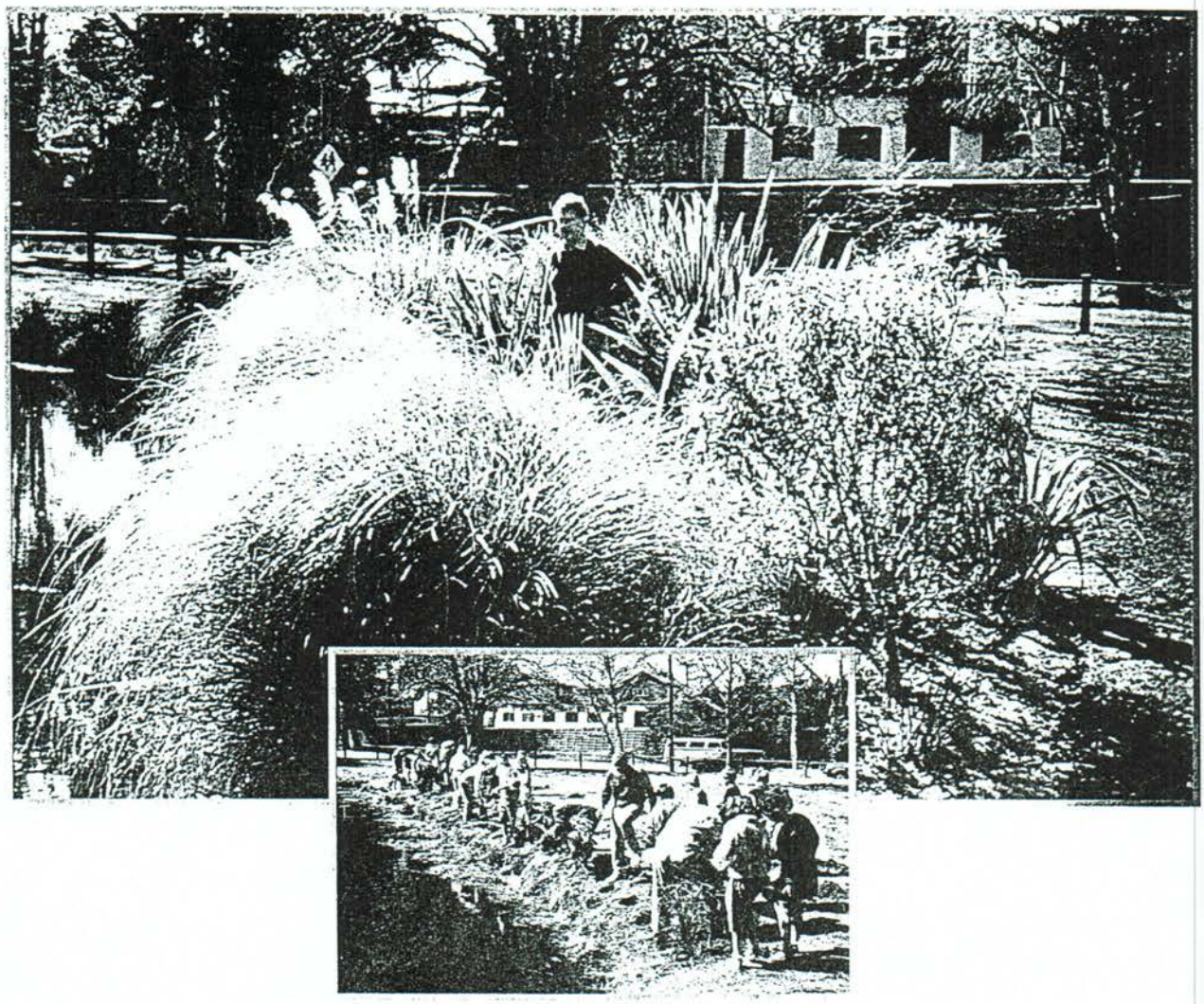
Proceedings of a Workshop on Scientific Issues in Ecological Restoration

Compiled by M. C. Smale and C. D. Meurk



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Restoration of coastal sand dunes using indigenous species – integration of research, management, and community

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Introduction

The widespread problem of sand dune erosion in some regions in New Zealand has been recognised since last century with guidelines on the use of both exotic and indigenous sand binding species to achieve stability (e.g., Whitcombe 1873; Kirk 1873). There are numerous descriptions of sand dune vegetation from earlier this century (e.g., Cockayne 1911) and more recently, ecological studies of coastal dunes (e.g., Esler 1970). Dune stabilisation techniques have often involved planting the exotic marram grass (*Ammophila arenaria*) or erecting solid barriers with considerable success in the use of marram grass in stabilising substantial areas of degraded sand country in many areas. However, there has been little work on large-scale restoration of sand dunes using indigenous species. This is due to a lack of knowledge of techniques for re-establishing indigenous species or for enhancing existing indigenous vegetation.

The Resource Management Act 1991 places an obligation on land managers to protect and preserve the natural character of the coastal environment, including areas of significant native vegetation. Consequently, there is keen interest by managing agencies for information on rehabilitation of coastal dunelands using indigenous plant species for coastal management plans. Local authorities, including Environment Waikato, also recognise the vital role that sand dunes have in protecting coastal development from hazards such as storms and erosion.

In collaboration with Environment Waikato, and to a smaller extent other land-managing agencies, including other local authorities and the Department of Conservation, staff of the New Zealand Forest Research Institute (NZFRI) have been investigating large-scale restoration techniques for sand dunes using indigenous species for several years. Initial emphasis was on establishment of the indigenous sand-binding species, but the programme now includes a wide range of coastal plant communities from foredune to coastal forest. An integral part of the NZFRI-Environment Waikato sand dune research and management programme has been the incorporation of community-based Beach Care groups into the programme.

This paper gives an outline of the NZFRI sand dune research programme, the rationale for managing the coastal environment, and the role of Environment Waikato as a regional managing agency. The role of the community in ecological restoration of sand dunes is also discussed.

The presentation at the workshop also considered the research and management of sand dunes in relation to two themes that are relevant to ecological restoration in a wider context. *'Rebuilding the tricky ones...'* and *'Monitoring success – knowing when we've arrived'* provided an opportunity to examine some of the philosophical issues in relation to ecological restoration.

NZFRI sand dune research programme

Previous work

A substantial amount of research has been carried out on the natural vegetation of coastal dunes in New Zealand (e.g., Esler 1970). However, there has been little work on restoration of sand dunes using indigenous species. Dune stabilisation techniques have involved planting exotic marram grass or erecting solid barriers. In part this has been because of a lack of knowledge of the role of indigenous species in sand stabilisation processes and a lack of research techniques to help re-establish indigenous species or enhance existing indigenous vegetation.

Aims of restoration research

NZFRI has an 8-year-old duneland research programme evaluating the role of native species in stabilising and protecting coastal sand dunes. Objectives are:

- At an applied level, to evaluate establishment techniques for a range of coastal species and to provide managers with choices for rehabilitating dunes where use of indigenous plant species is the preferred option. The long-term goal is to

produce practical guidelines for managers and beach users on the role and management of vegetation communities on sand dunes.

- At a more fundamental level, to increase our understanding of sand dune dynamics in relation to vegetation cover, of the ecology of the species, and of the population dynamics of the plant communities that are being established experimentally.

Sand-binding species

Initial research concentrated on two of our most important native sand-binding species, spinifex (*Spinifex sericeus*) and pingao (*Desmoschoenus spiralis*).

Establishment of pingao

The most effective method of establishing pingao is to plant nursery-raised seedlings on dunes. Seed collection and nursery techniques for raising large numbers of pingao seedlings are well proven. Planting trials have consistently indicated that pingao is very site specific. Eighteen-month-old seedlings planted on exposed unstable foredunes with sparse vegetation consistently outperform seedlings on vegetated stable dunes. Results suggest that mobile dunes with small to moderate rates of sand accumulation are the preferred habitat for this species. However, excessive accumulations of storm-driven sand or dune degradation will reduce survival.

Application of slow-release NPKMg fertiliser (Magamp®) at 30 g per plant, incorporated in the sand at planting, significantly boosted early growth and health. In all trials where Magamp® has been applied, the outstanding feature is the improvement in colour and vigour of fertilised plants.

Pingao provenance differences

Variation in size, plant habit, and leaf colour has been observed in pingao collected from different parts of the country. Seedlings of 34 provenances, representing many of the main populations from Northland to Southland as well as collections from Great Barrier Island and the Chatham Islands, were raised at the NZFRI nursery, Rotorua. Seedlings have been evaluated for a range of growth and weaving characteristics. Preliminary results indicate two major forms: one is initially taller and more erect, but collapsing to a sprawling rhizomatous form, often associated with provenances from beaches with wind-blown fine sand; the other is shorter, tufted and erect with multiple basal divisions, and is often associated with coarse sand or shingle beaches.

Pingao harvesting

In many areas inappropriate methods of harvesting fibre are contributing to the decline of natural stands of pingao. The effects of different harvesting methods on plants and the quantity of useful fibre produced are being evaluated in field and garden trials. Results will be used to recommend harvesting methods that are most appropriate for a supply of good-quality fibre and a sustained resource.

Establishment of spinifex

Trials to date have shown that establishing spinifex on dunes using a range of methods is difficult. However, spinifex has been used extensively in Australia to improve degraded dune systems using a range of techniques. On the basis of Australian experience, trials have been set up in New Zealand to determine appropriate strategies for local conditions. Some field germination of spinifex has been achieved by sowing seed to a depth of 100 mm, but low viability of seed is a recurring problem. Placement of runners 600 mm long in trenches 200 mm deep with the runner tips exposed has been partially successful. Trials are continuing, to determine the best sowing season, feasibility of establishment from cuttings, and the effect and optimal timing of fertiliser application. Raising large quantities of seedlings in the nursery is also difficult, with slow and poor germination of seed and high mortality of seedlings at all stages. However, as for pingao, dune planting trials using small numbers of seedlings show high survival, and have responded positively to application of slow-release fertiliser at planting.

Australian experience indicates that fertiliser treatment of existing colonies is an efficient way of improving their vigour and extent. A series of fertiliser trials has been established at two

Coromandel sites and at Port Waikato, where areas up to 30x5 m have been treated with a range of fertiliser types and application rates. Changes in vegetation cover are being monitored. Preliminary results indicate that spinifex responds vigorously to heavy applications of nitrogenous fertiliser. Research is continuing into the most cost-effective fertiliser option, including the timing of applications. The effects of increased fertility on composition of dune vegetation, including the response of weed species, is also being evaluated.

Coastal plant communities

Recent publications stress the importance and vulnerability of coastal ecosystems (e.g., Department of Conservation 1994) and the importance of restoring ecosystems and communities rather than individual species (UNCED 1992). Further, the Resource Management Act 1991 requires that coastal management and research should be holistic in approach and based on the community model. In recent years the NZFRI sand dune research programme has been refocused into a plant-community model rather than a single-species approach. This community-based research aims to provide managers with guidelines for establishing and maintaining an ecologically sound suite of native duneland species that provide diversity and enhance the natural character of our dunes.

Indigenous species now under study include sand fescue (*Austrofestuca littoralis*), the third significant native sand-binding species (Cockayne 1911). Shrub and tree species under investigation include pohuehue (*Muehlenbeckia complexa*), sand coprosma (*Coprosma brunnea*), pohutukawa (*Metrosideros excelsa*), coastal fivefinger (*Pseudopanax lessonii*), karo (*Pittosporum crassifolium*), kanuka (*Kunzea ericoides*), and ngaio (*Myoporum laetum*). Future research will also include now rare sand dune species such as *Pimelea arenaria* and *Euphorbia glauca*. Initial planting trials will test seedling quality and size, dune habitat, shelter, and fertiliser requirements. Screening trials of indigenous species have been recently established on stable dunes at two Coromandel beaches and two at Christchurch to evaluate the performance of over 20 species.

Monitoring sand dune transects

Sand movement is being monitored on a regular basis using transects set up on coastal dunes by several Regional Councils to provide long-term trends for land-use planning and hazard mitigation purposes. In dune profile surveys along the Christchurch beaches by the Canterbury Regional Council and on beaches in the Waikato region by Environment Waikato, there has been no systematic recording of vegetation cover in relation to sand movement. The influence of vegetation cover and the effects different species on dune stability and shape has long been recognised (e.g., Esler 1970). NZ FRI have developed a method for incorporating a vegetation component into existing sand dune transect monitoring programmes for the Christchurch beaches where 45 transects are regularly surveyed using a global positioning system (GPS).

Transect data is being entered in to a geographical information system (GIS) to identify the effect of vegetation cover on dune shape, sand volumes and sand movement over time. Interpolation between transects with the aid of aerial photography will allow for understanding of dune dynamics in relation to vegetation cover and also the comparative effects of beach utilisation and modification between well used beaches and remote sections of the coast. Intensive contour and vegetation mapping is also underway on selected recently recontoured sites along the Christchurch coast where reshaped sand dunes are being replanted with exotic and indigenous coastal species to enable long-term monitoring of dune processes and revegetation strategies.

Collaborative Research Programme

A major feature of the sand dune research programme is that it is integrated with coastal management agencies; most planting trials have been established and maintained with the full participation of local communities via Beach Care groups.

Besides NZFRI in a research role, the main participating agencies include the Department of Conservation (Science & Research Division and Conservancies), Regional Councils (Environment Waikato, Environment Bay of Plenty, Auckland

Regional Council, Canterbury Regional Council), and district or city councils (e.g., Christchurch City Council, Franklin District Council, Tairua District Council). Other participants include Maori trusts and incorporations, polytechnics, sand dune forest owners, and coastal estate developers, as well as local Beach Care groups at each site.

Research is jointly funded by the New Zealand Foundation for Research, Science and Technology, the Department of Conservation, the New Zealand Lottery Grants Board, and local authorities.

Duneland Research and Management Working Group

Preliminary discussions between NZFRI duneland researchers and management agencies including Environment Waikato, Auckland Regional Council, Canterbury Regional Council, and the Department of Conservation suggest that a duneland working group would be useful in advancing research and management. We anticipate the formation of an informal Duneland Research and Management Working Group, with the aim of:

- encouraging contact between managers, Beach Care co-ordinators and researchers of key agencies (e.g., regional councils, NZFRI, Department of Conservation);
- effective transfer of information on Beach Care activities, research results, and beach management;
- organising annual field trips and workshops focusing on dune problems, research trials, and community-based activities in a particular region;
- providing input into a co-ordinated research programme and determining appropriate funding strategies;
- co-ordinate and collaborate in publication of pamphlets and guidelines.

We suggest that the Working Group be kept small and focus on technical and practical aspects of coastal dune management and research, including community participation and revegetation. It is not intended that it compete with the newly formed Coastal Society.

Managing agencies' perspective – Environment Waikato

Environment Waikato is placing increasing emphasis on the management of coastal dune systems, especially where they lie between coastal development and the sea. The reasons for this are:

- protecting coastal development from hazards;
- preserving the natural character of the coastline;
- protecting and enhancing amenity values;
- protecting and enhancing ecological values;
- protecting and enhancing cultural and historical values.

Coastal hazard management

Coastal dune systems provide a vital role in protecting coastal development from hazards such as erosion and flooding. Once such buffer zones are lost (or where they are inadequate) and hazards impinge directly on development, serious and complex management problems arise. These are costly and can be difficult to resolve in a manner that adequately protects the natural and amenity values of the beaches. The major aim in coastal hazard management is to maintain the sand volumes in dune systems and their natural repair mechanisms. Where feasible and appropriate, efforts are also being made to enhance the volume of sand in dune systems by dune nourishment, particularly at sites where the existing systems are potentially inadequate. Maintaining and enhancing an appropriate cover of native coastal species is critical to dune management for hazard protection.

Natural character of the coastline

This is a Matter of National Importance in the Resource Management Act, and is likely to become one of the major coastal issues in New Zealand over the next decade. Natural character is primarily related to the natural (cf. man-made) elements of the coastal environment; coastal vegetation is a critical element. Council staff believe that protection and enhancement of native vegetation cover on dunes offers one of the major opportunities for both protection and enhancement of natural character.

Amenity values

This is a matter for which agencies exercising functions under the Resource Management Act are required to have particular regard (Section 7, Resource Management Act 1991). At present most New Zealand beaches are relatively devoid of trees and shrubs, particularly of native species, and improving this aspect has considerable potential to enhance their amenity value. For example, providing increased shade and wind shelter are critical issues at many beaches. The potential impact of trees and shrubs on the views from coastal development is one of the major impediments to extensive plantings for the purposes of enhancing amenity and ecological values and natural character.

Ecological values

The vegetation sequences found along dune coastlines – commonly a progression from sand-binding grasses to shrubs and trees – is very distinctive, but is now rarely found in New Zealand. There are probably few, if any, such sequences in a virgin state anywhere in the North Island. Re-establishment of such sequences, either by allowing natural succession to proceed or by accelerating the process, is a major priority for ecological restoration in the North Island. Environment Waikato is currently involved in re-establishing a native coastal vegetation sequence at Whitianga, and has found strong community support for the proposal. At this early stage the work is focusing on testing a number of coastal species (see below). Later it is planned to move towards re-establishment of a fuller native coastal sequence. At this stage it is not clear how this process is best facilitated; whether by allowing natural succession to proceed without interference, or by managing the process – perhaps by establishing an appropriate ground-cover or shrub nurse, or (more quickly, but more artificially) by attempting to plant the succession.

Other purposes

Many dunes have a range of intrinsic and human values additional to those discussed above. Some contain important archaeological sites; for example, a large number of *urupa* are located on dune systems. Maintaining and establishing appropriate coastal vegetation can be of considerable significance in such instances. Environment Waikato and NZFRI have been allowed to establish trial plantings on an *urupa* site at Whiritoa Beach on the Coromandel peninsula because of the importance of re-establishment of native coastal vegetation to the local *hapu*. The *urupa* is otherwise closed to public use, being fenced along its landward margin to prevent pedestrian access. The landowners also take an active part in the trials, participating in trial design, establishment, and monitoring, and take considerable pride in the work. There is considerable, and virtually untapped, potential for such partnerships around the New Zealand coast.

Management considerations

Establishing a good cover of appropriate coastal vegetation is critical to effective dune management for the above purposes. In terms of appropriate vegetation, Council staff place a strong emphasis on the use of native species and have serious reservations about the use of exotics for dune management. Issues of concern with exotics include the weed potential of some of these species (e.g., golden wattle – *Acacia sophorae*) and the incompatibility of such species with important management aspirations, including preservation of natural character, and protection and enhancement of ecological values. Staff also believe that species such as marram are – for a number of reasons – markedly inferior to native sand-binding grasses in terms of managing the seaward face of dunes, a critical area for coastal dune management.

Community Participation

Rationale

There is little question that the major threat to dune systems and their associated values arises from inappropriate human use and development. Similarly, some of the major impediments to the protection and enhancement of dune systems lie in community attitudes and practices. Thus, significant attitudinal and behavioural changes are required if our coastal dune systems are to be sustainably managed.

Environment Waikato believes that while other instruments (e.g., policy and regulation) have an important role, community participation in the management of coastal dunes offers one of the more appropriate methods by which community attitudes and practices can be changed. It also offers considerable potential as a means of technology transfer whereby the technical knowledge arising from research can be passed on to communities.

Beach Care programme

Environment Waikato initiated a Beach Care programme in early 1993 to facilitate more active community participation in coastal management, particularly dune and foreshore management. The groups act as a forum where the community can work together with Environment Waikato and the local district council (at some sites Department of Conservation staff also get involved) to develop and implement appropriate dune management programmes. The concept was modelled on the Australian Dune Care programme, and modified to facilitate more community involvement and better integration among government agencies.

The groups are initiated at priority sites for dune management action, normally where there is only a narrow and fragile dune buffer zone between development and the sea. There is usually extensive community consultation and information before a group is launched. As many of the communities are centred on holiday resorts, groups are usually launched with a public presentation over a holiday period.

Ultimately they are likely to be extended to most relevant sites. To date, there are eight groups in the Waikato region: seven on the eastern Coromandel Peninsula and one on the west coast. Most have memberships of 100-200, with activities co-ordinated by a Beach Care committee comprising locals and representatives from statutory agencies. Plans are developed by circulating ideas to all members by way of regular newsletters and by advertisement in the wider community (e.g., through media). Once a plan of action has been developed, working bees are held to organise implementation. Materials for the dune works (e.g., plants, materials for access ways and fences) are usually provided by the statutory agencies, with the community providing labour for implementation.

Effectiveness of community participation

The groups have proved to be very effective in the design and implementation of dune management programmes, activities including dune repair and nourishment, installation of a number of fenced vehicle and/or pedestrian ways, and plantings of several thousand native plants (particularly native sand-binding grasses, but also trees and shrubs at some sites). To date, most of the groups have focused on initial stages of dune management, particularly access management and establishing a good cover of sand grasses on the dune face to ensure natural dune stability and repair. Once these basic areas have been addressed, it is hoped that the groups can move into addressing some of the more complex and controversial issues associated with revegetation of beaches with coastal shrubs and trees.

The groups have also proved to be very enthusiastic with regard to local dune revegetation research, and have played an active role in trial work to date, facilitating technology transfer. This has been particularly notable at Whiritoa and Whitianga. Apart from direct involvement, group newsletters and working bees also provide useful means of technology transfer. To date, technology transfer has proved to be very effective, results from some trials being adopted into local practice even before being written up. It is hoped to reinforce this aspect as the groups develop and as the trials (mostly still in early stages) start generating results.

Though it is still too early to judge the effectiveness of the programme as a means of inculcating a dune care ethic into local communities, the degree of community support and the high profile of the groups is undoubtedly having an impact. Most groups are also moving into community information and education, and this direction will be further encouraged and supported in the future.

Overall, it appears that the model has considerable promise in terms of inculcating a dune care ethic, developing and implementing dune management

activities, and facilitating technology transfer. The model has now been adopted in the Bay of Plenty region, and a number of others are also looking closely at it.

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