley | Oneroa dunes |
| | 1985143 | 5802998 | PP_17 | Ridge between Onepū and Hut Valley | Oneroa |
| | 1985143 | 5802998 | PP_18 | Ridge between Onepū and Hut Valley | Head of Onepū |
| | 1985143 | 5802998 | PP_18A | Ridge between Onepū and Hut Valley | Panorama eastern side Onepū |
| | 1985143 | 5802998 | PP_18B | Ridge between Onepū and Hut Valley | Panorama eastern side Onepū |
| | 1985143 | 5802998 | PP_18C | Ridge between Onepū and Hut Valley | Panorama eastern side Onepū |
| | 1985143 | 5802998 | PP_18D | Ridge between Onepū and Hut Valley | Panorama eastern side Onepū |
| | | | IRE | Ridge between Onepū and Hut Valley | Panorama eastern side Onepū |

*Continued on next page*

*Table A3.1 continued*

| MAP ID | EASTING | NORTHING | PLOT LABEL | DESCRIPTION 1 | DESCRIPTION 2 |
|---|---|---|---|---|---|
| | 1985143 | 5802998 | PP_19 | Ridge between Onepū and Hut Valley | Ridge crest |
| 35 | 1948758 | 5803303 | PP_HHI | Mid-slopes Raetihi | Lower slopes of Raetihi |
| | 1948758 | 5803303 | PP_HH2 | Mid-slopes Raetihi | Lower slopes of Raetihi |
| | 1948758 | 5803303 | PP_HH2 | Mid-slopes Raetihi | Lower slopes of Raetihi |

# Appendix 4

## Reptile species list for Moutohorā (Whale Island) Wildlife Management Reserve

| SPECIES NAME | COMMON NAME |
|---|---|
| *Sphenodon punctatus* | Tuatara |
| *Woodworthia maculata* | Common gecko |
| *Oligosoma aeneum* | Copper skink |
| *Oligosoma* aff. *infrapunctatum* “crenulate” | Crenulate skink |

# Appendix 5

## Avifauna species list for Moutohorā (Whale Island) Wildlife Management Reserve

Table A5.1. Moutohorā (Whale Island) avifauna species list.
Note: * = species found in the waters around Moutohorā. B = species that breed on Moutohorā.

| SPECIES NAME | COMMON NAME | QUALIFIERS |
|---|---|---|
| *Acridotheres tristis* | common myna | |
| *Alauda arvensis* | Eurasian skylark | B |
| *Anas platyrhynchos* | mallard | |
| *Anthornis melanura* | korimako, bellbird | B |
| *Apteryx mantelli* | North Island brown kiwi | B |
| *Carduelis carduelis* | European goldfinch | B |
| *Carduelis chloris* | European greenfinch | B |
| *Carduelis flammea* | common redpoll | B |
| *Charadrius obscurus aquilonuis* | tūturiwhatu, northern New Zealand dotterel | B |
| *Chrysococcyx lucidus* | pīpīwharauroa, shining cuckoo | B |
| *Circus approximans* | kāhu, Australasian harrier | |
| *Columbia livia* | rock pigeon | B |
| *Coturnix ypsilophora* | brown quail | |
| *Cyanoramphus novaezelandiae* | kākāriki, red-crowned parakeet | B |
| *Daption capense* | Cape petrel | * |
| *Egretta novaehollandiae* | white-faced heron | |
| *Egretta sacra* | reef heron | |
| *Emberiza citronella* | yellowhammer | B |
| *Eudyptula minor* | kororā, little blue penguin | B |
| *Falco novaeseelandiae* | kārearea, New Zealand falcon | |
| *Fringilla coelebs* | pahirini, chaffinch | B |
| *Gerygone igata* | riroriro, grey warbler | B |
| *Gymnorhina tibicen* | Australian magpie | |
| *Haematopus unicolor* | tōrea tai, variable oystercatcher | B |
| *Hirundo neoxena* | welcome swallow | B |
| *Hydroprogne caspia* | taranui, Caspian tern | * |
| *Larus domincanus* | karoro, southern black-backed gull | B |
| *Larus novaehollandiae* | red-billed gull | |
| *Macronectes halli* | pāngurunguru, northern giant petrel | * |
| *Morus serrator* | tākapu, Australasian gannet | * |
| *Nestor meridionalis* | kākā, North Island kaka | |
| *Ninox novaeseelandiae* | ruru, morepork | B |
| *Passer domesticus* | tiu, house sparrow | B |
| *Pelecanoides urinatrix urinatrix* | northern diving petrel | * |
| *Petroica macrocephala* | miromiro, tomtit | B |
| *Phachyptila* spp | Prion species | * |
| *Phalacrocorax* carbo | black shag | |
| *Phalacrocorax melanoleucos* | little shag | |
| *Phalacrocorax varius* | pied shag | B |
| *Philesturnus rufusater* | tīeke, North Island saddleback | B |
| *Prosthemadera novaeseelandiae* | tūī | B |
| *Prunella modularis* | Dunnock | B |

*Continued on next page*

*Table A5.1 continued*

| SPECIES NAME | COMMON NAME | QUALIFIERS |
|---|---|---|
| *Pterodroma macroptera gouldi* | kuia, grey-faced petrel | B |
| *Puffinus bulleri* | Buller's shearwater | * |
| *Puffinus carneipes* | toanui, flesh-footed shearwater | * |
| *Puffinus gavia* | pakahā, fluttering shearwater | * |
| *Puffinus griseus* | tītī, sooty shearwater | * |
| *Puffinus tenuirostris* | short-tailed shearwater | * |
| *Rhipidura fuliginosa* | pīwakawaka, New Zealand fantail | B |
| *Stercorarius parasiticus* | Arctic skua | * |
| *Sterna striata* | tara, white-fronted tern | B |
| *Sternus vulgaris* | common starling | |
| *Stictocarbo punctatus* | spotted shag | B |
| *Thalassarche cauta steadi* | New Zealand white-capped mollymawk | * |
| *Thalassarche impavida* | Campbell black-browned mollymawk | * |
| *Thalassarche salvini* | Salvin's mollymawk | * |
| *Todiramphus sanctus* | kōtare, New Zealand kingfisher | B |
| *Turdus merula* | manu pango, Eurasian blackbird | B |
| *Turdus philomelos* | song thrush | B |
| *Zosterops lateralis* | silvereye | B |

# Appendix 6

## Tīeke (*Philesturnus carunculatus*) transect lines

(Parker (2005) with additions by M. Sothieson)