ECOLOGICAL SURVEY OF
REGENERATING INDIGENOUS
DUNE FOREST, MATATA,
BAY OF PLENTY

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## CONTENTS

1. **BACKGROUND** 1
2. **PROJECT OBJECTIVES** 1
3. **ECOLOGICAL CONTEXT** 3
4. **SURVEY METHODS** 5
   4.1 Existing information 5
   4.2 Vegetation and flora 5
   4.3 Avifauna 5
   4.4 Weeds 5
   4.5 Human impacts 5
5. **VEGETATION AND HABITATS** 6
   5.1 General pattern 6
   5.2 Detailed vegetation type descriptions 6
6. **INDIGENOUS AND ADVENTIVE VASCULAR PLANT TAXA** 12
7. **ECOLOGICAL PROCESSES** 15
   7.1 History of the eucalyptus stand 15
   7.2 Dieback process 18
   7.3 Regeneration strategies and sequences 19
   7.4 Relationship with the Manawake Ecological Corridor 20
8. **FLOWERING/FRUITING TIMES FOR INDIGENOUS TAXA** 21
9. **AVIFAUNA** 26
   9.1 Species present 26
   9.2 Food sources 26
   9.3 Attractiveness/usefulness assessment of flowers/fruit to native avifauna 27
10. **PEST PLANTS** 30
11. **MANAGEMENT** 33
    11.1 Current management 33
    11.2 Threats to indigenous regeneration 33
12. **FUTURE MANAGEMENT** 36
    12.1 Goal and objectives 36
    12.2 Objective 1: Management of vegetation succession 36
    12.3 Objective 2: Enhancement of indigenous flora-fauna Interactions 38
    12.4 Monitoring 39
13. **RELEVANCE TO OTHER SITES** 39
14. PROTECTION STATUS 40
15. CONCLUSIONS AND RECOMMENDATIONS 40

ACKNOWLEDGMENTS 42
REFERENCES 42

APPENDICES

1. Vascular Plant Species List 45
2. Fauna Species List 51
3. Site photographs 52

PROJECT TEAM

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1. BACKGROUND

Environment Bay of Plenty commissioned Wildland Consultants Ltd to undertake a botanical survey and ecological assessment of a stand of eucalyptus (*Eucalyptus botryoides*; bangalay; southern mahogany) forest on coastal dunes adjacent to Murphy’s Holiday Camp at Matata. The eucalyptus stand currently extends c.2.4 km to the west and c.0.8 km to the east of the holiday camp, and is a long-standing feature that has been present on the dunes since it was planted there by railway workers at least as early as 1920 (Greg Jenks, Coast Care Bay of Plenty, pers. comm.). Over the last 10 years or so the eucalyptus trees have suffered intermittent dieback, which has opened up the canopy, and a diverse range of woody indigenous species has established, such as houpara (*Pseudopanax lessonii*), kawakawa (*Macropiper excelsum*), pohutukawa (*Metrosideros excelsa*), taupata (*Coprosma repens*), and karo (*Pittosporum crassifolium*). The indigenous species have been developing, relatively rapidly, into forest, although there is still a taller sparse canopy of eucalyptus. Indigenous dune forest communities are now extremely rare in the Bay of Plenty Region and in most of New Zealand. The natural regeneration of indigenous species occurring at this site is unusual and very positive, and offers potentially useful guidance for indigenous revegetation strategies for other dune systems. It does need to be noted, however, that the situation at this particular site is somewhat unusual, with periodic dieback of the exotic tree canopy and seed source on the adjacent coastal cliffs and associated forest remnants in valleys and gully systems. These seed sources, from which seed is carried by wind and birds, combined with dieback and opening up of the eucalyptus canopy, are likely to have a significant influence on successional processes on the dunes.

This report provides a detailed description and an analysis of ecological processes underway at the site.

This study was jointly funded by Whakatane District Council (WDC) and Environment Bay of Plenty, the study area is managed by WDC, and Terry and Trish Murphy (Murphy’s Holiday Camp) are lessees of a large part of it.

2. PROJECT OBJECTIVES

These objectives include those set out in the project brief by Environment Bay of Plenty, as well as additional project elements contributed by Wildland Consultants Ltd (shown in bold text).

**Ecological/Botanical Survey**

- Collate and evaluate existing information, in digital and hard copy formats.
- Prepare a base map showing the extent of the study area, in collaboration with the client, using recent digital aerial photography (2002/03). Mapping work will be GIS-based.
- Map vegetation pattern.
• Undertake field assessment of vegetation and flora.

• **Compile detailed vegetation type descriptions.**

• Prepare indigenous and adventive vascular plants species list.

• Record all fauna, indigenous and exotic, observed in the project area or known to use or visit the site.

• **Obtain representative photographs of vegetation and habitat types in the project area.**

• Map weed distribution and density of cover for each species.

• Provide information on the flowering and fruiting times of indigenous plant species recorded at the site.

• Provide an index of attractiveness/usefulness of flowers and fruit of indigenous plants at the site to indigenous birds; e.g. 5 = very palatable; 1 = unpalatable.

• **Provide information on seed viability time(s).**

• Comment on the relevance of the biota present to the Manawahe ecological corridor.

• Record evidence of grazing (present or historical), fires, camping, firewood gathering, or other human impacts.

**Ecological Processes**

• Evaluate a sequence of older aerial photographs to assess and describe the history of the eucalyptus stand.

• Compile relevant information on stand history from written and verbal sources, such as knowledgeable local residents.

• Evaluate and describe the dieback process underway and its influence(s) on regeneration of indigenous species and successional sequences.

• Assess natural regeneration of the *Eucalyptus botryoides*, if any.

• Identify opportunities and methods for monitoring ongoing development of the stand.

• Identify any weed threats to regeneration of indigenous species.

• Evaluate the relative influences of human impacts (other than the establishment of eucalyptus forest) on indigenous regeneration, including grazing, fire, camping, firewood gathering, and any other activities.
• Identify key ecological processes being assisted by wind and/or bird movement of plant propagules into the site and the mechanisms and likely origins of the seed material.

• Provide an overview of the key ecological processes that are enabling the development of indigenous forest on the dunes at this site.

• Identify the relevance of ecological processes underway at this site to other coastal dunes in the Bay of Plenty region.

**Future Management**

• Identify management issues and options.

• Identify threats to key ecological processes.

• Assess current management regime(s) and make recommendations for future management.

• Identify opportunities for ecological restoration or enhancement of key ecological processes.

• Identify future management options for the canopy trees of *Eucalyptus botryoides*.

• Provide advice on the management regime and protection status of the developing dune forest.

3. **ECOLOGICAL CONTEXT**

**Landforms, Geology, Soils**

The Matata eucalyptus stand is on sand dunes in the coastal bioclimatic zone of the Otanewainuku Ecological District (ED) (Badel 2006). Otanewainuku ED covers 188,700 ha of the Northern Volcanic Plateau Ecological Region, and is characterised by a dissected ignimbrite plateau with deeply-incised gorges, and has only a short (16 km) section of coastal dunes. Dunes to the west of Otamarakau are in Tauranga ED, and dunes to the east of Matata are in Te Teko ED. The Matata-Otamarakau section of Holocene sand dunes is distinctive because it lies next to the Matata Hills land system, a landform composed mainly of Matahina ignimbrite, and having a steeply rugged coastal scarp. The Ohinekoao Stream gorge cuts back steeply into the hills above the dunes, and is considered to have the best exposed sequence of Pleistocene marine sedimentary strata in the northern North Island (Kenny and Hayward 1996). The instability of this area has periodic devastating effects on the dune system, most recently evidenced by the floods and debris flows of 18 May 2005.
On the sand dunes the mean annual rainfall is c.1400 mm, and there are very few frosts, whilst on the Matata Hills annual rainfall increases to 1600 mm with increasing distance from the coast, and up to 50 ground frosts occur every year (Badel 2006).

Vegetation

Vegetation on the dunes has been surveyed and described by Beadel (1985 and 1994). Apart from the eucalyptus forest, the narrow strip of coastal dunes also includes examples of spinifex (Spinifex sericeus) sandfield on the foredune, grading back into pohuehue (Muehlenbeckia complexa) vineland, with Ficinia nodosa and local taupata also present. There is a network of small wetlands in dune swales, including raupo (Typha orientalis) reedland, Bolboschoenus fluviatilis, and Baumea articulata.

The coastal cliffs, inland from the main road, are clothed with a strip of pohutukawa forest which produces a tremendous visual spectacle during good flowering years. A narrow strip at the base of the cliffs was previously grazed but much of this has been retired and planted with pohutukawa.

Vegetation on the Matata Hills has been described in several recent reports (Badel et al. 1996; Gosling 2004; Beadel 1999 & 2006). In general it is an area with coastal forest and secondary forest and scrub, grading back into semi-coastal forest. The Matata Scenic Reserve is the largest coastal forest remnant in Otanewainuku ED and includes unique pohutukawa-hard beech (Nothofagus truncata) forest cover on the most broken terrain (Badel 2006). Secondary vegetation types in the reserve are dominated by kanuka (Kunzea ericoides), rewarewa (Knightia excelsa), mamaku (Cyathea medullaris), with pohutukawa near the coast. There are also areas of manuka (Leptospermum scoparium), mingimingo (Leucopogon fasciculatus), prickly mingimimi (Cyathodes juniperina), akepiro (Olearia furfuracea), brush wattle (Paraserianthes lophantha), and Japanese honeysuckle (Lonicera japonica).

Avifauna

The coastal strip was surveyed in September 2001 (Wildland Consultants 2001) and bird species were documented in habitats along the coastal strip, including the beach, dunes, dune wetlands, and the eucalyptus forest. Indigenous species utilising the eucalyptus forest included kahu (harrier hawk; Circus approximans), welcome swallow (Hirundo tahitica neoxena), tauhou (silvereye; Zosterops lateralis), piwakawaka (North Island fantail; Rhipidura fuliginosa placabilis), riroriro (grey warbler; Gerygone igata), pipiwharahauora (shining cuckoo; Chrysococcyx lucidus lucidus), korimako (bellbird; Anthornis melanura), tui (Prosthemadera novaeseelandiae), and kereru (Hemiphaga novaeseelandiae). Two kereru were recorded in the 2001 survey.

In terms of fauna in the Matata Hills, the Ohinekoao Scenic Reserve and surrounds were recognised by Rasch (1989) as a very valuable example of wildlife habitat in coastal forest and scrub: ‘The site supports good numbers of field birds and forest insectivores like North Island fantail, grey warbler, and shining cuckoo’. In more recent reports, kereru are frequently mentioned as occupying the coastal forest areas, as well as ‘common forest and field birds’ (Badel et al. 1996, Beadel 2006).
Ecological Linkages

The eucalyptus stand is part of a larger, semi-continuous corridor of vegetation and habitats that includes the Matata Hills and extends 35 km inland through Manawha to Maungawhakamana (Badel et al. 1996), now known as the ‘Manawha Ecological Corridor’. Conservation-managed tawa-dominant forest within the corridor (further inland) supports a small population of North Island brown kiwi and a significant population of North Island kokako.

4. SURVEY METHODS

4.1 Existing information

Relevant information from previous Wildlands and Environment Bay of Plenty reports was collated and reviewed. A search was made to find any Scion (formerly NZ Forest Research Institute) reports relating to this site, however there were no references in the National Forestry Library or on the internal Scion database of staff reports. A meeting was held on 17 May 2007 with the Matata Coast Care Group (convened by Greg Jenks - Regional Coordinator, Coast Care Bay of Plenty), during which members were asked about the history of the stand and any observations they might have made over the years.

4.2 Vegetation and flora

A walk-through survey was conducted by two ecologists on 17 May 2007. Vegetation types were described using shorthand species codes and tier structure notation in the style of Atkinson (1985). Vegetation type boundaries were mapped onto aerial photographs (RDAM 2003), and GPS positions were recorded to ascertain the position of the boundaries and to record any salient features or reference points which would assist with mapping accuracy. A list of vascular plant was compiled, and some specimens were collected for subsequent verification.

4.3 Avifauna

Incidental observations were made of fauna encountered during the walk-through survey. Notes were taken during a meeting with the Matata Coast Care Group.

4.4 Weeds

The relative abundance of weed species in each of the vegetation types was recorded during the walk-through survey, and the positions of any small, localised infestations were recorded with a GPS.

4.5 Human impacts

The locations of tracks, campsites, rubbish, fences, grazing and other human induced impacts were recorded with a GPS. The Matata Coast Care Group provided some of the history of human impact in the area.
5. VEGETATION AND HABITATS

5.1 General pattern

The eucalyptus stand currently extends along c.3.5 km of the coast between Matata and Pikowai. About 2.4 km of the stand lies west of Murphy’s Holiday Camp and a further c.0.8 km lies east of it. The residential part of the camp is c.300 m wide, and is the largest break in eucalyptus cover. Stand width varies from c.120 m at its widest to only a few metres in several places, with the mean stand width being c.50 m.

The eucalyptus stand occupies between 50-100% of the dune width which remains between the railway track, State Highway 2, and the sea. The highway and railway track now cover c.45 m of the former back-dunes and dune slack wetlands which would have existed at the foot of the coastal scarp. On the inland side of the stand there is generally rough grassland dominated by kikuyu (Pennisetum clandestinum) or bracken fernland with abundant Japanese honeysuckle, though there are also some areas of taller vegetation, such as bracken fernland with emergent scattered kanuka (Kunzea ericoides), mingimingi, kawakawa (Macropiper excelsum), and pohutukawa. The Herepuru wetland abuts the northwestern inner edge of the eucalyptus stand.

On the open coast side of the stand there is a gentle dune depression filled with silt and debris from the recent floods in 2004 and 2005, which has been partly colonised by weedy grasses such as pampas (Cortaderia selloana), cocksfoot (Dactylis glomerata), and tall fescue (Schedonorus phoenix). At the eastern end the depression was formerly an open water lagoon which, since the 2005 floods, has become largely dryland, although there is still some ephemeral wetland present where recent establishment of grey willow, Persicaria decipiens, raupo, and other wetland-adapted species has occurred towards the coast. Beyond the depression there are pohuehue-dominant shrublands, often with small windswept bushes of kawakawa. Beyond this again there is spinifex grassland. On both sides of Murphy’s Holiday Camp, low eucalyptus trees extend out to the foredune, compressing the pohuehue bands of (Muehlenbeckia complexa) and spinifex-dominant vegetation types into a very narrow strips on the foredune.

5.2 Detailed vegetation type descriptions

These types are mapped on two sheets in Figure 1.

1. **Tall eucalyptus over a diverse kawakawa-dominated understorey on gently undulating dunes**

Tall eucalyptus trees (>c.20 m tall) shelter a subcanopy (c.6-8 m tall) dominated by kawakawa, and to a lesser extent houpara and eucalyptus, with occasional mamaku (Cyathea medullaris), ponga (Cyathea dealbata), and pohutukawa. The shrub tier is patchy; edges and light wells support kikuyu, pohuehue, mingimingi, brush wattle, bracken (Pteridium esculentum), pampas, sea couch (Elytrigia pycnantha), and a range of exotic herbs, however most
Figure 1: Vegetation types at the Eucalyptus stand, Matata

Legend

1. Tall eucalyptus over a diverse kawakawa-dominant understorey on gently-undulating dunes
2. Tall eucalyptus over pohutukawa, houpara, and kawakawa on gently-undulating dunes
3. Tall eucalyptus over shining karamu-eucalyptus subcanopy and bracken shrub tier on gently-undulating dunes
4. Tall eucalyptus over dense houpara on steeply-sloping dunes
5. Eucalyptus tree-land on gently-undulating dunes
6. Isolated patches of low eucalyptus on foredune
7. Low eucalyptus over houpara on foredune
8. Sparse low eucalyptus over kikuyu pasture on flattened foredune - grazed
9. Dead eucalyptus over weed-infested ephemeral wetland
10. Tall eucalyptus over kikuyu and pohuehue on gently-undulating dunes - grazed
11. Tall eucalyptus on steep dunes at eastern end - recently burnt
12. Sparse tall eucalyptus over brush wattie and kikuyu on disturbed stream banks
13. Scattered tall eucalyptus over kikuyu on disturbed stream banks
14. Scattered tall eucalyptus over kikuyu pasture on flattened dunes - grazed
15. Young indigenous plantings
Figure 1: Vegetation types at the Eucalyptus stand, Matata

Legend

- Current Vegetation

1. Tall eucalyptus over a diverse kawakawa-dominant understorey on gently-undulating dunes
2. Tall eucalyptus over pohutukawa, houpara, and kawakawa on gently-undulating dunes
3. Tall eucalyptus over shining karao-mata-eucalyptus subalpine and bracken shrub tier on gently-undulating dunes
4. Tall eucalyptus over dense houpara on steeply-sloping dunes
5. Eucalyptus treeless on gently-undulating dunes
6. Isolated patches of low eucalyptus on foredune
7. Low eucalyptus over houpara on foredune
8. Sparse low eucalyptus over kikuyu pasture on flattened foredune - grazed
9. Dead eucalyptus over weed-infested ephemeral wetland
10. Tall eucalyptus over kikuyu and pohuehue on gently-undulating dunes - grazed
11. Tall eucalyptus on steep dunes at eastern end - recently burnt
12. Sparse tall eucalyptus over brush wattle and kikuyu on disturbed stream banks
13. Scattered tall eucalyptus over kikuyu on disturbed stream banks
14. Scattered tall eucalyptus over kikuyu pasture on flattened dunes - grazed
15. Young indigenous plantings
parts of the shrub tier are densely vegetated with kawakawa, and have smaller amounts of local eucalyptus, karamu (*Coprosma lucida*), pigeonwood (*Hedycarea arboarea*), mahoe (*Melicytus ramiflorus*), taupata, kanuka, tree fuchsia (*Fuchsia excorticata*), gully fern (*Pneumatopteris pennigera*), arum lily (*Zantedeschia aethiopica*), tutu (*Coriaria arboarea*), Cyperus ustulatus, and *Haloragis erecta*. Under this shade the forest floor has a c.5 cm layer of leaf litter in which a range of indigenous seedlings are regenerating, including abundant kawakawa, frequent pigeonwood, and occasional nikau (*Rhopalostylis sapida*), supplejack (*Ripogonum scandens*), tawa (*Beilschmiedia tawa*), mangeao (*Litsea calicaris*), mapou (*Myrsine australis*), and puriri (*Vitex lucens*).

2. **Tall eucalyptus over pohutukawa, houpara, and kawakawa on gently undulating dunes**

Very tall eucalyptus (>c.20 m tall) on gently undulating dunes over a sparse sub-canopy of pohutukawa and houpara (c.8-10 m tall), with a dense mid-tier (c.4 m tall) dominated by kawakawa, with occasional karamu, pigeonwood, taupata, and akeake. The ground layer is covered in cocksfoot with scattered tall fescue, *Cyperus ustulatus*, kikuyu, Japanese honeysuckle, and inkweed. The groundcover at the informal campsite is mainly meadow rice grass (*Microlaena stipoides*).

3. **Tall eucalyptus over shining karamu-eucalyptus subcanopy and bracken shrub tier on gently undulating dunes**

Gentle undulating dunes to the east of Murphy’s Holiday Camp support tall eucalyptus forest (>c.20 m tall, moderate dieback), with a c.5-6 m tall, patchy understorey of shining karamu and eucalyptus poles, including occasional pohutukawa and akeake. The shrub tier is thick with bracken and pohuehue, and a range of species occurring only locally, such as kawakawa, shining karamu, mapou, kanuka, *Ficinia nodosa*, pohutukawa, *Asplenium flaccidum*, *A. polyodon*, blackberry (*Rubus fruticosus* agg.), and agapanthus (*Agapanthus praecox*). *Ficinia nodosa* and pohuehue tend to be more dominant on the coastal side of this vegetation type. Seedlings of rewarewa (*Knightia excelsa*), pohutukawa, shining karamu, mapou, rangiora (*Brachyglottis repanda*), and hangehange (*Geniostoma rupestre*) were noted here.

4. **Tall eucalyptus over dense houpara on steeply sloping dunes**

On steeply sloping dunes, tall eucalyptus (>c.20 m tall, moderate dieback) forms a patchy canopy above a c.5-6 m subcanopy dominated by houpara (*Pseudopanax lessonii*), including many houpara-lancewood hybrids (*P. lessonii* x *P. crassifolius*), with frequent young eucalyptus and occasional pohutukawa, kanuka, akeake (*Dodonaea viscosa*), mingimangi, and kawakawa. In large canopy gaps there are various mixtures of kikuyu, cocksfoot, and pohuehue, mixed with lesser amounts of bracken, *Ficinia nodosa*, *Calystegia soldanella*, *Oxalis rubens*, and *Fumaria muralis*. In the shade of houpara the shrub tier is very sparsely vegetated, with local shining karamu, mingimangi, hound’s tongue fern, *Asplenium polyodon*, and Japanese
honeysuckle (*Lonicera japonica*) over a ground cover of mainly fallen eucalyptus leaves.

5. **Eucalyptus treeland on gently undulating dunes**

Whilst generally less than 10 m tall, this eucalyptus treeland has occasional large individuals over 20 m tall. Large houpara, pohutukawa, taupata, and kawakawa are frequent in this type, and karō (*Pittosporum crassifolium*), akeake, and mahoe are occasional. The openness of the canopy is reflected in the groundcover which is dominated by pohuehue and kikuyu, with frequent bracken, *Muehlenbeckia australis*, and cocksfoot.

6. **Isolated patches of low eucalyptus on foredune**

Several patches of low eucalyptus (<c.6 m tall) occur on the foredune, separated from the rest of the eucalyptus canopy by a c.10-20 m wide strip of disturbed, silted, debris-laden pampas/cocksfoot grassland which originated with the most recent floods. Kawakawa is the most frequent associate, with occasional houpara, taupata, and pohutukawa. Windswept kawakawa extend out from the edges of the patches, often smothered in vines such as Japanese honeysuckle, pohuehue, and *Muehlenbeckia australis*, which bind the trees together into a molded form.

7. **Low eucalyptus over houpara on foredune**

This type has a low, patchy, windswept canopy of young eucalyptus, ranging from c.1 m in height at the front of the foredune to c.8 m high on the inland side, and includes frequent houpara, and occasional kanuka, akeake, kawakawa, and mapou. Pohuehue and *Ficinia nodosa* are the main groundcover species, while tall fescue, *Calystegia soldanella*, Japanese honeysuckle, *Lachnagrostis billardierei*, *Carex pumila*, and lupin (*Lupinus arboreus*) occur locally. Seedling kanuka are present.

8. **Sparse low eucalyptus over kikuyu pasture on flattened foredune - grazed**

On the foredune in a grazed paddock to the west of Murphy’s Holiday Camp, there is a sparse stand of low, multi-branched eucalyptus (c.5-6 m tall), over a weedy understorey dominated by kikuyu, and vigorously regenerating brush wattle (*Paraserianthes lophantha*), with scattered pohuehue, kawakawa, gorse, inkweed, purple-top (*Verbena bonariensis*), and fleabane. Nearest the beach the canopy is diminished by wind exposure, and occasional *Muehlenbeckia australis* vines scramble across it.

9. **Dead eucalyptus over weed-infested ephemeral wetland**

At the front edge of the steep dunes in the eastern sector of the site, adjacent to lagoon/dune slack system which was inundated with silt in the 2005 flood, there is a c.20 m tall, mostly dead or dying eucalyptus stand growing in moist conditions. Young eucalyptus spars are dotted around the c.6-10 m subcanopy, but the main biomass is at 0-2 m where there is a dense thicket of
mainly herbaceous wetland species. The dominant species are *Persicaria decipiens*, Australian fireweed (*Senecio bipinnatisectus*), fleabane (*Conyza albida*), *Cyperus ustulatus*, *Solanum americanum*, *Carex secta*, *C. virgata*, and *C. geminata*, while the less common species recorded include raupo, *Haloragis erecta*, *Paesia scaberula*, Mercer grass (*Paspalum distichum*), inkweed (*Phytolacca octandra*), Scotch thistle (*Cirsium vulgare*), *Bolboschoenus flaviatilis*, *Setaria gracilis*, *Carex solandri*, grey willow (*Salix cinerea*), and *Cyperus involucratus*.

10. Tall eucalyptus over kikuyu and pohuehue on gently undulating dunes - grazed

This gently sloping paddock is at least partially contoured or flattened and is intermittently grazed by sheep. It has scattered kawakawa, houpara, and eucalyptus ranging in height from >c.20 m down to c.4-5 m over a groundcover of kikuyu pasture with frequent patches of pohuehue, and local *Ficinia nodosa*, bracken, Japanese honeysuckle, and blackberry.

11. Tall eucalyptus on steep dunes at eastern end - recently burnt

At the eastern end of the eucalyptus stand the trees are very tall (>c.20 m) and sparse, with scattered islands of indigenous trees beneath them such as houpara, mahoe, and kawakawa. The open, patchy nature of this type is due to a recent fire which has left evidence in the scorched trunks of some large eucalyptus trees. The groundcover is highly variable; some parts have dense, springy mats of pohuehue and bracken with small amounts of Japanese honeysuckle, while others are dominated by low kikuyu and a host of colonising exotic herbs (e.g. fathen (*Chenopodium album*), inkweed, creeping buttercup (*Ranunculus repens*), herb Robert (*Geranium robertianum*), creeping mallow (*Modiola caroliniana*), and scrambling fumitory (*Fumaria muralis*), as well some indigenous species (e.g. *Microlaena stipoides* and *Calystegia soldanella*). The pohuehue-bracken association often has tufts of *Ficinia nodosa* and is interwoven with *Muehlenbeckia australis*.

12. Sparse tall eucalyptus over brush wattle and kikuyu on disturbed stream banks

These frequently disturbed stream banks have tall eucalyptus (>c.20 m tall) over large patches of brush wattle with some gorse (*Ulex europaeus*) and blackberry, over a mostly open ground layer dominated by kikuyu. Brush wattle is the most strongly regenerating woody species.

13. Scattered tall eucalyptus over kikuyu on disturbed stream banks

This is a highly disturbed stream margin with dense, waist-deep kikuyu with scattered eucalyptus, kawakawa, pampas, kanuka, *Muehlenbeckia australis*, velvety nightshade (*Solanum chenopodioides*), and *Solanum americanum*. 
14. Scattered tall eucalyptus over kikuyu pasture on flattened dunes - grazed

A few tall trees of eucalyptus remain in the grazed kikuyu pasture of the paddock to the west of Murphy’s Holiday Camp. Estimating from 2003 aerial photography there has been a reduction in eucalyptus cover in this paddock since 2003 (perhaps 200 m$^2$). The remaining eucalyptus are mostly dead, and there is one young pohutukawa.

15. Young indigenous plantings

Between the railway line and the edge of the eucalyptus stand a small, narrow, flat area is sparsely planted in cabbage trees (*Cordyline australis*), karaka (*Corynocarpus laevigatus*), pohutukawa, kawakawa, and harakeke (*Phormium tenax*), all of which seem less than 3-5 years old. Spaces between the planted species are covered in a mixture of Yorkshire fog (*Holcus lanatus*), pohuehue, kikuyu, and herb Robert, with occasional young bracken fronds and kahili ginger (*Hedychium gardnerianum*).

16. Exotic grassland on tracks

Vehicle and foot tracks are dominated by various exotic grasses (mainly Yorkshire fog, cocksfoot and kikuyu), usually with a high proportion of pohuehue, and local occurrence of *Microlaena stipoides*, herb Robert, sheep’s sorrel (*Rumex acetosella*), fleabane, blackberry, catsear (*Hypochaeris radicata*), Japanese honeysuckle, *Oxalis rubens*, *Myosotis sylvatica*, *Cyperus ustulatus*, naked lady (*Amaryllis belladonna*), bracken, *Ficinia nodosa*, and *Lachnagrostis billardierei*.

6. INDIGENOUS AND ADVENTIVE VASCULAR PLANT TAXA

A total of 78 indigenous taxa (species and hybrids) were recorded as occurring naturally in the study area, along with 101 adventive taxa (Table 1; Appendix 1). A small area has been planted with indigenous species in the last few years. This planting included four species which occur naturally in the area and one which is not regarded as being naturally-occurring at this site (karaka).

In terms of numbers of species, the woody flora (monocot and dicot trees, shrubs and lianes) is dominated by indigenous species, whilst the rest of the flora varies considerably. All ferns and most sedges are indigenous, whereas the grasses and herbs are heavily dominated by adventive species. These trends in species numbers also tend to be reflected in species cover in the respective tiers. In other words, the upper tiers, which are mostly woody, are dominated by indigenous species (except eucalyptus which is clearly dominant at the higher canopy levels), while lower tiers which are mainly herbaceous are dominated by adventive species (ferns and sedges tends to comprise only a small amount of the total vegetation cover).

---

This type has not been mapped as its extent is too narrow to map at 1:5,000. Refer to Figure 2 for an indication of where track vegetation is located.
**Figure 2: Weed distribution at the Eucalyptus stand, Matata**

(Sheet 1 of 2)

Legend:
- **Vegetation types (refer to text)**
- % % cover of weed species within vegetation type
- Small infestations

**Legend**

*Vegetation types (refer to text)*

- Eucalyptus 30%
- Japanese honeysuckle 20%
- Kikuyu 20%
- Japanese honeysuckle 1%

- Eucalyptus 70%
- Kikuyu 20%
- Japanese honeysuckle 1%

- Eucalyptus 50%
- Kikuyu 40%
- Japanese honeysuckle 1%

- Eucalyptus 30%
- Japanese honeysuckle 20%

- Eucalyptus 30%
- Japanese honeysuckle 20%

- Kikuyu 90%
- Eucalyptus 10%
- Pampas 1%

- Eucalyptus 70%
- Kikuyu 5%
- Japanese honeysuckle 2%

- Kikuyu 70%
- Brush wattle 30%
- Eucalyptus 30%
- Gorse 1%
- Blackberry 1%
- Japanese honeysuckle 1%
### Legend
- **<** Small infestations
- **%** % cover of weed species within vegetation type
- **-** Vegetation types (refer to text)

### Figure 2: Weed distribution at the Eucalyptus stand, Matata

**Sheet 2 of 2**

<table>
<thead>
<tr>
<th>Vegetation Type</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalyptus</td>
<td>70%</td>
</tr>
<tr>
<td>Kikuyu</td>
<td>5%</td>
</tr>
<tr>
<td>Brush wattle</td>
<td>30%</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>30%</td>
</tr>
<tr>
<td>Gorse</td>
<td>1%</td>
</tr>
<tr>
<td>Blackberry</td>
<td>1%</td>
</tr>
<tr>
<td>Japanese honeysuckle</td>
<td>1%</td>
</tr>
<tr>
<td>Sea couch</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Arum lily</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Japanese honeysuckle</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

**Sheet 3 of 3**

<table>
<thead>
<tr>
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<th>% Cover</th>
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</thead>
<tbody>
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<td>Kikuyu</td>
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<tr>
<td>Eucalyptus</td>
<td>30%</td>
</tr>
<tr>
<td>Blackberry</td>
<td>1%</td>
</tr>
<tr>
<td>Japanese honeysuckle</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Sheet 4 of 4**

<table>
<thead>
<tr>
<th>Vegetation Type</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kikuyu</td>
<td>50%</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>30%</td>
</tr>
<tr>
<td>Japanese honeysuckle</td>
<td>2%</td>
</tr>
<tr>
<td>African boxthorn</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

**Sheet 5 of 5**

<table>
<thead>
<tr>
<th>Vegetation Type</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
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<td>Kikuyu</td>
<td>50%</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>10%</td>
</tr>
<tr>
<td>Lupin</td>
<td>1%</td>
</tr>
<tr>
<td>Japanese honeysuckle</td>
<td>1%</td>
</tr>
<tr>
<td>Mercer grass</td>
<td>1%</td>
</tr>
<tr>
<td>Grey willow</td>
<td>1%</td>
</tr>
<tr>
<td>Cyperus involucratus</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>African boxthorn</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>
It is interesting to note the absence of some plant groups; i.e. there were no gymnosperms, lycopsids, psilopsids or orchids recorded during the survey. Some of the common fern allies (lycopods) would be expected to occur here in low numbers, because they are known from neighbouring Matata Scenic Reserve (Beadel 1991) and suitable habitats are present, e.g. *Lycopodium volubile*. Orchids potentially also occur here but may have been missed during this survey because it occurred in winter months.

No threatened plant species were found within the eucalyptus stand. However the stand is a potential habitat for *Pimelea tomentosa* (ranked ‘Chronically Threatened, Serious Decline’ in Hitchmough *et al.* 2007) and the seaward margins could provide potential habitat for *Tetragonia tetragonioides* (ranked ‘At Risk, Sparse’).

Table 1: Numbers of indigenous and adventive vascular plant taxa in different plant groups recorded in the eucalyptus stand at Matata, 2007.

<table>
<thead>
<tr>
<th>Plant Group</th>
<th>Indigenous (No. Taxa)</th>
<th>Adventive (No. Taxa)</th>
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</thead>
<tbody>
<tr>
<td>Monocot. trees and shrubs</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Dicot. trees and shrubs</td>
<td>29</td>
<td>9</td>
</tr>
<tr>
<td>Monocot. lianes</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Dicot. lianes</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Ferns</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Grasses</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>Sedges</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Rushes</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Monocot. herbs</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Composite herbs</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Dicot. herbs (other than composites)</td>
<td>5</td>
<td>39</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>78</strong></td>
<td><strong>101</strong></td>
</tr>
</tbody>
</table>

7. **ECOLOGICAL PROCESSES**

7.1 History of the eucalyptus stand

This brief history derives, in part, from verbal information provided by the Matata Coast Care Group at Murphy’s Holiday Camp on 17 May 2006, in the company of Greg Jenks (Coast Care Bay of Plenty) and Nancy Willems (Environment Bay of Plenty).

The stand is believed to have been planted in or before 1920, by railway workers who were building the railway tracks parallel with the state highway at that time. The primary purpose of the planting was to provide a local source of timber for railway sleepers. Secondary purposes were to protect the railway tracks from erosion and ‘to give the workers something to do’. The stand grew well but was frequently burnt by fires caused by steam trains in the early days. It used to extend as far as Haunone in the west (where there are still a few scrubby *Eucalyptus botryoides*), so it was probably originally at least twice as long as it is now. The railway maintenance crews used to bulldoze out the channels of streams crossing the tracks and the eucalyptus stand, but this ceased about 20 years ago.
The Marr family leased the land on which most of the eucalyptus stand is located from 1965 to 1985, and for the past 23 years Terry Murphy has leased the land (since marrying into the Marr family). Murphy’s Holiday Camp was constructed in the latter part of the 1980s, which resulted in some eucalyptus clearance and flattening of dune landforms. The stand has a decades-long history of being grazed by sheep and cattle until about 1988, when grazing was restricted to just the areas in close proximity to Murphy’s Holiday Camp. In 1985 there was a drought during which the stand was grazed heavily. Cattle droving along the coast was common until the 1980s also; however the cattle were mainly driven along the road and hardly ever through the eucalyptus. The last fires in the block to the east of Murphy’s Holiday Camp were about 15 years ago.

Plates 1 and 2 show the stand in the early 1970s. These views are of the eastern end of the stand (currently to the east of Murphy’s Holiday Camp).

In 1985 Sarah Beadel carried out a vegetation survey along this coast and made the following notes about the eucalyptus stand:

‘The canopy is entirely composed of eucalyptus trees, the vegetation is sparse and appears in places to have been recently cleared. However, there are scattered eucalyptus saplings, and native shrubs such as kawakawa and karamu with occasional bracken and Pteris tremula. Exotic herbs and grasses such as inkweed, purple groundsel and ragwort are scattered throughout. West of the eucalyptus forest there are a few scattered clumps of eucalyptus which generally occur in the rear-dune zone and occasional occur in the mid-dune zone. Around these clumps there are occasional native species such as karamu, tutu, taupata, coastal five-finger, pohutukawa, akeake, bracken, Scirpus nodosus\(^1\) and Muehlenbeckia complexa. Lupin, fennel, tall fescue and other exotic grasses and herbs are also common here.’ (Beadel 1985)

A comparison of present day vegetation with this description shows that in the intervening period (22 years), there has been a marked thickening in the undergrowth, from only scattered plants to a moderate to densely-populated shrub tier. Also, there is no mention of a tall sub-canopy, which is now evident in many parts of the stand (e.g. of houpara, kawakawa, pohutukawa, taupata, shining karamu, and other less common sub-canopy species).

Visual comparison of a series of aerial photographs from 1943, 1944, 1963, 1977, 1987, 1997, and 2003 has enabled the following observations to be compiled:

- In 1943/1944 the eucalyptus trees had only been in the ground for 20 years or so and trees were uniform in height with a relatively unbroken canopy. The adjacent hill country was more barren and disturbed than it is today, with a lot more young indigenous scrub.

\(^1\) Now known as *Ficinia nodosa.*
Plate 1: View of eucalyptus stand in about the early 1970s (Terry Murphy pers. comm.) (Photographer unknown, photo provided by Terry Murphy).

Plate 2: View of eucalyptus stand around the early 1970s (Terry Murphy, pers. comm.). (Photographer unknown; photo provided by Terry Murphy).
• By 1963 a marked change in stature and cover had occurred: trees were now mature and large gaps had developed between them. The stand was very narrow and patchy towards the western end, as it is today, but the eastern end had a tall, dense stand. Indigenous scrub on the adjacent hills was taller and covered a greater area than in 1943.

• By 1977 Murphy’s Holiday Camp was present, occupying one of the formerly denser areas of eucalyptus. The vegetation cover on the adjacent hills was becoming denser and taller.

• The vegetation pattern evident in the 1987 and 1997 photographs are essentially similar to the 1977 cover.

• The 2003 photography shows some thinning of the eucalyptus canopy, but a perceptible understorey is not evident.

• Felling of eucalyptus trees has occurred in the past decade, especially east of Murphy’s Holiday Camp.

On 18 May 2005, a band of very intense rain fell in the catchments behind Matata, triggering many landslips and several large debris flows. These, with their associated flooding, caused extensive damage in the Matata area (McSaveney et al. 2005). The catchment of the Ohinekoao Stream, which flows through the stand to the west of Murphy’s Holiday Camp, received some of the most intense rainfall during this event. A debris flow, including trees, large boulders, rocks, and finer sediments, reached SH2, and its associated debris flood damaged the railway, Murphy’s Holiday Camp, and the adjacent dune vegetation (McSaveney et al. 2005), including some of the eucalyptus stand. This intensity of rainfall and debris flow appears to be, approximately, a 500-year recurrence event (McSaveney et al. 2005).

7.2 Dieback process

Dieback began to be noted in the stand around the mid-1990s. This coincides with the appearance of a leaf-defoliating parasite in New Zealand, the brown lace lerp (Cardiaspina fiscella), which is known to occur at the Matata eucalyptus stand. This was first found near Auckland Airport in May 1996 (Appleton 1996). It spread rapidly to eucalyptus through the upper half of the North Island, from Whangarei in the north, to Rotorua in the south, and east to Gisborne (Green 2000). The brown lace lerp is a defoliating psyllid which causes severe damage to Eucalyptus botryoides, E. saligna and related tree species (Reay et al. 1998). The parasitoid Psyllaephagus gemitus was investigated as a possible biological control agent for the lerp and Australian research, funded from New Zealand, concluded it would probably be specific and effective (Green 2000). Although there was no approval for the parasitoid’s release in New Zealand, it was found attacking brown lace lerp in Auckland and Northland in November 1999 (Withers and Bain 2000, Green 2000). The parasitoid is currently reducing populations of the brown lace lerp in New Zealand and tree recovery is noticeable (Green 2000).
It is highly likely that the present state of eucalyptus dieback at Matata has been caused by the brown lace lerp, although the 2005 floods may also have put stress on some of the trees (for example in Vegetation Type 9). Once dieback began, indigenous regeneration became noticeably denser and, over the years has continued to expand and increase in height to the stage it has now attained, with large trees beneath the eucalyptus. Prominent indigenous species are houpara, pohutukawa, and kawakawa, with one patch of karo.

7.3 Regeneration strategies and sequences

It is obvious that the existence of the eucalyptus canopy, combined with the cessation of grazing, has allowed and promoted the rapid development of indigenous forest. Grazing suppressed regeneration for 65 years and the present indigenous cover has developed in only 20 years or so, in spite of the presence of rabbits and the smothering species kikuyu.

The eucalyptus have provided shelter and cover on the otherwise exposed and drought-prone dunes. They have also provided perching sites for seed-carrying bird species such as kereru.

Once an indigenous understorey was established, periodic dieback of the eucalyptus canopy over the last 10 years or so has increased light levels reaching the understorey and promoted its rapid development to forest.

The proximity of the site to Matata Scenic Reserve and also to the indigenous vegetation on the scarp and hillslopes above the study area is reflected in the diverse range of indigenous species which have established, or are establishing in the stand. Matata Scenic Reserve supports over 189 indigenous species (Beadel 1991 & 2001) and a wide selection of these species is present in the eucalyptus stand. Seed propagules would have arrived at the site by a variety of mechanisms. For example, large amounts of pohutukawa seed are likely to have arrived, via wind, from the adjacent scarp. During this survey a cluster of seedlings was found, including one each of tawa, supplejack, and mangeao (see Appendix 3: Site Photographs). These are likely to have arrived at the site via kereru (one kereru was seen in the site in the current study, see Plate 3 below, and they have been recorded previously – Wildland Consultants 2001).

Successful establishment of the predominantly indigenous understorey present today probably reflects factors such as:

- the shelter provided by the eucalyptus;
- removal of disturbance activities that were contributing to the lack of understorey, i.e. grazing;
- low infestation levels of pest plants (e.g. shrubs and lianes) at the time grazing ceased.
- dieback of the eucalyptus (caused by the brown lace lerp);
• proximity of the site to extensive areas of indigenous vegetation (and thus seed sources provided by native bird movement and wind).

In summary, it was the presence of a bare understorey (as a result of grazing), coupled with low weed presence (or weed species that were unsuited to compete against indigenous species in this habitat), adequate shelter from coastal climatic influences, and a proximate seed source (and dispersal agents) that allowed development of the indigenous vegetation present today beneath the eucalyptus stand.

7.4 Relationship with the Manawahe Ecological Corridor

The purpose of this section is to discuss the opportunities or potential synergies in relation to the Manawahe Ecological Corridor (MEC). The concept of the MEC began to be developed in the mid-1990s, during a survey of natural heritage sites in the Whakatane District area (Beadel et al. 1996), which identified a semi-continuous corridor of indigenous forest extending 30 km inland from Matata to Maungawhakamana (west of Kawerau) along the rugged edge of an ignimbrite plateau. These natural areas encompass Department of Conservation reserves, Whakatane District Council reserves, Queen Elizabeth II Trust covenants, and unprotected private land.

Efforts to protect or enhance wildlife habitat are being carried out by various agencies (including Environment Bay of Plenty), and private landowners. In the 2006 winter planting season Environment Bay of Plenty established 9,000 native plants with 80% for riparian protection and 20% for bush enhancement and on steep hill country (Hall 2006). The Manawahe Kokako Trust protects kokako over a 350 hectare area on private land in Manawahe, through intensive pest control and monitoring. In 10 years the group has increased the population of kokako from nine to over 50 (DOC website 2007). The Manawahe Eco Trust was formed in 2006 to promote ‘protection, education and recreation between the lakes and the sea’ and has already established about 110 km of possum and rat bait lines (BOP Landcare Roundup, April 2007).

The main potential synergies of the MEC to this site are for inland parts of the MEC to continue to act as a seed source for the regenerating forest beneath the eucalyptus, and possibly for the study area to act as a fruit source for bird species in winter months when houpara is ripe (as mentioned earlier). Kereru and tui, in particular, are highly mobile and can, potentially, range from the coast inland along the entire length of the MEC.
8. FLOWERING/FRUITING TIMES FOR INDIGENOUS TAXA

Flowering and fruiting times for indigenous taxa recorded in the site have been gathered from existing literature\(^1\), because site-specific phenological information is not available. Tables 2 and 3 present national averages for the species listed. Phenology usually varies according to latitudinal/altitudinal effects, and species responses to these climatic variables can be quite different. For example, species with narrow flowering and fruiting intervals may complete reproduction much earlier at lower latitudes and altitudes, whereas those with broader tolerances may flower or fruit all year round in warmer climes. Therefore, a more site-specific study would be necessary to determine the real availability of nectar, seeds and fruit for fauna at Matata in any particular month of the year. We can, at best, only postulate what may be occurring in terms of fauna-flora interactions based on the information summarised in Tables 2 and 3.

---

\(^1\) The primary sources were the Flora of New Zealand series (Allan 1982 and Moore & Edgar 1976) and the New Zealand Plant Conservation Network fact-sheets on their website (\[www.nzpcn.org.nz\]). Where these were deficient, Salmon (1980) and unpublished literature from DOC, QEII National Trust, and nursery sources were used.
Table 2: Flowering times for indigenous flowering plants recorded in the Matata eucalyptus stand, 2007.

- **Main period (higher numbers)**
- **Early/late period (lower numbers)**
- **Occasional flowering**

NB: ‘Abundance at site’ is a relative estimate of the abundance of reproductive individuals of the species. For example puriri and tawa were only present as juvenile plants, while most houpara were reproductive adults. - = no adults, + = few adults, ++ = moderate numbers of adults, +++ = dominant species in terms of flowering and fruiting.

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>Abundance at Site</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordyline australis</td>
<td>ti kouka, cabbage tree</td>
<td>+</td>
<td></td>
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<td></td>
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<tr>
<td>Phormium cookianum</td>
<td>wharariki, mountain flax</td>
<td>+</td>
<td></td>
<td></td>
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<tr>
<td>Phormium tenax</td>
<td>harakeke, flax</td>
<td>+</td>
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</tr>
<tr>
<td>Rhopalostylis sapida</td>
<td>nikau</td>
<td>-</td>
<td></td>
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<tr>
<td>Beilschmiedia tawa</td>
<td>tawa</td>
<td>-</td>
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<tr>
<td>Brachyglottis repanda subsp. repanda</td>
<td>rangiora</td>
<td>-</td>
<td></td>
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<td>Coprosma grandifolia</td>
<td>kanono</td>
<td>+</td>
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<td>Coprosma lucida</td>
<td>karamu</td>
<td>++</td>
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<tr>
<td>Coprosma repens</td>
<td>taupata</td>
<td>++</td>
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<td>Coprosma robusta</td>
<td>karamu</td>
<td>++</td>
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<tr>
<td>Coriaria arborea var. arborea</td>
<td>tutu</td>
<td>+</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Dodonaea viscosa</td>
<td>akeake</td>
<td>++</td>
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<td></td>
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</tr>
<tr>
<td>Entelea arborescens</td>
<td>whau</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td>Fuchsia excorticata</td>
<td>kotukutuku, tree fuchsia</td>
<td>+</td>
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<tr>
<td>Geniostoma rupestrae var. ligustrifolium</td>
<td>hangehange</td>
<td>++</td>
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Flowering species for which no fruiting or flowering times were found:

*Microlaena stipoides, Oplismenus hirtellus subsp. imbecillis, Carex breviculmis, Carex inversa, Carex maorica, Carex pumila, Carex solandri, Carex testacea, Carex virgata, Ficinia nodosa, Pseudognaphalium luteoalbum agg., Oxalis rubens, and Persicaria decipiens.*
Table 3: Fruiting times for indigenous flowering plants recorded in the Matata eucalyptus stand, 2007.

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<th>Abundance at Site</th>
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<th>Mar</th>
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</tbody>
</table>

NB: ‘Abundance at site’ is a relative estimate of the abundance of reproductive individuals of the species. For example puriri and tawa were only present as juvenile plants, while most houpara were reproductive adults. + = few adults, ++ = moderate numbers of adults, +++ = dominant species in terms of flowering and fruiting.
<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>Abundance at Site</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metrosideros excelsa</td>
<td>pohutukawa</td>
<td>++</td>
<td></td>
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</tr>
<tr>
<td>Myoporum laetum</td>
<td>ngaio</td>
<td>+</td>
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<tr>
<td>Myrsine australis</td>
<td>mapou</td>
<td>++</td>
<td></td>
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</tr>
<tr>
<td>Pittosporum crassifolium</td>
<td>karo</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td>Pseudopanax arbores var. arbores</td>
<td>whauwhaupaku, five finger</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td>Pseudopanax lessonii</td>
<td>houpara</td>
<td>+++</td>
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</tr>
<tr>
<td>Vitex lucens</td>
<td>puriri</td>
<td>-</td>
<td></td>
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<tr>
<td>Ripogonum scandens</td>
<td>kareao, supplejack</td>
<td>-</td>
<td></td>
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</tr>
<tr>
<td>Calystegia sepium</td>
<td>pohue</td>
<td>+</td>
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</tr>
<tr>
<td>Calystegia soldanella</td>
<td>panahi</td>
<td>+</td>
<td></td>
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<tr>
<td>Muehlenbeckia australis</td>
<td>puka</td>
<td>+++</td>
<td></td>
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</tr>
<tr>
<td>Muehlenbeckia complexa</td>
<td>pohuehue</td>
<td>+++</td>
<td></td>
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</tr>
<tr>
<td>Lachnagrostis billardierei</td>
<td>perehia</td>
<td>+</td>
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</tr>
<tr>
<td>Bolboschoenus fluviatilis</td>
<td>ririwaka</td>
<td>+</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Carex geminata</td>
<td></td>
<td>+</td>
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</tr>
<tr>
<td>Carex secta</td>
<td>purei</td>
<td>+</td>
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</tr>
<tr>
<td>Cyperus ustulatus</td>
<td>toetoe upokotangata</td>
<td>+</td>
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</tr>
<tr>
<td>Juncus edgariae</td>
<td>wi</td>
<td>+</td>
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<td></td>
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</tr>
<tr>
<td>Juncus planifolius</td>
<td></td>
<td>+</td>
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<tr>
<td>Dianella nigra</td>
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<td>+</td>
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</tr>
<tr>
<td>Typha orientalis</td>
<td>raupo</td>
<td>+</td>
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<tr>
<td>Senecio hispidulus</td>
<td></td>
<td>+</td>
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</tr>
<tr>
<td>Geranium solanderi</td>
<td></td>
<td>+</td>
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<tr>
<td>Haloragis erecta subsp. erecta</td>
<td>toataoa</td>
<td>+</td>
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<tr>
<td>Solanum americanum</td>
<td></td>
<td>+</td>
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</tbody>
</table>

Flowering species for which no fruiting or flowering times were found:

Microlaena stipoides, Oplismenhus hirtellus subsp. imbecillis, Carex breviculmis, Carex inversa, Carex maorica, Carex pumila, Carex solandri, Carex testacea, Carex virgata, Ficinia nodosa, Pseudognaphalium luteoalbum agg., Oxalis rubens, and Persicaria decipiens.
9. **AVIFAUNA**

9.1 **Species present**

Only six indigenous bird species were recorded at the site: piwakawaka, tauhou, riroriro, kereru, kotare (sacred kingfisher, *Todiramphus sanctus*), and tui. Kereru are classed as ‘Chronically Threatened - Serious Decline’ in the current New Zealand threat classification lists (Hitchmough *et al.* 2007). One kereru was observed in a eucalyptus tree (Plate 3).

In addition to the indigenous species, blackbird (*Turdus merula*), pheasant (*Phasianus colchicus*), and Australian magpie (*Gymnorhina tibicen*) were also recorded.

In 2001, small numbers of kereru, pipiwharauroa (shining cuckoo), tui, and korimako (bellbirds) were recorded in the eucalyptus stand, and numbers of fantails and grey warblers were higher here than elsewhere in the reserves along the coastal dunes in September 2001 (Wildland Consultants 2001). Kereru have obviously been utilising the site for many years.

Indigenous species which are potentially present include other common insectivores (e.g. morepork). Various shag species and white-faced herons may roost in the trees.

9.2 **Food sources**

Nectivorous birds such as tui and bellbird tend to move between habitat patches at different times of the year depending on where the best nectar sources are available. At the eucalyptus stand, there appears to be a major low in nectar production between April and June, when only the *Muehlenbeckia* species are providing larger quantities. *Muehlenbeckia* is not known as a source of nectar for birds (Castro and Robertson 1997), only for some species of butterfly (Craw 1975). At other times of the year there is moderate to low nectar production because the main nectar-bearing species which attract these birds are at low abundance in the site (e.g. pohutukawa, harakeke, wharariki, and karo) or they are juveniles (e.g. fuchsia, puriri, and rewarewa). The exception is possibly houpara, which is abundant and provides a good nectar source from December to February.

In terms of fruiting, there are reasonable quantities of fleshy fruit available over summer and early autumn months (e.g. taupata, shining karamu, mapou, mahoe, mingimingi, and *Muehlenbeckia* spp.), but there is only one main species providing fruit in the winter, which is houpara. The May to July fruiting time of houpara (*Pseudopanax lessonii*) may attract bird species into this site over these lean months.
A key factor in bird use of the stand is likely to have been the availability of good perching sites, in the eucalyptus, immediately adjacent to reasonable quality coastal forest. There may also be a good source of invertebrates available in the eucalyptus, however no estimate was made of the availability of invertebrates as food for birds (i.e. for kingfisher, morepork, shining cuckoo, grey warbler, etc.).

9.3 Attractiveness/usefulness assessment of flowers/fruit to native avifauna

General feeding behaviour and food preferences of frugivorous and nectivorous bird species found at the site are described below. This should be used to interpret Table 4, which summarises the usefulness of the plant species at the site to frugivores and nectivores (taking into account the present abundance of the plant species at the site).

Nectivores – Tui, Bellbird and, to a Lesser Extent, Silvereye

There are two nectivorous or ‘honeyeater’ bird species in the vicinity of the eucalyptus stand: tui are confirmed present in the current study and bellbirds were recorded as present in 2001. Castro and Robertson (1997) demonstrated that a wide variety of nectar-producing flowers are capable of fulfilling honeyeater diets, but that large ‘ornithophilous’ flowers (those which are coloured and shaped to be attractive to birds) are visited more often. At this site the most productive nectar species would be pohutukawa, fuchsia, harakeke, rewarewa, and puriri, however it has to be noted that these are all present in relatively low numbers (pohutukawa being the most common ornithophilous flower at and adjacent to the site). Medium to small-flowered species which are present at the site and are known to be visited by honeyeaters include karo, kanuka, supplejack, ngaio, nikau, hangehange, Pseudopanax spp., tawa, Hebe spp., and mapou (Castro and Robertson 1997). Houpara is not mentioned specifically in the paper by Castro and Robertson (1997), however it is probably a significant nectar source, based on the pattern shown by P. arboreus and P. crassifolius. Tui are larger than bellbirds, have higher energetic demands, and are more aggressive at defending their preferred food sources, therefore they are less likely to visit the smaller flowers and more likely to monopolise larger flowers. Silvereyes are generalists in terms of diet, eating a variety of invertebrates, fruit, and nectar, but they are often excluded from taking nectar by tui and bellbirds (Heather and Robertson 1996).

Frugivores – Kereru, Silvereye, Tui, and Bellbird

Kereru is the only common native bird species which regularly eats the largest fleshy native fruits of the New Zealand flora, though all large-fruited plant species except taraire¹ (Beilschmiedia tarairi) will have some of their fruits at the smaller end of the size range eaten by birds such as tui or bellbird (William Lee, Landcare Research, pers. comm.). Tawa and karaka are almost always dispersed by kereru (McEwen 1978). Fruits and seeds make up the most important part of the kereru diet (a very

¹ Taraire is not present in this site, it is only known from one location in the Bay of Plenty.
Table 4: Known nectar or fruit/seed producing plant species present in the Matata eucalyptus stand in 2007, and their usefulness/attractiveness to indigenous avifauna.

NB: ‘Abundance at site’ is a relative estimate of the abundance of reproductive individuals of the species. For example puriri and tawa were only present as juvenile plants, while most houpara were reproductive adults.
+ = few adults, ++ = moderate numbers of adults, +++ = dominant species in terms of flowering and fruiting.

‘Usefulness/attractiveness’
☺ = Usually would be a good source of nectar/fruit/seed, but not useful or attractive at present because nectar/fruit/seed not produced.
♀ = Small amounts only, therefore not particularly useful or attractive.
♀♀ = Useful or attractive as a food source.

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>Abundance at Site</th>
<th>Nectar</th>
<th>Fruit/Seed</th>
<th>Nectivores (e.g. tui, bellbird; to a lesser extent silvereye)</th>
<th>Frugivores (e.g. kereru, silvereye; to lesser extent tui &amp; bellbird)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordyline australis</td>
<td>ti kouka, cabbage tree</td>
<td>+</td>
<td>✓</td>
<td>✓</td>
<td>☺</td>
<td>☺</td>
<td>Only one individual seen.</td>
</tr>
<tr>
<td>Phormium cookianum</td>
<td>wharariki, mountain flax</td>
<td>+</td>
<td>✓</td>
<td></td>
<td></td>
<td>☺</td>
<td></td>
</tr>
<tr>
<td>Phormium tenax</td>
<td>harakeke, flax</td>
<td>+</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>☺</td>
<td></td>
</tr>
<tr>
<td>Rhopalostylis sapida</td>
<td>nikau</td>
<td>-</td>
<td></td>
<td>✓</td>
<td></td>
<td>☻</td>
<td></td>
</tr>
<tr>
<td>Beilschmiedia tawa</td>
<td>tawa</td>
<td>-</td>
<td></td>
<td>✓</td>
<td></td>
<td>☻</td>
<td>Kereru favourite.</td>
</tr>
<tr>
<td>Brachyglottis repanda subsp.</td>
<td>rangiora</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td>☻</td>
<td></td>
</tr>
<tr>
<td>Coprosma grandifolia</td>
<td>kanono</td>
<td>+</td>
<td></td>
<td>✓</td>
<td>☻</td>
<td>☻</td>
<td>Kereru, bellbird and tui favourite.</td>
</tr>
<tr>
<td>Coprosma lucida</td>
<td>shining karamu</td>
<td>++</td>
<td></td>
<td>✓</td>
<td>☻</td>
<td>☻</td>
<td>Kereru, bellbird and tui favourite.</td>
</tr>
<tr>
<td>Coprosma repens</td>
<td>taupata</td>
<td>++</td>
<td></td>
<td>✓</td>
<td>☻</td>
<td>☻</td>
<td>Kereru, bellbird and tui favourite.</td>
</tr>
<tr>
<td>Coprosma robusta</td>
<td>karamu</td>
<td>+</td>
<td></td>
<td>✓</td>
<td>☻</td>
<td>☻</td>
<td>Kereru, bellbird and tui favourite.</td>
</tr>
<tr>
<td>Coriaria arborea var. arborea</td>
<td>tutu</td>
<td>+</td>
<td></td>
<td>✓</td>
<td>☻</td>
<td>☻</td>
<td></td>
</tr>
<tr>
<td>Dodonaea viscosa</td>
<td>akeake</td>
<td>++</td>
<td></td>
<td></td>
<td></td>
<td>☻</td>
<td>Fruit/seed not known to be attractive to birds.</td>
</tr>
<tr>
<td>Fuchsia excorticata</td>
<td>kotukutuku, tree fuchsia</td>
<td>+</td>
<td>✓</td>
<td>✓</td>
<td>☻</td>
<td>☻</td>
<td>Large flowers with abundant nectar; large fleshy fruits; but only one or two plants noted.</td>
</tr>
<tr>
<td>Geniostoma rupestre var.</td>
<td>hangehange</td>
<td>++</td>
<td></td>
<td>✓</td>
<td>☻</td>
<td>☻</td>
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</tr>
<tr>
<td>ligustrifolium</td>
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</tr>
<tr>
<td>Hebe stricta var. stricta</td>
<td>koromiko</td>
<td>+</td>
<td>✓</td>
<td>?</td>
<td>☻</td>
<td>☻</td>
<td></td>
</tr>
<tr>
<td>Latin Name</td>
<td>Common Name</td>
<td>Abundance at Site</td>
<td>Nectar</td>
<td>Fruit/Seed</td>
<td>Nectivores (e.g. tui, bellbird; to a lesser extent silvereye)</td>
<td>Frugivores (e.g. kereru, silvereye; to a lesser extent tui &amp; bellbird)</td>
<td>Notes</td>
</tr>
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<td>------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Hedycarya arborea</td>
<td>porokaiwhiri, pigeonwood</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Kereru favourite; likely to increase in abundance in near future.</td>
</tr>
<tr>
<td>Knightia excelsa</td>
<td>rewarewa</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Large flowers with abundant nectar; but only juveniles noted.</td>
</tr>
<tr>
<td>Kunzea ericoides</td>
<td>kanuka</td>
<td>++</td>
<td>✓</td>
<td></td>
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<tr>
<td>Leptospermum scoparium</td>
<td>manuka</td>
<td>+</td>
<td>✓</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Leucopogon fasciculatus</td>
<td>mingimini</td>
<td>++</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Litsea calicaris</td>
<td>mangeao</td>
<td>++</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Macropiper excelsum subsp. excelsum</td>
<td>kawakawa</td>
<td>+++</td>
<td>✓</td>
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</tr>
<tr>
<td>Melicytus ramiflorus</td>
<td>mahoe</td>
<td>++</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>Metrosideros excelsa</td>
<td>pohutukawa</td>
<td>++</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>Large flowers with abundant nectar.</td>
</tr>
<tr>
<td>Myoporum laetum</td>
<td>ngaio</td>
<td>+</td>
<td>?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myrsine australis</td>
<td>mapou</td>
<td>++</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pittosporum crassifolium</td>
<td>karo</td>
<td>+</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudopanax arboreus var. arboreus</td>
<td>whauwhaupaku, five finger</td>
<td>+</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudopanax lessonii</td>
<td>houpara</td>
<td>+++</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitex lucens</td>
<td>puriri</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ripogonum scandens</td>
<td>kareao, supplejack</td>
<td>-</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calystegia sepium</td>
<td>pohue</td>
<td>+</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calystegia soldanella</td>
<td>panahi</td>
<td>++</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muehlenbeckia australis</td>
<td>puka</td>
<td>+++</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Nectar used by insects, but not known as a source for birds.</td>
</tr>
<tr>
<td>Muehlenbeckia complexa</td>
<td>pohuehue</td>
<td>+++</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Nectar used by insects, but not known as a source for birds.</td>
</tr>
<tr>
<td>Lachnagrostis billardiirei</td>
<td>perehia</td>
<td>++</td>
<td>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
wide variety of species is consumed), however leaves, flowers and buds comprise approximately 16% of the total diet averaged over a year (McEwen 1978). Tui and bellbird eat fruit when nectar is less available in the late summer and autumn (Heather and Robertson 1996). The species attractive to frugivores at this site include houpara, kawakawa, nikau, tawa, puriri kanono, karamu, tree fuchsia, shining karamu, taupata, mahoe, pigeonwood, *Muehlenbeckia* spp., five finger, and supplejack. Many of these are at low abundance (see Table 4). The most significant attractants of frugivores are likely to be houpara and kawakawa, because of their high concentration. Houpara is probably eaten by a variety of species in the winter months, when it is likely to be one of the only species fruiting abundantly in the site.

10. **PEST PLANTS**

Species are listed in order of threat/importance at the site.

**Kikuyu (*Pennisetum clandestinum*)**

This smothering grass is arguably the weed with the highest impacts at the site in terms of suppressing regeneration of indigenous species, however it only tends to be dominant in disturbed environments with high light levels.

**Japanese honeysuckle (*Lonicera japonica*)**

Japanese honeysuckle vines occur in low abundance throughout the site. There are also several local dense infestations where this species covers tens of square metres, generally in higher light areas, such as on the foredune, or on the inland side of the eucalyptus stand, amongst bracken. This species has the potential to alter or delay succession of indigenous vegetation, therefore it is an important weed at this site.

**Brush wattle (*Paraserianthes lophantha*)**

Brush wattle occurs frequently along some forest edges, especially on the inland side, and in frequently disturbed areas, such as grazed sites and stream margins. Much of it is very young and regenerating vigorously. Brush wattle can persist in scrubby coastal forest indefinitely, it seeds prolifically, and it regenerates in dense swathes after disturbances (such as fire, intensive grazing, and floods). It is therefore a high priority for control. However, control of brush wattle would need to be accompanied by restoration planting and ongoing weed control.

**Eucalyptus (*Eucalyptus botryoides*)**

If the goal for this site is to manage the vegetation back to predominantly indigenous species cover, eucalyptus would have to be considered for removal because it is naturalised and self-perpetuating on the site, even in areas of dense regeneration of indigenous species.
Smilax (*Asparagus asparagoides*)

One small infestation was noted, under trees in the eastern part of the site. This species is bird-dispersed and may have recently arrived in the stand via birds. It has the potential to expand its range under partial shade, therefore it is important to control this species while it is still at low abundance.

**Australian ngaio or Tasmanian boobialla (*Myoporum insulare*)**

One young Australian ngaio was found (and pulled out) in the eastern edge of the site, just outside the eucalyptus stand. This species is just beginning to naturalise in the Bay of Plenty, and there is anecdotal evidence that it hybridises with the New Zealand native ngaio (*Myoporum laetum*) (Mitcalfe 2002), thereby changing the genetic stock. Its similarity to the native species has resulted in it often being planted in error at ecological restoration sites.

**African boxthorn (*Lycium ferocissimum*)**

African boxthorn is a shrub/small tree which tends to occur on the edges of the stand, and is more important in the lower stature dune communities on the open coast edge which have higher light. It is an aggressive coloniser of dune habitats.

**Pampas (*Cortaderia selloana*)**

Pampas mainly occurs on the margins of the eucalyptus stand, preferring the highly silt-laden hollows which developed at the front of the stand, just behind the foredune, following the 2005 floods. It can be very abundant on this front edge. It is also present on track margins and other high light situations. Control is necessary as it becomes a very large plant and can occupy large areas, excluding native species.

**Kahili ginger (*Hedychium gardnerianum*)**

At least two small infestations were noted, and it is important to eradicate these as ginger is a rampant invader of indigenous forest understoreys.

**Grey willow (*Salix cinerea*)**

Grey willow is only present on the wetter, silt-laden parts on the open coast side of the eucalyptus stand, e.g. in Vegetation Type 9. It is currently at low abundance, but could expand, particularly in poorly drained areas. Grey willow is one of the most invasive wetland weeds in the Bay of Plenty.

**Crack willow (*Salix fragilis*)**

One young individual was noted in Vegetation Type 9 (wetland). This is of concern because crack willow is known to be very invasive in wetlands.
Montbretia (*Crocosmia x crocosmiiflora*)

One small, localised infestation was noted on the inland edge of the stand. This species can become common on disturbed forest edges and should be removed before it expands further.

Naked lady, belladonna lily (*Amaryllis belladonna*)

Small infestations are present in the eastern part of the stand, and have the potential to spread further.

Mercer grass (*Paspalum distichum*)

Only found in wetland vegetation (Type 9). This species suppresses indigenous wetland plants and thrives in high nutrient, high light environments.

Blackberry (*Rubus fruticosus agg.*)

Blackberry is restricted to the most highly disturbed parts of the site, especially within grazed areas and along stream margins.

Agapanthus (*Agapanthus praecox*)

One patch of agapanthus was recorded, possibly planted. It has the ability to expand and smother indigenous regeneration in disturbed coastal habitats.

Gorse (*Ulex europaeus*)

A typical weed of grazed pasture, this species is not likely to become a threat to the indigenous vegetation beneath the eucalyptus stand, and will only be perpetuated by continued grazing or similar disturbance.

Arum lily (*Zantedeschia aethiopica*)

This species was noted at very low abundance under dense vegetation (Type 1). It has the potential to expand through the site, particularly in the less well-drained areas. It prefers moist habitats.

Sea couch (*Elytrigia pycnantha*)

Only a few individuals of this species were noted under the forest in Vegetation Type 1. Forest is not usually its preferred habitat, but it can be a problem in estuarine waters.

*Cyperus involucratus*

This species is limited to wetland vegetation (Type 9) and is at low abundance. It is likely to spread within the site over time. Control is recommended.
Lupin (*Lupinus arboreus*)

Although present, this species is not abundant and does not appear to be thriving in the site. Control is not recommended.

Canna lily (*Canna indica*)

One small infestation, which should be removed. Populations of this species will slowly increase in size on a site like this. They are also visually intrusive.

11. MANAGEMENT

11.1 Current management

The study area is part of the Western Recreation Reserve and Whakatane District Council (WDC) and Terry and Trish Murphy are joint managers of the land. WDC actively manage two small access points to the beach which cross the railway tracks and go through the eucalyptus stand (the carpark adjacent to Murphy’s Holiday Camp and another carpark to the west). There is currently no management for conservation purposes. Terry and Trish Murphy graze small areas of the stand intermittently with sheep and cattle (both paddocks are fully fenced off from the rest of the stand), and a few beehives are kept under the stand.

11.2 Threats to indigenous regeneration

Several disturbance agents are at work, generating a high to moderate level of disturbance to the habitat overall (Figure 3). Disturbance favours weedy species such as brush wattle, kikuyu, Japanese honeysuckle, and others (see previous section for more detail). The most vigorous regeneration of indigenous species is in areas where the eucalyptus stand is widest and disturbances are at their lowest (especially in Vegetation Type 1).

Vehicle and foot tracks are common throughout the site, both along the length of the stand, as well as linking the state highway with the beach at numerous points. Apart from the car park at Murphy’s Holiday Camp, there is one other formal beach access with a car park. The maze of tracks under the eucalyptus is not as evident on aerial photography as in the adjacent pohuehue shrubland.

Sheep grazing occurs in paddocks on either side of Murphy’s Holiday Camp, but otherwise the rest of the stand is not grazed. Grazing tends to suppress indigenous species which would otherwise be regenerating under the eucalyptus (e.g. kawakawa, houpara, mahoe, *Coprosma* spp.), and weed species (e.g. blackberry, gorse, brush wattle) are encouraged by the frequent disturbance. Beehives are kept in the grazed paddock to the east of the holiday camp.

There is evidence of regular informal camping near the western end of the stand, which is a potential fire hazard to the vegetation. Rubbish and an old vehicle have been dumped under the trees.
Figure 3: Human impacts at the Eucalyptus stand, Matata

Legend
- Campsite
- Track
- Carpark
- Vegetation type boundary

Figure 3: Human impacts at the Eucalyptus stand, Matata (Sheet 1 of 2)
Figure 3: Human impacts at the Eucalyptus stand, Matata

Legend
- Beehive
- Grazing
- Dumped vehicle
- Rubbish
- Drain
- Track
- Fence
- Vegetation type boundary
Rabbits (*Oryctolagus cuniculus cuniculus*) are common throughout the site, as evidenced by numerous burrows and faecal pellets. Rabbits eliminate many sensitive plant species while young, and can even ring-bark older trees, thereby affecting development of the vegetation.

Almost nothing is known about the abundance of other animal pest species at the site, however it is highly likely that a wide variety of introduced mammals known from the Otanewainuku Ecological District is found at this site (Beadel 2006): brushtail possum (*Trichosurus vulpecula*), feral cat (*Felis catus*), ship rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), mouse (*Mus musculus*), stoat (*Mustela erminea*), weasel (*Mustela nivalis vulgaris*), ferret (*Mustela furo*), and hedgehog (*Erinaceus europaeus occidentalis*) would be expected to be present.

12. FUTURE MANAGEMENT

12.1 Goal and objectives

Any future management of the area must be developed between Whakatane District Council and Terry and Trish Murphy as the land managers.

If the eucalyptus stand is to be actively managed for conservation purposes, an appropriate goal would be ‘**to promote the dominance of indigenous plants in the dune forest, with a healthy population of indigenous fauna**’. There could be two main objectives as part of this goal:

- To manage the vegetation succession in such a way that the developing indigenous dune forest is released from competition with pest plants and from herbivory by pest animals, thereby enhancing the regeneration of indigenous plant species.

- To increase indigenous fauna use of the site by minimising predation and competition from introduced fauna, as well as direct human impacts.

12.2 Objective 1: Management of vegetation succession

There are at least three possible approaches to managing the eucalyptus stand to achieve indigenous species dominance in the future dune forest:

*Option 1: No Action*

- No control/removal of eucalyptus.

- Instigate monitoring to track changes over time.

- Future vegetation development would depend, in large part, on future changes (i.e. dieback) of the eucalyptus canopy, pest animal and weed abundance, and the extent of grazing.
**Option 2: Low-Level Intervention**

- Large eucalyptus trees would be left standing to provide some continuity of shelter, while trees smaller than 10 cm dbh would be removed using a cut-and-swab method\(^1\). The tall eucalyptus trees would gradually die out of their own accord over a long period of time, however new eucalyptus seedlings and saplings would have to be weeded out regularly if this approach were adopted, because there would still be a seed source on site.

- Other pest plants at the site which would require specific management are brush wattle, Japanese honeysuckle, kikuyu, boxthorn, and pampas. Eradication of small infestations would also be cost-effective if done at this stage, and the highest priority would be to concentrate on those with the potential for rapid future expansion in this habitat (i.e. kahili ginger, smilax, crack willow, grey willow, montbretia, and naked lady), as well as agapanthus, arum lily, and *Cyperus involucratus*.

- Gaps and edges could be planted with indigenous species such as houpara, kawakawa, karamu, taupata, karo, and pohutukawa. The main purpose of the planting would be to provide a protective buffer against wind exposure, but also to out-compete pest plants invading the area. Plant stock would need to be sourced from the coastal bioclimatic zone of the Otanewainuku Ecological District (ideally from within the site), or from the coastal bioclimatic zone in the neighbouring Tauranga ED or Te Teko ED. Pest plants would need to be controlled until canopy closure. Suitable threatened species which occur in the coastal zone of the Otanewainuku ED could be planted (e.g. *Pimelea tomentosa*) or which occur in other comparable coastal dune environments in the eastern Bay of Plenty (c.f. Shaw 1997).

- Control rabbits, which are a threat to naturally established seedlings as well as new plantings.

**Option 3: More Intensive Intervention**

- All eucalyptus trees below 10 cm dbh would be removed, as described in the previous option. The killing of large eucalyptus while standing (via ring-barking or stem drilling/cutting and poisoning) would be broken into five sectors and stages. After the first sector of tall trees was killed there would need to be monitoring of the stand and comparison to other areas where tall trees were not killed. If monitoring showed a favourable outcome in terms of indigenous species regeneration, further sectors could be killed in a stage-wise sequence. Visitors would need to be notified, using signage, and any risks to do with the railway or state highway would have to be minimised by considered felling of dead trees.

- Planting, pest plant control, and rabbit control would be required, as for Option 2.

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\(^1\) Small trees (less than 30 cm dbh) of *Eucalyptus botryoides* are known to coppice vigorously from stumps in Australia (Hamilton 2000), they probably also have this ability in New Zealand. Effective control would therefore need to be either ‘cut and swab’ (using an appropriate herbicide) or poison trees standing. Follow up control would also be required.
Discussion

Options 1 and 2 may be viable in the short term, however the existing tall eucalyptus are likely to survive on the site for a considerable period of time and the trees may eventually recover from the effects of the brown lace lerp infestations (particularly if the lerp’s biocontrol parasitoid Psyllaephagus gemitus reaches and is successful at this site). If this happens the shading from these trees is likely to have some effects on the indigenous trees currently thriving under the sparse eucalyptus canopy, but it is now unlikely that even a dense eucalyptus canopy will suppress the extensive regeneration of indigenous species, some of which are quite tolerant of a certain level of shading.

12.3 Objective 2: Enhancement of indigenous flora-fauna Interactions

Pest animal impacts are probably the key threat to indigenous fauna at the site, but food availability may also be a limiting factor. Food availability is partly addressed by enhancing vegetation, as for the previous objective, therefore the focus of this objective is on pest animal control.

Option 1: No Action

- No pest animal control.
- Instigate monitoring of pest abundance via tracking tunnels, wax blocks, trap-catch monitoring or other recognised methods which provide indices of relative abundance.

Option 2: Herbivore Control Only

- Control rabbits to protect establishing indigenous plants.
- No control of possums, rats, cats, or mustelids.

Option 3: Integrated Pest Control

- Pulsed control of possums, rats, cats, and mustelids via trapping or bait stations, with a focus on early spring and summer when birds are breeding.

Discussion

Without any control the pest animal population will continue to have negative impacts which are probably contrary to the objective of enhancing indigenous flora-fauna interactions (i.e. rabbits will attack the most sensitive plant species on the ground, possums will affect the canopy layer; possum, rats, cats, and mustelids will prey on birds and prevent them from breeding). Even if Option 3 were chosen, the site is long and narrow and would therefore be prone to constant reinvasion, thus the control would have to be intense and ongoing to see any real benefits for indigenous fauna.
Planting of species not naturally occurring at the site to increase food availability would not be recommended, as this is a unique dune forest in the Bay of Plenty which should be kept as natural as possible. Species such as tawa, rewarewa, nikau, and puriri, which are all currently represented by juveniles at the site, will grow to maturity if pest plants and animals are controlled, and will then provide a more diverse variety of food sources for birds and other fauna. Suitable threatened species which occur in coastal zone habitats could also be planted (see above).

12.4 Monitoring

Whatever management is instigated, the following monitoring approaches could be used to assess changes in vegetation structure, diversity and health, and to determine flora-fauna interactions at the site:

- A series of permanent vegetation plot should be established: with 5-10 plots spread through the study area to monitor change in vegetation structure and composition;
- Permanent photo points to monitor vegetation change;
- Five-minute bird counts: These could be undertaken annually or more frequently, for example bi-monthly, to provide more information depending on the information requirements;
- Miscellaneous observations on bird movements (presence, numbers) and seasonality of food sources (flowering/fruiting and use of plant species at the site) can also be recorded during visits to the site for other purposes which will help build up an overall picture of how birds are using the site. These cannot, however, be used as a substitute for regular monitoring, as above;
- Pest animal monitoring, e.g. via tracking tunnels, wax blocks, trap-catch methods, or other recognised methods which provide indices of relative abundance;
- Monitoring of the abundance of brown lace lerp and its introduced parasitoid *Psyllaephagus gemitus*. The presence/absence of the parasitoid at the site still needs to be established.

The intensity and type(s) of monitoring needs to be balanced with the level and type(s) of management instigated.

13. RELEVANCE TO OTHER SITES

Ecological processes occurring at this site are relevant to other coastal sand dunes in the Bay of Plenty region. The suite of species that has established naturally beneath the eucalyptus can be used to guide ecological restoration planting projects at other sites. Over the years, as the stand continues to increase in diversity and stature, it will continue to provide a guide and reference point for other projects.
14. PROTECTION STATUS

The area currently occupied by the eucalyptus stand is worthy of long term, formal protection because of its current status as developing indigenous forest. Indigenous dune forest is very limited in extent in the Bay of Plenty (e.g. in the coastal kanuka forest at Thornton there are a few pohutukawa on sand dunes at Waihau Bay, and woody species are regenerating locally on the Papamoa dunes), and this site serves as a unique guide for ecological restoration potential at other sites. Grazing, track construction, and felling of eucalyptus (which without appropriate care and follow up could result in replacement with adventive species) can be damaging to indigenous regeneration, and such practices need to be reviewed in the light of any goals adopted for the area.

15. CONCLUSIONS AND RECOMMENDATIONS

The eucalyptus stand at Matata, with its associated advanced understorey of developing indigenous forest, is a unique opportunity to evaluate the establishment of new coastal indigenous dune forest.

In summary, it was the presence of a bare understorey (as a result of grazing), coupled with low weed presence (or weed species that were unsuited to compete against indigenous species in this habitat), adequate shelter from coastal climatic influences, and a proximate seed source (and distribution mechanisms) that allowed development of the indigenous vegetation present today beneath the eucalyptus stand. Periodic dieback of the eucalyptus canopy has increased light levels and allowed more rapid development of what will be, in the relatively near future, a canopy of indigenous trees.

Seeds of indigenous species have been carried into the eucalyptus stand by wind and by birds, from the floristically-diverse vegetation on the adjacent coastal scarp and from adjacent stream gullies and other larger indigenous remnants.

The relative success and rapid development of indigenous vegetation at this particular site is undoubtedly due to the particular combination of a receiving environment suitable for indigenous regeneration (including a low abundance of smothering weeds), the adjacent seed sources, and seed movement mechanisms. It is very likely that significant indigenous regeneration would not be occurring if any of the above factors was missing or was significantly impeded.

It is notable that other environments immediately adjacent to the eucalyptus stand, such as kikuyu-dominant grassland (ungrazed) and pohuehue vineland (also ungrazed) are not showing evidence of abundant regeneration of indigenous tree species.
Future management options for the eucalyptus stand include:

- **Option 1** - No active management but monitor to assess changes over time;
- **Option 2** - Low-level intervention involving control of smaller eucalyptus, local planting, rabbit control, and monitoring;
- **Option 3** - More intensive intervention to progressively remove eucalyptus, and to undertake planting, rabbit control, and monitoring.

Three options for pest control are also presented:

- **Option 1** – No action;
- **Option 2** – Control herbivores only;
- **Option 3** – Integrated pest control of herbivores and predators.

The relative merits of the various options are discussed further in the text above. Recommendations based on evaluation of the options presented above are set out below.

**Vegetation Management**

Option 3 (staged removal of eucalyptus, weed control, and planting) is recommended, however it must be emphasized that a precautionary adaptive management approach is needed. In conjunction with removal of the first area of tall eucalyptus, monitoring should be undertaken to determine if the action has benefited indigenous species regeneration. It is suggested that monitoring would have to continue over a period of at least three to five years to give an indication of long-term effects. Only if a positive outcome was achieved should further sectors be killed in a stage-wise sequence. Option 2 is the next best, however it would be likely to prolong the management of eucalyptus on the site. Option 1 is not recommended.

**Flora-Fauna Interactions**

Option 2 (herbivore control) is recommended at present, because Option 3 is problematic due to the long, narrow shape of the site. Option 1 is not recommended.

**Protection**

Ensure that the protection status of the study area is adequate to provide long-term protection of the indigenous vegetation from disturbance, clearance, and grazing and other potentially damaging impacts.

**Monitoring**

A monitoring programme is recommended regardless of which options are chosen. The most important aspects to monitor are vegetation change (via permanent vegetation plots and photopoints), bird use of the site (via five-minute bird counts, and recording of miscellaneous observations), pest animal abundance, and to determine trends in the brown lace lerp population and that of its parasitoid. With regard to the last point, if the eucalyptus starts to recover through a decline in the
brown lace lerp, then more intensive management is likely to be required to achieve indigenous forest cover at the site in the future.

ACKNOWLEDGMENTS

We would like to thank Greg Jenks (Coast Care Bay of Plenty Regional Coordinator) and Nancy Willems (Environment Bay of Plenty) for commissioning this very worthwhile project. The Matata Coast Care group provided useful historical and contextual information. Terry Murphy supplied old photographs of the site and his insights from 23 years as the leaseholder of the land. Nancy Willems provided useful comments on a draft of this report.

REFERENCES


APPENDIX 1

VASCULAR PLANT SPECIES LIST

Key

1. Natural, and planted in Vegetation Type 15.
2. One young plant seen; appeared to be *Phormium cookianum* (wharariki, mountain flax) but could be *P. tenax*.
3. Seedling(s) only.
4. Planted in Vegetation Type 15 only; no natural karaka seen in study area.
5. Seedlings and saplings only.
6. Greg Jenks (Coast Care Bay of Plenty) pers. comm.
7. Environmental pest plant.

**Indigenous Species**

**Monocot. trees and shrubs**

*Cordyline australis*\(^1\)  
ti kouka, cabbage tree

*Phormium* sp.\(^2\)

*Phormium tenax*\(^1\)  
harakeke, flax

*Rhopalostylis sapida*\(^3\)  
nikau

**Dicot. trees and shrubs**

*Beilschmiedia tawa*\(^3\)  
tawa

*Brachyglottis repanda* subsp. *repanda*  
rangiora

*Coprosma grandifolia*  
kanono

*Coprosma lucida*  
karamu

*Coprosma repens*  
taupata

*Coprosma robusta*  
karamu

*Coriaria arborea* var. *arborea*  
tutu

*Corynocarpus laevigatus*\(^4\)  
karaka

*Dodonaea viscosa*  
akeake

*Entelea arborescens*\(^6\)  
whau

*Fuchsia excorticata*\(^5\)  
kotukutuku

*Geniostoma rupestr e* var. *ligustrifolium*  
hangahenge

*Hebe stricta* var. *stricta*  
koromiko

*Hedycarya arborea*  
porokaiwhiri

*Knightia excelsa*  
rewarewa

*Kunzea ericoides*  
kanuka

*Leptospermum scoparium*  
manuka

*Leucopogon fasciculatus*\(^4\)  
mimgimingi

*Litsea calicaris*\(^5\)  
mangeao

*Macropiper excelsum* subsp. *excelsum*\(^1\)  
kawakawa

*Melicytus ramiflorus*  
mahoe

*Metrosideros excelsa*\(^1\)  
pohutukawa

*Myoporum laetum*  
gaio

*Myrsine australis*  
mapou
Pittosporum crassifolium
*Pseudopanax arboreus* var. *arboreus*
*Pseudopanax crassifolius × P. lessonii*
*Pseudopanax lessonii*
Vitex lucens

Monocot. lianes

*Ripogonum scandens*

Dicot. lianes

Calystegia sepium
*Calystegia sepium × C. soldanella*
Calystegia soldanella
*Muehlenbeckia australis*
*Muehlenbeckia complexa*

Ferns

*Asplenium flaccidum* subsp. *flaccidum*
*Asplenium polyodon*
*Blechnum novaezelandiae*
*Cyathea dealbata*
*Cyathea medullaris*
*Dicksonia fibrosa*
*Diplazium australae*
*Hypolepis ambigua*
*Microsorum pustulatum*
*Paesia scaberula*
*Pneumatosperis pennigera*
*Pteridium esculentum*
*Pteris tremula*

Grasses

*Lachnagrostis billardierei*
*Microlaena stipoides*
*Oplismenus hirtellus* subsp. *imbecillis*

Sedges

*Bolboschoenus fluviatilis*
*Carex breviculmis*
*Carex geminata*
*Carex inversa*
*Carex maorica*
*Carex pumila*
*Carex secta*
*Carex solandri*

karo
whauwhaupaku, five finger
houpara
puriri
kareao, supplejack
pohue
panahi
puka
pohuehue
makawe
petako
kiokio
ponga
mamaku
wheki-ponga
kowaowao, hounds tongue fern
matata
pakau
bracken, rarahu
turawera, shaking brake
perehia
patiti, meadow rice grass
purei
Carex testacea
Carex virgata
Cyperus ustulatus
Ficinia nodosa

Rushes

Juncus edgariae
Juncus planifolius

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

Dianella nigra
Typha orientalis

Composite herbs

Pseudognaphalium luteoalbum agg.
Senecio hispidulus

Dicot. herbs (other than composites)

Geranium solanderi
Haloragis erecta subsp. erecta
Oxalis rubens
Persicaria decipiens
Solanum americanum

Adventive Species

Dicot. trees and shrubs

Eucalyptus botryoides
Lupinus arboreus
Lycium ferocissimum
Myoporum insulare
Paraserianthes lophantha
Rubus phoenicolasius
Rubus sp. (R. fruticosus agg.)
Salix cinerea
Salix fragilis

Dicot. lianes

Lonicera japonica

Japanese honeysuckle
Grasses

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrostis capillaris</td>
<td>browntop</td>
</tr>
<tr>
<td>Agrostis stolonifera</td>
<td>creeping bent</td>
</tr>
<tr>
<td>Alopecurus geniculatus</td>
<td>knee foxtail</td>
</tr>
<tr>
<td>Anthoxanthum odoratum</td>
<td>sweet vernal</td>
</tr>
<tr>
<td>Axonopus fissifolius</td>
<td>narrow-leaved carpet grass</td>
</tr>
<tr>
<td>Bromus wildenowii</td>
<td>prairie brome</td>
</tr>
<tr>
<td>Cortaderia selloana</td>
<td>pampas</td>
</tr>
<tr>
<td>Cynodon dactylon</td>
<td>Indian doab</td>
</tr>
<tr>
<td>Dactylis glomerata</td>
<td>cocksfoot</td>
</tr>
<tr>
<td>Ehrharta erecta</td>
<td>veld grass</td>
</tr>
<tr>
<td>Elytrigia pycnantha</td>
<td>Ukrainian brome</td>
</tr>
<tr>
<td>Holcus lanatus</td>
<td>Yorkshire fog</td>
</tr>
<tr>
<td>Lagurus ovatus</td>
<td>harestail</td>
</tr>
<tr>
<td>Paspalum dilatatum</td>
<td>paspalum</td>
</tr>
<tr>
<td>Paspalum distichum</td>
<td>Mercer grass</td>
</tr>
<tr>
<td>Pennisetum clandestinum</td>
<td>kikuyu grass</td>
</tr>
<tr>
<td>Poa pratensis</td>
<td>Kentucky bluegrass</td>
</tr>
<tr>
<td>Schedonorus phoenix</td>
<td>tall fescue</td>
</tr>
<tr>
<td>Setaria gracilis</td>
<td>knot-root bristle grass</td>
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<tr>
<td>Setaria palmifolia</td>
<td>palm grass</td>
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<tr>
<td>Sporobolus africanus</td>
<td>ratstail</td>
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<tr>
<td>Stenotaphrum secundatum</td>
<td>buffalo grass</td>
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</tbody>
</table>

Sedges

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
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<tbody>
<tr>
<td>Cyperus eragrostis</td>
<td>umbrella sedge</td>
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<tr>
<td>Cyperus involucratus</td>
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</tbody>
</table>

Rushes

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juncus bufonius</td>
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</tr>
<tr>
<td>Juncus effusus</td>
<td>soft rush</td>
</tr>
<tr>
<td>Juncus tenuis</td>
<td>track rush</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agapanthus praecox</td>
<td>agapanthus</td>
</tr>
<tr>
<td>Amaryllis belladonna</td>
<td>naked lady, belladonna lily</td>
</tr>
<tr>
<td>Asparagus asparagoides</td>
<td>smilax</td>
</tr>
<tr>
<td>Canna indica</td>
<td>canna lily</td>
</tr>
<tr>
<td>Crocosmia × crocosmiiflora</td>
<td>montbretia</td>
</tr>
<tr>
<td>Hedychium gardnerianum</td>
<td>kahili ginger</td>
</tr>
<tr>
<td>Zantedeschia aethiopica</td>
<td>arum lily</td>
</tr>
</tbody>
</table>
Composite herbs

Achillea millefolium  yarrow
Artemisia verlotiorum  Chinese mugwort
Aster subulatus  sea aster
Cirsium arvense  California thistle
Cirsium vulgar  Scotch thistle
Conyza albida  fleabane
Crepis capillaris  hawksbeard
Gamochaeta spicata  cudweed
Hypochoeris radicata  catsear
Lactuca serriola  prickly lettuce
Lapsana communis  nipplewort
Leontodon taraxacoides  hawkbit
Osteospermum jucundum  Australian daisy
Senecio bipinnatisectus  ragwort
Senecio jacobaea  gravel groundsel
Sonchus oleraceus  puha
Taraxacum officinale  dandelion

Dicot. herbs (other than composites)

Anagallis arvensis  scarlet pimpernel
Chenopodium album  fathen
Euphorbia peplus  milkweed
Foeniculum vulgare  fennel
Fumaria muralis  scrambling fumitory
Galium aparine  cleavers
Galium divaricatum  herb Robert
Lotus pedunculatus  lotus
Modiola caroliniana  creeping mallow
Myosotis sylvatica  garden forget-me-not
Orobanche minor  broomrape
Oxalis sp.  oxalis
Pastinaca sativa  wild parsnip
Pelargonium x hortorum  geranium
Physalis peruviana  cape gooseberry
Phytolacca octandra  inkweed
Plantago lanceolata  narrow-leaved plantain
Polycarpum tetraphyllum  allseed
Portulaca oleracea  wild portulaca
Prunella vulgaris  selfheal
Ranunculus repens  creeping buttercup
Rumex obtusifolius  dock
Silene gallica  catchfly
Sison amomum  stone parsley
Solanum chenopodioides  velvety nightshade
Solanum nigrum  black nightshade
Spergularia rubra
Trifolium repens
Verbena bonariensis
Verbena officinalis
Veronica anagallis-aquatica
Veronica arvensis
Veronica persica
Veronica serpyllifolia
Vicia sativa
Vinca major
Viola arvensis
Wahlenbergia sp.
sand spurrey
white clover
purple-top
vervain
water speedwell
field speedwell
scrambling speedwell
turf speedwell
vetch
periwinkle
field pansy
harebell
APPENDIX 2

FAUNA SPECIES LIST

This list only includes species recorded during the 17 May 2007 field visit.

**Birds**

*Indigenous*

- *Gerygone igata* (riroriro; grey warbler)
- *Hemiphaga novaeseelandiae* (kereru; kukupa; New Zealand pigeon)
- *Prosthemadera novaeseelandiae* (tui)
- *Rhipidura fuliginosa placabilis* (piwakawaka; North Island fantail)
- *Todiramphus sanctus* (kotare, sacred kingfisher)
- *Zosterops lateralis* (silvereye; tauhou)

*Exotic*

- *Gymnorhina tibicen* (Australian magpie)
- *Phasianus colchicus* (pheasant)
- *Turdus merula* (blackbird)

**Insects**

*Exotic*

- *Cardiaspina fiscella* (brown lace lerp)
APPENDIX 3

SITE PHOTOGRAPHS
Plate 4: Vegetation Type 1 - tall eucalyptus over a diverse kawakawa-dominant understorey on gently-undulating dunes.

Plate 5: Vegetation Type 1 - dense kawakawa, houpara and eucalyptus in understorey beneath open eucalyptus canopy.
Plate 6: A puriri (*Vitex lucens*) seedling in Vegetation Type 1.

Plate 7: Seedlings regenerating in leaf litter in Vegetation Type 1. Supplejack (*Ripogonum scandens*) at left, mangeao (*Litsea calicaris*) at top, and tawa (*Beilschmiedia tawa*) at bottom, with abundant tiny kawakawa (*Macropiper excelsum*) seedlings.
Plate 8: Spinifex grassland at the front edge of Vegetation Type 1.

Plate 9: Boundary of Vegetation Type 1 with the paddock; brush wattle is common in the understorey.
Plate 10: Campsite in the western part of the stand, in Vegetation Type 2. Tall eucalyptus over pohutukawa, houpara, and kawakawa on gently-undulating dunes.

Plate 11: Vegetation Type 3 - tall eucalyptus over shining karamu-eucalyptus subcanopy and bracken shrub tier on gently-undulating dunes.
Plate 12: Vegetation Type 4 - tall eucalyptus over dense houpara on steeply-sloping dunes (cabbage trees visible in foreground are planted (Vegetation Type 15).

Plate 13: Vegetation Type 5 - eucalyptus treeland on gently-undulating dunes.
Plate 14: Vegetation Type 6 - isolated patches of low eucalyptus on foredune. Grassland dominated by cocksfoot occupies the space between the main eucalyptus stand and these patches.

Plate 15: Vegetation Type 7 - low eucalyptus over houpara on foredune. Pohuehue vineland and spinifex grassland is present in front of this type.
Plate 16: Vigorously-regenerating brush wattle (*Paraserianthes lophantha*) in Vegetation Type 8 - Sparse low eucalyptus over kikuyu pasture on flattened foredune (grazed).

Plate 17: Vegetation Type 9 - dead eucalyptus over weed-infested ephemeral wetland. Note silt-laden weed-infested area in foreground which was a substantial dune slack wetland prior to the 2005 flood.
Plate 18: Vegetation Type 10 - Tall eucalyptus over kikuyu and pohuehue on gently undulating dunes (grazed).

Plate 19: Vegetation Type 11 - tall eucalyptus on steep dunes at eastern end (recently burnt). Pohuehue is present in the understorey.
Plate 20: Stream and stream banks with kikuyu in Vegetation Type 12.

Plate 21: Vegetation Type 13 - scattered tall eucalyptus over kikuyu on disturbed stream banks.
Plate 22: Vegetation Type 14 - scattered tall eucalyptus over kikuyu pasture on flattened dunes (grazed). Lone pohutukawa at centre left.

Plate 23: Vegetation Type 16 - exotic grassland on a vehicle track at the eastern end of the eucalyptus stand.