

## Problems Arising from the Intensive Use of Coastal Dunes in New South Wales, Australia

by  
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This paper discusses the problems of sand instability being encountered in coastal dunal areas of New South Wales. The area is described generally in terms of topography, climate and vegetation. The problems are outlined and the methods being used to combat these are discussed. Past research results and current research activities are described.

### DESCRIPTION OF AREA

The coastline of the State of New South Wales lies on the eastern edge of the Australian continent, between latitudes 28° and 38° South and is approximately 1450 km in length. It consists of consolidated rock headlands, stream entrances and numerous sand barrier beaches with associated dunal areas.

Heights of the frontal beach dunes average about 10 m, while associated hind dunes are up to 150 m. The slopes of faces vary but on hind dunes are up to 30°. Average annual temperatures along the coast, range from 21° in the south to 24°C in the north and minimum temperatures from 11°C to 15°C. Annual rainfall is highest in the north and decreases southward, the average ranging from 1670 mm in the north to 830 mm in the south. Its seasonal distribution is also varied, from autumn and summer dominant with a comparatively dry spring in the north to an even distribution throughout the year in the far south.

Wind direction and velocity are of special importance in the design of sand stabilization works. It is difficult to generalize about the features but the following observations can be made.

**Summer:** Predominately north-easterly winds averaging 8 knots of a morning and 13 knots of an afternoon.  
**Autumn:** Predominately westerly of a morning averaging 8 knots and easterly of an afternoon averaging 11 knots.  
**Winter:** Predominately westerly of a morning averaging 8 knots and southerly of an afternoon averaging 10 knots.  
**Spring:** Predominately westerly in the south averaging 9 knots and easterly in the north averaging 8 knots of a morning and north-easterly of an afternoon averaging 13 knots.

Cyclonic conditions affect the northern coastline from December to May with an average frequency of two per year. On the southern coastline the cyclonic period is May to October and the average frequency is also two per year. Wind velocities on the coast during cyclones can exceed 60 knots.

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The naturally occurring vegetative communities of the coastal sand areas vary considerably however certain basic features are constant along the coast.

The vegetation on the seaward face of the frontal dune is restricted to grasses and creeping herbaceous plants. These are dominated by *SPINIFEX HIRSUATUS* and *CYNODON DACTYLON*, *HIBBERTIA VOLUMINIS*, *CARPOBROTUS AEQUILATERUS*, *SCAEVOLA SUAVOLENS* and *ZOISIA MACCRANTHA*. *AMMOPHILA ARENARIA* was introduced to New South Wales coastal areas in about 1890 and is now present along much of the southern coastline on beach front dunes.

In the more sheltered areas behind the crest of the dune, tree and shrub species are dominant. *ACACIA SOPHORA*, *ACACIA SUAVOLENS*, various *Lepospermum* *Melaleuca* and *Banksia* species and *CUPANIOPSIS ANACARDIODES* are present in most areas. In the northern regions *CASUARINA EQUISETIFOLIA* can be found on exposed faces. The vegetation on the sand ridges behind the frontal dune system is an extension of this community with the addition of *Eucalypt* and *Angophora* species. Between the ridges wet and dry heath communities are present with some swamp forest. Where an extensive hind dunal system exists it is covered by a mixed *Eucalypt* and *Angophora* Forest.

### THE PROBLEMS

On and behind this coastal dunal area almost 4.5 million people live and work and at vacation times this number is increased by visitors from other parts of the country. The area is being developed to cater for a rapidly increasing population and an even more rapidly increasing recreational need by the community and the individual. The pressure exerted on the beaches as a result of this is causing an accelerated deterioration of the vegetation on the dunal areas.

In the past grazing of sheep and cattle on areas adjacent to the coast has resulted in damage to dunal vegetation. In places a complete breakdown of the stabilizing cover has resulted and large sand drifts have become established. In a recent survey (Walt, 1972) the total area along the coastline which could be classified as drifting sand was assessed as 6415 ha at 145 locations. These areas cover a coastal length of 318 km. There were 51 areas of drift each exceeding 10 ha and of these 14 exceeded 100 ha. Some of these drifts are causing damage of economic importance. Siltation of river channels and harbour works, destruction of valuable agricultural and residential land and the disruption of roadways are examples.

Along the 840 km of coastline north of Sydney is located the bulk of the Australian deposit of mineralized sands. The minerals produced from these sands include Rutile, Zircon, Ilmenite and Monazite.

Mining of these minerals involves complete destruction of the surface vegetation and upheaval of the sand mass. About 5000 ha at 150 locations have been disturbed in the past and mining is progressing at the rate of about 500 ha at 25 locations per year.

Mining operators are required under their operation conditions to stabilize these areas after mining and to restore the vegetation to a condition similar to that existing prior to mining. In some instances they are required to reclaim areas that were previously unstable.

There are consequently three separate problems to be considered in the management of coastal dunes in New South Wales. Since 1946 the Soil Conservation Service has been engaged in research and advisory work in this field and has conducted large scale reclamation works on a number of areas. The following is a summary of techniques used to overcome these problems and of the related research work being undertaken.

## POPULATION PRESSURE

The intensive use by people of the coastal zone tends to be concentrated at specific points: city beaches, tourist resorts and river entrances. The number of these locations is increasing with the increase in the density and the mobility of the population, but it is possible to identify the individual areas affected.

The responsibility for the care of these areas lies with local municipal councils and the Department of Lands. The Soil Conservation Service acts in an advisory capacity to these bodies.

The effects of this pressure on the dunal system are readily apparent. There is a destruction in part or whole of the naturally occurring vegetative cover on the sand dunes. As a result of the removal of this cover, erosion both by wind and wave action causes damage and often complete destruction of the frontal dune. In places, dunes have been completely destroyed during the construction of beach access ways, vehicle parking areas, roadways and other public amenities. Without a frontal dunal system the beach loses its ability to withstand further erosion and large scale engineering works become necessary to maintain it (Fig. 1).

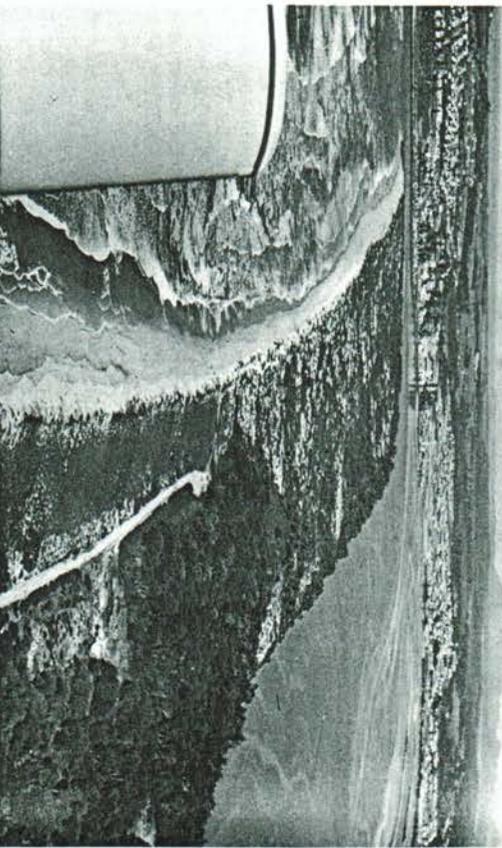


Fig. 1. Stabilized spit area of Port Macquarie on north N.S.W. coast. Work completed 1962 by Soil Conservation Service. Entire Spit was unstable.

The methods used to overcome these problems are a combination of reformation of the dunal system, revegetation of the sand surface and management of both the reclamation measures and the public to afford continuing protection. Dunes are reformed with earthmoving equipment and stabilized by planting SPINIFEX HIRSUTUS or AMMOPHILA ARENARIA (Fig. 2).

Past research has defined the areas on which each grass is most effectively used. Trials have also been carried out to examine the range of temporary surface stabilizers used to protect these plantings during establishment. Results have indicated the limitations of oil/laterx sprays and the success of brush matting or mulch in all circumstances.

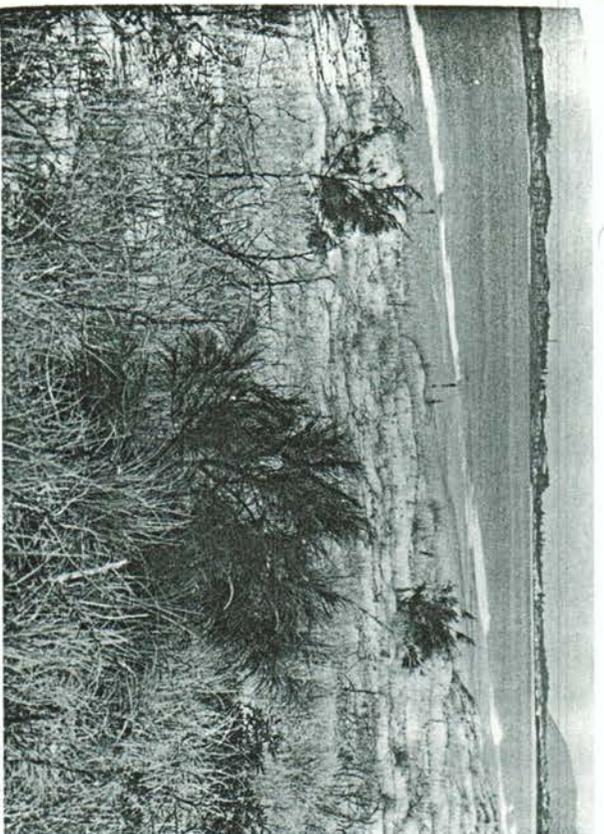


Fig. 2. Recently stabilized Frontal Dune showing SPINIFEX HIRSUTUS and young seedlings of CASUARINA EQUisetifolia and ACACIA SOPHORAE - the latter on the right edge of the photo.

Fertilizer rates of up to 75 kg of nitrogen, 30 kg of phosphorus and 30 kg of potassium per hectare are used at planting and the areas are topdressed as required. Current research trials are examining alternative fertilizer types and rates. Trials are also being carried out into the use of turf grass species for use on recreation areas and access tracks. Species which show the most promise are CYNODON DACTYLON, PASPALUM COMPRESSUM and DIGITARIA DECUMBENS.

## DRIFT AREAS

Reclamation works have been carried out on five of the larger drift areas along the coast by the Soil Conservation Service in conjunction with other bodies. At present work is being carried out on a further 350 ha currently being treated. Consideration is being given to establishing new reclamation projects on several larger areas including one of over 2000 ha.

Reclamation works involve reformation of frontal dune areas by the use of sand drift fencing or earthmoving equipment. Frontal areas are then stabilized using SPINIFEX HIRSUTUS or AMMOPHILA ARENARIA under a temporary surface cover of brush matting, mulch or oil/laterx spray. Exposed hind dune areas are treated in the same manner but the less exposed areas are sown with a grass mixture of CHLORIS GAYANA and CYNODON DACTYLON under a temporary cover crop of SECALE CEREALE or a Sorghum species. Fertilizer rates of 50 kg of nitrogen, 20 kg of phosphorus and 20 kg of potassium are used at sowing. The areas are later topdressed with additional fertilizer of high nitrogen content.

Each area is also used as an experimental area for the duration of the reclamation works.

A meteorological station is being established on one area to collect data of specific interest to sand stabilization work. This will enable climatological studies to be carried out.

A research project has been set up to examine the use of seed of *AMMOPHILA ARENARIA* and to compare it with *SPINIFEX HIRSUTUS* over a range of conditions (Fig. 3). Seeding rates and techniques with fertilizer rates and times of application are being studied. Recently completed research (Atkinson, 1971) has defined areas in which each species can be used and the type of temporary surface stabilizer most suitable. Current stabilization techniques incorporate these results. A study of the use of irrigation to establish these species is also being made.

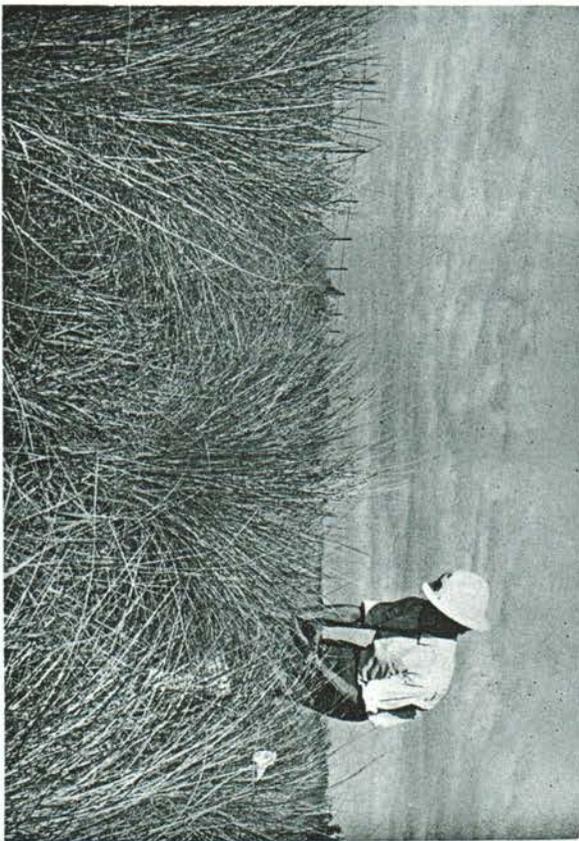


Fig. 3. Trial of *AMMOPHILA ARENARIA* at Crescent Head on North N.S.W. Coast. Trial examined fertilizer requirement and planting techniques.

To enable further understanding of the mechanics of sand drift the preliminary survey (Watt, 1972) is being extended to provide a comprehensive record of all areas and the rate of movement of drift dunes is being measured at selected sites.

#### MINING RESTORATION

The Soil Conservation Service acts in an advisory capacity to the mining industry for reclamation after mineral sands mining. Areas are reformed after mining to a similar shape and elevation to that prior to disturbance (Fig. 4). Before mining the low vegetation and the surface layer of sand and organic matter is removed and stockpiled. This material is restored and spread over the area after reshaping and contains all the plant roots and seeds which form the basis of the regeneration of the native plant species. Accurate removal and replacement of this material is essential.



Fig. 4. Aerial photograph of sand mining operation on beach front near Crescent Head on North N.S.W. coast. Plant is moving towards foreground of photo.

Frontal dune stabilization then takes place as previously described. On hind dune areas the respread surface material is more dense and acts as a mulch. A temporary cover crop is sown into this to protect the sand surface until there is an adequate cover of native plants.

Completed research trials (Atkinson, 1971) have defined the most suitable cover crops, the method of sowing, fertilizer rates and methods of fertilizer application. The cover crops recommended are *SECALE CEREALE* for autumn-winter sowing and a Sorghum species, preferably a Sorghum forage hybrid, for spring-summer sowing. These are sown through a seed drill with fertilizer at the rate of 50 kg of nitrogen, 20 kg of phosphorus and 20 kg of potassium with 2 kg of copper, 2 kg of zinc and 150 g of molybdenum per hectare. Seeding rates are 65 kg per hectare of *SECALE CEREALE* and 22 kg/ha of sorghum hybrid. Topdressing of nitrogen once the cover crops have become established, was found to encourage the growth of native plants. Topdressing rates are 50 kg of nitrogen per hectare. Results of earlier trial work comprised the basis for complete recommendations for mining restoration (Atkinson and Barr, 1970).

Current research projects involve the assessment of the regeneration of native species after mining and the relationship between this and the various restoration techniques.

#### SUMMARY

Sand dune reclamation in New South Wales is carried out in these three separate fields. However the principles of stabilization involved are the same. The area is reformed to a shape suitable for reclamation then stabilizing vegetation is planted and the sand surface temporarily protected until the vegetation is suffi-

ciently established to control drift. Once the surface is stabilized the native vegetation is re-introduced to reform the native communities. Fertilizer applications are made to obtain rapid stability and then to encourage the establishment of the native species.

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## An Ecological Approach to Dune Management in the National Recreation Areas of the United States East Coast\*\*\*

by  
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In recent years the American conservation movement has led to an increasing acreage of coastal dunes and beaches being placed under the protection of the United States National Park Service; presently seven National Seashores account for nearly 640 km of Atlantic coastline, and more are being planned. The past experience of the Service has been primarily with inland National Parks, where preservation of the natural features is the main concern and human impact is kept at a minimum. The National Seashores, however, are classed as 'Recreation Areas'; public use is their principal purpose and protection of natural resources is secondary. In these areas environmental manipulations have been authorized which would be unthinkable in a National Park.

The Service has lately made some rather important changes in its basic philosophies of land management. One of these comes from the realization that it may be less important to preserve actual things than it is to protect the processes which created the things. For example, Kilgore (1972) has shown that controlled burning is necessary to maintain giant Sequoia, (*SEQUOIA DENDRON GIGANTEUM*) forests; without the fires, the redwood is succeeded by fir (*ABIES*). Similarly, it is now realized that insect outbreaks are natural and sometimes ultimately beneficial events in the life of a forest. In the National Seashores, we have recognized that it is not only natural but necessary for the dunes and beaches to be continually rearranged by the wind and the sea, and that to try to hold all the sand in one place is an expensive frustration.

A second question of policy relates to the 'natural ecology' of land which has been misused by man in the past. The Service wishes to encourage natural processes to reestablish, as closely as possible, the original ecosystems of the lands it manages. In a highly dynamic area, however, such as the land-sea interfaces of the National Seashores, it may be hard to tell what the 'natural ecology' was. Even if we could answer this question, the environment may have changed so drastically that it is quite impractical to try to restore pre-Columbian conditions. The better course may be to encourage the establishment of whatever ecological conditions the modern physical environment will allow.

One other philosophical consideration which has been controversial lately has been the concept of stability. There is a basic conflict between the static stability visualized by the public in general and land developers in particular, versus the dynamic stability seen by natural scientists. This distinction is particularly relevant to National Seashore management and involves the things-or-processes argument mentioned above. Anyone who has invested in roads or buildings on a seacoast naturally rebels against the idea of freely shifting sand and moving

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