Coastal foredune vegetation in Wellington Conservancy

Current status and future management

Department of Conservation
Te Papa Atawhai

Coastal foredune vegetation in Wellington Conservancy

Current status and future management

by Randall Milne and John Sawyer

Published by:
Department of Conservation
P.O. Box 5086
Wellington
NEW ZEALAND

Prepared by:
Randall Milne & John Sawyer
Department of Conservation
Wellington Conservancy
P.O. Box 5086
Wellington
Tel: 04 472 5821

ISBN: 0-478-22337-4

Cover photo: *Austrofestuca littoralis* near the Pencarrow lakes, Wellington.
Photo by Mike Orchard.

CONTENTS

FIGURES

Executive summary

The status of coastal foredune vegetation in Wellington Conservancy is described in this report. A diversity of plant communities exists in dune ecosystems in Wellington Conservancy, such as inland dune communities at Lake Wairarapa, forested dunes at Pakipaki on the Foxton coast, dune lakes such as Lake Papaitonga and Lake Horowhenua, and ephemerally wet dune slacks throughout.

This report focuses on coastal foredune vegetation which is here defined as any area of coastal sand and gravel substrates that supports at least one of five selected indigenous coastal plant species. Those five species are *Austrofestuca littoralis* (sand tussock), *Desmoschoenus spiralis* (pingao), *Spinifex sericeus* (spinifex or silvery sand grass), *Coprosma acerosa* (sand coprosma), and *Pimelea* aff. *arenaria* (sand daphne) and were chosen as representatives of coastal foredune vegetation for the purpose of this report. Information about the distribution and ecology of those species is presented, and options for conservation management of coastal dune vegetation are outlined.

The Department of Conservation's goal for conservation of coastal foredune vegetation (and its associated fauna) in Wellington Conservancy is to ensure its continued protection and survival throughout its range, and to restore key sites. Coastal foredune vegetation was identified by the Department of Conservation in its Conservation Management Strategy for Wellington Conservancy (1996) as among the most threatened ecosystems and least well represented on lands administered by the Department.

Coastal foredune vegetation occurs discontinuously around the coast of Wellington Conservancy. Its distribution has contracted during the past 100 years and the area that supports pristine undisturbed foredune vegetation has been much reduced. Factors contributing to that decline include: physical damage by stock grazing and the effects of other pest animals (such as rabbits and hares); modification of dunes by planted exotic species (such as marram grass) and use of motor vehicles; and urban development of coastal areas. Establishment of pest plant species in coastal dunes has also changed the structure and composition of their plant communities.

Work currently underway in Wellington Conservancy to protect and restore coastal foredune vegetation is described. Plant nurseries are also identified from which it is possible to purchase coastal dune plant species of local provenance. Occurrence records for the five foredune plant species are provided and species distribution maps have been prepared using that data[1]. That baseline information can now be used to monitor future changes in species distributions.

Recommendations for protection of coastal foredune vegetation include:

- Protect (legally and/or physically) sites supporting coastal foredune vegetation throughout its range.
- Develop a standard survey method for monitoring coastal foredune vegetation and implement regular inspections to determine the condition of coastal dunes and to identify threats to their survival.

[1] Wellington Conservancy includes Chatham Islands but information about the status of dunes in the Chathams has not been included in this report. Data about Chatham Island dune communities (specifically *Austrofestuca littoralis* and *Desmoschoenus spiralis*) is currently being reviewed for inclusion in a separate report.

- Undertake field surveys to determine whether coastal foredune vegetation (especially the five representative species) still exists where it has not been recorded for more than ten years.
- Record new occurrences of native coastal foredune plants using species record sheets.
- Develop and implement projects to restore native coastal foredune vegetation to sites where it was known to have occurred.
- Raise public awareness of the need to protect and restore native coastal foredune vegetation and its associated fauna.
- Where possible and appropriate, seek to involve the public in all aspects of conservation management of coastal foredune vegetation (such as recording species occurrences, monitoring, and protection and restoration work).

1. Introduction

The purpose of this report is to describe the status of coastal foreforedune vegetation of Wellington Conservancy. The location and extent of Wellington Conservancy is shown in Figure 1. This report also presents options for protection and future management of coastal foredune vegetation. It will be used to raise awareness of coastal foredune vegetation and enable people to gain a greater understanding of its ecology and distribution. This report will also be used to direct management efforts to protect key coastal foredune vegetation communities. The report is written for anyone involved in conservation management of coastal dunes in Wellington Conservancy.

1.1 GOAL FOR CONSERVATION OF COASTAL FOREDUNES

The Department of Conservation's goal for conservation of coastal foredune vegetation (and its associated fauna) in Wellington Conservancy is to ensure its continued protection and survival throughout its range, and to restore key sites. It is assumed that by implementing measures to conserve plant communities of coastal foredune vegetation this will also benefit the associated fauna.

Coastal foredune vegetation was identified by the Department of Conservation in its Conservation Management Strategy for Wellington Conservancy (DOC 1996) as one of the most threatened ecosystems and one of the least well represented in lands administered by the Department. Protection and restoration of coastal foredune vegetation is, therefore, a priority for the Department of Conservation. Tied in with this is the need for good long term monitoring of the changing condition of foredune systems in the region. For more information see *Monitoring terrestrial habitats in Wellington Conservancy: A strategy for 2003–2012* (Urlich, in press), in particular strategic themes regarding threatened plant communities and habitats sustaining threatened biota. Several of recommendations of this report relate to aspects of condition reporting and long term monitoring of coastal foredune vegetation (see Section 6).

1.2 OBJECTIVES OF THIS INVESTIGATION

There are several objectives to achieve the above goal:

- To identify key sites for coastal foredune protection and restoration.
- To propose recommendations for protection and/or enhancement of coastal foredune vegetation.
- To map the range of five coastal native plant species chosen as representative of foredune vegetation and to describe their habitat and associated plant and animal communities.
- To determine the extent to which those species occur in protected natural areas.

Figure 1. Location and extent of Wellington Conservancy in the lower North Island, New Zealand.

1.3 CLASSIFICATION OF DUNE VEGETATION COMMUNITIES

A diversity of plant communities exists in dune ecosystems in Wellington Conservancy. Inland dune communities occur at Lake Wairarapa that were probably formed by northwesterly winds lifting fine sediments from lake shore turf areas (exposed when lake water levels are low) and deposition to the east. There are also forested dunes at Pakipaki on the Foxton coast (Ogle 1996) and at Turf Farm, Fisherman's Table and Tini Bush (Ravine 1992). There are dune lakes such as Lake Huritini, Lake Papaitonga and Lake Horowhenua, and areas of swamp on dunes such as Te Harakiki Swamp (Ravine 1992). There are also areas of ephemerally wet dune slacks throughout Wellington Conservancy. However, there is no nationally accepted classification of dune vegetation communities in New Zealand.

This report focuses on coastal foredune vegetation that is situated on the drier raised coastal sand and gravel substrates that support certain native species. It is dominated by low growing grasses, sedges and is seaward of the coastal forest zone. The vegetation structural classes into which this plant community falls include: grassland, sedgeland and sandfield (Atkinson 1985). It is similar to the dune community described by Newsome (1987) which is dominated by herbaceous plants and low shrubs occurring on recent dune sands.

1.4 COASTAL DUNES

Dunes form in coastal areas where: there is shelter from strong waves; there is a supply of sand; there are onshore winds; and dune-binding plants are present (or at least capable of becoming established). Dunes can also form where the beach slope is such that it will absorb wave energy and so provide shelter for vegetation to colonise. Sand is washed onto the shoreline in areas sheltered from strong wave action. Sand is supplied from rivers and also transported along the beachfront by a process of long-shore drift. Sand may also be from re-worked material off the continental shelf as sea levels rose from 18,000 to 7,000 years ago (D. Bergin pers. comm.). Dry beach sand is moved inland by wind and stopped by dunes and dune-binding plants. Dunes form in a variety of situations such as the mouth of rivers and estuaries, at the base of coastal cliffs, in bays, or in the margins of continuous, gently sloping landforms (Partridge 1992).

The closest dune to the sea is called the foredune, and is divided into a front and a back face (see Fig. 2). The front face is usually the most dynamic part of any dune system, and it is here where most sand is trapped, and where sand-binding plants are most vigorous. The two main species of sand-binders native to New Zealand are the endemic sedge, *Desmoschoenus spiralis* (pingao), and the grass, *Spinifex sericeus* (spinifex). A common introduced sand-binding plant is marram grass (*Ammophila arenaria*).

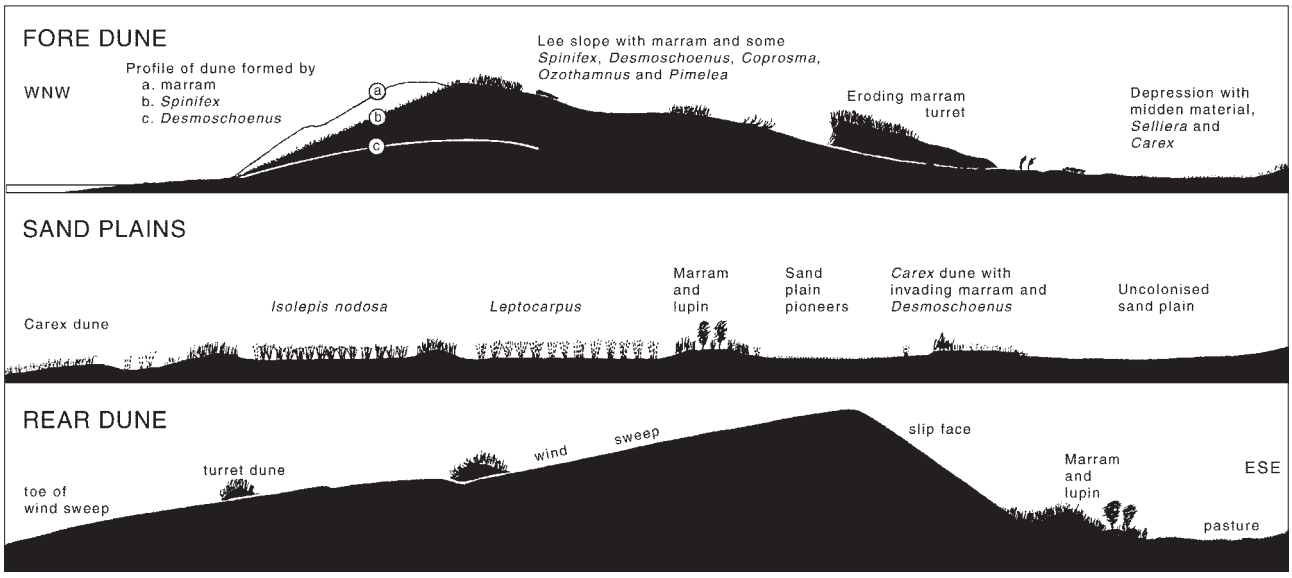

Figure 2. Generalised profile of foredune, sand plains and backdune showing topograph and distribution of plant communities (adapted with permission from Esler 1970).

Backdunes (behind the foredune) tend to be more stable. Plant species that act as sand stabilisers are found here, as well as on the back face of foredunes. Native species of sand stabilisers include; *Austrofestuca littoralis*, *Calystegia soldanella*, *Coprosma acerosa, Muehlenbeckia complexa*, and *Ozothamnus leptophyllus*. When backdunes become stabilised, they can be invaded by a variety of non-dune species (such as coastal matagouri, *Discaria toumatou*). Scrub and sometimes forest will develop in wet climates, while in dry climates sparse grassland often persists (Partridge 1992).

Between the foredune and backdunes, large unvegetated sand plains can result (see Fig. 2). Where the bases of dune hollows are close to the water table, dune slacks form, often with turf or wetland plants such as *Apodasmia similis, Phormium tenax* (flax), *Potentilla anserinoides* or *Selliera radicans*. If the water table is permanently above the sand surface, dune lakes result. In Wellington Conservancy dune lakes can be seen at Lake Papaitonga and Lake Horowhenua and at various other places in the Foxton dune country (see Ravine 1992). In drier situations, gravel spits, stone pavements or pebbly sand hollows support species such as *Pimelea* sp. and *Raoulia australis* (Partridge 1992). A preliminary list of indigenous plant species associated with coastal dune vegetation in Wellington Conservancy is provided in Appendix 1.

Dunes along the Horowhenua and Kapiti coast make up the longest stretch in Wellington Conservancy. Elsewhere dunes are generally less extensive and tend to be limited to the bases of coastal cliffs or terraces downwind from sand sources. For example, along the Wairarapa coast three situations are most common for dune systems:

- Areas where dunes occupy short segments of coastline (e.g. Pourere Stream)
- Narrow strips of dunes typically formed at the base of steep hills and cliffs (e.g. Te Humenga Point)
- Wider dune systems such as Uruti, eastern Wairarapa

Indigenous and exotic bird species found in association with dune communities in Wellington Conservancy are listed in Appendix 2. Lizard species found in coastal dune habitat include the common gecko (*Hoplodactylus maculatus*) and three species of skink: the common skink (*Oligosoma nigriplantare*); the spotted skink (*O. lineoocellatum*); and the copper skink (*Cyclodina aenea*). The red katipo spider (*Latrodectus katipo*) was once widespread in dune communities along the coastline of Wellington Conservancy. It is still found in some locations though there has been a large decrease in the spider's range and abundance (Patrick 2002). Coastal *Pimelea* spp. (such as *Pimelea urvilleana*) are host to endemic moth species of the genus *Notoreas* at several sites in the Conservancy (such as Pencarrow Lakes, Onoke Spit, and Castlepoint). New Zealand fur seals (*Arctocephalus forsteri*) are also known to haul-out to rest on coastal dunes in the Conservancy.

In this report, five native plant species have been chosen as representative of coastal foredune vegetation and are used to assess its condition throughout Wellington Conservancy. The five species: *Austrofestuca littoralis* (sand tussock), *Desmoschoenus spiralis* (pingao), *Spinifex sericeus* (spinifex), *Coprosma acerosa* (sand coprosma), and *Pimelea* aff. *arenaria* (sand daphne) occupy several niches within the drier raised foredune part of coastal plant communities. Pingao and spinifex are sand binders, sand tussock occurs on stabilised foredunes, and sand

coprosma and sand daphne occur on more stable dune sites such as the rear faces of foredunes and backdunes. These five species were chosen for several reasons:

- they are representative elements of coastal foredune vegetation in Wellington Conservancy
- since 1994, information has been compiled about their biogeography and ecology onto the Wellington Conservancy plant database
- they are a mix of common and rare species
- they are distinctive, easily recognisable in the field and lend themselves to monitoring by people without a high degree of botanical expertise

In addition, *Austrofestuca littoralis* and *Pimelea* aff. *arenaria* may be indicative of near pristine dune vegetation as they often disappear quickly following habitat disturbance. They may be used in the identification of coastal dunes worthy of, and a priority for, protection and conservation management.

There are many other native plant species that occur in coastal dune vegetation not used in this assessment. For example, *Carex pumila* may also be a good indicator of indigenous coastal dune vegetation as it is widespread throughout the region. Other woody shrub species such as *Coprosma repens* (taupata), *Discaria toumatou* (matagouri), and *Ozothamnus leptophyllus* (tauhinu) may also be used to indicate the condition of backdune vegetation or coastal shrubland that is further inland. Some coastal herbaceous plant species may be used to represent plant communities of ephemerally wet dune slacks. Future assessments of dune vegetation condition may be based on other species such as those in the preliminary list of native plant species associated with coastal dune vegetation in Wellington Conservancy (see Appendix 1). In addition, the distribution and abundance of key pest plant species of coastal dune vegetation (such as marram and boneseed) may also be used.

For more information about the form and function of coastal dunes, see Hesp (2000).

1.5 DESCRIPTION OF THE FIVE SPECIES

The five species, used in this report as representative of coastal foredune vegetation in Wellington Conservancy, are described below[2]. They are illustrated in Figure 3.

1. *Austrofestuca littoralis* (Labill.) – sand tussock, hinarepe

Has a stiff, erect habit, forming pale yellow-green or tawny tussocks up to 60 cm high. Leaves are 40–60 cm long, about 1 mm in diameter, and are strongly inrolled so they appear cylindrical. The tips are sharply pointed. Flowering stems 45–90 cm long, have a narrow, dense flower panicle at the top. Known habitat is coastal foredunes, and sandy or rocky places near the shore. This species occupies habitats that are slightly different from the other species in that it favours flat, stable surfaces and generally does not trap sand.

[2] Reference material used for species' descriptions include; Moore & Adams (1963), Herbert & Oliphant (1991), Smith-Dodsworth (1991), Wilson & Galloway (1993), Crowe (1995), Bergin & Herbert (1998), and Metcalfe (1998).

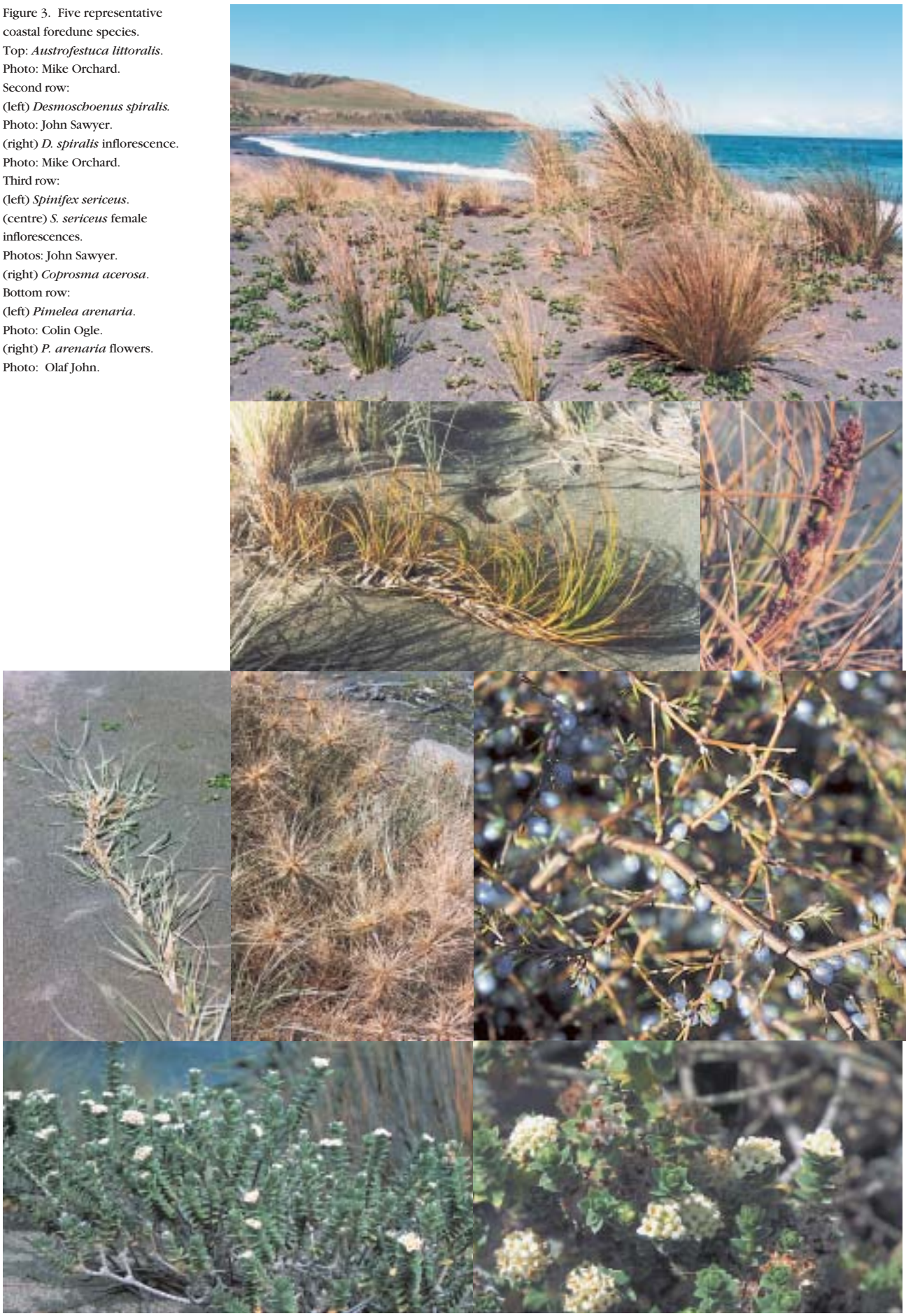

Figure 3. Five representative coastal foredune species.
Top: *Austrofestuca littoralis*.
Photo: Mike Orchard.
Second row:
(left) *Desmoschoenus spiralis*.
Photo: John Sawyer.
(right) *D. spiralis* inflorescence.
Photo: Mike Orchard.
Third row:
(left) *Spinifex sericeus*.
(centre) *S. sericeus* female inflorescences.
Photos: John Sawyer.
(right) *Coprosma acerosa*.
Bottom row:
(left) *Pimelea arenaria*.
Photo: Colin Ogle.
(right) *P. arenaria* flowers.
Photo: Olaf John.

2. *Desmoschoenus spiralis* (A. Rich., Hook. f.) – pingao, golden sand sedge

A stout, rigid sedge 60–90 cm tall. Has tufted, coarse, grass-like leaves that are narrow but thick. Leaves are generally yellow-green to golden in colour with the upper or inward-facing surface channelled, and the under or outward-facing surface keeled. The leaves are borne on long, thick, rope-like rhizomes that run out across the sand surface before becoming buried by drifting sand. Flower stem is up to 90 cm tall bearing a dark reddish-brown flower head 7–20 cm long produced in spring. Seeds are arranged in c. 12 small dark brown clusters, arranged in a spiral up the stem and are shed in summer. Pingao grows mostly on the front face of active foredunes but also on the rear face and backdunes provided that there is wind-blown sand. It can also grow on the top of sand hills. This species (along with spinifex) favours sloping and more or less unstable surfaces and is effective at trapping sand. The dried leaf of pingao has a beautiful golden colour and is often used by Maori to highlight patterns in woven articles and decorative panels. Pingao is a taonga of great cultural importance to Maori.

3. *Spinifex sericeus* (R. Br.) – spinifex, silvery sand grass, kowhangatara

Leaves are 30–60 cm long, stiff, and densely covered with silky hairs that give the plant a silvery sheen. The margins can be strongly inrolled. Creeping stems are smooth and yellow. Male flower spikes are numerous, 5–10 cm long, arranged in a terminal umbel; female heads are large and globose, 15–30 cm in diameter, with numerous radiating spines. Most spinifex populations consist almost exclusively of plants of one sex. Seeds are produced on female plants and occur in the centre of the globose heads and are released in late summer. Spinifex often occurs on the front face of active foredunes but can also be found on the back. Like pingao, it favours sloping, more or less unstable, surfaces and traps sand effectively.

4. *Coprosma acerosa* (Cunn.) – sand coprosma

Low-growing shrub forming patches up to 2 m across with interlacing springy branchlets that are orange-brown, and downy when young. Leaves often occur in clusters and are opposite, brown or yellowish–brown in colour. They are hairless, narrow and blunt at the tip. The stipules are short and blunt, rounded to triangular, more or less downy and fringed with hairs, with one or more tiny dark denticles. Male flowers are small and tubular with prominent anthers. Female plants produce small greenish flowers with prominent styles from October to November, followed by white and pale blue drupes, often with darker blue flecks. Fruits are 5–7 mm long, oblong or egg-shaped, occurring from February to March. Sand coprosma grows mostly on the landward side of coastal foredunes, cliffs, lowland and montane riverbeds, and terraces on stony ground. In Wellington Conservancy it has also been recorded on the seaward side of foredunes. It is often found in back dune hollows and blowouts. It has the ability to trap sand but not to the same extent as pingao and spinifex.

5. *Pimelea* aff. *arenaria* (A. Cunn.) – sand daphne, pinatoro

A low-growing shrub (<30 cm) with spreading branches often half covered in sand. Compact, leafy branchlets are more or less erect, with the under-surface densely hairy. The leaves are arranged in four rows at right angles to each other. Flowers are arranged in clusters at the end of branchlets, are present from September to March. Fruits occur from October to April and are about 3 mm long. Grows on the landward side of foredunes. In Wellington Conservancy it is also found in back hollows and blowouts and, like sand coprosma, has the ability to trap sand but not as effectively as pingao and spinifex.

1.6 CONSERVATION STATUS OF COASTAL FOREDUNE VEGETATION

Coastal foredunes were identified as threatened in the Wellington Conservancy Conservation Management Strategy (Department of Conservation 1996). They are poorly represented in areas administered by the Department of Conservation and in other protected natural areas. Plant communities of foredunes are, therefore, high priorities for protection and restoration.

People have modified a large part of New Zealand's coastline. Maori occupied some coastal areas and at those places crops were cultivated, seafood was collected and berries of some coastal species (such as *Coprosma acerosa*) were harvested. The impact on coastal foredune plant communities of such occupation is unknown.

Human impacts since European colonisation of New Zealand have also modified coastal foredunes. Residential developments, recreational activities, farming, roading, quarrying, fire, pest animals and forestry have all affected communities of coastal foredune species. Urban development has encroached on many areas, and off-road vehicles have destroyed and eroded many sites. Extensive planting of exotic species such as marram, lupin and pine have also reduced areas of native vegetation on coastal foredunes. Moreover, the relatively open growth form of native foredune vegetation has meant that many exotic plants have been able to colonise foredune communities. Appendix 3 is a preliminary list of adventive plant species, associated with coastal dune communities in Wellington Conservancy, that may become pests. Grazing and disturbance by stock, rabbits and hares in many areas has also decreased the extent of indigenous coastal foredune communities and abundance of native foredune species.

In urban areas, construction of sea walls has changed the dynamics of wave energy and the sand-blow processes have been altered. Sea walls reflect wave energy unlike sand dunes that absorb it. Erosion of beaches by back-scouring then occurs as the waves hit the wall and bounce off, and replenishment of the dunes with sand does not occur. Large lengths of the Kapiti/Horowhenua coastline have been developed for residential properties, farming, and forestry resulting in removal of much native dune vegetation. Removing vegetation from foredunes can make them unstable and susceptible to erosion during storm conditions. Previous dune-stabilisation work has involved planting marram grass (*Ammophila arenaria*) which creates steeper dunes that are more susceptible to blow-outs (Esler 1969). Vehicles used to launch boats have also damaged dune vegetation in some areas (Dix *et al*. 1990) and recreational use of vehicles (especially trail bikes) in dunes has had a considerable impact on vegetation condition.

In Wellington Conservancy, native vegetation on coastal foredunes has undergone a large contraction in its distribution. There are now areas where native vegetation occurred previously but is no longer found. Some species of coastal foredune vegetation (such as *Atriplex cinerea*) are now thought to be extinct in the Conservancy (Sawyer *et al.* 1998).

The conservation status of the five native plant species and the priority accorded them for management is shown in Table 1. The species have been assigned various priorities for conservation work in Wellington Conservancy because of their regional status (Empson & Sawyer 1996).

TABLE 1. CONSERVATION PRIORITY AND STATUS OF FIVE COASTAL FOREDUNE PLANT SPECIES

SPECIES	CONSERVANCY PRIORITY	STATUS
Austrofestuca littoralis	Medium	Gradual decline
Coprosma acerosa	High	No rank
Desmoschoenus spiralis	High	Gradual decline
Pimelea aff. *arenaria*	Medium-High	Serious decline
Spinifex sericeus	No rank	No rank

"National Status" taken from DOC (2002) and "Conservancy Priority" taken from Empson & Sawyer (1996). See those documents for explanation of terms.

1.6.1 *Ex-situ* status of coastal foredune vegetation

Several organisations have propagated and/or planted coastal dune species of local provenance:

- At Otari–Wilton's Bush, three species have been propagated and grown in the gardens there; *Austrofestuca littoralis* (sourced from Tongue Point, South Wellington Coast), *Coprosma acerosa* (from Red Rocks, South Wellington Coast and Flat Point, Eastern Wairarapa), and *Desmoschoenus spiralis* (from Owhiro Bay, South Wellington Coast and Petone, Wellington Harbour).
- Victoria University has planted *Desmoschoenus spiralis* and *Pimelea* aff. *arenaria* in gardens at the old Government Buildings. Other gardens on the campus also contain pingao and *Coprosma acerosa* (sourced from Red Rocks, Wellington South Coast and Castlepoint, Eastern Wairarapa).

Hutt City Council have planted *Coprosma acerosa* in their coastal gardens in Petone and Eastbourne, and *Pimelea* aff. *arenaria* in Petone. *Desmoschoenus spiralis* has been planted at sites along the Petone foreshore and public gardens in Eastbourne. Pingao has also been used as part of a revegetation programme at Lions Park, Petone, where c. 800 plants were planted and fenced. A new beach was created at Seaview Marina in the early 1990s and planted with pingao. Although no plantings of *Spinifex sericeus* were undertaken, natural regeneration is occurring within the fenced area at Lions Park, and a new population has established at Seaview Marina (A. Sanson pers. comm.). This demonstrates that it is not always necessary to introduce dune species if the conditions are right for them to do it themselves. Pingao has established in steeper areas at Seaview, while spinifex has

established on less steep areas (T. Silbery pers. comm. 1999). Pingao, *Austrofestuca littoralis* and *Coprosma acerosa* have been propagated from material of local provenance at Percy Scenic Reserve. *Coprosma acerosa* (sourced from Castlepoint, Eastern Wairarapa) is also grown in the garden of the Department of Conservation Area office at South Road, Masterton.

Plant nurseries that grow the five native coastal plant species of local Wellington provenance are shown in Table 2. Names and addresses of plant nurseries that grow and can supply coastal dune species are listed in Appendix 5.

1.6.2 Current projects for the protection and recovery of coastal dune vegetation

The following is a preliminary list of conservation projects for coastal foredune vegetation. This list is intended to give an idea about the type of work already being done in coastal dunes in Wellington Conservancy. Other projects may be underway or being developed.

1. Wellington City Council – Lyall Bay beach

Since 1990, a foredune restoration project has been under way at Lyall Bay beach. An area of foredune at the eastern end of Lyall Bay has been fenced off and boardwalks constructed through the foredunes. Planting of c. 2000 pingao per annum was undertaken. Plants were originally sourced from the west end of Lyall Bay and from Island Bay. Additional stock was provided by collecting seed from these plantings and propagated on for planting. After four years, the plants were well established, and a large foredune had formed. The seaward advance of pingao formed a new foredune and resulted in a hollow forming between this and the old foredune. In 1995, this hollow was planted with *Coprosma acerosa*. The project was extended to include areas at the western end of Lyall Bay where fencing was erected and irrigation installed. *Carex pumila* and *Calystegia soldanella* were planted in these areas. Mature pingao plants were also transplanted to this site from a nearby residence (Bedard 1996, D. Thompson pers. comm. 1999).

TABLE 2. PLANT NURSERIES PROPAGATING COASTAL DUNE SPECIES OF LOCAL PROVENANCE AND AVAILABLE FOR SALE

NURSERY[1]	SPECIES GROWN	PROVENANCE
Berhampore Nursery	*Coprosma acerosa*	Red Rocks
	Desmoschoenus spiralis	Houghton Bay, Windy Point
	Spinifex sericeus	Houghton Bay
Plantwise	*Coprosma acerosa*	Wairarapa, Red Rocks
	Desmoschoenus spiralis	Eastbourne
Terra Firma Ltd,	*Coprosma acerosa*	Wellington region
Taupo Native Plant Nursery	*Desmoschoenus spiralis*	Wellington region
	Spinifex sericeus	Wellington region

[1] *Contact details are provided in Appendix 5.*

2. Wellington City Council – South Coast Enhancement

An area from Breaker Bay to Moa Point has been targeted for enhancement by WCC. Work done here includes; formalising accessways to prevent pedestrian and vehicular traffic damaging vegetation, plantings of pingao and spinifex, and interpretation boards providing information on the Wellington South Coast. Other species of coastal plants have also been planted (D. Thompson pers. comm.)

3. The Shorland Park and Foreshore Community Taskforce, Wellington City

In 1995, 455 indigenous coastal plants (including pingao) were planted at Shorland Park in Island Bay. This work was in conjunction with Wellington City Council. Although there is a road at present separating the park from the beach, the long-term goal is to remove the road (Bedard 1996, D. Thompson pers. comm.)

4. Riversdale Dune Management Group, Eastern Wairarapa

Masterton District Council initiated restoration of dunes at Riversdale Beach after storm damage approximately 5 years ago. That involved planting pines for stabilisation, then shifting sand to contour a low-sloping dune. In conjunction with Riversdale Dune Management Group, pingao was planted. The trial plantings of pingao were successful although there was an initial problem with rabbits browsing the young plants. Areas of the dunes have been fenced off to stop vehicles damaging the dunes and to prevent dogs from wandering through them. A meeting of the dune management committee took place in April 1999 to discuss upcoming work, and talks are under way with Wellington Regional Council for a more active role in managing the dunes (S. Dahlberg, T. Taylor pers. comm.)

5. Castlepoint Scenic Reserve, Eastern Wairarapa

The Department of Conservation Wairarapa Area has been working with Makoura College to enhance the foredune vegetation at Castlepoint Scenic Reserve. Over 200 *Coprosma acerosa* were grown and planted in the dunes in 1996–1997 (G. Foster pers. comm.). Currently, pingao and spinifex are being grown to be planted at Castlepoint.

6. Pahaoa Station, Eastern Wairarapa

The Department of Conservation Wairarapa Area, working with neighbouring landowners (the Cameron family), fenced an area of pingao on lands administered by the Department in 1998. The area measures approximately 1200 m × 50 m (G. Foster pers. comm.).

7. Otakaha, Cape Palliser

In 1998, the Department of Conservation Wairarapa Area fenced an area of private land (owner Simon Crawford) comprising approximately 2.6 ha of foredune vegetation supporting pingao (Q. Hansen and G. Foster pers. comm.).

8. horizons.mw and Universal College of Learning (UCoL) – Spinifex trial

Horizons.mw (ex Manawatu-Wanganui Regional Council) have collected spinifex seed from Hokio Beach. The seed was mechanically separated at Seedtech (Massey University) and propagated at the Levin campus of UCoL (ex Manawatu Polytechnic). It was planted at Himatangi Beach in the spring of 1999. Although the

trial occurs outside Wellington Conservancy, the long-term goal is to replace marram with spinifex of local provenance at a number of locations including sites within the Conservancy. By planting spinifex between marram and fertilising, the goal is for marram to eventually disappear from these areas (D. Blakiston, J. Cudby, D. Havell, A. Madden pers. comm.). This trial was unsuccessful, because marram planted two years earlier proved too vigorous and out-competed the spinifex.

9. UCoL – Dune restoration south of Waikawa beach

Three to four years ago, pingao was planted out amongst driftwood on dunes south of Waikawa beach. Some plants were sprayed with a rabbit deterrent at the time of planting to deter browsing. Plants that were not sprayed were subsequently browsed. Planting amongst driftwood, as opposed to straight onto the dune, resulted in a good survival rate (D. Havell pers. comm.)

10. Makara Foreshore Reserve

This circa 40 m × 70 m site was still under dunes until the Home Guard bulldozed them in the early 1940s "to prevent the Japanese from concealing themselves there after landing" (pers. comm. from a local Makara resident who remembers the dunes). Car parks have reduced the area from its orginal size, and baches were built on parts of it in the 1970s. The remaining area is partly compacted pebbles and the rest is sand of varying depth. About one-third is covered in marram but there area extensive areas of *Spinifex sericeus*, remnant *Desmoschoenus spiralis*, two *Austrofestuca littoralis* tussocks, a few tiny patches of the locally very rare *Crassula mataikona* (see Mitcalfe & Horne 2001). More than 100 "*Raoulia* Makara" mats cover about 50% of the compacted area and e.g. *Calystegia soldanella*, *Disphyma australe*, *Colobanthus muelleri* and *Senecio lautus* are also present. For decades the reserve was overrun with weeds but the Wellington City Council have now engaged contractors to keep it clear of the main threats and an interpretation panel has been erected.

11. Horowhenua District Council, UCoL, horizons.mw and Waikawa Beach Ratepayers Association

In winter 2000, pingao and spinifex were planted seaward of the existing marram foredune in an attempt to build a new foredune at Waikawa Beach. It is hoped the new foredune will catch much of the sand blowing into the Waikawa Stream and slow the rate at which it is cutting south. A total of 7500 seedlings were planted but rabbit browsing and significant sand movement have token their toll on the pingao and, to a lesser extent, the spinifex. A rabbit deterrent spray is needed to allow pingao to establish on this site.

12. Coastal Dune Vegetation Network, Earnslaw One, AgResearch and horizons.mw

This project at Santoft Beach is part of a series of trials on difficult sites to test techniques that could be useful where past revegetation projects have had a low success rate. It is outside the Wellington Conservancy but the successful techniques likely to be applied to revegetation projects here. One of the aims is to determine if it is cost-effective to plant spinifex with marram on recontoured foredunes. The planting occurred in June 1999 and the spinifex has established well with stolon growth up to 3 m long within 18 months.

13. Matakitaki-A-Kupe Iwi

This project was initiated by the local iwi and involves fencing to exclude stock from the coastal platform between Cape Palliser and Waitetuna Stream (Ngapotiki Station Boundary). This project was jointly funded by iwi, Wellington Regional Council and the QEII National Trust. Most of this area is already under a QEII Open Space Covenant.

2. Methods and results

The Department of Conservation established a database for Wellington Conservancy in 1993, on which information is stored about the distribution of more than 400 indigenous plant species in the lower North Island. The database was established to assist the Department with implementation of a regional plant conservation strategy (Empson & Sawyer 1996). Information about many species that occur in coastal dunes is included on the database. Information was obtained from:

- Herbaria at Auckland (AK[3]), Wellington (WELT), Victoria University of Wellington (WELTU), New Zealand Forest Research Institute (NZFRI) and Lincoln (CHR)
- Plant checklists (see Sawyer 2001)
- Completed species record sheets (Appendix 7) for occurrences of coastal species
- Coastal Resource Inventory (Dix et al. 1990)
- Sand dune and beach vegetation inventory (Partridge 1992)
- Reports and publications e.g. *Wellington Botanical Society Bulletin*
- Other databases holding distribution information about coastal sand dune vegetation (e.g. see Hilton et al. 2000)
- Inventories of reserves and wildlife sites in Wellington Conservancy (Stephenson 1977, Parrish 1984, Wassilieff et al. 1986)

Information about the distribution of *Austrofestuca littoralis*, *Desmoschoenus spiralis*, *Spinifex sericeus, Coprosma acerosa*, and *Pimelea arenaria* in Wellington Conservancy has been collated into that database (Appendix 6). Some records are repeat occurrences for the same site so the number of sites where the species has been recorded is less than the number of records. Maps were prepared of the distribution of the five species (Figures 4–8). A regional network of individuals and agencies involved in conservation management of coastal dune vegetation was identified (see Appendix 4).

[3] Herbarium acronyms follow those recommended by Holmgren *et* al. 1990.

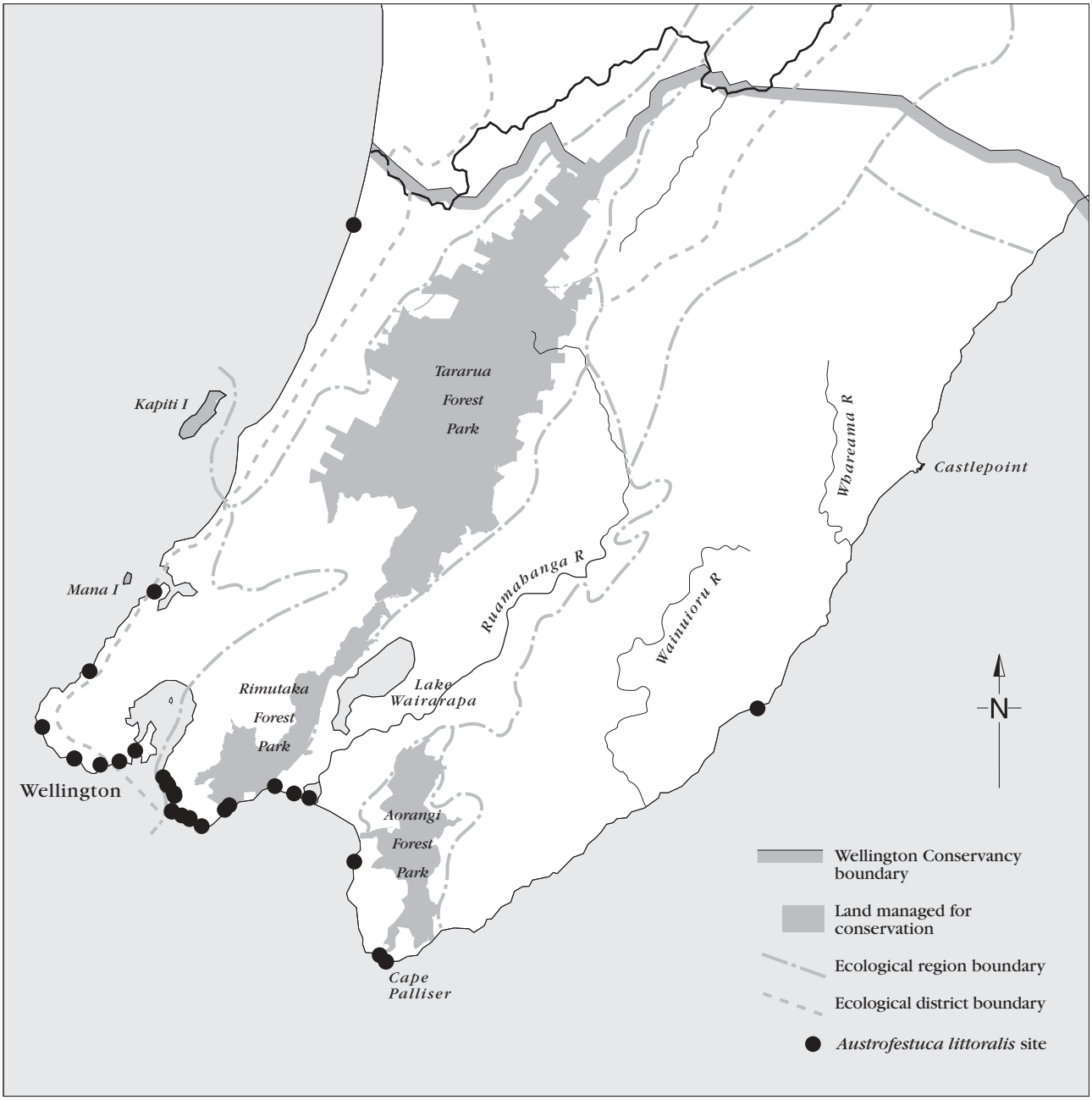

Figure 4. Distribution of *Austrofestuca littoralis*.

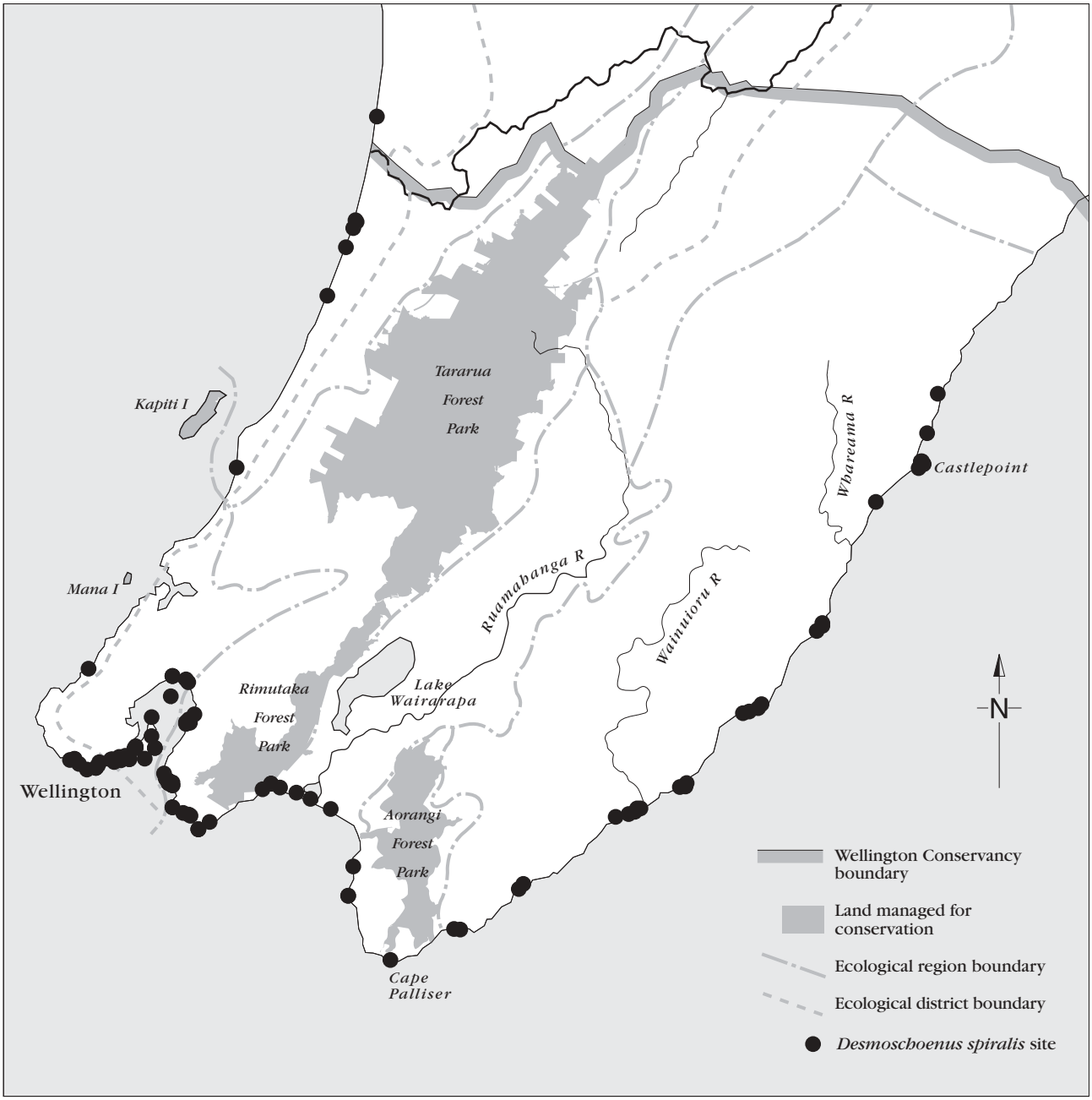

Figure 5. Distribution of *Desmoschoenus spiralis*.

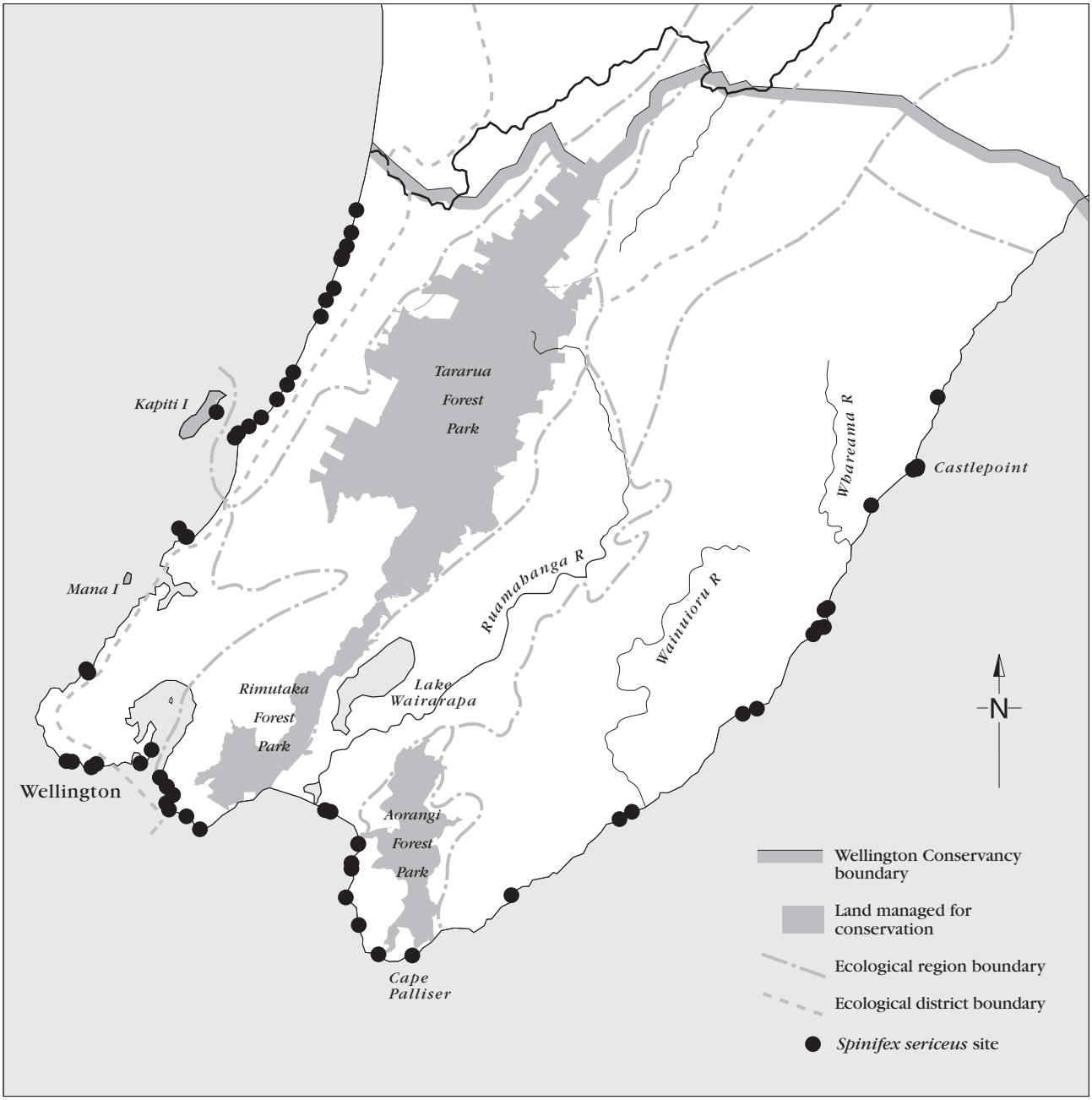

Figure 6. Distribution of *Spinifex sericeus*.

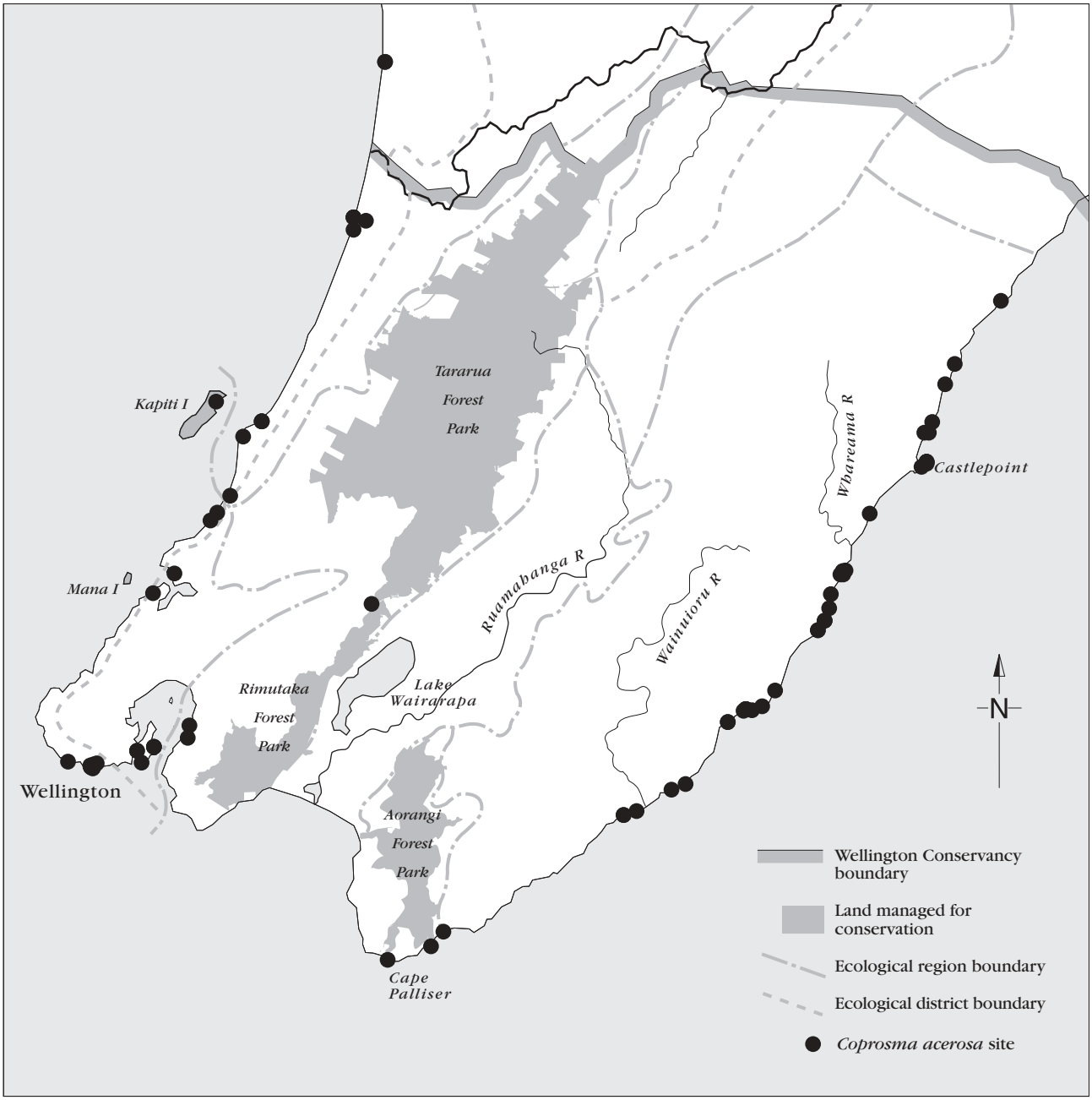

Figure 7. Distribution of *Coprosma acerosa*.

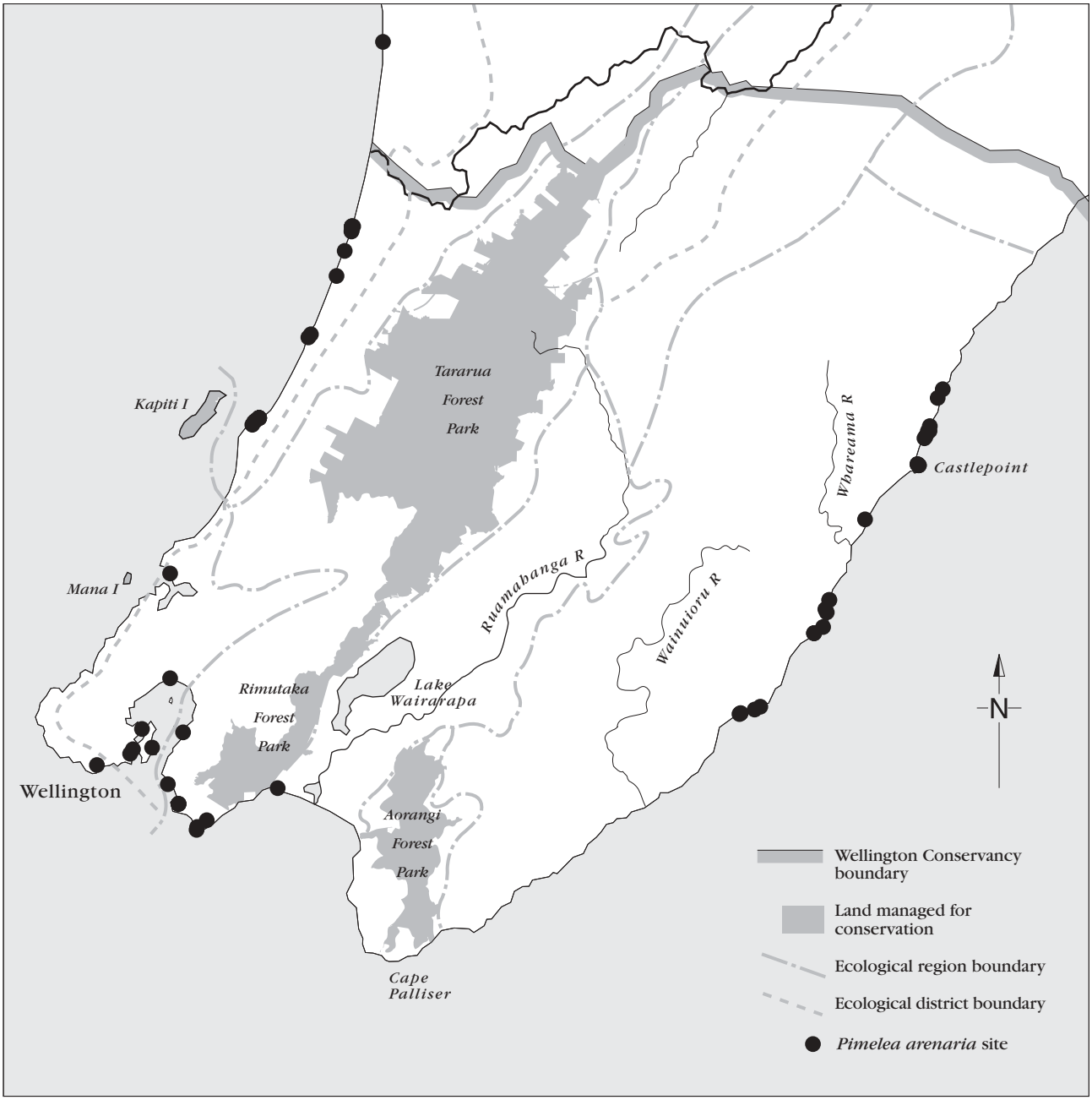

Figure 8. Distribution of *Pimelea* aff. *arenaria*.

3. Discussion

The distribution maps for the five plant species (Figures 4–8) are not definitive and can be improved. They indicate the occurrence of coastal foredune vegetation in Wellington Conservancy, which allows the species' ranges to be appreciated. Records for some species in some areas of the Conservancy are lacking, perhaps where surveys have not been done. Also some potential sources of biogeographical information have not yet been included in the plant database. Species may, therefore, be more widely distributed than is depicted, or may have declined since records began, so their current range may be smaller than is depicted. A systematic survey for all five species in all coastal foredunes in Wellington Conservancy will improve our knowledge of their distribution and abundance. Occurrence records for any foredune species may be sent to the Wellington Conservancy office of the Department of Conservation (see Appendix 7).

Records show that all five species have been observed in Wellington Conservancy at Flat Point in the Eastern Wairarapa and at Hokio Beach Dunes. Four of the species have been recorded at Uruti Point in Eastern Wairarapa (*Austrofestuca littoralis* was not recorded). Three species (*Austrofestuca littoralis*, *Desmoschoenus spiralis* and *Spinifex sericeus*) have been recorded in the coastal area from Pencarrow Head to Baring Head, east of Wellington. None of the sites are on lands administered by the Department of Conservation or are legally protected by other means.

Table 3 summarises database records for the five species in each ecological district in which they have been recorded. It shows that the five foredune species are poorly represented throughout their ranges on lands administered by the Department of Conservation. For example, in Foxton and Wellington Ecological Districts four of the species do not occur on lands administered by the Department. In addition, *Austrofestuca littoralis* and *Pimelea arenaria* do not occur on lands administered by the Department in four Ecological Districts. However, they may be protected on lands administered by other agencies (such as local authorities) or on lands that have been privately covenanted by other agencies such as the QEII National Trust.

Baseline data of the ranges of foredune plant species may be used as the basis for an up-to-date survey of all coastal foredune vegetation in Wellington Conservancy. Such a survey may then be repeated regularly as part of a long-term monitoring programme.

TABLE 3. NUMBER OF RECORDS OF COASTAL FOREDUNE PLANT SPECIES BY ECOLOGICAL DISTRICT IN WHICH THEY HAVE BEEN FOUND. NUMBER OF OCCURRENCES ON LANDS ADMINISTERED BY THE DEPARTMENT OF CONSERVATION, AND AGE OF THOSE RECORDS (PRE- OR POST-1988) ARE SHOWN IN BRACKETS

ECOLOGICAL DISTRICT[1]	*AUSTROFESTUCA LITTORALIS*	*COPROSMA ACEROSA*	*DESMOSCHOENUS SPIRALIS*	*PIMELEA ARENARIA*	*SPINIFEX SERICEUS*
Aorangi	6 (1–pre-1988)	4 (0)	5 (0)	No records	6 (0)
Cook Strait	2 (0)	11 (1–post-1988)	10 (possible 1–date unknown)[2]	3 (0)	16 (3–all pre-1988)[3]
Eastern Wairarapa	1 (0)	38 (7–1 post-1988)	26 (6–3 post-1988)	27 (6–2 post-1988)[4]	17 (4–2 post-1988)
Foxton	1 (0)	19 (0)	9 (0)	22 (0)	14 (1–post 1988)
Tararua	18 (1–post-1988)	8 (1–post-1988)	31 (1–pre-1988)	9 (0)	10 (1–post-1988)
Wairarapa Plains	3 (2–post-1988)	No records	4. (1–post-1988)	1 (0)	2 (1–post-1988)
Wellington	10 (0)	13 (0)	31 (0)	7 (0)	4 (1–pre-1988)

[1] *Chatham Ecological District will be included in a separate report.*

[2] *The site given is Makara Foreshore Reserve, but the NZMS 260 reference is approximate only.*

[3] *There are 4 other records (2 post-1988) that may occur on lands administered by the Department of Conservation, but the NZMS 260 reference is approximate only.*

[4] *Two records are given as Riversdale where there is a Department of Conservation reserve, but the NZMS 260 reference is approximate only.*

4. Protection and restoration of coastal foredune vegetation

4.1 PROTECTION OF COASTAL FOREDUNE VEGETATION

Conservation management of coastal foredunes may involve protection of ecosystems that support coastal foredune vegetation and their associated plant and animal communities. It may also involve protection of foredunes that formerly contained coastal foredune vegetation to which it can be restored, such as Makara Foreshore Reserve.

Protection to prevent damage to or loss of coastal foredune vegetation communities may be achieved by legal measures (such as covenants) and/or by physical intervention (such as fences and walkways, or wild animal control operations). Public awareness and community involvement programmes may also assist in protection of foredune areas.

4.1.1 Legal Protection

There are several mechanisms for achieving legal protection of coastal foredune vegetation. The following description of protection measures available to private landowners is taken from the brochure *Voluntary Protection of Nature on Private Property* (Department of Conservation, no date). That leaflet was prepared in collaboration with Local Government New Zealand, Nature Heritage Fund, Nga Whenua Rahui, Federated Farmers of New Zealand (Inc.) and the Queen Elizabeth the Second (QEII) National Trust.

1. Territorial Authorities

Sites of significant vegetation can be registered in schedules of district plans and accorded appropriate protection. Sites can be leased or purchased by the local authorities and financial incentives, such as rates relief, are sometimes available for voluntary protection measures. Some local authorities also have esplanade reserve requirements included in district plans for when coastal blocks are being developed. Under Section 221 of the Resource Management Act 1991 local authorities are allowed to place a "Consent Notice" on a land title to provide for continuing enforcement of a protection condition in a subdivision consent. While such a notice may provide a degree of formal protection for native plant and animal communities, covenant mechanisms provide greater certainty for protection and continuing management for protection.

2. Covenants

A covenant is a legal agreement that is registered against the title of the land. They are among the most common forms of land protection used by private landowners. Normally covenants are in perpetuity, but may also be for specific periods. Four main ways of covenanting are: conservation covenants with the Department of Conservation or other authorised bodies such as territorial local authorities; open space covenants with the QEII National Trust; nga whenua rahui kawenata between the Minister of Conservation and Maori landowners; heritage covenants with the

New Zealand Historic Places Trust. In rare cases, covenants are established by landowners themselves, without another party involved.

3. Protected private land agreements

These are actioned by the Department of Conservation to protect land under the Reserves Act, and are registered against the title of the property. They provide a similar level of protection as covenants.

4. Management Agreements

These are legal agreements between the Department of Conservation and landowners, to manage an area according to an agreed set of conservation objectives. They are not registered against the title.

4.1.2 Physical Protection

The chosen method of physical protection for coastal foredune vegetation will depend on what threats are identified for the site. Stock can be excluded (and therefore prevented from browsing or trampling native vegetation) by construction of fences. Fences can also be effective in preventing vehicles (such as 4WD vehicles or trail bikes) from causing damage to foredunes. However, fences in foredunes are difficult to maintain and can be shortlived in coastal environments. Protection of coastal dunes from browsing by rabbits and hares may require poisoning or shooting. Construction of boardwalks to define accessways through dune systems can reduce the impact on vegetation of large numbers of visitors to popular dunes (e.g. Lyall Bay, Wellington City). Mechanical, chemical or biological control of pest plant infestations in or near dune vegetation may also be required. Protection of coastal foredune vegetation from fire is important in fire-prone districts.

4.2 ECOLOGICAL RESTORATION OF COASTAL DUNE VEGETATION

Ecological restoration of coastal dune vegetation may involve the reinstatement of lost physical conditions, or lost plant and animal species. A general principle for ecological restoration is that a goal must be identified so that it is clear what is being aimed for. Threats to coastal foredune vegetation at a site must also be identified before commencing any restoration project so that actions may be taken to remove them.

Foredune protection measures and allowing for natural regeneration may be sufficient in some situations, although the natural replacement rate of dune vegetation can be slow. In some instances, a more active, interventionist approach may be more appropriate. Applying fertiliser to existing vegetation, or a planned replanting programme may be a faster, more effective way of restoring coastal dune vegetation to a particular site. However, fertilisers may also benefit pest plant species. Restoration may also require introduction of animals that would not arrive by themselves, or re-contouring of the dune profile.

Of paramount importance is the restoration of ecological processes rather than trying to restore “climax” vegetation into sites where pioneers are more suitable. Also, foredune plant species have different habitat requirements, so restoration

must take account of the need to match the right species with the right dune shape or habitat type. Restoration of coastal processes may involve changing or removing physical barriers to sand drift (such as groynes or sea walls); restoring sediment input to the coastal environment; and replacement of marram grass to allow for re-establishment of native species.

Other aspects of ecological restoration of coastal foredune vegetation are the need to monitor progress, to learn from any mistakes that are made and to learn how to do it better next time. Critical to the development and implementation of restoration projects is the need to involve people in all aspects of the project.

For more information about the rehabilitation of coastal foredunes in New Zealand using indigenous sand-binding species see Bergin & Kimberley (1999).

4.2.1 Propagation and establishment

Propagation and establishment of coastal foredune vegetation for restoration purposes have primarily focused on pingao, and spinifex to a lesser extent. Pingao is the easier to propagate, and several publications have reviewed the propagation of pingao for revegetation purposes (e.g. Walls 1990; Herbert & Bergin 1991; Herbert & Oliphant 1991; Bergin & Herbert 1998). Planting trials of pingao have shown that exposed unstable foredunes with no vegetative cover, or only a small amount, are more suitable than well-vegetated stable dunes (Herbert & Bergin 1991). Planting where there is driftwood cover has also been been successful (UCol trial). Planting of pingao in Petone several years ago resulted in less than 25% survival of plants where they were introduced to areas supporting marram. However, planting into open, drifting dune faces had more than 80% survival. Pingao is naturally a plant of open unstable dunes as it requires sand movement to grow well. The runners extend best when they are being covered by blown sand.

Propagating spinifex has been difficult with slow and poor germination rates occurring in the nursery and continued mortality of seedlings at most stages. Trials are continuing to determine the best sowing season, the feasibility of establishing plants from cuttings, and the effect of, and optimal time for, fertiliser applications (Bergin *et al*. 1997). At UCoL (Levin campus), germination trials have shown that by incorporating 50% dune sand into the seed sowing mix, and by delaying sowing the seed until spring, germination rates of 50–60% can be obtained (J. Cudby pers. comm.)

At Massey University, Ctech have experimented with mechanically removing spinifex seed from the seed head. By going through a 5-stage seed-cleaning process to obtain bare seed, they have obtained germination rates of 60–70%. A comparable germination trial with seed left in their hulls resulted in germination rates of only 1–2%. The seed-cleaning process does result in 3–4% loss of seeds because of mechanical damage. It is quicker than removing the seed by hand and has an estimated cost of $150 per 5500–6000 seeds, depending on the amount of seed contained in the seed heads (R. Southward pers. comm. 1999).

A summary of propagation techniques for the five species is shown in Table 4. Plant nurseries that are able to provide the five species sourced from Wellington Conservancy are shown in Table 2 and their contact details are provided in Appendix 5.

A series of technical bulletins providing relevant information for coastal managers has been developed by the Coastal Dune Vegetation Network (CDVN). Copies of these bulletins are available from Publications, Forest Research, Private Bag 3020, Rotorua.They are:

- "Pingao on Coastal Sand Dunes: Guidelines for seed collection, propagation and establishment", 1998, by D.O. Bergin and J.W. Herbert. *CDVN Technical Bulletin No. 1*.
- "Spinifex on Coastal Sand Dunes: Guidelines for Seed Collection, Propagation and Establishment", by David Bergin. *CDVN Technical Bulletin No. 2*.
- Sand Tussock on Coastal Sand Dunes: Guidelines for Seed Collection, Propagation and Establishment", by David Bergin. *CDVN Technical Bulletin No. 3*.
- "Coastal Sand Dunes: Form and Function", 2000-, by Patrick A. Hesp. *CDVN Technical Bulletin No. 4*.

4.2.2 Community involvement

Community groups are involved in some dune care and restoration projects in Wellington Conservancy (see Section 1.5.2.). A community will place a higher sense of value on the dune environment by being involved in its management. Communities will often identify personal gains from dune revegetation projects, such as protection from wind or sea erosion of their properties or valued recreational areas. Activities that threaten the vegetation, stability or natural processes are less likely to be tolerated as a result. Raising public awareness (especially of dune owners and those who use the dune environment) of the vulnerability of dunes to a range of threats may also help bring about protection of foredune vegetation. Awareness may be raised by media articles, newsletters, signs, interpretation material and by active involvement in dune conservation projects.

TABLE 4. PROPAGATION TECHNIQUES AND CULTIVATION REQUIREMENTS FOR FIVE NATIVE PLANT SPECIES OF COASTAL DUNE VEGETATION IN WELLINGTON CONSERVANCY

SPECIES	PROPAGATION TECHNIQUE	TIME TO COLLECT MATERIAL	CULTIVATION REQUIREMENTS	PLANTING OUT	REFERENCES
Austrofestuca littoralis	Seed	Late summer–autumn	Use fresh seed, sow in free-draining seed-raising mix (50:50 peat:sand), cover lightly with sieved river sand. Should germinate within 2 months. Grow on in open position where will not get water-logged.	Autumn–spring. Well-drained soil in open situation	Metcalfe 1998; A. Benbrook pers. comm. 1999; T. Silbery pers. comm. 1999.
	Division	Autumn (wait until flowering finished) or spring (before new growth appears).	Use vigorous pieces from outside of plant. Do not make divisions too small. Water regularly until established and new growth appears.		
Coprosma acerosa	Seed	Autumn	Clean seed to remove pulp. Store in fridge in sand for 4-5 months. Open bag weekly to aerate. Sow in 50:50 gravel:sand mix. 2–3 months for germination to occur.	Autumn–spring. Well-drained soil in open situation.	A. Benbrook pers. comm. 1999; T. Silbery pers. comm. 1999; R. Smith pers. comm. 1999.
	Half-ripe lateral cuttings (75–100 mm long) from male & female plants. Remove tip.	After flowering when wood has hardened.	Set in pumice:sand mix or fine pumice (3 mm). Two months to root, quicker with bottom heat and mist.		
Desmoschoenus spiralis	Seed	Early–mid Dec around Wellington (when seedfall begins, ripe seed is easily dislodged from seedhead). Collect seedheads, store in paper bag.	Sow seed with husks onto firm bed of seed-raising mix, cover with sieved potting mix (3–5 mm deep). Cover to provide humidity until germinated. Lightly water regularly.	Autumn–spring (avoid dry summer and winter storms). Well-drained soil in full sun.	Walls 1990; Herbert & Bergin 1991; Herbert & Oliphant 1991; Bergin & Herbert 1998; Metcalfe 1998; T. Silbery pers. comm. 1999.
Pimelea arenaria	Seed	Spring–autumn (when fruit is ripe).	Clean seed to remove pulp. Store in fridge for 4 months. Sow in 50:50 peat:sand mix. Takes 2 months to 1 year to germinate.	Autumn – spring	A. Benbrook pers. comm. 1999; T. Silbery pers. comm. 1999; R. Smith pers. comm. 1999.
	Cuttings–use firm growth	Early spring–late autumn	Strip lower leaves from stem carefully to avoid peeling bark. Set in pumice:sand mix with bottom heat and mist, low humidity.		
Spinifex sericeus	Seed	Late summer	Store in fridge until spring. Remove seed from chaff, sow in sand or 50:50 dune sand:seed raising mix to depth of 2.5 cm, place in dark.	Autumn or spring (avoid dry summer and winter storms). Well-drained soil in full sun.	Bergin & Shaw 1991; Metcalfe 1998; A. Benbrook pers. comm. 1999; D. Blackiston pers. comm. 1999.
	Runners–stem portion that has foliage or actively growing tip		Remove from parent, set into light potting mix or bed of sand under mist. Ready for planting in 15 months.		

5. Key sites for management of coastal foredune vegetation

Key sites for management of coastal foredune vegetation have been identified for each Ecological District in Wellington Conservancy (Figure 9). Key sites are:

- protected natural areas administered by the Department of Conservation that support coastal foredune vegetation;
- areas recommended for legal and/or physical protection because of their biological importance as examples of indigenous coastal foredune vegetation in Wellington Conservancy;
- areas recommended for ecological restoration work to re-establish a community of coastal foredune plant species and its associated fauna;

Figure 9. Key coastal dunes in Wellington Conservancy.

- areas where foredune protection or restoration projects already exist (where monitoring or follow-up protection or enhancement planting may be required).

A variety of sources of information has been used to identify key sites including:
- Protected Natural Areas Programme reports (e.g. Ravine 1992);
- Distribution maps of the five plant species (Figures 4 to 8);
- Ecological Sites database held at Wellington Conservancy;
- Coastal Resource Inventory (Dix et al. 1990); and
- North Island sand and beach inventory (Partridge 1992).

The Department of Conservation regards many areas that support dune vegetation as biologically important. For example, Pakipaki Dune forest, Waikawa Beach Road Forest, Lake Huritini and Te Harakiki Swamp were identified as Recommended Areas for Protection in the Foxton Ecological District Protected Natural Area's Programme report (Ravine 1992). However, those areas do not meet the definition of coastal foredune vegetation used in this report and are therefore excluded from the following list.

Some key sites by Ecological District are described below (see also Figure 9). This list is not definitive but provides an initial focus for habitat protection work. In due course other key sites may be identified where ecological restoration of dune plant communities can be done either to restore the geographical distribution of a particular species (e.g. *Pimelea* aff. *arenaria*) or a group of species. They may also provide increased opportunities for public involvement in dune conservation, especially at sites close to centres of human habitation (see also Section 1.6.2: Current projects).

Each of the key sites identified in this report will require a thorough inspection to determine threats to their continued survival and to identify practical management solutions. The discussion for each site includes some of the key conservation management activities required. A number of these sites are in private ownership and permission for access must be sought from the landowner.

FOXTON ECOLOGICAL DISTRICT

Key site: Hokio South Dune

Hokio South Dune covers an area of c. 200 ha and is 1.4 km long (Partridge 1992). All five representative plant species have been recorded from this area. Other species of foredune vegetation occur in the sand flats and backdunes. There is currently no legal or physical protection for the site. Marram, lupin and boxthorn are present, and some control work of those pest plant species may be necessary. There is an opportunity for public involvement at this site because of its proximity to settlements at Hokio and Levin. Nationally threatened plant species have been recorded from this area including *Libertia peregrinans*, *Mazus novaezelandiae* subsp. *impolitus* and *Ophioglossum petiolatum*. This area may also support *Selliera rotundifolia*—a recently described herb. This dune is privately owned and permission for access must be sought from the landowners.

COOK STRAIT ECOLOGICAL DISTRICT

Key site: Owhiro Bay to Karori Stream

Owhiro Bay to Karori Stream coastal scarp (300 ha.) is a mixture of private and public land, and reserve. It has only partial legal protection. All five species have been recorded at this site, but only sand tussock and pingao in the last 10 years. Banded dotterels are known to occur at this site. This is one of the only sites in the North Island where "Marlborough minimac" geckos occur. Common, brown and copper skinks and common geckos have also been recorded here (Miskelly 1995). A restoration project involving the public is recommended because of its proximity to Wellington City. Physical protection (involving fencing) may be necessary because of continual pressure from public use. The closure of the quarry presents opportunities for ecological restoration along the entire coast. Permission must be sought for access to privately owned areas.

AORANGI ECOLOGICAL DISTRICT

Key site: Te Humenga–Otakaha Stream

Pingao and spinifex dominate the foredunes and marram is absent. Native species occur in the sand plain and on backdunes (Partridge 1992). Therefore, this site provides an intact sequence of a dune vegetation community. Red katipo spiders (*Latrodectus katipo*) have been recorded from this site but only in small numbers (Patrick 2002). The site has no legal or physical protection. Restoration work may be necessary if the current instability of foredune is found to be human-induced. The rear dunes are also unstable. Physical protection of the site may also be necessary. Permission for access must be sought from the landowners.

WAIRARAPA PLAINS ECOLOGICAL DISTRICT

Key site: Ocean Beach

Ocean Beach is one of the few remaining sites where *Austrofestuca littoralis* has been recorded in Wairarapa in the last 10 years. Pingao and *Pimelea arenaria* have also been recorded here. Part of Ocean Beach is administered by the Department of Conservation and therefore has legal protection. It is also an important breeding site for banded dotterel and Caspian tern. An undescribed species of *Notoreas* moth has been recorded here. Red katipo spiders (*Latrodectus katipo*) have also been recorded from this site (Patrick 2002). It is recommended that the entire site be given legal protection. Revegetation maybe necessary to restore some of the native coastal plant species that have already been lost from the site (such as *Atriplex cinerea* and *Pimelea* aff. *arenaria*). Interpretation boards detailing the significance of the site may be erected. Vehicle users have damaged this coastal dune area and pest plants occur there and have the potential to spread. Physical protection of the area, by the construction of fences, would benefit the dune vegetation. Monitoring to determine if pest plants pose a threat to the coastal dune vegetation would also be useful.

Key site: Uruti Point

The Uruti Point dunefields form the largest area of dunes (c. 100 ha.) on the Wairarapa Coast and were classified as regionally important in the Coastal Resource Inventory (Dix *et al*. 1990). The dunes at Uruti Point have also been identified as recommended for protection in the draft Protected Natural Areas Programme report for the Eastern Wairarapa Ecological District. Of the five species investigated in this report, only *Austrofestuca littoralis* has not been reported from this site. Red katipo spiders (*Latrodectus katipo*) have been recorded from this site (Patrick 2002). Spotted skinks also occur here (Miskelly 1995). There is no legal or physical protection for the dunes. A road cuts through the dunes, and a strip above the high tide mark north of Uruti Point for the parking of fishing boats, has further damaged the dune system (Dix *et al*. 1990). Defining access-ways for vehicles through the dunes is recommended to prevent further damage. This site is privately owned and permission for access must be sought from the landowners.

Key site: Flat Point

The dunes at Flat Point are a significant area of biological importance. All five species have been recorded at this site. Spotted and common skinks occur at this site (Miskelly 1995). In terms of numbers of animals found, this is the most significant site for red katipo spiders (*Latrodectus katipo*) in the conservancy (Patrick 2002). The site has also been identified as a Recommended Area for Protection (RAP) in the draft Protected Natural Areas Programme report for the Eastern Wairarapa Ecological District. This site is also in private ownership and permission for access must be sought from the landowners.

Key site: Castlepoint Scenic Reserve

This is one of the few protected natural areas in Wellington Conservancy that supports coastal dune vegetation and is administered by the Department of Conservation. It is approximately 60 ha and is situated on the Wairarapa coast, 48 km east of Masterton. The reserve is dominated by a limestone landform known as "The Castle" (162 m), a linear reef and a promontory on which Castlepoint Lighthouse is situated. Those features protect a lagoon and the dune vegetation. *Pimelea arenaria*, *Desmoschoenus spiralis*, *Spinifex sericeus* and *Coprosma acerosa* all occur in the vegetation at this site. The rare Castlepoint groundsel (*Brachyglottis compacta*) is also endemic to this reserve. *Notoreas* "Castlepoint" is an undescribed species of moth species that has only been recorded from Castlepoint Scenic Reserve (Patrick & Dugdale 2000). Red katipo spiders (*Latrodectus katipo*) have also been recorded from this site (Patrick 2002). Common gecko also occur here with Wellington green gecko nearby (Miskelly 1995). Some pest plant control is necessary, such as control of Tasmanian ngaio (*Myoporum insulare*), buffalo grass, marram grass and tree lupin. Excessive pedestrian use and trail bike use has also affected some of the dune vegetation.

Key site: Pahaoa Scientific Reserve

This small reserve (7.5 ha) of coastal dune vegetation is administered by the Department of Conservation and supports *Desmoschoenus spiralis* (pingao). The reserve is situated at the mouth of the Pahaoa River on the Eastern Wairarapa coast. The area has been fenced to exclude stock. A complete assessment of threats to the dune vegetation at this site is required.

TARARUA ECOLOGICAL DISTRICT

Key site: Wainuiomata River–Turakirae Head

This area (150 ha) has partial legal protection and is a mixture of private and public land and reserve. Permission for access to privately owned areas must be sought from landowners. Four of the representative species (excluding *Coprosma acerosa*) have been recorded in the area. This site is also known to support banded dotterels. Spotted, common and copper skinks and common gecko also occur here (Miskelly 1995). Fencing remaining areas of dune vegetation may be necessary to prevent grazing by stock and damage by vehicles. Rabbits and hares are present but are thought to occur in low numbers (Dix *et al*. 1990) but an assessment will be necessary to determine if control is needed in order to protect the dune vegetation.

Key site: Lake Kohangapiripiri, Lake Kohangatera and coast to Baring Head

The dunes at the mouths of Gollans Stream and Cameron Creek and east to Baring Head are important for several reasons. Three of the representative species have been recorded there (*Desmoschoenus spiralis*, *Austrofestuca littoralis* and *Spinifex sericeus*). The coastal dunes also support a number of nationally and regionally threatened species such as *Muehlenbeckia ephedroides* and *Eryngium vesiculosum*. A variety of animals occur at this key site including banded dotterels, variable oystercatcher, and three moth species—*Notoreas* sp. unnamed, *Ericodesma aerodana* and *Agrotis innominata* (Patrick 1992). The foredune vegetation may require further protection from vehicles, stock and weeds. Interpretation signs describing the importance of the area may also be erected. The site is a mixture of private and public land. Permission from landowners must be sought for access to privately owned areas.

6. Recommendations for protection and recovery of coastal foredune vegetation

The following recommendations are priority actions for the protection and recovery of coastal dune vegetation in Wellington Conservancy:

- Legal and physical protection of key sites supporting coastal dune vegetation in all relevant Ecological Districts (especially sites identified as recommended for protection in Protected Natural Areas Programme reports);
- Identify and protect potential sources of seed (and other propagation material) for coastal dune species throughout their range.
- Visit sites to confirm continued existence of the coastal dune species throughout the ranges depicted in the distribution maps.
- Record occurrences of coastal dune species using standard species record sheets (see Appendix 7) and encourage other people to make known their observations of the plants. Records of the species should be passed onto Wellington Conservancy so they can be stored on the plant database.
- Develop a standard survey methodology for inspecting coastal dune vegetation communities (see Urlich in press).
- Survey to determine the condition of all coastal dune vegetation communities to determine their condition and distribution. Condition includes: presence or absence of the five representative plant species or other uncommon species and also their status (size of population, health and number of individual plants, existence and extent of threats to each population).
- Establish work programmes throughout the range of coastal dune vegetation in Wellington Conservancy that include:
    1. Protection of at least one key site in each Ecological District that supports a representative diversity of coastal dune plant and animal communities;
    2. Creation of at least one restoration project for coastal dune vegetation and its associated communities in each Ecological District that once supported coastal dune vegetation (where practicable). This includes enhancement planting at key sites where dune vegetation still occurs;
    3. Regular inspections to assess the condition of coastal dune vegetation at a site or series of sites throughout the Conservancy.
- Collect information about the structure and species composition of dune vegetation communities in order to characterise their associated plant and animal communities.
- Research to determine more accurately the former distribution of coastal dune vegetation, by locating more records of occurrences of the species.
- Research to determine the minimum area of protected dunes required to ensure conservation of coastal dune plant and animal communities.
- Raise public awareness of the importance of coastal dune vegetation protection and restoration.
- Work in collaboration with other agencies or individuals involved in conservation of coastal dune vegetation. Promote coastal dune vegetation protection and restoration in local authority District Plans. Encourage the use of plant species of local provenance in revegetation schemes of local authorities,

schools and other organisations involved in conservation of dune vegetation communities.

- Seek to involve the public, where possible and appropriate, in all aspects of conservation management of coastal dune vegetation (such as recording species occurrences, monitoring, and protection and restoration work at sites throughout the Conservancy in highly visible and accessible areas).

7. Acknowledgements

There are a great many people who have helped in the preparation of this report by providing material or information on species sites, existing projects, and/or propagation techniques. Those people include Anita Benbrook, David Bergin, David Blakiston, John Cudby, Sue Darlberg, Jo Fagan, David Hall, Philippa Hooper, Peter Hensley, Peter Kundycki, Aaron Madden, Mike Orchard, Grant Reburn, Athol Sanson, Tony Silbery, Robyn Smith, Robert Southward, Trish Taylor, and Derek Thompson.

We thank Colin Miskelly (DOC, Wellington) for providing information about fauna of coastal dune vegetation and for reviewing earlier drafts. We thank Jeremy Rolfe (DOC, Wellington) for design and production of this report and for comments on earlier drafts. Paul Hughes (DOC, Wellington) is thanked for preparing species distribution maps and for comments on earlier drafts. We also thank staff at Area Offices in Wellington Conservancy, Department of Conservation, especially Aalbert Rebergen, Dick Gill, Ian Cooksley, Tony Silbery, Garry Foster and Rob Stone. We also thank Colin Ogle, John Barkla, David Bergin, Barbara Mitcalfe and Chris Horne for reviewing this document and providing substantial comments that have been used to improve the report.

8. References

Anonymous. n.d. Vascular plant species list – Makara foreshore reserve. Unpublished plant checklist held by the Department of Conservation .

Atkinson, I. A. E. 1985: Derivation of vegetation mapping units for an ecological survey of Tongariro National Park, North Island, New Zealand. *New Zealand Journal of Botany*, 23: 361-378.

Bedard, A. 1996: (draft). Wellington Coast from Owhiro Bay to Oriental Bay: Enhancement and restoration guidelines. Unpublished report by Wellington City Council.

Bergin, D.O.; Kimberley, M.O. 1999: Rehabilitation of coastal foredunes in New Zealand using indigenous sand-binding species. *Science for Conservation 122*. Department of Conservation, Wellington.

Bergin, D. O.; Shaw, W. B. 1991: Propagation and establishment of *Spinifex sericeus* – A review. Forest Research Institute Contract Report: FWE 91/27. Department of Conservation.

Bergin, D. O.; Dahm, J.; Herbert, J. W.; Spence, H. 1997: Restoration of coastal sand dunes using indigenous species – integration of research, management and community. In: Smale, M. C.; Meurk, C. D. (comp.). Proceedings of a Workshop on Scientific Issues in Ecological Restoration. Christchurch. February 1995, 51 - 57. Landcare Research, Lincoln.

Bergin, D. O.; Herbert, J. W. 1994: Restoration of native plant communities on sand dunes. What's new in Forest Research No. 232. New Zealand Forest Research Institute, Rotorua.

Bergin, D. O.; Herbert, J. W. 1998: Pingao on coastal sand dunes: Guidelines for seed collection, propagation and establishment. Coastal Dune Vegetation Network Technical Bulletin No. 1.

Bergin, D.O.; Kimberley, M.O. 1999: Rehabilitation of coastal foredunes in New Zealand using indigenous sand-binding species. *Science for Conservation 122*. Department of Conservation, Wellington.

Brownsey, P. J. 1992: A terrestrial biological and ecological survey of Hue-Te Taka Peninsula, South-west Wellington Coast. Report prepared for Titchener, Monzingo, Aitken Ltd. Landscape Architects.

Buchanan J. 1872: List of plants found in Miramar Peninsula, Wellington Harbour. *Transactions and Proceedings of the New Zealand Institute 5*: 349-352.

Clark, L.; Horne J. C. 1993: Preliminary species list: for coastline from Wainuiomata River Mouth to Pencarrow Head, including habitat notes and some points of interest. Unpublished list.

Clark, L.; Horne, J. C.; Mitcalfe, B. 1994: Some indigenous vascular plants on the South Wellington coast from Windy Point to the Orongorongo River Mouth. Unpublished list.

Clelland, D. 1984: Red Rocks to Karori Stream. Unprotected Natural Areas of the Wellington Region: A survey of eleven areas of biological significance. Unpublished report prepared for the Wellington District Office, Department of Lands & Survey.

_____ 1984: Cameron's Valley – Lake Kohangapiripiri. Unprotected Natural Areas of the Wellington Region: A survey of eleven areas of biological significance. Unpublished report prepared for the Wellington District Office, Department of Lands & Survey.

_____ 1984: Gollans Valley – Lake Kohangatera. Unprotected Natural Areas of the Wellington Region: A survey of eleven areas of biological significance. Unpublished report prepared for the Wellington District Office, Department of Lands & Survey.

Cockayne, L. 1907: Report on a botanical survey of Kapiti Island. Append. J. House Rep. (New Zealand).

Crowe, A. 1995: Which Coastal Plant? Penguin Books (NZ) Ltd, Auckland.

de Lange P. J. 1990: Some comments regarding the Te Kopahou pine plantation and the landfill proposal with regard to the possible effects on the threatened indigenous plant populations. Unpublished contract report prepared for the Wellington Botanical Society.

de Lange, P. J.; Heenan, P. B.; Given, D. R.; Norton, D. A.; Ogle, C. C.; Johnson, P. N.; Cameron, E. K. 1999: Threatened and uncommon plants of New Zealand. *New Zealand Journal of Botany 37*: 603-628.

Department of Conservation. 1996: Conservation Management Strategy for Wellington 1996 - 2005. Department of Conservation, Wellington.

Department of Conservation. no date: Voluntary Protection of Nature on Private Property: Your land, Your choices. Department of Conservation.

Department of Conservation. 2002: Threatened and uncommon plants in New Zealand. Department of Conservation, Wellington.

Dix, B.; Robertson, H.; McAlpine, G.; Bishop, D.; Brady, J.; Moore, P. 1990 (comp.): Coastal Resource Inventory: First Order Survey – Wellington Conservancy. Department of Conservation, Wellington.

Druce A. P. 1966: Indigenous vascular plants in the vicinity of Cape Palliser, Southern Wairarapa, SL – 1000 ft (Ngawi to Ngapotiki). (Revised June1972, May 1974, July 1975, July 1976, May 1977, Oct. 1977, Nov. 1978, June 1979, June 1980, June 1983, Oct. 1986, Nov. 1986, June 1987). *Unpublished species list No. 12*. Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 7 pp.

Druce A. P. 1967: Indigenous vascular plants of Pahaoa Gorge Taipos, Eastern Wairarapa, sealevel to 1500 feet. (Revised June 1972, May 1974, April 1975, June 1976, May 1977, June 1979, May 1980, July 1985, April 1986, June 1986, July 1987). *Unpublished species list No. 16*. Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 8 pp.

Druce A. P. 1967b: Indigenous plants of Pahaoa Gorge Taipos, Eastern Wairarapa, Sea level – 1500ft (N166 14-17 to 19-11-). Unpublished list No. 16.

Druce A. P. 1968: Indigenous vascular plants between Owhiro Bay and Sinclair Head, South Wellington Coast, sea level to 1000 ft. (Revised Sept. 1970, April 1971, April 1972, June 1974, June 1975, June 1976, May 1977, June 1979, June 1980, July 1985, June 1986, Nov. 1988, June 1990, August 1992. *Unpublished species list No. 3*. Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 5 pp.

Druce A. P. 1972a: Indigenous vascular plants from Baring Head to Turakirae Head to Windy Point, South Wellington Coast, sea-level to 1000 feet. (Revised May 1974, July 1975, Sept. 1975, July 1976, May 1977, Oct. 1979, Dec. 1977, June 1983, March 1983, Jan. 1984, Aug. 1984 June 1986, Aug. 1987, Oct. 1987, Oct. 1988, May 1989, June 1990, July 1991, July 1992.) *Unpublished species list No 33*. Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 7 pp.

Druce A. P. 1972b: Indigenous vascular plants near the coast west of Levin, from near Hokio to the mouth of the Ohau River, S.L. to 150 feet. (Revised July 1974, July 1975, Oct. 1982, Sept. 1982). *Unpublished species list No. 235*. Botany Division, Department of Scientific and Industrial Research, Lower Hutt.

Druce A. P. 1972c: Vascular plants of the Wairarapa Taipos, sea-level to 2000 feet. (Revised May 1977, June 1978, June 1979, June 1980, Oct. 1982, April 1985, July 1986, June 1988.) *Unpublished species list No. 81*. Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 15 pp.

Druce A. P. 1972d: Indigenous plants in vicinity of Putangirua Stream, Palliser Bay. Unpublished list number 5.

Druce A. P. 1974: Indigenous higher plants (Psilopsids, Lycopods, Ferns, Gymnosperms, Flowering plants) of Aorangi Range. (Revised July 1975, July 1976, May 1977, Oct. 1977, June 1980, Oct. 1982, May 1983, Oct. 1986, Nov. 1986, June 1988, Aug. 1990, Nov. 1990, May 1991, Sept. 1991, July 1992). *Unpublished species list No. 19.* Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 11 pp.

Druce A. P. 1975: Indigenous vascular plants of Lakes Kohangatera and Kohangapiripiri, and the coast southwards to Baring Head, South Wellington Coast, sea-level to 100 feet. (Revised April 1978, June 1979, May 1980, Jan. 1984, June 1984, May 1986, Oct. 1988, Aug. 1990, July 1991, Nov. 1992). *Unpublished species list No. 127.* Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 4 pp.

Druce A. P. 1976: Indigenous vascular plants of South Wellington Coast and adjacent hills, from Paekakariki to Te Kaukau Point, sea level to 1000 feet. (Revised July 1976, Aug. 1976, May 1977, Nov. 1979, July 1980). *Unpublished species list No. 118*. Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 19 pp.

Druce A. P. 1980: Indigenous vascular plants of Tararua Range and Western Wellington Hills, Sea level–1566 m. Revised May 1982, May 1983, June 1983, Jan. 1984. *Unpublished species list No. 134.* Botany Division, Department of Scientific and Industrial Research, Lower Hutt. 38 pp.

Druce A. P. 1991: Indigenous plants on Mt Rimutaka and ridge south to old Railway (N161 72-38-). Unpublished list No. 4.

Druce, A. P.; Park, G. N. 1972: Indigenous vascular plants of Castlepoint, Wairarapa. Unpublished list number 21.

Druce, A. P.; Park, G. N. 1991: Indigenous vascular plants of Mount Percy, Eastern Wairarapa, sea-level to 1557 ft. Species list No. 18.

Duguid F. C. 1976: Matagouri at Herbertville Beach. Wellington Botanical Society Bulletin, No. 39: p 45.

Duguid F. C. 1990: Botany of northern Horowhenua lowlands, North Island, New Zealand. *New Zealand Journal of Botany Vol. 28*: 381-437.

Empsom, R. A.; Sawyer, J. W. D. 1996: Plant Conservation Strategy: Wellington Conservancy. Department of Conservation, Wellington.

Esler, A.E. 1970: Manawatu Sand Dune Vegetation. *Proceedings of the New Zealand Ecological Society 17*:41–46.

Esler A. E.; Greenwood, R. M. 1968: Omarupapaku (Round Bush), Foxton. Wellington Botanical Society Bulletin, Vol. 35: p 3-7.

Frank, M. 1993: A Wildlife and Vegetation Assessment of Fitzroy Bay, Wellington. Unpublished plant checklist.

Freegard, J.; Weeber, Y. B. 1986: Vegetation of Coast and Islands: Wellington Harbour. Wellington Harbour Maritime Planning Area Natural Resources Study. Wellington Harbour Maritime Planning Authority, Centre for Resource Mangement, Lincoln.

Fuller S. A. 1985: Kapiti Island vegetation. Report on the vegetation of Kapiti Island. Department of Lands and Survey, Wellington. 43 pp.

Heather, B.; Robertson, H. 1996: The Field Guide to the Birds of New Zealand. Penguin Books (NZ) Ltd., Auckland.

Herbert, A.; Oliphant, J. 1991: Pingao: The Golden Sand Sedge. Nga Puna Waihanga.

Herbert, J. W.; Bergin, D. O. 1991: Experimental rehabilitation of dunelands with pingao. FRI Contract Report: FWE 91/23. Department of Conservation.

Hesp, P. 2000: Coastal sand dunes: form and function. CDVN, Forest Research, Rotorua.

Hilton, M; Macauley, U.; Henderson, R. 2000: Inventory of New Zealand active dunelands. *Science for Conservation 57*. Department of Conservation, Wellington.

Holmgren, P. K.; Holmgren, N. H.; Barrett, L. C. 1990: Index Herbariorum, ed. 8. *Regnum Vegetabile* 120: 1-693.

Johnson, P.; Brooke, P. 1989: Wetland Plants in New Zealand. DSIR Publishing, Wellington.

McQueen, D. R.; Macdonald, M. C. 1977: Proposed reserve, Owhiro Bay Quarry to Sinclair Head. Report to Wellington City Corportion, Town Planning Division.

Metcalfe, L. 1998: The Cultivation of New Zealand native grasses. Random House, New Zealand.

Miskelly, C. 1995: Distribution of reptiles in Wellington Conservancy, with a key to lizard species. Unpublished report prepared by the Department of Conservation, Wellington.

Mitcalfe, B. J.; Horne, J. C. 1992: Some Indigenous Plant Communities of the Wellington Southwest Peninsula. Unpublished report for the Department of Conservation, Wellington.

Mitcalfe, B. J.; Horne, J. C. 2001: Makara Foreshore Reserve. Unpublished plant checklist held by the Department of Conservatiion, Wellington.

Moore, L. B.; Adams, N. A. 1963: Plants of the New Zealand Coast. Longman Paul Ltd, Auckland.

Moss, T. n.d.: Indigenous plants from coast between Baring Head and Pencarrow. Unpublished plant checklist (abridged version of A.P. Druce's list).

Newsome, P. F. J. 1987: The Vegetative Cover of New Zealand. Water and Soil Miscellaneous Publication No 112. Wellington, New Zealand.

Nicol, E. R. 1997: Common names of plants of New Zealand. Manaaki Whenua Press, Lincoln.

Ogle, C. C. 1962: Indigenous vascular plants of Kapiti Island. Unpublished plant checklist held by the Department of Conservation, Wellington Conservancy.

Ogle, C. C. 1996: Sand movement and the protection of natural areas on Pouto Peninsula, Northland. Conservancy Advisory Science notes, 145. Department of Conservation, Wellington.

Ogle, C. C. 1980: Native Plants of Pukerua Bay Reserves: Wairaka Road Gully, Coastal section of Wairaka and Raroa Reserves and Raroa Reserve. Appendix.

Ogle, C. C. 1987: Riversdale Beach Reserve and private land, immediately south of urban area. Unpublished plant checklist with notes held by the Department of Conservation, Wellington Conservancy.

Ogle, C. C. 1996: Indigenous vascular plants of three forest areas on dunes: Pakipaki, near Hokio, Levin, Horowhenua district. In "Sand movement and the protection of natural areas on Pouto Peninsula, Northland". Appendix 2. Conservancy Advisory Notes No. 145. Department of Conservation, Wellington.

Ogle, C. C.; et al. 1986: Vascular plants of South Wellington Coast: Wildlife Management "Speargrass Weevil" Reserve. Unpublished list.

Park, G. N. 1967: The vegetation and flora of Castlepoint and Cape Turnagain. Wellington Botanical Society Bulletin, Vol. 34, p 6-18.

Parrish, G. R. 1984: Wildlife and wildlife sites on the Wellington region. New Zealand Wildlife Service Report No. 38, Dept. of Internal Affairs.

Partridge, T. R. 1992: The sand dune and beach inventory of New Zealand. I. North Island. DSIR Land Resources Scientific Report No. 15.

Patrick, B. 1992: Some conservation values of the Kohangapiripiri dune – Pencarrow. Unpublished report to the Department of Conservation, Dunedin.

Patrick, B. 2002: Conservation status of the New Zealand red katipo spider (*Latrodectus katipo* Powell, 1871). *Science for Conservation 194*. Department of Conservation, Wellington.

Patrick, B.; Dugdale, J.S. 2000: Conservation status of the New Zealand Lepidoptera. *Science for Conservation 136*. Department of Conservation, Wellington.

Ravine, D. 1992: Foxton Ecological District: Survey report for the Protected Natural Areas Programme. Department of Conservation, Wanganui.

Sawyer, J. W. D. 2001: A bibliography of plant checklists and vegetation survey data sets for Wellington Conservancy (excluding Chatham Islands). Department of Conservation, Wellington.

Sawyer, J. W. D.; Townsend, A. J.; Beadel, S. M.; de Lange, P. J.; Shaw, W. B. 1998: Plants of National Conservation Concern in Wellington Conservancy. Department of Conservation, Wellington.

Smith-Dodsworth, J. C. 1991: New Zealand Native Shrubs and Climbers. David Bateman Ltd, Auckland.

Stephenson, G. 1977: Wildlife and wildlife areas in the Wellington region. Wellington Regional Planning Authority, Wellington.

Turner ,G. A.; Carlin W. F. 1975: Higher Plants of the Proposed Reserve, Castlepoint. Unpublished Appendix 1.

Urlich, S. In press: Monitoring terrestrial habitats in Wellington Conservancy: A strategy for 2003–2012. Department of Conservation, Wellington.

Walls, G. 1990: Cultivation, Provenance and Planting Trials with pingao (*Desmoschoenus spiralis*). Conservation Sciences Centre, Department of Conservation.

Wassilieff M. C.; Clark D. J.; Gabites I. 1986: Scenic Reserve of the Lower North Island. Biological Survey of Reserves Series No. 14. Department of Lands and Survey, Wellington. 297 pp.

Wassilieff, M. C. 1992: Vegetation survey of Makara Estuary and Foreshore. Unpublished report and plant list.

Wellington Botanical Society. 1984: Gollans Valley to Butterfly Creek. Unpublished plant checklist.

Wellington Botanical Society. 1994: Indigenous vascular plants in Fitzroy Bay (draft list). Unpublished plant checklist.

Wilkinson A. S.; Wilkinson A. 1952: Kapiti Bird Sanctuary – a Natural History of the Island. *Masterton Printing Company Ltd.* 190 pp.

Wilson, H.; Galloway, T. 1993: Small-leaved Shrubs of New Zealand. Manuka Press, Christchurch.

Appendix 1

PRELIMINARY LIST OF INDIGENOUS PLANT SPECIES ASSOCIATED WITH COASTAL DUNE VEGETATION IN WELLINGTON CONSERVANCY

This is not a definitive list of all indigenous plant species found in coastal dune communities but provides a preliminary indication of their floristic diversity in Wellington Conservancy.

The list was created by compiling names of species recorded in coastal dunes in the Coastal Resource Inventory (Dix *et al*. 1990), in the sand and beach inventory of New Zealand. North Island (Partridge 1992), on species record sheets, on site-specific information contained in folders held by the Department of Conservation, and from information held in the native plant databases at Wellington Conservancy such as the database of plant checklists (Sawyer 2001). Common names follow those given in Johnson & Brooke (1989) and Nicol (1997).

Acaena pallida	Sand piripiri
Apium prostratum	Shore celery (New Zealand celery)
Apodasmia similis	Jointed wire rush (Oioi)
Atriplex cinerea	Grey saltbush
Austrofestuca littoralis	Sand tussock
Brachyglottis compacta	Castlepoint groundsel
Bolboschoenus fluviatilis	Marsh clubrush (Kukuraho)
Calystegia soldenella	Shore bindweed
Calystegia sepium	Pink bindweed
Carex geminata	Cutty grass
C. pumila	Sand sedge
Coprosma acerosa	Sand coprosma
Coprosma repens	Taupata
Cordyline australis	Cabbage tree
Craspedia uniflora var. *grandis*	Woollyhead
Cyperus ustulatus	Giant umbrella sedge
Desmoschoenus spiralis	Pingao
Discaria toumatou	Matagouri (Wild Irishman)
Dysphyma australe	Iceplant
Eleocharis neozelandica	Spike sedge
Eryngium vesiculosum	Sea holly
Euphorbia glauca	Shore spurge
Gunnera arenaria	Sand gunnera
Isolepis nodosa	Knobby clubrush
Juncus gregiflorus	Leafless rush, Wiwi
Libertia peregrinans	New Zealand iris
Mazus novaezeelandiae subsp. *impolitus*	Dune mazus (Dwarf musk)
Melicytus crassifolius	Thick-leaved mahoe
Muehlenbeckia astonii	Shrubby tororaro
M. axillaris	Creeping pohuehue
M. complexa	Small-leaved pohuehue
M. ephedroides	Leafless pohuehue

Olearia solandri	Coastal tree daisy
Ozothamnus leptophyllus	Tauhinu
Phormium cookianum	Mountain flax
P. tenax	New Zealand flax (Harakeke)
Pimelea aff. *arenaria*	Sand daphne
P. prostrata	New Zealand daphne
P. urvilleana	
Plagianthus divaricatus	Shore ribbonwood
Poa cita	Silver tussock
Potentilla anserinoides	Silverweed
Pteridium esculentum	Bracken fern
Ranunculus macropus	Swamp buttercup
Raoulia australis	Common mat daisy
R. hookeri	Scabweed
R. "Makara"	
Schoenoplectus pungens	Three-square
S. tabernaemontani	Lake clubrush (Kopupu)
Scleranthus biflorus	Canberra grass
Sebaea ovata	
Selliera radicans	Remuremu
S. rotundifolia	
Solanum aviculare	Poroporo
Spinifex sericeus	Spinifex
Tetragonia implexicoma	New Zealand climbing spinach
T. tetragonioides	New Zealand spinach

Appendix 2

NATIVE AND EXOTIC BIRD SPECIES ASSOCIATED WITH COASTAL DUNE SYSTEMS

(b.) indicates used as breeding site.

This is a preliminary list of bird species that are dependent or partly dependent on coastal dune vegetation in Wellington Conservancy. The species listed are known to utilise dune vegetation and in so doing tie the dunes into ecological interactions across a wider landscape than is occupied by dunes alone. Therefore, this list is intended to improve our understanding of coastal dune ecology. Latin and common names follow those given in Heather & Robertson (1996).

Native Species

Ardea novaehollandiae	White-faced heron
Anthus novaeseelandiae	Pipit (b.)
Charadrius bicinctus	Banded dotterel (b.)
Circus approximans	Australasian harrier
Eudyptula minor	Little blue penguin (b.)
Haematopus unicolor	Variable oystercatcher (b.)
Halcyon sancta	Kingfisher
Himantopus himantopus	Pied stilt
Hirundo tahitica	Welcome swallow
Larus dominicanus	Southern black-backed gull (b.)
L. novaehollandiae	Red-billed gull (b.)
Phalacrocorax carbo	Black shag
Rhipidura fuliginosa	Fantail
Sterna caspia	Caspian tern (b.)
S. striata	White-fronted tern (b.)
Vanellus miles	Spur-winged plover
Zosterops lateralis	Silvereye

Introduced Species

Alauda arvensis	Skylark
Carduelis carduelis	Goldfinch
C. chloris	Greenfinch
C. flammea	Redpoll
Emberiza citrinella	Yellowhammer
Fringilla coelebs	Chaffinch
Gymnorhina tibicen	Magpie
Phasianus colchicus	Pheasant
Prunella modularis	Dunnock
Sturnus vulgaris	Starling

Appendix 3

PRELIMINARY LIST OF ADVENTIVE PLANT SPECIES ASSOCIATED WITH COASTAL DUNE SYSTEMS THAT HAVE THE POTENTIAL TO BECOME PESTS IN WELLINGTON CONSERVANCY.

The purpose of this list is to identify species that are, or have the potential to be, weeds of coastal dune vegetation. This is a preliminary list and it is expected that other species will be added to it as more information is gained about pest plant threats to coastal dunes. Many of these species may pose a threat to dune communities either by colonising dunes or by the activation of ground seed banks when sand and gravel is disturbed (e.g. by planting).

Common names follow those given in Nicol (1997).

Acacia spp. (incl *A. dealbata* and *A. sophorae*	Wattle
Agapanthus orientalis	African lily
Agrostis capillaris	Browntop
Ammophila arenaria	Marram grass
Banksia integrifolia	Coastal banksia
Bromus diandrus	Ripgut brome
Carpobrotus edulis	Ice plant
Cirsium arvense	Californian thistle
C. vulgare	Scotch thistle
Cortaderia jubata	Purple pampas grass
Cortaderia selloana	Pampas grass
Chrysanthemoides monilifera	Boneseed
Cupressus macrocarpa	Macrocarpa
Cynodon dactylon	Indian doab
Erharta calycina	
E. erecta	Veldt grass
Festuca arundinacea	Tall fescue
Glaucium flavum	Horned poppy
Holcus lanatus	Yorkshire fog
Juncus articulatus	Jointed rush
Lagurus ovatus	Hare's-tail
Lavatera arborea	Tree mallow
Lupinus arboreus	Tree lupin
Lycium ferocissimum	Boxthorn
Medicago polymorpha	Bur nedick
Parapholis incurva	Sickle grass
Pennisetum clandestinum	Kikuyu grass
Pinus spp.	Pine
Plantago coronopus	Buckshorn plantain
Polycarpon tetraphylla	Allseed
Rosa rubiginosa	Sweet briar
Rhamnus alaternus	evergreen buckthorn
Rubus fruticosus	Blackberry

Senecio angulatus	Cape ivy
Senecio elegans	Purple groundsel
Senecio glastifolius	Holly-leaved senecio
Stenotaphrum secundatum	Buffalo grass
Taraxacum officinale	Dandelion
Ulex europeus	Gorse

Appendix 4

NAMES AND ADDRESSES OF PEOPLE AND AGENCIES INVOLVED IN PROTECTION AND RECOVERY OF COASTAL DUNE VEGETATION IN WELLINGTON CONSERVANCY

INDIVIDUALS AND AGENCIES	CURRENT OR POTENTIAL INVOLVEMENT IN COASTAL DUNE VEGETATION CONSERVATION
Organisation: Coastal Dune Vegetation Network Contact person: Dave Bergin Address: Forest Research, Private Bag 3020, Rotorua Telephone: (07) 347 5818 www.forestresearch.co.nz (click on Research – cooperatives)	Recipient for information regarding coastal dune vegetation (nation-wide)
Organisation: Wellington Plant Conservation Network Contact person: John Sawyer Address: Department of Conservation, P.O. Box 5086, Wellington Tel: (04) 470 8427 E-mail: jsawyer@doc.govt.nz	Manages a regional plant database containing information about the biogeography and ecology of coastal dune plant species. Facilitates meetings of the Wellington Plant Conservation Network.
Organisation: horizons.mw (ex Manawatu-Wanganui Regional Council) Contact person: Aaron Madden Address: P. O. Box 289, Marton Telephone: (06) 3277189 E-mail: aaron.madden@horizons.govt.nz	Involved with planting trial of spinifex at Himatangi Beach.
Organisation: Horowhenua District Council Contact person: Peter Shore Address: Private Bag 4002, Levin Telephone: (06) 368 7189 Fax: (06) 367 9212	
Organisation: New Zealand Coastal Society NZCS Secretary P.O. Box 12 241 Wellington www.coastalsociety.org.nz	
Organisation: Otari-Wilton's Bush Contact person: Jane Wright Address: C/- Wellington City Council, PO Box 2199, 101 Wakefield St, Wellington Telephone: (04) 475 3245	Has expertise in propagation of native plants, including coastal dune species.
Organisation: Percy Scenic Reserve Contact person: Robyn Smith Address: C/- Excell Corporation, P.O. Box 30 648, Lower Hutt Telephone: (04) 570 6505	Has expertise in propagation of native plants, including coastal dune species
Organisation: Queen Elizabeth II National Trust Contact person: Tim Park Address: P.O. Box 3341, Wellington Telephone: (04) 472 6626 E-mail: tpark@qe2nattrust.org.nz	

INDIVIDUALS AND AGENCIES	CURRENT OR POTENTIAL INVOLVEMENT IN COASTAL DUNE VEGETATION CONSERVATION
Organisation: Riversdale Dune Management Group Contact person: Trish Taylor Telephone: (06) 378 9666	Chairperson of dune management committee. In conjunction with Masterton District Council, the group are involved with dune rehabilitation at Riversdale beach
Organisation: UcoL (ex Manawatu Polytech) Contact person: Dave Havell Address: Palmerston North campus, Private Bag 11022, Palmerston North Telephone: (06) 952 7001 ext 8662	Involved with spinifex trial at Himatangi beach and planting of pingao at dunes south of Waikawa
Organisation: UcoL (ex Manawatu Polytech) Contact person: David Blakiston Address: Levin campus, P.O. Box 1016, Levin Telephone: (06) 3681322	Involved with spinifex trial at Himatangi beach and planting of pingao at dunes south of Waikawa
Organisation: Wellington City Council Contact person: Peter Hensley Address: P.O. Box 2199, Wakefield St, Wellington Telephone: (04) 801 3610 Contact Person: Garth Nixon Address: P.O. Box 2199, Wakefield St. Wellington Telephone: (04) 801 3610 Contact Person: Jo Gillanders Address: P.O. Box 2199, Wakefield St. Wellington Telephone: (04) 801 3607	Landscape architect for WCC. Involved with planting of coastal vegetation from Moa Pt to Breaker Bay Landscape architect for WCC. Involved with planting of coastal vegetation from Worser Bay to Scorching Bay, and Owhiro Bay. Town Belt and Reserves Curator. Responsible for areas around Wellington south coast that contain or have been planted with coastal vegetation
Organisation: Wellington Regional Council Contact person: Jo Fagan Address: 142-146 Wakefield St, Wellington Telephone: (04) 384 5708 E-mail: jo.fagan@wrc.govt.nz	
Organisation: Department of Conservation, Wellington Conservancy Staff 1. Kapiti Area Office Contact Person: Dick Gill Address: Parata Street, P.O. Box 141, Waikanae Telephone: (04) 293 2191 Fax: (04) 293 6020 2. Wairarapa Area Office Contact Person: Garry Foster Address: South Road, P.O. Box 191, Masterton Telephone: (06) 377 0700 Fax: (06) 377 2976 3. Poneke Area Office (Rimutaka Forest Park) Contact Person: Rob Stone Address: P.O. Box 5086, Wellington Telephone (04) 472 5821 Fax: (04) 499 0077	Biodiversity field staff providing advice to landowners on management and protection of coastal dune vegetation. Also involved in survey of Protected Natural Areas and collection of seed of selected native species for use in ecological restoration projects.

Appendix 5

CONTACT DETAILS FOR NURSERIES THAT GROW COASTAL DUNE SPECIES OF LOCAL PROVENANCE

Nursery: **Terra Firma Ltd, Taupo Native Plant Nursery**
Contact Person: Phillip Smith
Address: 155 Centennial Drive, PO Box 437 Taupo
Telephone: (07) 378 5450
Austrofestuca littoralis, Coprosma acerosa, Desmoschoenus spiralis, Pimelea aff. *arenaria, Spinifex sericeus.* Large supply for most species. Various sources around the country. Mail Order available.

Nursery: **Plantwise**
Contact Person: Richard Slow
Address: 1 Summit Rd, Lower Hutt
Telephone: (04) 567 1732 Fax: (04) 567 1732
Coprosma acerosa, Desmoschoenus spiralis.

Nursery: **Talisman Nursery Ltd**
Contact Person: Alistair and Margaret Turnbull
Address: Ringawhati Rd, RD, Otaki
Telephone: (06) 364 5893
Desmoschoenus spiralis, Spinifex sericeus. Mail Order available.

Nursery: **Beramphore Nursery**
Contact Person: David Hall
Address: Berhampore
Telephone: (04) 3899729
Coprosma acerosa, Desmoschoenus spiralis, Spinifex sericeus.

Nursery: **Matatoa Nursery**
Address: Engles Road, Shannon
Telephone: (06) 362 7477 Fax: (06) 362 7472
Coprosma acerosa. Mail Order available.

Appendix 6

DISTRIBUTION INFORMATION DATABASE

Distribution information is provided for five native plant species representative of indigenous coastal vegetation in Wellington Conservancy. Those species are:

1. *Austrofestuca littoralis*
2. *Desmoschoenus spiralis*
3. *Spinifex sericeus*
4. *Coprosma acerosa*
5. *Pimelea arenaria*

The information has been taken from the Department's native plant database for Wellington Conservancy.

Explanation of terms used in the database of occurrences

Species record sheet – Information taken from completed copies of species record sheets (see Appendix 7)

WELT – Information taken from herbarium specimens held at the Museum of New Zealand – Te Papa Tongarewa.

WELTU – Information taken from herbarium specimens held at the School of Biological Sciences, Victoria University of Wellington.

AK – Information taken from herbarium specimens held at the Auckland Museum herbarium.

CHR – Information taken from herbarium specimens held at the Lincoln Herbarium.

CRI – Coastal Resource Inventory

PNAP survey site number

Unpublished species list – Information taken from the plant checklist database held by the Wellington Conservancy, Department of Conservation (Sawyer 2001).

NIC – Not in Wellington Conservancy but included in database records because of proximity to Conservancy boundary.

Full references for each occurrence are included in the bibliography to the main report.

Appendix 7

SPECIES RECORD SHEET

<table>
<tr><td colspan="3">SPECIES NAME:</td></tr>
<tr><td colspan="2">OBSERVER:
NAME:

TELEPHONE NUMBER:

ADDRESS:</td><td>NEAREST MAJOR LOCALITY:</td></tr>
<tr><td colspan="2" rowspan="2"></td><td>ECOLOGICAL DISTRICT:</td></tr>
<tr><td>OWNER/OCCUPIER OF LAND (if known):</td></tr>
<tr><td>MAP SERIES:</td><td>MAP NUMBER:</td><td>GRID REFERENCE:</td></tr>
<tr><td colspan="3">DATE OF OBSERVATION AND TIME:

LOCATION:

DESCRIPTION OF SITE (INCLUDING HABITAT):

SKETCH MAP OF SITE:</td></tr>
</table>

POPULATION FEATURES:

Number of individuals seen.
An indication of the scope of your survey i.e. is the population more widely spread?
An estimate of the age structure (number of adults, number of juveniles), flowering? fruiting? moulting?
Have you visited site before? If so how does it compare now?

WHAT IS THE CURRENT SITE MANAGEMENT?

ARE THERE ANY THREATS TO THE POPULATION?
e.g. herbivores, predators, land development, recreation, pollution, other.

RECOMMENDATIONS FOR MANAGEMENT OF THE SITE OR POPULATION:

WAS A PHOTOGRAPH TAKEN? Please circle	**YES** **NO**
WAS MATERIAL COLLECTED?	**YES** **NO**
TYPE OF MATERIAL	**SEED** **CUTTINGS** **SPECIMEN**

WHERE IS MATERIAL NOW?