Forestry in Relation to Sand Country Ecology

G. H. Hocking

The forester has the dual role of stabilizing drifting sand and practising forestry on part of the reclaimed land. In this second role he must co-operate with the farm development officer in working out a land use pattern of purely protective cover near the beach, with productive forest and pasture inland.

The present cycle of sand-drift has been induced by human interference with the vegetative cover during the last century, particularly by cattle grazing and burning. Any system of extensive management which does not protect the more vulnerable sand hills from the depredations of stock will perpetuate instability. Consequently the present reclamation is directed towards a more intensive land-use pattern which can assign the various sites to their best permanent use.

After the elimination of grazing, the first step towards stabilization of drifting sand is the construction or reconstruction of a foredune to cut off the movement of sand from the beach. Before attempting to stabilize the sand with vegetation, additional adjustment of its surface may be desirable within the dune complex to reduce such irregularities as will cause wind channels. Higher dunes may occasionally be allowed to blow down and fill hollows. Under local conditions it is rarely feasible to achieve stability by thatching the bare sand surface with scrub or branches, and reliance must usually be placed on establishment of plants on bare sand. It is convenient to distinguish three categories of plants in the artificial succession to a permanently stable cover:

(*a*) *Primary Stabilizers.* These are the specialized rhizomatous sand-binders: marram grass (*Ammophila arenaria*), silvery sand grass (*Spinifex hirsutus*) and the sedge pingao (*Desmoschoenus spiralis*). Species of minor importance in this group are *Carex pumila* and *Calystegia soldanella.* All owe their pioneering ability to vigorous rhizomes, protection from the abrasive action of blown sand and upward growth through accumulating sand. Marram is the pioneer *par excellence* in the reclamation of sand drifts. Silvery sand grass is of particular value in maintaining the seaward toe of the foredune. The weakness of pingao is that it rarely forms a continuous uniform cover. Single plants will effectively hold a patch of sand, but this may develop into a hillock with wind channels leading to a general break-down of the dune surface.

(*b*) *Secondary Stabilizers.* The pioneer species already mentioned are rarely able to achieve more than temporary stability by themselves. Though additional plants, including indigenous shrubs such as *Pimelea* and *Cassinia,* may follow them naturally, it is usually necessary to introduce a species such as tree lupin (*Lupinus arboreus*) to arrest the surface drift, shade the soil surface and improve its nutrient status, thus creating favourable conditions for the entry of a wide range of less specialized plants.

(*c*) *Tertiary Stabilizers.* These are the trees, shrubs and pasture plants forming the final stage of stabilization and, where possible, the productive crop. There is no clear-cut distinction between secondary and tertiary stabilizers, but the former are usually of a temporary nature comparable with an early seral stage of natural succession. In the productive forest zone the choice of tree species is rather restricted, but in the protective zone, extending for perhaps a quarter of a mile from the beach, conditions are varied and exacting, and there is a niche for a number of salt-resistant plants of various growth habits to make a graded canopy from the foredune to the forest proper. In selecting species for the frontal zone, not only must they be adapted to the several sites, but also reasonably easily procured and propagated, and preferably resistant to animal and insect attack.

Salt wind is the greatest single factor determining the extent and composition of high forest on coastal dunes. In contrast to the protective frontal zone, the high forest must depend largely on a few species of conifer. However, broadleaf trees are a desirable addi-

tion to the forest as soil improvers and for protection against fire. Repeated thinning to maintain a high diameter/height ration is of particular importance in these forests if wind throw and, particularly, wind breakage is to be kept to a minimum. Thinning is also desirable to minimise the damage to pines caused by *Sirex noctilio*.

In both stabilization and afforestation of sand country many environmental factors have to be considered.

(*a*) *Climate.* Wind is by far the most important climatic factor in causing soil instability and influencing plant growth. There are no data on wind intensity, but this appears to increase northward at least as far as the Turakina River. Abrasion is inimical to tender germinating plants and makes the choice of season of sowing important. The number of rain-days is more important than the amount of rainfall in maintaining a wet, and consequently stable, sand surface. On this coast rainfall is in the vicinity of 35 in. on 125 rain-days per annum. Sunshine causes very high surface temperature, particularly on the darker sands. Only well-protected plants, such as the sand grasses, can endure such temperatures, and shading of the surface must precede the introduction of less resistant species. Sharp frosts occur right up to the foredune.

(*b*) *Soils.* The sand becomes darker as well as coarser in proceeding north along the west coast of the Wellington Province. This colour difference is due to the increasing amount of hornblend and augite of volcanic origin. Shell fragments occur throughout and pH is generally high. The apparent nitrogen deficiency of the coarse Santoft sands slows down the rate of establishment of marram and so makes it more prone to wind damage. This in turn delays the establishment of lupin which would tend to rectify this deficiency. Soil moisture may become critical on dunes, while on sand flats the winter water-table may be too high for the growth of trees. Where wet flats and hollows are not fed from outside sources, developing forest on the dunes will often permanently lower the water-table, converting swamp or sedge associations into fertile sites capable of supporting more exacting forest trees.

(*c*) *Biotic Factors.* Domestic stock remain the greatest potential hazard to the vegetative cover. Rabbits and hares are a major problem in establishing protective vegetation and forest while, in attempts at direct seeding in the forward areas, mice have eaten seed. An insect of considerable importance in both reclamation and afforestation is the moth *Mecyna maorialis*, the larva of which feeds on tree lupin. The population of this insect builds up to epidemic strength at intervals of a few years. Tortricid larvæ also build up to epidemic strength periodically and cause defoliation of young pines, particularly where growing amongst lupin or other rank growth. *Sirex noctilio* causes mortality in *P. radiata*, particularly in overstocked stands in the thicket stage, and on sites prone to local drought conditions. Bacterial inoculants may be important on species of sand acacia.