Monitoring Coastal Sand Dune Vegetation Communities for Conservation

By Helga Küchly & Stephen Hartley

Handbook for the Wellington Conservancy

Abstract

Coastal sand dunes are a distinctive feature of the New Zealand landscape, but they are becoming increasingly rare due to human induced alternations like coastal development and introduction of non-indigenous species. Owing to the general lack of legal protection of coastal areas it is not surprising that a large number of plant taxa of conservation concern appear to be in this ecosystem.

While the identification of key conservation sites and management recommendations has recently been completed in a baseline study by Milne and Sawyer (2002), field records are erratically distributed over the area and much collected data has become obsolete. Thus, new field surveys should be undertaken to determine the occurrence of sand dune species and to allow the implementation of adequate conservation actions. Furthermore, to allow comparison of these data in a temporal and spatial manner general standards in how to obtain the species information have to be set.

The purpose of this handbook is to provide detailed guidance on the field survey method and plant determination with reference in particular to the Wellington Conservancy. It is designed to convey the overall changing physical and vegetation structure of sand dunes, with an emphasis on coastal foredunes. In addition the handbook gives detailed information about the sand dune ecosystem in general (geomorphology and vegetation), the threats that it faces, information about the conservation value, as well as detailed information about the plant species occurring in the Wellington Conservancy.

Keyword: Coastal foredune, handbook, monitoring method, vegetation, geomorphology, plant species, conservation, Wellington Conservancy

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Part one – Introduction

1. Purpose

Coastal sand dunes are a distinctive feature of the New Zealand landscape, but they are becoming increasingly rare. 70% of coastal sand dune ecosystems nationwide have been lost in New Zealand within the last 80 years and compared with their original state, many of the remaining dune systems are biologically impoverished and barren (Gibbs 2002).

The Wellington Plant Conservation Strategy (Sawyer 2004) identified that the greatest number of plant taxa of conservation concern appear to be in the lowland and coastal areas of the Wellington Conservancy, which covers roughly 1,135,400 hectare of the lower North Island. About 62 of these plant taxa (39%) are classified as coastal and many are poorly represented within the existing conservation network (Sawyer 1996).
Many different processes influence the survival of taxa and the dynamic nature of sand dune ecosystems lead to natural fluctuations in their population size. The recent population extinction and rise in number of threatened coastal plant taxa, however, has an anthropogenic origin as people have been modifying large parts of the coastline.

Information on the distribution and abundance of threatened coastal plants, the identification of key conservation sites and management recommendations has recently been completed in a baseline study by Milne & Sawyer (2002). Besides the raising of public awareness and the protection (legally and physically) and restoration of sites supporting coastal foredune vegetation, the conservation recommendation to preserve sand dune ecosystems stresses the need for continuous monitoring of the current condition of dunes and distribution of plant species with conservation concern. As field records are erratically distributed over the area and collected data has become obsolete, new field surveys should be undertaken to determine the occurrence of sand dune species. The Department of Conservation suggested that this could be accomplished by the development of a standard survey method for monitoring coastal foredune vegetation, which is the aim of this handbook.

The monitoring handbook is designed to convey the overall changing physical and vegetation structure of sand dunes, with emphasis on coastal foredunes. The purpose of the handbook is to provide a brief introduction into the topic and detailed guidance on the field survey method and plant determination. The implementation of the survey does not require specialist geomorphologic or botanical expertise but consistent work commitment of the surveyor.

2. Introduction to sand dune ecosystem

"Coastal dunes are aeolian landforms that develop in coastal situations where an ample supply of loose, sand sized sediment is available to be transported inland by the ambient winds.(…) they are the spatial transition between the continental/terrestrial and marine/aqueous environments." (Martinez et al. 2004, p.3).
The term "aeolian" indicates that all dunes have been formed by wind action, the lifting, transportation and deposition of sand grains. Highly specialised plant species that can withstand salt winds, high surface temperature, low nutrient and water availability and sand-blasting, can modify dunes into relatively stable landforms.

Sand dune form and vegetation

Dunes form in coastal areas where there is shelter from strong waves, a good supply of sand, onshore winds and dune-binding plant species. Sand is washed onto the shoreline in areas sheltered from strong wave action. A variety of factors influence the nature and distribution of sediments and the form of the current coastline. The geological and mineralogical characteristics of eroded rock types, volcanic and tectonic processes, river dynamics and variations in sediment supply and the force of waves, tides, currents and wind and their various combinations have all lead to the accumulation of sand on the sea floor (Hesp 2000).

Figure 1 illustrates the main features of the beach system. The *nearshore zone* extends from the wave base (waves first interact with sea bottom) to the breakpoint (waves initial break). It is followed by the *surf zone*, the area of major wave breaking. The *beach* stretches out from the low tide line to the *swash limit* (limit to which swash reaches), which is where most of the deposition of drift material such as wood, vegetative matter by waves occurs (sometimes also referred to as wrack or drift line). Sand dunes or cliffs are usually the next landward geomorphic feature.

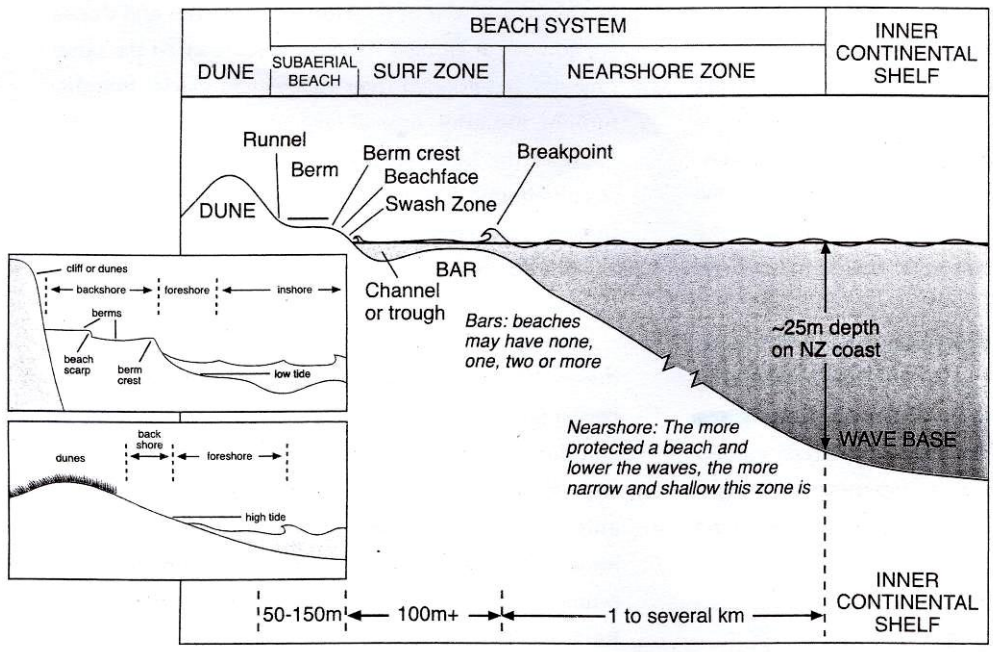

Figure 1: Schematic diagram of beach system (Hesp 2000, p.4)

Sand dune formation and dynamics are largely influenced by processes operating in the surf zone (zone of breaking waves) and on the beach. The amount of sand available for dune formations is controlled by the interaction of waves, currents and the sea floor slope (see table in Appendix 3).
Reflective beaches (Figure 2, 4a) occur where wave energy is low, where coarser sand and gravel are the predominant sediment type and where the beach slope is relatively steep. As most of the wave energy is reflected back to the sea sediment is mainly transported alongshore thus dunes are usually small. *Dissipative beaches* (Figure 2, 4c) develop on coasts with high wave energy, silt to fine sand sediment and shallow beach slope. Large dune formation is characteristic for this beach type as the predominant sediment transport is in the onshore direction. *Intermediate beaches* lie in between above-named conditions (Viles & Spencer 1995, Hesp 2000).

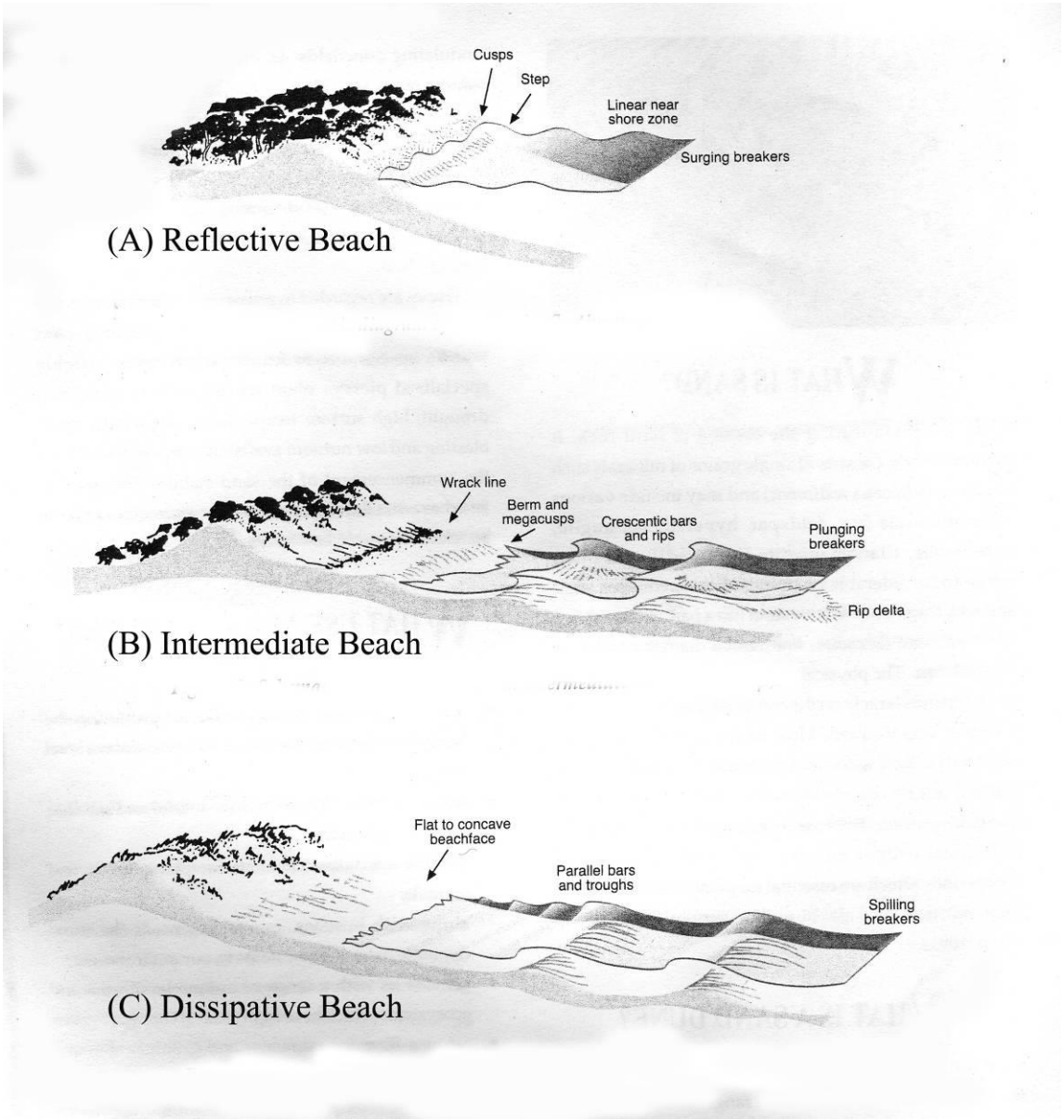

Figure 2: Schematic diagram of beach characteristics (Hesp 2000, p. 5)

Beside the beach type and sediment availability, wind strength and direction determine how much sand is transported from the beach further inland. The frequency and magnitude of storms also influence dune developments. Vegetation is very effective in modifying the wind flow and rapidly reducing wind flow velocities, thus increases sand deposition and dune growth.

Sand deposition, accumulation and erosion result in a variety of coastal dune types. On the landward edge of the coastal beach the foremost dune can have two opposed origins: either from the abrasion of existing dunes on eroding coasts, or sand deposition originating from the sea bed. The final formation to be considered is called *foredune*, which are the focus of this handbook.

Newly developing foredunes (*incipient foredune*) are primarily initiated by sand trapping of pioneer vegetation and driftwood. Plant species types are very important in determining the morphology of these dunes. The two dominant pioneer native species in New Zealand, *Desmochoenus spiralis* (pingāo) and *Spinifex sericeus* (spinifex) are spreading, rhizomatous and stoloniferous plants. As illustrated in Figure 3, these species tend to produce lower, less hummocky and more regular dune forms than the exotic, tall and dense *Ammophila arenaria* (marram grass) (pingāo 8-14°, < 3 m; spinifex 14-16°, <6 m; marram 24-28°, <8 m) (Esler 1978) .The different dune shapes are formed by the different rooting system of these three plants as demonstrated in Figure 4.

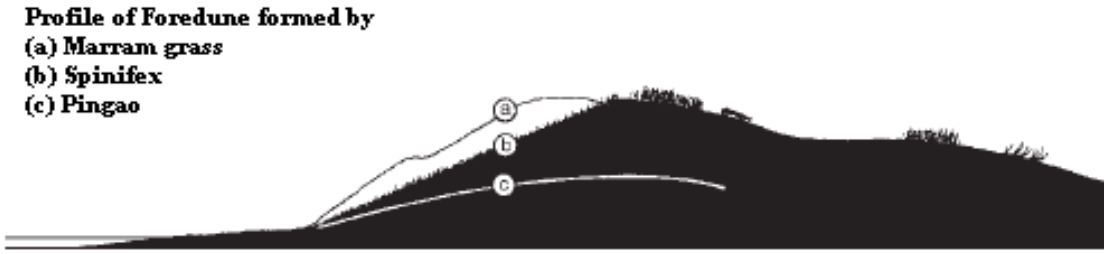

Figure 3: Dune formation profile of different sand binding species (adapted from Milne and Sawyer 2002, originally developed by Esler 1970)

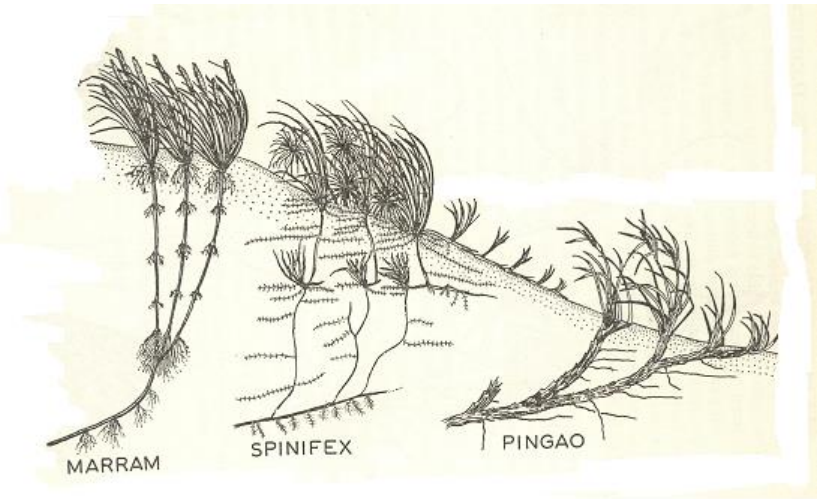

Figure 4: Rooting system of three sand-binding plant species (adapted from Moore & Adams 1963, p.54)

These incipient foredunes can have either an episodic life followed by erosion and accretion or develop to more complex established foredunes. This latter process is characterised by a more stabilized landward slope, the increase of nutrients and decrease of salt spray levels, less sand inundation and the occurrence of "intermediate', often woody, plant species, such as *Austrofestuca littoralis* (sand tussock), *Calystegia soldanella* (shore bindweed), *Coprosma acerosa* (sand coprosma), *Lycium ferocissimum* (boxthorn), *Muehlenbeckia complexa* (small-leaved pohuehue) and *Ozothamnus leptophyllus* (tauhinu), *Pimelea arenaria* (sand daphne). Along with these will be a range of grasses and herbs and where the dune is already relatively stable tall shrubs and small tress, as well as a variety of non-dune species will occur (Newsome 1987; Milne & Sawyer 2002). Dunes generally have a low species diversity compared with other habitat types which require specialist plant types such as the above mentioned sand binding plant species.

Five species have been identified by Milne & Sawyer (2002) as *key species* of Wellington's foredune vegetation regarding the representativeness in the plant community, availability of data and identification by surveyors. These include the two sand binding species *Desmochoenus spiralis* (pingāo) and *Spinifex sericeus* (spinifex) on the more unstable seaward dune face and *Coprosma acerosa* (sand coprosma), *Austrofestuca littoralis* (sand tussock) and *Pimelea arenaria* (sand daphne) on more stabilised sites such as the rear face of the foredune. The two latter species are also a good indicator of pristine dune vegetation as they do not occur on sites with high habitat disturbance.

In the dynamic process a new incipient foredune may develop and the original foredune could then become secluded from the dynamic process of sand accumulation and erosion (*relict foredune*). Thus, wide dune plains can develop over time. *Blowouts* are common features of established foredunes and are mainly initiated wherever there is a reduction of vegetation cover, which results in increased sand erosion. Once initiated, the change of wind flow and the significant greater wind flow velocities will lead to further rapid erosion and saucer or trough shaped hollows will form (Hesp 2000). If erosion in blowouts or between two foredunes continues down to the water table, *dune slack* or *lakes*, like Lake Papaitonga and Lake Horowhenua in the Wellington District, can occur (Milne & Sawyer 2002). These are generally natural processes of change, but these processes can certainly be distorted due to human induced alternations.
Further description of dune morphology not directly related to foredunes can be found extensively in the literature (e.g. Bird 2000, Hesp 2000).

Threats to sand dune ecosystems

Sand dunes are highly dynamic ecosystems and thus changes of one small part of this system may have knock-on effects over a much wider extent. There is no doubt that human activities, since the arrival of the first human settlers in New Zealand, have had a negative impact on their unique natural character.

Maori located their first settlements within sand dunes (Hesp 2000). They altered the environment by burning coastal forest and cultivating crops (Gibbs 2002). Some species were harvested, such as *Coprosma acerosa* (sand coprosma) for its berries and *Desmochoenus spiralis* (pingāo) for enhancing craft weavings. It remains generally unknown how large the impact of these first settlers was on the dune ecosystem, but it was undoubtedly less than the following widespread disturbance caused by European settlers.

Early European farming techniques included using sand dunes as pasture for their livestock. The trampling and grazing by these animals may lead to a declining state of dune-binding plant species and thus, to the erosion and inland migration of sand dunes (Dawson & Lucas 1996). As a result the Sand Drift Act was enacted in 1907 and Cockayne (1911) was commissioned to conduct a survey of New Zealand's coastal sand dunes and produce a recommendation for dune stabilisation. *Ammophila arenaria* (marram grass), *Lupinus arboreus* (yellow-flowered lupine), *Pinus spp.* (pine) and other exotic species were planted as a result of previous experience in sand stabilisation treatments in Europe and North America.

Unfortunately, *Ammophila arenaria* proved to be an aggressive invader and as it was widely planted in almost all active dunelands and rapidly spread beyond these sites it has changed the natural character of New Zealand's duneland forever (Hilton et al. 2000). It is at a competitive advantage over *Desmochoenus spiralis* (pingāo) because of its pattern and form of growth. While the indigenous sand-binder pingāo forms open, well spaced tufts, the exotic marram grass grows more densely and can travel underground for excess of 1 meter before sending up tillers (Freedgard et al. 1986). Moreover the steep-sided dunes formed by this species are more vulnerable to erosion compared to the forms created by natural sand-binders (Gabites 1993). It also has been suggested that the establishment of *Ammophila arenaria* on coastal foredunes has forced birds to nest closer to the tide line, where eggs are more vulnerable to flooding (Collar et al. 1994). Thus, minor changes in the structural appearance of sand dunes might have significant effects on species populations.

Through the general open growth form of native foredune vegetation many other exotic plant species, such as weeds escaped from gardens were able to colonize them [e.g. *Cortaderia selloana* (pampas grass) in the northern North Island and *Senecio elegans* (wild cineraria)] (Dawson & Lucas 1996, Milne & Sawyer 2002). Pasture grasses and clover can be a serious threat to native species on degraded private farmland as they are not only more competitive, but also encouraged/accelerated by artificial fertiliser, dung and urine and trampling of habitat by livestock (Dopson et al. 1999).

Since the 1950s coastal subdivision and development have also had a large impact on the dune environment. Dunes have been covered with housing and bulldozed for coastal view. An example from the Wellington Region is the two following pictures of Lyall Bay (Figure 5 and 6).

Figure 5 and 6: Lyall Beach, Wellington viewed from Sutherland Road in 1911 & 2006.
(Ref. PAColl-5584-45 Alexander Turnbull Library, Wellington, New Zealand, 1911 & Helga Küchly, 2006)

Recreation is an additional significant factor affecting most dune systems today. Lighting fires, excavating sun-traps, "sand-sliding", trampling damage by leisure visitors and horse traffic, vehicle access to launch boats and the increased popularity of recreational use of off-road vehicles all may cause blowouts and may prevent the regeneration or survival of most native dune species (Doody 1989, Dix et al. 1990, Gibbs 2002). In the desire to provide clean and pleasant beaches for holiday makers some beaches are cleared of beach litter. As seaweed, driftwood and other debris often provide the starting point of a new dune growth, sand and nutrient processes are altered (Doody 1989).

Furthermore, the direct and indirect alteration of sediment cycles by activity such as sand mining (Carter 1991) and the construction of shoreline structures (sea walls, groynes, rip-raps and breakwaters) change the dynamics of wave energy and sand blow processes. This often results in the narrowing and lowering of the beach that front them (Viles & Spencer 1995) and the damage of the natural dune structure by the reflected wind and storm waves (compared to sand dunes which absorb this energy).
Sea walls can also hinder sand moving dynamics and make it difficult for sand-binding species to establish as these species require a moving substrate for continuous growth (Gabites 1993). The stabilisation of dunes also enables the invasion of woody weed species like *Banksia integrifolia* (coastal banksia), *Lycium ferocissimum* (Boxthorn) a*nd Rubus fruticosus (*Blackberry).
Effects of global warming might also affect dune ecosystems through a change in wind and wave energy and a likely sea level rise (Urlich & Brady 2003).

As most sand dune ecosystems are located outside the existing conservation network and anthropogenic pressure is likely to continue, it is not surprising that sand dune habitats are one of the most threatened ecosystems in New Zealand. Dopson et al. (1999) stated in their document that the predominant threat to sand dune ecosystems is habitat loss and weed encroachment. With the New Zealand Threat Classification System lists 2002 (Hitchmough 2002) six sand dunes species (of the species stated under Appendix 6) were identified as having high conservation priority.

The species with the highest priority (category 1: nationally critical) is *Sebaea ovata*. Third priority (category 3: nationally vulnerable) is given to *Muehlenbeckia astonii* (shrubby tororaro). *Mazus novaezelandiae* subsp. *impolitus* (dune mazus) has been classified under category 4: serious decline. Under gradual decline (category 5) the species *Eleocharis neozelandica* (spike sedge), *Libertia peregrinans* (New Zealand iris) and *Selliera rotundifolia* can be found. Detailed description of these species and the structure of the classification system can be found in Dopson et al. (1999), Hitchmough (2002) and Molloy et al. (2002); however the following table will illustrate the key threats to these plant species.

Table 1: Nationally threatened sand dune plant species occurring in the Wellington Conservancy (after Dopson et al. 1999, Hitchmough 2002 and Molley et al. 2002)

Species	Priority Ranking Category	Threat
Eleocharis neozelandica **(Spike sedge)**	(5) Gradual Decline	• Weed encroachment (esp. pampas grass) • Change of natural dynamic of the habitat • Recreational use of habitat (vehicles) • Browse (rabbit) • Stock trampling • Eutrophication • Lack of legal protection
Libertia peregrinans **(New Zealand iris)**	(5) Gradual Decline	• Successional vegetation change • Weed encroachment • Recreational use of habitat (vehicles) • Habitat degradation and destruction
Mazus novaezelandiae **subsp. *impolitus f. impolitus*** **(Dune mazus)**	(4) Serious Decline	• Habitat degradation and destruction (dune slack converted to pasture or exotic forestry) • Weed encroachment (pasture grasses, clover)
Muehlenbeckia astonii **(Shrubby tororaro)**	(3) Nationally Vulnerable	• Habitat fragmentation and degradation • Recruitment failure (single sex populations and hybridisation) • Browse and Trampling • Lack of legal protection • Weed encroachment (smoothing by vines and marram grass)
Sebaea ovata	(1) Nationally critical	• Habitat destruction • Weed encroachment (pasture grasses, clover) • Browse (plume moth caterpillars) • Stock trampling
Selliera rotundifolia	(5) Gradual Decline	• Habitat degradation and destruction • Weed encroachment

2.3. Conservation value of sand dune ecosystems

Coastal sand dunes are important for the natural character of the coast, which refers to the ecological, physical, spiritual, cultural or aesthetic qualities that derive from nature.

Sand dunes and other coastal ecosystems like wetlands and lakes have a significant impact on the quality of coastal ground water as they act as natural filters of polluted water, which drains through them into the ground. Furthermore they play an essential role in coastal protection against shoreline erosion and flooding through providing a reservoir of sand and absorbing wave energy, as the following pictures of the Coastal Care Restoration Project at Papamoa East in the Bay of Plenty illustrates:

Figure 7 & 8: Before and after planting spinifex and pingao (May 1999 & June 2003) at Karewa Parade, Papamoa East (Coast Care BOP, 2004)

As mentioned earlier in 0. [Threats to sand dune ecosystems], alteration of the morphological structure of beaches such as shoreline structures can reduce this protective effect. As dunes were the first settlements of Maori, they also have a cultural and archaeological value with ancient middens and burial grounds sometimes still visible at sites. Besides this, the dunes also have an amenity value to us as they have significant contribution to our enjoyment of coastal recreation (Hesp 2000).

Looking at the ecological importance, sand dunes have become a habitat for many specialised plants and animals. The dynamic nature of the dunes creates various niches, which provide suitable habitat for a variety of specialist. Many of our native plants are so well adapted to the sand dune ecosystem that they can't compete outside it or they are dependant on newly exposed areas such as *Desmochoenus spiralis* (pingāo) and *Spinifex sericeus* (spinifex), which only can grow on moving substrate (Esler 1978).

Many bird species use sand dunes as a breeding site and are therefore dependent or partly dependent on coastal dune vegetation (Downing & Murphy 2001, Milne & Sawyer 2002), as the list of native bird species in Table 2 on the following page illustrates:

Table 2: Preliminary List of native Bird Species associated with coastal Sand Dune Systems in the Wellington Conservancy (Milne & Sawyer 2002, p.48)

Ardea novaehollandiae	White-faced heron
Anthus novaeseelandiae	Pipit
Charadrius bicinctus	Banded dotterel
Eudyptula minor	Little blue penguin
Haenatopus unicolor	Variable oystercatcher
Hacyon tabitica	Welcome swallow
Larus dominicanus	Southern black-backed gull
Larus novaehollandiae	Red-billed gull
Phalacrocorax carbo	Black shag
Rhipidura fulliginosa	Fantail
Sterna caspia	Caspian tern
Sterna striata	White-fronted tern
Vanellus miles	Spur-winged plover
Zosterops lateralis	Silvereye

Several insects are associated with the sand dune ecosystem, such as the moths *Ericodesma aerodana, Kupea electilis, Kiwaia jeanae* (Patrick & Dugdale 1999) and at least another 12 moths in the genus *Notoreas* (Patrick 1998). But probably the most well known example of a strictly coastal specialist in New Zealand is the endemic black and red katipo spider *Latrodectus katipo and atritus.* They usually inhabit the foremost dunes establishing webs in low-growing dune plants or driftwood. While both species can survive even in highly modified dune systems (Foster & Foster 1973) they cannot survive in dense vegetation such as in dense exotic marram grass, *Ammophila arenaria,* as they almost always construct their webs over open sand. Additional the removal of driftwood (firewood for nearby residence or in the process of beach cleaning) also have an impact on the spider since this is a favourite site for their snares (Patrick 2002).
Consequently coastal sand dunes should be preserved for the diversity of habitat and conservation of rare and specialised species associated with them.

3. Methodology – Conceptual issues

The formulation of a standardised monitoring handbook for coastal foredune vegetation in the Wellington District was carried out in several stages: first, an extensive research of existing literature, secondly, a trial implementation in the field at Lyall Bay (Wellington, New Zealand) and third, the revision of the monitoring concept.
The objective of the monitoring method is first, the assessment of the current geomorphic and vegetation status and management of coastal sand dunes (particularly foredune) and second, the detection of change through repeated measurement of these characteristics.
It aims for the survey data to be representative of the whole population and that the recorded parameters should be as comparable as possible, both in space and time. Furthermore the method was developed to be reasonable inexpensive, easy to apply in the field and for the results to be relatively uninfluenced by changing the surveyors.
The literature revision of coastal sand dune vegetation assessment and monitoring projects was less successful than first expected due to the lack of methodical academic literature with specific statements on the topic. Publications covering monitoring methods in concern of habitat and species conservation could be found in Mueller-Dombois & Ellenberg (1974), Goldsmith (1991), Traxler (1997) and Elzinga et al. (2001). To obtain get a broad idea about survey methods used in New Zealand in general, I will start out with a review of examples of survey methods for habitat and vegetation classifications other than sand dunes.

3.1. Review of vegetation and habitat surveys in New Zealand

An inventory method for describing New Zealand vegetation with emphasis on the compositional variation in mountain land forest is the so called RECCE or Reconnaissance method described by Allen (1992). It is a rapid broad-scale survey, similar to the widely used Braun-Blanquet method (Mueller-Dombois & Ellenberg 1974), which is used for phytosociological analysis. Also developed for mountain land forest, the method has been widely used in the description of other vegetation types varying in structure and composition such as shrub or grasslands. The method includes species list in height levels, with specific associated cover estimates, records of site characteristics and additional vegetation parameters. This method is generally quite similar to the one used in this handbook mainly because both derive from the basic principle of Braun-Blanquet. However as vegetation height of sand dunes is not multi-layered and through the general nature of both habitats, the parameters and characteristics differ quite considerably.
Two methods for permanent plots in grassland are described by Wiser & Rose (1997). The Wraight 20*20 m quadrate method (Wraight 1962) records plant species frequency data from a series of subquadrates by: using sampling rings evenly spaced along a transect, assessing species cover at eight randomly selected locations and measuring stature and density of the dominant tussock species on the plot. Cover is estimated with the Braun-Blanquet (1964) scale. This method was widely used by the former New Zealand Forest Service to assess changes associated with animal pest impact.
The Scott height-frequency method (Scott 1965) takes plant species frequency data over a range of height levels from a series of evenly spaced subquadrates along a 50 m transect. The method was used by the former Department of Scientific and Industrial Research (DSIR) and university researchers. Its advantage is the assessment of the change in habitat structure.

Unfortunately the use of permanent plots as described later in 3.3. [Vegetation] is quite difficult in highly mobile environments such as sand dunes and therefore both methods could not be implemented. Nevertheless general concepts were taken under consideration during the development of the monitoring method on hand.
The Ministry of the Environment developed a national standard process for the classification and assessment of estuarine and palustrine wetlands (Clarkson et al. 2002). An updated version can be found in Clarkson et al. (2004). The handbook gives a framework for the classification of wetlands and standardised wetland field record sheets. Using maps showing the wetland extent and main vegetation types and through the record sheet, subsequent assessments of the wetlands ecological significance can be made. Additionally, characteristics of the state of the wetland [such as the change in hydrology and ecosystem intactness (loss in area, effects of fragmentation), the change in dominance of native plants] and pressure indications [such as catchments water quality, animal access (stock) and undesirable species] can form a baseline for monitoring of the general condition of a wetland site. It would be desirable to develop a similar handbook for the classification and assessment for coastal sand dunes and I hope that the developed handbook in this document could be a first step towards it.
Monitoring methodologies for certain dune plant taxa have been developed by the Department of Conservation, such as for *Muehlenbeckia astonii* (shrubby tororaro) (de Lange & Jones 2000), but as the methodologies for monitoring single plant species differs strongly to monitoring the whole vegetation only little information could be taken from these documents. Therefore the following description of the monitoring method used to assess coastal sand dune vegetation was mainly developed by adjusting general monitoring and survey methods and guidelines to the specific characteristics of this kind of habitat.

3.2. Morphology

Changes in dune morphology or position may indicate variations in aridity, wind velocity and direction or disturbance by human. The method of measurement for this survey is the change in size, shape and position of the foredune.

To measure the dune shape a topographic profile along each transects should be made using a tape and hand-level (Abney level or surveyor's level) or cross staff. The survey consists of a series of angle and distances between points along the profile, as demonstrated in the following illustrations (Figure 9).

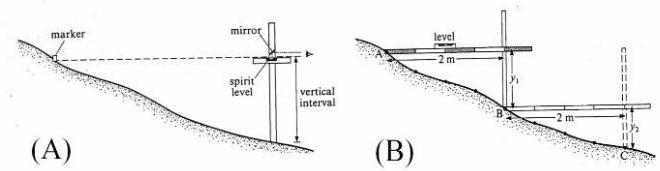

Figure 9: Slope profile survey with (A) cross staff, (B) transect poles (Chalmers & Parker 1989, p.31)

On the basis of these slope measurements the surveyor should then try to classify the dune to one of the stages of foredune morphology (based on Carter 1988, Hesp 1988a and Arens 1994) as illustrated in Figure 10 on the following page. To detect the morphological state it might be necessary to await the result of slope investigations of the following years.

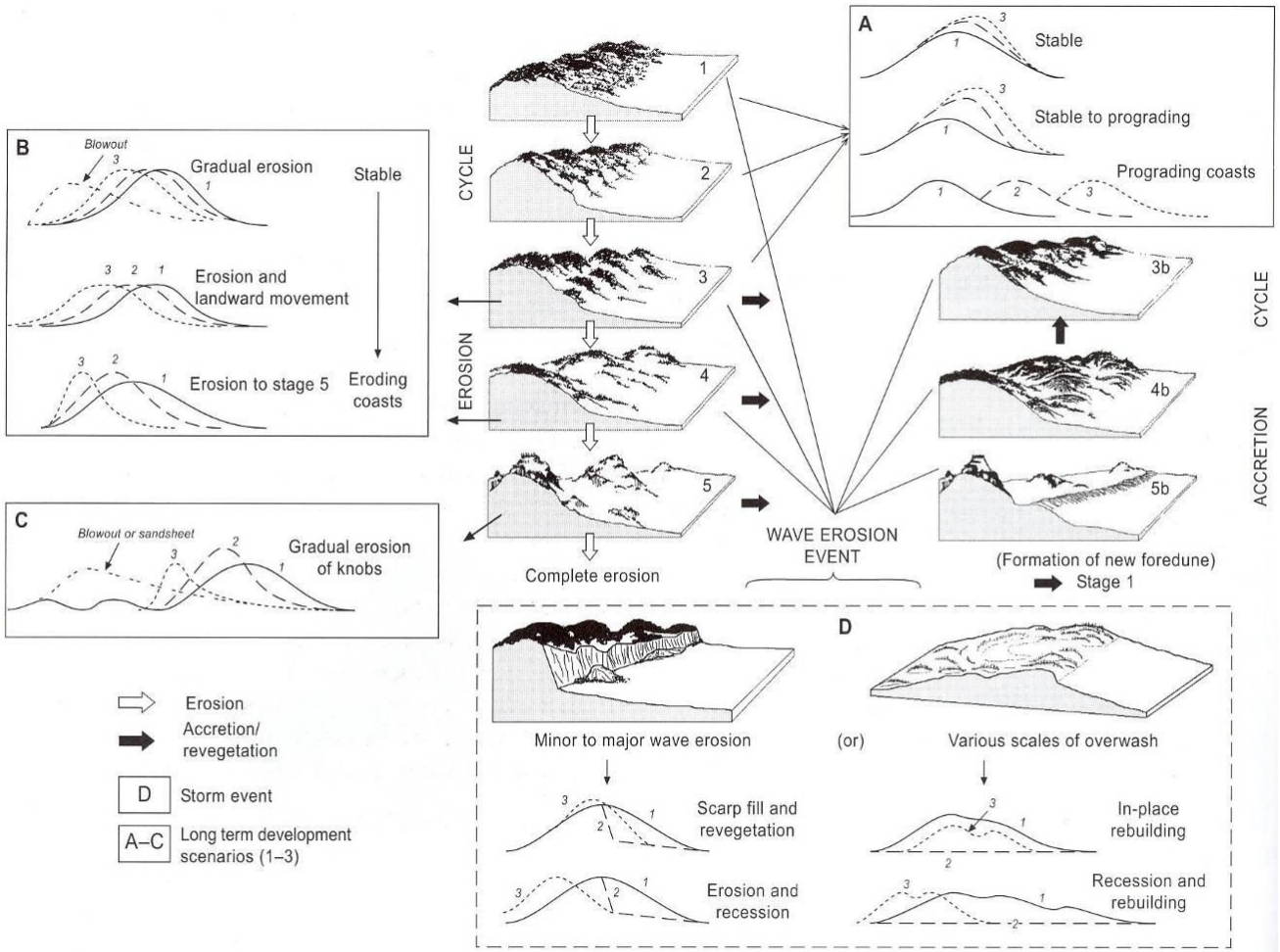

Figure 6.9 A model of established foredune morphology, dynamics and evolutionary trends on stable, prograding and eroding coasts. A foredune may remain in a particular stage, or it may evolve by erosion, accretion or vegetation processes to another stage. The long term evolution will be strongly influenced by beach surf zone state, sediment supply and coastal trend (prograding, stable or eroding) (based on Carter, 1988; Hesp, 1988a; Arens, 1994).

Figure 10: foredune morphology (Short 1999, p.158)

As it was difficult to find a definition of the *margin of foredune* within the literature and through contacting researchers of coastal sand dune, I propose to use the margin of the most seaward vegetation in this purpose. As illustrated in the model of foredune morphology in Figure 10, vegetation is largely responsible for the sand retention, hence the dune shape. Difficulties with this definition might arise on incipient foredune with only scattered vegetation cover but without the initiation of erosion processes. However with the low slope of foredune formed by *Desmochoenus spiralis* (pingão) and *Spinifex sericeus* (spinifex) I think it will be even more difficult to define the margin on attributes of slope. Furthermore on the basis of the dune characteristics stated in 0 [Morphology], the surveyor should asses the type of beach (reflective, intermediate or dissipative). Overall the consistency of the method will be more important than the technique used to detect changes in the dune morphology.
As shoreline engineering structures may have significant impact on sediment, hydrodynamics and shoreline geomorphology, they are included in the morphological description of the dune system. Additionally, obvious threat and management actions are also part of the data recording sheet provided in the Appendix 1.

3.3. Vegetation

Sand dune system are common throughout New Zealand, but only few locations have been sampled and described in detail [e.g. Farewell Spit in the northern South Island (Brown 1978), Chrystalls Beach at the East Coast of the South Island (Dobner et al. 1995), Whatipu Beach in the northern North Island (Pegman & Rapson 2005) and Cole Creek at the West Coast of the South Island (Sykes & Wilson 1991)].
Milne & Sawyer (2002) state that the Wellington dune community is similar to the one described in Newsome (1987) as illustrated in 0 [Sand dune form and vegetation], but suitable previous surveys of the Wellington Region in particular are generally lacking. Therefore the monitoring method developed is not only concerned with the distribution of species with conservation concern but more the vegetation pattern on the whole. Furthermore, the measurement of the nature, extent and significance of permanent changes requires these baseline vegetation surveys.

This kind of monitoring is often referred to as *surveillance* monitoring (Hella-Well 1991, Urlich & Brady 2003) or *non-regulatory* monitoring (Bayfield 1996), as predefined standards and critical values are generally lacking. In the conceptual classification of monitoring project (modified from Plachter 1991, Reich 1993 and Rowell 1993 in Traxler 1997, p.39), conservation studies can be separated into *general* and *specific* surveillance projects. *Outcome* and *result* monitoring are placed under specific surveillance and are not part of this survey. In the more detailed perspective general surveillance can be separated into *loss and damage*, *site integrity* and *site quality* monitoring. The methods developed should be regarded as site integrity monitoring as it will identify the spatial and qualitative changes of the habitat.

Sand dune ecosystems are also very dynamic habitats and the likelihood of shifting species distribution in association with changing dune morphology makes it impractical to use permanent plots. Furthermore, it would be quite difficult to tag permanent markers of the plot boundaries in such a highly dynamic surface and possible disruption from beach visitors.
Regarding the allocation of plots, Traxler (1997) and Greig-Smith (1983) comment that the *transect method* is an excellent instrument in monitoring gradients and moving vegetation borders as occur in the sand dune ecosystem. Smith et al. (1985) differentiate between *line transects*, where all plants contacting a line between two points are recorded, and *belt transects* with a defined width. As the first method is quite uncommon and transforms the plot into a one-dimensional line the belt transect technique was chosen as a more suitable method for this project. A transect is generally not referred to as one plot, but rather as an arrangement of several plots in a line along a gradient (here perpendicular to shoreline). These quadrates can be placed along the line continuously or at set intervals. The latter is used in this monitoring method to minimize time and effort. Furthermore Bormann (1953) found that using transect methods can cut the number of plots in half while retaining the standard error of random sampling techniques. Nevertheless, to assure that the survey method is following basic statistical principles transects are placed randomly over the area of interest (*stratified random sampling*) using a random number table (in Appendix 5). Caution is advised when areas of different management action (e.g. replanting of sand-binding plant species, fencing) are contained in the site, and it is recommended to subdivide the area before the random placement of transects.

To assure that the recorded vegetation changes are representative for the total area of interest, a *minimum area*, depending on the homogeneity of the plant population, has to be examined. It is accomplished when despite an increase in area no new species are added (Mueller-Domboise & Ellenberg 1974). Unfortunately, there was no information available about how big the minimum area should be in sand dune ecosystems and how to proceed when using the transect method, but due to the small-size occurrence of sand dunes in the Wellington Region, the whole foredune can be set as the minimum area. Furthermore, to assure that each sampling unit is independent, which means they are not correlated to each other (response of species from one quadrate to the other); plots should be placed with adequate space between each other. The average size and pattern of gaps or microsites in the habitat, the average size of individuals and the size of clones should be considered when making these decisions (Elzinga et al. 2001).

The *sampling intensity*, which can be referred to in this context as the distance between transects along the shoreline, is an indirect proportional function of the confidence interval and is a measurement of the reliability of the survey. It is dependant on the homogeneity of the plant population. The degree of homogeneity is expressed as the standard deprivation of the median or variance. Furthermore the confidence limits and accuracy (e.g. a 10% in change of vegetation cover should be identified) have to be set. Detailed information about the calculation of the necessary number of samples can be found in the literature (e.g. Greig-Smith 1983; Chalmers and Parker 1989, Traxler 1997 and Elzinga et al. 2001).

Besides the sampling intensity, the survey should always be conducted in the same *period of the year* to allow the comparison of data between different survey years. It is not possible to precisely orientate the time of the measurements on the date of the calendar as the annual course of the season might differ between years, often by several weeks. Especially at the beginning of the vegetation period, 2-3 weeks time difference can have a large impact on detected cover values. It is therefore appropriate to conduct the survey in a period, where most of the vegetative growth is largely finished and many plants already flower or yield fruits (Glanz 1986). To identify long-term vegetation trends Ferris-Kaan & Patterson (1992) suggest a survey frequency depending on the plant life-forms. As sand dune ecosystems are composed of a mixture of annual and perennial life-forms an interval of 2-3 years is recommended.

As a *qualitative* description of population dynamics, *presence/absence* data is generally too inaccurate for conservation surveys as information about the disappearance of species from sites is received too late to be able to response to it. Hence information about the population size and defined position should be acquired. This enables explicit statements of natural growth to be made and allows the description of trends in population propagation /decline (Käsermann 2002).

As most sand dune species grow in clonally, rhizomatous or poorly defined groups, direct *quantitative* measurements of the number of individual of plant species are practically impossible. Hence approximate values of cover and frequency are used to describe population dynamics (*semi-quantitative technique*). *Cover* values reflect the comparative (relative) area that plants take up for light absorption (Bonham 1998). It is the area that is covered by the plant on a vertical projection and is expressed as the fractional amount of the total plot area (Mueller-Domboise & Ellenberg 1974). It provides information about the *dominance* relationship in the population.

I chose to use a modified estimate scale after Braun-Blanquet (1964) as it is quite accurate in the bottom range of the scale (most species generally occur at ≤10% cover) but is still not too time consuming compared to more precise estimation scales (e.g. Zacharias 1996). It is also a very common score used in monitoring change in New Zealand (Wiser et al. 1997). A similar scale after Domin (1923) has been used in the survey method of sand dunes in Ireland (The Heritage Council 2005) with the additional recording of species found outside the quadrate. As this method is also very effective in the detection of rare species, but at the same time not too time consuming I constructed my method along similar lines. However, as no survey in New Zealand using an estimation scale after Domin (1923) could be found, I choose to use the more common scale after Braun-Blanquet (1964) as in Table 3, which is less accurate in the lower percentage range, but through the higher recognition within New Zealand datasets from different surveys is more likely to be comparable with each other.

Table 3: Estimate scale modified after Braun-Blanquet (1964)

scale	**% cover of species**
+	outside the quadrate
1	< 1
2	1-5
3	6-25
4	26-50
5	51-75
6	76-100

General caution has to be made with the interpretation of the results. As cover values fluctuate highly during the year only substantial changes in value should be interpreted.

To obtain information about the *spatial distribution pattern* of species, *frequency* values can be estimated within the data obtained by the cover estimation process. The number of samples where the species is present divided by the total number of plot samples represents the frequency (Clarke 1986). Compared to cover, frequency is a very impartial (objective) parameter as only presence/absence in each sub-plot is recorded compared to the estimating percentage cover. Sand dune ecosystems are relatively species poor habitats and frequency measurements are therefore not very time-consuming. However, frequency is not an absolute parameter and will change with the chosen size of the subplot (Traxler 1997). As vegetation surveys with conservation concern also aim to detect *all* species present in the area (rare and endangered species are commonly not widespread over the area), I attempted first to solve this problem by using *nested plots* (e.g. Morrison et al. 1995) using more than one plot size around the same plot centre as illustrated below:

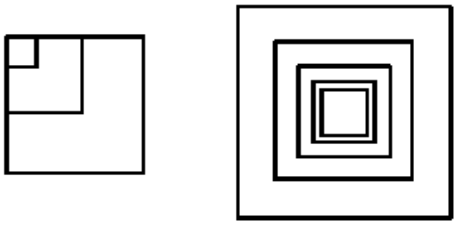

Figure 11: Variations of nested plots (adapted from Traxler 1997, p.46)

However, as the implementation in the field demonstrated, the marking of the plot boundaries was the most time consuming process and the dune system was highly disturbed by the trampling of the surveyor. Due to the low species diversity only minor changes in the detection of species occurred with the extension of the plot size. Therefore the method now involves only single sized plots with an additional search of its surrounding area, as illustrated in the following picture (and further explanation in Part Two- General Guidance):

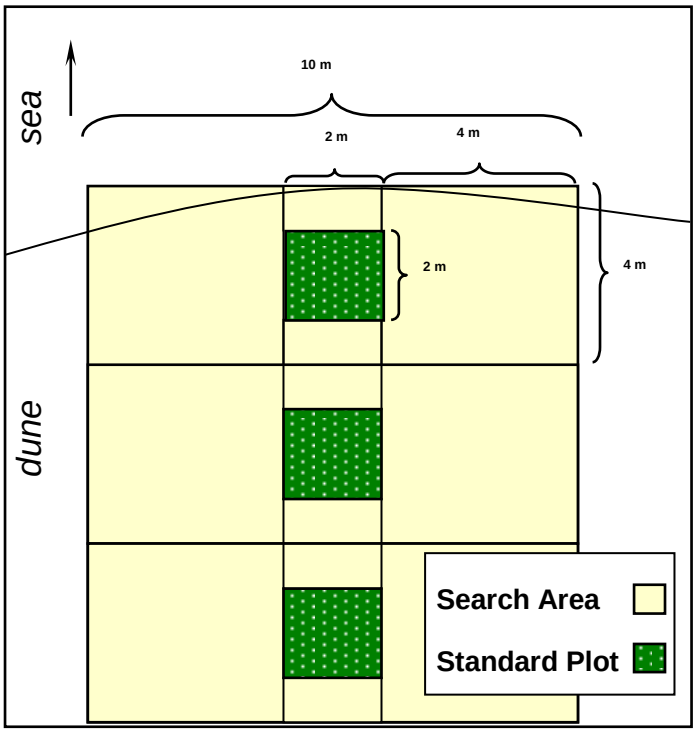

Figure 12: Plot alignment on transect

Finally, decisions about the *plot boundary* have also to be made. This is important as many dune plants have a large basal diameter and may often straddle a boundary, leading to overestimation of these species if all plant parts touching the line are included and underestimation if only plant completely within the quadrate are recorded. Elzinga et al. (2001) recommends to use both extremes at each of the four sides of the quadrate (adjacent or alternately). But as the main purpose of the study is to detect change, it is more important to be consistent, but generally I would advice following Elzinga's recommendation.

Concerning the actual implementation in the field, the plot size and the interval of plots in transects have to be set. For this purpose I summarised the method and plot size researchers used in various sand dune vegetation surveys, as illustrated in Table 4 on the following page.

Table 4: Comparison of different sand dune vegetation surveys in New Zealand

Published Paper	Brown (1978)	Pegman and Rapson (2005)	Dobner et al. (1995)	Sykes and Wilson (1991)
Total Survey Area	3.5 km long	400*2000m	-	~ 1 km long
Number of Plots	4 transects	90	100	15 transects
Standard Plot Size	2 m wide transect	10*10 m	1*1 m	0.5*0.5 m
Placement of Plots		• Random sampling • Shoot presence	• Restricted randomisation	• Random placing of transects, 1m intervals of plots along each transect
Vegetation measurements	• % cover with distance to the sea (m)	• % cover, water, litter, shell, exotic plants	• Shoot presence	• Shoot presence/ absence
Physical measurements		• Slope • Plant Height • Sand sample • Sand movement (sand traps)	• Sand sample • Sand movement (sand traps)	• Slope • Sand sample every 10m along transect

The first attempt to determine an appropriate plot size through the study of previous dune surveys was rather unsuccessful as various sizes had been used.
Sykes and Wilson (1991) used a relatively small plot size to minimise mixed samples of different dune zonation as in their study they were mainly interested in the distribution of habitat types and their correlation to environmental factors. Pegman & Rapson (2005) were mainly interested in the recording of dune succession and therefore used the largest plot size. Dobner et al. (1995) gave a detailed description of the area and distribution pattern and it is suggested by the author that the plot size they used (1*1 m) will also be the most suitable for the monitoring survey method of this handbook.
However, the implementation in the field showed that with the large diameter of sand binding plant species several plots of the size 1*1 m only contained one of these species despite the occurrence of various other species nearby the observed quadrate. I therefore would suggest a plot size of 2*2 m which will include more species but at the same it still will be easy manageable to estimate cover percentages.

Finally, the list of indigenous and exotic plant species associated with coastal dune vegetation in the Wellington Region was taken from Milne & Sawyer (2002) as the basis for the plant recording sheet found in the Appendix 6 and 7 (with correction of nomenclature and spelling mistakes). The only plant added to their list was *Cakile maritime* (Sea rocket) as it could be found at various sites around Wellington (e.g. Lyall Bay).This list also indicates species identified as key species of the sand dune community after Milne & Sawyer (2002) and nationally threatened species listed in Dopson et al. (1999).
Detailed guidance to conduct the survey will be explained in the following Part Two-General Guidance.

Part Two – General guidance

1. Prior to field work

- **Advance information:**
  Prior to going out in the field, existing information of the site (previous habitat surveys, management actions, severe storm events etc.) should be acquired (e.g. Department of Conservation, local beach care group).
  Aerial photographs are particularly useful. It is helpful if the surveyor has some understanding of the management and other factors likely to affect sand dunes.
  Information about key conservation sites in the Wellington Region can be found in *Coastal foredune vegetation in Wellington Conservancy - current status and future management* (Miles & Sawyer 2002).
  The guidance should be read prior to the field visit and the observer should make him/ herself familiar with the recording sheet.

- **Required skills:**
  The implementation of the survey does not require specialist geomorphologic or botanical expertise but consistent work commitment of the surveyor. It is important that the person carrying out the assessment be capable of identifying the species with the information given in this handbook or through the consultation of third party verification.

- **Access and permission:**
  Permission should be obtained whenever required (e.g. access through private land). Landowners should be informed about the implementation of the survey; additionally it might be desirable to inform the Department of Conservation and any other conservation agencies responsible for the region.

- **Required equipment:**
  Baseline maps, plant identification keys, field forms, measurement tapes (100 m and 10 m), camera, field notebook, plastic bags and permanent marker (for plant samples, e.g. unidentified species), ball of string (bright coloured) and rods or, if required, an estimation frame and equipment for the slope survey [tape and hand-level (Abney level or surveyor's level) or cross staff]. A *hand-held GPS* is extremely desirable for accurate location of sample points.
  It is recommended to have enough copies of the form for conducting the analysis of the site.
  It might be helpful to use a clip-board and "weather-writer' (soft pencils might also be useful) and to keep all documents in a waterproof folder or the like.

- **Health and safety:**
  Safety should always be an integral part of a landscape assessment.
  Every effort should be made to minimize risk, such as:
    - Surveyors should inform others about the location and time of the undertaking fieldwork. This is especially important for surveyors working alone in remote areas.
    - Wearing the right clothes and sun protection (e.g. sunhat, sunscreen, long sleeves and trousers, boots or sturdy shoes).
    - Weather forecast should be consulted.
    - Watching out for hazards, especially in urban areas (e.g. broken glass, sharp metal or decomposing waste).
    - Carrying a basic first aid kit.

- **Suitable conditions and seasonal timing :**
  It is recommended to conduct the survey in a period, where most of the vegetative growth is largely finished and many plants already flower or yield fruits (in Wellington around January to late March). Furthermore, following observations of the same site should be conducted in the same vegetation period to allow the comparison if the data (flowering or fruiting of particular plant species).

2. The Form

- The form is separated into a general site description (2 pages) and transect recording sheet (4 pages).

- The form is designed to be straight-forward and simple to fill in, and should be completed in full.
  The surveyor should take adequate time to make sure that all handwriting is clearly legible (otherwise it might slow down data entry process and can introduce errors into the datasets)
  Additional information should only be added if substantially important for the evaluation.

General study site description

- **Site no:**
  Each study site should be consecutively numbered.

- **General information:**
  Contact details of surveyor, general information about site, grid reference (New Zealand) and Geodatum (D.94 or WGS 64) used when working with GPS device.

- **Location of study area:**
  Start and End point data (GPS) should be included to mark the approximate extent of the examined area.

- **Location of data storage:**
  Place (hard drive, cd etc.) where information about site (recording sheets, photographs, maps, slope measurements etc.) is held.
  Besides adequate local storage of the collected data, it is also recommended that all data sheets are logged within the National Vegetation Survey databank (Landcare Research), which is the national repository for vegetation data.

    - **Map no:**
      Geographic information (e.g. GPS coordinate data) of features (extent) of dune vegetation, plot location, anthropogenic features) should be illustrated in map form [e.g. handwritten map or more desirable the entry into a geographic information system (e.g. Arcmap)]. These maps should be consecutively numbered consequential to the Site No

    - **Photographs:**
      For the visual illustration of the site photographs should be taken showing:
        - The overall character of the beach and foredune
        - Anthropogenic features
        - Erosion
        - Conservation Management Action
        - Sample plots

Be sure to include information about the location of taken photographs (Site No.) and the number of taken photographs (to be able to identify missing pictures). Include such information in the file name when taking digital photographs or on a placard when using films.

- **Sketch map:**
  Simple handwritten map to illustrate general site characteristics (especially helpful when observer works with GPS device in the assistance of a more precise map production back in the office);

Morphology

- **Beach type:**
  Beach types should be roughly classified with the utilisation of the beach characteristic table below, and information about the physical structure, climate and oceanic data etc. For the purpose of this survey it will be sufficient enough to make this decision using characteristics easily detected in the field, mainly beach slope, beach profile, common sediment type and dunes.

Table 5: Beach Characteristics (adapted from Viles and Spencer 1995, p.37)

Characteristic	Reflective	Intermediate	Dissipative
Approx. surf zone width (m)	< 10	10-100	100->1000
Wave breaker height (m)	<1	1-2.5	>2.5
Breaker Type	Plunging-collapsing	Spilling-plunging	Spilling
Beach slope (°)	> 3°	3-1°	<1°
Common Sediment Size	Coarse sand, gravel	Medium sand	Silt to fine sand
Dunes	Usually small	Intermediate	Usually large

- **Foredune margin:**
  Foredune margin should be measured by taking the location of the foremost vegetation boarder of dune with the help of a GPS device. Location where point data is held should be indicated under location of data storage. Alternatively aerial photography can be used to detect the foremost vegetation border (as stated in the column).

- **Foredune morphology:**
  This point only can be completed after the measurement of the slope of each transect and the extent of the foredune vegetation and the use of the foredune morphology characteristic (Figure 10, p.18). It might be necessary to await measurements of assessments in the following years to make this classification.

Anthropogenic influence

- The spatial location of these features should be either recorded on a hand-written map (with compass bearing, distance to transect or the like) or, if possible, with GPS coordinates. In both cases the short key used in the map, or for the GPS coordinates, should be to simplify matters stated under spatial location.
  Generally, the purpose of these following measurements is to help interpret the more quantitative measurements (like plant cover).
  For the visual illustration photographs should be taken, but to avoid accumulation of irrelevant data pictures should be taken in moderate amount.

- The measurement of it the impact will only be recorded in a very broad scale in respect to its effect on environment (e.g. high impact of tramping tracks by beach visitors would be the absence of plant species and sand erosions on these tracks on and high frequency of these disturbance on the study area)

- **Houses/developments:**
  Record of any houses or other development structures (kind should be stated) in the immediate vicinity of the sand dune (surf club, batch, café/restaurant etc.).

- **Shoreline structures:**
  Similar to above point, any structures should be recognised, their location should be measured and short key stated. Pictures illustrating the different structures can be found in the Appendix 4.
  General definitions of the stated sea structures are (adapted from the online Wikipedia):

    - **Breakwater**: A wall built parallel to the coasts to intercept incoming waves and thus protect the shoreline.
    - **Groynes**: Groynes are structures running vertical to the shoreline, generally made of concrete, wood or piles of large rocks. The effect of groynes is to accumulate sand on the up-drift side.
    - **Seawall**: A wall of stone, concrete, or other sturdy material, built along the shoreline to prevent erosion even by the strongest and highest of waves
    - **Rip-Raps**: A pile of large, sharp boulders built seaward of the shoreline to prevent erosion by waves or currents

- **Vehicle/boat access:**
  Any access path through the dune system;

- **Car park:**
  Any car park in close proximity to dune system;

- **Pipes:**
  Visible sewage pipes, road drainage water etc.;

- **Thoroughfare through dune system:**
  Any road etc. through the dune system or in close proximity; traffic density of vehicles [from **1**, no impact (never) to **5**, extreme impact (thoroughfare day and night)]

- **Sand mining:**
  Any extensive extraction of sand;

- **Trampling of livestock/other animals:**
  Any presence of use of sand dune as pasture for livestock, or visible presence of other animals and their impact on the sand dune vegetation [from **1**, no impact (no visible sight) to **5**, extreme impact (numerous trampling tracks, high sand erosion)]

- **Grazing of livestock/other animals:**
  Any presence of use of sand dune as pasture for livestock, or visible presence of other animals and their impact on the sand dune vegetation [from **1**, no impact (no visible sight) to **5**, extreme impact (high grazing damage on plants, absence of palatable plant species)]

- **Others:**
  Any other anthropogenic feature not stated above and direct/indirectly affecting the sand dune ecosystem should be described.

Recreation

- **Trampling tracks of beach visitors:**
  Impact of beach visitors walking through sand dune [from **1**, no impact (no visible sight) to **5**, extreme impact (numerous trampling tracks, high sand erosion at these sights, high frequency of beach visitors throughout the year)]

- **Evidence of vehicles**:
  Impact of vehicles launching boats through sand dune or recreational use of off road vehicles [from **1**, no impact (no visible sight) to **5**, extreme impact (numerous tracks, high sand erosion at these sights, high frequency of vehicles throughout the year)]

- **Beach litter (debris)**:
  Occurrence of seaweed, driftwood and other natural debris of the beach

- **Domestic litter**:
  Any domestic litter left behind from beach visitors and washed ashore [from **1**, no impact (no visible sight) to **5**, extreme impact (high frequency of litter throughout the site, at beach and sand dunes, various kinds of rubbish (organic and hazardous))]

- **Beach litter clearing:**
  Clearing of natural and domestic litter from the beach; Impact depending of occurrence of cleaning event [from **1**, no impact (no visible sight) to **5**, extreme impact (every day)]

- **Others:**
  Any other recreational impact of beach visitors not stated above and direct/indirectly affecting the sand dune ecosystem should be described.

Erosion

- **Wind:**
  Presence of blowouts or sand covering vegetation; a picture can be found in the Appendix 4.

- **Wave:**
  Scarp or overwash of sand dunes, if possible with data of the storm event responsible;

- **Others:**
  Any other form of erosion not stated above/or under anthropogenic impact and direct/indirectly affecting the sand dune ecosystem should be described.

Conservation management actions

- **Fortified beach access:**
  Any fortified beach access for beach visitors;

- **Fencing:**
  Any fencing for the protection of vegetation;

- **Replanting:**
  Replanting of sand dune species, if known with information about the species used and date of action;

- **Weed control:**
  Any control procedure of exotic weeds, if known with information about the removed species and date of action;

- **Fertilisation:**
  Any application of fertiliser and if known data of the treatments;

- **Others:**
  Any other form of conservation management action directly/indirectly affecting the sand dune ecosystem should be described.

Transect survey

2.3.1. Survey method:

- **Subdivide site into areas,** if necessary areas of equal management action (e.g. replanting, fencing).

- **Select number of transects and spacing between them** (sampling intensity) (see also Greig-Smith 1983 p.5; Traxler 1997, p.65) e.g. one transect every 100 m or 2 transects in each subdivided area.

- **Place transects** randomly within these sub-areas using a random number table (provided in the Appendix 5).

- Choose **standard plot size** (2*2 m recommended)

- Use **belt-transect method** with set interval of standard plots (2m distance between standard plot boarders recommended), placing the first and last standard plot approximately at half distance from the dune border (if 2m distance is chosen this would be 1 m from the approximate dune border).

- The following Figure illustrates the placement of the plots along the transect:

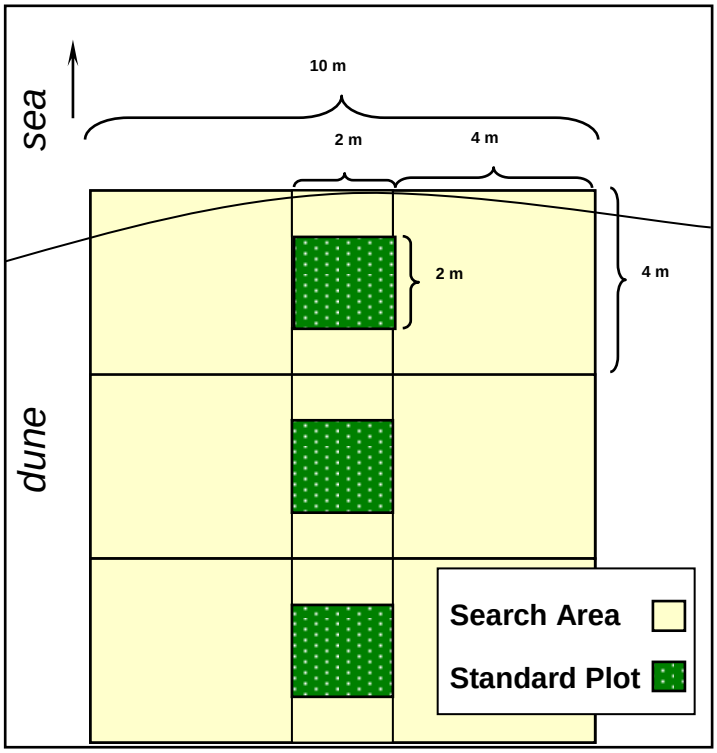

Figure 13: Plot alignment on transect

- **Site No:** Re-enter number of study side used in the general site description sheet.

- **Transect No:** Each transect should be consecutively numbered. It is advised to use a number in correlation to the site N. (e.g. 1/1, the first number indicating the site and the second number the transect). Furthermore the distance to starting point of the survey (e.g. from random number table) should be recorded and the bearing in magnetic of transect so further surveyor knows what direction to walk

Morphology

- **Slope measurements:** Measure the elevation along the transect using one of the common work methods (Figure 9, p. 17). Detailed information about elevation measurements can be found in Leopold & Dunne (1972). The point of the measurement at the transect should be recorded in m distance from the start point.

Vegetation

- **Plot No.:** Each plot should be consecutively numbered. It is advised to use a number in correlation to the site N. and transect N. (e.g. 1/1/1, the first number indication the site and the second the transect and the third the plot).

- Plots can be either marked with the use of rods and colourful rope or an estimation frame or measurement tapes, but the experience in the field showed that generally the easiest and fastest way to mark the plot would be to line two measurement tapes with the spacing of the transect (e.g. 2m) along the transect and to use coloured sticks to mark the boarder of the standard plots.

- Plants on the recording sheet are in alphabetic order and were obtained from Miles & Sawyer (2002) with correction of spelling mistakes of the Latin names and the addition of *Cakile maritime* (Sea rocket).

- Exotic species are marked with grey shading; the five key species of coastal sand dunes after Miles & Sawyer (2002) are in bold letters; and nationally threatened species listed in Dopson et al. (1999) are underlined.

- Key description and photographs of most of the species found in the transect sheet can be found in the Appendix 6 and 7.

- Further information about sand dune species in general can be found in Crowe (1995) and Allan et al (2000), about the five key species in Miles and Sawyer (2002) and about the six nationally threatened species in Dopson et al. (1999).

Cover

- Estimate cover of all *standard plots* of the transect of:
    - Vegetation (species by species)
    - Exposed sand
    - Surface water
    - Shell
    - Organic litter (including dead plant material)
    - Rubbish

- Use the modified estimation scale after Braun-Blanquet (1964) as illustrated below:

Table 6: Estimate scale modified after Braun-Blanquet (1964)

scale	% cover of species
+	outside the quadrate
1	< 1
2	1-5
3	6-25
4	26-50
5	51-75
6	76-100

- Note: In an 2*2 m plot 1% are 20 cm ^{2}

- Plant species not occurring in the quadrate but nearby should also be recorded ("+" in the recording sheet). As surveys with conservation concerns are also particularly interested in the rare species the search for species should be done in a conductive manner. I recommend to search in a zigzag walking pattern up to a defined distance at both sides of the transect (e.g. 10m) extending half the distance to each plot boundary (e.g. 4m). This search area is illustrated in Figure 13. Search should also be limited to a certain time (e.g. 3 min) to standardise the undertaken search effort.

- Notable species occurring outside these "surrounding search area" should also be recorded with their distance and bearing to the closest transect and/or exact location (GPS) in the respective recording sheet of the closest transect.

- It should be taken into consideration that the accuracy of any estimate is dependant on (Greig-Smith 1983, Traxler 1997):
    - Plot size (the smaller the better)
    - Distribution pattern (compact spots are easier to estimate than distributed individuals)
    - Growth form of the species (large leafy plants often overestimated)
    - Variation in conspicuousness between different states (e.g. flowering – vegetative)
    - Visual differentiation of species
    - Layers of different plant height (top cover might be overestimated)
    - Boundary decision (see 3.3. Vegetation for more detail).

- Number of observers (two observers at the same time are much more accurate)
- Training of the observer

- To improve percentage cover values the actual procedure can be conducted as following (Traxler 1997):
  - Accurate search of the whole quadrate at an immediate distance to detect species and to make rough estimation of cover (plenty, medium, sparse).
  - Envisage the areas covered by one species collected into one corner of the quadrate to estimate the percentage cover value (using the Braun Banquet (1964) estimation scale as listed above), as illustrated below:

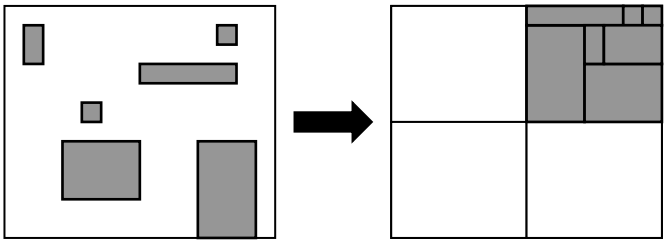

Figure 14: Imaginary pushing together of areas covered by a species for improved cover estimation (adapted from Traxler 1997, p.105)

  - Then step back and estimate at a glance the same value from a broader range.
  - Compare the two values and decide upon the most appropriate estimation value.

- Other practical assistance for the vegetation estimation (Traxler 1997):
  - *"Fist trick"* (up to 15 % cover): a man hand fist makes up a 10 *10 cm quadrate (which is 0.5% in a 2*2 m quadrate). By moving the fist over compact species, percentage cover can be added up without the imaginary shifting.
  - *Estimation frame*: collapsible metal quadrate secured at the corners by butterfly bolts and a wire reticule. First count squares that are fully occupied, than those partly occupied (estimate how many full square this would be)

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I first got interested in the topic after I found out how little lowland and in particular coastal areas are covered under the current conservation network and that scientific information about these sites is generally lacking. It seems like coastal sand dunes are slightly 'out of fashion' at the moment as it took immense time and effort to find suitable literature and without the help of various people this handbook might have never been completed.
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Appendix 1: General Site Recording Sheet

Site Nr:	**Date:**

GENERAL INFORMATION

Observer: Name: Address: Tel.: E-mail:	**Nearest Major Location:**
	Ecological District:
	Owner/Occupier of Land (if known):
	Grid Reference:
	Geodatum:
Location of study area : Start/End Point(GPS)	**Sketch Map:**
Location of Data Storage: **Map Nr:** **Photographs:** ☐ Yes ☐ No	

MORPHOLOGY

Beach Type: ☐ Reflective ☐ Intermediate ☐ Dissipative

Foredune Margin: ☐ Aerial Photograph ☐ Measurement

Foredune Morphology:

☐ 1 (stable) ☐ 2 (stable to prograding) ☐ 3 (prograding to eroding)

☐ 4 (eroding and landward movement) ☐ 5 (strong eroding)

ANTHROPOGENIC FEATURES	**Present**	**Absent**	**Spatial Location, Photo & Comments**
Houses/Developments:	☐	☐	
Shoreline Structure:			
Breakwaters	☐	☐	
Groynes	☐	☐	
Rip-Raps	☐	☐	
Sea walls	☐	☐	
Others :			
Vehicle/Boat access to beach:	☐	☐	
Car park:	☐	☐	
Pipes:	☐	☐	
Thoroughfare through dune system:			
Paved	☐ Yes	☐ No	
Traffic Density	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5		

Sand mining:	☐	☐	
Trampling of Livestock/other Anilmals: Impact on dune vegetation: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐	☐	
Grazing of Livestock/other Anilmals: Impact on dune vegetation: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐	☐	
Other:			

RECREATION	**Present**	**Absent**	**Spatial Location, Photo No & Comments**
Trampling tracks of Beach Visitors: Impact on dune vegetation: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐	☐	
Vehicle tracks : Impact on dune vegetation ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐	☐	
Beach Litter:	☐	☐	
Domestic Litter : Impact on dune vegetation ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐	☐	
Beach Litter Clearing: Impact on dune vegetation ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐	☐	
Other:			

EROSION	**Present**	**Absent**	**Spatial Location, Photo No & Comments**
Wind:			
Blowout	☐	☐	
Sand covered vegetation	☐	☐	
Wave:			
Scarp	☐	☐	
Overwash	☐	☐	
Date of last severe storm event (if known):			
Other:			

CONSERVATION MANAGEMENT ACTIONS	**Present**	**Absent**	**Spatial Location, Photo No & Comments**
Fortified beach access:	☐	☐	
Fencing:	☐	☐	
Replanting: Species (if known): Dates (if known):	☐	☐	
Weed control: Species (if known): Dates (if known):	☐	☐	
Fertilisation: Dates (if known):	☐	☐	
Others:			

Appendix 2: Transect Recording Sheet

Site No:	**Date:**
Transect No:	
GENERAL INFORMATION	
Reference point (GPS):	**Length of Transect(m):**
Distance to Start (m):	**Number of Plots:**
Transect Location (GPS): front: rear:	**Picture No:**
Comments to location:	

MORPHOLOGY

Slope Measurement:

Point at Transect (m)	Slope	Point at Transect (m)	Slope

VEGETATION

Standard Plot (ST) Search Area (SA)	(ST)	(SA)	(ST)	(SA)	(ST)	(SA)	
Plot No:							Comments:
Exposed sand							
Surface water							
Shell							
Organic litter							
Rubbish							

Acaena pallida Sand piripiri							
Acacia spp. (incl *A. dealbata* and *A. sophorae* Wattle							
Agapanthus praecox African lily							
Agrostis capillaris Browntop							
Ammophila arenaria Marram grass							
Apium prostratum Shore celery							
Apodasmia similis Jointed wire rush (Oioi)							
Atriplex cinerea Grey saltbush							
Austrofestuca littoralis **Sand tussock**							
Banksia integrifolia Coastal banksia							
Bolboschoenus fluviatilis Marsh clubrush (Kukuraho)							
Brachyglottis compacta Castlepoint groundsel							
Bromus diandrus Ripgut brome							
Cakile maritima Sea Rocket							
Calystegia sepium subsp. roseate Pink bindweed							
Calystegia soldanella Shore bindweed							
Carex geminata Cutty grass							
Carex pumila Sand sedge							
Carpobrotus edulis Ice plant							
Chrysanthemoides monilifera subsp. monilifera Boneseed							
Cirsium arvense Californian thistle							
Cirsium vulgare Scotch thistle							
Coprosma acerosa **Sand coprosma**							
Coprosma repens Taupata							
Cordyline australis Cabbage tree							
Cortaderia jubata Purple pampas grass							
Cortaderia selloana Pampas grass							
Craspedia uniflora var. *grandis* Woollyhead							
Cupressus macrocarpa Macrocarpa							
Cyperus ustulatus f. ustulatus Giant umbrella sedge							
Cynodon dactylon Indian doab							

Desmoschoenus spiralis **Pingao**							
Discaria toumatou Matagouri (Wild Irishman)							
Disphyma australe subsp. australe Iceplant							
Ehrharta calycina							
Ehrharta erecta Veldt grass							
Eleocharis neozelandica Spike sedge							
Eryngium vesiculosum Sea holly							
Euphorbia glauca Shore spurg							
Glaucium flavum Horned poppy							
Gunnera arenaria Sand gunnera							
Holcus lanatus Yorkshire fog							
Isolepis nodosa Knobby clubrush							
Juncus articulatus Jointed rush							
Juncus gregiflorus Leafless rush, Wiwi							
Lagurus ovatus Hare's-tail							
Lavatera arborea Tree mallow							
Libertia peregrinans New Zealand iris							
Lupinus arboreus Tree lupin							
Lycium ferocissimum Boxthorn							
Mazus novaezeelandiae subsp. impolitusf. impolitus Dune mazus							
Medicago polymorpha Bur medick							
Melicytus crassifolius Thick-leaved mahoe							
Muehlenbeckia astonii Shrubby tororaro							
Muehlenbeckia axillaris Creeping pohuehue							
Muehlenbeckia complexa Small-leaved pohuehue							
Muehlenbeckia ephedroides Leafless pohuehue							
Olearia solandri Coastal tree daisy							
Ozothamnus leptophyllus Tauhinu							
Parapholis incurva Sickle grass							
Pennisetum clandestinum Kikuyu grass							
Phormium cookianum subsp. hookeri Mountain flax							

Phormium tenax New Zealand flax (Harakeke)							
Pimelea arenaria **Sand daphne**							
Pimelea prostrata New Zealand daphne							
Pimelea urvilleana							
Pinus spp. Pine							
Plagianthus divaricatus Shore ribbonwood							
Plantago coronopus Buckshorn plantain							
Poa cita Silver tussock							
Polycarpon tetraphyllum Allseed							
Potentilla anserinoides Silverweed							
Pteridium esculentum Bracken fern							
Ranunculus macropus Swamp buttercup							
Raoulia australis Common mat daisy							
Raoulia hookeri Scabweed							
Rhamnus alaternus Evergreen buckthorn							
Rosa rubiginosa Sweet briar							
Rubus fruticosus Blackberry							
Schoenoplectus pungens Three-square							
Shoenoplectus tabernaemontani Lake clubrush (Kopupu)							
Scleranthus biflorus Canberra grass							
Schedonorus phoenix Tall fescue							
Sebaea ovata							
Selliera radicans Remuremu							
Selliera rotundifolia							
Senecio angulatus Cape ivy							
Senecio elegans Purple groundsel							
Senecio glastifolius Holly-leaved senecio							
Solanum aviculare f. latifolium							
Spinifex sericeus **Spinifex**							
Stenotaphrum secundatum Buffalo grass							
Taraxacum officinale Dandelion							

Tetragonia implexicoma New Zealand climbing spinach							
Tetragonia tetragonioides New Zealand spinach							
Ulex europeus Gorse							

Appendix 4: Photo index of Shoreline Structures and Blowouts

Breakwaters:

Figure 15: Breakwater at Lyall Bay, Wellington (Helga Küchly)

Groynes:

Figure 16: Groynes at Whareroa Beach, Paekakariki (Helga Küchly)

Rip-Raps :

Figure 17: Rip-Rap Rock Structure at Whareroa Beach, Paekakariki (Helga Küchly)

Sea wall:

Figure 18: Sea Wall at Oriental Bay, Wellington (Helga Küchly)

Blowout :

Figure 19: Blowout in New Zealand (Seafriends Marine Conservation and Education Centre)

Figure 20: Blowout coupled with trampling damage on Lyall Bay sand dunes, Wellington (Helga Küchly)

Appendix 5: Random Number Table

Table 7: Random number table

row no.	random numbers													
1	38	53	33	96	16	73	27	26	46	0	97	17	45	81
2	97	16	96	22	81	23	68	93	4	80	26	73	65	52
3	82	5	13	80	43	17	29	10	30	93	8	43	5	61
4	90	90	12	31	19	37	32	9	8	49	32	65	9	39
5	15	36	61	32	88	24	83	98	13	90	47	53	93	80
6	64	86	61	94	73	36	15	24	68	76	48	16	84	98
7	22	16	64	2	83	0	87	86	78	4	83	83	25	90
8	84	65	0	15	48	97	87	20	85	73	94	45	98	44
9	16	26	6	48	82	29	6	90	29	56	32	60	56	36
10	61	7	41	48	7	14	89	27	32	84	7	67	85	39
11	22	2	46	10	47	71	31	67	42	14	45	72	27	77
12	14	46	19	26	63	38	49	29	79	27	9	24	37	11
13	9	34	37	23	85	50	59	80	56	57	76	88	93	86
14	2	69	98	88	18	57	59	11	73	63	91	56	98	51
15	84	61	24	4	13	90	76	97	86	73	41	51	31	86
16	73	36	36	36	33	92	16	59	36	30	39	33	0	60
17	7	36	2	48	63	72	47	0	41	1	76	70	89	30
18	98	56	79	38	31	72	55	10	6	55	55	15	0	76
19	80	5	53	64	48	55	74	41	88	84	17	16	81	88
20	89	10	18	21	23	16	3	36	93	53	47	53	68	38
21	36	13	94	56	28	28	25	30	74	64	5	39	96	19
22	45	93	62	26	0	30	22	22	33	5	22	86	0	6
23	9	63	49	17	47	38	2	60	94	88	39	32	16	10
24	63	83	89	56	79	82	0	28	10	67	73	22	65	46
25	44	76	3	71	0	53	62	44	32	1	94	39	21	42
26	85	28	37	2	74	4	88	17	33	52	66	39	54	7
27	45	13	48	40	10	9	22	34	19	53	64	44	53	39
28	56	92	36	44	0	15	85	60	21	87	22	70	38	65
29	51	11	97	86	97	17	89	4	53	3	69	35	80	14
30	17	11	89	20	11	41	75	52	18	94	63	75	55	51
31	11	93	55	24	19	69	27	61	48	24	75	43	70	55
32	54	24	64	63	47	36	76	54	75	8	91	74	45	1
33	22	89	76	47	22	43	41	98	53	14	3	84	28	19
34	59	11	44	10	20	36	83	42	46	46	7	44	31	95
35	47	46	80	18	87	89	44	70	5	85	23	69	66	86
36	64	14	49	15	73	64	56	92	94	17	7	38	77	73
37	92	58	78	56	47	51	82	52	89	0	8	50	39	31
38	8	52	96	73	19	56	75	13	87	77	80	70	60	56
39	48	28	82	57	62	68	4	75	4	88	93	84	88	46
40	27	92	31	76	19	49	42	35	95	54	45	94	49	27
41	94	71	76	78	84	57	12	14	67	70	39	9	87	59
42	48	51	18	49	70	17	93	68	19	16	42	24	66	84
43	34	7	41	38	88	34	43	67	12	33	78	8	0	85
44	24	36	14	56	23	22	70	64	26	47	69	11	22	13
45	16	84	53	84	3	77	76	95	83	80	62	38	63	30
46	46	34	61	64	89	63	48	68	55	35	12	94	44	63
47	34	92	25	21	29	5	66	92	8	88	41	90	18	40
48	7	60	30	84	11	85	59	9	38	59	54	87	62	18
49	65	6	89	47	18	52	13	25	21	78	19	15	87	66
50	9	93	54	87	70	14	31	49	18	25	69	49	22	41

Appendix 6: Indigenous Plant Species List

Acaena pallida (Kirk) Allan
Sand piripiri

- Structural Class: Dicotyledonous Herbs other than Composites
- Family : Rosaceae

Helga Küchly

Main stems stout, < to 1 m. Leaves < 2 cm, obovate-oblong to oblong, subsessile. Heads ~ 4 cm. diameter.

- Status : Not Threatened
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No

(Flora of New Zealand)

Apium prostratum subsp. prostratum var. filiforme (A.Rich.) Kirk
Shore celery (New Zealand celery)

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Apiaceae

Gillian Crowcroft (NZPCN)

Herb, perennial. Leaves dark, glossy, and much-divided like garden celery or parsley. Flowers tiny, white, in clusters.

- Status: Not Threatened
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No
- Flowering: Late Spring to early Autumn

(Clarke, 1995, p. 48)

Apodasmia similis (Edgar) Briggs et L.A.S.Johnson
Jointed wire rush (Oioi)

- Structural Class : Rushes and Allied
- Family : Restionaceae
- Alternative Names: Leptocarpus similis Edgar

Helga Küchly

Restiad with jointed zigzag stems. Leaves with dark bands along the stem. Flowers rush-like, in tight clusters at or near the top of the stem, monoecious.

- Status: Non Threatened
- Endemic Specie : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: Spring

(NZPCN, Crowe, 1995, p. 51)

Atriplex cinerea Pior.
Grey saltbush

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Chenopodiaceae


Shannel Courtney (NZPCN)

Sub-shrub, low, spreading , semi-succulent, densely covered with silvery-grey scales, up to 1.5 metres tall and 3m wide. Leaves are grey-silver and usually linear-oblong with gradually tapering bases and blunt apices. Male and female flowers usually occur on different plants.

- Status: Coloniser
- Endemic Specie : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species: None
- Flowering: Female plants flower all year, male flowers from September to May.
- Fruiting: Not Known

(NZPCN)

Austrofestuca littoralis (Labill.) E.B.Alexev.
Sand tussock

- Structural Class: Grasses
- Family: Poaceae
- Alternative Names: Previously known as Festuca littoralis.


Geoff Walls (NZPCN)

Tussocks up to about 70 cm tall. Leaves fine, rolled, somewhat drooping (coarser than silver tussock), initially green, often fading at tips to silver, and drying to golden-straw colour. Seed heads no longer than leaves; seeds relatively large, barley-like, leaving a characteristic zig-zag look to the remaining head when fallen.

- Status: Gradual Decline
- Endemic Species: No
- Endemic Genus : No
- Endemic Family : No
- Similar Species: *Ammophila arenaria* is often confused with sand tussock because they grow in the same habitat.
- Flowering: early summer
- Fruiting: early summer
- Threat: Browsing and Grazing & competition with Marram grass

(NZPCN)

Bolboschoenus fluviatilis (Torr.)Sojak
Marsh clubrush (Kukuraho)

- Structural Class:
- Family: Cyperaceae
- Alternative Names: Scirpus fluviatilis (Torr.) Gray;


John Smith-Dodsworth (NZPCN)

Herb, perennial. Stems sharply 3-sided. Leaves 6-16 mm wide, flat and the leaf sheath is convex. The bracts underneath the inflorescence are spreading, leafy and very unequal. The bristles at the base of the fruit (achene) are equal to or surpassing the fruit.

- Status: Not Threatened
- Endemic Species: No
- Endemic Genus : No
- Endemic Family : No

(NZPCN, KY State Nature Preserves Commission)

Brachyglottis Compacta (Kirk) B.Nord.
Castlepoint groundsel

- Structural Class: Dicotyledonous Trees & Shrubs
- Family: Asteraceae


Gillian Crowcroft (NZPCN)

Bushy shrub, <4 m, spreading branchlets. Leaves oval 0.8–1.6 in (2–4 cm) long, are green above, white below, with slightly toothed edges. The flowers are yellow.

- Status: Range Restricted
- Endemic Species: Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: December-February

(NZPCN, Salmon, 1991)

Calystegia sepium subsp. roseata Brummitt
Pink bindweed

- Structural Class : Dicotyledonous Lianes and Related Trailing Plants
- Family : Convolvulaceae
- Alternative Names : Has been referred to in New Zealand as Calystegia sepium


John Smith-Dodsworth (NZPCN)

Vine, rhizomatous, all parts exuding white latex. Roots thickened, white. Leaves membranous, dark to yellow-green 30-140(-170) x 25-90(-110) mm, usually narrowly triangular, sagittate, with or without tails, sinus deeply cleft to rounded. Flowers solitary; peduncles 30-120 mm long, glabrescent, ridged or narrowly winged.

- Status : Non Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Calystegia silvatica, which differs by the broadly triangular-ovate, dark green leaves without sagittate tails and much larger white flowers. The F1 hybrid between these two speices have pale pink-white striped flowers
- Flowering : September - April (-June)
- Fruiting : (October-) November - August

(NZPCN)

Calystegia soldanella (L.)R.Br.
Shore bindweed

- Structural Class: Dicotyledonous Lianes and Related Trailing Plants
- Family: Convolvulaceae


Helga Küchly

Creeping vine. Leaves roundish to kidney-shaped, glossy and fleshy, on long stalks. Flowers large, pale with dark pink bands, bell-shaped.

- Status: Not Threatened
- Endemic Specie : No
- Endemic Genus : No
- Endemic Family : No
- Flowering : Late Spring to early Autumn)
- Fruiting: Present throughout the year

(NZPCN, Crowe, 1995, p.31)

Carex geminata Schkuhr
Cutty grass

- Structural Class : Sedges
- Family : Cyperaceae
- Alternative Names : Carex ternaria var. gracilis Cheeseman, C. confusa Hamlin.


John Smith-Dodsworth (NZPCN)

Sedge, rhizomatous, robust bright-green to yellow-green, 0.5-1.2 m tall. Leaves numerous, double-folded, margins very scabrid. Spikes yellow-green, grass-green, or dark-green mottled red or purple, all pedunculate, pendulous, rather narrow, often twisted and "worm-like".

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species : C. lessoniana, which can be distingusihed by the compact inflorescences, with wider, though smaller, usually erect spikelets, and by distinctly beaked utricles.
- Flowering : (September-) October-November (-December)
- Fruiting : October – March

(NZPCN)

Carex pumila Thunb.
Sand sedge

- Structural Class : Sedges
- Family : Cyperaceae


John Smith-Dodsworth (NZPCN)

Sedge, coarse, monoecious, rhizomatous, tufted perennial, 0.4 m high, with a long, creeping rhizome. Flower brown.

- Status : Not Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No
- Flowering: November-February

(NZPCN)

Coprosma acerosa A. Cunn.
Sand coprosma

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Rubiaceae


Helga Küchly

Shrub, wiry, zigzag sprawling or bushy, monoecious. Leaves very narrow, sharp-pointed, opposite, yellowish or brownish. Fruit translucent pale-blue.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Fruiting: Summer

(NZPCN, Crowe, 1995, p.8)

Coprosma repens A. Rich.
Taupata

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Rubiaceae


Helga Küchly

Shrub creping or bushy (<8 m), monoecious. Leaves very glossy, opposite, almost round, often rolled under at the edges. Flowers greenish white. Fruit bright orange.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: Summer

(NZPCN, Crowe, 1995, p.9)

Cordyline australis (Forst.f.) Endl.
Cabbage tree

- Structural Class : Monocotyledonous Trees and Shrubs
- Family : Laxmanniaceae
- Alternative Names : Dracaena australis Forst.f., Dracaenopsis australis (Forst.f.) Planchon


Helga Küchly

Tree up to 20 m tall, trunk stout, 1.5-2 m diam, many-branched above. Bark corky, persistent, fissured, pale to dark grey. Leaves numerous, dark to light green, narrowly lanceolate to lanceolate, erect to erecto-patent,. Flowers sweetly perfumed, perianth 5-6 mm diam., white, tepals free almost to base, reflexed. Stamens about same length as tepals.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering : (September-) October-December (-January)
- Fruiting : (December-) January-March
- Threats: Although widespread and abundant, populations have been decimated in some parts of New Zealand due to a mysterious illness linked to a Myoplast like Organism (MLO) believed to cause a syndrome known as Sudden Decline.

(NZPCN)

Craspedia uniflora var. grandis Allan
Woollyhead

- Structural Class : Dicotyledonous Herbs - Composites
- Family : Asteraceae

Herb, perennial, rosette-forming. Leaves with rough hairs.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Cyperus ustulatus f. ustulatus A.Rich.
Giant umbrella sedge

- Structural Class : Sedges
- Family : Cyperaceae
- Alternative Names : Cyperus ustulatus, Mariscus ustulatus (A.Rich.) C.B.Clarke

Helga Küchly

Sedge, up to 2 m tall with leaves crowded at base of culms. Culms stout, triquetrous, glabrous, striated, green, rarely brown in distal part, at base, upright at flowering, collapsing at seed fall. Leaves 1.4 -3.2 mm x 1-2 m, grey green, strongly keeled, leaf margin and keel sharply scabrid, sheath light pink to light purple-pink.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering : July - December
- Fruiting : July - April

(NZPCN)

Desmoschoenus spiralis (A.Rich) Hook.f.
Pingao

- Structural Class : Sedges
- Family : Cyperaceae
- Synonym: Isolepis spiralis A.Rich., Anthophyllum urvillei Steudel, Scirpus frondosus Boeck, Scirpus spiralis (A.Rich.) Druce

Helga Küchly

Helga Küchly

Sedge, 60–90 cm tall with tufted, coarse, yellow-green to green grass-like leaves.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 late summer.

- Status : Gradual Decline
- Endemic Species : Yes
- Endemic Genus : Yes
- Endemic Family : No
- Similar Species : None..
- Flowering : Spring and early summer
- Fruiting : Late summer

(NZPCN)

Discaria toumatou Raoul
Matagouri (Wild Irishman)

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Rhamnaceae

John Smith-Dodsworth (NZPCN)

Shrub, much-branched, stiff, spiny, <5 m high. Flowers 3-5 cm in diameter.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: October- January
- Fruiting: December-March

(NZPCN, Salmon 1991)

Disphyma australe (Aiton) N.E.Br. subsp. australe
Native iceplant

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Aizoaceae
- Synonym: *Disphyma australe*


Helga Küchly

Sprawling succulent. Leaves green to wine red, succulent, and three-angled. Flowers white to deep pink, < 6 cm in diameter.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: Spring to Summer

(NZPCN, Crowe, 1995, p.29)

Eleocharis neozelandica Kirk
Spike sedge

- Structural Class : Sedges
- Family : Cyperaceae


Lisa Forester (NZPCN)

Sedge, rhizomatous, widely creeping and mat-forming of damp sandy flats. Rhizomes brown, 1 mm diam. culms, rigid, curved, sheaths membraneous, lower purple-brown, upper brown with orifice slight to very oblique, tapering to a sharp point. Spikelets, 4-10-flowered, broadly ovoid, acute to obtuse, broader than culm. Glumes 2.5-3.5 mm, ovate, obtuse, uninverved.

- Status : Gradual Decline
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Could only be confused with E. gracilis which may also grow in similar habitats. However, that species has hypogenous bristles, a trifid style and trigonous nuts.
- Flowering : throughout the year
- Fruiting : throughout the year

(NZPCN)

Eryngium vesiculosum Labill.
Sea holly

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Apiaceae


Jeremy Rolfe (NZPCN)

Short-lived perennial herb with prostrate branches < 30 cm long. Leaves oblong or oblanceolate, <15 cm long, including petiole, with margins coarsely spinose-toothed; stem leaves shorter, cuneate, with 3-5 spinose teeth. Inflorescence basal or at branch nodes, +/- sessile; flower heads ovoid, 6-10 mm long, 5-8 mm diameter.; Flowers blue. Fruit 5-6 mm long, covered with blunt bladdery scales

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN, New South Wales Flora Online)

Euphorbia glauca G.Forst.
Shore spurge

- Structural Class : Dicotyledonous Herbs
- Family : Euphorbiaceae


Helga Küchly

Perennial herb with multiple erect stems up to 1 m tall, underground rhizomes. Stems reddish. Leaves alternate, blue-green. Flowers in terminal bunches, each flower surrounded by a deep red cup-like structure with purple glands. Sap a burning milky juice.

- Status : Serious Decline
- Endemic Taxon: Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering : September to March (sporadic flowering throughout the year can occur)
- Fruiting : December to July
- Threats : Domestic and feral cattle, sheep and pigs are the major threats, through browse and trampling. Competition from taller vegetation is significant. Coastal development (e.g., road widening) and erosion are further threats on the Chatham Islands. Population fragmentation makes the remnants vulnerable to sudden decline.

(NZPCN)

Ficinia nodosa (Rottb.) Goetgh., Muasya et D.A.Simpson
Knobby clubrush

- Structural Class : Sedges
- Family**:** Cyperaceae
- Synonym: Isopletis nodosa***;*** Scirpis nodosus


Helga Küchly

Sedge, erect clump-forming to 90 cm high. Stems are cylindrical about 2mm wide. Leaves are reduced to sheaths at stem bases. Flower spikelets are reddish-brown, dense and globular near tips of stems.

- Status : Not Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No
- Flowering**:** October – February

(NZPCN)

Gunnera arenaria Cheeseman
Sand gunnera

- Structural Class : Dicotyledonous Herbs
- Family : Gunneraceae

Fleshy stem reddish with dropping yellow fruit attached.

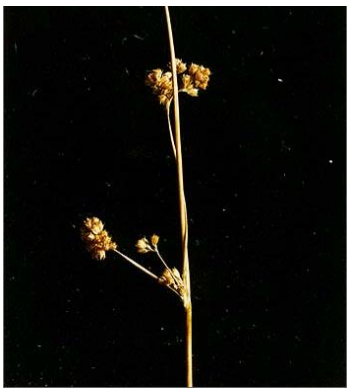
- Status : Gradual Decline
- Endemic Taxon: Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN, Moore and Adams 1963)

Juncus gregiflorus L.A.S.Johnson et K.L.Wilson
Leafless rush

- Structural Class : Rushes and Allied Plants
- Family : Juncaceae

K McCombs (Christchurch City Council)



K McCombs (Christchurch City Council)

Herb, perennial. Leaves basal. Inflorescence of several dense discrete clusters of flowers at the apex of branches. Culms yellow-green to mid-green, not glaucous.

- Status : Not Threatened
- Endemic Taxon: Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN, New South Wales Flora Online)

Libertia peregrinans Cockayne et Allan
New Zealand iris

- Structural Class : Monocotyledonous
- Herbs
- Family : Iridaceae

Jim Campbell (NZPCN)

John Barkla (NZPCN)

Leaves copper orange coloured, 15–70 cm long and emerge at intervals in crowded fans from horizontal rhizomes. Usually flowers and fruits are not carried above the height of the leaves.

- Status : Gradual Decline
- Endemic Taxon: Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering : October - January
- Fruiting : January - February

(NZPCN)

Mazus novaezeelandiae subsp. impolitus Heenan f. impolitus

Dune mazus (Dwarf musk)

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Phrymaceae

Mike Thorsen (NZPCN)

Andrew Townsend (NZPCN)

Herb, perennial, creeping, forming compact, leafy rosettes, leaves spoon-shaped, dark green to yellow-green 20–75 mm long. The margins of the leaves may be pigmented brown. Flowers, 1 to 5 Mimulus-like, white with a yellow throat. It is distinguished from subsp. novaezeelandiae by its dull green leaves that are hairless or only sparsely hairy.

- Status : Serious Decline
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Mazus pumilio which has blue or lilac flowers and a finely toothed leaf margin. This predominantly Australian species is known in New Zealand from only one site in Northland, but is now sold by many garden centres as M. novazeelandiae.
- Flowering : November.
- Fruiting : December to April.
- Threats : Very susceptible to disturbance, habitat clearance and modification.

(NZPCN)

Melicytus crassifolius (Hook.f.) F.Muell.

Thick-leaved mahoe

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Violaceae

Jeremy Rolfe (NZPCN)

John Smith-Dodsworth (NZPCN)

Large, flat, springy cushions, up to 20 cm thick, closely adpressed to rocky surface. Flowers < 3 mm in diameter. Berries 6 mm in diameter.

- Status : Sparse
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: September-January
- Fruiting: October-March

(NZPCN, Salmon 1991)

Muehlenbeckia astonii Petri
Shrubby tororaro

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Polygonaceae

Helga Küchly

Helga Küchly

Shrub ,rounded bushy deciduous divaricating up to 3m in height. Zigzag branches form a compact, springy plant. Branchlets reddish brown, more or less interlacing but not twining. Bark on older branches dark grey/brown and furrowed. Leaves small thin, broadly heart-shaped occur in small clusters or alternately along the longer branchlets. Tiny flowers are greenish to white. It has separate male and female plants.

- Status : Nationally Vulnerable
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Muehlenbeckia complexa which is a scrambler, not a shrub and has twining, tangled orange-brown young stems with no distinct trunk nor thickened branches.
- Flowering : mid-August- January (May)
- Fruiting : December - March

(NZPCN)

Muehlenbeckia axillaris (Hook.f.) Endl.
Creeping pohuehue

- Structural Class : Dicotyledonous Lianes and Related Trailing Plants
- Family : Polygonaceae

John Barkla (NZPCN)

Shrub, postrate, spreading, trangled, forming patches up to 1 m across. Flowers 3-4 mm in diameter.Seads 3mm long sitting in a white cup.

- Status : Not Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No
- Flowering: November- April

(NZPCN, Salmon 1991)

Muehlenbeckia complexa (A.Cunn.) Meisn.
Small-leaved pohuehue

- Structural Class : Dicotyledonous Lianes and Related Trailing Plants
- Family : Polygonaceae

Jeremy Rolfe (NZPCN)

Wire Vin. Leaves small, round to heart-shaped, sometimes violin-shaped, and alternating. Flowers inconspicuous, sweet-smelling. Fruit black, tree-angled seed in a freshly, ice-coloured cup.

- Status : Not Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No
- Flowering: Late Spring to Summer

(NZPCN)

Muehlenbeckia ephedroides Hook.f.
Leafless pohuehue

- Structural Class : Dicotyledonous Lianes and Related Trailing Plants
- Family : Polygonaceae


John Barkla (NZPCN)


Jeremy Rolfe (NZPCN)

- Status : Sparse
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Olearia solandri (Hook.f.)Hook.f.
Coastal tree daisy

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Asteraceae


Jeremy Rolfe (NZPCN)


Jeremy Rolfe (NZPCN)

Flowers up to 10 mm in diameter.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: February-April

(NZPCN, Salmon 1991)

Ozothamnus leptophyllus (G.Forst.) Breitw. et J.M.Ward
Tauhinu

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Asteraceae


Jeremy Rolfe (NZPCN)


Jeremy Rolfe (NZPCN)

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Phormium cookianum subsp. hookeri (Hook.f.)
Mountain flax

- Structural Class : Monocotyledonous Herbs
- Family : Xanthorrhoeaceae
- Alternative Names : Phormium cookianum, Phormium hookeri Gunn ex Hook.f.


Helga Küchly

Herb, 1-1.5(-2) m tall. Leaves numerous, arising from fan-like bases. Individual leaves stiff near base and semi-erect, becoming decurved or pendulous from basal third to half of length, olive-green to yellow-green. Lamina margin, entire, finely pigmented red, orange-red or black. Flowers 25-40 mm long, tubular, greenish or yellow, sometimes flushed orange. Ovary erect. Capsules 100-200 mm long, dark green, trigonous in cross-section, pendulous, tapering toward tip, twisted, initially fleshy becoming papery with age, long persistent.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Distinguished from Phormium tenax by the pendulous, twisted capsules. Differing from subsp. cookianum by the longer, "floppy" uniformly olive green leaves.
- Flowering : (September-) October-November (-January)
- Fruiting : (November-) December (-March)

(NZPCN)

Phormium tenax J.R.Forst. et G.Forst
New Zealand flax (Harakeke)

- Structural Class : Monocotyledonous Herbs
- Family : Xanthorrhoeaceae


John Smith-Dodsworth (NZPCN)

Leaves long, stiff, upright, 1-3 m long. Flowers always dull red. Seeds in straight, upright pods.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Could only be confused with the so called mountain flax (Phormium cookianum subsp. hookeri) from which it is easily distinguished by the erect rather than pendulous seed pods
- Flowering : (September-) October-November (-January)
- Fruiting : (November-) December (-March)

(Crowe, 1995, p.43, NZPCN)

Pimelea arenaria A.Cunn.
Sand daphne

- Structural Class : Dicotyledonous Trees & Shrubs
- *Family :* Thymelaeaceae


G.M. Crowcroft (NZPCN)

Shrub (<30 cm), spreading branches often half covered in sand. Compact, leafy branchlets are more or less erect, with the under- surface densely hairy. Leaves arranged in four rows at right angles to each other. Flowers arranged in clusters at the end of branchlets. Fruits are about 3 mm long.

- Status : Gradual Decline
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering : September – March
- Fruiting : October - April
- Threats : Competition from marram grass; browsing and trampling,vehicle damage and fire.

(NZPCN)

Pimelea prostrata (J.R.Forst. et G.Forst.)
New Zealand daphne

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Thymelaeaceae


John Barkla (NZPCN)

Shrub, mat-forming with obvious leaf scars on the older stems. Leaves very small, blue-green, crowded, opposite. Flowers white, in clusters, sweetly scented. Fruit small, white.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: Spring to Summer

(NZPCN, Crowe, 1995, p.38)

Pimelea

urvilleana A.Rich.

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Thymelaeaceae

Simon Walls (NZPCN)

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Plagianthus divaricatus J.R.Forst. et G.Forst.
Shore ribbonwood

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Malvacea

John Smith-Dodsworth (NZPCN)

Jeremy Rolfe (NZPCN)

Shrub, deciduous, widely branched with tough, wiry, dark, intertwining stems, forming a dense bush. Leaves few, small, narrow, in tufts or alternating. Flowers few, honey-scented, cream, tiny.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : Yes
- Endemic Family : No
- Flowering: Spring

(NZPCN, Clarke, 1995, p.56)

Poa cita Edgar
Silver tussock

- Structural Class : Grasses
- Family : Poaceae

Helga Küchly

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Potentilla

anserinoides Raoul
Silverweed


Jeremy Rolfe (NZPCN)

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Pteridium esculentum (G. Forst.) Cockayne
Bracken fern

- Structural Class : Ferns
- Family : Pteridaceae
- Alternative Names : Pteridium aquilinum var. esculentum (G.Forst.) Kuhn


Jeremy Rolfe (NZPCN)

Fern with deeply rooted, subterranean rhizomes. Stipes woody, grooved, smooth, chestnut-brown, drying grey. Fronds broadly ovate, 3-4-pinnate, topside dark green, often glaucous, paler beneath. Pinnae curled downwards, upper surface glabrous, undersides bearing curly, red-brown hairs on the midribs and straight, white, oppressed hairs along the veins. Spores yellow to orange yellow.

- Status : Not Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No
- Flowering : None (spore bearing)
- Fruiting : None (spore bearing)

(NZPCN)

Ranunculus macropus Hook.f.
Swamp buttercup

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Ranunculaceae


Colin Ogle (NZPCN)

Herb, semi-aquatic to aquatic. Rosettes tufted on stout creeping stems. Leaves ternate, leaflets sessile or shortly stalked, cuneiform, shallowly 3-fid, apices crenate, serrate or entire, lateral leaflets slightly to distinctly larger than terminal, cauline leaves few, similar to basal but smaller.

- Status : Gradual Decline
- Endemic Species : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Confused with R. amphitrichus and R. glabrifolius. Species hybridizes with R. amphitrichus. Species is distinguished by the larger flower, with broad, irregularly spaced, oblong petals.
- Flowering : September - April
- Fruiting : October - July

(NZPCN)

Raoulia australis Hook.f. ex Raoul
Common mat daisy

- Structural Class : Dicotyledonous Herbs – Composites
- Family : Asteraceae


John Smith-Dodsworth (NZPCN)

Creeping perennial, mat-forming, and greyish. Leaves spoon-shaped, closely packed, overlapping in five rows and <2 mm long with dense, woolly covering on both surfaces, expect at the leaf base.

- Status : Not Threatened
- Endemic Species : Yes
- Endemic Genus : Yes
- Endemic Family : No
- Flowering: January-February

(NZPCN, Bishop, 1990, p.69)

Raoulia hookeri Allan var. hookeri
Scabweed

- Structural Class : Dicotyledonous Herbs - Composites
- Family : Asteraceae


John Smith-Dodsworth (NZPCN)

- Status : Non Threatened
- Endemic Species : Yes
- Endemic Genus : Yes
- Endemic Family : No

(NZPCN)

Schoenoplectus pungens (Vahl) Palla
Three-square

- Structural Class : Sedges
- Family : Cyperaceae


John Smith-Dodsworth (NZPCN)

- Status : Not Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Schoenoplectus tabernaemontani (C.C.Gmel.) Palla
Lake clubrush (Kopupu)

- Structural Class :
- Sedges
- Family : Cyperaceae


.John Smith-Dodsworth (NZPCN)

- Status : Not Threatened
- Endemic Species : No
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Scleranthus biflorus (J.R.Forst. et G.Forst.) Hook.f.
Canberra grass

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Caryophyllaceae

John Smith-Dodsworth (NZPCN)

- Status : Not Threatened
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Sebaea ovata Labill.) R.Br.

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Gentianaceae

Colin Ogle (NZPCN)

Lisa Forester (NZPCN)

Herb, annual, sparingly branched, erect, 50-300 mm tall. Stems 4-angled, hairless, pale yellow-green. Leaves, sessile , in opposite pairs, , fleshy, pale green to almost blue-green, ovate to broadl-ovate or suborbicular, , well spaced along stem; midrib prominent, with one conspicuous longitudinal vein either side. Flowers 6.5 mm long, scarcely opening; calyx-lobes 5, narrowly ovate-lanceolate, acute with rigid narrowly winged keel.

- Status : Nationally Critical
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No
- Similar Species : Two introduced weeds, centuary (Centaurium erythraea and C. tenuiflorum) occur in the same habitat, and are superfically similar. Centuary can be distinguished by its pink to deep rose flowers, whose anthers spirally twist after anthesis, and by the 1-locular rather than 2-locular ovary.
- Flowering : November – January
- Fruiting : December - February

(NZPCN)

Selliera radicans Cav.
Remuremu

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Goodeniaceae

.John Barkla (NZPCN)

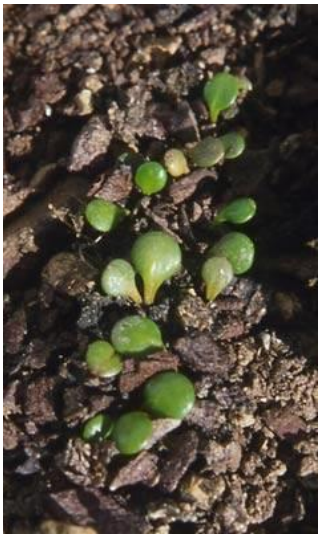
Leaves fleshy, flattered, club-shaped. Flowers many white, lop-sided, scented.

- Status : Not Threatened
- Endemic Taxon : Yes
- Endemic Genus : No
- Endemic Family : No
- Flowering: Spring to Summer

(NZPCN, Clarke, 1995, p. 59)

Selliera rotundifolia Hennan

- Structural Class : Dicotyledonous Herbs other than Composites
- Family : Goodeniaceae



Barbara Mitcalfe (NZPCN)

Herb, rhizomatous, mat-forming, forming dense patches up to 700 mm diam., or diffuse patches when trailing through other vegetation. Stems 1-2 mm diam. Petiole 3-7(-17) x 0.5-1 mm, distinct from leaf. Leaves dark green, glabrous, alternate, appressed to ground, lamina 3-7 x 3-5 mm, rotund, orbicular, leathery, entire, apex obtuse, base obtuse. Flowers single, arising in leaf axils.

- Status : Gradual Decline
- Endemic Taxon : Yes
- Endemic Genus : No
- Endemic Family : No
- Similar Species: Distinguished from the allied S. microphlla and S. radicans by the distinctive, small, rounded to completely orbicular leaves.
- Flowering : December – February
- Fruiting : January - May
- Threats: Spread of faster growing and taller weed species which are rapidly modifying the damp, dune swale and estuarine habitats this species favours.

(NZPCN)

Solanum aviculare f. latifolium G.T.S.Baylis
Poroporo

- Structural Class : Dicotyledonous Trees & Shrubs
- Family : Solanaceae

. Peter de Lange (NZPCN)

- Status : Sparse
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Spinifex sericeus R.Br.
Spinifex

- Structural Class : Grasses
- Family : Poaceae

Helga Küchly

Grass, creeping stems, leafy runners, smooth and yellow, monoecious. Leaves silvery, grassy, covered with silky hairs. Seeds on large spiky balls, < 30 cm in diameter.

- Status : Not Threatened
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No

(NZPCN, Crowe, 1995, p.17)

Tetragonia implexicoma (Miq.) Hook.f.
New Zealand climbing spinach

- Structural Class : Dicotyledonous Lianes and Related Trailing Plants
- Family : Aizoaceae

.Jeremy Rolfe (NZPCN)

- Status : Not Threatened
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No

(NZPCN)

Tetragonia tetragonioides (Pall.) Kuntze
New Zealand spinach

- Structural Class : Dicotyledonous Lianes and Related Trailing Plants
- Family : Aizoacea

Missouri Botanic Gardens (NZPCN)

This herb has light chunky green leaves and stems are woody towards their base.

- Status : Sparse
- Endemic Taxon : No
- Endemic Genus : No
- Endemic Family : No
- Flowering : October-February
- Fruiting : November - March

(NZPCN)

Appendix 7: Exotic Sand Dune Plant Species Index

Acacia spp. **(incl *A. dealbata* and *A. sophorae)*** **Wattle** • Structural Class : Dicotyledonous Trees & Shrubs • Family : Fabaceae	 John Smith-Dodsworth (NZPCN)	Shrub to large tree, with small creamy-yellow flowers in many-flowered round heads. Twice divided leaves, dark green. • Weed status : Adventive- Not yet classified • Areas of Origin : Australia • Flowering: September- November (Roy et al. 1998,p.150, NZPCN)
Agapanthus praecox **African lily** • Structural Class : Monocotyledonos Herbs • Family : Alliaceae • Synonym: *Agapanthus orientalis, Agapanthus praecox subsp. orientalis*	 Helga Küchly	Robust, clump-forming perennial, < 60 cm tall. Rhizomes thick, long, white. Leaves 20-70 x 2-6 cm, leathery, arching, and arising from base in clumps up to 20, sap watery. Flowers small, purplish-blue or white, in many-flowered umbrella-shaped clusters 7 x 5 cm, Dec-Feb. Seeds thin, papery, black. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1952 • Areas of Origin : South Africa • Flowering: December- February (NZPCN)
Agrostis capillaries *L.* **Browntop** • Structural Class : Grasses • Family : Poaceae	 John Smith-Dodsworth (NZPCN)	Grass, perennial; up to 70 cm tall. Roots with rhizomes; All parts hairless, dark to bluish-green. Leaf blade flat, short and narrow, 100-150 x 1-5 mmribs regular, margins slightly rough. Ligule short, membranous and translucent, almost invisible. Leaf sheath rounded, usually smooth. Emerging leaf rolled. Seedhead open, usually up to 15cm long with spreading branches, fine, light brown, seeds tiny, brown. • Weed status : Adventive - Not Yet Classified • Approx year naturalised : 1987 • Areas of Origin : Europe, Asia • Flowering: December, January (NZPCN)

Ammophila arenaria (L.) Link **Marram grass** • Structural Class : Grasses • Family : Poaceae	 Helga Küchly	Stout rhizomatous perennial grass. Rhizomes tough, creeping long distances in loose sand. Leaves to 700 x 3-6 mm, greyish-green, tips sharp, reddish-brown sheaths overlapping; blades tightly rolled (appear cylindrical) in exposed conditions, loosely rolled in shade; densely hairy ribs above, striped below, narrow ligule 25 mm long. Seed head a dense spike, whitish, to 30 cm long. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1873 • Areas of Origin : Europe, North Africa • Similar species : Leymus racemosus is more robust, foliage less bluish. Austrofestuca littoralis. • Flowering time : November-March (NZPCN)
Banksia integrifolia L.f. **Coastal banksia** • Structural Class : Dicotyledonous Trees & Shrubs • Family: Proteaceae	 Peter de Lange (NZPCN)	Tree, growing up to 6m, fast growing. Leaves scattered or irregular wholes forming dense cluster at ends of the branches. Leaves oblong or narrowly elliptical, < 18 cm, clear midrib, • Weed status : Adventive- Not yet classified • Areas of Origin : Australia • Flowering time : throughout the year (NZPCN; Environmental Protection Agency/ Queensland Park and Wildlife Service)
Bromus diandrus Roth **Ripgut brome** • Structural Class : Grasses • Family: Poaceae	 Kate Blood (CRC Weed Management)	The inflorescence is loosely flowered and the awns of the seeds are 3-6 cm long. The herbage is usually covered with short, spreading hairs. • Weed status : Adventive- Not yet classified • Areas of Origin : Eurasia (NZPCN)

Cakile maritima Scop. **Sea rocket** • Structural Class : Dicotyledonous Herbs and other Composites • Family: Brassicaceae	 Helga Küchly	Annual, low spreading herb. Leaves fleshy, lobed, yellowish-green, peppery taste. Flowers mauve, pink or violet. • Weed status : Adventive- Not yet classified • Flowering: Late spring to summer • Area of Origin: Europe, Mediterranea • Similar Species: *Cakile edentula* is missing the two horns at the base of its seed pots. (NZPCN ; Crowe 1995)
Carpobrotus edulis (L.) N.E.Brown **Ice plant** • Structural Class : Dicotyledonous Herbs and other Composites • Family: Aizoaceae	 Helga Küchly	Low growing, mat-forming, succulent perennial. Leave sare smooth, hairless, triangular in cross section, very fleshy, 7-12 cm long, linear, tips pointed, dark green. Flowers are pale yellow, aging to pinkish-orange, 8-10 cm diameter with yellow stamens. • Weed status : Adventive- Not yet classified • Flowering: October- Feburary • Area of Origin: South Afrika • Similar Species: *Carpobrotus aequilaterus* , also called ice plant, is similar but smaller (flower 6.5-8 cm in diameter). *Disphyma australe (Aiton) N.E.Br. subsp. australe* has even smaller white or yellow flowers (< 4 cm in diameter). (NZPCN ; Roy et al. 1998,p. 26)
Cirsium arvense L. Scop. **Californian thistle** • Structural Class : Dicotyledonous Herbs - Composites • Family: Asteraceae	 John Smith-Dodsworth (NZPCN)	Thistle, perennial, far-creeping root system, <1 m tall. Leaves lance shaped with triangular lobes an teeth on margin, green on top an pale beneath, 15*5 cm. • Weed status : Adventive- Not yet classified • Approx year naturalised : problem since early 1900s • Areas of Origin : Eurasia • Similar species: *Carduus spp., C. arvense* are small flowerheads, dioecious plants, and stems that are not conspicuously spiny-winged. • Flowering: December-Feburary (NZPCN ; Roy et al. 1998, p.56; ISSG)

Cirsium vulgare (Savi) Tenore **Scotch thistle** • Structural Class : Dicotyledonous Herbs - Composites • Family: Asteraceae	 John Barkla (NZPCN)	Thistle, stout, well-branched, biennial; grows from a rosette that can be very large (< 1.5m).Leaves are hairy on both surfaces, spines on the upper surface and white cotton un underside, 30*10 cm. Flowers reddish-purple. Appears in very large numbers after fire or soil disturbance. • Weed status : Adventive- Not yet classified • Approx year naturalised : problem since early 1900s • Areas of Origin : Eurasia and north Africa • Flowering: November- March (NZPCN ;Roy et al. 1998, p.61)
Cortaderia selloana (Schult. et Schult.f.) Asch. et Graebn. **Pampas grass** • Structural Class : Grasses • Family: Poaceae • Synonyms: *Arundo selloana* Schult. and Schult. f., *C. argentea* (Nees) Stapf, *Cortaderia dioica* (Spreng.) Speg., *Gynerium argenteum* Nees	 Helga Küchly	Tussock grass, < 3.5 m in diameter, and flowering stalks that can reach upwards of 4 m in height. Leaves are gray or bluish-green with narrowly tapering tips. The inflorescence can be described as a silver or white with heavy branching and a feathery appearance. • Weed status : Adventive- Not yet classified • Areas of Origin : South America • Similar species : *Cortaderia jubata* can be distinguished from *C. selloana* by the looser, yellowish or purplish panicle and somewhat smaller spikelets. (NZPCN ;Global Invasive Species Database)
Chrysanthemoides monilifera (L.) Norl. subsp. monilifera **Boneseed** • Structural Class : Dicotyledonous Trees & Shrubs • Family : Asteraceae • Synonym: *Chrysanthemoides monilifera*	 Nic Singers (NZPCN)	Bushy, semi-woody, much branched shrub or small tree to 2-3 m. Young stems ribbed and woolly, becoming smooth. Leaves alternate, smooth, leathery, entire, 70 x 35 mm, margins irregularly toothed. Bright yellow daisy-like flowers, 25-30 mm diam, Sep-Feb. Fruit an oval green drupe, 6-9 mm, hard with thin fleshy covering. • Weed status : Unwanted • Approx year naturalised : 1870 • Areas of Origin : S.W. Cape area, South Africa • Flowering: September-February (NZPCN)

Cupressus macrocarpa Hartw. ex Gordon **Macrocarpa** • Structural Class : Gymnosperm Trees & Shrubs • Family: Cupressaceae	 Peter de Lange (NZPCN)	A medium sized tree, with a straight, narrow crown when young but spreading dramatically with age. When found along the coast, the tree and crown are typically wind swept and very picturesque; Twig: Stout (for cypress), square, covered in scale-like leaves, overall a thick, coarse texture; Leaf**:** evergreen, scale-like, blunt tipped, tight and crowded on the twig in opposite pairs resulting in a square twig, mostly lacking gland; Flower: monoecious; males are small, pale yellow-green at ends of branch tips, often in abundance; females small light green near branch tips. • Weed status : Adventive- Not yet classified (NZPCN ;College of Natural Resources)
Cynodon dactylon(L.) Pers. **Indian doab** • Structural Class : Grasses • Family: Poaceae	 John Smith-Dodsworth (NZPCN)	Grass, perennial, mat-forming, rhizomatous and stoloniferous. Erect or ascending culms (10-40 cm. Stolons are flattened, rooting at nodes. Leaves are generally smooth, with a conspicuous ring of white hairs at the junction of blade and sheath. • Weed status : Adventive- Not yet classified • Approx year naturalised :1846 • Areas of Origin : Pantropical (NZPCN)
Ehrharta calycina Smith. • Structural Class : Grasses • Family: Poaceae		Grass, annual or perennial, 30-180 cm tall, forming dense tufts. Inflorescence is an open panicle of hairy spikelets, usually purple, especially in summer. Spikelets are 4.0-8.5 mm long. The sterile lemmas are similar in texture and are hairy with long hairs, the first more than two-thirds the length of the second. • Weed status : Adventive- Not yet classified • Approx year naturalised :1958 • Areas of Origin : southern Africa (NZPCN, California Invasive Plant Council)

Ehrharta erecta Lam. **Veldt grass** • Structural Class : Grasses • Family: Poaceae	 Peter de Lange (NZPCN)	Grass, perennial, distinct from *E. calycina* in having a crabgrass-like habit with decumbent as well as ascending jointed stems. The sterile lemmas of *E. erecta* are without awns. • Weed status : Adventive- Not yet classified • Areas of Origin : Southern Africa • Reason for Introduction: Agricultural (NZPCN, California Invasive Plant Council)
Schedonorus phoenix (Scop.) Holub **Tall fescue** • Structural Class : Grasses • Family: Poaceae • Synonyms: *Festuca arundinacea*	 John Smith-Dodsworth (NZPCN)	Grass, perennial, very robust, hairless (except auricles). Stems erect, 50 - 110 (-150) cm high. Blade rolled when young, large (3 - 10 mm), flat, strongly veined, coarse, rough on the upper side, shiny below, dark green. Panicle-like inflorescence, spreading even after flowering, oblong, loose. Spikelets 4 - 7 - flowered, briefly aristate, 10 - 15 mm long. Variable species. • Weed status : Adventive- Not yet classified • Areas of Origin : southern Africa (NZPCN, Food And Agriculture Organization of the United Nations)
Glaucium flavum Crantz **Horned poppy** • Structural Class : Dictyledonous herbs other than Composites • Family : Papaveraceae • Synonyms: *Glaucium glaucium* (L.) Karst.	 Helga Küchly	Herb, annual or perennial, 30-90 cm tall rosette-based. Leaves are firm, hairy, pubescent and glaucous, ovate to oblong, and are irregularly pinnatifid, 7-20 cm long and 2.5-5 cm (1-2 in.) wide, margins deeply toothed. Flowers yellow. The seed capsule is sublinear and often curved, 15-30 cm long and 5 mm wide. • Weed status : Adventive- Not yet classified • Areas of Origin : Black Sea region and Mediterranean Europe (NZPCN, Invasive Plant Atlas of New England)

Holcus lanatus L. **Yorkshire fog** • Structural Class : Grasses • Family : Poaceae	 Helga Küchly	Grass, perennials; culms 30-60 cm tall, velvety canescent. Sheaths 6-12 cm long, striate, velvety canescent; Inflorescences silvery to purplish, paniculate, contracted, 8-15 cm long. • Weed status : Adventive- Not yet classified • Approx year naturalised: 1844 • Areas of Origin : Europe • Reason for introduction: Agricultural (NZPCN, Hawaiian Ecosystems at Risk project (HEAR))
Juncus articulatus L. **Jointed rush** • Structural Class : Rushes and Allied Plants • Family : Juncaceae • Synonyms: Juncus lampocarpus Ehrh	 John Smith-Dodsworth (NZPCN)	Grass, extremely variable, 6 to 40 cm tall, 2 to 4 narrow, cross-partitioned leaves; Inflorescence 2 to 5 cm long with many heads. Dark brown capsules in flowers longer than the perianth. Sepals and petals exhibit pointed Tips. • Weed status : Adventive-Not yet classified • Approx year naturalised :1864 • Areas of Origin : Europe, North America, North Africa • Reason for introduction: Accidental (NZPCN)
Lagurus ovatus L. **Hare's-tail** • Structural Class : Grasses • Family : Poaceae	 Helga Küchly	Grass, annual, erect or geniculate, caespitose. Leaves scattered along the culms. *Culms* 17-90 cm high, branched above or unbranched above, 2-5 noded. Plants bisexual. Rudimentary spikelets absent. Inflorescence densely a panicle, pallid or purple (slightly, awns and glume veins sometimes pigmented), erect, densely contracted, 10-20 mm wide, ovate or elliptic or globose, symmetrical, partially exserted or fully exserted, glabrous or puberulous (densely, hairs spreading), ridged. • Weed status : Adventive- Not yet classified • Approx. year naturalised: 1873 • Areas of Origin : Mediateranean (NZPCN ; Grass Genera of the World)

Lupinus arboreus Sims **Tree lupin** • Structural Class : Dicotyledonous Trees & Shrubs • Family : Fabacea • Synonyms: Lupinus macrocarpus Hook. & Arn., Lupinus propinquus E. Greene, Lupinus rivulars Dougl. ex Lindl.	 Jeremy Rolfe (NZPCN)	Shrub, hairy, soft- wodden with spreading braches, < 3m. Leaves land-like, lance-shaped (5- 11),15-40 mm long. Flowers yellow, pealike, strongly-scented, in spikes, 10-30 cm long. • Weed status : Adventive- Not yet classified • Approx year naturalised: 1899 • Areas of Origin : North America • Reason for introduction : Consolidating coastal sand dunes, bevore establishment of pine forests. • Similar Species: *Lupinus angustifolium*, has blue flowers (August- April). *Lupinus polyphyllus*, extremely attractive spices of pink, white, yellow, orange, blue or purple flowers (September- Feburary). • Flowering: October- May (NZPCN, Roy et al. 1998, p.144)
Lycium ferocissimum Miers **Boxthorn** • Structural Class : Dicotyledonous Trees & Shrubs • Family: Solanaceae	 Helga Küchly	Shrub, everygreen perennial, densly-branched, erect, woody, < 6m tall with strong spines at the tips of the branches. Leaves narrow, oblong, <40 mm long and 12 mm wide.Flowers white or pale mauve, 10-13 mm long; Berries orange-red, 10 mm wide. • Weed status : Adventive- Not yet classified • Approx year naturalised: 1870 • Areas of Origin : South Africa • Reason for introduction : Ornamental • Flowering: July- March (NZPCN, Roy et al. 1998,p. 254)

Lavatera arborea L. **Tree mallow** • Structural Class : Dicotyledonous Herbs other than Composites • Family : Malvaceae • Synonym: *Malva dendronorpha*	 Helga Küchly	Herb, biennial, usually with a single stem up to 2 m tall. Stems hairy when young, becoming hairless and woody at base when older. Leaves velvety to the touch, with 5-7 lobes, up to 20 cm across. Lilac to purple flowers arranged in clusters at end and along upper parts of the stem. 6-8 seeds per fruit. • Weed status : Adventive - Not Yet Classified • Approx year naturalised : 1870 • Areas of Origin : W. and S. Europe, N. Africa • Reason for introduction : Ornamental • Similar species : There are several other large Lavatera species that have naturalised in New Zealand. L. arborea usually has a single stem, but can confidently be identified by the fused enlarged, spreading fruiting calyx. • Flowering: August-November and January-May (NZPCN)
Medicago polymorpha L. **Bur medick** • Structural Class : Dicotyledonous Herbs other than Composites • Family: Fabacea	 Helga Küchly	Herb, annual, stems prostrate, up to 4 dm long, branched. When mature, the spiny seed pods detach and stick to your socks; Leaves**:** tri-foliate leaflets, with margin strongly toothed. Distinct folds along center vein; Flowers: small, yellow, single "pea-like". • Weed status : Adventive- Not yet classified • Areas of Origin : Eurasia • Flowering: throughout the year (NZPCN, Pacific Island Ecosystems at Risk (PIER))

Parapholis incurva (L.) C.E.Hubb. **Sickle grass** • Structural Class : Grasses • Family: Poaceae • Synonyms: Aegilops incurva L., Parapholis incurva	 Stephan Imhof University Marburg, Germany)	Grass, annual, erect or decumbent, caespitose. Leaves scattered along the culms. *Culms* 4-49 cm high, slender, branched above, 3-9 noded. Leaf blades joining the sheath gradually, basally flat and involute (above), subulate, 15-65 mm long, 0.4-1.7 mm wide; adaxially scabrous (sparsely on the veins), channelled; Plant is bisexual. Inflorescence a single spike, green or purple, rigid, slender, erect, straight or curved, often strongly curved, cylindrical, symmetrical, partially exserted. Main inflorescence axis 20-135 mm long. • Weed status : Adventive- Not yet classified • Approx year naturalised: 1867 • Areas of Origin : Eurasia (NZPCN, The Grass Genera of the World)
Pennisetum clandestinum Chiov. **Kikuyu grass** • Structural Class : Grasses • Family: Poaceae • Synonyms: *Pennisetum inclusum* Pilg., *Pennisetum longstylum* Hochst., *Pennisetum longstylum* var. *clandestinum* (Hochst. ex Chiov.) Leeke	 John Smith-Dodsworth (NZPCN)	Grass, creeping, perennial, hairy, mat-forming. Stolons very long, climbing supported, rooting frequently. Rhizomes long. Leaves alternate, 5-40 x 3-9 cm, bright green to yellow-green, soft and drooping, sparsely hairy above and below, blades folded, Seedhead of 2-3 tiny spikelets in upper leaf sheaths, wispy anthers and stigmas • Weed status : Adventive- Not yet classified • Approx year naturalised : 1936 • Area of origin: Tropical eastern Africa. • Reason for introduction: Soil stabilization and erosion control, Translocation of machinery/equipment, for ornamental purposes (NZPCN)

***Pinus spp.* Pine** • Structural Class : Gymnosperm Trees & Shrubs • Family: Pinaceae	 Helga Küchly	About 73 species. Trees or shrubs, aromatic, evergreen; crown usually conic when young, often rounded or flat-topped with age. Bark of older stems variously furrowed and plated, plates and/or ridges layered or scaly. Branches usually in pseudowhorls; shoots dimorphic with long shoots and dwarf shoots; dwarf shoots borne in close spirals from axils of scaly bracts and bearing fascicles of leaves (needles). Leaves dimorphic, spirally arranged; Plants monoecious (rarely semi-dioecious); staminate cones numerous and small, in a dense, spikelike cluster around base of current year's growth, mostly ovoid to cylindric-conic, tan to yellow, red, blue, or lavender. • Weed status : Adventive- Not yet classified • Reason for introduction: Forestry (NZPCN, Gymnosperm Database http://www.conifers.org/pi/pin/)
Plantago coronopus L. **Buckshorn plantain** • Structural Class : Dicotyledonous Herbs • Family : Plantaginaceae	 Jeremy Rolfe (NZPCN)	Herb, annual or perennial with persistent taproot. Leaves all radical, 120 x 5 mm with 1-4 pairs of lobes or teeth. Flowering stem up to 45 cm long, usually clothed in hairs, cylindrical spike contains many flowers. Capsule up to 2 mm long, usually containing 4 small pinkish-brown seeds. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1873 • Areas of Origin : Europe, W. Asia • Reason for introduction : Accidental • Similar species : P. coronopis is a very variable species in New Zealand. Can be distinguished by the combination of the radical leaves with lobes or teeth, and the scape with many flowers. • Flowering time : July-April (NZPCN)

Polycarpon tetraphyllum (Linnaeus) Linnaeus **Allseed** • Structural Class : Dicotyledonous Herbs other than Composites • Family : Caryophyllaceae	 Jeremy Rolfe (NZPCN)	Herb, annual, sprawling, 5-10 cm tall with many forked branches. Leaves oval and fairly broad, ~ 1 cm long, rounded tips and short but distinct stalks. Flower white, tiny, < 3 mm in diameter, at the end of branches. • Weed status : Adventive- Not yet classified • Approx year naturalised : • Areas of Origin : Mediterranean and Middle East • Reason for introduction : Accidental • Similar Species: *Sagina apetala* grows in similar places, but pearlwort has very narrow leaves in pairs and flowers are less densely clustered • Flowering: October-March (NZPCN ; Roy et al. 1998,p. 112)
Rosa rubiginosa L. **Sweet briar** • Structural Class : Dicotyledonous Trees & Shrubs • Family : Rosaceae	 John Barkla (NZPCN)	Shrub, deciduous, rather erect, sometimes dense, 1~3m high, often with suckers. Leaves divided into five to nine, broad, elliptical, serrated leaflets, <4 cm long and 2.8 cm wide, hairy underneath. Flowers pink, five petals, <4 cm diameter, in clusters of one to three flowers. • Weed status : Adventive - Not Yet Classified • Approx year naturalised : 1867 • Areas of Origin : Europe and north America • Reason for introduction : Ornamental • Flowering: November- January • Fruiting: February -May (NZPCN ; Roy et al. 1998,p.238)
Rhamnus alaternus L. **evergreen buckthorn** • Structural Class : Dicotyledonous Trees & Shrubs • Family : Rhamnaceae	 Graeme Lacock (NZPCN)	Shrub, evergreen, <5m tall. Leaves leathery, glossy on the top surface, elliptical or egg-shaped, < 6 cm long and 3 cm wide, entire or with teeth. Flowers green, small, 3-4 mm in diameter. Fruit glossy, dark red at first, turning black when ripe, egg-shaped drupes, < 7 mm long. • Weed status : Adventive- Not yet classified • Areas of Origin : Mediterranean • Flowering: May-November (NZPCN ; Roy et al. 1998,p. 231)

Rubus fruticosus L. **Blackberry** • Structural Class : Dicotyledonous Trees & Shrubs • Family : Rosaceae	 Jeremy Rolfe (NZPCN)	Shrub, perennial, very prickly, scrambling, woody, ~ 2m tall. Leaves compound, three to five, oval, toothed leaflets arranged palmately. Flowers white to pink, 2-3 cm in diameter, five petals and numerous stamens, in many-flowered clusters. Fruit aggregated berries, 10-15 mm long, red at first, turning black when ripe. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1867 • Areas of Origin : Europe • Similar Species: The species is extremely variable and has sometimes been divided into many species and very many varieties. • Flowering: November- April • Fruiting: November-May (NZPCN , Roy et al. 1998,p.239)
Senecio angulatus L.f. **Cape ivy** • Structural Class : Dicotyledonous Herbs -Composites • Family : Asteraceae	 Peter de Lange (NZPCN)	Herb, glabrous, scandent, perennial poor climbing ability, sometimes forming a dense tangled shrub up to 2m tall. Stems usu. sparingly branched. Leaves petiolate, lamina not lobed, ovate to deltoid, obtuse to acute, mucronate, obtuse to truncate at base, coarsely toothed. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1940 • Areas of Origin : South Africa • Similar Species: *Senecio mikanioides* has thinner leaves, better climbing abilities and ear-like projections at the base of the leaf stalks. • Flowering: March-August (NZPCN)
Senecio elegans L. **Purple groundsel** • Structural Class : Dicotyledonous Herbs -Composites • Family : Asteraceae • Synonyms: Senecio pseudo-elegans Less.	 Helga Küchly	Herb, annual or short-lived perennial. Leaves deeply bipinnate lobed, rather fleshy with base stem-clasping. Branching stems to 60 cm high, bearing terminal clusters of daisy flowers 2.5-4 cm across with bright purple rays and yellow discs. Fruit with pappus. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1935 • Areas of Origin : South Africa • Flowering: October-December (NZPCN , The unique Flora of Tasmania)

Senecio glastifolius L.f. **Holly-leaved senecio** • Structural Class : Dicotyledonous Herbs -Composites Family : Asteraceae	 John Sawyer (NZPCN)	Herb, erect, hairless, perennial becoming distinctly woody towards it's base, <1 m tall. Leaves are oblong or narrow elliptic in shape, with serrated edges and often coarse toothed at base, 3-15 cm long x 1-2.5 cm wide 12 -20 purple/pink daisy-like florets with yellow centres. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1969 • Areas of Origin : South Africa • Similar species : *Senecio elegans*, but that species has 12–15 involucral bracts • Flowering: September-November (NZPCN)
Stenotaphrum secundatum (Walter) Kuntze **Buffalo grass** • Structural Class : Grasses • Familiy: Poaceae • Synonym: *Ischaemum secundatum* Walter	 Jeremy Rolfe (NZPCN)	Grass, stoloniferous perennial, forming dense leafy mat to about 20 cm, with ascendant, much branched culms to 50 cm. Forms dense turf when regularly mowed or grazed. Stems flattened. Leaves stiff, blue-grey in colour mostly glabrous except at base;folded in bud, usually rounded or obtuse at the tip when expanded, scabrous leaf margins, underside of midrib, and keel of sheath. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1872 • Areas of Origin : Africa, America • Reason for introduction : Pasture (NZPCN ; Tropical Forages)
Taraxacum officinale **Dandelion** • Structural Class : Dicotyledonous Herbs -Composites Family: Asteraceae	 Jeremy Rolfe (NZPCN)	Herb, perennial. Leaves only growing from the crown, broader toward the tip, <30 cm long and 10 cm wide, almost hairless, thin, dissected into shallow or deep lobes with triangular teeth pointing towards base of leaf, with large, triangular terminal lobes. Flowers bright golden-yellow, 3-5 cm in diameter, solitary, composite, made up of five-toothed strap-shaped ray florets. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1852 • Areas of Origin : Europe • Flowering: throughout the year (NZPCN ; Roy et al. 1998, p.88)

Ulex europaeus L. **Gorse** • Classified Structural Class : Dicotyledonous Trees & Shrubs Family : Fabaceae	 Helga Küchly	Shrub,< 2m high; main stems erect or spreading, densely branched in younger parts but eventually bare at base; Leaves of seedlings not spinous but with 3 hairy leaflets; spines branched; terminal and lateral spines rigid, deeply furrowed, 15~30 mm long; Flowers solitary; bracteoles acute to rounded, 1.5~3 mm wide. • Weed status : Adventive- Not yet classified • Approx year naturalised : 1867 • Areas of Origin : Western Europe • Reason for introduction : Ornamental, Hedge plant • Flowering: May- November (January) (NZPCN)