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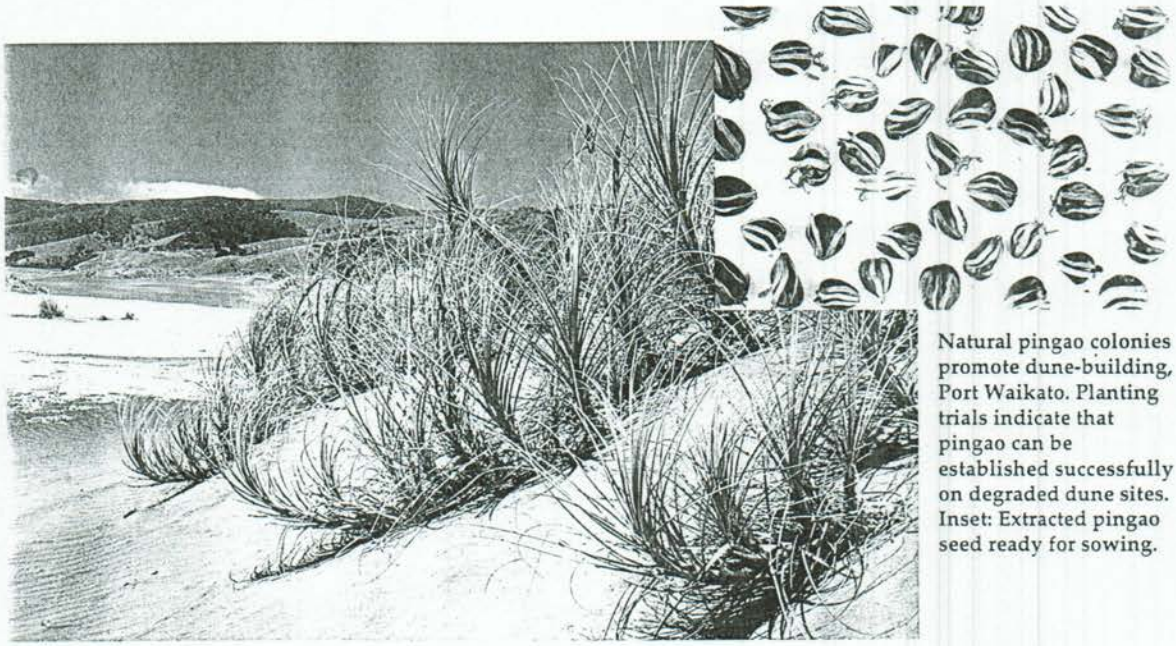
Restoration of native plant communities on sand dunes



Natural pingao colonies promote dune-building, Port Waikato. Planting trials indicate that pingao can be established successfully on degraded dune sites. Inset: Extracted pingao seed ready for sowing.

Many areas of sand dune coastline in New Zealand have been modified by farming practices, sand mining, residential and industrial development, or recreational activities. This disturbance has often resulted in major changes to dunes, often leading to instability of the sand. Expensive artificial barriers have been erected in attempts to stabilise sand movement, with mixed success. Introduced marram grass, yellow tree lupin, buffalo grass, and other exotics have been planted in some areas to combat erosion, and in some sites have displaced native species.

In recent years, however, there have been some attempts to restore natural vegetation communities on sand dunes. Establishment programmes using native species on specific sites may be appropriate for reasons associated with cultural, aesthetic, recreational, conservation, or biodiversity considerations; 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, while recognising tribal kaitiakitanga.

NZFRI has a long-established duneland research programme evaluating the role that native species have in stabilising and protecting coastal sand dunes. The intention is to increase our understanding of sand dune dynamics in relation to vegetation, and to provide managers with options for rehabilitating dunes where native plant species would be preferred. Research has concentrated, initially at least, on two of our most important native sand binding species, spinifex and pingao. These were identified by the botanist Leonard Cockayne early this century as the major sand binding species in the native flora that were widespread and performed an important role in stabilising foredunes.

The sand dune research programme is funded by the Department of Conservation and the Foundation for Research Science and Technology with support from the Waikato Regional Council.

Pingao research

Pingao (*Desmoshoenus spiralis*) is an endemic sand-binding plant found growing on or near coastal foredunes, and is one of the four natural fibres extensively used for weaving by Maori. In pre-European times, pingao was widespread and abundant on foredunes in both North and South Islands, but most populations are now reduced to small discontinuous patches, and this decline is continuing.

Unfortunately, the decline in pingao coincides with a resurgence of interest in traditional weaving skills, and in most districts the residual populations are too small to sustain the demand for pingao fibre. Planting trials are being used to develop techniques for rehabilitating degraded dunes with pingao, and together with provenance and harvesting trials in progress, will assist in providing a sustainable resource for weaving.

Planting of pingao

The most effective method of establishing pingao on dunes is the planting of nursery-raised seedlings. Pingao seed can be collected from established stands in large quantities in late December-early January. Seed germinates within 4 weeks of sowing, and 50- to 80-cm-tall, 18-month seedlings raised in PB 0.75 polythene bags have shown 70–80% survival and good growth on foredunes after 2 years. Seedlings with a well-balanced shoot and root system were more suited for planting on dunelands than excessively large seedlings.

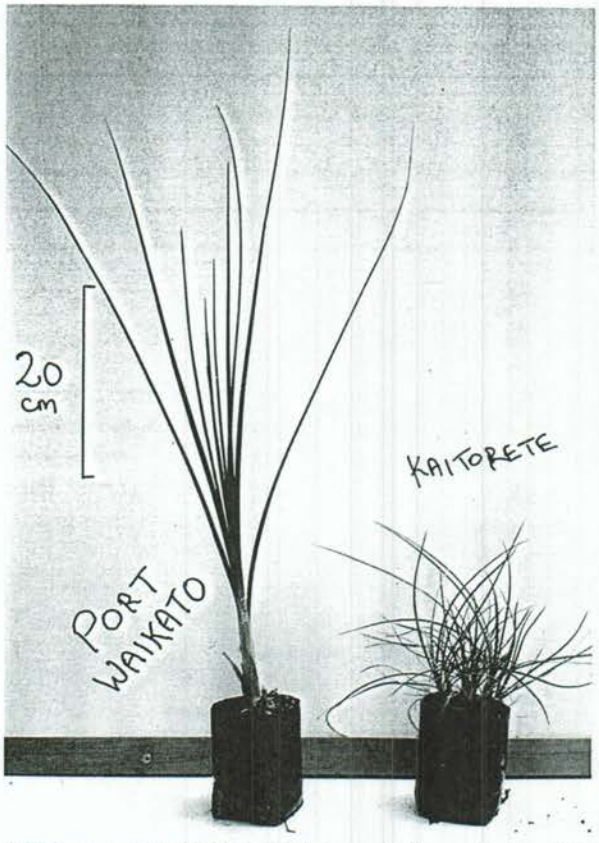
Planting trials indicate that pingao is very site specific. Seedlings planted on exposed unstable foredunes with sparse vegetation consistently outperform seedlings on vegetated stable dunes. On one site, seedlings excavated 8 months after planting showed well-developed root systems extending more than 40 cm from the base of culms. Group planting of 25–30 seedlings at 50x50-cm spacing between plants has been effective in dune building after 6 months. Results suggest that mobile dunes with small to moderate accumulation of sand are the preferred habitat for pingao. However, excessive accumulations of storm-driven sand, or dune degradation will reduce survival of plants.

Application of slow-release NPK fertiliser at 30 g per plant, incorporated with the sand when each seedling was planted, significantly boosted early growth and health. In all trials where slow-release fertiliser has been applied, the outstanding feature is the improvement in colour and vigour of fertilised plants. Hydrogel, a water-storing material that may be tapped for water by plant roots in dry periods, has not improved growth performance of pingao in trials to date.

Provenance differences in pingao

Variation in size, plant habit and leaf colour has been observed in pingao collected from different parts of the country. NZ FRI was assisted by the Department of Conservation and others in collecting seed from many sites throughout New Zealand. Seedlings of 34 provenances, representing many of the main pingao populations from Northland to Southland, as well as collections from Great Barrier and the Chatham Islands, were raised at the NZ FRI Nursery, Rotorua.

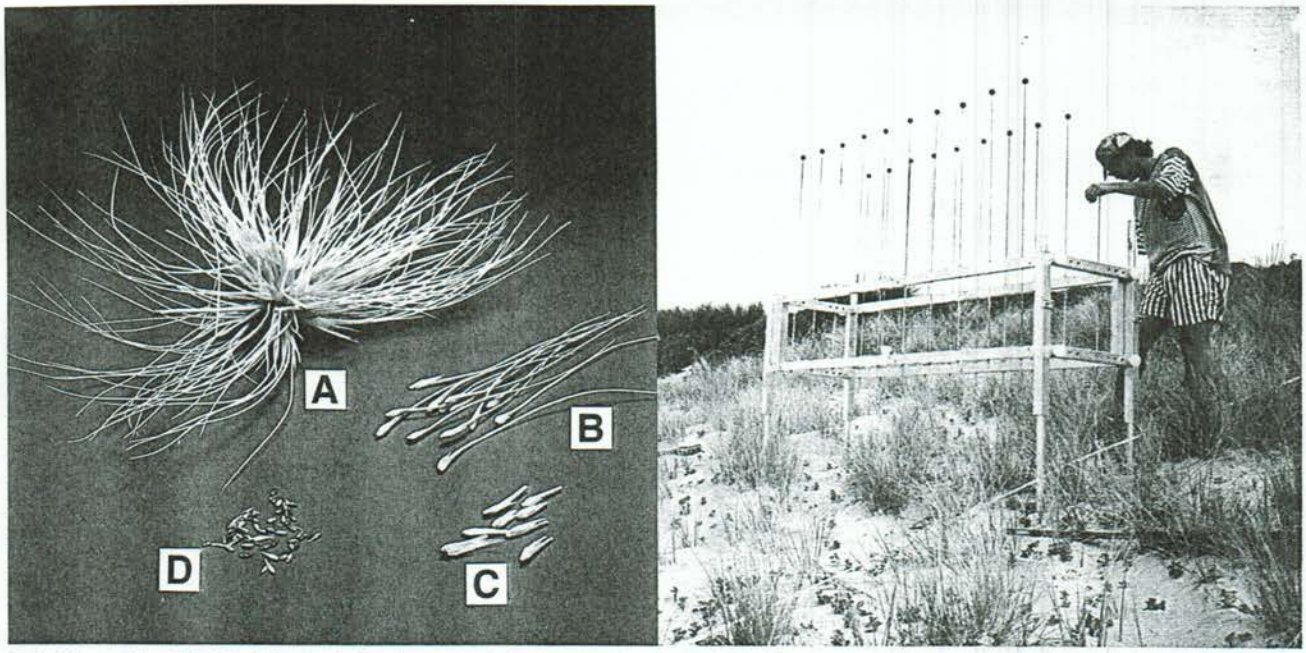
Seedlings have been evaluated for a range of growth and weaving characteristics. Preliminary results indicate two major plant forms — one taller and more erect, with few basal divisions, often associated with provenances collected from beaches with a fine sand; the other short and tufted with multiple basal divisions, often associated with coarse sand or shingle beaches. Most provenances have been out-planted at 4 different locations — gardens within the grounds of two polytechics and a nursery site, and one dune site — for observation of growth and plant characteristics. This study will offer an opportunity for weavers to select provenances that best meet their requirements for leaf material.



Appearance and growth habit of pingao differ markedly with different provenances (seed sources).

Harvesting of pingao fibre

In many areas, inappropriate methods of harvesting fibre are contributing to the decline of natural stands of pingao. In the past, the harvesting of pingao was governed by Tikanga Maori, but now much harvesting appears to be indiscriminate and even exploitive.



Spinifex seed and field trials. Left: Seed prepared for sowing; A — whole seedhead (spike); B — spikelets (usually 75–200 per spike); C — spikelets with spine removed; D — extracted seed. Right: Measuring dune plant abundance and distribution with a point sampling frame for fertiliser and dune dynamics studies. Spinifex and *Calystegia soldanella* are prominent.

The effects that different harvesting methods have on plants, and the quantity of useful fibre produced, are being evaluated in field and garden trials. Initial results indicate that both cutting and wrenching of the whole leaf cluster kills most shoots. Clipping the individual weaving-quality leaves from the leaf cluster, although taking longer than cutting, leaves the growing point intact.

Harvested leaves are being evaluated for length, colour, curvature and external damage, and the most appropriate season for harvesting is also being investigated. Results will be used to recommend harvesting methods for pingao that are most appropriate for a supply of good quality fibre and a sustained resource.

Community dune care

NZ FRI has been collaborating with agencies associated with duneland management and use including the Department of Conservation, Regional and District Councils, polytechnics, individuals, and Maori trusts and incorporations. Recently, in collaboration with the Waikato Regional Council, we have been working closely with community-based dune care groups. Similar groups in Australia have been successful in co-ordinating and carrying out rehabilitation and monitoring projects on local beaches. Many aspects of the NZ FRI sand dune research programme are now integrated into the dune care movement that is being developed by local authorities in parts of New Zealand. The aim is to interact with local communities over management issues and, with their support, to establish trials which will then indicate practical ways of rehabilitating and managing sand dunes.

Spinifex research

Spinifex (*Spinifex sericeus* — kowhangatara) is native to both Australia and New Zealand, and is widespread on sand dunes. In Australia, spinifex has been used for many years as one of the major species in large scale sand dune rehabilitation programmes in New South Wales and Queensland. Techniques widely used in Australia for establishing spinifex are now being evaluated in trials in several New Zealand dune areas.

Establishing spinifex

Raising large numbers of spinifex seedlings in the nursery has so far proved difficult. In Australia spinifex is usually established in dune areas by direct seeding and transplanting of cuttings. A pilot trial has shown that successful germination can be achieved by sowing to a depth of 100 mm. The placement of 600-mm-long runners into 200-mm-deep trenches with the runner tips exposed has been partially successful.

Trials are continuing on determination of the best sowing season, establishment from cuttings, and the effect and timing of fertiliser application.

Improvement of existing spinifex stands

Australian experience indicates that fertiliser treatment of existing spinifex plants and colonies is an efficient way of improving the vigour and extent of spinifex stands. A series of spinifex fertiliser trials has been established on two Coromandel sites and at Port Waikato, where areas up to 30x5 m are treated with a range of fertiliser types and application rates. Relative changes in vegetation cover are being monitored using a vegetation point sampling frame placed at defined intervals along transects from the foredune to the backdune within

each fertilised and non-fertilised area. Initial results indicate that spinifex responds with vigorous growth to heavy applications of high-nitrogen fertiliser. Research is continuing into the most cost-effective fertiliser option including timing of applications. The effects of increased fertility on species composition of dune vegetation, including the response of weed species, are also being evaluated.

Other native duneland species

NZ FRI is extending its studies to include a wider range of native dune species. These include *Austrofestuca littoralis*, another significant native sand binding species, which is now rare. Shrub and tree species under investigation include the common pohuehue (*Muehlenbeckia complexa*), sand coprosma (*Coprosma repens*), pohutukawa (*Metrosideros excelsa*), coastal fivefinger (*Pseudopanax lessonii*), karo (*Pittosporum crassifolium*), kanuka (*Kunzea ericoides*) and ngaio (*Myoporum laetum*). Future research will also include less common sand dune species such as *Pimelia arenaria* and *Euphorbia glauca*. Planting trials will test the effects of seedling quality and size, dune habitat, shelter, and fertiliser on plant performance.

The native species sand dune research programme aims to provide managers with guidelines for establishing and maintaining an ecologically sound suite of native duneland species that will provide diversity and enhance the natural character of our dunes.

Related coastal vegetation studies

Monitoring of dune dynamics, native vegetation pattern and threats

All dune plants have different ecological requirements and occupy subtly different habitats. To determine these differences and their interaction with those of introduced species such as marram grass, a long-term monitoring programme has been set up to follow the fate of natural pingao and spinifex-dominated plant communities on several duneland sites. Baseline data for two sand dunes has been gathered using a vegetation point sampling frame to estimate percentage ground cover by species. Sampling will be repeated at intervals to monitor change in relation to time, changes in dune morphology, and other factors. The long-term goal is to generate a model of site preferences which can be used to identify appropriate areas for key duneland species. Any threats from invasive exotic species will be identified so that appropriate management strategies can be developed.

Pot trials with fertiliser

Field trials show that native dune plants respond to nitrogenous fertiliser, but their precise nutritional requirements are unknown. Glasshouse pot trials now in progress will determine which components of fertilisers are responsible for boosting growth of pingao and spinifex. Other coastal species will be tested in future trials. Results will assist in selection of the most cost-effective fertiliser treatments for invigorating and rehabilitating dune vegetation.

Restoration of native salt marsh vegetation

Factors affecting the retreat of major salt marsh species are being investigated in a Bay of Plenty estuary. The pattern of vegetation is similar to that of other salt marsh communities in the region, and salinity gradients indicate that the dominant species are within their salinity tolerance limits. Remnants of salt marsh vegetation are on a higher level than surrounding mudflats, suggesting that the level of the estuary is decreasing through erosion. Wave action is undermining marginal plants on the exposed site. Changes in soil chemistry that lead to root death pre-disposing margins to rapid erosion could also be a contributing factor. Such changes could have been initiated by stopbanking, drainage and river diversion.

Transplants of the major native rush species, *Juncus maritimus* and *Leptocarpus similis*, were planted on sheltered and exposed sites adjacent to the declining salt marsh. Three clump sizes were tested, and early results show that large clumps (100x100x150 mm depth) are most successful on mudflats and that survival is better on sheltered sites. Where mangroves were transplanted, only small propagules survived within the first few months, and only on sheltered sites. Monitoring of these trials is continuing.

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