# Mana Island *ecological restoration plan* review

JUNE 2010

Department of Conservation
*Te Papa Atawhai*

# *Mana Island ecological restoration plan* review

Colin Miskelly

May 2010

Published by
Department of Conservation
P.O. Box 5086
Wellington 6145, New Zealand

This review is dedicated to the memory of Robin Gay, Wellington Conservancy's landscape architect from 1990 to 2002, who died in December 2008. Robin designed the revegetation programme on Mana Island, as well as designing and over-seeing the restoration of Waikoko wetland.

During his previous employment with the Department of Lands and Survey, Robin took many photographs of Mana Island when it was a MAF quarantine research facility and then a Lands and Survey farm. These images provide insight into the island's past, and valuable benchmarks to assess progress with ecological restoration on the island.

This report was prepared by Colin Miskelly, Conservation Analyst, Wellington Hawke's Bay Conservancy. In June 2010, Colin took up the position of Curator, Terrestrial Vertebrates at the Museum of New Zealand Te Papa Tongarewa.



ISBN:

# Abstract

The *Mana Island ecological restoration plan* is reviewed in light of progress made since the plan was published in 1999. The principles and objectives of the plan remain sound, although the wisdom or achievability of some potential individual species translocations is questioned based on new information.

Ngāti Toa (as tangata whenua) and the Friends of Mana Island Incorporated Society are recognised as the major stakeholders that the Department of Conservation must work with to achieve successful restoration and management of the island. Effective management partnerships are required involving all three groups.

Excellent progress has been made with restoration of shoreline and cliff communities, although further effort is needed to attract burrow-nesting petrels, which are still in low numbers and with localised distributions. An extensive young forest has been created by planting over 500,000 trees and shrubs; further work is needed to restore diversity to the forest by under-planting (especially of canopy species, and ferns and other non-woody species) and introductions of forest birds. Introductions of forest-dwelling invertebrates should await establishment of a tawa, milktree and kohekohe canopy, and development of a deeper leaf litter layer containing more decaying wood.

Restoration of Waikoko wetland, which was constructed in 1998, is constrained by the absence of a restoration model or plan identifying appropriate vegetation, invertebrate and fish communities. Similarly, a threatened plant action plan is needed to guide the successful establishment of a wider range of nationally and regionally threatened plant species on the island.

Further vertebrate species proposed for introduction to Mana Island include rowi (Okarito brown kiwi), Chatham Island snipe, whitehead, bellbird, tuatara, Whitaker's skink and robust skink. It is anticipated that tūī, kererū and possibly kākā will establish populations naturally.

All habitats on Mana Island remain susceptible to weed invasion. Huge progress has been made in the removal and suppression of weed species, and a maintenance weed control programme will be required for the foreseeable future.

There are many fascinating stories to tell on Mana Island, spanning its complex human, ecological and conservation history. But few people are able to visit the island to experience its magic, due to the current absence of regular transport to the island. Exploring ways to increase public awareness of the island, and to make the island more accessible, will be a challenge for the Department, Ngāti Toa and the Friends of Mana Island Incorporated to jointly solve.

# CONTENTS

# 1. Background

Management of Mana Island Scientific Reserve is guided by the *Wellington Conservancy Conservation Management Strategy* (DOC 1996) and the *Mana Island ecological restoration plan* (Miskelly 1999). There has been considerable progress with ecological restoration of the island since these plans were written, and especially through involvement of the Friends of Mana Island Society (formed in 1999): FOMI have taken the lead on implementing many projects proposed in the ecological restoration plan. The plan did not have an identified timeframe for completion or revision, but provided a timeframe for tasks through to 2020. Progress with ecological restoration on the island was recognised in 2009 through the project being selected as one of the top 25 ecological restoration projects in Australasia (www.doc.govt.nz/conservation/land-and-freshwater/australasias-top-25-restoration-projects/mana-island-ecological-restoration/).

The *Wellington Conservancy Conservation Management Strategy* (CMS) was intended as a ten-year planning document, and work is well progressed on the relevant sections of a revised CMS (currently on hold due to expansion of the conservancy to include Hawke's Bay).

Due to the impressive progress made ecological restoration on Mana Island since 1999, it is timely to review the plan to determine whether its principles are sound 11 years on, and to identify key restorative projects for the next decade. The improving ecological health of the island has also made the island a more attractive visitor destination, and planning for expected increased visitation needs to take into account protection of conservation values and opportunities available for visitor enjoyment and participation.

It is expected that the Ngāti Toa Treaty of Waitangi settlement will require closer collaboration between DOC and Ngāti Toa in management planning and operational activities on Mana Island. FOMI is the third major strategic partner in management of Mana Island, and all three partners have had opportunity to discuss, add to, or otherwise modify or ratify objectives and tasks.

# 2. *Mana Island ecological restoration plan* review terms of reference

1. Review the plan to identify whether ecological restoration principles and tasks identified remain sound, or should be modified, removed or added to.
2. Identify tasks that have been partially or wholly completed, and those tasks not yet undertaken.
3. Review draft CMS to identify principles and actions that should be incorporated in the restoration plan.
4. Identify uncompleted tasks still appropriate to action, and possible additional ecological restoration actions.

### Managing visitor opportunities and experiences on Mana Island

5. Summarise existing visitor levels and opportunities.
6. Identify messages that the Department and key stakeholders wish to convey to visitors.
7. Identify opportunities for volunteer participation in ecological restoration and other aspects of island management.
8. Identify infrastructure and planning requirements to inform visitors, and ensure their safety and enjoyment while protecting the ecological and historical values of the island.

# 3. Progress with ecological restoration

The *Mana Island ecological restoration plan* sought to restore the terrestrial ecology of the island at an ecosystem level, although many tasks were identified at a species level. Assessment of progress can therefore be made both at an holistic 'ecosystem' level and at an individual task level. It is theoretically possible to achieve ecosystem restoration while individual species restoration projects may fail, and conversely a species could be successfully restored while wider ecosystem restoration goals fail to be met.

In order to assess progress with both ecosystem and species restoration on Mana Island, relevant sections of the *Mana Island ecological restoration plan* have been reviewed in sections 3.4 and 3.5, and progress towards achieving identified outcomes assessed.

## 3.1 SUMMARY OF PROGRESS WITH ECOLOGICAL RESTORATION

The following 1986–2009 timeline summarises milestones in the ecological restoration of Mana Island. This is biased towards faunal translocations, as these are one-off or short term, well-documented events compared to longer term projects such as revegetation, weed control, biosecurity measures, and threatened plant management.

1986 Last farm stock (dairy bulls) removed

1987 Tree planting initiated; takahē introduced

1988 Mana Island gazetted as a scientific reserve

1989–90 Mice eradicated, freeing the island of introduced mammals

1993 Goldstripe geckos rediscovered on Mana Island; first seabird attraction sound system installed

1995–96 North Island robins re-introduced from Kapiti Island

1996 Cook Strait giant weta and Wellington tree weta translocated from Mana Island to Matiu/Somes Island; brown skinks discovered on Mana Island

1997 First diving petrel chick translocation; gannet decoys installed; 250,000th tree planted

1998 Spotted skinks, Wellington green geckos and Duvaucel's geckos released; Waikoko wetland restored

1999 *Mana Island ecological restoration plan* published; Friends of Mana Island Society formed; diving petrel chick translocations completed (118 chicks fledged over 3 years); first breeding by diving petrels

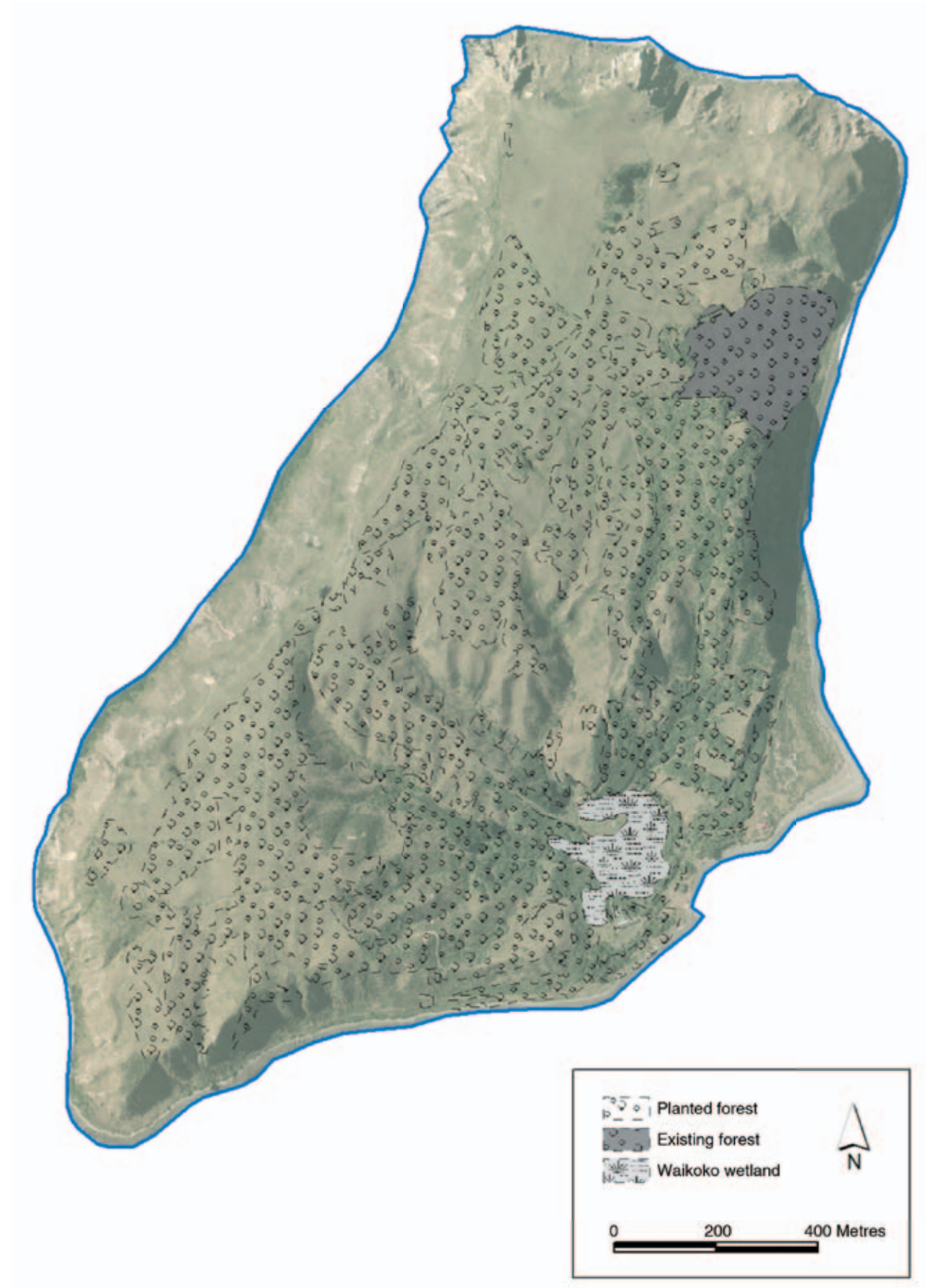


Figure 1. Areas planted on Mana Island 1987–2009, based on a GIS compilation of shape-files for each year of planting (data held by Wellington Hawke's Bay Conservancy, DOC). The base orthophotograph was provided by Porirua City Council.

2001 Captive-reared brown teal released on Waikoko wetland

2002 First fairy prion chick translocation; underplanting with future canopy species begins

2004 Speckled skinks, yellow-crowned parakeets and flax weevils released; fairy prion chick translocations completed (240 chicks fledged over 3 years); second diving petrel colony discovered

2005 First breeding by yellow-crowned parakeets and fairy prions

2006 First fluttering shearwater chick translocation; first release of Wellington speargrass weevils

2007 First release of shore plover (captive-reared); first breeding by shore plovers; *Notoreas* moths identified on natural and planted *Pimelea*.

2008 Fluttering shearwater chick translocations completed (211 chicks fledged over 3 years); 500,000th tree planted.

2009 Five shore plover chicks fledged; three adult fluttering shearwaters caught near loud speakers; Mana Island recognised as one of the "Top 25" ecological restoration projects in Australasia by the journal *Ecological Management & Restoration* and the Ecological Society of Australia.

Plantings have been completed over approximately 85.5 ha of the 217 ha island at a density of approximately 6,000 plants per hectare (Fig. 1); about 32.6 ha have been under-planted with species that require shelter or shade to establish. It is not proposed to substantially increase the area to receive initial plantings.

Since 1986 there have been ongoing programmes of weed control (main species targeted: boxthorn, boneseed, *Senecio glastifolius*, kikuyu grass) and attempts to establish or bolster nationally or locally threatened plant populations, including Cook's scurvy grass, large-leaved milk tree, *Euphorbia glauca*, *Pimelea* aff. *aridula*, *Muehlenbeckia astonii*, *Rubus squarrosus*, *Fuchsia perscandens*, matagouri, and the grass *Trisetum antarcticum*.

In addition to being the largest successful mouse eradication at the time (1989–90), and having volunteers and contractors plant over 500,000 trees, Mana Island is the site of the world's most complex seabird translocation project. This has involved translocations of 704 downy nestlings of three species of burrow-nesting petrels over 11 years, and their daily hand-feeding to fledging by teams of volunteers (11,116 pureed sardine or krill meals delivered via syringe and crop tube; Miskelly *et al*. 2009). The first two species have returned to breed in low numbers; diving petrels have established, while the persistence of fairy prions is far from certain. The third species (fluttering shearwater) is expected to start returning from 2010.

Mana Island is also the focus of a complex reptile restoration programme, with six resident species (two nationally threatened), four species re-introduced, and three more planned. Eight bird species (3 nationally threatened), two threatened weevil species and 22 threatened plant species have been introduced or re-introduced.

## 3.2 PROGRESS WITH SEABIRD RESTORATION ON MANA ISLAND

Efforts to restore seabirds to Mana Island, in recognition of their role as 'ecosystem engineers' is the most notable feature of the Mana Island ecological restoration programme when compared to other restoration projects in New Zealand and world-wide. Results to date are summarised here:

### Burrow-nesting seabirds

#### *Sooty shearwater*

About 100 pairs naturally present, mainly on the south-west cliff-top between the two petrel translocation sites, with a few pairs east of the trig. Numbers appear stable, although a few pairs have colonised north of the diving petrel / fairy prion translocation site. Sooty shearwater populations nationally are declining at about 2% per annum, apparently due to oceanographic effects (Scofield & Christie 2002), therefore substantial colony growth is unlikely in the short to medium term.

#### *Common diving petrel*

Translocated (20 chicks returned = 17%) and naturally colonised since 1997 (111 unbanded adults handled) (Miskelly & Taylor 2004; C. Miskelly unpublished data). Two small, dispersed colonies are known, with about 15 pairs centred on the translocation site, and a smaller colony of 5–10 pairs between Lance's Gully and the trig (Miskelly *et al*. 2004). About two-thirds of known birds disappeared in 2005 (cause unknown); the main colony has since recovered from a low of 6 pairs in 2005.

Given the continuing recruitment of unbanded birds, and the expected presence at other cliff sites, the diving petrel population on Mana Island should continue to grow unaided (Jones & Miskelly submitted).

#### *Fairy prion*

Translocated (19 chicks returned to date = 8%) and naturally colonised since 2004 (four adults banded) (Miskelly *et al*. 2009). Three pairs bred in or near the translocation site in 2008–09 (two of these successfully fledged chicks), but only a single pair was confirmed breeding in 2009–10. Of the 23 adult prions recorded on Mana Island, 11 were known males, 3 were probable males, 7 were known females, and 2 were of unknown sex. Although males outnumber females 2:1, there is potential for more than three pairs. Given the small number of breeding pairs, and the low recruitment of unbanded adults, the status of fairy prions on Mana Island is precarious.

#### *Fluttering shearwater*

Translocated during 2006–08 (Gummer & Adams 2008; Miskelly *et al*. 2009), the first chicks are expected back in 2010, and recruitment of translocated chicks may occur through to at least 2017. Based on the 12.5% return rate recorded on Maud Island (Bell *et al*. 2005; Miskelly *et*

*al*. 2009), it is expected that about 26 of the translocated chicks should return to Mana Island. So far three adult female fluttering shearwaters have been attracted by the two sound systems, and have established burrows.

A survey using a trained "petrel dog" in November 2009 (funded by FOMI) confirmed the known breeding sites for diving petrels and fairy prions, but did not locate additional sites nor evidence of breeding by other petrel species. The dog did indicate seabird activity at a burrow near the northern speaker, which that evening was found to be occupied by the island's third adult fluttering shearwater. As with the two previous birds, this was an unbanded adult rather than one of the translocated chicks.

### *White-faced storm petrel*

White-faced storm petrel calls have been included on the petrel sound-attraction units on Mana Island since 1993. Two birds were caught near the original sound system, on 2 Nov 2000 and 20 Sep 2001. It is possible that storm petrels will attempt to colonise the plateau inland from the loud speakers, but none was found during the November 2009 dog search.

No-one has attempted to translocate any species of storm petrel, which are the smallest of the petrels. There are no large colonies close to Mana Island, with neither Sentinel Rock (Marlborough Sounds) nor Motunau Island having enough pairs to sustain harvest for translocation. The nearest large colonies are in the Bay of Plenty, Hauraki Gulf, Chatham Islands and Foveaux Strait.

### *Flesh-footed shearwater*

Flesh-footed shearwater calls are not currently included on the petrel sound-attraction units. A small number of flesh-footed shearwaters breed in the Cook Strait region, on Titi Island. The nearest large colonies are in the Bay of Plenty and Hauraki Gulf.

### *Blue penguin*

Blue penguins are a common breeding species on Mana Island, probably numbering in the hundreds of pairs. No attempt has been made to estimate their numbers or population trends.

## Surface-nesting and tree-nesting seabirds

Other than attempts to attract gannets to Mana Island, no positive action has been taken to encourage surface-nesting seabirds.

### *Black-backed gull*

The large Mana Island black-backed gull population (estimated at 2500–2600 pairs in the early 1990s) has been controlled since 1994, and is now a few scores of pairs mainly confined to the cliffs. Control was undertaken to prepare the island for shore plover introduction, which commenced in 2007.

### *Red-billed gull*

About 150 red-billed gulls bred on the northern cliffs in 1993/94. Although still present, the current population size is unknown.

### *White-fronted tern*

Twenty pairs of white-fronted terns bred on stacks off the north coast in 1993/94. The current population size is unknown.

### *Australasian gannet*

A potential colony site on the western cliff-top was cleared of vegetation in 1997, painted white to simulate guano, and 100 concrete gannet decoys positioned. Two birds landed among the decoys on the day they were put in place (December 1997), and one bird was seen there at night in March 1998. A call unit was installed in 1999. There are no records of birds ashore subsequent to 1998, and the site is now overgrown. The decoys were repainted by FOMI in 2009, but are currently largely obscured by vegetation. Efforts to prepare a new site began in March 2010.

This same technique has worked successfully at Young Nicks Head, near Gisborne. Decoys and a sound system were deployed in September 2008; by mid October an average of 30–45 gannets were on the ground at any one time, and in early December 2008 over 200 gannets were present, extending 100 metres either side of the decoys (www.ecoworks.co.nz/Gannets.htm). The first eggs (six) were found in January 2010, but no chicks fledged in 2010 (Steve Sawyer pers. comm.).

### *Pied shag*

Pied shags began roosting in the macrocarpas north of the boatshed in 2006, with up to 30 birds present most nights. Chicks were first recorded in April 2010 (Sue Caldwell pers. comm.). The colony is a major nutrient point-source, and attempts have been made to establish Cook's scurvy grass within the 'halo'.

### *Little shag*

Little shags no longer roost above the pond in lower House Valley, but often roost next to the landing pad and with the pied shags in the macrocarpas.

## 3.3 ECOSYSTEM LEVEL RESTORATION GOALS IDENTIFIED IN THE *MANA ISLAND ECOLOGICAL RESTORATION PLAN*

*The primary restoration goal for Mana Island is to maintain those threatened species and communities that have survived on Mana Island within self-sustaining ecosystems similar to those likely to have existed on the island before human contact.*

Secondary restoration goals (where these are compatible with the primary goal) are:

- Recreate coastal forest, shoreline, cliff and wetland plant communities typical of the Wellington coast and similar to those expected to have occurred on the soils and landforms present on Mana Island, using seed sources as close as possible to (if not on) Mana Island
- As far as possible, restore invertebrate communities typical of the plant communities created
- Eradicate/control animals and plants which would severely compromise other restoration goals
- Maintain grassland at priority archaeological sites to enhance interpretation and site preservation

The *Mana Island ecological restoration plan* identified six key restorative actions required to provide the basis for recreating viable ecosystems on Mana Island representative of what may have existed on the island prior to human disturbance. These were considered fundamental to restoring ecosystem viability because of the species and processes that are dependent on their successful implementation.

### 1. Restore forest

It is presumed that most of Mana Island was forested originally. Restoration of forest to at least a third of the island will provide habitat for many plants, invertebrates, birds and reptiles, most of which are no longer present on the island and will have to be reintroduced. The original forest was likely to have been predominantly kohekohe, tawa, milktree, and northern rātā with associated tītoki, mahoe, pigeonwood, nīkau and emergent rimu.

### 2. Attract nesting seabirds

Terrestrial ecosystems on New Zealand islands that have never had introduced predators are dominated by the presence of dense nesting colonies of seabirds, especially burrowing petrels. These birds have an enormous impact on other components of the ecosystem through their burrowing, trampling, gathering of nest material and, especially, through the input of nutrients. The droppings, regurgitations and corpses generated by dense seabird colonies support dense and diverse communities of invertebrate scavengers and predators, which are in turn preyed on by lizards and birds. The top predator in these seabird-dominated ecosystems is the tuatara, which preys directly on the seabirds, as well as taking large invertebrates and lizards. Seabird burrows also provide sheltered microhabitats of relatively constant temperature and high humidity that provide homes for a diversity of obligate and facultative burrow-dwellers including cave and ground weta, skinks and tuatara.

### 3. Restoration of Waikoko wetland

Wetlands on islands are a rare habitat, and so there are few wetland habitats in New Zealand that are free of the effects of introduced mammals. Restoring the wetland on Mana Island will provide habitat for a variety of threatened wetland plants, locally extinct birds (especially brown teal) and possibly the threatened brown mudfish.

## ATTRIBUTES OF RESTORED ECOSYSTEMS IDENTIFIED BY THE SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL

The following text is extracted from: Society for Ecological Restoration International Science & Policy Working Group, 2004. *The SER International Primer on Ecological Restoration*. www.ser.org and Tucson: Society for Ecological Restoration International.

Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability.

Restoration attempts to return an ecosystem to its historic trajectory. Historic conditions are therefore the ideal starting point for restoration design. The restored ecosystem will not necessarily recover its former state, since contemporary constraints and conditions may cause it to develop along an altered trajectory.

### Definition of Ecological Restoration

*Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.*

### Attributes of Restored Ecosystems

An ecosystem has recovered—and is restored—when it contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy. It will sustain itself structurally and functionally. It will demonstrate resilience to normal ranges of environmental stress and disturbance. It will interact with contiguous ecosystems in terms of biotic and abiotic flows and cultural interactions.

The nine attributes listed below provide a basis for determining when restoration has been accomplished. The full expression of all of these attributes is not essential to demonstrate restoration. Instead, it is only necessary for these attributes to demonstrate an appropriate trajectory of ecosystem development towards the intended goals or reference. Some attributes are readily measured. Others must be assessed indirectly, including most ecosystem functions, which cannot be ascertained without research efforts that exceed the capabilities and budgets of most restoration projects.

## 4. Reintroduce avian pollinators and seed dispersers

The composition and distribution of tree and shrub species within the forest on Mana Island will reflect the minds and methods of the people who created it for many decades. Over time the natural processes of pollination, seed dispersal, germination and seedling survival will gradually create a more natural forest, with local community structure suited to the microclimate at each site. While there are many potential invertebrate

1. The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
2. The restored ecosystem consists of indigenous species to the greatest practicable extent.
3. All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonise by natural means.
4. The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.
5. The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.
6. The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.
7. Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.
8. The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.
9. The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions. Nevertheless, aspects of its biodiversity, structure and functioning may change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

Other attributes gain relevance and should be added to this list if they are identified as goals of the restoration project. For example, one of the goals of restoration might be for the restored ecosystem to provide habitat for rare species or to harbour a diverse gene pool for selected species. Other possible goals of restoration might include the provision of aesthetic amenities or the accommodation of activities of social consequence, such as the strengthening of a community through the participation of individuals in a restoration project.

pollinators on the island, the only bird pollinators present at the time the plan was written were recently arrived generalists such as silvereyes and starlings, rather than species like bellbird, tūī and kākā that co-evolved with New Zealand forest plants. Similarly with seed dispersal, introduced passerines and silvereyes can only cope with small fruits, while the re-establishment of kererū will ensure a seed dispersal agent is present for the large-fruited dominant canopy species tawa and kohekohe.

### 5. Introduce a diversity of forest-dwelling invertebrates

Invertebrates have crucial roles in nutrient cycling and pollination as well as providing a prey source for most vertebrates proposed for introduction. Diverse invertebrate communities are essential for the functioning of terrestrial ecosystems, providing (along with fungi) the means by which organic material is broken down and made available to plants or higher trophic levels. The sheer number of invertebrate species present in a healthy ecosystem is far too vast to consider a species-by-species approach to restoration. The community approach advocated in the *Mana Island ecological restoration plan* should ensure that the dominant invertebrate species characteristic of the main forest types (kohekohe and tawa-dominated) are restored to Mana Island.

### 6. Weed control

There is a real risk that plant communities on Mana Island will become dominated by inappropriate species before restoration has proceeded sufficiently far for natural processes to ensure the spread of plant species typical of the eastern Cook Strait Ecological District. While there will be a long term need for maintenance control of aggressive weed species, intensive weed control is crucial during the early stages of ecological restoration on Mana Island. Continual vigilance will be required to ensure that colonising (and recolonising) weed species are destroyed before they become established.

## 3.4 PROGRESS WITH RESTORING ECOSYSTEMS ON MANA ISLAND

Mana Island terrestrial and freshwater habitats can be grouped into four broad categories: shorelines and cliffs; forest and shrublands; grasslands; and wetlands. Of these, grasslands are an artefact of the island's farming history. With the exception of weed control and the intended removal of woody vegetation from a few identified archaeological sites (awaiting detail in historic site maintenance plans), Mana Island's remaining grasslands are essentially unmanaged. Most such areas are slowly reverting to native shrubland and forest, while providing habitat for grassland fauna in the interim. Grasslands have therefore been left out of the following analyses, which have focussed on the three other main ecosystem types, which are all being managed to restore indigenous biodiversity and ecosystem processes.

Progress with restoring Mana Island terrestrial and freshwater ecosystems was assessed qualitatively using the Society for Ecological Restoration International *Primer on Ecological Restoration* (see text box).

The SERI nine key attributes of restored ecosystems were used to assess progress with restoration in each of the three main habitats on Mana Island, by modifying the attributes into an eleven-point scoring system where -5 is a totally degraded or non-existent state, and +5 represents an hypothetical pristine state with essentially intact indigenous communities

and natural ecosystem processes. In practice, a positive score signifies that the restored ecosystem is tracking towards the desired or reference state, while a negative score indicates deteriorating condition away from the desired or reference state.

1. **The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.**

### *Shorelines and cliffs*

The shorelines and cliffs on Mana Island have been left largely to regenerate naturally, and are predominantly covered in native shrubs and vines and a mixture or introduced and native grasses and sedges. The proportion of shrubland to grassland varies around the island, but at all sites is trending towards increased indigenous cover. Extensive rocky bluffs add to the overall impression of natural landscapes. Later successional stages on beach and coastal margins are very rare nationally (Nick Singers pers. comm.) and so Mana Island is a site where these could be restored. Widespread woody weeds (principally boxthorn) have been reduced to a negligible component. Invertebrate and reptile communities are abundant and diverse, though some iconic reptile species are rare (McGregor's skink, spotted skink and Duvaucel's gecko have restricted distributions) or absent (tuatara and Whitaker's skink). Nesting blue penguins, gulls and terns are in expected densities, but burrowing-nesting petrels have very restricted distributions.

Score = 4.

### *Forest and shrublands*

The restored forests and shrublands on Mana Island were designed to replicate the structure and composition of forest remnants growing on similar soils on the nearby mainland (Miskelly 1999). Eco-sourced seeds and cuttings have been consistently used, and the restored habitats are almost entirely comprised of appropriate indigenous species. Interplanting of plant species (including podocarps) that require shelter and shade to establish was initiated in 2002. North Island robins and yellow-crowned parakeets have been introduced, and reintroductions of bellbirds and whiteheads are planned for May 2010. Tūī have recolonised naturally, with breeding confirmed in 2009/10. Kererū and morepork are seen regularly in small numbers, but are not thought to be resident or breeding. Both shining and long-tailed cuckoos are often present in spring and summer, but the latter does not have a breeding host until whiteheads are established. Kiwi, kākā and snipe are not yet present.

The forest is still at an early stage, and intended canopy species (kohekohe, tawa, milktree, northern rātā and podocarps) are minor components, although planted kohekohe, northern rātā and milktrees are already producing viable seeds. There is limited decaying timber within the forest, and the duff layer is poorly developed. Invertebrate communities are poorly known, but are unlikely to be representative of natural kohekohe, tawa and podocarp forests due to the long absence of host species and habitats.

Score = 3.

### *Wetlands*

The wetlands on Mana Island were artificially constructed in 1998 using stopbanks and weirs to replace farm drains and re-create a system analogous to ponds forming in and behind natural landform features (e.g., depressions and landslips). While considerable hydrological planning was included in their design, the reference ecosystem was not clearly articulated. This was deliberate, as it was recognised that the newly formed wetlands would need to settle into a definable hydrological regime before they could be compared to e.g., different wetlands on Kapiti Island. This reference comparison has not yet been done, but is a necessary step before further restoration of the wetlands is attempted.

Initial plantings of indigenous wetland species have been undertaken, but the bared sites were rapidly invaded by predominantly weedy species (especially the extremely aggressive, smothering greater bindweed *Calystegia silvatica*). Swampland tree species (kahikatea, pukatea, swamp maire) are absent or present only as recent plantings. Freshwater invertebrate communities have not been studied, and the freshwater fish community is almost non-existent (a few longfin eels have been seen). Native wetland birds include pukeko, paradise shelduck, welcome swallow and re-introduced brown teal. Mallards are present, replacing the ecologically similar native grey duck. Other native bird species occasionally using the wetlands include takahē, shore plover, spur-winged plover and pied stilt. Fernbird, banded rail and crakes are absent. Shags and herons are present on the island; their limited use of the wetlands reflects the absence of fish within the wetlands.

Score = 2.

## 2. The restored ecosystem consists of indigenous species to the greatest practicable extent.

### *Shorelines and cliffs*

Woody weeds have been reduced to a negligible component. Remaining introduced grasses are not being managed, and are gradually being overtopped by native shrubs and vines. Introduced fauna are a minor component, other than nesting and roosting rock pigeons and starlings. The cliff and shoreline communities are essentially similar to other Cook Strait islands that have had more time to recover from human disturbance (e.g., Kapiti Island and Takapourewa).

Score = 5.

### *Forest and shrublands*

Woody weed species (e.g., tree lucerne, karo) have been reduced to a negligible component. Remaining introduced grasses are being overtopped by planted and regenerating shrubs and trees. Invertebrate communities are predominantly indigenous, and the reptile community entirely so. Birds are a mix of native and introduced species, with natives expected to become increasingly dominant as the forest matures. Many introduced birds are likely to persist due to nearby grassland and shrubland, and the extensive edge in relation to patch size of the Mana Island forest. Blackbirds and chaffinches (at least) are expected to remain common in

Mana Island forests, along with very large night-time roosts of starlings that fly from the mainland each evening and depart in the morning. Further native bird species can be re-introduced, or will colonise naturally.

Score = 3.

### *Wetlands*

The wetlands on Mana Island have limited floristic and faunistic diversity. The vegetation growing on seasonally inundated margins is a mixture of native and introduced species. Similarly the birds using the margins are a mix of native and introduced species (the latter mainly finches plus mallard ducks). The indigenous component will increase as native shrubs and trees establish, but some species of plants, fish, invertebrates and possibly birds will require translocation.

Score = 1.

## 3. All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonise by natural means.

### *Shorelines and cliffs*

Most functional groups are widespread and at expected densities. Exceptions are burrow-nesting petrels and large-bodied lizards (limited distribution), and tuatara (top predator, absent). Petrels would be expected to dominate the ecology of cliff-tops and all areas on cliffs that have sufficient soil depth for burrows, providing marine-sourced nutrients, aerating soil, and providing habitat (sheltering burrows with stable temperature and humidity) for invertebrates and reptiles. Most missing or rare species have the potential to colonise or expand their range with minimal intervention. Tuatara and Whitaker's skink will need to be re-introduced; ongoing effort is required to attract petrels.

Score = 4.

### *Forest and shrublands*

Many plant species typical of kohekohe, milktree, tawa and podocarp forest communities are absent, and may need to be physically restored when the forest is sufficiently mature (e.g., sedges, filmy ferns and other ferns, lianas and epiphytes). Burrow-nesting petrels are absent from Mana Island forests, and will take many decades to spread from their current cliff-top toeholds. Native forest bird communities are depauperate, and require further introductions and colonisations. Tuatara and at least one forest-dwelling lizard (robust skink) are absent, and most other forest-dwelling lizards are rare or localised (including Wellington green gecko, Duvaucel's gecko, speckled skink and McGregor's skink). Invertebrate communities probably lack many species typical of kohekohe, tawa and podocarp forest communities, and the same is likely to apply to fungi, bacteria and other soil-dwelling organisms.

Score = 2.

### *Wetlands*

Trophic flows within Mana wetlands have not been defined nor compared with a reference system. Freshwater invertebrate communities need to be described and compared with those on Kapiti Island and on the adjacent mainland. Similarly, the expected fish community needs to be described. All five freshwater fish species known from Kapiti Island are diadromous. Other than during winter and spring floods, Waikoko stream rarely has sufficient flow to reach the sea other than through beach gravels, and so physical barriers to fish migration need to be considered if any are to be introduced. Banded rails and the two crake species could potentially colonise naturally, but all three are rare near Wellington.

Score = 0.

## 4. The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.

### *Shorelines and cliffs*

The shorelines and cliffs of Mana Island are in a predominantly natural state, with largely intact and improving native vegetation cover, abundant lizards and native invertebrates, and locally common seabirds (gull and tern colonies, some petrel colonies, widespread nesting penguins). Provided habitat-altering weeds continue to be suppressed, the physical environment is ideally suited for all native species present or intended for restoration.

Score = 5.

### *Forest and shrublands*

The restored forests and shrublands on Mana Island are comprised of appropriate indigenous species for forest establishment on the desired trajectory towards kohekohe, milktree, tawa and podocarp forest communities. The current absence of burrow-nesting seabirds in Mana Island forests will result in infertile soils (compared to e.g., Takapourewa forest) and relative absence of microhabitats for burrow-inhabiting invertebrates and reptiles. Many plants and invertebrates will not establish until the forest is more mature, providing such niches as deep moist litter, decaying trunks and branches, large forks and horizontal branches for epiphyte establishment, and the full diversity of forest plants for host-specific invertebrates. Some forest bird species may not be able to establish until the forest is more diverse (e.g., kākā and possibly kererū), and long-tailed cuckoos could not establish unless their host species whitehead is established. Score = 3.

### *Wetlands*

The reference state and therefore the desired trajectory for Mana Island wetlands are ill-defined. Provided the reference state selected is appropriate for the current hydrological regime of the wetlands, the physical environment should remain essentially unchanged and the wetlands should develop along the desired trajectory.

Score = 4.

## 5. The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.

### *Shorelines and cliffs*

The shoreline and cliff ecosystem on Mana Island is dominated by natural processes, including coastal processes (wave action, storm events, air-borne salt), natural regeneration of native shrubs and vines, disturbance and nutrient input from a diversity of seabirds, and erosion by wind, rainfall run-off and earthquakes. The ecosystem is robust, and will continue to improve if weeds are maintained at low densities, and seabirds continue to recover.

Score = 5.

### *Forest and shrublands*

The restored forests and shrublands on Mana Island are vigorous and healthy, with only local die-off due to summer dry conditions and wind-borne salt. Floristic diversity is low (particularly among non-woody species), and it is likely that low native invertebrate and vertebrate diversity limits some mutualistic processes (e.g., if plants require specialist pollinators or seed dispersers). Steps are being taken to rectify this, with tūī and kererū more regularly present and in larger numbers as the forest matures, and plans to re-introduce bellbirds starting in 2010.

Score = 3.

### *Wetlands*

The Mana Island wetlands show extreme seasonal variation in water levels, as expected for an island with low summer rainfall. Seasonally inundated areas have many weed species, and these will need to be managed as native plant communities are restored. Until the desired reference state is defined, it is difficult to determine whether Mana Island wetland ecosystem is functioning normally.

Score = 2.

## 6. The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.

### *Shorelines and cliffs*

The shoreline and cliff ecosystem on Mana Island is well integrated with the surrounding marine and terrestrial ecosystems. Nutrients arrive from the marine environment via storm-wrack, airborne particles, and seabird and fur seal droppings, regurgitations and corpses. Nutrients enter the marine environment from the land via point-source run-off, wind-blown particles, coastal and earthquake-induced erosion (including rock falls and dislodged vegetation), and birds returning to sea with soil and vegetation adhering to them. Nutrients, seeds and faunal propagules move readily between the adjacent grassland and forest/shrub ecosystems via wind, surface water flow, and the movements of birds, reptiles and invertebrates.

Score = 5.

### *Forest and shrublands*

The restored forests and shrublands on Mana Island are reasonably well integrated with the surrounding marine and terrestrial ecosystems. Nutrients arrive from the marine environment via airborne particles, and penguin droppings, regurgitations and corpses. Nutrients enter the marine environment from the land via point-source run-off, wind-blown particles, and penguins returning to sea with soil and vegetation adhering to them. Nutrients, seeds and faunal propagules move readily between the adjacent grassland and coastal ecosystems via wind, surface water flow, and the movements of birds, reptiles and invertebrates.

Score = 5.

### *Wetlands*

The restored wetlands on Mana Island are reasonably well integrated with the surrounding marine and terrestrial ecosystems. Nutrients arrive from the marine environment via airborne particles, and bird droppings. It is not known whether diadromous fish are regularly able to enter the wetlands, although eels are clearly able to do so occasionally. Options for fish movement need to be considered during definition of a reference ecosystem. Nutrients enter the marine environment from the wetlands via the Waikoko stream outlet, wind-blown particles, and waterfowl moving to the sea with sediment and vegetation adhering to them. Nutrients, seeds and faunal propagules arrive from adjacent terrestrial ecosystems via gravity, wind, surface water flow, and the movements of birds, reptiles and invertebrates.

Score = 4.

## 7. Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.

### *Shorelines and cliffs*

Farm stock were progressively fenced off from the cliffs and shoreline, and finally removed in 1986. Mice were eradicated in 1989, and rigorous biosecurity measures are in force (Brown *et al*. 2004). Major weeds have been reduced to low densities both on the cliffs and shoreline and in adjacent habitats. The risk of fire is managed through controlled public access, and well-established protocols restricting smoking to safe environments, and limiting use of machinery during times of high fire risk.

Score = 5.

### *Forest and shrublands*

Farm stock were removed in 1986, and revegetation initiated. Mice were eradicated in 1989, and rigorous biosecurity measures are in force (Brown *et al*. 2004). Major weeds have been reduced to low densities. The risk of fire is managed through controlled public access, and well-established protocols restricting smoking to safe environments, and limiting use of machinery during times of high fire risk.

Score = 5.

### *Wetlands*

Farm stock were removed in 1986, mice were eradicated in 1989, and rigorous biosecurity measures are in force (Brown *et al*. 2004). Physical restoration of the wetlands started in 1998. Weed invasion continues to be a threat. The risk of fire is managed through controlled public access, and well-established protocols restricting smoking to safe environments, and limiting use of machinery during times of high fire risk.

Score = 4.

## 8. The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.

### *Shorelines and cliffs*

The shoreline and cliff ecosystem on Mana Island is extremely resilient to the frequent strong winds, summer drought, and storm events.

Score = 5.

### *Forest and shrublands*

The restored forests and shrublands on Mana Island are resilient to the frequent strong winds, summer drought, and storm events.

Score = 5.

### *Wetlands*

The restored wetlands on Mana Island are expected to be resilient to the frequent strong winds, summer drought, and storm events, and these will need to be factored into the reference ecosystem.

Score = 4.

## 9. The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions.

### *Shorelines and cliffs*

The shoreline and cliff ecosystem on Mana Island is substantially similar to that on e.g., Takapourewa, other than the current rarity of burrow-nesting petrels and large-bodied reptiles on Mana Island. Provided the current efforts to suppress weeds and attract petrels are maintained, the ecosystem will persist indefinitely.

Score = 5.

### *Forest and shrublands*

The restored forests and shrublands on Mana Island are immature and lack the floristic and faunal diversity found on e.g., Kapiti Island. Some species of plants, birds and insects may colonise naturally as the forest matures, but many species will have to be re-introduced. In the absence of ongoing planting, faunal introductions and some weed control, Mana Island forest may never achieve the structure and complexity of the reference ecosystem.

Score = 2.

### *Wetlands*

The restored wetlands on Mana Island are immature and lack the floristic and faunal diversity found on e.g., Kapiti Island. Some species of plants, fish, birds and invertebrates may colonise naturally as the wetlands mature, but some species will have to be re-introduced. In the absence of ongoing planting, faunal introductions and weed control, Mana Island wetlands may never achieve the structure and complexity of the yet-to-be-defined reference ecosystem. Score = 2.

## **Overall scores** (from maximum possible 45, and minimum -45)

### *Shorelines and cliffs*

Score = 43. The shoreline and cliff ecosystem on Mana Island is healthy and robust, with extensive and increasing indigenous cover, few habitat-altering weeds, and abundant and diverse invertebrate and lizard communities. A diversity of seabirds provides nutrient inputs from the marine environment, although burrow-nesting seabirds other than penguins currently have restricted distributions. Further reptile introductions are planned, and weed control will need to continue.

### *Forest and shrublands*

Score = 31. The forests and shrublands on Mana Island are healthy, but are at a youthful stage, requiring several decades of growth and management to increase the diversity of plants, vertebrates and invertebrates. Weed spread and reinvasion is manageable, but will require ongoing commitment.

### *Wetlands*

Score = 23. The main wetlands on Mana Island have been created since 1998, and suffer from a lack of information on what types of indigenous wetland communities would be expected to develop at such sites. Development of a reference model, and further floral and faunal introductions towards achieving the model, could rapidly increase the overall restoration score. The potential fish and invertebrate communities should be a focus of the reference model. Weed management will continue to require attention until indigenous wetland plant communities are sufficiently robust to withstand reinvasion.

## Potential future work

1. Continue suppression of priority weed species in all habitats.
2. Continue efforts to restore and attract burrow-nesting seabirds to Mana Island.
3. Develop and implement a restoration model for Waikoko wetland.
4. Increase the floral diversity of forests and wetlands through the introduction of eco-sourced plants into appropriate microhabitats.
5. Investigate methods to increase the diversity of invertebrate communities as forests mature.
6. Promote Mana Island as a research site for invertebrate and fungal community restoration, and wider ecological community research.

## 3.5 SPECIES LEVEL RESTORATION GOALS IDENTIFIED IN THE *MANA ISLAND ECOLOGICAL RESTORATION PLAN*

*The primary restoration goal for Mana Island is to maintain those threatened species and communities that have survived on Mana Island within self-sustaining ecosystems similar to those likely to have existed on the island before human contact.*

Secondary restoration goals (where these are compatible with the primary goal) are:

- Establish self-maintaining populations of threatened plants of the Wellington coast of Cook Strait appropriate to the habitats present on Mana Island, using seed sources as close as possible to the island (but further afield if the species are extinct in the Wellington region)
- Reintroduce or encourage colonisation by all native animal species known to have previously occurred on Mana Island
- Introduce (or reintroduce) threatened and locally extinct vertebrates of the southern North Island that are not able to exist in the presence of introduced mammals, and are likely to have occurred in coastal habitats in the Wellington region
- Where previously occurring vertebrate taxa are extinct, introduce an ecologically similar conspecific or congeneric taxon (if one exists within New Zealand) to restore trophic processes and lost evolutionary potential
- Introduce (or reintroduce) threatened macro-invertebrates appropriate for an island in eastern Cook Strait
- Eradicate/control animals and plants which would severely compromise other restoration goals

### 3.5.1 Progress with restoring diversity to Mana Island ecosystems

Progress with restoring individual species to Mana Island was assessed by reviewing specific research and management actions identified to be achieved by 2010 in the *Mana Island ecological restoration plan*. These were assessed under the headings Threatened plants; Birds; Reptiles; Freshwater fish; and Invertebrates. Comment is made on progress with restoration, and also developments on Mana Island and at other sites that may influence the desirability or achievability of the identified restoration actions.

### 3.5.2 Threatened plants

The *Mana Island ecological restoration plan* listed 73 plant species that were either nationally or regionally threatened, and may be suitable for restoration on Mana Island (see tables 7.1 to 7.3 in Miskelly 1999). Of these, at least 22 have been planted on Mana Island; 19 are known to be thriving as planted specimens, but only seven are currently regenerating unaided on Mana Island (Table 1).

If Mana Island's potential for threatened plant conservation is to be fully realised, much more effort is needed to identify species suitable for establishment, to identify suitable microhabitats for each species, and to identify (and if necessary manage) factors limiting regeneration. The goal for each species should be the establishment of a viable population producing multiple generations without the need for ongoing management.

### *Potential future work*

1. Develop and implement a threatened plant action plan for Mana Island (see DOCDM-552814)

TABLE 1. NATIONALLY OR REGIONALLY THREATENED PLANT SPECIES PLANTED ON MANA ISLAND.
'Thriving' refers to the original planted specimens only. 'Regenerating' refers to species known to be producing healthy seedlings, or spreading vegetatively.

| SPECIES | THRIVING? | REGENERATING? |
|---|---|---|
| *Carex litorosa* | Yes | |
| *Coprosma acerosa* (sand coprosma) | Yes | |
| *Discaria toumatou* (matagouri) | Yes | |
| *Dodonaea viscosa* (akeake) | Yes | Yes |
| *Doodia squarrosa* | Yes | |
| *Entelea arborescens* (whau) | Yes | Yes |
| *Euphorbia glauca* (shore spurge) | Yes | Yes |
| *Fuchsia perscandens* | | |
| *Gahnia rigida* | Yes | |
| *Hebe elliptica* var. *crassifolia* | Yes | Yes |
| *Ileostylus micranthus* (pirita) | | |
| *Lepidium oleraceum* (Cook's scurvy grass) | Yes | |
| *Leptinella nana* | Yes | Yes |
| *Melicytus obovatus* | Yes | Yes |
| *Muehlenbeckia astonii* (shrubby tororaro) | Yes | |
| *Pimelea* aff. *aridula* Pipinui Point | Yes | |
| *Rubus squarrosus* | Yes | |
| *Sophora molloyi* (Cook Strait kōwhai) | Yes | |
| *Sophora chathamica* (kōwhai) | Yes | |
| *Streblus banksii* (large-leaved milk tree) | Yes | Yes |
| *Trisetum antarcticum* | Yes | |
| *Tupeia antarctica* (tupia) | | |

## 3.5.3 Birds

The *Mana Island ecological restoration plan* recommended 18 bird species to attract or translocate to Mana Island. Of these, specific effort on the island has been made with 9 species (little spotted kiwi, fluttering shearwater, fairy prion, diving petrel, Australasian gannet, brown teal,

shore plover, yellow-crowned parakeet and North Island robin), attempts have been made to locate a suitable source population for fernbird, and there is a current proposal to translocate whiteheads and bellbirds to Mana Island from Kapiti Island in April 2010. Two further species—kererū and tūī—have colonised the island naturally, with tūī being seen regularly, and believed to have bred in 2009/10. No effort has yet been made with banded rail, Chatham Island snipe, North Island kākā or rock wren.

## Species accounts

### *Kiwi*

A kiwi was present on Mana Island from October 1992 to June 2006. This bird (a male, from Franz Josef) was thought to be a little spotted kiwi when it was released on Mana Island, but genetic comparisons revealed it to be a little spotted kiwi x rowi hybrid. A female little spotted kiwi was moved to Mana Island from Kapiti Island in June 1994 as a potential mate; it was last heard c.1998, and the birds apparently never bred. In 2006 the male was moved to Allports Island in Queen Charlotte Sound, to pair with a female little spotted kiwi × rowi hybrid found more recently in Okarito Forest, thereby making Mana Island available for another kiwi taxon.

Ancient mitochondrial DNA analysis of kiwi bones (Shepherd & Lambert 2008) has revealed that rowi—which are now confined to Okarito—formerly occurred from there through to southern Hawke's Bay, and were the 'brown kiwi' represented in bones from Wairarapa. The Kiwi Recovery Group has therefore recommended that rowi (threat ranking Nationally Critical; Miskelly *et al*. 2008) be translocated to Mana Island, but this has yet to occur.

### *Burrow-nesting petrels*

Progress with restoring burrow-nesting petrels to Mana is summarised in Section 3.2. Diving petrels have been breeding on the island for over ten years, but the population remains small and reliant on ongoing immigration. The fairy prion population is more precarious, although 19 of the translocated chicks returned to Mana Island, so far only four unbanded birds have been attracted, and this is probably insufficient for a population to establish. The prospects for fluttering shearwaters to establish are better, with three unbanded birds attracted to the sound systems before the first chicks returned. Translocated chicks are expected back from 2010.

Methods for translocating petrels are now well known, with Mana Island proving invaluable as a testing ground for techniques subsequently applied to more endangered petrel species (Miskelly *et al*. 2009). It is now known for both diving petrel and fairy prion that the length of time they are at the release site (Mana Island) does not affect the return rate, and so future translocations of these species could target only large chicks, shortening the time that they need to be cared for at the release site.

Ongoing maintenance of automatic sounds systems to broadcast calls, and possibly the installation of further sound systems, is vital for assisting the re-establishment of burrow-nesting petrels on Mana Island, and thereby

regain the benefits that they provide as ecosystem engineers. Further fairy prion translocations may be necessary if this species is to establish on Mana Island, but large numbers of birds would need to be moved based on the 8% return rate from the 240 chicks translocated during 2002–04.

### *Australasian gannet*

Attempts to attract gannets to Mana Island are described in Section 3.2. There is still potential for this technique to work, based on the recent very successful project at Young Nicks Head. If the Mana Island site is to be attractive to gannets, it will need an annual work programme to keep the site free of vegetation, to maintain the decoys in good condition, and to maintain the appearance of guano as a long-distance visual attractant for gannets flying near the island.

### *Brown teal*

The Mana Island brown teal population is descended from 16 captive-reared birds: nine released on 14 Aug 2000 (two years after the construction of Waikoko wetland), one on 3 Nov 2000, and six on 25 July 2001. Many ducklings have been produced, but the population remains small, indicating that habitat is limiting for this very territorial duck.

### *Banded rail, spotless crake and marsh crake*

None of these three small rail species has yet been recorded on Mana Island, but all three species are capable of dispersing long distances, and may arrive naturally. Occasional surveys using playback of calls should be undertaken around Waikoko wetland.

### *Takahē*

The takahē is the one bird species on Mana Island whose presence conflicts with other restoration goals (Miskelly 1999). The island currently holds about 20% of the world population of this iconic bird, which has a threat ranking of Nationally Critical (Miskelly *et al*. 2008). Takahē prefer a mosaic of grassland and shrubland to pure forest, and this was a major reason behind the decision not to restore forest to all of the interior of Mana Island.

Long-term maintenance of a large takahē population on Mana Island will require ongoing habitat manipulation, with removal of woody vegetation from islands of grassland. While this may prove necessary, it is expected that increasingly large areas of non-forested habitat on mainland New Zealand will be cleared of mammalian predators through the use of exclosure fences, and that the importance of small islands for the takahē recovery programme will eventually diminish.

### *Shore plover*

Captive-reared shore plover (threat ranking Nationally Critical; Miskelly *et al*. 2008) from the National Wildlife Centre (Mount Bruce) and Isaac Wildlife Trust (Christchurch) have been released on Mana Island since March 2007, and the programme is continuing. As of February 2010, 125 birds had been released. The source of the captive population was eggs harvested from RaNgātira Island, and a single wild-caught male from

Western Reef (both sites in the Chatham Islands; Dowding *et al*. 2005). At the start of the 2009/10 breeding season, 26 birds were resident on Mana Island; six pairs attempted to breed, producing seven fledglings (R. Collen & H. Gummer pers. comm.). The release programme is likely to continue for at least one further year.

### *Chatham Island snipe*

The snipe recovery plan recommended that Chatham Island snipe be introduced to islands adjacent to the North Island to provide an ecological replacement for the extinct North Island snipe, and identified Mana Island as a possible site to attempt this (Roberts & Miskelly 2003). This would have the added benefit of improving the conservation status of a species currently ranked as Nationally Vulnerable (Miskelly *et al*. 2008).

Mana Island provides ideal habitat for snipe (Miskelly 1999), but it is anticipated that the Chatham Island community will be reluctant to support translocation of this endemic taxon away from the Chatham Islands. A partnership between the Chatham Islands community, iwi, Friends of Mana Island and the Department may be required to complete this task.

### *Kererū*

Kererū have been seen increasingly frequently on Mana Island since c.2005, with several sightings of two or three birds at a time. They are not thought to be present year-round, nor is there yet any evidence of breeding, but it is clear that kererū are capable of colonising Mana Island, and will probably establish a resident population when the forest matures sufficiently.

### *Kākā*

There have not yet been any sightings of kākā on Mana Island, but they may reach the island from their local strongholds on Kapiti Island and in Karori Sanctuary (both 22 km away). It is likely to be many years before Mana Island forests produce sufficient fruit, nectar and wood-boring insects to support a resident kākā population, and so translocation is not recommended until the forest is more mature (and then only if the birds don't colonise naturally).

### *Yellow-crowned parakeet*

Twenty-seven yellow-crowned parakeets from Te Kākāho (Outer Chetwode Island) were released on Mana Island on 12 May 2004. The population established rapidly, and parakeets are now abundant and widespread on Mana Island.

### *Rock wren*

Initial attempts to translocate rock wren to Anchor Island in Fiordland were unsuccessful (28 birds translocated in 2005). Efforts were also made to establish rock wrens on Secretary Island in 2008 and 2009, with at least 24 birds translocated (www.doc.govt.nz/conservation/land-and-freshwater/australasias-top-25-restoration-projects/fiordland-islands-restoration/project-

implementation/). Unless rock wren can be established on a mammal-free island in Fiordland, it is unlikely that they will be available for translocation to more northern sites.

### *Fernbird*

North Island fernbird was one of the target species for which Waikoko wetland was constructed on Mana Island. This taxon has disappeared from the southern North Island, with the nearest population being on the north bank of the Manawatu Estuary. This population was surveyed by Emilio Tobón in 2005 under contract to the Friends of Mana Island Incorporated Society. Tobón (2005) estimated the population at 20 pairs, which is too few to sustain the 30–40 individuals usually sought during bird translocations. Also, the preferred habitat for fernbirds (dense shrubland growing over dense beds of reeds or sedges) have not yet developed (and may not develop) around Waikoko wetland. Some fernbird populations do thrive in more terrestrial habitats, but within the southern North Island there is currently better fernbird habitat on Kapiti Island, at Pauatahanui Inlet Wildlife Refuge, and around Lake Wairarapa.

### *Whitehead*

Approval has been granted for the Friends of Mana Island Incorporated Society to translocate 40–60 whiteheads from Kapiti Island to Mana Island in May 2010, concurrent with translocation of a similar number of bellbirds.

### *North Island robin*

Mana Island has a population of approximately 80 North Island robins, which are the descendants of 66 birds translocated from Kapiti Island in 1995 and 1996 (Empson & Miskelly 1999). The population is limited by the extent of closed-canopy forest, and will expand as plantings mature.

### *Bellbird*

Approval has been granted for the Friends of Mana Island Incorporated Society to translocate 40–60 bellbirds from Kapiti Island to Mana Island in May 2010, concurrent with translocation of a similar number of whiteheads. Bellbirds have apparently reached Mana Island on at least four occasions, but have not established a population. Known records include one on 27 or 28 Apr 1996 (Maree Hunt), one seen and another heard between 9 Sep and Oct 2005 (Tony Henry and Di Batchelor), one seen on 4 Jan 2008 (Grant Timlin, it had been heard for 2–3 weeks previous), and one heard 30 Jun 2008 (Grant Timlin). The sex of the birds seen was not recorded.

### *Tūī*

Tūī have recolonised Mana Island naturally and are now conspicuous on the island, albeit in low numbers compared to Kapiti Island and Karori Sanctuary. Evidence of breeding was detected during the 2009/10 breeding season, with recently fledged chicks seen (Frank Higgott pers. comm.). No targeted restorative action is needed for tūī, which are expected to increase further as plantings mature.

### Potential future work

1. Complete translocations of shore plover, whiteheads, bellbirds and rowi to Mana Island.
2. Monitor and confirm establishment of tūī and kererū, and maintain records of sightings of other vagrant and colonising species (e.g., kākā and red-crowned parakeets).
3. Continue to operate sound attraction systems for petrels, and monitor the establishment and spread of each species.
4. Assess the need for and practicality of further fairy prion chick transfers to Mana Island.
5. Restore and maintain the gannet colony
6. Survey for banded rail and crakes around wetlands.
7. Seek support for translocation of Chatham Island snipe to Mana Island.

## 3.5.4 Reptiles

Mana Island has a diverse reptile community, with six resident species, four translocated species, and three further species being considered for translocation (bones of two of the latter—tuatara and robust skink—have been found in archaeological deposits on the island; Miskelly 1999). Mana Island is the national stronghold for McGregor's skink and goldstripe gecko, both of which have natural populations that persisted on the island and that have increased greatly since mouse eradication. The other resident species are common gecko, copper skink, common skink and brown skink.

Lizard releases began on 25 Feb 1998, when nine Wellington green geckos, 21 Duvaucel's geckos and 50 spotted skinks were released. A further 19 Duvaucel's geckos were released on 27 Nov 1998, 48 speckled skinks were released on 17 Jan 2004, and a total of 47 green geckos had been released by 28 Apr 2005, when 20 ex-captive animals were released. The green geckos were sourced from populations between Pukerua Bay and Wainuiomata, the Duvaucel's geckos from North Brother Island, the spotted skinks from Matiu/Somes Island, and the speckled skinks from Takapourewa (Stephens Island).

Post-release survival and dispersal of spotted skinks on Mana Island were studied by Rachel Griffiths as part of an M.Con.Sci. study (Griffiths 1999). Post-release survival and dispersal of Duvaucel's geckos on Mana Island were studied by Nadia Jones as part of an M.Con.Sci. study (Jones 2000). Both species are considered well established on Mana Island, although recent sightings of Duvaucel's geckos have all been near the release site at the mouth of Forest Valley. There have been few post-release sightings of speckled skinks, and none confirmed for Wellington green gecko. Two apparently locally bred speckled skinks were caught at the release site on 15 Sep 2005, 20 months after their release (C. Miskelly pers. obs.).

Note that the *Mana Island ecological restoration plan* used the term '*Cyclodina* skinks' to collectively refer to McGregor's skink, Whitaker's skink and robust skink. The genus *Cyclodina* has since been synonymised with the other New Zealand skink genus *Oligosoma* (Chapple *et al.* 2009). The above three species are collectively referred to as 'nocturnal skinks' below.

Reptile research and management tasks identified in the *Mana Island ecological restoration plan* included:

- Survey for presence of McGregor's skink at the proposed robust skink release site and at the mouth of Tauhinu Valley (done)
- Annual monitoring of population growth and spread of McGregor's skink (ceased in 1999, but continued sporadically as part of other lizard research projects)
- 5-yearly monitoring of distribution of goldstripe gecko (achieved through Halema Flannagan's MSc research (Flannagan *et al*. 1999; 2000), and the Jan–Feb 2008 lizard survey led by Tony Whitaker)
- Monitor establishment and expansion of all reptile species introduced to Mana Island (ongoing)
- Research sympatry and niche overlap in nocturnal skinks (not done)
- Research interactions between speckled skink and nocturnal skinks (done for McGregor's skink before speckled skinks were released; Heap *et al*. 2003)
- Research sympatry and niche overlap in *Hoplodactylus* geckos (done for Duvaucel's gecko and goldstripe gecko; Flannagan *et al*. 1999; 2000)
- Complete translocations of: Cook Strait tuatara, Duvaucel's gecko, Wellington green gecko, robust skink, Whitaker's skink, spotted skink, and speckled skink (done for Duvaucel's gecko, Wellington green gecko, spotted skink and speckled skink; planning is well advanced for Whitaker's skink releases, using animals sourced from Pukerua Bay and currently held and being bred in captivity).

### Potential future work

1. Develop more efficient methods to survey for green geckos.
2. Monitor and confirm establishment of Wellington green gecko and speckled skink, and any future reptile translocations.
3. Complete translocations for tuatara, Whitaker's skink and robust skink.
4. Monitor population spread and contact zones for McGregor's skink, spotted skink and speckled skink.

## 3.5.5 Freshwater fish

Options for restoring or creating freshwater fish habitat on Mana Island are constrained by the absence of a restoration model for the main wetland area (Waikoko wetland). This includes establishing whether the wetland has sufficient above-ground flow to the sea for migration of diadromous fish species, or whether the hydrological regime in any of the ponds is suitable for the non-diadromous ('land-locked') brown mudfish. Mudfish are capable of aestivating during drought conditions, but are vulnerable to eel predation.

### Potential future work

1. Develop and implement a restoration model for Waikoko wetland.
2. Assess the suitability of Waikoko wetland for the introduction of brown mudfish, and introduce if suitable.

### 3.5.6 Invertebrates

The *Mana Island ecological restoration plan* recommended seven macro-invertebrate species for introduction. Of these, two species have been introduced:

Eighty flax weevils were transferred from Maud Island to Mana Island on 12 May 2004, and a further 70 on 15 June 2006 (total = 150). All were released in a small area alongside the southern track, near the main petrel colony. The weevils are well established; feeding sign is very apparent on flax leaves, and on calm nights it is easy to find ten or more weevils in as many minutes at the release site.

Forty-one Wellington speargrass weevils sourced from the Wellington south coast were released on Mana Island between 29 Mar 2006 (7 animals) and 19 Dec 2007 (9 animals). All were released into a dense patch of speargrass on the western cliff-top, just south of Lance's Gully (i.e. about 650 m south-southwest of the trig). Fresh feeding sign has been found since, but the animals themselves have been conspicuous by their absence.

The remaining macro-invertebrates recommended for introduction were the stag beetle *Lissotes reticulatus*, the giant pill millipede, and the large land snails *Rhytida greenwoodi*, *Wainuia urnula* and *Powelliphanta traversi otakia*. Habitat is not yet suitable for these species, which require establishment of forest, decaying timber and/or deep leaf litter. The almost complete absence of tree ferns on Mana Island is a limiting factor for land snails, which seek out the moist detritus that accumulates in dead tree fern fronds.

The *Mana Island ecological restoration plan* also recommended bulk introduction of forest invertebrates from Kapiti Island following canopy closure of the main canopy species kohekohe, milk tree and tawa (and also karaka, but this is no longer considered appropriate for large-scale establishment on Mana Island, as it is not considered native to the island). Canopy closure of kohekohe and tawa and creation of dead wood habitat has yet to occur, and so it is premature to consider introduction of invertebrates typical of kohekohe, milk tree and tawa forest.

#### Potential future work

1. Increase the floral diversity of forests through the introduction of eco-sourced plants (including tree ferns) into appropriate microhabitats.
2. Monitor and confirm establishment of Wellington speargrass weevils.
3. Translocate flax weevils within Mana Island to the vicinity of Waikoko wetland.
4. Investigate methods to increase the diversity of invertebrate communities as forests mature

# 4. Assessment of the preliminary draft Conservation Management Strategy to identify principles and actions that should be incorporated in the restoration plan

Kapiti and Mana Islands are together identified as one of eight significant "places" in the draft Wellington CMS (prepared before Wellington Hawke's Bay Conservancy amalgamation).

Text, outcomes, objectives, policies and milestones relevant to Mana Island in the preliminary draft are reproduced here:

"…Mana Island Scientific Reserve is the most complex and ambitious ecological restoration project in the CMS area. Farmed for nearly 150 years, the island has been free of introduced mammals since the last stock were removed in 1986, and mice eradicated in 1989. Threatened species that persisted on the island include nationally significant populations of Cook Strait giant weta, McGregor's skink and goldstripe gecko. Over half a million trees have been planted, with much of the effort provided by volunteers organised by Forest & Bird, and the Friends of Mana Island Society (FOMI). Guided by the *Mana Island ecological restoration plan* (1999), FOMI also works closely with the department to achieve species reintroductions, plantings of rare, naturally uncommon and threatened species, and weed control. The island is notable for its diverse lizard community (10 species, 4 of which have been introduced) and pioneering research into methods to translocate burrow-nesting seabirds. Other introduced or reintroduced fauna include takahē, robin, brown teal, yellow-crowned parakeet, shore plover, flax weevil and Wellington speargrass weevil.

Mana Island is generally open to the public between 8:00 am and 5:00 pm, provided they land in the bay between the old woolshed and the wharf.

In addition to their importance to biological conservation, both Kapiti and Mana Islands have fascinating human histories, with many traces of Maori and European settlement remaining. Both islands had shore whaling stations in the 1820s and 1830s, and were then farmed before eventually being protected as reserves. This complex milieu of history, ecosystem protection and management, species conservation, community involvement, and recreational use is why these islands are of such high conservation value, and why their careful management is of intense interest to so many people.

## OUTCOMES – KAPITI AND MANA ISLANDS

1. Kapiti and Mana Islands continue to be showcases of New Zealand's biodiversity, natural heritage and conservation management. There are no introduced mammals, few invasive weeds, the forests are thriving, the birdlife is prolific and there is an abundance and diversity of other indigenous plants, reptiles, and invertebrates.
2. Visitors to these internationally important islands gain an appreciation of island habitat restoration and conservation management through interpretation, and through recreational opportunities that do not disturb the islands' habitats, biota, heritage or other visitors experiencing Kapiti and Mana Islands.
3. Tangata whenua, landowners and relevant community groups are actively involved in management of Kapiti and Mana Islands through collaborative partnerships.

## MANAGEMENT OBJECTIVES – KAPITI AND MANA ISLANDS

1. To conserve the indigenous habitats and species of Kapiti and Mana Islands, with priority given to those species that persisted in unmanaged populations.
2. To restore indigenous ecosystems and communities on Kapiti and Mana Islands appropriate to the ecological settings of each island.
3. To use Kapiti and Mana Island as sanctuaries for nationally threatened species, where consistent with their respective ecological restoration plan, and supported by relevant species recovery groups.
4. To keep mammal pests off Kapiti and Mana Islands, and reduce the chances of new pest species becoming established.
5. To reduce the impact and range of pest plants and invertebrates on Kapiti and Mana Island, and eradicate them if possible.
6. To conserve the integrity of historic sites on Kapiti and Mana Islands.
7. To allow visits to Kapiti and Mana Island by the public, subject to conservation of natural and historic resources.
8. To increase public understanding and appreciation of the natural and historic resources of Kapiti and Mana Island.
9. To build and maintain co-operative working relationships with tangata whenua and interested parties to conserve Kapiti and Mana Islands' natural and historic resources, to interpret historic resources and to be good neighbours.

## MANAGEMENT POLICIES – KAPITI AND MANA ISLANDS

1. Will maintain and implement biosecurity plans to prevent the introduction and spread of new pests on Kapiti and Mana Islands, including requiring concessionaires to ensure that all members of their party are aware of and implement appropriate biosecurity measures.
2. Should undertake further ecological restoration work on Kapiti and Mana Islands, including further native species introductions as appropriate.
3. Should identify and work to protect representative or significant indigenous species and communities on Kapiti and Mana Islands, including those that are rare, naturally uncommon or threatened.
4. Will develop an ecological restoration plan for Kapiti Island Nature Reserve and further implement the ecological restoration plan for Mana Island.
5. Will control, and where possible eradicate, pest plants, vertebrates and invertebrates on Kapiti and Mana Island that compromise indigenous biodiversity recovery.
6. Should work with tangata whenua and other interested parties to provide for management planning, protection, interpretation, memorable visitor experiences and increased public awareness of sites of historic and cultural significance on Kapiti and Mana Islands.
7. Will manage visitor access to Kapiti and Mana Islands to protect biodiversity values.
8. Will support priority research on Kapiti and Mana Islands that benefits conservation management or the understanding of the islands' ecology and history.

## MILESTONES – KAPITI AND MANA ISLANDS

1. Kapiti and Mana Islands are showcases of New Zealand's biodiversity, natural heritage and conservation management. There are no introduced mammals, few invasive weeds, the forests are thriving, the birdlife is prolific and there is an abundance and diversity of other indigenous plants, reptiles, and invertebrates.
2. Visitors to these internationally important islands gain an appreciation of island habitat restoration and conservation management through interpretation, and through recreational opportunities that do not disturb the islands' habitats, biota, heritage or other visitors experiencing Kapiti and Mana Islands.
3. Tangata whenua, landowners and relevant community groups are actively involved in management of Kapiti and Mana Islands through collaborative partnerships."

The Outcomes, Management Objectives, Management Policies, and Milestones in the preliminary draft CMS are completely consistent with the *Mana Island ecological restoration plan* and the tasks recommended here. Areas that will require special attention are the development and maintenance of collaborative partnerships with Ngāti Toa as tangata whenua, and Friends of Mana Island Incorporated Society as the leading community group involved in the ecological restoration of Mana Island, and also provision of interpretative methods and materials to ensure that visitors gain an appreciation of ecological restoration and conservation management.

# 5. Summary of recommended tasks to continue the ecological restoration of Mana Island

1. Develop and maintain management partnerships with Ngāti Toa as tangata whenua.
2. Develop and maintain management partnerships with Friends of Mana Island Incorporated Society.
3. Continue suppression of priority weed species in all habitats (see Appendix 2).
4. Continue measures to minimise the risk of fire.
5. Carry out pest mammal surveillance, contingency and audit requirements as identified in the island biosecurity plan (Brown *et al*. 2004).
6. Continue efforts to restore and attract burrow-nesting seabirds.
7. Develop and implement a restoration model for Waikoko wetland.
8. Increase the floral diversity of forests and wetlands through the introduction of eco-sourced plants (including threatened plants and tree ferns) into appropriate microhabitats.
9. Investigate methods to increase the diversity of invertebrate communities as forests mature.
10. Develop a threatened plant action plan.
11. Complete translocations of shore plover, whiteheads, bellbirds and rowi.
12. Monitor and confirm establishment of tūī and kererū, and maintain records of sightings of other vagrant and colonising species (e.g., kākā and red-crowned parakeets).
13. Assess the need for and practicality of further fairy prion chick transfers to Mana Island.
14. Restore and maintain the decoy gannet colony
15. Survey for banded rail and crakes around wetlands.
16. Seek support for translocation of Chatham Island snipe.
17. Develop more efficient methods to survey for green geckos.
18. Monitor and confirm establishment of Wellington green gecko and speckled skink, and any future reptile translocations.
19. Complete translocations for tuatara, Whitaker's skink and robust skink.
20. Monitor population spread and contact zones for McGregor's skink, spotted skink and speckled skink.
21. Assess the suitability of Waikoko wetland for the introduction of brown mudfish, and introduce if suitable.
22. Monitor and confirm establishment of Wellington speargrass weevils.
23. Translocate flax weevils on Mana to the vicinity of Waikoko wetland.
24. Develop interpretative methods and materials to ensure that visitors (both actual and virtual) gain an appreciation of ecological restoration and conservation management on Mana Island.

# 6. Managing visitor opportunities and experiences on Mana Island

## 6.1 EXISTING VISITOR LEVELS AND OPPORTUNITIES

Mana Island is open to the public between 8:00 am and 5:00 pm, provided they land in the bay between the old woolshed and the wharf. The only exception to this is when the island is closed to the public during extreme fire conditions. Unlike Kapiti and Matiu/Somes Islands, there is currently no regular ferry or concessionaire providing transport to the island.

Until recently, 400–700 visitors per year travelled to Mana Island on the charter vessel *Marinowai* as part of organised volunteer tree planting groups. There is no longer a charter operator offering a regular service to Mana Island, and the number of visitors has fallen to 400–550 per annum, about half of whom travel on the DOC vessel *Mana Ranger*. This compares to 9000–10,000 visitors per annum to Kapiti Island, and 10,000–12,000 per annum to Matiu/Somes Island (visitor numbers held by DOC, see DOCDM-55863).

With such low visitor numbers, DOC has not been able to justify much investment in visitor facilities and interpretation on the island. The track network is based on tracks and routes used during the farming era, and is mainly maintained by mowing. Steeper sections of some tracks were re-aligned in 1998 when a digger and bulldozer were barged to the island for restoration of Waikoko wetland. A few bench seats are provided alongside the circuit track, and there are toilets between the landing and the historic woolshed.

Over half the visitors to the island are hosted or met by DOC staff and receive a verbal briefing, often summarising the island's history. Visitors arriving by private vessels find an orientation and information kiosk at the landing beach, and signage to the track network. The few interpretation signs on the island have been funded mainly through sponsorship raised by FOMI and Forest & Bird, with some historic interpretation funded by DOC. Interpretive information is provided inside the historic woolshed, inside the Lockwood, and in panels near the landing (on takahē, northern rātā, and restoration planting), at Waikoko wetland, at the decoy gannet colony, and at the historic lighthouse site at the summit.

Web-based information on Mana Island is available via the Friends of Mana Island website (www.manaisland.org.nz), the DOC website (www.doc.govt.nz) (particularly the pages:

www.doc.govt.nz/parks-and-recreation/places-to-visit/wellington/kapiti/mana-island-scientific-reserve, and www.doc.govt.nz/conservation/land-and-freshwater/australasias-top-25-restoration-projects/mana-island-ecological-restoration) and the Porirua City Council website (www.pcc.govt.nz/About-Porirua/Porirua-s-heritage/Porirua-s-suburbs/Mana-Island).

Published information on Mana Island history includes: *Mana Island* (Day c.1987), *The Bay: a history of community at Titahi Bay* (Fordyce & MacLehn 2000), *Pakehas around Porirua before 1840; sealers, whalers, flax traders and Pakeha visitors before the settlers in 1840* (Richards 2002), and *Mana Island; Te Mana o Kupe ki Aotearoa* (Maysmor 2009).

## 6.2 MESSAGES TO CONVEY TO VISITORS

As mentioned above, the low numbers of visitors to Mana Island make it hard to justify much investment in on-site interpretation. Alternatives to on-site interpretative panels include providing web-based information, and/or developing a self-guided walk. This could be in the form of numbered posts on the circuit track, with visitors taking (or borrowing) a printed factsheet from the visitor kiosk on arrival, providing information to read at each numbered post. This could be phased out over time as visitor numbers increase and more interpretative panels are installed.

There are many stories to tell on and about Mana Island, and the following list should be considered as a starting point for discussion rather than a definitive list:

- Kupe's explorations and naming of the island
- Fifteenth century Maori occupation, life-style and diet, including kumara gardens and midden remains of birds, fish and shellfish
- Ngāti Toa presence, including Te Rangihaeata and Waitohi (era overlaps with early European settlement). Spectacular images painted by George French Angus in 1844
- Shore-whaling for right whales 1820s–1830s
- Early European farming and gardening, and land transactions
- Mana Island lighthouse and settlement 1863–77 (existing interpretation panel)
- Leasehold farming era (J.F.E. Wright 1865–86; Vella family 1886–1953, John Gault 1953–1971)
- MAF quarantine research station 1971–78, and its demise due to a scrapie outbreak
- Lands and Survey bull farming era, farm-stock removal, gazettal as a Scientific Reserve, transfer to newly formed Department of Conservation, mouse plague
- Mouse eradication (1989–90) and responses of resident threatened species (Cook Strait giant weta, McGregor's skink, goldstripe gecko)
- Revegetation programme—design, model ecosystems, scale of programme, eco-sourcing of plants, process from seed-collection through to planting, volunteer effort, planting trials, under-planting
- Restoration of forest birds (focus on robins, kākāriki, tūī, kererū, bellbirds and whiteheads)
- Restoration of Waikoko wetland and brown teal (existing interpretation panel)

- Restoration of seabirds (build on existing interpretation panel at gannet site)
- Restoration of reptiles to Mana Island
- Biosecurity and weed control
- Friends of Mana Island history and involvement
- Ngāti Toa Treaty of Waitangi settlement and the future of Mana Island

## 6.3 OPPORTUNITIES FOR VOLUNTEER PARTICIPATION IN ECOLOGICAL RESTORATION AND OTHER ASPECTS OF ISLAND MANAGEMENT

The many successes in the ecological restoration of Mana Island since 1987 have been built on the back of huge volunteer input. This has occurred at many levels from planning, writing proposals, fund-raising, public awareness and co-ordination of effort through to the rolled-up sleeves and sweat of volunteer labour for a multitude of tasks including mouse eradication, seed-collection, nursery work, planting, weed control, species translocations and monitoring, cooking for field teams, cleaning and infrastructure maintenance.

These opportunities will continue, with almost all the tasks identified in Section 5 above being suitable to be undertaken by volunteers in partnership with the Department of Conservation. This includes the development of further interpretative material both on-site and via the internet, fleshing out the themes listed in Section 6.2.

## 6.4 INFRASTRUCTURE AND PLANNING REQUIREMENTS FOR VISITORS

The existing visitor infrastructure is adequate for the current low number of people that visit Mana Island. Visitation rates could make a quantum leap if a concessionaire took up the opportunity to provide a regular boat service to Mana Island. Management of boat transport and guiding concessions is likely to be a focus of any Ngāti Toa/DOC management agreement for Mana Island, and this may include the need for additional visitor infrastructure.

The main landing area on Mana Island is adjacent to the main Ngāti Toa habitation site, including the sites of Te Rangihaeata's whare and Waitohi's tomb. Visitor facility development near the landing must await clarification of Ngāti Toa's interests in management of these historic sites.

# 7. Acknowledgements

This review benefitted from ideas contributed at a workshop attended by FOMI representatives and DOC staff on 30 April 2010, at a meeting with Ngāti Toa representatives on 18 May 2010, and comments provided via email by staff and associates unable to attend the workshop. I particularly acknowledge the contributions of Lynn Adams, Nadine Bott, Sue Caldwell, Jason Christensen, Lisa Clapcott, Ian Cooksley, Colin Giddy, Richard Gill, James Griffiths, Graeme Hastilow, Frank Higgott, Claudia Hill, Paul Johnston, Mike Joy, Alan McKenzie, Richard Nester, Brian Paget, Clinton Purches, Colin Ryder, John Sawyer and Jennie Smeaton. The review report was formatted for publishing by Jeremy Rolfe.

# 8. References


Bell, M.; Bell, B.D.; Bell, E.A. 2005. Translocation of fluttering shearwater (*Puffinus gavia*) chicks to create a new colony. *Notornis 52*: 11–15.

Brown, K.; Giddy, C. Stone, R. 2004. *Island biosecurity plan: Wellington Conservancy (excluding Chatham Island)*. Wellington, Department of Conservation.

Chapple, D.G.; Ritchie, P.A.; Daugherty, C.H. 2009. Origin, diversification, and systematics of the New Zealand skink fauna (Reptilia: Scincidae). *Molecular phylogenetics and evolution 52*: 470–487.

Day, K. c.1987. *Mana Island*. Porirua Museum History Series no. 2. Porirua, Porirua Museum.

Department of Conservation 1996. *Wellington Conservancy Conservation Management Strategy*. Wellington, Department of Conservation.

Department of Conservation 2010. Vision 2020: a Conservation Management Strategy for the Wellington Region 2010–2020 (preliminary draft).

Dowding, J.E.; Collen, R.; Davis, A.M.; O'Connor, S.M.; Smith, M.H. 2005. Gains and losses in the New Zealand shore plover (*Thinornis novaeseelandiae*) recovery programme 1993–2003. Pp 36–42 in Straw, P.J. (ed.) *Status and conservation of shorebirds in the East-Asian-Australasian flyway*. Proceedings of the Australasian Shorebirds Conference, 13–15 December 2003, Canberra, Australia. Wetlands International Global Series 18, International Wader Studies no. 17. Sydney, Australian Wader Studies Group.

Empson, R.A.; Miskelly, C.M. 1999. The risks, costs and benefits of using brodifacoum to eradicate rats from Kapiti Island, New Zealand. *New Zealand journal of ecology 23*: 241–254.

Flannagan, H. J. 2000. Conservation biology of the goldstripe gecko (*Hoplodactylus chrysosireticus*) and interactions with Duvaucel's gecko (*Hoplodactylus duvaucelii*) on Mana Island, Cook Strait, New Zealand. MSc thesis. School of Biological Sciences, Massey University, Palmerston North, New Zealand. 92 pp.

Flannagan, H.; Fordham, R.; Sarre, S. 1999. Investigating interactions between goldstripe geckos and Duvaucel's geckos on Mana Island. Abstract from the Proceedings of the Society for Research on Amphibians and Reptiles in New Zealand annual conference. *New Zealand journal of zoology 26*: 257.

Fordyce, L.; MacLehn, K. 2000. *The Bay: a history of community at Titahi Bay*. Titahi Bay, Titahi Bay Residents and Ratepayers Association.

Griffiths, R. 1999. The translocation and establishment of spotted skink (*Oligosoma lineoocellatum*) from Matiu-Somes Island to Mana Island. Unpublished Masters in Conservation Science thesis, Victoria University of Wellington. 181 pp.

Gummer, H.; Adams, L. 2008. Report on transfer and fledging of fluttering shearwater chicks (*Puffinus gavia*) from Long Island to Mana Island in 2008. Department of Conservation unpublished report, docdm-264504.

Hansford, D. 2005. Returning mauri to Mana. *Forest & bird (February)*: 12–16.

Heap, A.; Burns, K.; Miskelly, C. 2003. A cage trial of sympatry between speckled skinks *Oligosoma infrapunctatum* and McGregor's skinks *Cyclodina macgregori*. Unpublished report for Department of Conservation, docdm-549184.

Jones, H.P.; Miskelly, C.M. submitted. Viability of a restored population of diving petrels (*Pelecanoides urinatrix*).

Jones, N. 2000. Establishment, dispersal and population viability of translocated Duvaucel's gecko (*Hoplodactylus duvaucelii*) on Mana Island. Unpublished Masters in Conservation Science thesis, Victoria University of Wellington. 79 pp.

Maysmor, B. 2009. *Mana Island; Te Mana o Kupe ki Aotearoa*. Porirua, Pataka Museum.

Miskelly, C. 1999. *Mana Island ecological restoration plan*. Wellington, Department of Conservation.

Miskelly, C. 2007. Petrel translocations. p.8 *in* Wilson, K-J. (ed.) The *state of New Zealand's birds 2006; Special report; New Zealand's seabirds*. Supplement to *Notornis 54(1).*

Miskelly, C.M.; Dowding, J.E.; Elliott, G.P.; Hitchmough, R.A.; Powlesland, R.G.; Robertson, H.A.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2008. Conservation status of New Zealand birds, 2008. *Notornis 55*: 117–135.

Miskelly, C.M.; Taylor, G.A. 2004. Establishment of a colony of common diving petrels (*Pelecanoides urinatrix*) by chick transfers and acoustic attraction. *Emu 104*: 205–211.

Miskelly, C.M.; Taylor, G.A. 2007. Common diving petrel (*Pelecanoides urinatrix*) breeding at 1 year old. *Notornis 54*: 239–240.

Miskelly, C.M.; Taylor, G.A.; Gummer, H.; Williams, R. 2009. Translocations of eight species of burrow-nesting seabirds (genera *Pterodroma*, *Pelecanoides*, *Pachyptila* and *Puffinus*: Family Procellariidae). *Biological conservation 142*: 1965–1980.

Miskelly, C.; Timlin, G.; Cotter, R. 2004. Common diving petrels (*Pelecanoides urinatrix*) recolonise Mana Island. *Notornis 51*: 245–246.

Richards, R. 2002. *Pakehas around Porirua before 1840; sealers, whalers, flax traders and Pakeha visitors before the settlers in 1840*. Wellington, Paremata Press.

Roberts, A.; Miskelly, C. 2003. *Recovery plan for the snipe species of New Zealand and the Chatham Islands (*Coenocorypha *spp.) tutukiwi. 2003–2015*. Wellington, Department of Conservation. 29 pp.

Scofield, R.P.; Christie, D. 2002: Beach patrol records indicate a substantial decline in sooty shearwater, *Puffinus griseus* numbers. *Notornis* 49: 158–165.

Shepherd, L.D.; Lambert, D.M. 2008. Ancient DNA and conservation: lessons from the endangered kiwi of New Zealand. *Molecular ecology 17*: 2174–2184.

Society for Ecological Restoration International Science & Policy Working Group, 2004. *The SER International Primer on Ecological Restoration*. www.ser.org and Tucson: Society for Ecological Restoration International.

Taylor, G.A.; Miskelly, C.M. 2007. Re-laying following egg failure by common diving petrels (*Pelecanoides urinatrix*). *Notornis 54*: 240–242.

Tobón, E. 2005. Population survey of the North Island fernbird in the Manawatu Estuary. Unpublished report for the Friends of Mana Island.

# Appendix 1

## SCIENTIFIC NAMES OF SPECIES MENTIONED BY VERNACULAR NAME IN THE TEXT

| BIRDS | |
|---|---|
| Australasian gannet | *Morus serrator* |
| Banded rail | *Gallirallus philippensis* |
| Bellbird | *Anthornis melanura* |
| Black-backed gull | *Larus dominicanus* |
| Blackbird | *Turdus merula* |
| Blue penguin | *Eudyptula minor* |
| Brown teal | *Anas chlorotis* |
| Chaffinch | *Fringilla coelebs* |
| Chatham Island snipe | *Coenocorypha pusilla* |
| Common diving petrel | *Pelecanoides urinatrix* |
| Crakes | *Porzana* spp. |
| Diving petrel | *Pelecanoides urinatrix* |
| Fairy prion | *Pachyptila turtur* |
| Fernbird | *Bowdleria punctata* |
| Finches | *Carduelis* and *Fringilla* spp. |
| Flesh-footed shearwater | *Ardenna carneipes* |
| Fluttering shearwater | *Puffinus gavia* |
| Gannet | *Morus serrator* |
| Grey duck | *Anas superciliosa* |
| Gulls | *Larus* spp. |
| Herons | *Egretta* spp. |
| Kākā | *Nestor meridionalis* |
| Kererū | *Hemiphaga novaeseelandiae* |
| Kiwi | *Apteryx* spp. |
| Little shag | *Phalacrocorax melanoleucos* |
| Little spotted kiwi | *Apteryx owenii* |
| Long-tailed cuckoo | *Eudynamys taitensis* |
| Mallard duck | *Anas platyrhynchos* |
| Marsh crake | *Porzana affinis* |
| Morepork | *Ninox novaeseelandiae* |
| North Island robin | *Petroica longipes* |
| North Island snipe | *Coenocorypha barrierensis* |
| Paradise shelduck | *Tadorna variegata* |
| Pied shag | *Phalacrocorax varius* |
| Pied stilt | *Himantopus leucocephalus* |

| | |
|---|---|
| Pukeko | *Porphyrio melanotus* |
| Red-billed gull | *Larus novaehollandiae scopulinus* |
| Robin | *Petroica longipes* |
| Rock wren | *Xenicus gilviventris* |
| Rowi | *Apteryx rowi* |
| Shags | *Phalacrocorax spp.* |
| Shining cuckoo | *Chrysococcyx lucidus* |
| Shore plover | *Thinornis novaeseelandiae* |
| Snipe | *Coenocorypha* sp. |
| Sooty shearwater | *Ardenna griseus* |
| Spotless crake | *Porzana tabuensis* |
| Spur-winged plover | *Vanellus miles* |
| Starling | *Sturnus vulgaris* |
| Terns | *Sterna* spp. |
| Takahē | *Porphyrio mantelli* |
| Tūī | *Prosthemadera novaeseelandiae* |
| Welcome swallow | *Hirundo tahitica neoxena* |
| White-faced storm petrel | *Pelagodroma marina* |
| White-fronted tern | *Sterna striata* |
| Whitehead | *Mohoua albicilla* |
| Yellow-crowned parakeet | *Cyanoramphus auriceps* |

| OTHER VERTEBRATES | |
|---|---|
| Brown mudfish | *Neochanna apoda* |
| Brown skink | *Oligosoma zelandicum* |
| Common gecko | *Hoplodactylus maculatus* |
| Common skink | *Oligosoma polychroma* |
| Cook Strait tuatara | *Sphenodon punctatus punctatus* |
| Copper skink | *Oligosoma aeneum* |
| Duvaucel's gecko | *Hoplodactylus duvaucelii* |
| Goldstripe gecko | *Hoplodactylus chrysosireticus* |
| Longfin eel | *Anguilla dieffenbachii* |
| McGregor's skink | *Oligosoma macgregori* |
| Mouse | *Mus musculus* |
| Robust skink | *Oligosoma alani* |
| Speckled skink | *Oligosoma infrapunctatum* |
| Spotted skink | *Oligosoma lineoocellatum* |
| Tuatara | *Sphenodon punctatus* |
| Wellington green gecko | *Naultinus elegans puntatus* |
| Whitaker's skink | *Oligosoma whitakeri* |

| INVERTEBRATES | |
|---|---|
| Cook Strait giant weta | *Deinacrida rugosa* |
| Flax weevil | *Anagotus fairburni* |
| Giant pill millipede | *Procyliosoma tuberculata* |
| Stag beetle | *Lissotes reticulatus* |
| Wellington speargrass weevil | *Lyperobius huttoni* |
| Wellington tree weta | *Hemideina crassidens* |

| PLANTS | |
|---|---|
| Boneseed | *Chrysanthemoides monilifera* |
| Boxthorn | *Lycium ferocissimum* |
| Cook's scurvy grass | *Lepidium oleraceum* |
| Kahikatea | *Dacrycarpus dacrydioides* |
| Karaka | *Corynocarpus laevigatus* |
| Karo | *Pittosporum crassifolium* |
| Kikuyu grass | *Pennisetum clandestinum* |
| Kohekohe | *Dysoxylum spectabile* |
| Large-leaved milk tree | *Streblus banksii* |
| Mahoe | *Melicytus ramiflorus* |
| Matagouri | *Discaria toumatou* |
| Milk tree | *Streblus banksii* |
| Nīkau | *Rhopalostylis sapida* |
| Northern rātā | *Metrosideros robusta* |
| Pigeonwood | *Hedycarya arborea* |
| Pukatea | *Laurelia novae-zelandiae* |
| Rimu | *Dacryidium cupressinum* |
| Speargrass | *Aciphylla squarrosa* |
| Swamp maire | *Syzigium maire* |
| Tawa | *Beilschmiedia tawa* |
| Tītoki | *Alectryon excelsus* |
| Tree lucerne | *Chamaecytisus palmensis* |

# Appendix 2

## MANA ISLAND WEED SPECIES AND CONTROL TARGETS (AS IDENTIFIED IN 2008)

| WEED SPECIES | CONTROL TARGET | COMMENT | WEED DENSITY[1] |
|---|---|---|---|
| Acacia<br>*Acacia* spp. | 0 % density by 2013 | | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Agapanthus<br>*Agapanthus campanulatus* | Eradicate by 2014 | | No Map |
| Angelica<br>*Angelica pachycarpa* | 0 % density by 2014 | | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Banksia<br>*Banksia integrifolia* | Control | | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Blackberry<br>*Rubus fruticosus* agg. | 0 % density by 2014 | | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Boneseed<br>*Chrysanthemoides monilifera* | 0 % density by 2020 | | Refer map DOCDM-256942<br>Data DOCDM-256952 |
| Boxthorn<br>*Lycium ferocissimum* | By 2014 reduce to 25 % of the density of what was spatially recorded in 2006/07 financial year. | | Refer map DOCDM-256961<br>Data DOCDM-256978 |
| Broom<br>*Cytisus scoparius* | 0 % density by 2013 | | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Elaeagnus<br>*Eleagnus ×reflexa* | Control | | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Fennel<br>*Foeniculum vulgare* | 0 % density by 2014 | | No Map |
| Gorse<br>*Ulex europaeus* | 0 % density by 2014 | | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Greater bindweed<br>*Calystegia sylvatica* | Control | Trial required using the herbicide versatil (or equivalent product vivendi)at a rate of 1 percent | No Map |
| English ivy *Hedera helix* and German ivy *Senecio mikanioides* | Control | Weed source bought in by starlings, consider starling control | Refer map DOCDM-259652<br>Data DOCDM-257057 |
| Karaka<br>*Corynocarpus laevigatus* | Control | Discuss management of groves with Ngāti Toa | No map |
| Karo<br>*Pittosporum crassifolium* | Control | Weed source bought in by starlings, consider starling control | Refer map DOCDM-256101<br>Data DOCDM-256921 |
| Kikuyu grass<br>*Pennisetum clandestinum* | Eradicate by 2012 | | Refer map DOCDM-60711 |
| Mallow<br>*Malva sylvestris* | 0 % density by 2020 | | Refer map DOCDM-259652<br>Data DOCDM-257057 |

| WEED SPECIES | CONTROL TARGET | COMMENT | WEED DENSITY[1] |
|---|---|---|---|
| Macrocarpa *Cupressus macrocarpa* | 0 % density by 2020 With the exception of well defined areas | Areas where macrocarpa will be left for shelter, historic reasons etc are to be defined and mapped | Refer map DOCDM-259652 Data DOCDM-257057 |
| *Muehlenbeckia australis* | Discretionary control | | No map |
| Pampas grass *Cortaderia selloana* and *Cortaderia jubat*a | Eradicate by 2013 | | Refer map DOCDM-259652 Data DOCDM-257057 |
| Pink ragwort *Senecio glastifolius* and purple groundsel *Senecio elegans* | Control | | Refer map DOCDM-259838 Data DOCDM-259848 |
| Pohutukawa *Metrosideros excelsa* | Eradicate by 2013 | Discuss removal of mature trees with the Gault family. | Refer map DOCDM-259652 Data DOCDM-257057 |
| *Pseudopanax* hybrid | Control | | Refer map DOCDM-259652 Data DOCDM-257057 |
| Radiata pine *Pinus radiata* | Eradicate by 2014 | Remove any mature trees by 2010 | Refer map DOCDM-259652 Data DOCDM-257057 |
| Ragwort *Senecio jacobaea* | Control | | No Map |
| Sweet pea vine *Dipogon lignosus* | Control | | Refer map DOCDM-259652 Data DOCDM-257057 |
| Tasmanian ngaio *Myoporum* aff. *insulare* and hybrids | 0 % density by 2020 | Will require the input of a botanist to identify these plants | No Map |
| Tree lucerne *Chamaecytisus palmensis* | Control | | Refer map DOCDM-259853 Data DOCDM-259866 |
| Wandering jew *Tradescantia fluminensis* | Eradicate by 2014 | | No Map |

[1]Weed density as identified on mapping exercise undertaken in the 06/07 financial year