ACTIVE (COASTAL) SAND DUNES, NEW ZEALAND

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CLASSIFICATION

National: Active (coastal) sand dunes are classified as Naturally Uncommon Ecosystems in New Zealand (Williams et al. 2007) and are identified as priority ecosystems for conservation on private land (Ministry for the Environment 2007) and more generally within the New Zealand Biodiversity Strategy (http://www.biodiversity.govt.nz/picture/doing/nzbs/contents.html).

International: Active coastal sand dunes occur throughout the world, but the biotic community associated with New Zealand's active dunes is unique.

IUCN Habitats Classification Scheme (Version 3.0): 13 Marine Coastal/Supratidal; 13.3 Coastal Sand Dunes

ECOSYSTEM DESCRIPTION

Active sand dunes are those dune lands whose physical landscape and ecological character results from continuously moving wind–blown sand or high rates of sedimentation (Figure 1). They are predominantly coastal in New Zealand. Large transgressive dune systems were widespread on the western (windward) coasts of the North Island and South Island, with prograded foredune barriers with lesser active dune systems widespread elsewhere. The former are geomorphically dynamic and often physically complex, and may contain a corresponding complex of environments and plant communities (Johnson, 1993, Johnson & Rogers 2003, Hilton et al. 2000). A distinctive dune flora and fauna is associated with areas of more active sedimentation (i.e. active sand dunes, as defined by Williams et al. 2007), however, dune systems usually contain a range of ecosystems reflecting the complex of environments and geomorphic histories. These ecosystems are associated with active dunes, inter-dune wetlands (established and ephemeral) bare to sparsely vegetated deflation and depositional surfaces, lakes shrubland, grasslands formed in conjunction with marram grass (*Ammophila arenaria*) and coastal turfs.

Characteristic native biota

The native sand-binding sedge pīkao or pīngao or golden sand sedge (*Ficinia spiralis*) is the keystone species of New Zealand's active sand dunes. Pīngao is endemic to New Zealand and (along with spinifex (*Spinifex sericeus*) is commonly associated with foredunes and areas of high sand movement within transgressive dune systems. These plants stabilise sandy areas by trapping wind-blown sand. Other biota associated with active sand dunes are plant species such as kokihi (*Tetragonia tetragonioides*), sand wind grass (*Lachnagrostis ammobia)*, and sand tussock (*Poa billardierei*); invertebrates such as the endemic katipo spider (*Latrodectus katipo*), which is restricted to coastal dune and beach areas, and shorebird species (e.g. New Zealand dotterel, *Charadrius obscurus*).

Distribution

Active sand dunes occur in many coastal areas of the North, South and Stewart islands, and on some offshore islands (Johnson 1992; Hilton et al. 2000, Figure 1). The larger remaining active sand dunes are in Northland (e.g. Aupōuri Peninsula, Awhitū peninsula), Auckland's west coast (Manukau Heads), Waikato (Aotea and Kāwhia harbours), the Manawatū coast, Farewell Spit, the Fiordland coast, Kaitorete Spit and on Stewart Island (particularly Mason Bay and Doughboy Bay), however, smaller and fragmented remnants of larger dune systems occur throughout New Zealand

Abiotic environment

Active sand dunes are dynamic systems where some degree of sand movement is essential to the functioning of the system. The plant and animal communities which inhabit active sand dunes are adapted to move with the sand. If it becomes too stable and water table and soil moisture change then organic layers may develop, and the dunes may transform to shrub and forest dominated ecosystems.

There are major differences in dune system development between west (windward) and east (lee) coasts of the three main islands (Hilton et al. 2000). The relatively greater size of west coast dunelands reflects New Zealand's location in the southern South Pacific in the prevailing westerly air stream, the size of coastal sand systems and the accommodation spaces available for late-Holocene coastal barrier development. East coast active dunelands are, in general, smaller, less dynamic and more clearly associated with local sediment sources. This is particularly so between North Cape and East Cape on the east coast of the North Island. Almost all the east coast active dunelands are less than 1 km in width and many are only a few tens to a hundred metres in width. The dunelands of the west and east coasts of the South Island, in contrast, receive sediment from northward alongshore sand transport systems generated by prevailing south and southwest winds and waves (Hilton et al. 2000). The dunes of the south coast of Otago Peninsula, for example, are comprised of sediments delivered to the coast by the Clutha River, swept north along the inner continental shelf by southerly swell waves and across the foreshore by southerly winds. In contrast, the dunelands of the northeast coast of the North Island are largely associated with closed sand systems.

Key processes and interactions

In healthy active sand dune systems key processes are sand movement, and establishment of sand binders causing local stabilisation of the dunes followed by colonisation by other species. Natural on-going sand disturbance prevents the establishment of tall woody vegetation and the cycle repeats itself (Figure 3). This system is therefore maintained by frequent sedimentation (sand erosion and deposition). Facilitation is a key biotic process whereby sand binding plants create localised areas of stable sand which facilitates the establishment of other plant and animal species.

THREATENING PROCESSES

Most of New Zealand's dune systems have been modified to some degree by human activity or introduced plants over the last 800 years. It is not known how much Māori influenced the active dune lands, but their fires may have locally reduced plant cover and increases sand movement. European fires (post 1800) have destroyed native sandbinding communities and farm animals have grazed extensive areas. Rabbits threaten many rare sand dune species (Norbury 1996). Introduced plants are the major threat to the survival of this ecosystem (Hilton et al. 2005). The most significant introduced plant considered a threat is marram grass (*Ammophila arenaria*). Other introduced plants considered a threat are South African ice plant (*Carpobrotus edulis*), tree lupin (*Lupinus arboreus*) and radiata pine (*Pinus radiata*). All of these introduced plants were intentionally planted for dune stabilisation in the period from 1890, and are still being used to stabilise active dunes. These introduced plants stabilise the dune systems effectively preventing the establishment key native dune species such as pīngao (Hilton et al. 2005). Replacing pīngao with marram grass has also changed the habitat of the native katipō spider, which is now considered to be a threatened species. Coastal development is also a significant threat. Forestry and farm development have modified once extensive natural dune ecologies to the point where recovery is now impossible. Irresponsible use of ATVs and 4WD vehicles is also a problem in some areas. Maintaining remaining active dune systems of high conservation value will require active and intensive management of these exotic species.

Figure 1. Active sand dune ecosystems including: (top left) large 100m high dunes with scattered vegetation patches, 90 Mile Beach, Northland; (top right) native sand binder, pīngao *(Spinifex sericeus)* and shore convovulous (*Calystegia soldanella*); (bottom two panels) degraded dunes dominated by invasive plant species including marram grass (*Ammophila arenaria*) and tree lupin (*Lupinus arboreus).*

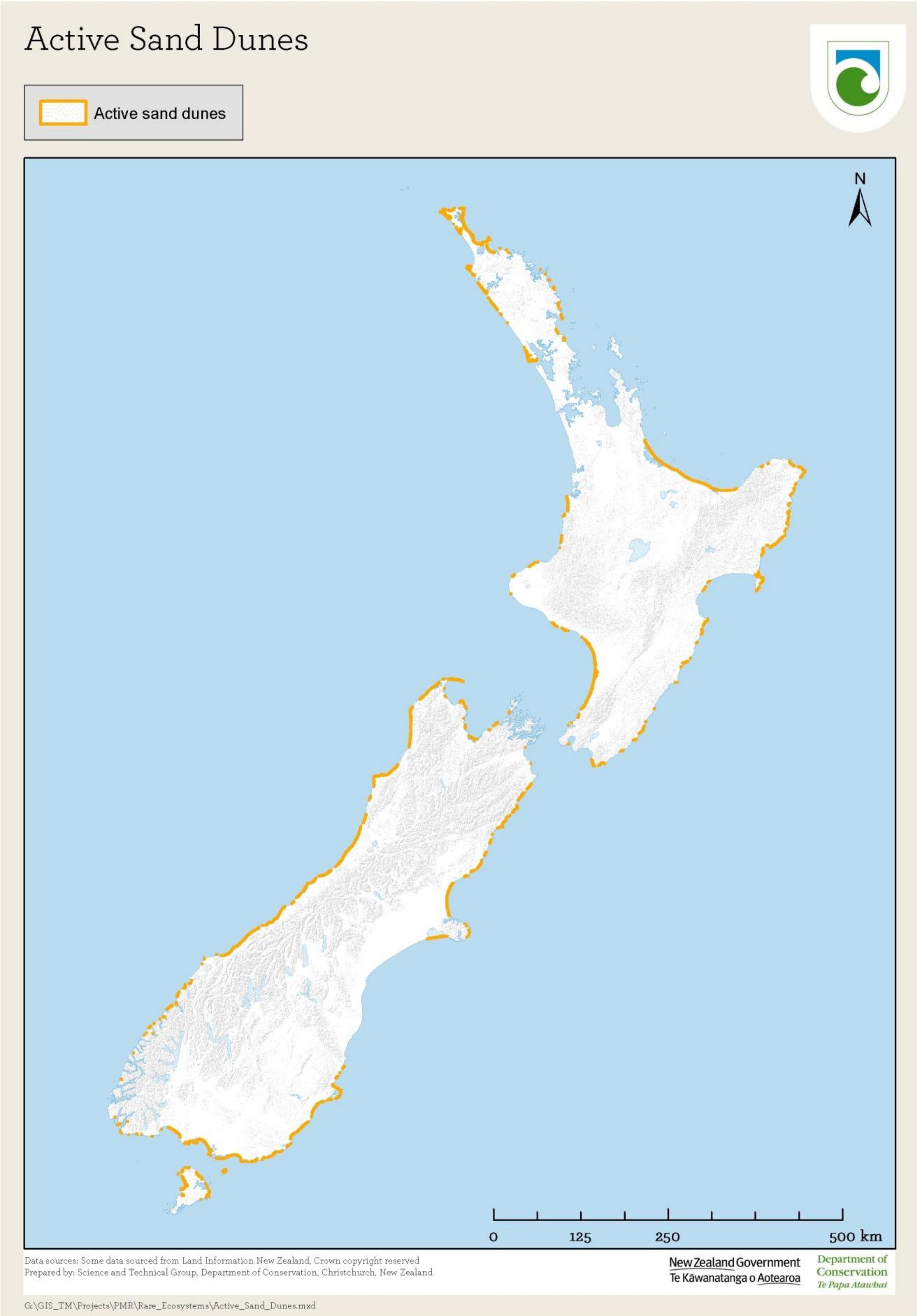

Figure 2: Map of New Zealand showing the current distribution of active coastal sand dunes.

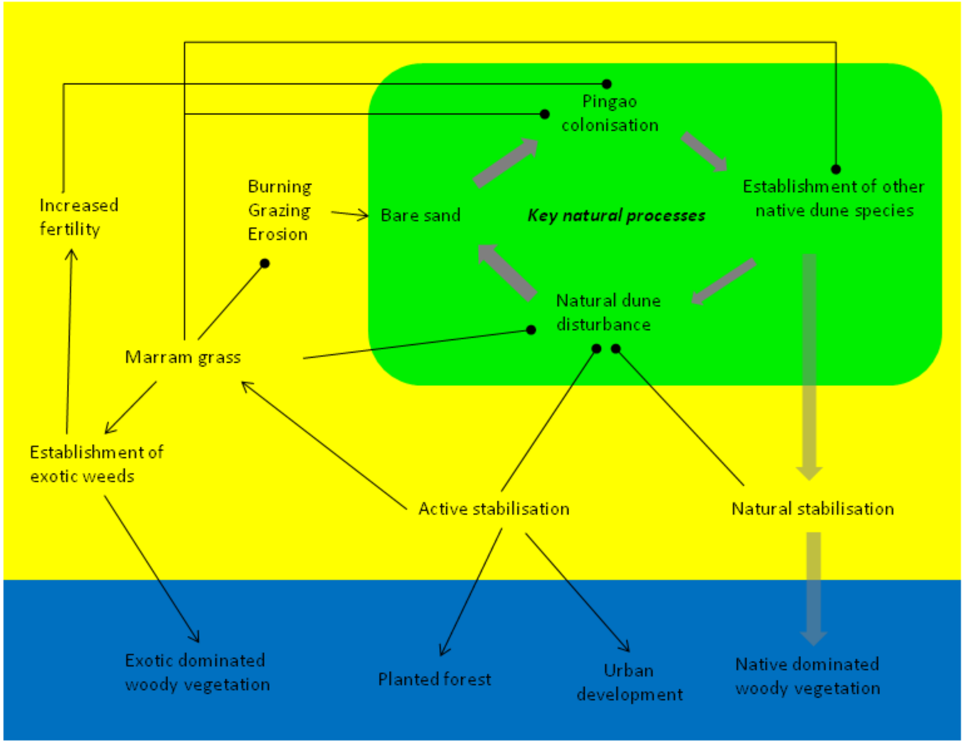

Figure 3: Process diagram for active coastal sand dunes. Green box represents processes occurring in healthy sand dune ecosystems. Yellow box incorporates threatening processes and the blue box represents transformed ecosystems that are no longer classified as active sand dunes. Arrows indicate relationships that either promote the process at which the arrow is directed (arrowhead), or inhibit/reduce its effects (solid point).

ASSESSMENT

Summary

Criterion	A	B	C	D	E	overall
subcriterion 1	EN	LC	DD	DD	NE	EN
subcriterion 2	EN	NT	DD	DD		
subcriterion 3	DD	LC	DD	DD		

Criterion A

Current decline: The national area of active coast dunes in New Zealand is estimated at around 129 740 ha in 1911 (Cockayne (1911). The area in 1950 was 127,000 ha (Hilton et al. 2000), indicating very little decline from 1911 to 1950. By the 1990's, the distribution of active sand dunes had been reduced by to 38 949 ha (Hilton et al. 2000). Taking 1995 as the average year of the 1990's estimate, this equates to a 70% reduction over a 45 year period. Extrapolating to a 50 year period increases this decline to 76%. A recent estimate obtained by overlaying current land cover maps (imagery from 2008) put the area at 25,208 ha. This indicates a further reduction of 36% over the 8 years from 2000 to 2012. Using the exponential decline model predicts that the distribution in 1962 was approximately 94,000 ha, giving a 73% reduction over the previous 50 years. Active sand dunes are therefore **Endangered** under criterion A1.

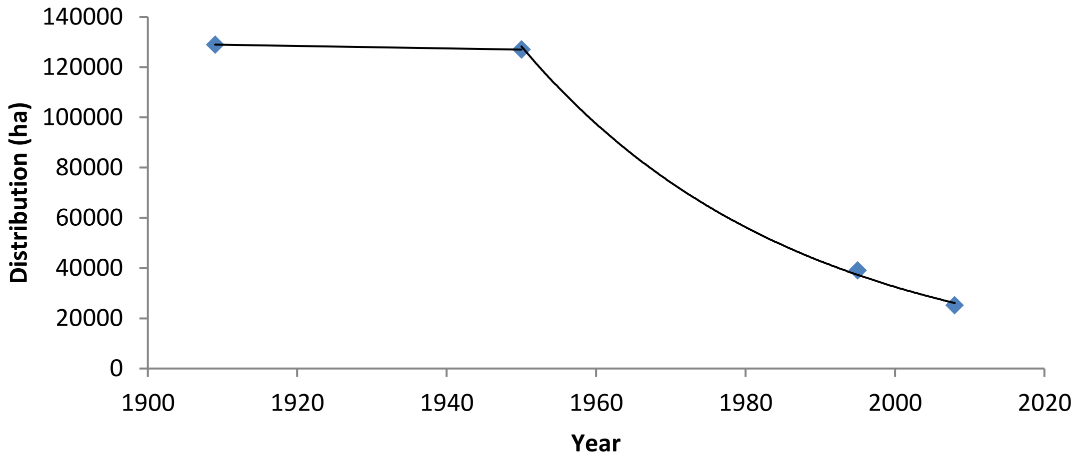

Figure 4. Area estimates in 1911, 1950, 1990's (plotted at 1995) and 2008. Area is relatively constant from 1911 to 1950, and subsequent declines are well fitted by a model of exponential decline. The abrupt decline post-1950 is due to the initiation of government sponsored dune stabilisation programmes.

Future decline: Despite the occurrence of some localised restoration projects, the threats facing active sand dunes are likely to continue in the future as most remaining active dune systems are facing severe threats, particularity from invasive species. Extrapolating the current relationship gives a further predicted decline of 73% over the next 50 years. Active sand dunes are therefore **Endangered** under criterion A2.

Historical decline: Research has shown that dune lands had natural periods of expansion over the late Holocene (last 10,000 years) and there is some evidence for increase in sand dune distribution with pre-European burning (e.g. in the Manawatu). Because they are continually moving, and because of New Zealand's relatively recent colonisation, it is difficult to accurately estimate the 1750 extent of active dune lands. Due to the uncertainty in the area of active sand dunes in 1750 they are listed as **Data Deficient** under criterion A3.

Criterion B

Extent of occurrence: Current EOO is estimated as 62,848,416ha, or 628,484 square km. The status under criterion B1 is therefore **Least Concern**.

Area of occupancy: Current mapped distribution of active sand dunes is 25,208ha. The number of 10 km square grid cells occupied by this ecosystem is 393, with 53 grid cells being occupied by >1%. Because this is close to the vulnerable threshold of 50, and since there is evidence for significant on-going declines in both area (e.g. due to coastal development), and function (e.g. due to spread of marram grass and other weeds), this ecosystem is listed as **Near Threatened** under criterion B2.

Locations: This ecosystem exists at many locations (Figure 1) so it is listed as **Least Concern** under criterion B3.

Criterion C

Current decline: The response variable used to indicate decline in abiotic environment is sand movement, as loss of sand movement (i.e. dune stabilisation) alters the physical processes controlling the structure and function of the active sand dune ecosystem (Figure 3). In the absence of direct measurements of sand movement, vegetation cover of strongly sand-binding species (e.g. woody plants) could be used as a surrogate measure. This could be estimated by taking a random sample of 100 point locations within the mapped extant area of active sand dunes and quantifying the % vegetation cover at that location and the dominant species. The number of locations which are deemed to be "stable" (i.e. complete vegetation cover of stable sand dune species) would give the extent of the decline in the abiotic variable. This assessment would require extensive field data and thus active sand dunes are listed as **Data Deficient** under criterion C1.

Future decline: There is evidence for rapid weed invasion through the record of aerial photography, but also evidence of dune restoration occurring on Stewart Island, Fiordland, Kaitorete Spit and within smaller systems in the North Island (e.g. Hilton et al. 2002). Since there is not enough data to evaluate this criterion, active sand dunes are listed as **Data Deficient** under criterion C2.

Historical decline: Due to the uncertainty in the abiotic environment of active sand dunes in 1750 they are listed as **Data Deficient** under criterion C3.

Criterion D

Current decline: Indigenous dominance is a key biotic indicator, with the dominance of exotic species considered a threat (i.e. marram grass) being linked to significant declines in the native communities, outcompeting the native sand binder species (Hilton et al. 2005). This could be quantified by taking a random sample of 100 points spread across the entire distribution and quantifying those with marram or other exotic species present, and their relative abundance. Due to the current absence of data active sand dunes are listed as **Data Deficient** under criterion D1

Future decline: There is evidence for further weed invasion, but also evidence of dune restorations (e.g. Hilton et al. 2002). Active sand dunes are therefore listed as **Data Deficient** under criterion C2.

Historical decline: **Data Deficient**

Criterion E

Not evaluated

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