



Human Modification of New Zealand coastal dune ecosystems

INTRODUCTION

Dune management and restoration is primarily required because of the significant modification of dune ecosystems that has occurred since human settlement in New Zealand. Coastal dunes are probably the most modified and degraded of all of New Zealand's major ecosystems – with very few that have not been significantly altered by human activities. In most cases, significant modification dates back centuries, so that very few New Zealanders have any understanding of the degree of change which has occurred. The dunes as we

see them today are generally significantly altered from original natural conditions.

This article provides a brief outline of the various human activities that have modified New Zealand's coastal dune ecosystems – including extensive removal of original vegetation sequences, widespread and serious wind erosion issues, introduction of exotic vegetation, introduction of grazing animals, coastal subdivision, “gardening” of dunes, recreational pressures and other effects.



Near-original dune vegetation sequences that include coastal native forest are rare in New Zealand. Remnants occur along parts of the Catlins coast, Otago (above) and parts of South Westland (below).

INITIAL DUNE CONDITIONS

The initial pre-human condition of New Zealand's dune systems is discussed in detail in other articles in this Handbook. However, in brief summary, New Zealand's coastal dunes were generally extensively vegetated – even though periods of natural disruption and destabilisation occurred (e.g. on the original Manawatu dunefields).

Dune vegetation sequences typically consisted of low sand trapping vegetation (e.g. spinifex, pingao) on more seaward dunes, giving way landwards to progressively higher (and probably increasingly diverse) vegetation and eventually forests. In many places, dunes had extensive forest cover extending close to the coastline.

On the entire New Zealand coast there are only a handful of locations (e.g. Catlins coast, Otago; South Westland) where original (or near-original) intact coastal dune vegetation sequences including coastal dune forests remain. Isolated (and generally small) coastal dune forest remnants or fragments occur more widely but are also relatively rare.



Some of the best examples of backdune vegetation sequence in New Zealand comprising a wide range of native shrub and tree species, Ship Creek dunes, south Westland.



DISRUPTION OF DUNE VEGETATION

Early human settlement

Available evidence indicates that widespread disruption and removal of coastal dune forests and associated vegetation followed early human settlement, dating from 700-800 years ago – reflecting extensive occupation and use of coastal margins.



In some places, the disruption of dune vegetation was sufficiently severe to give rise to significant issues with windblown sand, particularly along the exposed west coast of the upper North Island. For instance, in the 1840's Reverend Samuel Marsden described the sandhills behind Muriwai Beach west of Auckland as follows:

... the sandhills are very high ... There is no vegetation on them and the sand shifts with the contending winds. They are several miles broad and extend along the coast ... further than the eye can reach" (Murdoch, 1994).

Available evidence suggests the dunes along this coast were primarily vegetated and stabilised prior to human settlement.

In some other places, vegetation disruption and associated effects were less severe and extensive coastal forests or at least shrubland still remained



at the time of early European settlement. In some places, previously human destabilised areas were also recovering. For example, in regard to the dunes of Muriwai noted above, a letter dated 12 March 1924, notes:

... forty years ago the great coastal sand littoral that extended from Muriwai to at least the mouth of the Kaipara [Harbour] channel, was covered with a more or less compact vegetative mass of manuka, flax, toitoi, bracken and various forms of shrubs, scrub and trees" (quoted from copy of the letter contained in Alexander, 1999, p289).



Wind erosion and sand encroachment

Following European settlement, further extensive disruption of dune vegetation occurred due to land clearance, fire and the introduction of stock and grazing animal pests.

This gave rise to escalating issues with wind erosion and drifting sand around much of New Zealand from the late 1800's. In 1880, the area of drifting sands was estimated at 40,000 ha and had increased to 120,000 ha by 1909 (McKelvey, 1999). The problem was so serious and widespread that it was the subject of a major report to Parliament (Cockayne, 1911) and formulation of the Sand Drift Act 1908.

This wind erosion significantly modified the morphology of many dune systems around New Zealand, giving rise to migrating dunes and sand sheets which often extended considerable distances inland over older topography (e.g. Cockayne, 1910; 1911). Accordingly, it significantly modified both dune morphology and the areal extent of dunelands.

The effects were particularly severe on dunes along the west coast subject to strong onshore winds. By way of example, New Zealand Forest Service (1957) noted the following in regard to the dunes around Muriwai:

...(vegetation) cover was ... deliberately destroyed by fire ... used, first to eradicate pigs and deer, and then as a means of obtaining grazing. The fire, followed by rabbits, resulted gradually in severe wind erosion to the greater part (65%) of the area and by 1920 this erosion gave cause for considerable anxiety .. valuable, high-grade, fertile farming country .. being directly menaced with inundation by drifting sands. ... an inspection revealed that during the 30-year period 1901 to 1930 the sand had advanced 1000 to 1,300 feet and was still moving forward very rapidly,...

EARLY DUNE STABILISATION

Use of exotic species

The serious wind erosion led to active human intervention to manage and stabilise the coastal dunes around much of the coast of New Zealand. Accordingly, stabilisation extensively introduced exotic vegetation on New Zealand dunelands – most notably the exotic sand binder marram grass (*Ammophila arenaria*) and a range of nitrogen fixing species including tree lupin (*Lupinus arboreus*) and coastal wattle (*Acacia sophorae*).

Conversion to productive land use

Many of the stabilised areas were converted to productive land uses using exotic species, particularly pines (*Pinus* sp.) or pasture. McKelvey (1999) notes the following standard approach was typically adopted for conversion to pine forests:

- placement of sand fences to build up and repair the most seaward dunes;
- planting of marram grass to stabilise the sands;
- after the marram grass established, sowing of tree lupin; and
- about three years later, planting trees.



Marram grass was planted to stabilise coastal dunes in many regions before conversion to pine forests.



Conversion to pasture involved a similar approach with stabilisation by marram grass planting followed by planting of various introduced nitrogen fixing herbaceous species.

These exotic species now occupy large areas of remaining natural dunelands and seriously compete with native dune vegetation. The stabilisation also converted large areas of dunelands to pasture and forest. In some areas, the stabilisation also artificially established large frontal dunes along the coast (Dahm and Spence, 2002).



Example of marram-dominated dune system, Wanganui coast near Himatangi.

DUNE MODIFICATION AND SUBDIVISION

Widespread subdivision of beaches for holiday settlements, particularly since WWII, saw extensive coastal settlements developed over many of New Zealand's dunelands – particularly along the east coast of the North Island and along the Tasman and Golden Bay coasts.

In most areas these settlements also encroached very close to the shore, with only a very narrow dune buffer (often < 30 m) left between properties and the sea. Frontal dunes were frequently bulldozed and levelled to provide improved sea views and facilitate recreational use. The frontal dunes were often capped with soil and grassed. In extreme cases, the entire frontal dune was replaced with levelled and grassed dunes.



Example of wide frontal dune bulldozed flat and capped with fill - Pauanui Beach, Coromandel. The local Coastcare group have subsequently restored a zone of natural dune vegetation in this area.



EXOTIC VEGETATION DISPLACING NATIVES

A wide variety of exotic species introduced by humans are now extensively established on New Zealand dune systems forming a significant component of dune vegetation (e.g. Partridge, 1992; Johnson, 1992; Gadgil 2006).

Foredunes

Many of these exotic species significantly impact on native ecosystems and native biodiversity and some even impair natural dune building and repair.

As noted earlier, marram grass was extensively used in dune stabilisation and is now widespread – sometimes largely replacing native sand binders such as pingao (*Ficinia spiralis*) (Partridge, 1995) and spinifex (*Spinifex sericeus*) on the frontal foredune. This species also has a significant effect on frontal dune morphology, especially on exposed coasts with strong winds where it tends to build higher and steeper frontal dunes (Esler, 1978). It also occurs over extensive backdunes areas at many locations, inhibiting recovery of native vegetation.



Exotic perennial grasses extending over seaward face of dune, displacing the native sand binders - Pauanui Beach, Coromandel. The local Coast Care group have since restored the native sand binders over a suitable width.

Backdunes

A large number of other exotic species also occur on NZ dunes and particularly the semi-stable and stable landward zones. These can be particularly problematic on dunes close to coastal settlements where dumping of garden wastes and “gardening” of dunes by adjacent property owners often introduce exotic species.



Dune system dominated by the exotic species coastal wattle (dark green) and marram grass (light coloured flowerheads), Himatangi on the Manawatu-Wanganui coast.

Many of these weeds are quite aggressive such as agapanthus (*Agapanthus praecox*), South African ice plant (*Carpobrotus edulis*), various garden plants such century plant (*Agave* sp.), yucca (*Yucca* sp.), cacti, arctotis (*Arctotis stoechadifolia*) and gazanias (*Gazania rigens*), woody asparagus (*Asparagus* sp.) and many others. Many can seriously invade or even displace native vegetation communities.



Exotic perennial grasses and weeds from lawns and pastoral land uses also commonly invade dunes and even displace native vegetation. Aggressive taller vegetation and shrubs/trees are also common – including pampas (*Cortaderia* sp.), coastal banksia (*Banksia integrifolia*), coastal wattle, Tasmanian ngaio (*Myoporum insulare*) and many others.

Restoration options

There is little potential to completely remove exotic vegetation in the foreseeable future from all coastal sand dunes in New Zealand. For instance, there are vast tracts of dunes dominated by marram grass, particularly in southern latitudes.

Most management and restoration work focuses on restoring the relatively small proportion of dunes in high use urban areas that occur along the beaches of coastal settlements, resorts and cities by Coast Care groups and management agencies. Where sufficient width of dune and resources are available the aim is to restore a natural representative sequence of native dune vegetation including control of the more aggressive invading exotic species.





ANIMAL BROWSING AND GRAZING

New Zealand's native duneland vegetation has been extensively altered by grazing and by browsing mammals. Much of New Zealand's native dune vegetation (particularly endemic species) evolved without grazing mammals and many are highly palatable. Grazing and browsing has significantly contributed to many species being rare or threatened.

Stock grazing contributed extensively to historic sand drift problems and wind erosion with blow outs, but wind erosion, blow-outs and migrating sands still occur in places where stock have access to dunes.

More significantly, native dune vegetation and native successional recovery continues to be severely impacted by browsing pest animals – particularly rabbits and hares but also pigs and deer in some places. This browsing can significantly reduce and even eliminate more palatable species (e.g. pingao, coastal five finger and many others). There is also strong field evidence that browsing significantly slows or alters natural regeneration and successional recovery of native dune vegetation.



Rabbit browsing has removed nearly all leaves from this coastal five finger (*Pseudopanax lessonii*).



Example of severe rabbit infestation on an area of dunes at Waikawau Bay, eastern Coromandel.



Implications for restoration

Accordingly, restoration programmes that incorporate animal pest control have enhanced recovery of some species (e.g. pingao). However, ongoing pressure from pest animal browsing is likely to remain a significant long term threat on all dunes. Monitoring pest animal impact and timely control will remain an essential part of long-term dune management programmes.



RECREATIONAL PRESSURE AND WIND EROSION

Native sand binding species are sensitive to damage by trampling or vehicles. Problems with disruption of vegetation cover commonly arise in high use areas where pedestrian beach access is poorly managed and in areas where motorbike and other vehicle use occurs on dunes. Damage to spinifex and pingao cover on the seaward dune face seriously impairs natural dune building and repair and can also lead to wind erosion, blow-outs and problems with windblown sand.

Following WWII, the popularity of coasts and beaches has seen extensive recreational pressure on many dune systems – often leading to localised blow outs and other wind erosion issues. Fortunately, local Coast Care programmes are now addressing these issues at many sites with repair of the damage and improved provision of beach accessways to protect sensitive dune vegetation. These community based programmes are also contributing to significantly increase public awareness and support, and the development of a dune care ethic.

Off-road vehicles have disrupted dune vegetation and given rise to wind erosion problems in many areas, particularly since the 1970s due to the marked increase in the ownership of off-road motorbikes and four-wheel drive vehicles (see Technical Handbook Article No. 10.2 – *Effects of vehicles on sand dunes*).



Dunes largely denuded of vegetation by various recreational pressure - including off-road vehicles - Marokopa Beach on the Waikato west coast in 2004. The local Coastcare group has since restored native sand binders over most of this large spit.



Off-road vehicles on dunes damage dune vegetation and leads to wind erosion of sand.





Changes in Dune Fauna

The introduction of a wide range of exotic fauna (e.g. insects, animals and birds) and vegetation and the significant loss and modification of native dune vegetation communities has had significant adverse effects on native dune fauna.

The changes in native dune fauna are still only poorly understood but available information indicates that modification of dune ecosystems has significantly reduced some landsnail fauna, some moth species, common skinks, katipo spiders and the Cromwell chafer beetle.

There are also isolated examples where modified dunes provide important habitat for threatened species (e.g. the Fairy tern colony at Mangawhai, Northland).





OTHER FACTORS

Coastal settlements tend to lead to the proliferation of coastal structures, some of which can impact on beaches and dunes. The most notable impacts are generally associated with sea walls which isolate dunes from the wider beach system. Sea walls also pose a significant threat to the longer term resilience of beaches and natural shorelines. However, sea walls are primarily used where subdivision and development has been placed too close to the sea – so the natural dune vegetation is often already quite modified. Nonetheless, there is often opportunity with appropriate design to either avoid the need for the structures or to design and locate them to minimise adverse impacts.

Other structures on dunes and beaches include stormwater outlets which can locally aggravate dune erosion during coastal storms. Similarly, large fixed structures like boardwalks and viewing platforms located too far seaward can exacerbate sand erosion.

Historically, dunes and dune vegetation have sometimes also been impacted by sand extraction from beaches and dunes. While not a major factor on New Zealand dunes, the effects can be significant locally.





REFERENCES

- Alexander, D. 1999: Consolidation, Development and Public Works Takings in Southern Kaipara. A report commissioned by Crown Forestry Rental Trust, January 1999. 406p.
- Cockayne, L. 1910: *New Zealand Plants and Their Story*. Government Printer, Wellington. 190p.
- Cockayne, L. 1911: Report on the sand dune-areas of New Zealand, their geology, botany and reclamation. Parliamentary Paper C13. Department of Lands. Wellington. 76p.
- Dahm, J.; Spence, H. 2002: Muriwai: Coastal hazard management strategy. Coastline Consultants. Hamilton, New Zealand.
- Esler, A.E. 1978: *Botany of the Manawatu District*. Government Printer, Wellington, New Zealand. 206p.
- Gadgil, R.L. 2006: Marram grass friend or foe? A review of the use of *Ammophila arenaria* on New Zealand sand dunes. New Zealand Forest Research Institute Ltd, Rotorua. *Coastal Dune Vegetation Network Bulletin No. 5*.
- Johnson, P.N. 1992: The sand dune and beach inventory of New Zealand. II. South Island. *Department of Scientific and Industrial Research Land Resources, Scientific Report No. 16*. 278p.
- McKelvey, P. 1999: *Sand Forests*. Canterbury University Press, Christchurch. 168 p
- Murdoch 1994: Maori healing and herbal. New Zealand ethnobotanical sourcebook. Paraparaumu, New Zealand. Viking Sevenses.
- New Zealand Forest Service 1957: Notes on Woodhill Sand Dune Area. Notes forwarded to New Zealand Forest Service (NZFS), Head Office Auckland by Inspector in Charge, Management Division, NZFS, Wellington, file 27/1/4, dated 7 November 1957.
- Partridge, T.R. 1992: The sand dune and beach inventory of New Zealand. I. North Island. *Department of Scientific and Industrial Research Land Resources, Scientific Report No. 15*. 253p.
- Partridge, T.R. 1995: Interaction between pingao and marram on sand dunes. *Department of Conservation Science for Conservation Series No. 3*. 27p.

Author: Jim Dahm, Eco Nomos Ltd



Dunes Restoration Trust of New Zealand
Email: info@dunestrust.org.nz
www.dunestrust.org.nz

2014

ISSN 2230-6919



Community Environment Fund

The Ministry for the Environment does not necessarily endorse or support the content of this publication in any way.