

Management Strategy for Tawhirihoe Scientific Reserve, Tangimoana, New Zealand

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1.0 Executive Summary

This Management Strategy outlines the department of Conservation's objectives and policies for the management of Tawhirihoe Scientific Reserve. It describes the geology and ecology of the reserve, its history of use by Maori and European New Zealanders, and any previous management. It lists the range of threats that currently face the reserve, and outlines the departments planned management programme that will address these threats.

Tawhirihoe Scientific Reserve is a 152 ha area of dune country that lies in the Foxton Ecological District, just south of Tangimoana township, that was obtained by the department of Conservation in January 2001. The reserve contains one of the last examples of a dynamic dune and ephemeral wetland system, that once stretched along the west coast from Paekakariki to Hawera, as well as a population of North Island fernbirds, and was recommended for protection under the Protected Natural Areas Programme.

The ephemeral wetlands contain a range of indigenous successional plant species, some of which are nationally or locally threatened, that are specifically adapted to the shifting sand substrate and fluctuating water table levels of the region. Studies of the dynamics of the ecosystem suggest that the plant community requires continual landward sand movement and the creation of new habitat to persist.

A number of processes currently threaten the short- and long-term persistence of the ecosystem, and will require active management by the department. The planting of exotic sand-binding species for sand stabilisation has greatly reduced the rate of ephemeral wetland formation, while planting of commercial timber species has also slowed sand movement, as well as lowering the water table, affecting wetland dynamics. A number of pest plants are well established in the reserve, and off-road vehicle use by the public is common in some areas. Tawhirihoe is used for rabbit and pheasant hunting, and to gain access the Tangimoana Forest. There is also a high fire hazard associated with the reserve.

The Department plans to manage the reserve to minimise these threats, by targeting a number of key areas. These include the management of dune stability and movement, the restriction of vehicle access, the control of pest plant species, and the enhancement of native flora and fauna. the department also recognises the need to involve local stakeholders and the wider community in the successful management of Tawhirihoe, and acknowledges the opportunities to increase scientific knowledge and capacity that the reserve provides.

2.0 Introduction

This management strategy sets the department of Conservation's objectives and policies for the management of Tawhirihoe Scientific Reserve, located south of Tangimoana, at the mouth of the Rangitikei River. Tawhirihoe lies in the Foxton Ecological District, which stretches from Paekakariki in the south to the Tangahoe River near Hawera in the north. The district is characterised by a coastal dune topography and associated vegetation. The majority of the land in the region has been converted to agricultural use, resulting in the almost complete loss of the original indigenous ecosystems.

The reserve contains one of the last examples of a mobile parabolic dune and ephemeral wetland system that once stretched along the North Island west coast from Paekakariki to Hawera, and contains a number of rare native plant species that are adapted to the unique conditions found in these ecosystems.

The Department of Conservation (hereafter referred to as the department) assumed control of Tawhirihoe from the Manawatu District Council in January 2001, and will manage the reserve as a Scientific Reserve under Section 21 of the Reserves Act 1977.

This report outlines the legal status of the reserve (and a smaller adjacent Recreational Reserve), its geological and ecological features, the Māori and European history of the area, the management history of the reserve, and the range of threats it faces. The report then lists the department's vision for the reserve, and outlines the management objectives and policies that will be required to achieve this vision.

2.1 LOCATION AND DESCRIPTION

Tawhirihoe Scientific Reserve lies to the south of Tangimoana Beach Road, one km south-west of Tangimoana township, and 32 km west of Palmerston North (Figure Y). The reserve covers a total area of 152.4 ha. The topography of the reserve consists of foredunes near the coast, a band of parabolic dunes and ephemeral wetlands behind them, with older dunes covered in exotic grasses, marram and exotic tree species along the inland boundary (Figure X). A section of the south-east corner of the reserve is covered in *Coprosma propinqua* and jointed wire rush (*Leptocarpus similis*), and provides habitat for a North Island fernbird (*Bowdleria punctata vealeae*) population.

2.2 LEGAL DESCRIPTION

Two separate areas are covered by this Management Strategy:

Area A: 152.4213 ha; being Part Section 644, Town of Carnarvon, situated in Block II, Sandy Survey District (SO 24797) (Part GN B 782501.3), hereafter known as Tawhirihoe Scientific Reserve.

Area B: 6.6520 ha; being Part Section 643, Town of Carnarvon, Block II, Sandy Survey District (SO 24797) (Part GN B 782501.3).

The two sections are separated by Tangimoana Beach Road, with the larger Area A (Section 644) lying to the south of the road, and Area B (Section 643) situated to the north.

2.3 LEGAL STATUS

Area A: Classified as a Scientific Reserve (New Zealand Gazette 18/1/2001, No. 6, p123) under Section 21 of the Reserves Act 1977.

The principal or primary use of a scientific reserve is:

“For the purpose of protecting and preserving in perpetuity for scientific study, research, education, and the benefit of the country, ecological associations, plant or animal communities, types of soil, geomorphological phenomena, and like matters of special interest.”

Area B: Classified as a Recreational Reserve (New Zealand Gazette 18/1/2001, No. 6, p123) under Section 17 of the Reserves Act 1977.

Under the Act, the principal or primary use of a Recreational Reserve is:

“For the purpose of providing areas for the recreation and sporting activities and the physical welfare and enjoyment of the public, and for the protection of the natural environment and beauty of the countryside, with emphasis on the retention of open spaces and on outdoor recreational activities, including recreational tracks in the countryside.”

Section 644 was named as Tawhiriho Scientific Reserve at the time of classification (New Zealand Gazette 18/1/2001, No. 6, p123), and is the primary focus of this Management Strategy. However, Section 643 is included in the strategy, as it will need to be managed in conjunction with Tawhiriho Scientific Reserve with respect to a number of issues.

2.4 SIGNIFICANCE OF THE NAME “TAWHIRIHOE”

The name Tawhiriho was agreed upon by members of Ngāti Raukawa, Rangitāne, and Ngāti Apa, and refers to a site situated at the mouth of the Rangitīkei River near, and possibly under, the current site of the Tangimoana township. The name itself refers to a battle fought using hoe (paddles), although the site is also important for a number of other reasons (see Section 3.5) (Rangipo Metekingi, 2001).

3.0 Resource information

3.1 LANDFORM AND GEOLOGY

The unique nature of the landscape and biota of Tawhirihoe Scientific Reserve is the result of the underlying geology of the region, and an understanding of these processes is vital to the successful conservation and management of the reserve.

Tawhirihoe lies in a zone of quaternary geologic formations of the most recent series, which appear as sand dunes near the coast, and river terraces and silt along the main rivers (Carlin, 1975). The sand deposits have been worn from the inland Hawera series of basal conglomerate, volcanic sand, dune and marine sand, as well as from Tertiary-aged sandstones and mudstones from the central ranges. These surface deposits overlay an old Mesozoic geosyncline, that has been raised by folding and faulting, as well as by a relative drop in sea level.

The sand in the region is derived from three primary sources; greywacke from the Ruahines, volcanic sediments from Taranaki and the Tongariro volcanic plateau, and sediments from the Whanganui basin (Ravine, 1992). These sediments are carried down the regions rivers, transported east and south-east by the prevailing currents, and deposited as sand down the coast. Sand is blown inland by the prevailing north-westerly winds, and forms a network of dunes running from the west/north-west to east/south-east.

Four phases of dune building have been described (Cowie, 1963).

- 1) Koputoroa Phase Dunes (10,000 - 20,000 years before present). The oldest and furthest inland. They are the most limited in extent, and are thought to be formed from the braided courses of rivers draining periglacial areas. They have a higher degree of soil development than the other phases.
- 2) Foxton Phase Dunes (2,000 - 4,000 years b.p.). Arise from volcanic activity in the Taupo, Tongariro and Taranaki Districts, but are younger than the Taupo Eruption of... .. They have well developed topsoil, and form a near continuous belt up to 7 km wide that runs south from the west of Bulls to near Levin, broken only by the major rivers.
- 3) Motuiti Phase Dunes (120 - 1000 years b.p.). Attributed to destabilisation of existing dunes following vegetation destruction by early Maori. The dunes contain pumice from the Taupo and other eruptions, and overtop sands from the Foxton Phase.
- 4) Waitarere Phase Dunes (Present - 120 years b.p.). Result from erosion of coastal dunes following european settlement and farming. Sand has been added through increased sediment loads in rivers, following inland land clearance.

The Motuiti and Waitarere Phases are considered to be the most rapid and dynamic, with sand accretion rates of greater than 1 m per year (Cowie, 1963), and annual dune migration rates of greater than 73 m per year (Hesp, pers. comm., In Singers, 1997) recorded during the current phase.

The prevailing north-westerly winds form regular landforms and dune patterns in the region. As sand is deposited on the beach, a foredune forms over existing driftwood. This may occur repeatedly forming relict foredunes and swales stretching inland, all running parallel to the coast. Periodic disturbances, either through wind action or mechanical means, can result in a blowout of the foredune. Over time, these will enlarge

to form parabolic dunes with dune hollows behind them. Two or more parabolic dunes may merge to form sand basins and sand plains. The overlying sand in the sand basins tends to be blown away down to the water table, leaving flat areas, termed terminal deflation hollows (Singers, 1997), on which ephemeral wetlands may form. This process is dynamic, resulting in a mix of landforms over a small area.

Dune lakes may form in the region as a result of moving parabolic dunes covering water outflows from older sand plains. In some cases, a chain of lakes may form, the most obvious being where Waitarere Phase dunes meet Motuiti Phase dunes between the Rangitikei and Manawatū Rivers. These lakes are shallow and not fixed, and will move inland with the prevailing winds. Pukepuke Lagoon, just to the south-east of Tawhirihoe, and Lake Koputara south of Himatangi, are examples of such dune lakes.

3.2 CLIMATE

The climate in the surrounding region is mild, with warm summers and moderate winters (Ravine, 1992). The average mean monthly temperature in February is 17.6°C, and 8.3°C in July (Carlin, Unpubl. Lands and Survey Report). The average annual minimum is 4.0°C, and the average annual maximum is 28.7°C, with temperatures slightly warmer in the north of the region. Rainfall ranges from 854 mm in Foxton to 1054 mm at Paraparaumu. The dominant feature of the region is the wind, with westerly and north-westerly winds predominating. Gusts exceed 34 knots on 82-85 days per year at Paraparaumu, and on an average of 76.3 days per year at Wanganui., and are the key process driving dune dynamics and wetland formation.

3.3 FLORA

The mild climate, gentle contours and easy accessibility of the Foxton Ecological District have resulted in large scale land conversion, primarily into agriculture. Consequently, less than 5% of the surface area is now predominantly covered by indigenous vegetation (Ravine, 1992). The area surrounding and including Tawhirihoe Scientific Reserve has also been subject to land-use conversion.

There are few observations of the pre-European vegetation of the region (refer to Esler, 1978; Duguid, 1991), although the present day vegetation in remaining natural areas does give some indication of its' former nature and distribution.

Foredunes would have been covered by spinifex (*Spinifex sericeus*) and pingao (*Desmoschoenus spiralis*), especially on the seaward side. The landward side was most likely covered by shrubs such as tauhinu (*Ozothamnus leptophylla*), sand coprosma (*Coprosma acerosa*) and matagouri (*Discaria toumatou*), with some sand daphne (*Pimelea arenaria*) and club sedge (*Isolepis nodosa*). Further inland, the deeper soils of the Koputaroa and Foxton Phase dunes would have supported shrubs and trees, and forests may have existed within one km of the sea.

Currently, the foredunes at Tawhirihoe are covered with Spinifex, pingao, and large areas of Marram (*Ammophila arenaria*), planted as part of the Manawatu-Wanganui Regional

Council's sand stabilisation policy (Anon, 1999). Pockets of *Pinus radiata* and *Acacia sophorae* also occur on the foredunes, and on the margins of the wetlands.

The inland margin of the reserve, including the south-eastern fernbird area, was planted with *P. radiata* by the Manawatū District Council for sand stabilisation purposes in the early 1990's, although some trees were immediately removed by the department (DoC File LPT-304, Palmerston North Area Office). These trees are now 5-8 m tall, and are interspersed with boxthorn (*Lycium ferocissimum*), pampas (*Cortaderia sellocana*), willows (*Salix* sp.), blackberry (*Rbus fruticosus*) and *Pinus nigra*.

The ephemeral wetlands that are one of the key features of Tawhirihoe contain a range of specialised plants that colonise these areas, often in a fairly predictable successional progression. One of the first species to colonise the newly formed sand plain is the sand sedge *Carex pumila*, which follows the edge of the moving deflation hollow inland. Following the sand sedge, other early successional species, such as *Selliera radicans*, *S. rotundifolia*, *Isolepis cernua*, *I. basilaris*, *Triglochin striata*, *Ranunculus acaulis*, *Gnaphalium arenaria*, *Myriophyllum wotschii*, *Lilaeopsis orbicularis*, *Limosella lineata*, *Epilobium billardierearum*, and *Eleocharis neozelandica*, soon colonise the newly formed sand plain. *S. rotundifolia*, *I. basilaris*, and *E. neozelandica* are listed as nationally threatened species, while *G. arenaria* and *M. wotschii* are classified as regionally threatened (Cameron *et al.* 1995). As the sand plain ages, larger plants invade, such as *I. nodosa*, *Leptocarpus similis* and *Schoenus niteus*, *Pimelea* "Himatangi" (*Pimelea* "Turakina" in Singers, 1997). For a full plant species list, see Appendix 1.



Plate 2. The southern wetland from Singers' 1997 study, showing the two artificial wetlands, in the centre-left, created during his study. The *Eleocharis neozelandica* that colonised the wetlands in 1997 was not found in winter 2001.

Eventually, species such as toetoe (*Cortaderia toetoe* and *C. fukida*), flax (*Phormium tenax*), cabbage trees (*Cordylina australis*), manuka (*Leptospermum scoparium*), *Coprosma porpinqua*, and *Olearia solandri* would invade, and, if undisturbed, these dune plains would reach a climax as coastal swamp forest, dominated by kahikatea (*Dacrydium dacrydioides*) and pukatea (*Laurelia novae-zelandiae*).

Widespread land-use conversion and sand stabilisation, both throughout the district, and within Tawhirihoe Scientific Reserve itself by previous land management authorities, has resulted in the prevention of dune migration and the continued formation of ephemeral wetlands in the coastal region. Thus the wetlands at Tawhirihoe constitute the last 45 ha of this habitat between Tangimoana and Himatangi (Singers, 1997), and is the best remaining example of this unique coastal ecosystem in the region.

3.4 FAUNA

There is little information available on the indigenous fauna historically present in Tawhirihoe, but the extent and diversity of the habitat that once existed in the region suggests that it was diverse and significant.

The most conspicuous component of the fauna that remains is the birds, particularly migratory species. Migratory species that use the estuaries in the region each year, and are occasionally found in the reserve, include rare visitors such as the great knot (*Calidris tenuirostris*), wandering tattler (*Tringa incana*), Terek's sandpiper (*T. terek*) and red-kneed dotterel (*Erythrogomys cinctus*), as well as more common species such as least golden plover (*Pluvialis fulva*), bar-tailed godwit (*Limosa lapponica*) and the lesser knot (*C. canutus*). Other visitors include the black stilt (*Himantopus novaezelandiae*), South Island pied oystercatcher (*H. astralegus*), pied stilt (*H. himantopus*), black-backed gull (*Larus dominicanus*), white-faced heron (*Ardea novaezelandiae*) and white-fronted tern (*Sterna striata*). The drier dune areas found in Tawhirihoe Scientific Reserve support very large populations of exotic birds, among the highest concentrations in the country (Falla, 1957).

The southern and eastern portions of the reserve hold a known population of North Island fernbirds, and resulted in this area being proposed as a Recommended Area for Protection (RAP 26, Foxton Ecological District) under the Protected Natural Areas Programme (Ravine 1992). This species is widely but patchily distributed north of a line from the Manawatū Estuary to Porangahau on the east coast, placing the Tawhirihoe population at the southern end of the species' range.

New Zealand fur seals (*Arctocephalus forsteri*) and whale strandings are occasionally recorded along the beaches around Tawhirihoe Scientific Reserve, although neither taxa breeds in the region.

Exotic mammals present in the area include rabbits (*Oryctolagus cuniculus*), hedgehogs (*Erinaceus europaeus*), mustelids (*Mustela* sp.), Norway (*Rattus norvegicus*) and ship rats (*R. rattus*) and house mice (*Mus musculus*) (Innes, 1990; Murphy and Pickard 1990; Ravine, 1992). Sambar deer (*Cervus unicolor unicolor*) were released at the Rangitikei River in 1875, and are widespread in the region, having spread southwards as far as Hokio, and northwards to Waitotara. Little is known about the mammals present in Tawhirihoe Scientific Reserve itself, although rabbits and sambar are known to occur.

Information on the invertebrate fauna present in the reserve is scarce. Moths are the most common insects in the region, followed by flies and beetles (Brockie, 1957), although many species probably remain undescribed. The moth *Ericodesma aerodana*, the caterpillars of which feed on sand daphne (*Pimelea arenaria*), was resighted at Wiritoa, south of Wanganui, in the early 1990's after 111 years and may be present at Tawhirihoe (Ravine, 1992). The katipo spider (*Latrodectus katipo*) is locally common along the coast

north and south of Tawhirihoē (Ward, 1998), although the distribution survey failed to find the species in the reserve itself.

There are no records of native amphibians and reptiles in the reserve, although gold-stripe geckos (*Hoplodactylus chrysosireticus*) are known from just outside the region, as are common geckos (*Hoplodactylus maculatus*) and common skinks (*Oligosoma nigriplantare*). Leathery turtles (*Dermodobys coriacea*) have been recorded on this coast (Ravine 1992). Two introduced frogs, the golden bell frog (*Litoria raniformis*) and the whistling tree frog (*L. ewingi*), are common throughout the district, and are known to occur in the reserve.

The Rangitikei River is a popular whitebaiting spot, and inanga (*Galaxias maculatus*), common bullies (*Gobiomorphus cotidianus*), long- and short-fin eels (*Anguilla dieffenbachii* and *A. australis* respectively), and yelloweye mullet (*Aldrichetta forsteri*) are known from the lower reaches of the river (DoC File FIS-010, Palmerston North Area Office; M Joy, pers. comm.). The drain that runs through the reserve dries up over the summer and is used as a vehicle access, but may be seasonally important for migratory native species.

3.5 MĀORI AND EUROPEAN HISTORY

Māori history

Historically, Tawhirihoē was part of a recognised highway, used by tribes moving up and down the coast, and as such, many different iwi and hapū, as well as early European travellers, would have been familiar with the site (Metekingi, 2001). Northbound travellers would have often been held up at Tawhirihoē, whilst waiting to cross the Rangitikei, and would have foraged and temporarily camped there.

The reserve and its immediate surroundings are of particular significance to Ngāti Apa, who used both Tawhirihoē as a seasonal fishing kāinga, and maintained a pa at Pukepuke Lagoon between 1770-1840, which would have been a rich source of tuna (shortfin eels) and waterfowl (Anon, 1990). Later, Pukepuke was used seasonally by Ngāti Apa for food gathering. Tawhirihoē is frequently mentioned in recorded narratives of Ngāti Apa tūpuna from the lower and central Rangitikei hapū of Ngāti Apa.

The treaty of Waitangi was signed at Tawhirihoē by the chiefs of the Ngāti Kauae and Ngāti Taura hapū of Ngāti Apa, and it was here that Ngāti Apa voiced their opposition to the proposed Manawatū Purchase, developed by the New Zealand Company.

Tawhirihoē was also a site of inter-tribal conflict, when a section of Ngāti Raukawa, aided by Ngāti Rangitāne, occupied the site in an act of aggression against Ngāti Apa. Following pressure from Crown agents however, Ngāti Raukawa and Rangitāne removed themselves from Tawhirihoē to avoid open conflict.

European History

A large proportion of the area surrounding Tawhirihoē was originally held as a pastoral lease by J. McKelvie ("Run 24"; 2000 ha). In the late 1800's, the town of Carnarvon was laid out on the site of Tawhirihoē Scientific Reserve, although sections were never sold, and the administration of the block fell to the Manawatu County (now Manawatu District)

Council. In 1917, 60-70 ha was acquired from J. McKelvie's lease, and the town of Tangimoana was schemed and surveyed into sections. Squares in the town were planted to stop dune movement and sand encroachment, and in the early 1920's sections were offered to the public by public ballot. Tenure was by way of 33 year renewable leases, on the basis of one man, one ballot. The first ballot was so popular that a second survey was conducted within two years, and all the sections were successfully balloted.

The New Zealand Forest Service was initially involved with land management around the reserve in the 1960's and 70's, in an advisory role only. However, it was realised that commercial planting was a viable option for areas of the dunes where farming was undesirable, and large tracts, including Tangimoana Forest to the south of Tawhirihoe, and Santoft to the north of the Rangitikei, are now planted in *Pinus radiata* and managed as commercial forests (currently by Ernslaw One Ltd). Whilst the plantations provide both sand stabilisation and a commercial return, they also lower the water table and prevent the dynamic sand movement that ephemeral wetland species require.

Erosion by the Rangitikei is a major and ongoing concern. The town of Tangimoana was in danger of being washed away in the 1950's, which resulted in the mechanical straightening of the river, and the development of an artificial wetland. The river is currently cutting down towards the south and into the north-western corner of the reserve, although winter flood events will undoubtedly continue to alter its course.

3.6 HISTORY OF THE RESERVE

There was considerable interest from the department of Lands and Survey in the 1970's in developing the area around and including Tawhirihoe into a 3,500 ha Regional Park. The development envisioned the Park as addressing a need for "*facilities that will permit dispersal of recreational activities within an easy driving distance of population centres*" (Anon, 1976). The regional park would have run north up the coast from Himatangi to just across the Rangitikei, and would have included Tangimoana Forest, Pukepuke Lagoon, Tangimoana township and what is now Tawhirihoe Scientific Reserve. It was envisioned the park would have catered for activities such as fishing, swimming, surfing, camping, boating, and bird-watching, as well as more space-consuming activities such as off-road vehicle use, horse trekking and golf. However, widespread support for the regional park did not materialise, and the proposal was never developed.

It is interesting to note that the Lands and Survey reports place the least conservation value on the dune system at Tawhirihoe, noting that better examples of the dynamic dune system existed south of Himatangi. The report does not recommend the retention of the area, but rather proposes the planting of the entire area for stabilisation purposes (Anon, 1975). Unfortunately, the dunes north of Himatangi were all stabilised in the 1980's by the New Zealand Forest Service, under the Ministry for the Environment's Foxtangi Sand Stabilisation Scheme, while those south of Himatangi have been planted in pine trees by the private owners. As a result, the region's only remaining example of a dynamic dune system is found at Tawhirihoe.

Recent studies of the dynamics and vegetation of the dune system in the reserve have highlighted the ecological value of the area. The New Zealand Ecological Society pushed for the gazettal of areas along the Manawatu coast as reserves to preserve the dune system (Anon, 1976), while Burgess (1984) researched the ecology of *Carex pumila* in the region.

The area that now constitutes Tawhirihoe Scientific Reserve was recommended as an area for protection under the Protected Natural Areas (PNA) Programme (Ravine, 1992), and this proposal was further supported by the study of Singers (1997), which highlighted the unique nature of the ecosystem at Tawhirihoe.

Following the findings and recommendations of Burgess (1984) and Ravine (1992), the department of Conservation approached the Manawatu District Council in 1992, with the aim of acquiring the area, to be managed as a reserve by the department. The need for this action was exacerbated by the planting of the dunes south of Tangimoana by the Forest Service in the 1980's, and subsequent loss of dynamic dune systems in this area, and the commencement of sand stabilisation activities by the District Council in the reserve itself in the early 1990's. After nearly ten years of negotiation, the District Council and the department agreed to swap the land at Tawhirihoe for two gravel reserves administered by the department in the Pohangina Valley. The Manawatu District Council retained control of the old Tangimoana dump site (Lot 1, Block II Sandy Survey District (DP 85204)), which covers 6.7 ha, and lies directly to the south of the Tangimoana Beach Road (Figure X). The exchange and classification of the reserve was achieved in January 2001, and was announced in the New Zealand Gazette (18/1/01, No. 6, pg. 123). The two sections (Section 643 and Section 644) were officially designated as a Scientific and Recreational Reserve respectively. The larger southern section (Section 644) was named as the Tawhirihoe Scientific Reserve, and is the specific focus of this Management Strategy, although the area of Recreational Reserve (Section 643) will be referred to in the strategy where necessary.

3.7 THREATS

Ever since human colonisation, the area around Tawhirihoe has undergone extensive modification. As long as 1000 years ago, Māori used fire to encourage bracken growth, to flush birds, and to increase access (Ravine, 1992). By the time Europeans arrived, much of the forest had already gone, replaced by bracken and kanuka. Early European settlers reduced forest cover further, cutting for timber, and clearing and draining land for agriculture.

Two of the most insidious threats to the natural state of the ecosystem at Tawhirihoe are sand stabilisation and land drainage. Widespread land stabilisation has been historically undertaken by central, regional and district authorities, under legislation such as the Sand Act 1908 and later, the Resource Management Act 1991, and through specific schemes, such as the Foxtangī Sand Stabilisation Scheme of the 1980's. The stated purpose of such management actions is to protect productive lands, with the additional benefit of revenue generation from the planting of commercial species such as *Pinus radiata*. Widespread planting of marram to stabilise the foredunes has also occurred, most recently by the Regional Council as a requirement of the Regional Plan (Proposed Land and Water Regional Plan, May 1999, Horizons.mw), as specified by the Resource Management Act 1991. The stabilisation of the foredunes and the planting of shifting dunes both greatly reduce the size and extent of the dynamic dune region at Tawhirihoe, and active management is required to reduce the effects of these actions.

Widespread land drainage has historically been undertaken in the region surrounding Tawhirihoe (Ravine 1992), and this still affects the reserve. The Manawatu District Council maintains drains in the region as part of their District Plan, including the drains

entering and leaving Pukepuke Lagoon. Drainage lowers the water table throughout the year, which, in turn, reduces the development and persistence of ephemeral wetlands in the reserve. The drain that runs along the inland margin of Tawhirihoe is not covered by the District Council's drainage scheme, and so the department has a greater opportunity to manage the local water table in a manner that will best benefit the reserve.

Off road vehicle use is common in the reserve, particularly in the northern portion, where the reserve is used to access the beach, and for recreational purposes. This use can do serious damage, particularly to sensitive plant species in ephemeral wetlands. Vehicle traffic on the foredunes is of less concern, as plants in this habitat are better adapted to disturbance, and some movement of sand on the foredune is necessary in the creation of new ephemeral wetlands behind the foredunes. The northern area of the reserve is generally acknowledged as having the lowest ecological value (Ravine, 1992; Singers, 1997), and is the area least detrimentally affected by vehicle disturbance. However, the presence of vehicles is not desirable in the reserve, and should be prohibited under Section 21(2)b of the Reserves Act 1977.

Occasional dumping of household rubbish, green waste, and vehicle bodies occurs at Tawhirihoe. These actions can pose environmental risks to the reserve; through the leaching of cleaning compounds and other potentially toxic substances from household wastes, the introduction of weeds into the reserve in green waste, and the risk of fire from glass and metals in vehicle bodies and household rubbish.

The high level of public access to Tawhirihoe poses a significant fire risk to the reserve. The most recent fire, in 1994, burnt approximately 40 ha at the southern end of the reserve, and came within 40 m of Tangimoana Forest to the south of the reserve. The removal of any pines and marram in the reserve to promote sand movement and wetland formation should reduce the amount of fuel available in the reserve, but the significant fire risk associated with Tawhirihoe will remain, particularly in the summer months.

Stock can also have indirect effects on the indigenous vegetation and dynamics of the dunes. Loss of plant cover from foredunes through stock foraging and trampling can result in dune destabilisation and more frequent blow-outs, and has greatly reduced the cover of spinifex and pingao in the region (Ravine 1992).

A number of exotic weeds pose a threat to Tawhirihoe Scientific Reserve. As well as marram, pampas (*Cortaderia sellosana*) is common in the reserve, and widespread in the region. Jointed rush (*Juncus articulatus*) and tall fescue (*Festuca arundinaceae*) occur in the dune hollows and in the fernbird area in the southeast of the reserve, as do a number of other pasture grasses and weeds. With the exception of jointed rush, however, most of the pasture grasses and weeds are not able to survive the long periods of inundation during winter when the water table is high, and are not major problems in the reserve (Singers, 1997).

Willows, gorse (*Ulex europeus*), boxthorn (*Lycium ferocissimum*) and blackberry (*Rubus fruticosus*) are found in the fernbird area, and can be expected to cause significant weed problems if they are not controlled. Old man's beard (*Clematis vitalba*) is established in the wider Foxton Ecological District, although should not greatly threaten the reserve. Manchurian wild rice (*Zizania latifolia*) is established near Waikanae and pyp grass (*Ehrharta villosa*) has spread from its original planting, and both species may become threats in the future (Ravine 1992).

Vertebrate species known to be present in the reserve include rabbits and Sambar deer (Singers, 1997; DoC Files LPT-304; WAN-118, Palmerston North Area Office). Singers concluded that rabbit browse may be important in determining the elevational zonation of *Eleocharis zeozelandica* at Tawhirihoe, with plants at higher elevations experiencing much heavier browsing (Singers 1997). An influence of rabbit browsing on community composition has been shown in studies conducted in English wetlands (Willis *et al.*, 1959;



Plate 3. Off-road vehicle use is common in the reserve, particularly on the sand plains in the northern portion of the reserve. The northern section (sub-section 2) has historically been used as an access to the beach and the former Tangimoana dump and for general recreational use, and has lower ecological values than the rest of the reserve



Plate 4. The inland end of the southern wetland from Singers' 1997 study. Vehicle damage to the wetland is visible in the foreground, while a sand blowout can be

seen on a steep marram-covered dune at the middle left, and pines planted for sand stabilisation are shown in the centre distance

Ranwell, 1960), and may now be important at Tawhirihoe. Sambar deer are known to use the south-eastern portion of the reserve (G. Blackwell, pers. obs.), but information on their impacts is scarce. There is currently no information available on the presence, abundance or impacts of any other exotic mammal species in the reserve.

4.0 Management Strategy for Tawhirihoe Scientific Reserve

4.1 Vision and Goals

Vision

To have a dynamic parabolic dune system with actively forming ephemeral wetlands at Tawhirihoe Scientific Reserve that ensures the continued survival of all indigenous species associated with the ecosystem, and that allows the natural persistence and functioning of a unique biological community.

Goals

To maintain and enhance the natural features of Tawhirihoe Scientific Reserve, with particular reference to the natural dynamics of the parabolic dune and ephemeral wetland ecosystem, and the North Island fernbird population.

To take every opportunity to inform tangata whenua and other stakeholders about the distinctive nature of the flora and fauna at Tawhirihoe, and to foster an appreciation of this dynamic, unique ecosystem.

To use the status of Tawhirihoe as a Scientific Reserve to undertake research and management that will increase understanding of the ecology of the reserve, and to build scientific and managerial capacity within and outside the department.

To allow recreation within the reserve in keeping with the department's management objectives.

5.0 Management Objectives

5.1 Establishment of management framework

- Production of 10-year Management Strategy
- Produce Annual Operational Plans to implement the objectives of the Management Strategy
- Review the success of the management objectives outlined in the Strategy after five years

PERFORMANCE MEASURES

- To produce the first Management Strategy by September 2001
- To produce Annual Reports on the management of the reserve
- To have the Annual Operational Plan prepared by 30 June each year
- To review the management Strategy in 2006

EXPLANATION

The Management Strategy, of which this is the first, should set the department's overall vision and goals for the reserve. It should include a discussion of the features of the reserve the department wishes to protect and enhance, and should identify any threats to these features or processes. The strategy should outline the management objectives that will be required to achieve the management goals, and list the performance measures and timeline associated with each objective. The Management Strategy should be produced in accordance with Sections 17 and 21 of the Reserves Act 1977, and should be consistent with all other relevant legislation.

Annual reports will outline the management actions taken and the outcomes achieved in the preceding year, and should be produced in accordance with the objectives of the Management Strategy. Annual Plans should also highlight any problems associated with the management of the reserve, and suggest any areas where management objectives may require modification or updating.

Subsequent Management Strategies and Operational Plans will need to be adaptive, and responsive to changing management objectives and successes, which should be highlighted in the Annual Reports. A review of management outcomes and the success of the original Management Strategy in achieving the departments objectives for the reserve should be conducted after five years. This will allow any modification of the goals, objectives or management procedures for the reserve that may be required.

In order to facilitate the planning, implementation, and reporting of management actions in Tawhirihoe Scientific Reserve, the reserve area has been divided into 6 sub-sections, which will be used for the remainder of this report, and should be quoted in any subsequent documents relating to the reserve. Sub-sections 1-5 constitute Tawhirihoe Scientific Reserve, whilst ss-6 defines the northern Recreational Reserve, which will need to be considered in the overall management of Tawhirihoe. The sub-sections were originally described in The Tangimoana Land Acquisition-Weed Assessment, 23/11/98 File: LPT-304, and are as follows (see Figure X):

- ss-1. The core area, containing the majority of unstable dunes and existing wetlands,
- ss-2 The area north of the core area through to the beach road and dump site, and inland to the main metal track),
- ss-3 The area south of the core area through to Tangimoana Forest, and inland to the main metal track,

- ss-4 The area inland of the main metal track, bounded to the south by Tangimoana Forest, and to the north by the east/west track,
- ss-5 The area north of the east/west track and inland of the main metal track, and
- ss-6 The area north of the Tangimoana Beach road (Section 643; Recreational Reserve)

Unless stated otherwise, any reference to the reserve refers to Tawhirihoe Scientific Reserve (Section 644), and does not include the Recreational Reserve (Section 643).

5.2 Public Access into the reserve

- Prohibit public vehicle access into Tawhirihoe Scientific Reserve
- Allow public vehicle access to the Recreational Reserve (Part Section 643)
- Allow pedestrian, horse and dog access to the entire reserve
- Place signs on Tangimoana Beach Road informing the public of the status and allowed use of Tawhirihoe Scientific Reserve and the adjacent Recreational Reserve
- Continue to maintain the main metal track from the inland Landcorp boundary but block off access from the main road.
- Allow hunting of small game (rabbits and pheasants) and sambar deer in the reserve when issued with a permit (S.94, Reserves Act 1977)

PERFORMANCE MEASURES

- To have no public vehicles in the reserve by 2004
- To have signs on Tangimoana Beach Road informing the public of the status of the reserve, and of the activities allowed, by 2003
- To have the main metal track passable by four wheel drive vehicles at all times
- To have hunting of small game and sambar in the reserve controlled by permits by 2003

EXPLANATION

Currently the northern end of the reserve (ss-2) is used as a beach access (due to the mouth of the Rangitikei River cutting down towards the south), for off-road recreation, and to bypass the locked gate on the main metal track. The reserve is also used by locals for hunting access (pheasants, rabbits), and for recreation with two and four-wheeled motorcycles and four-wheel drive vehicles. Dogs are brought into the reserve for recreation and for hunting rabbits and pheasants, horses are ridden throughout the reserve, and firewood collection occurs along the main metal track and into the

Tangimoana Forest. Thus, there is a history of use of the reserve by local people, and a sense of “local ownership” of the resource. It is therefore in the department's best interest to work with this positive feeling towards the reserve, and allow the continuation of some public activities in specific areas of the reserve, rather than attempting to impose and police a “no use” access policy

While the northern portion of the reserve (ss-2) is characterised as having lower ecological value than the rest of the reserve (Ravine, 1992), it is not practical to allow vehicle use in this section whilst prohibiting access to the more valuable southern sections of the reserve. It is the intention of the management goals for Tawhirihoe that the areas of mobile parabolic dunes and ephemeral wetlands will be enlarged and enhanced, particularly in ss-1 and ss-3. Whilst the native flora found in these ephemeral communities is adapted to a relatively minor level of disturbance through natural processes, vehicle disturbance in these areas is undesirable. Consequently, it is proposed that vehicles be prohibited from the entire Tawhirihoe Scientific Reserve, whilst pedestrian access and horse and dog use should be allowed throughout the reserve.

Signs will need to be placed along the boundary of the reserve, informing the public of both the status of the reserve and the permitted activities. The main sign should be placed on Tangimoana Beach Road, in conjunction with a sign outlining the status of the Recreational Reserve on the northern side of the road. Additional signs may need to be placed at key points around the boundary of the reserve, such as along the foredunes, along the boundary with Frecklington Farm, and at the southern fernbird area, where the reserve adjoins the Tangimoana Forest.

The Recreational Reserve (Section 643, ss-6) is currently used by the public to access the river and beach, for collecting firewood, and for general recreation. A number of pest plants are well established in the reserve, including pampas, acacia, *Senecio glastifolius*, macracarpa, and pines, and the more open areas are well used by off-road vehicles. Overall, the reserve has much lower ecological value than Tawhirihoe. It is recommended that the public be encouraged to continue using this reserve for these purposes, as this reduces pressure on Tawhirihoe, and these are all allowed uses under Section 17 of the Reserves Act 1977.

The main metal track provides an inland access to the eastern and southern sections of the reserve, including the fernbird section (ss-4), and allows the department to conduct any management activities that may be required. The track is also currently used by the public to access the reserve, particularly to complete “round-trip” circuits, dump rubbish and by hunters accessing sambar deer blocks in Tangimoana Forest to the south of the reserve. The track initially cuts across private land when it leaves Tangimoana Beach Road, and does not fall under Departmental control until it crosses the northern reserve boundary (see Figure X). This arrangement may create access issues in the future, particularly if the current trend of public interference with the gate continues. Currently the main metal track, and the reserve, can be accessed along the forestry road that runs east-west across the southern end of the reserve, that is accessed via a locked gate on the Landcorp road.

Thus, it is recommended that the inland metal track be maintained only as far as needed for access for management. Additionally, the boundary fence should be continued along the inland boundary to Tangimoana Beach Road, and barriers should be placed on the road to discourage use (See Section 5.3). This will allow Departmental vehicle access for any management or fire control activities, and will still permit hunter access to

Tangimoana Forest, but should reduce public vehicle access to the more sensitive areas of the reserve.

It is also recommended that permits to hunt rabbits and pheasants be allowed in the reserve, under Section 94 of the Reserves Act 1977. The administration of pheasant hunting would fall to the Rangitikei Fish and Game Council, while the hunting of sambar in Tawhirihoe should also be considered. The reserve could be balloted as part of the Tangimoana Forest block, with the allocation of permits administered by the Sambar Deer Management Foundation.

5.3 Boundary issues

- Fence northern boundary of reserve from Frecklington Farm to the Tangimoana Beach Road
- Maintain existing boundary fences around the reserve

PERFORMANCE MEASURES

- To have the boundary fence completed and maintained by June 2003.

EXPLANATION

The nature of the reserve creates problems for boundary integrity and maintenance. Vehicles can access Tawhirihoe via the foredunes or along Tangimoana Beach Road. The main metal track in particular is commonly used by the public and has the potential to create access issues for the department and adjoining landholders. As outlined in Section 5.2, access to the reserve and the Tangimoana Forest can be gained through a locked gate on the Landcorp Road. It is therefore recommended that the main metal track be closed off, through the extension of the boundary fence to the road, and by the construction of barriers across the track at the northern boundary. Attention should also be drawn to the fact that the north-eastern section, from the departments' boundary to Tangimoana Beach Road, is private property and not part of the Tawhirihoe Scientific Reserve, which should also discourage use.

5.4 Management of dune stability and wetland formation

- To remove marram and other exotic flora from the foredunes to promote sand migration in ss-1 and ss-3 to allow ephemeral wetland creation
- To remove all pines, pampas, and other exotic woody species in ss-1 and ss-3 to promote natural sand movement events

- Close the vehicle track running north-south through the foredunes that bisects the reserve
- To retain a buffer of pines along the inland boundary of the reserve to manage the land-ward movement of sand and prevent movement of sand onto neighbouring properties. Ideally this will be a managed buffer.
- To maintain the water table at as high a level as possible

PERFORMANCE MEASURES

- To have no marram on the foredunes in ss-1 and ss-3 by June 2007
- To remove all pines, pampas and other woody weeds from ss-1 and ss-3 by June 2007
- To have a functioning pine buffer strip along the eastern boundary of the

EXPLANATION

The dynamic dune and wetland ecosystem found in Tawhirihoe is the defining feature of the reserve. Historically, this ecosystem covered a much larger area in the Foxton Ecological District, but land stabilisation and land drainage schemes have greatly reduced its extent (Ravine, 1992; Singers, 1997). These processes, particularly land stabilisation, also threaten the viability and persistence of the ecosystem at Tawhirihoe. The wetland plants found in the area require the continual movement of sand inland from the foredunes to create dune slacks upon which they can colonise, and in which the successional process can occur. Currently, the foredunes in the reserve are largely covered with planted marram grasses, with some smaller areas of the native sand binders spinifex and pingao. Dunes bound with marram are much steeper than those stabilised by native species, and are prone to more infrequent, but much larger, dune blow-outs. Areas on the foredunes and throughout the reserve are also covered in woody weed species, such as pine (*Pinus radiata* and *P. pinaster*), Acacia (*Acacia sophorae*), and macroparapa (*Cupressus macrocarpa*), as well as pampas (*Cortaderia sellocana*), which slow or prevent dune migration. Therefore, the department intends to remove all marram, pampas, and woody weed species from ss-1 and ss-3, which should promote the colonisation of the foredunes with the native sand binders spinifex and pingao. This should facilitate more frequent, smaller sand movements. The majority of the pines on the inland side of the main metal track, in ss-4 and ss-5 will also be removed to promote sand migration.

The vehicle track that runs behind the foredunes for the length of the reserve cuts through the areas of Tawhirihoe where the department plans to enhance natural dune migration processes (Plate 5). It is in these areas that vehicles can cause the most damage to the dune system. The closing of the track should assist the department in enforcing the ban on vehicles in the reserve.



Plate 5. The foredunes in the southern sections of the reserve are covered in native species such as spinifex, pingao, sand pimelea and sand coprosma. They have a gentler contour than foredunes bound with marram, and are prone to smaller, more gradual dune blowouts (c.f. Plate 4). The vehicle track running along the inland margin of foredunes disrupts the natural dynamics of the dunes.

Under natural conditions, the shifting parabolic dunes eventually stop moving inland, either through stabilisation by vegetation, or as a result of running out of sand (Singers 1997). Under Section 9 of the Resource Management Act 1991, the department is bound by the Land Management Rules of the Regional Council's Proposed Land and Water Regional Plan, which prohibit actions that promote the movement of any soil or sediment onto neighbouring properties. Thus, the department will be responsible for arresting the movement of any sand its' management actions may produce. This will be achieved through the retention of a 50-80 m buffer strip along the inland boundary of the reserve in ss-4 and ss-5, which, in conjunction with sand binding by other species and dune sand depletion, should provide a robust buffer to sand migration onto adjoining properties. Opportunities to minimise the costs to the department of pine removal will be sought, including contracting out the management and removal of pines in the reserve.

5.5 Management of pest plants

- To remove all pampas, boxthorn, and *Acacia sophorae* from the reserve
- To remove all buddleia from the reserve
- To remove all *Carpobrotus edulis* and *Senecio glastifolius* from the reserve
- To remove all pines and woody-weed species, with the exception of the pine buffer strip, from the fernbird area (ss-4)
- Monitor pasture weeds and grasses in the ephemeral wetlands (ss-1; ss-3)
- To assess the presence and abundance of pest plants in the recreational reserve on the northern side of Tangimoana Beach Road (ss-6)

- To continue monitoring the status of all pest plants in the reserve and undertake any control as required

PERFORMANCE MEASURES

- To have no adult pampas, boxthorn, or Acacia in the reserve by 2006, and spot control of seedlings
- To have spot control only of *Buddleia* by 2005
- To have spot control only of *C. edulis* and *Senecio glastifolius* by 2005
- To have no adult pines or other wood weeds in the fernbird area by 2006
- To have sufficient information of the ecology of pasture weeds and grasses in the wetlands by 2005 to undertake control if required
- To have sufficient information of the distribution of, and threat posed by, pest plants in the Recreational Reserve by 2005 to undertake any control as required

EXPLANATION

Exotic plant species are present throughout the reserve, many of which pose significant ecological risks to the reserve, and will require active management. Several species have been actively planted, primarily for sand stabilisation purposes, while the majority of weeds have dispersed into the reserve naturally. The species of primary concern are those on the foredunes of the reserve (ss-1;3) that are preventing dune migration, which have been addressed in Section 5.3, and the range of insidious species in the wetland areas that have the potential to spread rapidly and severely compromise the ecological value of these areas. It is expected that the different types of pest plants in the reserve will require different approaches to, and levels of, management.

The weeds present in the reserve can be divided into four broad categories, which pose different levels of risk to the dune ecosystem, and require different levels of control. 1) Exotic sand binding species. These species include marram, pines, and Acacia, and taken together, they can prevent natural sand movement and the creation of ephemeral wetlands. They have been dealt with in the main part of the reserve (ss's1-3;5) in Section 5.3.

2) Established weeds that have potential to pose a major threat. Several species are established in the reserve that have the potential to cause major degradation of the ecological values of the reserve. These include pampas, buddleia, willows and boxthorn, all of which are currently well established in the reserve, and, in the case of pampas, there is a large source population in Tangimoana Forest. Pampas and boxthorn are widely scattered throughout the reserve, while buddleia is current most common along the main metal track. These species all have the ability to rapidly cover large areas, and to significantly compromise the ecological values of the reserve. The removal of these weeds from Tawhirihoe is therefore of very high priority to the department.

3) Insidious species that are currently present at low densities, but have the potential to cause major ecological damage. The two main species present that fall into this category are iceplant (*C. edulis*) and *Senecio glastifolius*. Both are present in scattered locations among the foredunes in ss-1 and ss-2, and *S. glastifolius* is established on the inland margin of the northern wetland. Both species have the potential to rapidly become established and form large dense colonies of plants, which can alter dune migration patterns and smother native species. The opportunity exists for the department to control these species whilst they are present at low densities, and before they become well established.

4) Species that pose minor ecological threats to the reserve. There are a range of pasture grasses and flat weeds in the reserve, such as creeping bent (*Agrostis stolonifera*), tall fescue (*Festuca arundinacea*), fleabane (*Coryza albida*), catsear (*Hypochoeris radicata*), and purple groundsel (*Senecio elegans*). These species are most common in the margins of the ephemeral wetlands, although they are unable to survive the long periods of inundation during the winter and spring (Singers, 1997), and so do not appear to pose a major threat. However, monitoring of the extent and any impacts of these species will be required.

The Recreational Reserve, on the northern side of Tangimoana Beach Road contains a range of pest plant species from each of the four categories, including marram, *P. pinaster*, pampas, *S. glastifolius*, and exotic pasture grasses and weeds, and has a lower overall ecological value than the rest of the reserve. Control of all species may not be warranted, although due to the location of this section upwind from the main reserve, some targeted control will be necessary, particular of pampas, *S. glastifolius*, and *P. pinaster*.

5.6 Management of pest animals

- To monitor rabbit numbers on the reserve and implement any necessary control measures
- To monitor sambar deer density and impacts on the reserve and undertake any control as required
- To investigate the presence and impacts of rodents and insectivores in the reserve
- To exclude any domestic stock from the reserve
- To monitor the presence and impacts of mammalian predators in the reserve especially in the fernbird area (ss-4)

PERFORMANCE MEASURES

- To have sufficient information on the presence and impacts of rabbits in the reserve by 2005 to implement any control measures that may be required
- To monitor sambar deer impacts on the vegetation, and keep any impact at a level that is insignificant compared to natural successional processes

- To have sufficient information on the presence and impacts of rodents and insectivores in the reserve by 2005 to implement any control measures that may be required
- To have sufficient information on the presence and impacts of mammalian predators in the fernbird area by 2005 to implement any control measures that may be required
- To have all domestic stock removed from the reserve within 3 days of notification

EXPLANATION

There is very little information available about the identity, distribution and impacts of pest animals in Tawhiriho Scientific Reserve. Singers recorded rabbit browse on a number of wetland species in the reserve, and concluded that this may be important in determining the elevational zonation of *Eleocharis zeozelandica* at Tawhiriho, with plants at higher elevations experiencing much heavier browsing (Singers 1997). However, the extent and long term impacts of this browsing are unclear, and the necessity of any rabbit control is unknown. Research into the ecology of rabbits at Tawhiriho is therefore required, and is needed to identify any future management actions.

Sambar deer are known to occasionally enter the reserve from Tangimoana Forest, and tracks and wallows can be found in the fernbird area (ss-4). There is no information on their impacts on the native flora in this area, and it is unclear if any control of deer numbers over and above the hunting permitted in Tangimoana Forest is required. Hunting of sambar in the Manawatu-Wanganui Region is regulated under Section 8(3) of the Wild Animal Control Act 1977, although the department has authority to undertake control operations in the reserve as required, as specified under Section 21(2)a of the Reserves Act 1977. Routine monitoring of sambar presence in the fernbird area should be undertaken, and any control instigated if necessary. The department should also consider including the reserve in the Tangimoana Forest sambar block, administered by the Sambar Deer Management Foundation, and allowing the hunting of the block by ballot during the season.

There is currently no information available on the presence of rodents, hedgehogs, or mammalian predators in the reserve, although they can be expected to occur there, at least occasionally. Rodents may impact upon native flora in the reserve, especially in the wetlands, and additionally, along with hedgehogs, they may be consuming significant numbers of invertebrates. Mammalian predators that may be present include ferrets (*Mustela furo*), stoats (*M. erminea*) and feral cats (*Felis catus*), and these may pose a threat to the fernbird population. Routine monitoring programs should be established in the reserve for these species, and the results used to guide any subsequent management actions. Some predator control may be required in the fernbird area if populations are found to be declining.

Stock intrusion in to the reserve has not been a major problem in the past, although cattle are present on adjoining properties to the east and south-east. Any unbranded stock that are found on the reserve can be forfeited to the crown under Section 96(1) of the Reserves Act 1977, while branded stock shall be removed at the owners expense, or forfeited to the crown (Section 96(2), Reserves Act 1977).

5.7 Monitor plant community composition and dynamics

- Establish monitoring of the species composition and ecology of the foredunes
- Establish monitoring of the species composition and ecology of ephemeral wetlands
- Establish monitoring of the species composition and ecology of the fernbird area (ss-4)

PERFORMANCE MEASURES

- To have a complete and current inventory of the plant species present at Tawhirihoe Scientific Reserve, and an understanding of their community dynamics by 2010

EXPLANATION

The successful management of Tawhirihoe Scientific Reserve requires a complete and current knowledge of the species present in the reserve, and of their community dynamics and trajectories. Information is required on whether the distributions of indigenous and pest plants already present at Tawhirihoe are stable or changing, and whether species are colonising or disappearing from the reserve. It is only from this knowledge base that successful management can be achieved.

The flora in the reserve can be divided into three communities, which each have different characteristics and species compositions. The foredune community is structurally the most simple, and is currently dominated by marram, with scattered areas of spinifex and pingao. However, a number of other species are found in this community, predominantly on the lee side of stabilised foredunes, including tauhinu (*Ozothamnus leptophylla*), sand coprosma (*Coprosma acerosa*) and sand pimelea (*Pimelea arenaria*). It is expected that the department's removal of marram from the reserve will significantly alter the composition and dynamics of the foredune community, and an understanding of this process will be an important component in the departments management of the reserve.

The wetland community was studied by Singers (1997), and this provided a wealth of information about the species composition and dynamics of the plant communities in these areas. The study noted that the dwarf spike sedge (*Eleocharis neozelandica*) was common in the reserve and could establish well on artificial wetlands, and suggested this could be a useful management technique. Singers' also concluded that pasture weeds and grasses posed only a minor risk to the wetland communities, due to their inability to survive winter inundation, although the effect of wood pest plants, such as pines and blackberry, is unclear. Recent casual surveys have noted an absence of *E. neozelandica* from the artificial wetlands, and the extent of the pasture species cover is unknown. Thus monitoring of the dynamics of species in these areas is required for successful management.



Plate 6. The southern fernbird area, looking east towards the Tangimoana Forest and Pukepuke Lagoon. The vegetation is a mix of jointed wire rush, *Coprosma propinqua* and *Muehlenbeckia complexa*. Threats include lowering of the watertable by drains, and exotic species such as pampas, *Pinus radiata* and *P. pinaster*.

During the 1992 PNA survey, only the western end of the fernbird area (ss-4; Plate 6) was surveyed, and the area was recommended for protection on the basis of this study (Ravine 1992). The current boundaries of the reserve, however, encompass a much larger contiguous area, of which little is known about the flora or fauna present. The section is threatened by a number of pest plants, including pines planted along the eastern boundary, and willows, boxthorn, gorse, and a wide range of exotic pasture species. It is not currently clear if and how fast the pest plants might be spreading, or what indigenous species are present throughout the entire area. The implications of water table fluctuations, particularly as a result of widespread pine planting in an around the area, are unknown and require investigation.

The more complete understanding of the indigenous and pest flora present in the three communities that this surveying will provide is vital to the successful management of Tawhirihoe, and should receive an ongoing commitment from the department.

5.8 Management of threatened native flora

- Survey the reserve for new species or populations
- Augment populations of *Eleocharis neozelandica* in the reserve
- Monitor populations of *Pimelea arenaria*, *Isolepis basilaris*, *Myriophyllum votschii*, *Selliera rotundifolia*, *Desmoschoenus spiralis*, and *Gurmera arenaria* in the reserve and manage if required
- Establish populations of *Pimelea* "Himatangi" in the reserve

PERFORMANCE MEASURES

- To have a complete inventory of the species present in the reserve by 2006 (in conjunction with Section 5.6)
- Have *Eleocharis neozelandica* secure in the reserve by 2006
- To establish self sustaining populations of *Pimelea* “Himatangi” in the reserve by 2006
- To have sufficient information on *P. arenaria*, *I. basilaris*, *M. votschii*, *S. rotundifolia*, *D. spiralis*, and *G. arenaria* by 2005 to undertake management as required

EXPLANATION

The Department has very little information on the current status of the indigenous flora in the reserve, particularly species that are present at low densities. This situation will be partly addressed by the community monitoring undertaken under Section 5.6. However, monitoring of individual rare species is required, and it is anticipated that some active management will be necessary.

E. neozelandica is listed as a nationally threatened species (Cameron *et al.*, 1995), and is now greatly restricted in its distribution. The plant was relatively common in the reserve in the mid 1990's (Singers, 1997), and was shown to be an early successional species able to colonise artificial wetlands. Recent casual surveys however, have failed to locate *E. neozelandica* in areas where it was common in Singers' study (D. Ravine, pers. comm.), and the density of the species appears to have dropped in the reserve. Monitoring of population trends of *E. neozelandica* is urgently required, and active management may be necessary.

Similarly, *Pimelea* “Himatangi” (“Turikana” under Singers, 1997) is listed as “Taxonomically unknown, status critical” (Cameron *et al.*, 1995). The species does not occur naturally at Tawhiriho, but the reserve is the nearest area of suitable habitat to the known source population at Himatangi. *Pimelea* “Himatangi” only occurs naturally near areas of *Schoenus niteres* overtopped by jointed wire rush (*Leptocarpus similis*), an association that occurs on the margins of ephemeral wetlands at Tawhiriho. Seedlings planted in 1995 initially established well, but did not spread; *Pimelea* “Himatangi” appears to require water dispersal, which did not occur during the original study (Singers, 1997). Replanting of *Pimelea* “Himatangi” should occur in the reserve, as part of the department's attempts to secure viable populations of the species.

A number of other rare plants also occur in the reserve. While they are not as rare as *E. neozelandica* or *Pimelea* “Himatangi”, species such as *Pimelea arenaria*, *Isolepis basilaris*, *Myriophyllum votschii*, *Selliera rotundifolia*, *Desmoschoenus spiralis*, and *Gunnera arenaria* all require monitoring, and possibly enhancement, in the reserve.

It should be noted that the actions taken under Section 5.3) Management of sand stability are anticipated to result in an increase in the area of shifting dunes and ephemeral wetlands at Tawhiriho. This should aid in the management of rare flora in the reserve through the creation of extra habitat, and augment any Departmental management actions.

5.9 Management of native fauna

- To monitor the fernbird population in the reserve and undertake any control of threats if required (see 5.4)
- To conduct regular surveys for katipo and introduce them into the reserve if expedient
- To conduct surveys throughout the reserve for invertebrates, lizards, freshwater fish and other bird species

PERFORMANCE MEASURES

- To have a self-sustaining fernbird population in the reserve
- To have sufficient information on katipo presence in the reserve and surrounding region by 2004 to introduce them into the reserve if considered expedient
- To maintain an current inventory of the invertebrates, lizards, freshwater fish and bird species other than fernbirds, and have the information necessary to manage any species as required

EXPLANATION

Virtually no information exists about the native fauna present in the reserve. Fernbirds are known to occur in ss-4, and may use other areas of the reserve, whilst fantails (*Rhipidura fuliginosa*), New Zealand pipits (*Anthus novaeseelandiae*), pukeko (*Porphyrio porphyrio*) and paradise shelducks (*Tadorna variegata*) are known to occur, and tui (*Prosthemadera novaeseelandiae*) may be occasional visitors (Heather and Robertson, 1996). No information exists on the fernbird population size, or on any threats to the species persistence in the reserve, although they are known to still occur at Tawhirihoe (D. Ravine, pers. comm.). There is very little information about populations of other bird species in the reserve, and the importance of Tawhirihoe to migratory bird species is unknown.

No information exists about the invertebrates or reptiles that may occur in the reserve. The moth *Ericodesma aerodana*, the caterpillars of which feed on sand daphne (*Pimalea arenaria*), was resighted at Wiritoa, south of Wanganui, in the early 1990's after 111 years (Ravine, 1992), and may be present at Tawhirihoe. A study of the invertebrate fauna of the dune country in the Foxton Ecological District in the 1950's found that moths, flies and beetles were the most common insects in this habitat (Brockie 1957), although nothing is known about Tawhirihoe itself. Similarly, the katipo spider (*Latrodectus katipo*) is locally common along the coast north and south of Tawhirihoe (Ward, 1998), and opportunities may exist to establish populations of *L. katipo* in the reserve.

There are no records of native amphibians and reptiles in the reserve, although gold-stripe geckos are known from just outside the region, as are grey geckos, common skinks and leathery turtles (Ravine 1992). Two introduced frogs, the golden bell frog and the whistling tree frog, are common throughout the district, and are known to occur in the

reserve, whilst the drains in the reserve may be seasonally important to migratory fish species, and the wetlands may hold populations of the brown mudfish (*Neochanna apoda*).

Thus, monitoring programmes for invertebrates, reptiles, fish and bird species present in the reserve are urgently required, both to increase the departments knowledge of the ecology of the reserve, and to provide the information necessary to conduct any active species management that may be required.

5.10 Fire control

- To implement fire control measures as the delegated Fire Authority to minimise the risk of fire in the reserve
- To contain and control any fires on the reserve with minimal loss of the ecological value of Tawhirihoē or threat to surrounding properties

PERFORMANCE MEASURES

To have no fires at Tawhirihoē Scientific Reserve that cause significant damage to the ecological values of the reserve or to surrounding properties

EXPLANATION

The range of features associated with the reserve make it a high fire-hazard area. Tawhirihoē has a high level of public use, and contains large standing crops of light and heavy fuels, in the form of marram and other grasses, and planted pines and other woody species respectively. The strong prevailing north-westerly winds and relatively dry summers also increase the fire risk associated with the reserve, and there is a history of arson attacks in the area (File Note: LAN-3602, Palmerston North Area Office).

The area is designated a State Area under the Forest and Rural Fires Act 1977, and the department is designated as the Fire Authority (Section 11, Forest and Rural Fires Act 1977). the department is also responsible for a one km safety margin around the reserve. Given the high fire risk posed by the reserve, the department will need to be proactive in its fire prevention measures. the department should specify that no fires may be lit in the reserve as a fire control measure under Section 19 of the Forest and Rural Fire Act, and signs should also be placed in the reserve as a specified fire control measure, under the same section of the Act. There is always a risk of damage to signs and information placed in the reserve by a small proportion of the community, and the possibility that signs will, in fact, promote arson events in the reserve. However, the department will need to advise the public of the fire ban in the reserve, particularly if it is subsequently considered appropriate to prosecute any offenders, if they can be identified.

5.11 Research Opportunities

- To undertake research in the reserve that will increase understanding of the ecology of the reserve that can be used to assist management and build Departmental capacity
- To promote and facilitate the involvement of universities and other research and educational agencies in studies which may improve knowledge of the reserve
- To investigate aspects of the history, nature and functioning of the reserve that are of cultural significance to tangata whenua

PERFORMANCE MEASURES

- To undertake and support all research opportunities presented by the reserve
- To continue to advanced understanding of the cultural significance of the reserve to tangata whenua, and to formalise consultation and information sharing between the department and tangata whenua

EXPLANATION

Tawhirihoē has been designated a Scientific Reserve under the Reserves Act 1977. The Act states under Section 21(e) that:

“ With the consent of the Minister, the reserve, or any specified part of the reserve, may be manipulated for experimental purposes or to gain further scientific knowledge.”

The reserve presents a range of opportunities for research by the department and outside agencies, that can increase knowledge of the composition and functioning of the ecosystem present at Tawhirihoē, as well as providing information that can be used to build internal and external capacity. The study of the ecology of the ephemeral wetlands conducted by Singers is an excellent example of this approach (Singers, 1997). The reserve is close to both Massey and Victoria universities, and a number of CRI's, and is easily accessed.

The Department should promote and facilitate all research opportunities in the reserve that increase knowledge of the species, communities and ecosystems present. The pursuit of collaborative research projects where possible should produce the maximum scientific and management outcomes for the department.

5.12 Advocacy and Promotion

- To keep the local community informed of the departments objectives for the reserve, and of any relevant management actions or outputs
- To use the reserve to educate the general public about the unique nature of the dynamic dune ecosystem present at Tawhirihoē
- To involve conservation groups and interested parties in management opportunities
- To promote the reserve through the local, regional and national media

PERFORMANCE MEASURES

- To always have a positive professional relationship with the local community and all interested stakeholders
- To take every opportunity afforded by the reserve to educate the general public
- To utilise all opportunities to involve conservation groups in the management of the reserve
- To take every opportunity to promote the reserve through media releases at the local, regional, and national level

EXPLANATION

Tawhiriho Scientific Reserve contains one of the last remaining examples of the dynamic dune and wetland ecosystem that once ran the length of the Foxton Ecological District (Ravine, 1992). The department's management of the reserve provides an opportunity not only to preserve what remains of the ecosystem, but also to inform the public about a unique natural community.

The support of the local community will be especially important to the success of the department's management objectives for the reserve, particularly with respect to access issues. A combination of approaches that could include public meetings, newsletters, visits to the reserve, and informal on-site contact should be most likely to generate local community support.

The reserve can also be used to educate the wider public, targeting both regular and casual visitors to the area. Interpretation panels and signs, and an information pamphlet can all be used to promote the unique values of Tawhiriho, and the conservation aims of the department for the reserve. The management of the reserve should also present opportunities to involve local conservation groups and other interested parties, particularly through actions such as weed and rubbish removal, and the management and enhancement of native flora and fauna.

The Department should also take every opportunity to promote the reserve in the local, regional and national media, both to illustrate the reserve for its own intrinsic values, as well as to highlight the aims and practices of the department as a whole. Tawhiriho Scientific Reserve will be particularly useful in highlighting the department's policies and concerns with respect to coastal land management issues, and will draw attention to the need to coordinate coastal land conservation between private landholders, regulatory bodies and government agencies.

5.13 Information management and capacity building

- To keep accurate records of all management plans, actions and outcomes associated with the project
- To keep an accurate account of the costs and benefits associated with inputs, management actions, and outcomes
- To make information on research findings, management actions and outcomes available to build capacity within and outside the department

PERFORMANCE MEASURES

- To have all information relating to management actions, expenditure and outcomes on file and easily retrievable
- Use of standardised reporting procedures, and other established and informal channels to build capacity in the project and the department, and in the wider scientific community

EXPLANATION

The successful management of Tawhirihoe will require an accurate and comprehensive account of all Departmental plans, actions, expenditures and outcomes. Files should be held at the Palmerston North Area Office, but should at all times be available throughout the department to aid information transfer and capacity building. It is expected that research carried out at Tawhirihoe under its' designation as a Scientific Reserve will be of considerable value, both to the department, and within the wider scientific community. Tawhirihoe Scientific Reserve also has an important role to play in achieving Departmental strategic research goals with respect to community and ecosystem restoration (Saunders, 2000).

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7.0 Appendix 1

WANGANUI PLANT LIST 120

List of vascular plants for Tangimoana dunes¹, just south of Rangitikei River mouth.

(¹ mostly Tawhirihoe Scientific Reserve, but also includes site of old rubbish dump)

CC Ogle & N Singers - based on many visits from 1990 onwards
Department of Conservation, Wanganui

Last amended 29 Jan. 2001

Nationally threatened and uncommon species (de Lange *et al.* 1999): **CRITICAL** *Pimelea* "Turakina" (transplanted here); **VULNERABLE** *Selliera rotundifolia*, *Isolepis basilaris*; **DECLINING** *Eleocharis neozelandica*, *Pimelea arenaria* "southern form", **RECOVERING** *Desmoschoenus spiralis*.
CHR = specimen collected in this area for herbarium at Landcare Research NZ, Lincoln.

Abundance Ratings

a = abundant

c = common

o = occasional

u = uncommon

l = local (species in small area, but can be common or abundant there)

* = exotic sp.

Gymnosperm trees

* <i>Cupressus macrocarpa</i>	(macrocarpa)	u
* <i>Pinus pinaster</i>	(maritime pine)	u
* <i>P. radiata</i> [<i>mostly planted</i>]		o

Dicot trees, shrubs and lianes

* <i>Acacia sophorae</i> [<i>extending from plantings</i>]	(sand wattle)	o
* <i>Artemisia arborescens</i> CHR	(hedge artemisia)	u
* <i>Calystegia soldanella</i>	(sand convolvulus)	o
<i>Cassinia</i> (<i>Ozothamnus</i>) <i>leptophylla</i>	(tauhinu)	o
<i>Coprosma acerosa</i>	(sand coprosma)	o
<i>Discaria toumatou</i> – <i>planted here, from near L. Alice</i>	(<i>matagouri</i>)	
<i>Leptospermum scoparium</i>	(manuka)	u
* <i>Lupinus arboreus</i>	(lupin)	a
* <i>Lycium ferocissimum</i>	(boxthorn)	u
<i>Muehlenbeckia complexa</i>	(pohuehue)	o
<i>Olearia solandri</i>	(a shrub)	
* <i>Paraserianthes lophantha</i>	(brush wattle)	u
<i>Pimelea arenaria</i>	(sand daphne)	lc
<i>Pimelea</i> "Turakina" – <i>planted here</i>		
* <i>Rubus fruticosus</i> agg.	(blackberry)	u
* <i>Ulex europaeus</i>	(gorse)	u
* <i>Vicia sativa</i>	(vetch)	o

Monocot tree

<i>Cordyline australis</i>	(ti kouka, cabbage tree)	o
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Fern ally

**Equisetum arvense* horsetail 1

Ferns

Pteridium esculentum (bracken) 1

Herbaceous monocots

1. Grasses

**Agrostis stolonifera* (creeping bent) 1
**Aira caryophylla* (silvery hair grass) o
**Ammophila arenaria* (marram grass) a
**Anthoxanthum odoratum* (sweet vernal) o
**Briza minor* (slender quaking grass) u
**Bromus diandrus* (ripgut brome) c
**B. hordeaceus* (soft brome) u
Cortaderia fulvida (toetoe) c?
**C. seloana* (pampas grass) o
C. toetoe (toetoe) u
**Cynodon dactylon* (Indian doab) l
**Dactylis glomerata* (cocksfoot) o
**Festuca arundinacea* (tall fescue) c
**Holcus lanatus* (Yorkshire fog) o
Lachnagrostis billardierei (sand bent) o
**Lagurus ovatus* (hare's tail) a
**Pennisetum clandestinum* (kikuyu grass) u
**Polypogon monspeliensis* (beard grass) o
Spinifex sericeus (spinifex) c
**Sporobolus africanus* (rat's tail) u
**Vulpia bromoides* (vulpia hair grass) u

2. Sedges

Carex pumila (sand carex) c
**Cyperus congestus* u
C. ustulatus (mariscus) u
Desmoschoenus spiralis (pingao) u
Eleocharis acuta (spike sedge) u
E. neozelandica u
Isolepis basilaris lc
I. cernua u
**I. marginata* u
I. nodosa (club sedge) c
Schoenoplectus pungens (3-square) u
S. tabernaemontani (kapungawha) o
Schoenus nitens c

3. Rushes

**Juncus acutus* (sharp rush) 1
**J. articulatus* (jointed-leaved rush) la
**J. bufonius* (toad rush) u
J. caespiticius u
J. maritimus var. *australiensis* (sea rush) u
J. pallidus u
Leptocarpus similis (jointed wire-rush) a

4. Monocots other than grasses, sedges & rushes

* <i>Asparagus officinalis</i>	(garden asparagus)	u
<i>Microtis unifolia</i>	(onion-leaved orchid)	o
<i>Phormium tenax</i>	(NZ flax harakeke)	u
* <i>Sisyrinchium</i> "blue"		o
<i>Triglochin striatum</i>	(arrow grass)	o
<i>Typha orientalis</i>	(raupo)	lc

Herbaceous dicots

<i>Acaena anserinifolia</i>	(piripiri, bidibid)	u
* <i>Achillea millefolium</i>	(yarrow)	u
* <i>Amaranthus powellii</i>	(redroot)	u
* <i>Anagallis arvensis</i>	(scarlet pimpernel)	o
<i>Apium prostratum</i>	(sea celery)	u
* <i>Aster subulata</i>	(sea aster)	o
* <i>Beta vulgaris</i> (CHR)	(silver beet)	u
* <i>Carpobrotus edulis</i> ¹	(ice plant)	o
* <i>Centaureum erythraea</i>	(centaury)	u
* <i>Cerastium glomeratum</i> ?	(annual? mouse-eared chickweed)	o
* <i>Conyza albida</i>	(fleabane)	o
<i>Cotula coronopifolia</i>	(batchelor's button)	l
<i>Epilobium billardierianum</i>	(willow-herb)	o
* <i>Foeniculum vulgare</i>	(fennel)	u
* <i>Gnaphalium coarctatum</i> ? (recorded as <i>G. spicatum</i>)	(cudweed)	u
<i>Hydrocotyle hydrophila</i>		l
* <i>Hypochoeris glabra</i>	(smooth catsear)	u
* <i>H. radicata</i>	(catsear)	u
* <i>Lactuca virosa</i>	(acrid lettuce)	u
* <i>Leontodon taraxacoides</i>	(hawkbit)	c
<i>Lilaeopsis ruthiana</i> (?)	(tape-measure plant)	l
<i>Limosella lineata</i>		l
<i>Lobelia anceps</i>	(NZ lobelia)	o
* <i>Lobularia maritima</i>	(alyssum)	la
* <i>Lotus pedunculatus</i>	(lotus major)	o
* <i>L. suaveolens</i>		o
* <i>Lythrum hyssopifolia</i>	(hyssop loosestrife)	o
* <i>Malva sylvestris</i>	(large-flowered mallow)	la
* <i>Medicago lupulina</i>	(black medick)	c
* <i>Melilotus indicus</i>	(King Island melilot)	la
* <i>Mentha pulegium</i>	(pennyroyal)	u
* <i>Modiola caroliniana</i>	(creeping mallow)	o
* <i>Myosotis sylvatica</i>	(garden forget-me-not)	u
<i>Myriophyllum votschii</i>		l
* <i>Oenothera glazioviana</i>	(evening primrose)	lc
* <i>O. stricta</i>	(evening primrose)	o
* <i>Orobanche minor</i>	(broomrape)	u
<i>Oxalis rubens</i>		u
* <i>Parentucellia viscosa</i>	(tarweed)	c
* <i>Plantago lanceolata</i>	(narrow-leaved plantain)	u
* <i>P. major</i>	(broad-leaved plantain)	l
* <i>Polycarpon tetraphyllum</i>	(allseed)	o

¹ *C. aequilaterus* may be present as well; some plants seen on 18 Jan 2000 had purple flowers

*Polygonum hydropiper	(water pepper)	u
*Portulacca oleracea	(purslane)	l
Potentilla anserinoides	(native cinquefoil)	l
*Prunella vulgaris	(selfheal)	lc
Pseudognaphalium sp. (P. luteo-album agg.; P. "Kaitorete" of A P Druce)	(cudweed)	l
Ranunculus acaulis		o
*R. repens	(creeping buttercup)	o
*Rumex acetosella	(sheep's sorrel)	lc
*R. crispus	(curled dock)	u
*Sagina procumbens	(pearlwort)	u
Samolus repens	(sea primrose)	u
Selliera radicans	(half star)	u
S. rotundifolia	(half star)	c
*Senecio elegans	(purple groundsel)	o
*S. glastifolius	(pink ragwort)	u
*S. jacobaea	(ragwort)	o
*Silene gallica	(catchfly)	o
*Sonchus asper	(prickly sowthistle)	o
*Solanum chenopodioides	(velvety nightshade)	u
*Taraxacum officinale	(dandelion)	c
*Trifolium arvense	(hare'sfoot trefoil)	o
*T. fragiferum	(strawberry clover)	o
*Verbascum thapsus	(woolly mullein, flannel leaf)	u

TOTALS (excluding planted native species)

Indigenous Species = 49

Adventive Species = 86

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