



R2868

VEGETATION ASSESSMENT OF TE TUHI I OIOROA AOTEA HEADS SCIENTIFIC RESERVE



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Vegetation Assessment of Te Tuhi I Oioria Aotea Heads Scientific Reserve

Contract Report No. 2868

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1. INTRODUCTION AND PROJECT BRIEF

Te Tuhi I Oioroa Aotea Heads Scientific Reserve (Oioroa) is located on the west coast of the Waikato Region (Figure 1). It covers the northern head of the harbour, with the northern most point occurring just south of the Waihi Stream near Manuaitu. Oioroa comprises an extensive area of transgressive duneland with numerous wetlands within the deflation plains, a small dune lake at Korua Bay, pasture (32.9 ha) and coastal forest which is part of an extensive area of coastal forest and wetland at Rauiri Head. The reserve is currently 588.8 ha, however as the coastal boundary of the reserve is the mean high water spring mark, the total area varies as the head of the harbour is constantly changing shape depending on sediment supply and climatic events.

The reserve and surrounding area have a long history of Maori use and occupation, dating back to *c.*1,400 AD (Fox and Cassels 1983; Wilkes 2001). Historical sites include urupa, other waahi tapu, middens, kumara soils, and other evidence of horticultural sites. Many midden are visible in the dunefields at Oioroa having been exposed by winds moving sand. Several pa sites are present in surrounding areas and include Kororomaiwaho (on the boundary of the reserve) and Manuaitu.

Oioroa, also known as the Oioroa Land Block, was acquired by the Crown in 1856 and is currently under claim (Wai 872) (Department of Conservation and Raoraokauere A3 Trust 2002). The Crown did not actively manage Oioroa following acquisition, and according to Wilkes (2001) it was considered a '*wasteland, inhabited by wild horses and goats, and by livestock straying from adjacent farms*'. The area was used for military purposes between 1965 and 1967, and by the navy, as a bombing range in 1974.

The Oioroa Land Block was gazetted as a scientific reserve in 1978. The site was administered by the former Lands and Survey Department up until March 1987 when it became administered by the Department of Conservation as a Scientific Reserve under the Reserves Act 1977.

A draft co-management plan was developed in August 2002 which '*reflects the joint partnership between representatives of the hapu and the Department of Conservation Waikato Conservancy in managing the site as outlined in the Memorandum of Understanding between the trustees of Raoraokauere A3 as the representatives of Ngati Te Wehi and the Conservancy*' (Department of Conservation and Raoraokauere A3 Trust 2002). The draft co-management plan identifies a range of management issues including damage to archaeological sites from dune movement, modification from invasive weeds, and damage to the site from visitors and stock grazing.

The Department of Conservation contracted Wildland Consultants to conduct a vegetation assessment of Oioroa for the purpose of updating the 2002 draft co-management plan.

Figure 1: Location of Te Tuhi I Oioroa Aotea Heads Scientific Reserve.



Specific tasks included the following:

- Prepare a map of vegetation types;
- Assess the floristic values and threats; and
- Identify restoration options and opportunities at the site which include grazed public conservation land.

Not included in the brief but requiring further investigation is assessment of fauna values (and their threats) in order that a fully integrated ecosystem restoration programme may be completed. Some information of fauna values exists including West Coast dotterel survey and predator management data (J Gumbley, M Paviour, Department of Conservation pers. comm.), New Zealand Ornithological Society / Department of Conservation annual seabird census data and invertebrate filed notes (B Patrick, Wildland Consultants, pers. comm.).

2. ECOLOGICAL CONTEXT

2.1 Description of the Ecological District

Oioroa, is located within the Kawhia Ecological District, which reaches the southern edge of Raglan Harbour to the North, and is bordered by the Marokopa fault in the South-east, west of Otorohanga. Kawhia Ecological District encompasses Aotea Harbour and Kawhia Harbour, and includes the two large, basaltic-andestic volcanoes Mt Pirongia and Mt Karioi. Large areas within the ecological district are forested, with forest and scrub occurring to the harbours' edge in places.

The catchment of Aotea Harbour is formed mainly of greywacke, with small areas of sandstone, siltstone and limestone occurring on the eastern edge of the harbour, while the Kawhia Harbour catchment has a basement of greywacke rock overlain by large remnants of Oligocene calcareous sandstones, siltstones and limestones. The coastline comprises Pleistocene dune sands, pumiceous sands and sands with lignite, particularly in the north and head of Kawhia Harbour. Young undifferentiated Holocene sand dunes occur on the north head of Aotea Harbour and to the south around Lake Taharoa. Aotea Harbour and Kawhia Harbour are both drowned river valleys. Rolling sand dunes up to 140 m high have formed at the mouth of both of these harbours, and along the southern coastline. A few dune lakes have formed in hollows; some of these are temporary. The more sparsely vegetated dunes are continually moving. On coastal dunes there are yellow brown sands (Tuahu sandy loam) on easy rolling and rolling land; while Horea soils have formed on the more weathered dunes in rolling, hilly, moderately steep, and steep country (Regnier and Clarkson 1988).

Most of the forested areas within Kawhia ED occur within Pirongia Forest Park, and Mount Karioi. Around Aotea Harbour the native vegetation is very patchy and modified. Vegetation of fertile alluvial flats has mostly been cleared, and sand dune communities are also highly modified. Most of the sand dunes have invasive species such as marram (*Ammophila arenaria*), radiata pine (*Pinus radiata*) plantations, tree

lupin (*Lupinus arboreus*), boxthorn (*Lycium ferocissimum*), and exotic grasses. Spinifex (*Spinifex sericeus*) is still dominant on the foredunes, but often in association with marram (Regnier and Clarkson 1988).

Before human occupation the northern head of the Aotea Harbour was probably forested. This coastal forest would have developed on the “Paparoa Dunes” which had formed prior to Maori occupation (Pain 1979). The coastal forest probably comprised emergent rata (*Metrosideros robusta*) and rimu (*Dacrydium cupressinum*) over kohekohe (*Dysoxylum spectabile*), puriri (*Vitex lucens*) and nikau (*Rhopalostylis sapida*) with kanuka (*Kunzea ericoides*), kowhai (*Sophora microphylla*) and pohutukawa (*Metrosideros excelsa*) more common along the harbour fringes (Regnier and Clarkson 1988). The destabilisation of the dunes is considered to be due to Maori occupation and associated agriculture (Pain 1979), although tropical and extratropical cyclones may have also contributed to destabilisation (McFagden 1985). The current sand supply for the actively migrating dunes at Oioroa is almost entirely derived from erosion of the old Paparoa fossil dune system with minimal sand supply from the beach (Department of Conservation and Raoraokauere A3 Trust 2002).

2.2 Significance of dunelands

The extent of active dunelands declined dramatically in extent throughout New Zealand after world war two, with a loss of nearly 72% in the Waikato Region since the 1950s (Hilton *et al.* 2000). The Waikato Region has extensive dunes from Marokopa northwards however these dunelands are mostly highly modified (Edbrooke 2005). In the Kawhia Ecological District, there is only 3.4% of the remaining extent of dune vegetation cover that existed prior to c.1840 (Leathwick *et al.* 1995). Large areas were afforested with pines between 1960 and the late 1980s, including some of the coastline around Kawhia (Hilton 2006). Other sites have been mined for ironsand, such as at Tahoroa (Hilton 2006).

The only extensive, intact dune systems remaining are those near Kawhia, Aotea and Raglan Harbours, and at Port Waikato (Wildland Consultants and EPRO Ltd 1999; Edbrooke 2005). While these sites still retain many of their natural values, all contain an abundance of invasive, exotic species, such as wilding pines, pampas, marram and other adventive grasses.

Oioroa is ranked as being of national importance in the Geopreservation Inventory (1989) due to the type of dunelands present. These include the ancient Te Akekae Dunes (42,000-120,000 years BP), Paparoa Dunes (c.7,000 years BP) and the most recent Nukimiti Dunes (derived from active wind erosion of the Paparoa Dunes) (Department of Conservation and Raoraokauere A3 Trust 2002).

Oioroa was not included in the 1992 inventory of dunes of national importance (Partridge 1992) and is not currently in the draft list of ‘Dunes of National Conservation Significance’ (http://dunes.otago.ac.nz/dunes_of_national_significance) although it is listed as having significant conservation values. Oioroa was never visited as part of the 1992 inventory which provided the basis for the current draft list of Dunes of National Conservation Significance (Mike Hilton, *pers. comm.*). Oioroa appears to meet at least three of the four criteria for dunes of national significance. It must meet all four to be considered nationally significant.

3. METHODS

Relevant information from previous management reports was collated and reviewed prior to field work being carried out.

The Reserve was inspected by two plant ecologists on 8 and 9 February 2012. Department of Conservation staff provided boat access. The ground survey involved walking through most of the vegetation and habitat types present within the Reserve. Some areas of vegetation were viewed from vantage points within the Reserve. GPS points were recorded for the locations of selected pest plant infestations and species of interest (i.e. rare or uncommon species). Representative photographs were taken of vegetation types, rare and uncommon species, and pest plant infestations.

Vegetation and habitat types were delineated onto hard copy field maps (2007 aerial photographs at 1:8,000). The boundaries of short stature vegetation with sparse cover (e.g. spinifex sandfield) were difficult to capture in the field due to the quality and scale of the field maps. To improve delineation 2012 aerial photography accessed at <http://maps.google.co.nz/> was used to improve the accuracy of the boundaries of these vegetation types, however boundaries should be considered indicative for all of the 'sandfield', 'loamfield' and 'shellfield' vegetation and habitat types. The field maps and GPS points collected in the field were used for data input into the Department of Conservation GIS to produce the vegetation map.

An aerial photograph from 1944 (reproduced in Kahotea 2011) was used to compare historical vegetation extent with present vegetation patterns.

The University of Waikato herbarium, the New Zealand Plant Conservation Network (www.nzpcn.org.nz) and the New Zealand Virtual Herbarium (www.virtualherbarium.org.nz) databases were used to determine whether some species at Oioroa are uncommon in the Waikato Region.

Names of vegetation and habitat types follow Atkinson (1985) and therefore provide some information on species dominance and abundance. Dune terminology follows Hesp (2000).

4. VEGETATION AND HABITAT TYPES

Fifty-two vegetation and habitat types were identified during the field work. These are described in Appendix 1, and mapped in Figure 2. The vegetation map has also been produced at a larger scale (eight A4 colour maps) in Appendix 2. Plates illustrating most of the vegetation types present at Oioroa are presented in Appendix 3.

The topography of Oioroa is shown in Figure 1. It consists of a plateau (c.120 m ASL) on the northern boundary that drops steeply away to the west and east. The plateau (c.47.9 ha) is dominated by pasture species with 7 ha leased for grazing although all of the plateau except fenced forest remnants have been intermittently grazed up to the present time. A small fenced remnant of kanuka-mahoe forest (c.0.3 ha) is present on the plateau. The steep hills to the west of the plateau are dominated by harakeke-

(coastal toetoe) flaxland (c.0.3 ha) and tauhinu-*Ficinia nodosa*-pampas-coastal toetoe shrubland (c.13.3 ha).

The land drops less steeply away from the plateau to the south where several other remnants of coastal forest occur. They include a very small remnant of pohutukawa forest (c.0.1 ha) and a larger remnant of kanuka-mahoe-pohutukawa forest (c.0.9 ha) surrounded by pasture grasses with scattered lupin, bracken, pohuehue and *Ficinia nodosa*. Just beyond this begins the transgressive dunelands (i.e. actively migrating dunes), the major landform present at Oioroa. They consist of a series of tall sparsely vegetated dunes with sinuous precipitation ridges (i.e. steep slipface of a dune) on the landward side.

Most of the transgressive dunelands are covered in bare sand (c.341.5 ha) but there are numerous middens present on the surface and old soils have been exposed in many places. The most common plant species present on the migrating dunes are spinifex, marram, coastal toetoe, pampas and tauhinu. Vegetation cover occurs where there is some shelter and the water table is reasonably close to the surface of the dune. Many of the vegetation types have <20% cover of plant species (i.e. 'sandfield', 'loamfield', 'shellfield' vegetation types) but there are pockets of denser vegetation on the less exposed faces of the dunes.

The dunes are migrating towards Rauiri Head which contains an extensive area of kanuka forest and scrub. Seventeen hectares of this forest type occurs within the reserve and is discussed in more detail in the following section.

There is c.700 m between the start of the transgressive dunelands and the Tasman Sea comprised of incipient foredunes (i.e. youngest foredunes adjacent to the sea), established foredunes (older more permanent foredunes) and a deflation plain with extensive dune slacks. Spinifex dominates the incipient dunes with very occasional shore bindweed and marram. Behind these are established dunes which are dominated by tauhinu/spinifex tussockland (c.11.7 ha) and tauhinu/spinifex sandfield (c.20 ha) with pockets of pampas-*Ficinia nodosa*-tauhinu/marram tussockland in dune slacks. The large deflation plain landward of the established dunes is typically complex consisting of alternating dry and damp sand plains with dune slacks on the seaward margin. *Carex pumila* dominates the youngest damp sand plains (closest to the migrating dunes). The older damp sand plains are more diverse containing indigenous turf species (e.g. *Limosella lineata*, *Schoenus concinnus* and *Zoysia minima*) as well as taller rushes, shrubs, sedges and grasses (e.g. oioi, sea rush, tauhinu, *Ficinia nodosa*, coastal toetoe and pampas). A similar suite of species also occurs within the dune slacks although they are dominated by tall fescue and pohuehue at the northern end. Tauhinu/spinifex marram sandfield covers the dry sand plains.

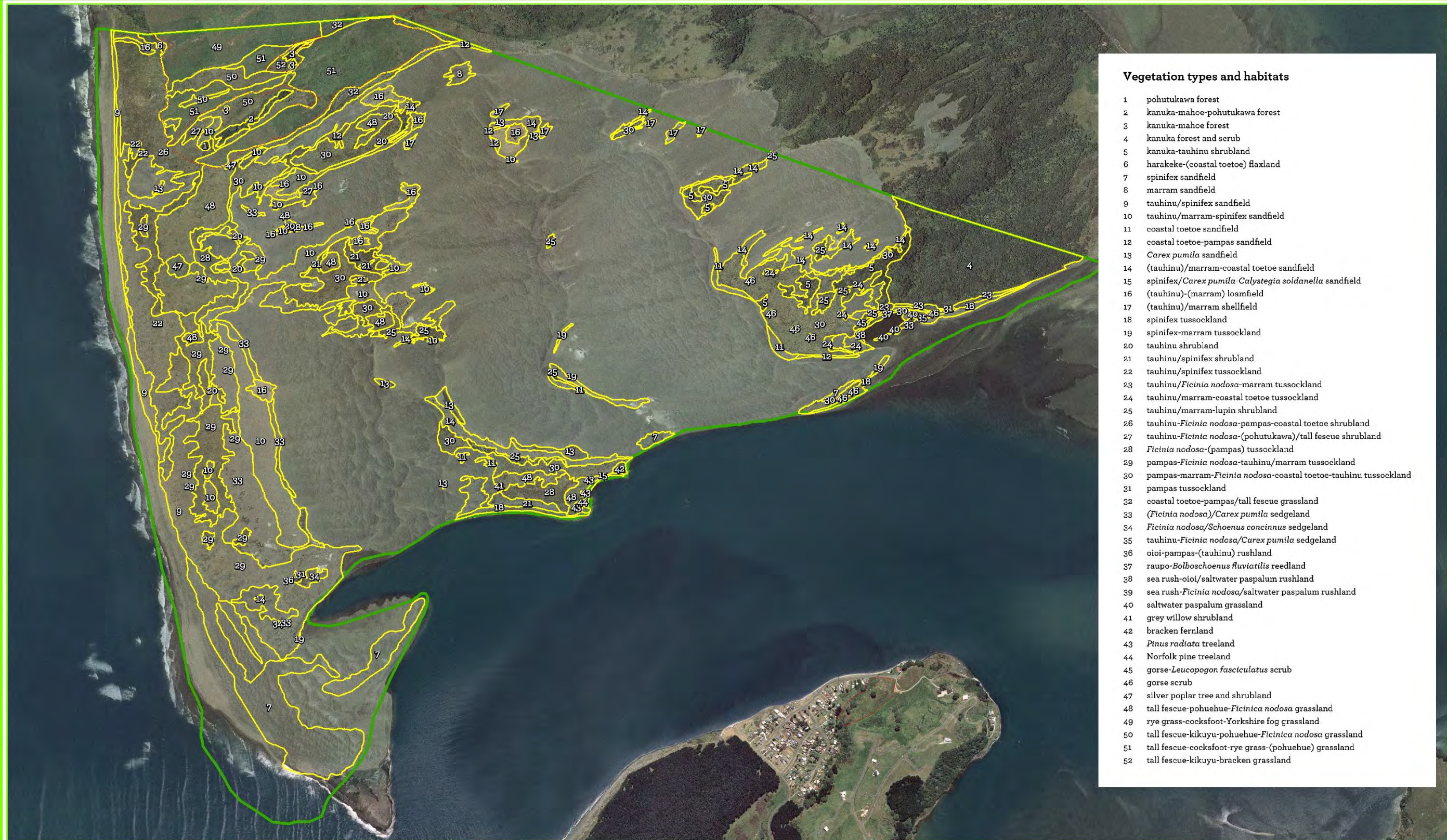
A similar pattern of incipient dune, established foredune and deflation plain occurs on the harbour margins but at a smaller scale with a similar suite of vegetation types. The harbour also contains several sheltered bays where the incipient foredune is more gently sloped and has a higher diversity of species than along the west coast and a higher concentration of weed species such as gorse, pampas, radiata pine and Norfolk Island pine. A small dune lake has formed at Korua Bay which contains *Ruppia polycarpa*. It is fringed with raupo, *Bolboschoenus fluviatilis* and saltwater paspalum.

Figure 2: Vegetation and habitat types at Te Tuhi I Oioroa Aotea Heads Scientific Reserve

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 Drawn by: A Barnsdall



Vegetation types and habitats

- 1 pohutukawa forest
- 2 kanuka-mahoe-pohutukawa forest
- 3 kanuka-mahoe forest
- 4 kanuka forest and scrub
- 5 kanuka-tauhinu shrubland
- 6 harakeke-(coastal toetoe) flaxland
- 7 spinifex sandfield
- 8 marram sandfield
- 9 tauhinu/spinifex sandfield
- 10 tauhinu/marram-spinifex sandfield
- 11 coastal toetoe sandfield
- 12 coastal toetoe-pampas sandfield
- 13 *Carex pumila* sandfield
- 14 (tauhinu)/marram-coastal toetoe sandfield
- 15 spinifex/*Carex pumila*-*Calystegia soldanella* sandfield
- 16 (tauhinu)-(marram) loamfield
- 17 (tauhinu)/marram shellfield
- 18 spinifex tussockland
- 19 spinifex-marram tussockland
- 20 tauhinu shrubland
- 21 tauhinu/spinifex shrubland
- 22 tauhinu/spinifex tussockland
- 23 tauhinu/*Ficinia nodosa*-marram tussockland
- 24 tauhinu/marram-coastal toetoe tussockland
- 25 tauhinu/marram-lupin shrubland
- 26 tauhinu-*Ficinia nodosa*-pampas-coastal toetoe shrubland
- 27 tauhinu-*Ficinia nodosa*-(pohutukawa)/tall fescue shrubland
- 28 *Ficinia nodosa*-(pampas) tussockland
- 29 pampas-*Ficinia nodosa*-tauhinu/marram tussockland
- 30 pampas-marram-*Ficinia nodosa*-coastal toetoe-tauhinu tussockland
- 31 pampas tussockland
- 32 coastal toetoe-pampas/tall fescue grassland
- 33 (*Ficinia nodosa*)/*Carex pumila* sedgeland
- 34 *Ficinia nodosa*/*Schoenus concinnus* sedgeland
- 35 tauhinu-*Ficinia nodosa*/*Carex pumila* sedgeland
- 36 oioi-pampas-(tauhinu) rushland
- 37 raupo-*Bolboschoenus fluviatilis* reedland
- 38 sea rush-oioi/saltwater paspalum rushland
- 39 sea rush-*Ficinia nodosa*/saltwater paspalum rushland
- 40 saltwater paspalum grassland
- 41 grey willow shrubland
- 42 bracken fernland
- 43 *Pinus radiata* treeland
- 44 Norfolk pine treeland
- 45 gorse-*Leucopogon fasciculatus* scrub
- 46 gorse scrub
- 47 silver poplar tree and shrubland
- 48 tall fescue-pohuehue-*Ficinia nodosa* grassland
- 49 rye grass-cocksfoot-Yorkshire fog grassland
- 50 tall fescue-kikuyu-pohuehue-*Ficinia nodosa* grassland
- 51 tall fescue-cocksfoot-rye grass-(pohuehue) grassland
- 52 tall fescue-kikuyu-bracken grassland

----- DOC fencelines Vegetation type extents Te Tuhi I Oioroa Aotea Heads Scientific Reserve

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At the head of the harbour is a highly mobile spit, which comprises low mobile dunes with a sparse cover of spinifex and a few small patches of pingao and marram.

4.1 Significant vegetation and ecosystem types

Six significant vegetation and ecosystem types are present at Oioroa. Their locations are shown in Figure 3 and are described below.

Pohutukawa Forest (Vegetation Type 1)

Only a very small remnant of pohutukawa forest was present at Oioroa, and was notable for occurring on sand. Coastal forest is very much reduced in its original extent, with only small remnants of the original vegetation remaining in the Kawhia Ecological District (Regnier and Clarkson 1988). Pohutukawa forest is very much reduced from its original extent, and has become very rare, with estimates of a 95% reduction of its original cover throughout New Zealand, due largely to farming, roading and urban development (Simpson 1994).

Kanuka Forest and Scrub (Vegetation Type 4)

The south-eastern corner of Oioroa contains part of an extensive area of kanuka forest and scrub that covers most of Rauiri Head on the north-western margins of the Aotea Harbour. More than 70 indigenous vascular plant species were found within the kanuka forest and scrub, a relatively diverse range of species which reflects varying landforms and water table within this area. Kanuka forest was previously common on coastal sand dunes and areas which were too dry or too frequently disturbed to support mature forest (Burrows 1973), but kanuka formed on sand has now become a very rare forest type throughout New Zealand (Smale 1994).

Damp Sand Plains (Vegetation Types 13 and 33)

Oioroa contains significant areas of damp sand plains (i.e. deflation plains), a type of ephemeral wetland and a historically rare ecosystem type (Williams *et al.* 2007). The damp sand plains mostly run parallel to the coast and are a result of wind eroding the sandsheet to the level of the water table (Hesp 2000). At Oioroa the damp sand plains are mostly sand with dominated by indigenous turf species which include *Carex pumila*, *Limosella lineata* and *Schoenus concinnus*. *Ficinia nodosa*, marram, and pampas are occasionally present.

Dune Slacks (Vegetation Types 29, 34, 35 and 48)

Oioroa contains significant areas of dune slacks, another historically rare ecosystem type (Williams *et al.* 2007). Dune slacks are defined as a vegetated depression between sand dune ridges where the water table is close to or above the sand surface (Johnson and Gerbeaux 2004). Dune slacks at Oioroa support a range of vegetation types from those dominated by indigenous species (e.g. *oioi*, *Ficinia nodosa*, *Schoenus concinnus*, *Zoysia minima* and *Lobelia anceps*) to those dominated by exotics (e.g. pampas and tall fescue).

Dunes Dominated by Indigenous Species

Oioroa contains significant areas of incipient and established dunes with <1% cover of exotic species, with only a few scattered individuals of ecosystem changing weeds such as marram and pampas. Dunes of this type are concentrated within the south-western area of the reserve and are dominated by spinifex with scattered tauhinu, pingao, and *Ficinia nodosa*. Dunes that retain this degree of naturalness are increasingly rare within New Zealand (Esler 1978).

Dune Lake (Vegetation Types 35, 37-40)

Oioroa contains a small dune lake (c.0.68 ha) at Korua Bay which has formed within the last 70 years as it does not appear on aerial photographs from 1944. The lake water was turbid during the field survey and only the submerged macrophyte, *Ruppia polycarpa*, was present within the lake. The lake is fringed with raupo, *Bolboschoenus fluviatilis*, sea rush and the invasive saltwater paspalum. A number of turf species were also present on the margins of the lake and included *Triglochin striata*, *Lilaeopsis novae-zelandiae*, *Samolus repens* var. *repens*, *Lobelia anceps*, *Selliera radicans* and *Isolepis cernua*. Dune lakes are uncommon in the Waikato Region with the majority occurring in the Kawhia and Awhitu Ecological Districts (Wildland Consultants 2011).

5. FLORA

Two hundred and four species were recorded for the reserve, comprising 123 indigenous species and 81 exotic species. These are listed in Appendix 4. The indigenous flora is relatively diverse, reflecting the varied habitat present. The naturalised flora is discussed in Section 6 below.

5.1 Threatened species

One threatened species classed as At Risk-Relict (as per de Lange *et al.* 2009) is present - pingao (*Ficinia spiralis*). It was recorded at six locations (Figure 3). Only a single plant was found at three of the locations with the largest area (4 m × 2 m) found on the landward slope of a migrating dune. Pingao was present on bare sand or within the 'spinifex sandfield' vegetation type.

Pingao was previously widespread throughout New Zealand, but now has a very limited distribution, including within the Waikato Region, where it is only found sparsely along the west coast from Port Waikato to Taharoa, and some of the eastern Coromandel beaches (Brandon *et al.* 2004).

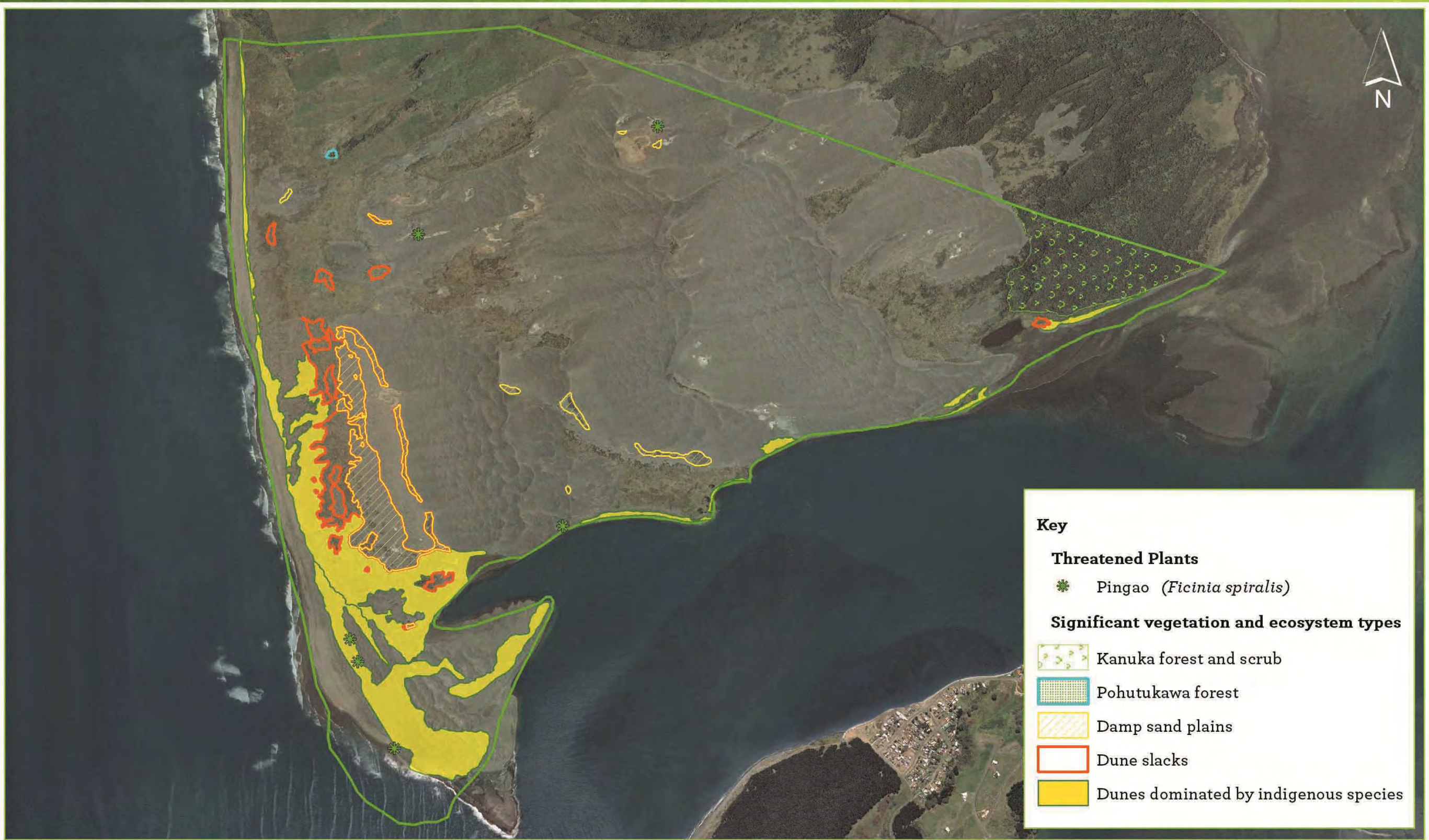
It is possible other threatened species are present at Oioroa as it was not possible to thoroughly search within the time constraints of the field survey. Threatened species that could be present include sand tussock (*Poa billardierei*, At Risk-Declining), sand coprosma (*Coprosma acerosa*, At Risk-Declining), and sand daphne (*Pimelea villosa* - At Risk-Declining). All of these species are either currently present or were historically present in dunelands on the Waikato West Coast (www.virtualherbarium.org.nz, accessed 11/5/2012).

Figure 3: Threatened plants and significant vegetation and ecosystem types.



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 Scale: 1:14,000 @ A3
 Drawn by: A Barnsdall

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Key

Threatened Plants

- * Pingao (*Ficinia spiralis*)

Significant vegetation and ecosystem types

- Kanuka forest and scrub
- Pohutukawa forest
- Damp sand plains
- Dune slacks
- Dunes dominated by indigenous species

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5.2 Uncommon species

Two species present at Oioroa are uncommon in the Waikato Region. The distribution of both these species is not well known for the Waikato Region, but based on current knowledge they could be considered to be uncommon in the Region. *Schoenus concinnus*, a small indigenous sedge present on damp sand plains and dune slacks at Oioroa is not known from the Waikato West Coast and there are only a few historic records of occurrences elsewhere in the Waikato Region.

Zoysia minima is a small indigenous grass also found on damp sand plains at Oioroa. It is found at only a few sites on Waikato West Coast; Carters Beach (Te Akau), Awaroa Scenic Reserve (Kawhia Harbour) and Ngatutara Point (Port Waikato). There are several historic records from inland sites and near Whiritoa on the east coast.

Zoysia pauciflora is also present, the distribution of this species on the west coast of the Waikato Region is also poorly known with the only other record being a 1959 record from Whale Bay (see below re distributional limits). Another species that is only known from a few sites on the western side of the Waikato Region is *Mentha cunninghamii*.

5.3 Distributional limits

Several species present occur near their southern limits on the west coast of the North Island, as follows:

- *Coprosma macrocarpa* subsp. *minor* - southern limit is Kawhia Harbour;
- *Austroderia splendens*, coastal toetoe - southern limit is Kawhia Harbour;
- *Meterosideros excelsa*, pohutukawa - southern limit on the west coast of the North Island is south of here at Wai-iti, but it occurs only infrequently between Wai-iti and Manukau (Simpson 2005).
- *Zoysia pauciflora* - known southern limit on the west coast of the North Island is here or just further south at Whale Bay from where there is 1959 record.

6. THREATS

6.1 Pest plants

A range of pest plants are present at Oioroa. These are listed in Table 1 along with their pest status according to the Waikato Regional Pest Management Strategy (Environment Waikato 2008). Small infestations of pest plants considered a high priority to control and/or eradicate, are shown in Figure 4. A description of the density and distribution of pest plants follows (in alphabetical order) with recommendations for management.

Table 1: Plant pests at Oioroa and their pest status in the Waikato Regional Council Pest Management Strategy (WRCPMS) 2008-2013.

Species	Common Name	Pest Status in the WRCPMS 2008-2013
<i>Alnus glutinosa</i>	alder	
<i>Alternanthera philoxeroides</i> ¹	alligator weed	Eradication ²
<i>Ammophila arenaria</i>	marram	
<i>Araucaria heterophylla</i>	Norfolk Island pine	
<i>Cenchrus clandestinus</i>	kikuyu	
<i>Cortaderia selloana</i>	pampas	Containment ³
<i>Cortaderia jubata</i>	purple pampas	Containment
<i>Euphorbia paralias</i>	sea spurge	
<i>Iris pseudacorus</i> ¹	yellow flag iris	Containment
<i>Lupinus arboreus</i>	lupin	
<i>Osteospermum fruticosum</i> ¹	rain daisy, dimorphotheca	
<i>Paspalum vaginatum</i>	saltwater paspalum	Potential ⁴
<i>Pinus radiata</i>	radiata pine	
<i>Populus alba</i> 'Nivea'	silver poplar	
<i>Rubus fruticosus</i>	blackberry	
<i>Salix cinerea</i>	grey willow	Containment
<i>Schedonorus arundinacea</i>	tall fescue	
<i>Spartina anglica</i>	spartina	Eradication
<i>Ulex europaeus</i>	gorse	Containment

¹ Outside of the reserve.

² Waikato Regional Council will directly control and manage.

³ Land occupiers are responsible for controlling.

⁴ Concern to the region but landowners not required to control.

Alder

Alder saplings (<10 individuals) occur within the saltwater paspalum grassland (Vegetation Type 40) on the margins of the dune lake at Korua Bay (Figure 4). It is advisable to eradicate the saplings to prevent further spread of this ecosystem changing weed which could pose a threat to dune slacks located elsewhere in the reserve.

Alligator Weed, Dimorphotheca, and Yellow Flag Iris

Small patches of alligator weed, dimorphotheca and yellow flag iris were found c.50m north of the reserve boundary where the *Euphorbia paralias* infestation was present. This is probably the southern-most alligator weed population in New Zealand. They were present at or close to a site where items floating in ocean currents wash ashore. Control of all these infestations was undertaken on 30 April 2012. Regular follow-up inspections and control, as required, will need to be undertaken of this site.

Blackberry

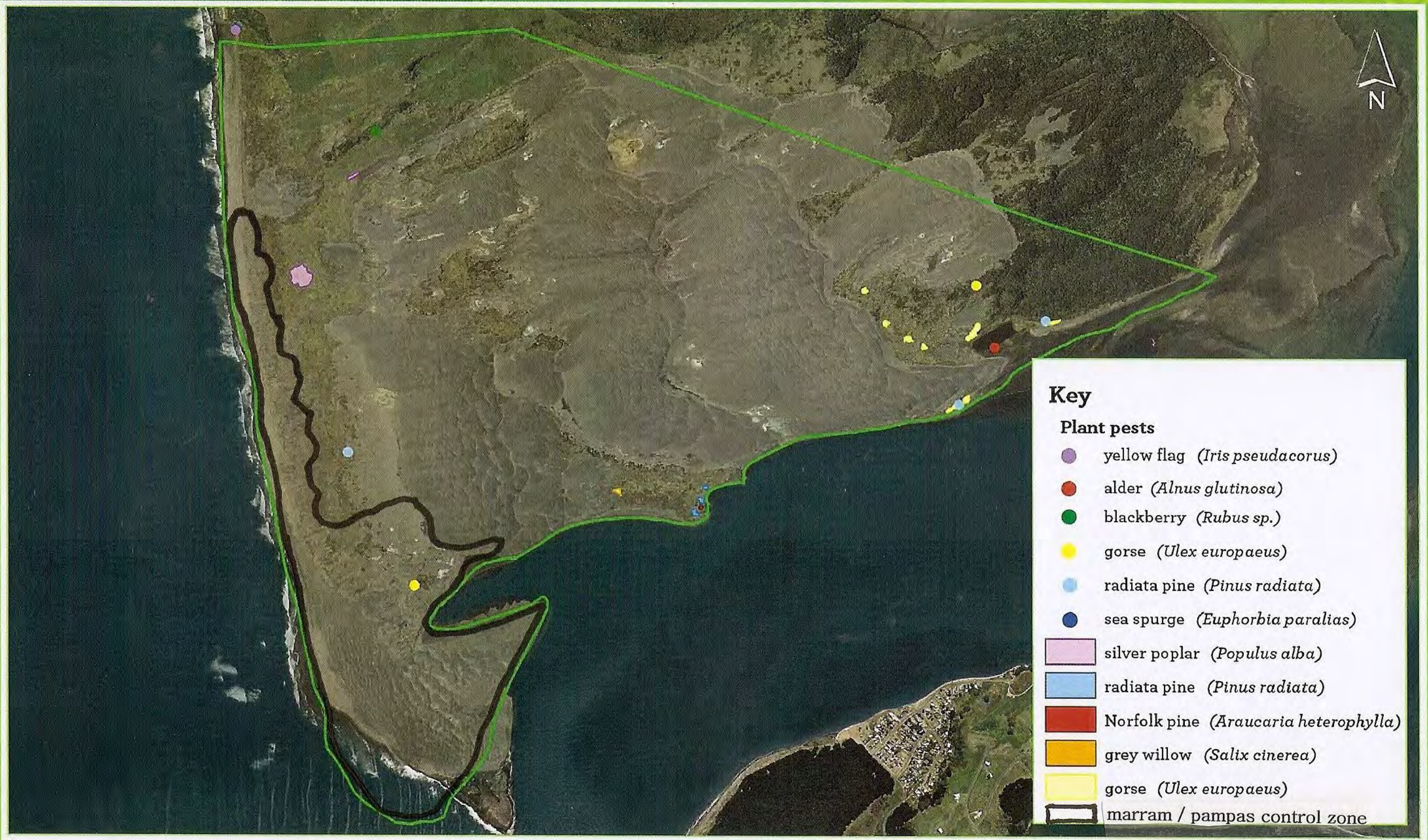
Blackberry was present in kanuka forest and scrub (Vegetation Type 4) and kanuka-mahoe-pohutukawa forest (Vegetation Type 2). Blackberry is not considered a threat to the kanuka forest as infestations are small and it is likely to be outcompeted by other species. Where blackberry occurs within the kanuka-mahoe-pohutukawa forest (location shown on Figure 4), the canopy is very open and the blackberry infestations

Figure 4: Location of small infestations of pest plants at Te Tuhi I Oioroa Aotea Heads Scientific Reserve

0 500 1,000 m

Printed: 02/05/2012
Scale: 1:14,000 @ A3
Drawn by: A Barnsdall

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File path: G:\1112_Projects\Flora\Aotea\Aotea_Survey_Final_Map.mxd



Key

Plant pests

- yellow flag (*Iris pseudacorus*)
- alder (*Alnus glutinosa*)
- blackberry (*Rubus sp.*)
- gorse (*Ulex europaeus*)
- radiata pine (*Pinus radiata*)
- sea spurge (*Euphorbia paralias*)
- silver poplar (*Populus alba*)
- radiata pine (*Pinus radiata*)
- Norfolk pine (*Araucaria heterophylla*)
- grey willow (*Salix cinerea*)
- gorse (*Ulex europaeus*)
- marram / pampas control zone

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Te Kāwanatanga o Aotearoa Te Papa Ahuwhiri

are likely to expand. It is advisable to eradicate blackberry from this site to prevent spread into surrounding grassland where regeneration of indigenous species is slowly occurring following recent exclusion of stock.

Gorse

Gorse is common around Korua Bay and was found at scattered locations elsewhere (Figure 4). It is likely to be eventually outcompeted in regenerating indigenous scrub and shrubland (Vegetation Types 5 and 30). Where it occurs on foredunes and seasonally wet dune slacks it is more likely to spread and therefore control is recommended as a medium priority.

Grey Willow

Grey willow was found in a depression in established dunes near Potoorangi Bay (Figure 4). This species is a high priority for control as it is an ecosystem changing weed that could spread into other suitable habitat (e.g. dune slacks, wetlands surrounding dune lake) within the reserve.

Kikuyu

Kikuyu is common in grassland vegetation types on the northern plateau (Vegetation Types 50 and 52). It may need to be controlled depending on the restoration goals for this area. See Section 7 for further discussion regarding restoration options of the grazing lease area.

Lupin

Lupin is common throughout the reserve but only dominates at several locations within the reserve (i.e. Vegetation Types 25 and 30). It can lower light levels in open habitats causing subsequent invasion by weedy shrubs or trees and may facilitate the invasion of higher fertility grasses by increasing soil nitrogen. However in 1989, lupin blight established in New Zealand and has substantially reduced the vigour of this species, resulting in large periodic dieback of infestations. Control of this species is therefore probably not necessary but should be re-assessed every five years.

Marram

Marram is widespread at Oioroa although its' density varies considerably. Together with pampas and purple pampas, it is considered the greatest threat to the naturalness of the vegetation communities at Oioroa. It is recommended that marram should be controlled on incipient dunes and within the established dunes and the deflation plains along the northern coastline and in the south-western section of the reserve which has the highest incidence of threatened plants and significant vegetation and ecosystem types (control zone shown in Figure 4). Marram occurs at densities of <5% in the south-western part of the reserve, except at the very western end of Potoorangi Bay where there is a small dense infestation (Vegetation Type 19). If more resources are available then control should be extended beyond this core zone into surrounding areas.

Norfolk Island Pine

Several Norfolk Island pine have been planted by visitors to the reserve at a small bay east of Potoorangi Bay. While Norfolk Island pine is not highly invasive, they grow to over 50 m in height which would significantly detract from the outstanding natural landscape values at Oioroa.

Pampas, Purple Pampas

Pampas and purple pampas were widespread at Oioroa. It is a dominant species in seven vegetation types (12, 26, 29, 30, 31, 32, and 36) and scattered through many others (e.g. Vegetation Types 4, 23, 25, and 48). We recommend that the same pest control approach is taken to that recommended for marram. Like marram, pampas and purple pampas are not widespread in the south-western end of the reserve and therefore it would be feasible to eradicate it from this part of the reserve, extending control beyond this core zone into surrounding areas depending on resources.

Radiata Pine

Radiata pine is present at a number of locations within the reserve (Figure 4) and may have been planted by visitors. It occurs as individual trees within several vegetation types but there is also a small area (Vegetation Type 43) where several mature trees are surrounded by saplings. This species has the potential to spread into established dunes. It currently occupies only c.0.13 ha and therefore it is considered a high priority for eradication.

Saltwater Paspalum

Saltwater paspalum is an invasive grass that occurs on the margins of the dune lake at Korua Bay (Figure 2). It is likely to have smothered habitat of coastal turfs resulting in their disappearance and has the potential to smother the diverse sea rush-*Ficinia nodosa*/saltwater paspalum rushland that occurs on the western side of the lake as it already dominates part of this vegetation type. It currently occupies 0.25 ha and could potentially be eradicated over a period of years using a grass-specific herbicide to avoid off-target damage. While eradication is desirable it would be more feasible to control it on the western and southern margins of the dune lake where it has the potential to cause the most damage to indigenous plant communities. Left uncontrolled spread of saltwater paspalum is likely to result in the almost total exclusion of indigenous plant species in the medium term in this area.

Sea Spurge

During the survey, one plant of sea spurge was found on the sand dunes at the northern end of the reserve. A further small infestation was found approximately 50 m north, outside of the reserve. This was the first time that this invasive weed species has been found in New Zealand (Beadel 2012). Sea spurge is a serious invasive pest plant that has not previously been recorded as naturalised in New Zealand, but has long been expected to establish here. It is a serious threat to indigenous sand dune vegetation communities (including threatened plant species),

and unvegetated fauna habitat, which is a key habitat for several nationally threatened species. Further information is provided in Appendix 5.

All plants in both infestations have been removed, but it is likely that plants will continue to establish from the seed bank.

It is of high priority to inspect the entire front of the foredune of the reserve for further infestations, and to be vigilant in inspecting the two infestation sites, and controlling any subsequent regrowth twice a year for the next 5-6 years, and probably longer. It has also been suggested that the following should be undertaken to preclude redistribution of ungerminated seed if the infestation areas are remobilised during storm events:

- Careful excavation of surface debris, wood, flotsam and jetsam - to be burnt on site;
- Excavation of the top 30 cm of sand (or more depending on patterns of sedimentation) - to be passed through a large 2 mm garden sieve (material retained in sieve to be burnt off site in a contained situation).

These actions may also reduce the length of time, twice annual site inspections would be required for.

The northern infestation site is obviously a site where items floating in ocean currents wash ashore. Piles of driftwood were present, along with miscellaneous plastic items. Three other weed species were also present: yellow flag (*Iris pseudacorus*), dimorphotheca (*Osteospermum fruticosum*), and alligator weed (*Alternanthera philoxeroides*). Control of all these infestations has been undertaken.

Silver Poplar

Silver poplar is present at two locations within the reserve (Figure 4) and is currently part of an eradication programme being undertaken by the Department of Conservation. Eradication of this weed should remain a high priority.

Spartina

Spartina is only present on the margin of the dune lake at Korua Bay. It is currently part of an eradication programme being undertaken by the Department of Conservation. Six small sparse patches remain in an area $c.50 \times 30$ m. Eradication of this weed should remain a high priority.

Tall Fescue

Tall fescue currently dominates six vegetation types (27, 32, 48, 50, 51, and 52) totalling $c.43.73$ ha and is present in several others. It is mostly confined to the northern end of the reserve where it occurs on the pasture dominated plateau, on the coastal hills surrounding the plateau and in the most northern duneslacks and is partly responsible along with marram and pampas for stabilising previously migrating dunes. It is not feasible to eradicate tall fescue from the reserve however we consider

it a medium priority to prevent it from spreading further south of its current distribution.

Yellow Flag Iris

A small patch (<1 m²) of yellow flag iris was observed just north of the boundary of Oioroa near the mouth of the Waihi Stream. It was present at a site where items floating in ocean currents wash ashore. Three other weed species were also present: alligator weed, dimorphotheca and sea spurge. Control of all these infestations was undertaken on 30 April 2012. Regular follow-up inspections and control, as required, will need to be undertaken of this site.

6.2 Pest animals

It is likely that several pest animal species are having a detrimental effect on some vegetation types at Oioroa. Possums are likely to be impacting on the small pohutukawa forest and kanuka-mahoe-pohutukawa forest remnants near the northern boundary of the reserve. Possum control is recommended to help maintain and encourage regeneration of these forest types.

Browse damage was observed on spinifex on the migrating dunes and on the foredunes adjacent to the harbour boundary. This is likely to be from rabbits and/or hares. While spinifex is abundant at Oioroa it is likely that rabbit/hare browse is preventing its spread into unvegetated areas and preventing the spread of the threatened plant pingao which occurs at similar locations. Control of rabbits/hares is recommended.

6.3 Stock grazing

Permitted and unpermitted grazing occurs on the northern plateau at Oioroa. The permitted area has undergone pastoral improvements by the lessee and has minimal conservation value. The unpermitted grazing areas have not been managed for pasture and still retain some indigenous vegetation including scattered kanuka and cabbage trees. There are several large patches of bare sand in these unpermitted areas which were probably caused by grazing and stock trampling. To prevent further degradation of these areas it is recommended that grazing cease to allow regeneration to indigenous scrub and shrubland. Regeneration is likely to be slow, occurring over decades unless active restoration is undertaken.

6.4 Dune stabilisation

Some of the significant vegetation and ecosystem types occur at Oioroa because of the habitats created by migrating dunes. These include the damp sand plains and dune slacks. The largest occurrence of these are located seaward of the migrating dunes and are likely to diminish over time. This is because the foredunes adjacent to the West Coast have become more stable due to diminished sand supply from the beach. This process is being exacerbated by weeds as discussed in Section 6.1. Weed control, particularly of pampas and marram, in the south-western section of the reserve is recommended to slow down this process.

We would expect that suitable habitat for the vegetation types associated with damp sand plains and dune slacks will continue to be created provided there are no efforts to stabilise the migrating dunes. However this appears to be happening naturally as a comparison between 1944 and 2007 aerial photographs (in Kahotea 2011) show that the dunes are no longer advancing toward Rauiri Heads with the most landward dunes having reverted to forest and scrubland within the last 70 years.

7. RESTORATION OPPORTUNITIES

The following sections describe further opportunities to restore and enhance vegetation at Oioroa that were not covered in management recommendations in the previous section.

7.1 Enhance the natural character of established foredunes

Oioroa contains significant vegetation and ecosystem types however it appears to be ‘missing’ some key species. These species include four threatened plant species that may have been present in the past at Oioroa. These include sand tussock, sand daphne, sand coprosma (*Coprosma acerosa*) and New Zealand spurge. All of these species should establish successfully at Oioroa if planted into open habitat in well drained areas within established foredunes if pest animals are excluded. In addition we would recommend planting pingao on incipient foredunes to expand the current population which is very small at both Oioroa and along the West Coast of the Waikato Region.

7.2 Revegetation of previously grazed areas

As discussed in Section 6.3, it is recommended that grazing cease on the northern plateau to allow natural regeneration to occur however this is likely to take decades to revert back to coastal forest. Another option is to revegetate this area to achieve this outcome much sooner. Three revegetation options are presented below.

Option 1

Revegetate all of the previously grazed area with suitable species (Table 2) in PB2/3 sizes at 1.2 m spacings to achieve canopy closure within 3-4 years minimising the need for ongoing weed control beyond this period. Revegetation of this type costs c.\$35k per hectare if undertaken by a contractor supplying plants and labour. This figure excludes travel expenses, plant delivery costs, site/monitoring visits, and GST.

Option 2

Revegetate all of the previously grazed area with suitable species (Table 2) in PB2/3 sizes at 2 m spacings to achieve canopy closure within 5-6 years. While up front costs are considerably less than those of Option 1, total costs could be substantially higher subject to how much maintenance and ongoing weed control might be required. Revegetation of this type costs c.\$13.5k per hectare if undertaken by a contractor supplying plants and labour. This figure again excludes travel expenses, plant delivery costs, site/monitoring visits, and GST, and assumes there are unlikely to be substantial issues generated by invasive weed species.

Table 2: Plant species recommended for establishing coastal forest on previously grazed areas at Oioroa.

Species	Common Name
<i>Coprosma macropiper</i> subsp. <i>minor</i>	karamu
<i>Cordyline australis</i>	cabbage tree
<i>Dodonea viscosa</i>	akeake
<i>Kunzea ericoides</i>	Kanuka
<i>Leptospermum scoparium</i>	manuka
<i>Melicytus ramiflorus</i> subsp. <i>ramiflorus</i>	mahoe
<i>Meterosideros excelsa</i>	pohutukawa
<i>Sophora microphylla</i>	kowhai

Option 3

Large pohutukawa (PB 5) planted at 10 m spacings throughout the previously grazed area. This is a much cheaper alternative than Options 1 and 2, costing c.\$5.5k per hectare. This approach has been undertaken elsewhere e.g. coastal cliffs on the Matata Straights, kikuyu covered hillslopes at Mauao (Mount Maunganui). Maintenance of the trees would be required until they reach 1.2-1.5 m tall. It generally takes 5-8 years to achieve good cover but canopy closure will take 10-20 years.

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VEGETATION AND HABITAT DESCRIPTIONS

1. Pohutukawa forest

Landform: Hillslope

Area: 0.1 ha

Single stem pohutukawa (10-12 m) form a dense canopy in sand. There is no shrub layer beneath the canopy. The ground cover is dominated by an indigenous herb, *Tetragonia implexicoma*. Pohuehue, sand wind grass (*Lachnagrostis billardierei*), *Coprosma rhamnoides*, seedlings of coastal toetoe (*Cortaderia splendens*), and catsear (*Hypochaeris radicata*) are also present. Marram is scattered around the margins.

2. Kanuka-mahoe-pohutukawa forest

Landform: Hillslope

Area: 0.9 ha

Kanuka (6-10 m), mahoe (6-8 m) and pohutukawa (10 m), form a dense canopy in sand. The shrub layer is sparse comprising scattered *Coprosma rhamnoides* and *Carmichaelia australis*. The ground cover is dominated by *Tetragonia implexicoma* and an indigenous grass *Oplismenus hirtellus* subsp. *imbecillis*, with local patches of *Carex testacea*, *Pteris tremula*, and inkweed (*Phytolacca octandra*). Other species present but confined to the margins include pampas, broad-leaved fleabane (*Conyza sumatrensis*), scotch thistle (*Cirsium arvense*), cocksfoot (*Dactylis glomerata*), kikuyu (*Cenchrus clandestinus*), Yorkshire fog (*Holcus lanatus*), and tall fescue (*Schedonorus arundinaceus*). A small area of dead kanuka was present within this vegetation type with an understorey of dense blackberry (*Rubus fruticosus*).

3. Kanuka-mahoe forest

Landform: Hillslope

Area: 0.3 ha

Kanuka (6-10 m) and mahoe (6-8 m) form an open canopy in sand. The ground cover is dominated by exotic grasses which include Yorkshire fog and ripgut brome (*Bromus diandrus*). Other species present in the understorey include *Carex testacea*, bracken (*Pteridium esculentum*), black nightshade (*Solanum nigrum*), and local blackberry.

4. Kanuka forest and scrub

Landform: Relict dune adjacent to the harbour (Rauriri Head).

Area: 17.7 ha

Kanuka (6-12 m) dominates the canopy with local manuka (*Leptospermum scoparium*) and scattered cabbage tree (*Cordyline australis*). The sub-canopy is sparse to

moderately abundant, comprising kanuka (6-8 m), cabbage tree, scattered akeake (*Dodonea viscosa*), forest cabbage tree (*Cordyline banksii*), mahoe (*Melicytus ramiflorus* subsp. *ramiflorus*), and wheki (*Dicksonia squarrosa*), with mamaku (*Cyathea medullaris*) most abundant towards the northern boundary of the reserve. The shrub tier (1-3 m) is dense and diverse consisting of kanuka, prickly mingimingi (*Leptecophylla juniperina* var. *juniperina*), mingimingi (*Leucopogon fasciculatus*), *Coprosma propinqua* var. *propinqua*, *Coprosma ×cunninghamii*, mahoe, akeake, karamu, hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*), and mapou (*Myrsine australis*), with occasional *Carmichaelia australis*, *Pomaderris amoena*, and *Corokia cotoneaster* (one individual observed). Several vine species were present including *Clematis paniculata*, *Muehlenbeckia australis*, *Calystegia sepium* subsp. *roseata*, and *Calystegia tuguriorum*.

On the seaward margins tauhinu, gorse, bracken and *Ficinia nodosa* are common in the understorey with several exotic grasses and herbs. Further inland the ground cover is far more diverse with many indigenous grasses (meadow rice grass (*Microlaena stipoides*), *Oplismenus hirtellus* subsp. *imbecillis*, *Poa anceps* agg., *Poa pusilla*, sand wind grass, and *Rytidosperma gracile*), ferns (*Adiantum cunninghamii*, *Asplenium oblongifolium*, *Asplenium polyodon*, *Blechnum filiforme*, *Blechnum minus*, *Blechnum novae-zelandiae*, *Doodia australis*, *Paesia scaberula*, *Polystichum wawranum*, *Pteris macilenta*, and *Pteris tremula*), sedges (*Baumea juncea*, *Carex dissita*, *Carex solandri*, *Cyperus ustulatus* f. *ustulatus*, *Eleocharis gracilis*, *Isolepis cernua*, *Lepidosperma australe*, and *Uncinia uncinata*), herbs (*Acaena anserinifolia*, *A. novae-zelandiae*, *Centella uniflora*, *Dichnodra repens*, *Epilobium brunnescens* subsp. *brunnescens*, *Hydrocotyle elongata*, *Hydrocotyle moschata*, *Lagenifera petiolata*, *Lagenifera pumila*, *Pseudognaphalium luteoalbum* agg., *Leptostigma setulosa*, *Lobelia anceps*, *Mentha cunninghamii*, *Nertera dichondrifolia*, *Nertera scapinoides*, and *Solanum americanum*). Several indigenous orchids were observed (*Microtis unifolia* agg., *Pterostylis banksii* and *Thelymitra longifolia*) and it is likely that other orchid species are present due to the abundance of suitable habitat. Exotic species are also present in the understorey, including scattered pampas, blackberry seedlings, and local gorse.

5. Kanuka-tauhinu shrubland

Landform: Migrating dune
Area: 3.8 ha

Shrubland dominated by kanuka and tauhinu with scattered mingimingi and gorse. The ground cover is dominated by sand, with scattered seedlings of kanuka, tauhinu, gorse, and pampas. Also present are meadow rice grass, haretail, *Lotus suaveolens*, and lotus (*Lotus pedunculatus*).

6. Harakeke-(coastal toetoe) flaxland

Landform: Sea cliff
Area: 0.3 ha

Flaxland dominated by harakeke, with scattered coastal toetoe. Bracken, shrubs of pohutukawa (c.2 m tall), and *Cyperus ustulatus* occur in local patches.

7. Spinifex sandfield

Landform: Foredune, northern head of the harbour
Area: 17.5 ha

Spinifex is dominant, but not abundant (cover <20%) on incipient (newly developing) foredunes, including the rapidly accreting northern head of Aotea Harbour (southern tip of the reserve). There is occasional pingao (*Ficinia spiralis*) and marram.

8. Marram sandfield

Landform: Gently sloping precipitation ridge
Area: 0.6 ha

This vegetation type consists of scattered marram on sand. No other species were present. This vegetation type was quite common within the transgressive dunefield however as it rarely contained more than a handful of plants, only one area was large enough to be captured on the vegetation map.

9. Tauhinu/spinifex sandfield

Landform: Established dune
Area: 23.1 ha

This vegetation type is dominated by spinifex with scattered tauhinu. The northern most occurrences of this vegetation type are the most stable with several other species present including sand wind grass, shore bindweed, hawkbit, marram, haretail, and pampas. Towards the southern end of the reserve this vegetation type occurs on less stable hummocky dunes with many small blowouts.

10. Tauhinu/marram-spinifex sandfield

Landform: Deflation plain, migrating dune
Area: 22.9 ha

This vegetation type occurs on slightly raised areas on the deflation plain that runs parallel to the coast and on the margins of exposed soils on the transgressive dunes. The dominant species are tauhinu, marram, and spinifex. In small damp areas there is occasional *Carex pumila*, *Ficinia nodosa*, *Sagina procumbens*, *Lobelia anceps*, and *Schoenus concinnus*. Hawkbit, broad-leaved fleabane, hairy birdsfoot trefoil and local pampas occur within this vegetation type.

11. Coastal toetoe sandfield

Landform: Precipitation ridge
Area: 1.4 ha

Coastal toetoe is dominant, but not abundant (cover <20%) on the downwind margin of a transgressive dunefield (i.e. precipitation ridge). There is local scattered pampas and purple pampas.

12. Coastal toetoe-pampas sandfield

Landform: Precipitation ridge
Area: 1.9 ha

Similar in composition and location to coastal toetoe sandfield but with pampas more common.

13. *Carex pumila* sandfield

Landform: Deflation plain, migrating dune
Area: 1.6 ha

Carex pumila scattered on damp sand. Gravel and shells are usually also present on the surface.

14. Tauhinu/marram-coastal toetoe sandfield

Landform: Migrating dune, established foredune
Area: 7.6 ha

Scattered tauhinu (<20%) over marram with locally common coastal toetoe and local spinifex. Gorse very occasionally present.

15. Spinifex/*Carex pumila*-shore bindweed sandfield

Landform: Incipient dune
Area: 0.2 ha

Spinifex dominant over scattered *Carex pumila* and shore bindweed. Other species present include local *Tetragonia implexicoma*, haretail and sand wind grass.

16. (Tauhinu)-(marram) loamfield

Landform: Migrating dune, deflation plain
Area: 3.9 ha

Tauhinu and marram occur at very low abundances (<5%) on soils exposed by wind erosion.

17. (Tauhinu)/marram shellfield

Landform: Exposed middens on migrating dune
Area: 0.8 ha

Tauhinu and marram occur within shell middens exposed by wind erosion. Spinifex and coastal toetoe are occasionally present.

18. Spinifex tussockland

Landform: Incipient foredune
Area: 1.9 ha

Spinifex is dominant on incipient foredunes within the harbour. Tauhinu, marram, shore bindweed, and *Carex pumila* are scattered within the vegetation type.

19. Spinifex-marram tussockland

Landform: Incipient foredune
Area: 1.2 ha

Spinifex and marram are dominant on incipient foredunes within the harbour. Other species sometimes present include tauhinu, *Ficinia nodosa*, hawkbit, and broadleaved fleabane.

20. Tauhinu shrubland

Landform: Migrating dune
Area: 1.8 ha

This vegetation type is dominated by tauhinu with scattered coastal toetoe, pampas, lupin, and occasional *Ficinia nodosa*. Spinifex and marram are common on the margins.

21. Tauhinu/spinifex shrubland

Landform: Migrating dune
Area: 2.3 ha

Tauhinu over spinifex with locally common coastal toetoe. Other species present include lupin, broad-leaved fleabane, haretail, *Pseudognaphalium luteoalbum* agg., and marram.

22. Tauhinu/spinifex tussockland

Landform: Established foredune
Area: 11.7 ha

This vegetation type is dominated by tauhinu and spinifex. All other species occur at very low abundances and include hawkbit, broad-leaved fleabane, haretail, marram, *Ficinia nodosa*, and hairy birdsfoot trefoil.

23. Tauhinu/*Ficinia nodosa*-marram tussockland

Landform: Established dunes
Area: 0.9 ha

This vegetation type is dominated by marram with scattered *Ficinia nodosa* and tauhinu, and local pampas and coastal toetoe. Other species present include spinifex, broad-leaved fleabane, haretail, and hairy birdsfoot trefoil.

24. Tauhinu/marram-coastal toetoe tussockland

Landform: Transgressive dunes
Area: 1.5 ha

This vegetation type is dominated by tauhinu over marram with scattered coastal toetoe and local lupin.

25. Tauhinu/marram-lupin shrubland

Landform: Transgressive dunes
Area: 3 ha

Shrubland dominated by tauhinu and lupin over marram, with scattered coastal toetoe.

26. Tauhinu-*Ficinia nodosa*-pampas-coastal toetoe shrubland

Landform: Established dune, hillslope
Area: 13.3 ha

An extensive vegetation type where tauhinu, *Ficinia nodosa*, pampas, and coastal toetoe are the most common species. Tall fescue and bracken are more common on hillslopes whereas marram, spinifex, harakeke, and *Cyperus ustulatus* occur mainly at the base of the hills. Small pohutukawa (2 m) are scattered throughout this vegetation type.

27. Tauhinu-*Ficinia nodosa*-(pohutukawa)/tall fescue shrubland

Landform: Hillslope
Area: 0.6 ha

This vegetation type occurs adjacent to the remnant area of pohutukawa forest. Tauhinu and *Ficinia nodosa* are dominant over tall fescue with scattered small pohutukawa (2 m). Kanuka and marram are local. Other species present include coastal toetoe, lupin, hawksbeard, sweet vernal (*Anthoxanthum odoratum*), cocksfoot, white clover (*Trifolium repens*), and blackberry.

28. *Ficinia nodosa*-pampas tussockland

Landform: Established dune
Area: 4 ha

This vegetation type occurs on established dunes adjacent to densely vegetated deflation plains/slacks. *Ficinia nodosa* is dominant with scattered pampas, akeake, and local coastal toetoe. Other species present include tauhinu, broad-leaved fleabane, hawksbit, haretail, white clover, and tall fescue.

29. Pampas-*Ficinia nodosa*-tauhinu/marram tussockland

Landform: Deflation plain, dune slack
Area: 8.2 ha

This vegetation type is characteristic of the later successional stages within the deflation plains/slacks at Aotea Heads. Pampas, *Ficinia nodosa* and tauhinu are dominant over marram, sand wind grass, tall fescue, haretail, lotus and white clover. Other species present include *Muehlenbeckia complexa*, coastal toetoe, oioi, lupin, and gorse. There are a few examples of *Carex testacea*.

30. Pampas-marram-*Ficinia nodosa*-coastal toetoe-tauhinu tussockland

Landform: Migrating dune
Area: 25.6 ha

This vegetation type is a mosaic of locally abundant pampas, *Ficinia nodosa*, coastal toetoe, and tauhinu. Marram is common around the margins with scattered spinifex. Other shrubs present include lupin, kanuka, cabbage tree, and gorse. A range of grasses and herbs are present, the most common include sand wind grass, haretail, hairy birdsfoot trefoil, broad-leaved fleabane, lotus, and white clover.

31. Pampas tussockland

Landform: Dune lake
Area: 0.4 ha

Pampas tussockland occurs as a dense band behind the small dune lake at Korua Bay. Pampas is dominant, with occasional coastal toetoe. Saltwater paspalum (*Paspalum vaginatum*) occurs towards the edge of the dune lake.

32. Coastal toetoe-pampas/tall fescue grassland

Landform: Edge of migrating dune
Area: 3.1 ha

Coastal toetoe and pampas are dominant over tall fescue with local bracken. Lupin is scattered and tauhinu occurs locally on the margins.

33. (*Ficinia nodosa*)/*Carex pumila* sedgeland

Landform: Deflation plain
Area: 11.8 ha

Scattered *Ficinia nodosa* over *Carex pumila* forms this vegetation type. *Limosella lineata* is common in damp areas with occasional *Schoenus concinnus*. Marram, pampas, and coastal toetoe are also scattered through this vegetation type.

34. *Ficinia nodosa*/Schoenus concinnus sedgeland

Landform: Dune slack
Area: 0.5 ha

Ficinia nodosa, oioi, and pampas are scattered over a dense mat of *Schoenus concinnus*. Other ground cover species present include *Zoysia minima*, *Lobelia anceps*, hairy birdsfoot trefoil, slender birdsfoot trefoil, spinifex, marram, and hawkbit. Shells are also present on the surface of the sand.

35. Tauhinu-*Ficinia nodosa*/Carex pumila sedgeland

Landform: Wetland at dune lake
Area: 0.2 ha

This vegetation type is dominated by tauhinu over *Carex pumila* and shore bindweed, with scattered *Ficinia nodosa* and lupin. A range of grass and herb species were also common, including Yorkshire fog, haretail, sand wind grass, lotus, hairy birdsfoot trefoil, *Pseudognaphalium luteoalbum* agg., scarlet pimpernel (*Anagallis arvensis*), and tarweed (*Parentucellia viscosa*).

36. Oioi-pampas-tauhinu rushland

Landform: Dune slack
Area: 0.1 ha

This vegetation type is dominated by oioi and tauhinu, with several large areas of pampas. Several other small trees and shrubs were present, including pohutukawa (1 m), manuka (1 m), and Spanish heath (*Erica lusitanica*). Sea rush (*Juncus kraussii* var. *australiensis*) was common amongst oioi and tauhinu. The understorey comprises *Schoenus concinnus* which forms a dense mat. Other ground cover species included white clover, lotus, haretail, sand wind grass, lotus, hairy birdsfoot trefoil, tarweed, and centaury (*Centaureum erythraea*). *Limosella lineata*, spinifex, and marram were common on the margins.

37. Raupo-*Bolboschoenus fluviatilis* reedland

Landform: Wetland at dune lake
Area: 0.2 ha

This vegetation type is dominated by dense stands of raupo (*Typha orientalis*) and *Bolboschoenus fluviatilis*. Swards of saltwater paspalum were interspersed amongst the reeds with scattered pampas along the landward margin.

38. Sea rush-oioi/saltwater paspalum rushland

Landform: Wetland at dune lake
Area: 0.1 ha

Saltwater paspalum forms dense colonies in places. Elsewhere scattered sea rush and oioi with local pampas occur over seawater paspalum, arrow grass (*Triglochin striata*), and *Isolepis cernua*. Other species present include *Samolus repens* var *repens*, *Lobelia anceps*, *Selliera radicans*, *Lilaeopsis novae-zelandiae*, sand wind grass, and silver hairy grass (*Aira caryophyllea* subsp. *caryophyllea*). *Carex pumila* and *Schoenoplectus pungens* occur locally.

39. Sea rush-*Ficinia nodosa*/saltwater paspalum tussockland

Landform: Wetland at dune lake
Area: 1 ha

Dense stands of sea rush are surrounded by *Ficinia nodosa* and saltwater paspalum. Pampas, *Schoenoplectus pungens*, and *Bolboschoenus fluviatilis* are locally abundant.

40. Saltwater paspalum grassland

Landform: Wetland at dune lake
Area: 0.3 ha

Dense swards of saltwater paspalum form the dominant cover, with a scattering of other species including alder (*Alnus glutinosa*) saplings, pampas, sea rush, *Ficinia nodosa*, *Schoenoplectus pungens*, and tauhinu. A small patch of a pest plant species, spartina (*Spartina anglica*) (classed as “eradication” by the Regional Council), is present within this vegetation type.

41. Grey willow shrubland

Landform: Dune slack
Area: 0.04 ha

Grey willow (2-3 m) forms a dense canopy. The understorey was not sighted but is unlikely to contain more than a sparse groundcover due to very low light levels.

42. Bracken fernland

Landform: Plateau
Area: 0.2 ha

This vegetation is dominated by bracken (*Pteridium esculentum*) with scattered kanuka (3 m). Other species present include *Ficinia nodosa*, Yorkshire fog, and ripgut brome.

43. Radiata pine treeland

Landform: Foredune
Area: 0.1 ha

Radiata pine (2-6 m) forms a dense canopy over pampas, *Ficinia nodosa*, tall fescue, kikuyu (*Cenchrus clandestinus*), broad-leaved fleabane, and saplings of radiata pine. It is thought that some of the older radiata pine were planted by visitors.

44. Norfolk pine treeland

Landform: Foredune
Area: 0.01 ha

Norfolk pine (4-6 m) is the dominant canopy species over pampas, *Ficinia nodosa*, tall fescue, kikuyu and broad-leaved fleabane. It is thought that the Norfolk pine have been planted by visitors.

45. Gorse-mingimingi scrub

Landform: Migrating dune (stabilised)
Area: 0.2 ha

This vegetation type is dominated by gorse (1-2 m) and mingimingi (1-2 m) with scattered kanuka, tauhinu, akeake, and coastal toetoe. Pampas is locally common. Other species present include *Ficinia nodosa*, marram, lupin, and cabbage tree.

46. Gorse scrub

Landform: Incipient foredune, established dune, migrating dune (stabilised)
Area: 0.3 ha

Gorse (1-2 m) is the dominant species with pampas, coastal toetoe, tauhinu, kanuka, mingimingi, and radiata pine often scattered in the canopy. Ground cover species include seedlings of gorse, kanuka, and tauhinu, as well as grasses and herbs (e.g. harestail, spinifex, marram, hairy birdsfoot trefoil, and meadow rice grass).

47. Silver poplar tree and shrubland

Landform: Dune slack, migrating dune (stabilised)
Area: 0.6 ha

Dense suckering silver poplar (*Populus alba* 'Nivea') (1-1.5 m) is dominant with scattered tauhinu and pampas. Ground cover is dominated by tall fescue and *Ficinia nodosa*.

48. Tall fescue-pohuehue-*Ficinia nodosa* grassland

Landform: Dune slack, migrating dune (undergoing stabilised)
Area: 13.7 ha

This vegetation type is dominated by tall fescue, pohuehue (*Muehlenbeckia australis*) and *Ficinia nodosa*, with local pampas, bracken, and *Cyperus ustulatus*, the latter occurring within the dampest area of this vegetation type. Other species present include *Muehlenbeckia complexa*, *Muehlenbeckia australis* × *M. complexa*, *Carex testacea*, cocksfoot, Yorkshire fog, white clover, hawksbeard, Scotch thistle (*Cirsium vulgare*), ragwort (*Jacobaea vulgaris*), cleavers (*Galium aparine*), lotus, swamp plantain (*Plantago australis*), four-seeded vetch (*Vicia tetrasperma*), and upright hedge parsley (*Torilis japonica*).

49. Rye grass-cocksfoot-Yorkshire fog grassland

Landform: Hill plateau
Area: 7.7 ha

This vegetation type occurs in an area that has been grazed under a lease arrangement and has been managed by the lessee to improve the quality of the pasture. It is dominated by the following pasture grasses; rye grass (*Lolium perenne*), cocksfoot, and Yorkshire fog. Other species present include creeping bent (*Agrostis stolonifera*) prairie grass, kikuyu grass, white clover, and scattered Californian thistle (*Cirsium arvense*).

50. Tall fescue-kikuyu-pohuehue-*Ficinia nodosa* grassland

Landform: Hill plateau
Area: 6.5 ha

This vegetation type has been grazed intermittently but has not undergone pasture management. It is dominated by tall fescue, kikuyu, pohuehue and *Ficinia nodosa* with scattered lupin, tauhinu, and kanuka. Meadow rice grass and bracken are local. Patches of bare sand, some up to 30 m × 10 m wide are present within this vegetation type. Other species present include creeping bent, harestail, Californian thistle, marram, sand wind grass, and *Cyperus ustulatus*.

51. Tall fescue-cocksfoot-rye grass-(pohuehue) grassland

Landform: Hill plateau

Area: 19.2 ha

This vegetation type has been grazed intermittently but has not undergone pasture management. It is dominated by tall fescue, cocksfoot and rye grass with many small patches of pohuehue. Other species present include ratstail (*Sporobolus africanus*), harestail, creeping bent, ti kouka (cabbage tree), lupin, *Ficinia nodosa*, and Californian thistle.

52. Tall fescue-kikuyu-bracken grassland

Landform: Hill plateau

Area: 0.7 ha

This vegetation type has been grazed intermittently but is now fenced from grazing. It is made up of a mosaic of tall fescue-kikuyu grassland and bracken fernland, with scattered kanuka. Other species present include Yorkshire fog, ripgut brome (*Bromus diandrus*), and *Cyperus ustulatus*.

VEGETATION MAPS

**See Appendix 1 for descriptions of
vegetation and habitat types.**

Map 1



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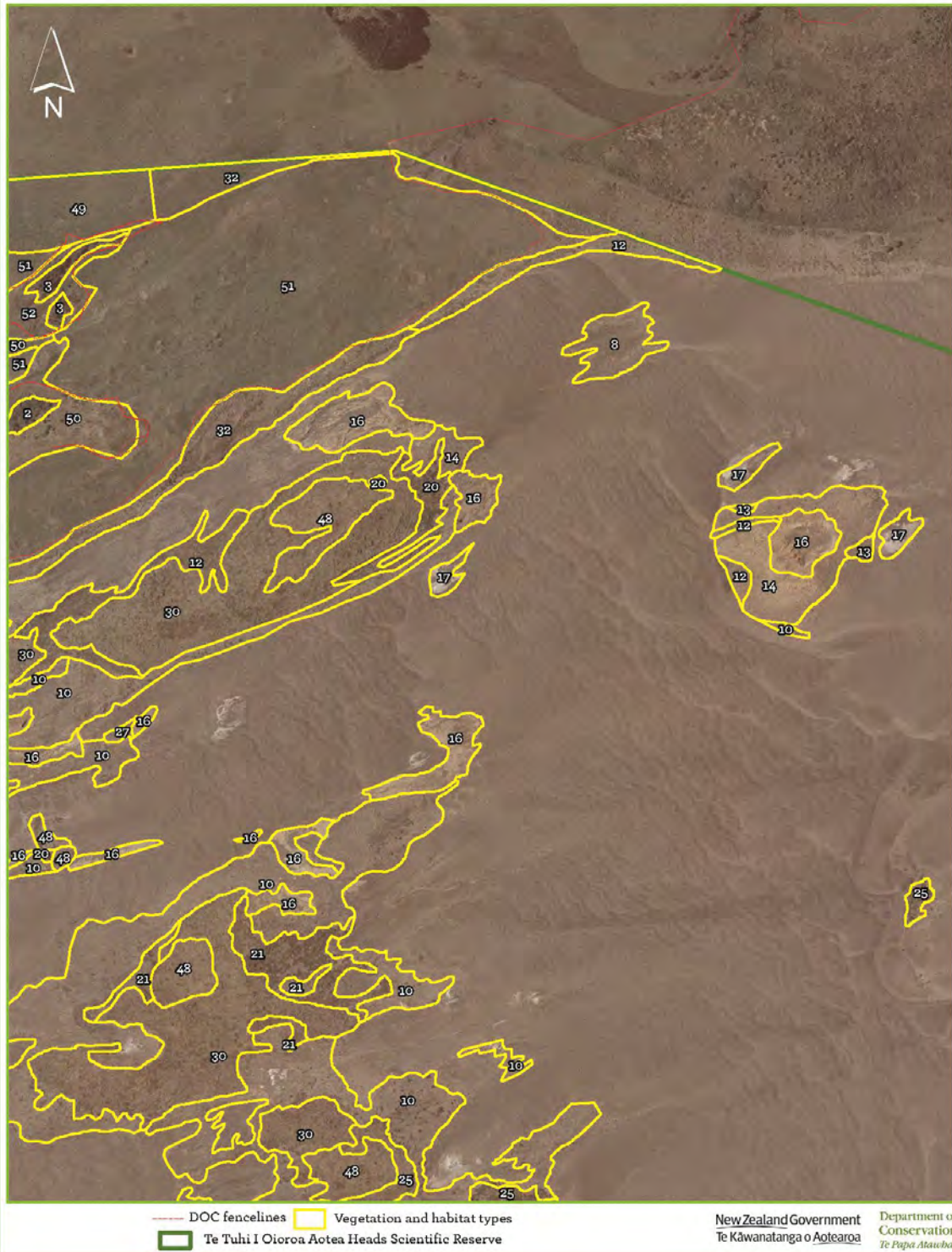
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Map 2



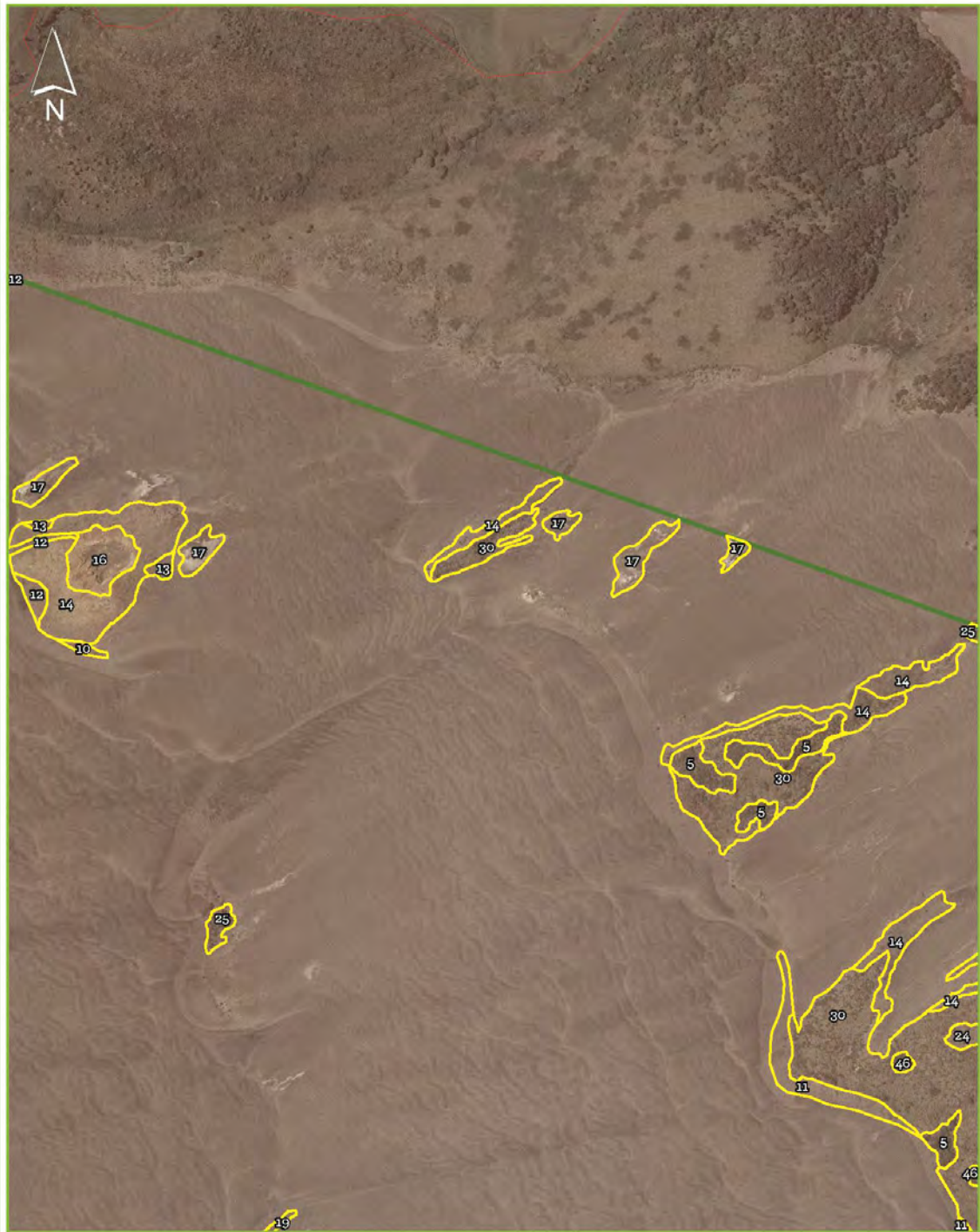
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Map 3



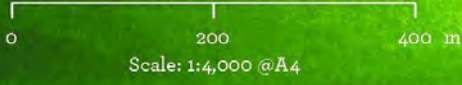
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Map 4



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Map 5



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Map 6

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Map 7

0 200 400 m
Scale: 1:4,000 @A4

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Map 8



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SITE PHOTOGRAPHS



Plate 1: Pohutukawa forest (Vegetation Type 1) on sand, a rare vegetation type found on the hills at the north end of Oioroa.



Plate 2: Kanuka-mahoe-pohutukawa forest (Vegetation Type 2), occurs adjacent to the pohutukawa forest in Plate 1.



Plate 3: Kanuka-mahoe forest (Vegetation Type 3) occurs on the northern hilltops of Oioroa. It has been fenced from stock grazing.



Plate 4: Kanuka forest and scrub (Vegetation Type 4) viewed from the top of a transgressive dune. The kanuka forest borders the Aotea Harbour at Rauiri Head.



Plate 5: *Baumea juncea* in the understorey of the kanuka forest (Plate 4). This vegetation type has a high species diversity with few pest plants.



Plate 6: Kanuka-tauhinu shrubland (Vegetation Type 5) was common on the most landward crest of the transgressive dunes.



Plate 7: Harakeke-(coastal toetoe) flaxland (Vegetation Type 6) on the northern sea cliffs at Oioroa.



Plate 8: Spinifex sandfield (Vegetation Type 7) on the highly mobile sands of the northern head of Aotea Harbour. A few examples of the threatened plant pingao (a small patch can be seen in this photo) occurs within this vegetation type.



Plate 9: Marram sandfield (Vegetation Type 8) on the landward slope of a transgressive dune.



Plate 10: Tauhinu/spinifex sandfield (Vegetation Type 9) on the foredunes at Oioiroa.



Plate 11: Tauhinu/marram-spinifex sandfield (Vegetation Type 10) on the windward slope of a transgressive dune.



Plate 12: Coastal toetoe sandfield (Vegetation Type 11) on the slipface of a transgressive dune.



Plate 13: Coastal toetoe-pampas sandfield (Vegetation Type 12) on the slipface of a transgressive dune. Very few pampas plants were flowering during the field survey.



Plate 14: *Carex pumila* sandfield (Vegetation Type 13) on the windward slope of a transgressive dune. Shells and stones were often present within this vegetation type.



Plate 15: (Tauhinu)/marram-coastal toetoe sandfield (Vegetation Type 14) behind a shell midden on the landward slope of a transgressive dune.

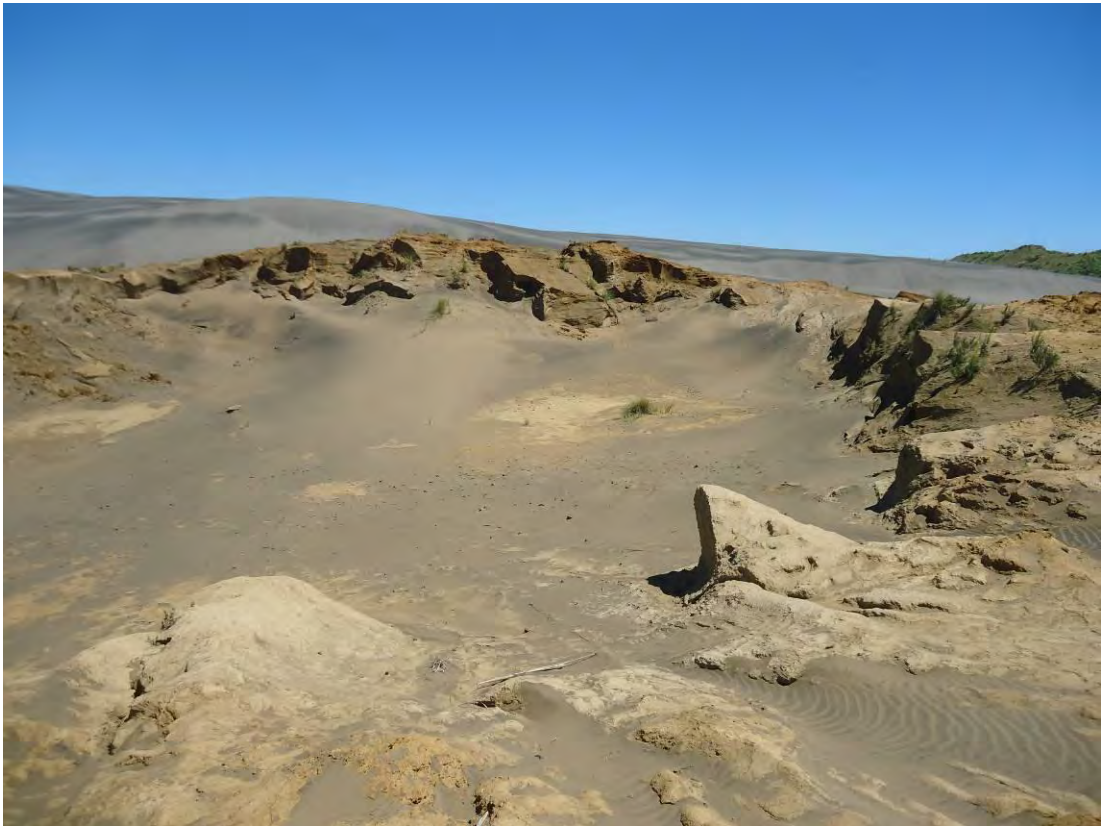


Plate 16: (Tauhinu)-(marram) loamfields (Vegetation Type 16) occur where wind has exposed the soil surface within the transgressive dunes.



Plate 17: (Tauhinu)/marram shellfields (Vegetation Type 17) occur where wind has exposed shell middens within the transgressive dunes. Not all middens were vegetated.



Plate 18: Spinifex tussockland (Vegetation Type 18) on the seaward face of an incipient dune within Aotea Harbour.



Plate 19: Tall fescue-pohuehue-*Ficinia nodosa* grassland (Vegetation Type 48) is visible in the foreground. Tauhinu shrubland (dark coloured shrubs, Vegetation Type 20) is visible in the midground below the sparsely vegetated windward slope of a transgressive dune with exposed soils and shell middens.



Plate 20: Tauhinu/spinifex shrubland (Vegetation Type 21) within a small depression on the windward slope of a transgressive dune.



Plate 21: Tauhinu/spinifex tussockland (Vegetation Type 22) in established foredunes.



Plate 22: Tauhinu/*Ficinia nodosa*-marram tussockland (Vegetation Type 23) on the crest of an incipient dune within the Aotea Harbour. Kanuka forest can be seen on the landward margin.



Plate 23: Tauhinu/marram-coastal toetoe tussockland (Vegetation Type 24) on a transgressive dune at Korua Bay.



Plate 24: Tauhinu/marram-lupin shrubland (Vegetation Type 25) rings an area of bare sand within a vegetated transgressive dune at Korua Bay. Kanuka scrub can be seen in the background.



Plate 25: Tauhinu/spinifex tussockland (foreground, Vegetation Type 22) and tauhinu-*Ficinia nodosa*-pampas-coastal toetoe shrubland (Vegetation Type 26) on the hills behind, at the northern end of Oioroa.



Plate 26: Tauhinu-*Ficinia nodosa*-(pohutukawa)/tall fescue shrubland (Vegetation Type 27) on the northern hillslopes adjacent to remnant pohutukawa forest (not visible).



Plate 27: *Ficinia nodosa*-(pampas) tussockland (Vegetation Type 28) on the margins of a dune slack between Korua and Potoorangi Bay. Radiata pine and Norfolk pine can be seen in the background.

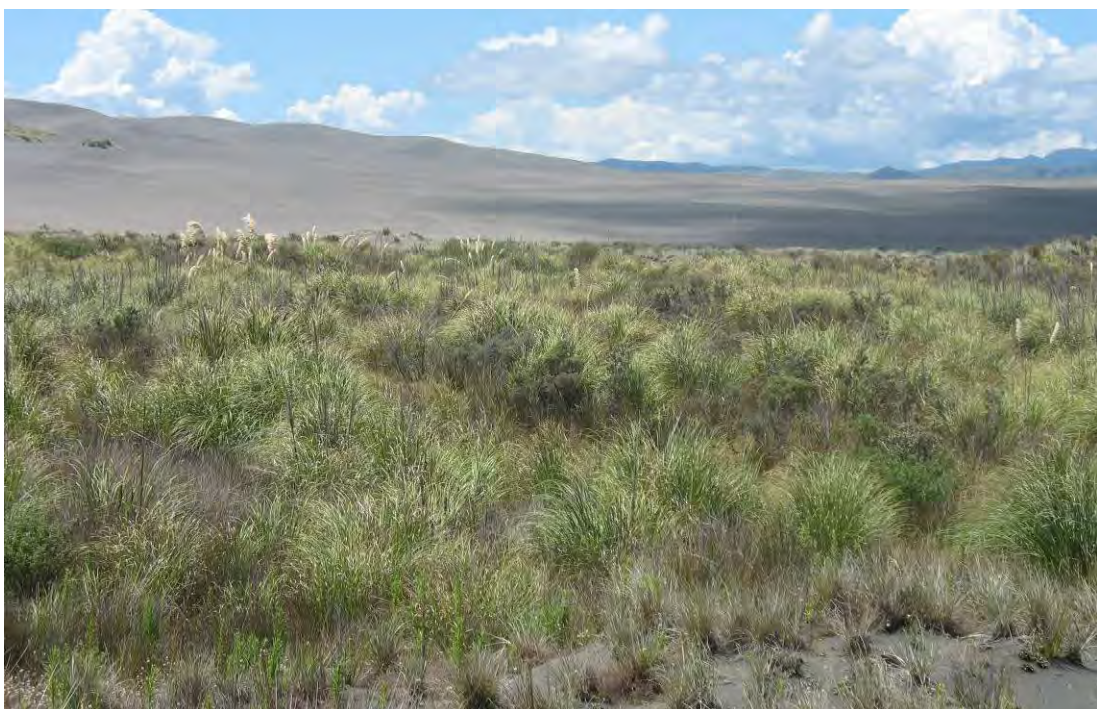


Plate 28: Pampas-*Ficinia nodosa*-tauhinu/marram tussockland (Vegetation Type 29) dominate this dune slack within a large deflation plain between the established dunes and transgressive dunes at Oioroa.



Plate 29: Pampas-marram-*Ficinia nodosa*-coastal toetoe-tauhinu tussockland (Vegetation Type 30) on the windward side of a transgressive dune at Oioroa.



Plate 30: Pampas tussockland (Vegetation Type 31) behind saltwater paspalum grassland (Vegetation Type 40) on the margins of the dune lake at Korua Bay.



Plate 31: Coastal toetoe-pampas/tall fescue grassland (Vegetation Type 32) on the crest of the northern hills at Oioroa. This area has been fenced to prevent stock access.



Plate 32: (*Ficinia nodosa*)/*Carex pumila* sedgeland (Vegetation Type 33) on the damp margins of a deflation plain between two transgressive dunes.



Plate 33: *Ficinia nodosa*/*Schoenus concinnus* sedgeland (Vegetation Type 34) occurs in dune slacks within established dunes and on the seaward margin of the largest deflation plain at Oioroa.



Plate 34: Oioi-pampas-(tauhinu) rushland (Vegetation Type 35) within a small dune slack. Immediately behind this vegetation type is *Ficinia nodosa*/*Schoenus concinnus* sedgeland (Vegetation Type 34). Tauhinu/spinifex sandfield (Vegetation Type 9) is present on the surrounding dunes.



Plate 35: Raupo-*Bolboschoenus fluviatilis* reedland (Vegetation Type 37) on the margins of the dune lake at Korua Bay.



Plate 36: Sea rush-*Ficinia nodosa*/saltwater paspalum rushland (Vegetation Type 39) on the seaward margin of the dune lake at Korua Bay.



Plate 37: Saltwater paspalum grassland (Vegetation Type 40) on the seaward margin of the dune lake at Korua Bay. Small alder saplings can be seen on the right hand side of the photo within the grassland.



Plate 38: Grey willow shrubland (Vegetation Type 41) on the margins of a dune slack.



Plate 39: Radiata pine treeland (Vegetation Type 43) at a small bay between Korua and Potoorangi Bays.



Plate 40: Gorse-mingimingi scrub (Vegetation Type 45) on the hillslope above the dune lake at Korua Bay.



Plate 41: Silver poplar tree and shrubland (Vegetation Type 47) surrounded by tall fescue-pohuehue-*Ficinia nodosa* grassland (Vegetation Type 48) at the northern end of the largest deflation plain at Oioroa.



Plate 42: Tall fescue-pohuehue-*Ficinia nodosa* grassland (Vegetation Type 48) with local giant umbrella sedge (*Cyperus ustulatus*) and pampas.



Plate 43: Tall fescue-kikuyu-pohuehue-*Ficinia nodosa* grassland (foreground, Vegetation Type 50) and rye grass-cocksfoot-Yorkshire fog grassland (background, (Vegetation Type 48), the latter has been part of a grazing lease to the adjacent farmer (Mr Peacock).



Plate 44: Sea spurge (*Euphorbia paralias*) just north of the boundary of Oioroa.



Plate 45: Yellow flag just north of the boundary of Oioroa.



Plate 46: The mouth of the Waihi Stream where yellow flag, alligator weed and sea spurge were found.

VASCULAR SPECIES RECORDED AT TE TUHI I OIOROA AOTEA HEADS SCIENTIFIC RESERVE

INDIGENOUS SPECIES

Monocot. trees and shrubs

<i>Cordyline australis</i>	ti kouka, cabbage tree
<i>Cordyline banksii</i>	ti ngahere, forest cabbage tree

Dicot. trees and shrubs

<i>Carmichaelia australis</i>	makaka, maukoro
<i>Coprosma</i> × <i>cunninghamii</i> (<i>Coprosma propinqua</i> × <i>C. robusta</i>)	
<i>Coprosma propinqua</i> var. <i>propinqua</i>	mingimingi
<i>Coprosma rhamnoides</i>	
<i>Coprosma robusta</i>	karamu
<i>Coprosma macrocarpa</i> subsp. <i>minor</i>	karamu
<i>Coprosma macrocarpa</i> subsp. <i>minor</i> × <i>C. propinqua</i>	
<i>Corokia cotoneaster</i>	korokio
<i>Dodonaea viscosa</i>	akeake
<i>Geniostoma ligustrifolium</i> var. <i>ligustrifolium</i>	hangehange
<i>Hebe stricta</i> var. <i>stricta</i>	koromiko
<i>Kunzea ericoides</i>	kanuka
<i>Leptecophylla juniperina</i> var. <i>juniperina</i>	prickly mingimingi
<i>Leptospermum scoparium</i> agg.	manuka
<i>Leucopogon fasciculatus</i>	mingimingi
<i>Melicytus ramiflorus</i> subsp. <i>ramiflorus</i>	mahoe
<i>Metrosideros excelsa</i>	pohutukawa
<i>Myrsine australis</i>	mapou
<i>Ozothamnus leptophyllus</i>	tauhinu
<i>Pomaderris amoena</i>	tauhinu
<i>Sophora</i> sp. (seedlings only)	kowhai

Dicot. lianes

<i>Calystegia soldanella</i>	panahi, shore bindweed
<i>Calystegia sepium</i> subsp. <i>roseata</i>	pohue
<i>Calystegia tuguriorum</i>	powhiwhi, native bindweed
<i>Calystegia sepium</i> subsp. <i>roseata</i> × <i>C. soldanella</i>	
<i>Clematis paniculata</i>	puawananga
<i>Muehlenbeckia australis</i>	puka
<i>Muehlenbeckia complexa</i>	pohuehue
<i>Muehlenbeckia australis</i> × <i>M. complexa</i>	

Lycopods and psilopsids

Lycopodium volubile

waewaekoukou

Ferns

Adiantum cunninghamii

huruhuru tapairu, maidenhair fern

Asplenium flaccidum

makawe

Asplenium oblongifolium

huruhuruwhenua

Asplenium polyodon

petako

Blechnum filiforme

panako

Blechnum minus

swamp kiokio

Blechnum novae-zelandiae

kiokio

Blechnum minus × *B. novae-zelandiae*

Cyathea medullaris

mamaku

Dicksonia squarrosa

wheki

Doodia australis

pukupuku

Microsorium pustulatum

kowaowao, hound's tongue fern

Paesia scaberula

matata

Polystichum wawranum

Pteridium esculentum

rarahu, bracken

Pteris macilenta

sweet fern

Pteris tremula

turawera, shaking brake

Pyrrosia eleagnifolia

leather-leaf fern

Orchids

Earina mucronata

peka-a-waka

Microtis unifolia agg.

maikaika

Pterostylis banksii

tutukiwi

Thelymitra longifolia

maikuku

Grasses

Austroderia splendens

Deyeuxia avenoides

Echinopogon ovatus

Lachnagrostis billardierei

perehia; sand wind grass

Microlaena stipoides

patiti, meadow rice grass

Oplismenus hirtellus subsp. *imbecillis*

Poa anceps agg.

Poa pusilla

Rytidosperma gracile

Spinifex sericeus

kowhangatara, spinifex

Zoysia minima

Zoysia pauciflora

Sedges

<i>Baumea juncea</i>	
<i>Bolboschoenus fluviatilis</i>	purua grass
<i>Carex breviculmis</i>	
<i>Carex dissita</i>	
<i>Carex flagellifera</i>	manaia
<i>Carex geminata</i> agg.	rautahi
<i>Carex pumila</i>	
<i>Carex raotest</i>	
<i>Carex solandri</i>	
<i>Carex testacea</i>	
<i>Cyperus ustulatus</i> f. <i>ustulatus</i>	toetoe, upokotangata
<i>Eleocharis acuta</i>	spike sedge
<i>Eleocharis gracilis</i>	
<i>Ficinia nodosa</i>	wiwi
<i>Ficinia spiralis</i>	pingao
<i>Isolepis cernua</i>	
<i>Lepidosperma australe</i>	
<i>Schoenoplectus pungens</i>	
<i>Schoenoplectus tabernaemontani</i>	kapungawha
<i>Schoenus concinnus</i>	
<i>Uncinia uncinata</i>	kamu matau a Maui

Rushes

<i>Apodasmia similis</i>	oioi
<i>Juncus kraussii</i> var. <i>australiensis</i>	wi sea rush

Monocot. herbs (other than orchids, grasses, sedges, and rushes)

<i>Dianella nigra</i>	turutu
<i>Phormium tenax</i>	harakeke, flax
<i>Ruppia polycarpa</i>	
<i>Triglochin striata</i>	arrow grass
<i>Typha orientalis</i>	raupo

Composite herbs

<i>Lagenifera petiolata</i>	parani
<i>Lagenifera pumila</i>	papataniwhaniwha
<i>Pseudognaphalium luteoalbum</i> agg.	pukatea
<i>Senecio lautus</i> var. <i>lautus</i>	
<i>Senecio minimus</i>	

Dicot. herbs (other than composites)

<i>Acaena anserinifolia</i>	piripiri
<i>Acaena novae-zelandiae</i>	piripiri
<i>Apium prostratum</i> subsp. <i>prostratum</i>	tuutae kooau, New Zealand celery

<i>Centella uniflora</i>	
<i>Dichondra repens</i>	Mercury Bay weed
<i>Disphyma australe</i> subsp. <i>australe</i>	horokaka
<i>Epilobium brunnescens</i> subsp. <i>brunnescens</i>	
<i>Galium propinquum</i>	mawe
<i>Hydrocotyle elongata</i>	
<i>Hydrocotyle moschata</i>	
<i>Leptostigma setulosa</i>	
<i>Lilaeopsis novae-zelandiae</i>	
<i>Limosella lineata</i>	mudwort
<i>Lobelia anceps</i>	punakuru
<i>Mentha cunninghamii</i>	hioi, native mint
<i>Nertera dichondrifolia</i>	
<i>Nertera scapanioides</i>	
<i>Oxalis rubens</i>	sand oxalis
<i>Ranunculus acaulis</i>	
<i>Ranunculus reflexus</i>	maruru
<i>Samolus repens</i> var. <i>repens</i>	makaokao
<i>Selliera radicans</i>	remuremu
<i>Solanum americanum</i>	raupeti
<i>Tetragonia implexicoma</i>	

NATURALISED AND EXOTIC SPECIES

Gymnosperms

<i>Araucaria heterophylla</i>	Norfolk Island pine
<i>Pinus radiata</i>	radiata pine

Dicot. trees and shrubs

<i>Alnus glutinosa</i>	common alder
<i>Erica lusitanica</i>	Spanish heath
<i>Ligustrum lucidum</i>	tree privet
<i>Lupinus arboreus</i>	lupin
<i>Populus alba</i> 'Nivea'	silver poplar
<i>Rubus</i> sp. (<i>R. fruticosus</i> agg.)	blackberry
<i>Salix cinerea</i>	grey willow

Grasses

<i>Agrostis stolonifera</i>	creeping bent
<i>Aira caryophyllea</i> subsp. <i>caryophyllea</i>	silver hairy grass
<i>Ammophila arenaria</i>	marram
<i>Anthoxanthum odoratum</i>	sweet vernal
<i>Briza maxima</i>	large quaking grass
<i>Bromus diandrus</i>	ripgut brome
<i>Bromus willdenowii</i>	prairie grass
<i>Cenchrus clandestinus</i>	kikuyu grass

<i>Cortaderia jubata</i>	purple pampas
<i>Cortaderia selloana</i>	pampas
<i>Dactylis glomerata</i>	cocksfoot
<i>Holcus lanatus</i>	Yorkshire fog
<i>Lagurus ovatus</i>	haretail
<i>Lolium perenne</i>	rye grass
<i>Paspalum vaginatum</i>	saltwater paspalum
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Schedonorus arundinaceus</i>	tall fescue
<i>Spartina anglica</i>	spartina
<i>Sporobolus africanus</i>	ratstail
<i>Vulpia</i> sp.	

Sedges

<i>Cyperus congestus</i>	purple umbrella sedge
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Rushes

<i>Juncus articulatus</i>	jointed rush
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Monocot. herbs (other than orchids, grasses, sedges, and rushes)

<i>Iris pseudacorus</i> (outside of site)	yellow flag
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Composite herbs

<i>Aster subulatus</i>	sea aster
<i>Cirsium arvense</i>	California thistle
<i>Cirsium vulgare</i>	Scotch thistle
<i>Conyza parva</i>	smooth fleabane
<i>Conyza sumatrensis</i>	broad-leaved fleabane
<i>Crepis capillaris</i>	hawksbeard
<i>Gamochaeta coarctata</i>	purple cudweed
<i>Hypochaeris radicata</i>	catsear
<i>Jacobaea vulgaris</i>	ragwort
<i>Lactuca virosa</i>	acid lettuce
<i>Leontodon taraxacoides</i>	hawkbit
<i>Osteospermum fruticosum</i> (outside of site)	rain daisy, dimorphotheca
<i>Senecio bipinnatisectus</i>	Australian fireweed
<i>Sonchus asper</i>	prickly puha
<i>Sonchus oleraceus</i>	puha, sow thistle
<i>Taraxacum officinale</i>	dandelion

Dicot. herbs (other than composites)

<i>Alternanthera philoxeroides</i>	alligator weed
<i>Anagallis arvensis</i>	scarlet pimpernel
<i>Centaureum erythraea</i>	centaury
<i>Cerastium fontanum</i> subsp. <i>vulgare</i>	mouse-ear chickweed

<i>Euphorbia paralias</i> ¹	milkweed
<i>Euphorbia peplus</i>	scrambling fumitory
<i>Fumaria muralis</i>	cleavers
<i>Galium aparine</i>	yellow flax
<i>Linum trigynum</i>	slender birdsfoot trefoil
<i>Lotus angustissimus</i>	lotus
<i>Lotus pedunculatus</i>	hairy birdsfoot trefoil
<i>Lotus suaveolens</i>	gypsy wort
<i>Lycopus europaeus</i>	forget-me-not
<i>Myosotis</i> sp.	wild seradella
<i>Ornithopus perpusillus</i>	yellow serradella
<i>Ornithopus pinnatus</i>	tarweed
<i>Parentucellia viscosa</i>	cape gooseberry
<i>Physalis peruviana</i>	inkweed
<i>Phytolacca octandra</i>	swamp plantain
<i>Plantago australis</i>	allseed
<i>Polycarpon tetraphyllum</i>	selfheal
<i>Prunella vulgaris</i>	sheep's sorrel
<i>Rumex acetosella</i>	broad-leaved dock
<i>Rumex obtusifolius</i>	pearlwort
<i>Sagina apetala</i>	pearlwort
<i>Sagina procumbens</i>	catchfly
<i>Silene gallica</i>	stone parsley
<i>Sison amomum</i>	black nightshade
<i>Solanum nigrum</i>	upright hedge parsley
<i>Torilis japonica</i>	white clover
<i>Trifolium repens</i>	Australian speedwell
<i>Veronica plebeia</i>	four-seeded vetch
<i>Vicia tetrasperma</i>	

¹ On site boundary.

SEA SPURGE (*EUPHORBIA PARALIAS*) - A SERIOUS NEW INVASIVE WEED FOUND IN NEW ZEALAND

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Recently I discovered two small infestations of sea spurge (*Euphorbia paralias*) near the mouth of the Waihi Stream on the west coast of the North Island of New Zealand. Waihi Stream is north of Aotea Harbour, a small harbour between Kawhia Harbour and Raglan Harbour. Sea spurge is a serious invasive pest plant that has not previously been recorded as naturalised in New Zealand, but has long been expected to establish here. It is a serious threat to indigenous sand dune vegetation communities (including threatened plant species), and unvegetated fauna habitat, which is key habitat for several nationally threatened species.

Two small infestations were found: one comprising one plant with several fertile stems, just on the boundary of the Aotea Heads Scientific Reserve, and the other infestation c.100 m to the north, just north of the Reserve boundary. The total infestation comprised c.65 flowering plants and over 100 seedlings, covering c.10 × 8 m. A specimen has been lodged in the Auckland Museum Herbarium (AK198572), and photographs are attached, including photographs from Wilsons Promontory National Park in Australia.

Sea spurge is native to western and southern Europe, but is widely naturalised in the coastal districts of southern Australia, and has also recently naturalised on Lord Howe Island. It is a weed of coastal environments and offshore islands, and occurs on “free draining sandy soils on beaches, around estuaries, through dune fields, in coastal herbfields, grasslands, heaths and shrublands, and may also grow along rocky shorelines and in sand-filled cracks between rocks” (http://keyserver.lucidcentral.org/weeds/data/03030800-0b07-490a-8d04-0605030c0f01/media/Html/Euphorbia_paralias.htm).

Sea spurge is a long-lived perennial plant 20-70 cm tall that dies back after flowering. It flowers late spring to early winter, reaching reproductive maturity in its second year. The fruit opens explosively when mature and seeds travel a short distance from the plant. It has a tap root, and a toxic sap which irritates the skin and is harmful to the eyes.

Sea spurge seeds are buoyant in sea water and can disperse over long distances on ocean currents, which is probably how it arrived in New Zealand. Seeds only begin to reduce in viability after six years in sea water. Older plants can produce up to 5,000 seeds per year.

The infestation site is obviously a site where items floating in ocean currents wash ashore. Piles of driftwood were present, along with miscellaneous plastic items. Three other weed species were also present: yellow flag (*Iris pseudacorus*), dimorphotheca (*Osteospermum fruticosum*), and alligator weed (*Alternanthera philoxeroides*). This is probably the southern-most alligator weed population in New Zealand.

In Australia sea spurge usually initially colonises at the back of a beach, at the base of the foredune, and quickly develops dense infestations that stabilise the dunes. In Australia it also creates a different dune structure to that created by the indigenous plant species. In New

Zealand, if allowed to establish, it is likely that it will also displace many of our indigenous species, including spinifex, pingao, *Carex pumila*, *Calystegia soldanella*, *Pimelea villosa*, and sand coprosma. In Australia, it decreases availability of beach-nesting sites for shore birds, and is likely to threaten birds with similar habitat requirements in New Zealand, such as NZ dotterel and terns.

The age of the New Zealand population is unknown, but the larger patch has been at the site for at least two years, and probably at least 3-4 years.

The three current priorities are:

- To determine whether this is the full extent of the New Zealand population;
- To eradicate the known infestation. Sea spurge control methods are well understood in Australia, and careful removal and destruction of the plants and seeds at the infestation site using biosecure methods is a very high priority;
- To develop a strategy to deal with ongoing arrival of seed from Australia, to ensure that it does not establish on our coasts in the future.

Initial control of the two patches has been undertaken, including removal of seed heads, pulling-out of plants, and herbicide treatment of the foliage left on site. These sites will require long-term ongoing monitoring and control to ensure that regeneration from the seed bank is killed. A strategy for dealing with the ongoing arrival of propagules from Australia also needs to be developed, to ensure that this species does not establish in New Zealand. Several agencies (DOC, MPI (Ministry for Primary Industry), Waikato Regional Council) are working together to develop a strategy and ensure that appropriate action is instigated and maintained.

Any possible sightings of this species should be reported to the MPI Pest and Disease Line (0800 80 99 66).

It is disappointing that sea spurge has arrived in New Zealand, but if this is the full extent of the New Zealand population, then appropriate, prompt and ongoing action will ensure that it is controlled and not allowed to become established.



Plate 1: *Euphorbia paralias*: Single fertile plant about 50m from the main infestation (since removed). North of Aotea Harbour, West Coast, North Island, New Zealand. S.M. Beadel, April 2012.



Plate 2: *Euphorbia paralias*: flowers and seeds. North of Aotea Harbour, West Coast, North Island, New Zealand. S.M. Beadel, April 2012.



Plate 3: *Euphorbia paralias* north of Aotea Harbour, West Coast, North Island, New Zealand: largest patch comprising c.70 fertile plants and over 100 seedlings. Note the yellow flag infestation in the background. S.M. Beadel, April 2012.



Plate 4: *Euphorbia paralias* north of Aotea Harbour, West Coast, North Island, New Zealand: seedlings within the largest patch. S.M. Beadel, April 2012.



Plate 5: Extensive *Euphorbia paralias* infestation on the foredune at Wilsons Promontory, Victoria, Australia. S.M. Beadel, April 2012.



Plate 6: Extensive *Euphorbia paralias* infestation on rear dunes at Wilsons Promontory, Victoria, Australia. S.M. Beadel, April 2012.



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