

10 Rushes and allied plants

Centrolepis ciliata
Empodisma minus

Juncus acuminatus
Juncus antarcticus
Juncus articulatus

Juncus gregiflorus
Juncus novae-zelandiae
Juncus planifolius

Luzula picta
Luzula subclavata

11 Other monocots

Arthropodium candidum
Astelia fragrans
Astelia grandis
Astelia solandri

Collospermum hastatum
Collospermum microspermum
Dianella nigra
Herpolirion novae-zelandiae

Luzuriaga parviflora
Phormium cookianum
Phormium tenax

Potamogeton suboblongus
Sparganium subglobosum
Triglochin striata

Botany of Whangapoua wetlands and dunes, north-eastern Great Barrier Island

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Introduction

Great Barrier Island (Aotea) is recognised as a key conservation area by the Department of Conservation (DoC) mainly because: it is the largest island off the coast of the North Island of New Zealand, it contains extensive indigenous forest habitats of outstanding significance, a range and quality of freshwater and marine habitats, and contains two endemic flowering plants (*Kunzea sinclairii*, *Olearia allomii*) (DoC 1995). Greater than 60% of the island is formally protected and managed by DoC and the two large forested Scenic Reserves (Harataonga and Tryphena) are managed by Auckland City Council (see Fig. 1).

Little has been written specifically on the Whangapoua wetlands and dunes on the east coast of northern Great Barrier Island (see Fig. 1). Kirk (1869) was the first to publish something comprehensive on the botany of Great Barrier Island, including a species list of native and naturalised vascular plants. But there is nothing specific on Whangapoua apart from his occasional specimens collected there on 19 December 1867. Kirk does mention "On the eastern coast there is a considerable tract of sand-dunes and swamps, where a few peculiar plants may be found." "Most of the ordinary sand plants are found on the eastern coast: *Convolvulus soldanella*, *Desmoschoenus spiralis*, *Spinifex sericeus* (as *S. hirsutus*), *Coprosma acerosa*, are abundant; as is the naturalised *Raphanus sativus*, *Atriplex billardieri* (*sic*), and *Melicytus novae-zelandiae* (as an undescribed *Melicytus* sp.) are also found here." Four of these seven species were not recorded by this present survey for Whangapoua: *C. acerosa*, *R. sativus*, *A. billardieri* and *M. novae-zelandiae* (not a sand species!). Kirk also records 14 main wetland species from the east coast, which are probably based on the extensive Kaitoke wetland. There are various general and specific accounts on the island's botany since Kirk, including an updated native vascular plant list by Bartlett & Gardner (1983). The

Whangapoua wetland is the only large estuarine habitat on Great Barrier Island. It includes mangroves (*Avicennia marina*), salt-marsh, saltmeadow, shallow tidal flats, freshwater swamps, and is bounded on the eastern side by a sandspit and a magnificent, exposed sandy beach. The estuarine habitat harbours many uncommon bird species: fernbird, bittern, spotless crane, banded rail, and a large number of brown teal. Ogle (1980) regarded the whole estuarine system as one of the least modified in New Zealand and for its size one of the most valuable to wildlife. The Wildlife Service (Ogle 1980) found it contained the highest bird diversity of any area on Great Barrier. The Department of Lands and Survey bought Okiwi Station, the area surrounding the estuary (514.5 ha, containing some 450 ha of pasture), in 1984. Cameron (1985) made the case which fell on deaf ears for Whangapoua estuary and Okiwi Station along with four other natural areas on Great Barrier and the whole of Little Barrier to be considered for National Reserve status. Before Okiwi Station was gazetted as a Farm Park the Crown land carve up occurred and the "farmed" area of this outstanding conservation area was allocated to the newly formed Landcorp in 1987 (which was extremely contentious at the time). In 1992 the taxpayers of New Zealand, assisted by public subscription, bought the area "again" (costing nearly \$1 million) so that it could be managed for its conservation values as well as being farmed. DoC now manages the farm as the Okiwi Recreation Reserve (514.5 ha) and the estuary and sandspit as the Whangapoua Stewardship Area (390 ha). Hopefully the Whangapoua wetlands will be included in the proposed marine reserve DoC is attempting to establish in the north-eastern part of Great Barrier Island (DoC 1991, Jeffs & Irving 1993: 1.6-1.7, DoC 1995: table 9).

At the request of DoC I surveyed the wetland and dune vegetation of the Whangapoua estuary on

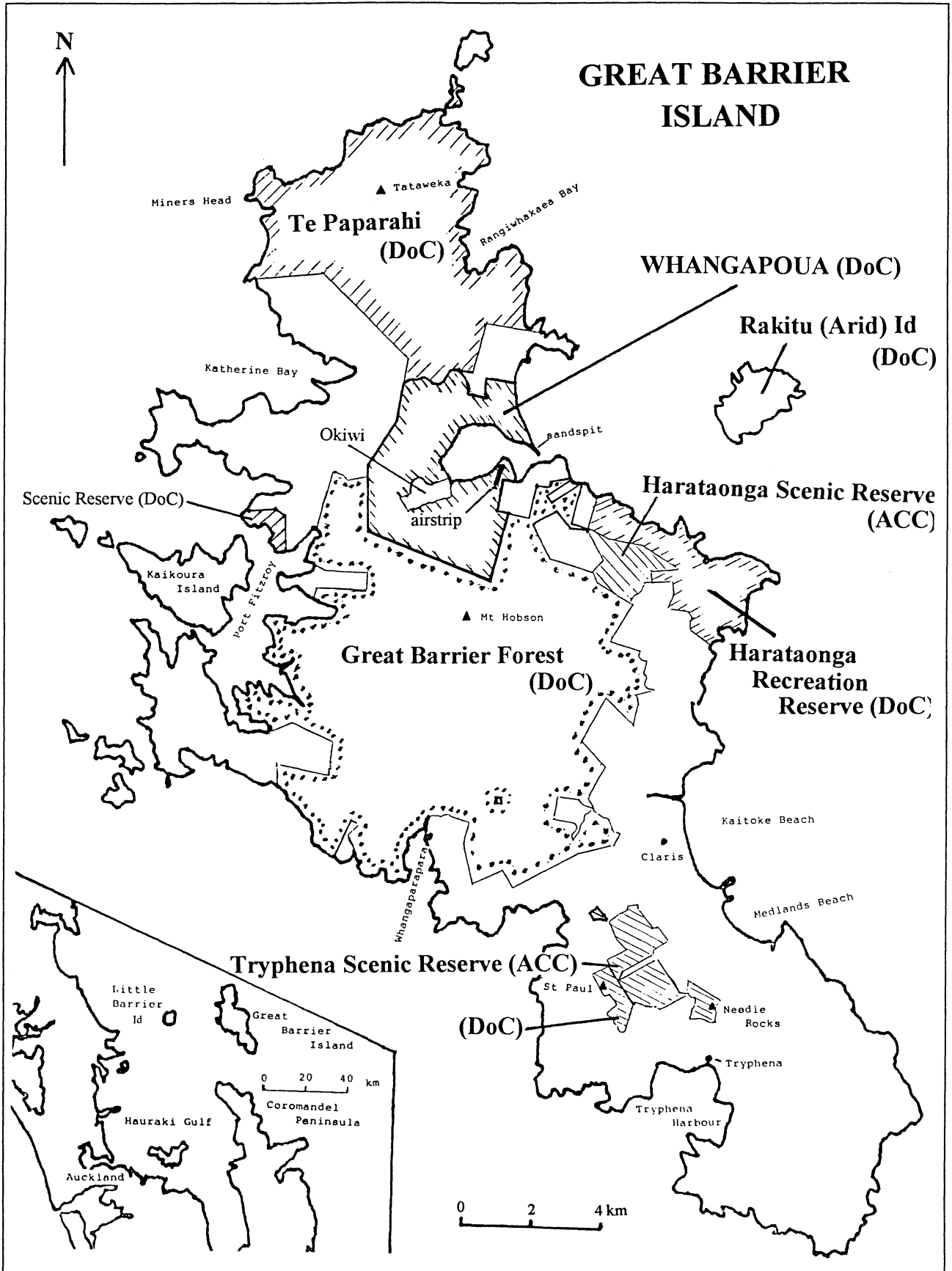


Fig. 1. Department of Conservation and Auckland City Council main reserves on Great Barrier Island.

2 April 1992. Additional information was added from my previous visits to the area in April 1980 and March 1986, and from a brief walk along the back of the Whangapoua Beach on 26 October 1992 and two days later a walk around the estuary via Mabeys Rd. The 1992 survey was a part of a series of surveys of intertidal, subtidal, wildlife and botanical ecosystems of the north-east coast of Great Barrier Island initiated to assist with the formulation of a marine reserve in this area (Jeffs & Irving 1993). My portion of the report is repeated here with no extra field work by me. The text has been expanded, the botanical names are updated and voucher specimen numbers added (37% are vouchered) from a recent computer search of the Auckland Museum (AK) and the Auckland University (AKU) herbaria databases, which now have most of their wild New Zealand plants databased (this search also added 3 new records and subtracted 1). This publication is to make the information of this important estuary more accessible (by being published) and up to date. Indeed, in an inventory of the North Island's sand dune and beach vegetation by Partridge (1992: 207) the important Whangapoua dunes were not included because of a lack of published information.

Method

A day's survey of Whangapoua estuary was carried out in April 1992 on foot, starting from a freshwater swamp by Mabeys Road at 0930 hours. A north-south traverse of the estuary was carried out including the DoC northern "paddocks" and the coastal margin around the Okiwi airstrip. An eastern deviation across the dune spit and a western loop through the mangroves was also included before departing from Okiwi airstrip at 1600 hours. Most of the western margin of the estuary was not studied by me at close quarters.

Forty three specimens were collected during the survey and these are lodged in the Auckland Museum herbarium (AK) and are cited in Appendix 1. Only vascular plants were recorded, apart from macro-lichens on some of the woody plants, lower plants were not an obvious component of the vegetation. However, it is recognised that in the brackish estuarine water, plankton are very rich in

terms of biomass and are the beginning of all marine food chains. Both salt-marshes and mangroves are highly productive areas and export organic detritus to the adjacent coastal sea.

An inventory was made of all vascular species observed (see Appendix 1), dominant species, broad vegetation zones and composition were noted. Field work was complemented by studying a recent colour aerial photograph and checking AK and AKU herbaria for Whangapoua specimens. The delineation of the vegetation zones along the western margin of the estuary were discussed with Chris Green. The only previously published botanical information specifically on Whangapoua area is by Ogle (1980) who mentions the dominant species and estuarine zones. For wildlife information see Ogle (1980, 1981) and Jeffs & Irving (1993).

Results

The vascular flora of Whangapoua wetlands and dunes is quite diverse with 165 species of which 59% are native (Table 1). The 67 adventive species are mainly herbaceous and few are prominent in the vegetation. Only four adventive species are present in the estuarine community (see Appendix 1).

Although the vegetation classes intergrade in places, the Whangapoua estuary and surrounds can be divided into six broad categories: forest, manuka-kanuka shrublands, pasture, saltwater wetlands, freshwater wetlands and sand dunes. Only the latter three categories were studied and mapped (Fig. 2).

Saltwater Wetlands

This category includes all areas inundated by extreme high water spring tides and covers some 295 ha, and are shown on the map (Fig. 2) as the area inside the line noting the limit of estuarine vegetation. Within this area approximately 35 % is sand and mud with some eel grass (*Zostera novazelandica*), 40% is mangrove or manawa, 18% is sea rush (*Juncus kraussii*), 5 % is oioi (*Apodasmia similis*) and *Baumea juncea*, and small areas (2%) of pure saltmeadow: *Triglochin striata*,

Table 1. Vascular flora of Whangapoua wetlands and dunes.

Plant Group	Native	Adventive	Total species
Ferns	9		9
Conifers	2	1	3
Dicotyledons	48	39	87
Monocotyledons	39	27	66
Total species	98	67	165

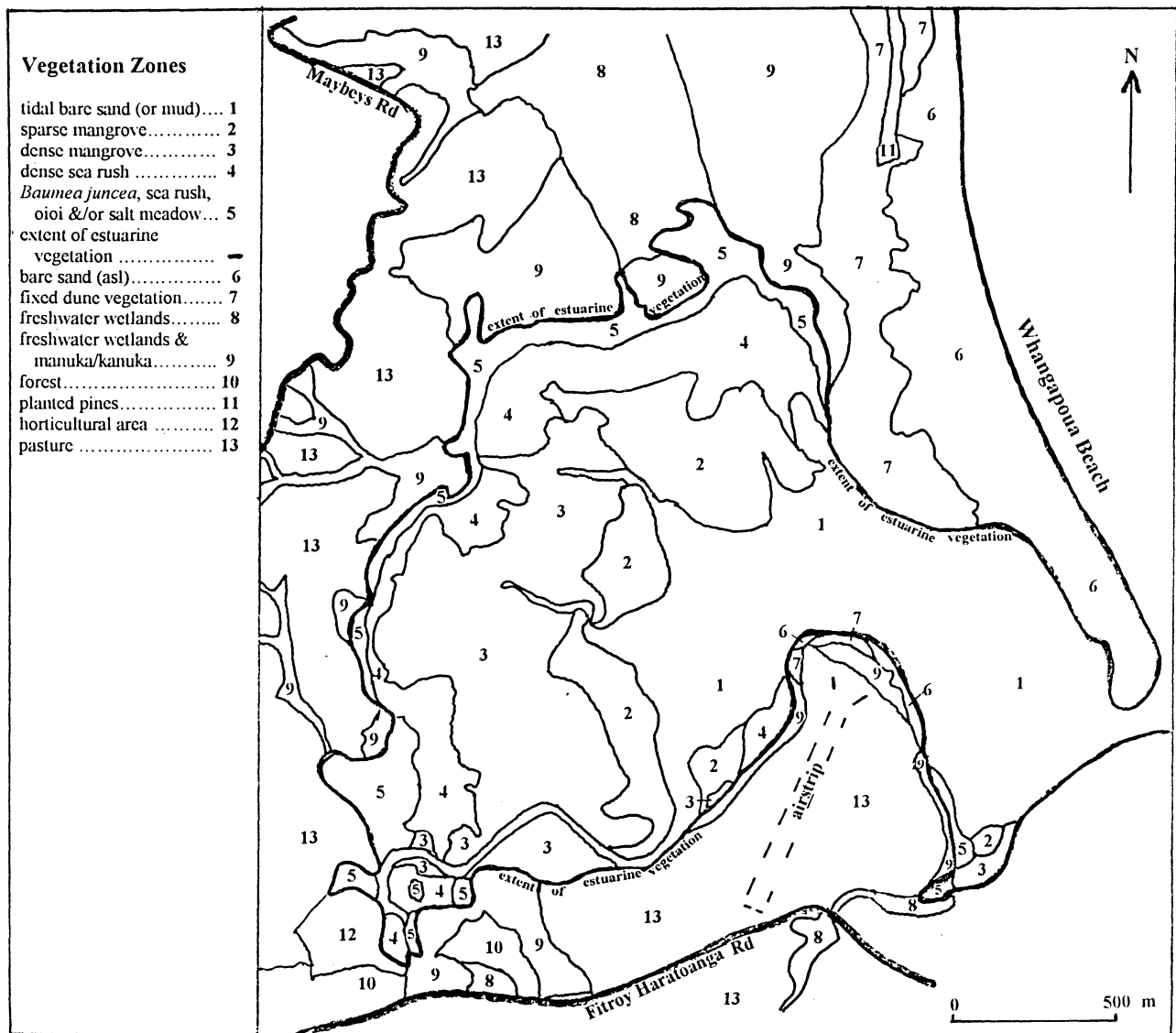


Fig. 2. Location of vegetation zones within the Whangapoua estuary (after fig. 8.1 of Jeffs & Irving 1993).

glasswort (*Sarcocornia quinqueflora*) and *Selliera radicans*. The bare part of the estuary is mostly the sandy eastern area towards the mouth (where the currents are strongest). Some 2 km west of the mouth the sediment becomes less sandy and more typical of mangrove mud flats. Here eel grass is present below and around the lower mangrove level, but is rather sparse. There are 70 ha of mangroves concentrated in the western part of the estuary (area type 3, see Fig. 2). Here the mangroves are dense, continuous and mostly around 1 m tall by the larger channel.

Around the lower mangrove level and in most of the northern mangrove zone the plants are low (< 1 m tall) and cover less than 50% of the substrate. These sparse mangroves (area type 2) account for a further 36 ha within the estuary. Mangroves are absent in the sandy areas by the estuary mouth,

but low mangroves are present in the shelter of the small bay just east of Okiwi airstrip.

At the upper mangrove level, there is an abrupt change into a virtually pure sea rush zone, up to 300 m wide. This sudden species change is related to the tide level and the decreasing inundation by the sea (mangroves are normally inundated by sea water at each high tide, i.e. twice every 25 hours). The major sea rush zone is in the north and western parts of the estuary; it is dense, predominantly without other species and 50-75 cm tall. The upper boundary of the sea rush zone frequently grades into *Baumea juncea* and/or oioi.

In the upper north-east corner of the estuary the *Baumea* zone commonly has mats of *Selliera radicans*, glasswort, *Samolus repens* and finally this ends up as a low saltmeadow (approximately 100 x

50 m) dominated by *Selliera*, glasswort and *Triglochin*. Beard grass (*Polypogon monspeliensis*), *Lobelia anceps*, *Isolepis cernua*, saltwater paspalum (*Paspalum vaginatum*), *Samolus repens* and glaucous goosefoot (*Chenopodium glaucum*) are also present. Although all these species are seen elsewhere in the estuary, especially along the tidal parts of the drains in the northern "paddocks", this is the most extensive saltmeadow present. Similar areas also exist on the western estuary boundary (C. Green pers. comm.). Such areas would only be reached by extreme high water spring tides that occur about every 3 weeks. The margins of the upper tidal drains are lined with *Triglochin* and *Lobelia*. Bachelor's button (*Cotula coronopifolia*), *Isolepis cernua*, sea rush, mangrove, and *Apium* "white denticles" are occasionally present in the drains. (*Apium* "white denticles" appears to be an undescribed species, widespread in New Zealand salt-marshes, and it is unknown whether it is native or adventive to New Zealand.)

In places the saltmarsh is contiguous with a manuka (*Leptospermum scoparium*) shrubland (e.g. by the sandspit and near the airstrip). In such places tangled shrubs of marsh ribbonwood (*Plagianthus divaricatus*) are occasionally present along this interface. A single 2 m tall shrub of coastal tree daisy (*Olearia solandri*) is also present in this zone near the airstrip. Coastal tree daisy is locally common by the tidal creek, 1 km east of the Okiwi School. Apart from these two localities it was not seen elsewhere within the estuary. Clumps of needle tussock (*Stipa stipoides*) are locally frequent along the upper estuarine zone on both mud or sand. The shrublands on the western side of the estuary are tall (2-6 m high) and usually comprised of an equal mix of manuka and kanuka (*Kunzea ericoides*). Dally pine (*Psoralea pinnata*) is frequently present in these shrublands. Additional saltwater species are present in the dune hollows (see Appendix 1).

Freshwater wetlands

Freshwater wetlands surround the estuary. They begin in the higher forested land, traverse the rough paddocks and drain into the estuary. In 1992 they varied from totally grazed, to partially drained, to a few that lacked recent modification. The best freshwater wetland seen is on the north side of Mabeys Road just west of the start of the Te Paparahi Track. It is long, narrow and surrounded by 3-5 m tall manuka with the occasional cabbage tree (*Cordyline australis*) and regenerating kahikatea (*Dacrydium dacrydioides*). The swamp is dominated by raupo (*Typha orientalis*), *Schoenoplectus tabernaemontani*, and swamp millet (*Isachne globosa*) which are dense and approx-

imately 1.5 m tall. Commonly associated with these species is the scrambling vine, pink bindweed (*Calystegia sepium*), kiokio (*Blechnum novae-zelandiae*), swamp willow weed (*Polygonum salicifolium*), *Epilobium pallidiflorum* and various sedges, e.g. *Eleocharis acuta*, *Carex lessoniana*, *C. virgata* and giant umbrella sedge (*Cyperus ustulatus*). Two exotic species, lotus (*Lotus pedunculatus*) and Mexican devil (*Ageratina adenophora*), are also frequent. Locally, New Zealand flax (*Phormium tenax*) and *Baumea teretifolia* are present.

This wetland crosses the road and continues eastward to a series of "paddocks" which have been partially drained. Before reaching these drains, the composition of the wetland is similar to above, but is more open with rough pasture adjacent to it dominated by rush species e.g. soft rush (*Juncus effusus*), giant rush (*J. pallidus*) and *Juncus gregiflorus* and a sedge, *Carex virgata*. Common along the open swamp margin is *Ranunculus urvilleanus* amongst globe sedge (*Cyperus brevis-folius*) and various rushes (*Juncus* spp.).

The series of fenced, partly drained "paddocks" down to the upper estuarine zone is an extensive open wetland dominated by giant rush, about 1.5 m tall. Most of this area has been severely modified over the last decade by drainage channels, rotary mowing and grazing. It is now (1992) mostly being left to regenerate. Nine other rush species are present; especially common ones being soft rush and *Juncus gregiflorus*. Lotus is common and exotic grasses are uncommon, apart from sweet vernal (*Anthoxanthum odoratum*) and kikuyu grass (*Pennisetum clandestinum*). Occasionally present is swamp millet, *Centella uniflora*, *Pseudognaphalium leuteoalbum*, raupo (not dense) and fleabane (*Conyza albida*). Locally there are more open areas of *Isolepis prolifer*, Mercer grass (*Paspalum distichum*), wind grass (*Lachnagrostis filiformis*), danthonia (*Rytidosperma racemosum*) and low rushes (*Juncus articulatus*, *J. acuminatus*). Giant rush decreases in height to about 1 m tall and sea aster (*Aster subulatus*) is frequent approaching the upper estuarine zone. Although fenced, cattle droppings are present throughout this area.

By the north end of Okiwi airstrip, behind the estuarine zone or dunes, are a series of narrow, silty freshwater depressions. These are dominated by *Schoenoplectus tabernaemontani*, *Eleocharis acuta* and swamp willow weed. Small herbs of centella, *Lilaeopsis novae-zelandiae*, sneezewort (*Centipeda minima*) and *Ranunculus amphitrichus* are present on the bare mud amongst the taller species. *Leptinella tenella* was collected from this habitat in 1980 by Ogle. Behind these hollows is

rough grazed pasture dominated by knee high rushes e.g. soft rush and *Juncus sarophorus*.

Another freshwater wetland studied is on the south side of the Fitzroy-Harataonga Road opposite the Okiwi airport building. This is a totally grazed wetland, on private land, which runs through a paddock, draining the steep forested land to the south. Common here is swamp millet, *Isolepis prolifer*, Mercer grass, globe sedge, *Schoenoplectus tabernaemontani*, *Baumea rubiginosa* and various rushes e.g. *Juncus articulatus*, *J. prismatocarpus* and soft rush. Native pond weed (*Potamogeton cheesemani*) and the exotic creeping buttercup (*Ranunculus repens*) are present. This wetland crosses the road and continues down to a small bay east of the airstrip near the estuary mouth.

On the north side of the Fitzroy-Harataonga Road, opposite the entrance to the Okiwi Recreation Reserve, is a beautiful raupo swamp (c. 120 m by 80 m) dominated by 6-8 m tall cabbage trees. Pink bindweed and New Zealand flax are present. On the swamp's north-eastern side is kanuka, a very tall kahikatea and a nikau (*Rhopaloslylis sapida*).

Dunes

There are two separate dunes areas. By far the largest is at the back of Whangapoua Beach and extending over the sandy spit to the northern side of the estuary mouth. The last (southern) 1 km of this spit is low (less than 10 m asl) and contains open, low vegetation. North of this open spit are consolidated dunes (up to 60 m asl.) which are covered in 2-4 m tall manuka. The smaller dune is on the southern side of the estuary mouth at the northern end of the Okiwi airstrip.

The mobile foredunes of Whangapoua Beach are dominated by pingao (*Desmoschoenus spiralis*) and spinifex (*Spinifex sericeus*). Mats of shore bindweed (*Calystegia soldanella*) are occasionally present and two tussocks of *Austrofestuca littoralis* were seen. In the more stable sites behind the mobile dunes on the sandspit, tauhinu (*Ozothamnus leptophylla*), wire vine (*Muehlenbeckia complexa*), kikuyu grass, harestail (*Lagurus ovatus*), pampas grass (*Cortaderia selloana*) and tree lupin (*Lupinus arboreus*) are frequent. Less common species include *Isolepis nodosa*, woody-root oxalis (*Oxalis rubens*), *Zoysia pauciflora* and wildling radiata pines (*Pinus radiata*). The small radiata pine plantation on the lee of the spit was cut down in 1986-87, but several were resprouting. Browsing on the pingao is apparent, presumably by rabbits.

The low-down dune hollows contain a different flora, all herbaceous estuarine species. *Carex*

pumila, *Selliera radicans*, *Lobelia anceps* and *Lilaeopsis novae-zelandiae* are common. Occasionally present are *Limosella lineata*, oioi and jointed rush (*Juncus articulatus*), *Isolepis cernua*, beard grass, hawkbit (*Leontodon taraxacoides*) and saltwater paspalum. Most of these species are also present in the estuarine zone.

Inside the spit, near the mouth is a band of oioi and sea rush (10-30 m wide) and locally a low sandy turf of saltwater paspalum, *Samolus repens*, glasswort, *Selliera radicans*, *Carex pumila* occurs, and then bare sand flats below this zone.

The small dune at the end of the Okiwi airstrip is about 300 m long by 25 m wide. Three-quarters of it is dominated by spinifex and the balance by *Carex pumila*. Other dune species present include sand wind grass, shore bindweed, harestail, *Zoysia pauciflora*, woody-root oxalis, buffalo grass (*Stenotaphrum secundatum*) (locally common), tree lupin and a single clump of pingao. Stock grazing and vehicle tracks were evident.

Threatened species

Nationally threatened species (see Cameron et al. 1995) *Austrofestuca littoralis*, an Australasian sand grass (Status: Rare; Regionally Endangered) - on the Whangapoua Beach fore-dune, it is one of the last colonies of this native grass in the Auckland region. In the 19th century it was more widespread but there have been no records for over 50 years of this species in the Auckland region apart from the east coast beaches of Great Barrier Island (Whangapoua, Kaitoke and Medlands Beaches). The cause of this plant's decline is unknown but it is probably due to grazing animals and human modification of dune areas. Only two clumps were seen on the Whangapoua dunes in 1992; in 1999 Phil Todd and Geoff Stone recorded two adult and twelve juvenile plants from the same area (P. Todd pers. comm.). In January 1999 about 60 plants were recorded on Kaitoke Beach and six plants at Medlands Beach (R.J. Stanley pers. comm.). The abundance of pingao (a declining New Zealand dune species) and spinifex in the absence of the introduced sand-binding marram grass (*Ammophila arenaria*) means that the three native sand-binding monocots can be seen (and studied) together without marram affecting their ecology. (Note that a single clump of marram was seen on Whangapoua Beach in October 1992. It appeared to have been recently washed ashore and was destroyed.)

Centipeda minima (Status: Local) – since 1903 there have only been five collections (based on AK

and AKU herbaria) of this herb in the Auckland region: three at Whangapoua and one each at Little Barrier and Kawau Islands. All Whangapoua collections came from damp areas by the Okiwi airstrip where it was locally frequent in 1986 and 1992 as low clumps up to 30 cm across. It was seen there again in 1999 by P. J. de Lange (P. Todd pers. comm.).

Atriplex billardierei (Status: Endangered) - the only Great Barrier records are Kirk (1869) and two Kirk collections: "Whangapoua Sands" on 19 December 1867 (WELT 51801) and the other December 1867 which has no specific Great Barrier locality (WELT 51806). This northern North Island entity may be different from the Australasian *A. billardierei* s.str. (P.J. de Lange pers. comm.) which now only survives on the coast just south of North Cape.

Pomaderris hamiltonii (Status: Rare) – although the adjacent shrublands to the Whangapoua estuary are excluded for this article, it is worth noting that *P. hamiltonii* occurs around the western and north-western fringes of the estuary by Mabeys Road where it was first discovered on Great Barrier in 1992 (see Cameron 1992).

Regionally threatened or uncommon species (see de Lange et al. 1999)

Ranunculus urvilleanus - initially this species was listed nationally as "Vulnerable" (Wilson & Given 1989), but later deleted from the national threatened list because it was more common than previously thought (Cameron et al. 1993) and more recently its deletion further supported by de Lange & Gardner (1997). However, it is listed as regionally Declining (de Lange et al. 1999). The discovery during this 1992 survey of a large population of this northern endemic New Zealand buttercup, on the margins of swampy ground near Mabeys Road, was important as it is one of the largest populations known in the Auckland region. Although de Lange & Gardner (1997) state that "... so long as low-level disturbance of *R. urvilleanus* habitats continues, the species will very likely be able to maintain itself." I feel they have over-looked the threat of weed competition in these open habitats, such as from kikuyu grass (*Pennisetum clandestinum*), and therefore these populations should be monitored to see if the species can maintain itself in the long term under the increasing weed threat.

Leptinella tenella - the presence of the small New Zealand endemic daisy (found by C. Ogle in 1980, AK 169712) in a silty depression by the Okiwi airstrip is another important record. All *Leptinella* species are very local or scarce in northern New Zealand. Apart from this Great Barrier record, in the

Auckland region over the last 100 years *L. tenella* has only been collected at Little Barrier Island and two mainland sites (northern Manukau Harbour and near Albany). Regionally listed as Declining.

Ditch millet (*Paspalum orbiculare*) – Great Barrier Island is the regional stronghold for this species, but it may be an early Polynesian introduction to New Zealand (see Cameron 1998). Status Declining.

Threatened and other species that are likely to be present, or were likely once to be present

Botanically the Whangapoua area has not been fully studied and other species will no doubt be discovered with further fieldwork. For example, two species which are easily overlooked are *Amphibromus fluitans* (Status: Nationally Critical) and *Carex litorosa* (Status: Regionally threatened). The discovery of the Australasian freshwater grass, *A. fluitans* in 1989 by Peter de Lange (1990) in a small dune pond near Claris was a new record for Great Barrier Island (AK 199925). Similar habitats exist at Whangapoua. The endemic New Zealand sedge *Carex litorosa* grows in estuarine zones and is very local in the North Island. Kirk recorded it for Great Barrier (Kaiarara) last century (AK 11179) and it may well be present in the Whangapoua estuary as well.

Pimelea arenaria is a sand dune shrub (Status: Nationally Local) once occurring throughout the North, South and Chatham Islands. I am only aware of two Great Barrier collections and neither have a locality cited for the island: Kirk, 1867 (WELT 52995) and Matthews & Carse, 1919 (AK 101201). The Whangapoua dunes would be an ideal habitat for this species that now appears to be extinct throughout the Auckland region.

Eleocharis neozelandica (Status: Nationally Vulnerable) – first discovered on Great Barrier in January 1999 at Kaitoke Beach by Bec Stanley (Stanley 1999, AK 236524). The only other regional site it is known from is Whatipu, west Auckland. At both sites it grows on wet sand and it is possible that suitable sites occur at Whangapoua.

Euphorbia glauca (Status: Nationally Rare; Regionally Declining) - sand dunes are a common habitat of this species which was recorded by Kirk (1869) for Great Barrier (no specimen located) and also seen there (1975-1980) by the late J.K. Bartlett, but no locality given (Bartlett & Gardner 1983). It used to be wide-spread in the Auckland region, and is now only known from Motukorea (Browns) and Little Barrier Islands.

Epilobium pallidiflorum (Status: Declining).

Sand coprosma (*Coprosma acerosa*) – although this is not considered to be a threatened species it has disappeared or decreased (mainly due to human impacts) from many dune areas in the region. Kirk recorded it on the east coast of Great Barrier and it still grows there today at Kaitoke Beach (AKU 14170). The Whangapoua dunes are an ideal habitat for this species and it would have almost certainly once have grown there.

Conclusions

Botanical values of Whangapoua

The main botanical values of the area are its large size, the lack of recent modification, its representativeness of north-eastern New Zealand estuarine vegetation, the unbroken sequences of different vegetation types and the species present. Extensive areas exist of different vegetation types that change and integrate along a salt gradient and a substrate gradient (mud to sand). Nationally (see Cameron et al. 1995) and regionally threatened species (see de Lange et al. 1999) are present in the wetlands and dunes and others are likely to be present. On botanical values alone it is nationally important.

One of the most important features of the Whangapoua estuary is the general lack of recent ground disturbance in the whole estuary catchment. (Note the Mabey farm in the north mainly drains separately to the sea). In places the sequence from forest on the upper catchment slopes down through freshwater wetlands (flanked by manuka-kanuka shrublands) to estuarine vegetation to the sea is virtually unbroken via dominantly native vegetation (though reduced to mostly narrow strips across the farmland zone). Dune vegetation also intermingles with saltmarsh and freshwater wetlands.

Apart from a couple of old drainage channels in the south-west corner and extensive drains in the northern freshwater/saltwater "paddocks" the estuary is relatively unmodified. The northern drains (dug in 1979-80 in an attempt to drain and farm this area) are filling in with sediment and mangroves are starting to establish in the more shallow drains.

The absence of all spartina species and possums (*Trichosurus vulpecula*) on Great Barrier increases the botanical value of Whangapoua estuary. Many New Zealand estuaries are grossly modified by these adventive intertidal grasses and possums can heavily browse accessible mangrove vegetation.

It has been fortunate during the 1980s that low impact farming was carried out on the surrounding

Okiwi Station. Intensive farming with fertilisers and high stock numbers would directly influence the wetland vegetation.

The importance of the Whangapoua estuary and surrounds is highlighted in an article on setting priorities for threatened New Zealand species by Davies et al. (1992): "The habitats most important for threatened plants, namely lowland, coastal herbfields and freshwater wetlands, are the most severely reduced in area and are under-represented in the conservation estate. . . In order to maintain its biodiversity New Zealand must protect sites that are rich in species and have diverse ecosystems." All of the natural areas of Whangapoua strongly qualify for preservation under these criteria. There is no other opportunity in north-eastern New Zealand to control virtually the whole catchment of an estuary approaching this size, and in such good condition.

Future Management

Fortunately few aggressive weeds are present that would potentially dominate the vegetation. Pampas grass is one that does require immediate control otherwise it will cover much of the dune areas. Wildling pines and tree lupin need to be kept in check as well. Dally pine is locally common in the wetter areas behind the north-west part of the estuary. This weed needs to be monitored to see if it is increasing its range. Marram grass should not be allowed to establish on the dunes.

Stock needs to be totally excluded from the wetlands and dunes, and rabbits need to be managed on the dunes. More farmland should be retired to develop wider bush and wetland corridors between the forest and estuary, as well as provide a wider buffer area around the estuary. The estuary buffer is particularly narrow along the western and southern boundaries. If widened it would achieve a better gradation from saltmarsh to shrubland, instead of changing abruptly from saltmarsh to farmland as much of it currently is. The upper estuarine zone of marsh ribbonwood is absent in most places and the coastal tree daisy is extremely local.

The proximity of the manuka-kanuka shrublands to a good seed source (the dense native forest in the upper Whangapoua catchment), ensures that the shrublands will return quickly to forest as long as stock are excluded. From the Fitzroy-Harataonga Rd, possibly the best riverine podocarp forest on Great Barrier Island, consisting of kahikatea and totara (*Podocarpus totara*) with puriri (*Vitex lucens*) can be seen close to the south-west corner of the estuary. (It is a scarce forest type on Great Barrier

Island). Other riverine trees present are kanuka, kowhai (*Sophora microphylla*), kohekohe (*Dysoxylum spectabile*), and mahoe (*Melicactus ramiflorus*). Vines of climbing rata (*Metrosideros perforata*) and *Parsonsia capsularis*, and the epiphytic leatherleaf fern are also present. This rather scattered riverine strip of trees gives a good indication of what could be achieved, if the wetland buffers across the farmland were widened to allow shrubland and forest regeneration.

All artificial channels should be allowed to fill in. This would cause the partially drained freshwater wetlands to regenerate.

To retain the high conservation values of the estuary, management of the whole catchment is vital. The purchase of Okiwi Station by DoC in 1992 should assure the future conservation of the biota in perpetuity through wise conservation management of the farm as a Recreation Reserve. But the Whangapoua estuary and dunes still require suitable legal status to protect their scientific values. DoC (1995: table 8) recognises this and have recommended all Great Barrier reserves and conservation areas administered by the Department be up-graded to a Conservation Park or National Reserve status, though this is yet to occur. As I proposed in 1985 (Cameron 1985), I strongly support National Reserve status for these outstanding conservation areas on Great Barrier Island. Rakitu (Arid) Island, purchased by the Crown on 14 October 1994, should also be given this upgraded "umbrella" reserve status.

Consideration should be given to reintroducing plants that used to occur at Whangapoua or occur (-red) on Great Barrier elsewhere and were highly

likely to have occurred at Whangapoua. E.g. *Atriplex* aff. *billardi*, *Amphibromus fluitans*, *Euphorbia glauca* and sand coprosma.

Since 1992

Farm stock has been fenced from most of the natural areas and several areas have been retired from grazing. (Consideration should be given to the currently grazed wahi tapu area on the northern boundary of Whangapoua to be retired and allowed to regenerate.) DoC has fenced along the streams, to support bush and wetland corridors, which cross the pastoral zone and strengthen the biological connection between the estuary and forest behind. Because of its natural values Whangapoua has been identified by DoC as the priority site on Great Barrier Island for weed control, which means ongoing funding for weeding is most likely. To date this control has focussed on the dune weeds: pampas grass, apple of Sodom (*Solanum linnaenum*) and gorse (*Ulex europaeus*). Pine trees near the end of the sandspit that resprouted after initially being cut down in 1986-87, were felled in 1998. Three new naturalised plants have been recorded at Whangapoua since 1992: smilax (*Asparagus asparagoides*) 50-60 plants at north end of the dunes, moth plant (*Araujia sericifera*) only a couple of plants seen on the dunes, and *Sigesbeckia orientalis* which was locally common in a freshwater swamp. The former two are aggressive environmental weeds and they will be added to the species to be targeted for weed control (P. Todd pers. comm.). Dally pine which is locally common on the farm/wetland boundaries and Mexican devil are also likely to be added to this target list. No control of the rabbits, nor feral pigs (which cause seasonal damage), has occurred.

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Appendix 1. Vascular plant species of Whangapoua wetlands and dunes.

Key

- * = adventive species
 + = present in 1992
 h = hollow
 m = margin of the habitat
 r = removed, October 1992

Records from other sources:

- FCS = collected by J. Frater, R.S. Cooper & A.B. Stephenson in 1965 (AK 117595), not seen in 1992
 F & S = collected by J. Frater & A.B. Stephenson in 1965 (AK 122198); not seen in 1992
 K = collected by T. Kirk in 1867-68 (AK 11172, WELT 51801); not seen in 1992
 O = collected by C.C. Ogle in 1980 (AK 169712); not seen in 1992
 S = collected by G.S. Stone in 1997 (AK 235384); not seen by me
 T = recorded by P. Todd in 1998-99 (pers. comm.); not seen by me

	MAORI / COMMON NAME	FRESH WATER	SALT WATER	DUNE	VOUCHER
Ferns (9)					
<i>Blechnum novae-zelandiae</i>	kiokio	+			
<i>Cyathea dealbata</i>	ponga	+m			
<i>C. medullaris</i>	mamaku	+m			
<i>Doodia australis</i>	rasp fern	+m			
<i>Histioptens incisa</i>	water fern	+			
<i>Paesia scaberula</i>	scented fern	+			
<i>Pteridium esculentum</i>	bracken	+			
<i>Pteris tremula</i>		+			
<i>Pyrrosia eleagnifolia</i>	leather-leaf fern	+m			
Conifers (3)					
<i>Dacrycarpus dacrydioides</i>	kahikatea	+			AK 117618
<i>Pinus radiata</i> *	radiata pine			+	
<i>Podocarpus totara</i>	totara	+			
Dicotyledons (87)					
<i>Ageratina adenophora</i> *	Mexican devil	+		+	
<i>Alectryon excelsus</i>	titoki	+m			
<i>Amaranthus lividus</i> *	purple amaranth	+m			AK 207407
<i>Anagallis arvensis</i> s.str.*	scarlet pimpernel			+h	
<i>Apium</i> "white denticles"			+		AK 207412 & 207423
<i>Araujia sericifera</i> *	moth plant			T	
<i>Aster subulatus</i> *	sea aster	+	+		
<i>Atriplex billardiarei</i>				K	WELT 51801
<i>A. prostrata</i> *	orache		+		AK 207426
<i>Avicennia marina</i>	mangrove, manawa		+		
<i>Cakile edentula</i> *	sea rocket			+	
<i>Callitriche stagnalis</i> *	starwort	+			
<i>Calystegia sepium</i>	pink bindweed	+		+	
<i>C. soldanella</i>	shore bindweed			+	AK 122152
<i>Centaureum erythraea</i> *	centaury			+	
<i>Centella uniflora</i>	centella	+			
<i>Centipeda minima</i>	sneezewort	+			AK 207429, AKU 19601
<i>Cerastium fontanum</i> *	mouse-ear chickweed	+			AK 207403

<i>Chenopodium glaucum</i>	glaucous goosefoot			+		AK 207419
<i>Cirsium arvense*</i>	Californian thistle	+m				
<i>C. vulgare*</i>	scotch thistle	+m			+	
<i>Conyza albida*</i>	broad-leaved fleabane	+m			+m	AKU 19600
<i>Coprosma robusta</i>	karamu	+m				
<i>Coriaria arborea</i>	tutu	+m				
<i>Cotula australis</i>	soldier's button			+		AKU 196602
<i>C. coronopifolia</i>	bachelor's button			+		
<i>Dysoxylum spectabile</i>	kohekohe	+m				
<i>Epilobium pallidiflorum</i>		+				AK 91943 & 207395
<i>Galium aparine*</i>	cleavers				+	
<i>Geranium homeanum*</i>					+	AK 209408
<i>Gnaphalium involucreatum</i>		+				AK 207402
<i>G. simplicicaule*</i>		+m				
<i>Gonocarpus micranthus</i>		+				
<i>Haloragis erecta</i>	shrubby haloragis	+m				
<i>Hypochoeris radicata*</i>	catsear	+m			+	
<i>Kunzea ericoides</i>	kanuka	+m				
<i>Leontodon taraxacoides*</i>	hawkbit	+m			+	
<i>Leptinella tenella</i>		O				AK 169712
<i>Leptospermum scoparium</i>	manuka	+				AK 122237
<i>Leucopogon fasciculatus</i>	mingimingi	+m	+m			AK 110516 & 117594
<i>Lilaeopsis novaezelandiae</i>		+			+h	
<i>Limosella lineata</i>					+h	AKU 196603
<i>Lobelia anceps</i>				+	+h	
<i>Lotus angustissimus*</i>	slender birdsfoot trefoil	+m				
<i>L. pedunculatus*</i>	lotus	+			+	
<i>L. suaveolens*</i>	hairy birdsfoot trefoil			+m		
<i>Ludwigia palustris*</i>	water purslane	+				
<i>Lupinus arboreus*</i>	tree lupin				+	
<i>Meliclytus ramiflorus</i>	mahoe	+m				AK 110529
<i>Mentha pulegium*</i>	pennyroyal	+m				
<i>Metrosideros excelsa</i>	pohutukawa			+m		AK 122268
<i>M. perforata</i>		+m				
<i>Muehlenbeckia complexa</i>	wire vine				+	AK 122278
<i>Olearia solandri</i>	coastal tree daisy			+		AK 207427
<i>Oxalis rubens</i>	woody-root oxalis				+	
<i>Ozothamnus leptophylla</i>	tauhinu				+	AK 122157
<i>Parsonia capsularis</i>		+m				
<i>Physalis peruviana*</i>	cape gooseberry				+	
<i>Phytolacca octandra*</i>	inkweed	+m				
<i>Plagianthus divaricata</i>	marsh ribbonwood			+		
<i>Plantago lanceolata*</i>	narrow-leaved plantain	+m				
<i>Polygonum punctatum*</i>	American willow weed	+				AK 207404
<i>P. salicifolium</i>	swamp willow weed	+				AK 143257
<i>Prunella vulgaris*</i>	selfheal	+m				
<i>Pseudognaphalium luteoalbum</i> agg.		+m				
<i>Psoralea pinnata*</i>	dally pine	+m				
<i>Ranunculus amphitrichus</i>		+				
<i>R. repens*</i>	creeping buttercup	+				
<i>R. sardous*</i>	hairy buttercup	+m				AK 207400
<i>R. urvilleanus</i>		+				AK 207398
<i>Rumex acetosella*</i>	sheep's sorrel				+	
<i>R. conglomeratus*</i>	clustered dock	+				
<i>Salsola kali*</i>	saltwort				F & S	AK 122198
<i>Samolus repens</i>				+		
<i>Sarcocornia quinqueflora</i>	glasswort			+		
<i>Selliera radicans</i>				+	+h	AK 207421
<i>Senecio bipinnatisectus*</i>	Australian fireweed	+m				
<i>S. biserratus</i>					+	AK 209407
<i>S. glomeratus</i>		+				
<i>S. hispidulus</i>		+m				
<i>Sigesbeckia orientalis*</i>		S				AK 235384
<i>Solanum americanum</i>	small flowered nightshade	+m				AK 207406
<i>S. linnaenum*</i>	apple of Sodom				+	
<i>Sonchus oleraceus*</i>	sow thistle	+m			+h	
<i>Sophora microphylla</i>	kowhai	+m				
<i>Ulex europaeus*</i>	gorse			+m	+	
<i>Vitex lucens</i>	puriri	+m				

Monocotyledons (66)					
<i>Aira caryophylllea</i> s.str.*	silvery hair grass		+m		
<i>Ammophila arenaria</i> *	marram grass			+r	AK 209406
<i>Apodasmia similis</i>	oioi		+	+	
<i>Anthoxanthum odoratum</i> *	sweet vernal	+m			
<i>Asparagus asparagoides</i> *	smilax			T	
<i>Austrofestuca littoralis</i>				+	AK 209409, AKU 19604
<i>Axonopus affinis</i> *	carpet grass	+m			
<i>Baumea articulata</i>		+			
<i>B. juncea</i>		+m	+		
<i>B. rubiginosa</i>		+			
<i>B. teretifolia</i>		+			AK 207397
<i>Bromus arenarius</i> *				K	AK 11172
<i>B. diandrus</i> *	ripgut bone			+	
<i>Carex flagellifera</i>				+	
<i>C. lessoniana</i>			+		
<i>C. pumila</i>	sand sedge		+		
<i>C. virgata</i>		+			
<i>Cordyline australis</i>	cabbage tree	+			AK 117614
<i>Cortaderia selloana</i> *	pampas grass			+	
<i>Cyperus brevifolius</i> *	globe sedge	+			
<i>C. ustulatus</i>	giant umbrella sedge	+		+	AK 122254
<i>Desmoschoenus spiralis</i>	pingao			+	AK 122181 & 222637
<i>Digitaria sanguinalis</i> *	summer grass	+m			
<i>Eleocharis acuta</i>		+			
<i>Isachne globosa</i>	swamp millet	+			AK 207396
<i>Isolepis cernua</i>			+	+h	
<i>I. nodosa</i>				+	AK 122340
<i>I. prolifer</i>		+			AK 207409
<i>I. sepulchralis</i> *		+			
<i>Juncus acuminatus</i> *		+			AK 207418
<i>J. articulatus</i> *	jointed rush	+		+h	AK 207424
<i>J. dichotomus</i> *		+			AK 207414
<i>J. effusus</i> *	soft rush	+			
<i>J. gregiflorus</i>	leafless rush	+			AK 117621
<i>J. kraussii</i>	sea rush		+	+h	
<i>J. pallidus</i>	giant rush	+			AK 207401 & 207416
<i>J. planifolius</i>		+			
<i>J. prismatocarpus</i>		+			
<i>J. sarophorus</i>	leafless rush	+			AK 207417
<i>J. tenuis</i> *	track rush	+			
<i>Lachnagrostis billardierei</i>	sand wind grass			+	
<i>L. filiformis</i>	wind grass	+			AK 207408
<i>Lagurus ovatus</i> *	harestalk			+	AK 145514
<i>Microtis unifolia</i>				+	
<i>Paspalum dilatatum</i> *	paspalum	+m			
<i>P. distichum</i> *	Mercer grass	+			
<i>P. orbiculare</i>	ditch millet	+			AK 207405
<i>P. urvillei</i> *	Vasey grass	+			
<i>P. vaginatum</i> *	saltwater paspalum		+	+	AK 207420
<i>Pennisetum clandestinum</i> *	kikuyu grass	+		+	
<i>Phorium cookianum</i>	mountain flax			FCS	AK 117595
<i>Phormium tenax</i>	flax, harekeke	+	+m		AK 117637
<i>Poa trivialis</i> *				+	
<i>Polypogon monspeliensis</i> *	beard grass		+	+h	
<i>Potamogeton cheesemanii</i>	pondweed	+			AK 207399
<i>Rhopalostylis sapida</i>	nikau	+m			AK 117599
<i>Rytidosperma racemosum</i> *	danthonia	+			AK 207415
<i>Schoenoplectus tabernaemontani</i>		+			
<i>Spinifex sericeus</i>	spinifex			+	AK 122348
<i>Sporobolus africanus</i> *	ratstail	+m			
<i>Stenotaphrum secundatum</i> *	buffalo grass			+	
<i>Stipa stipoides</i>	needle tussock		+		
<i>Triglochin striata</i>			+		AK 207413
<i>Typha orientalis</i>	raupo	+			
<i>Zostera novaezelandica</i>	eel grass		+		AK 207422
<i>Zoysia pauciflora</i>				+	AK 207425