COASTAL DUNE VEGETATION NETWORK
ANNUAL GENERAL MEETING
AND FIELD TRIP
12-13 MARCH 1998

compiled by

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CONTENTS Page

AGENDA

Thursday, 12 March. Field Trip (hosted by Greg Jenks, Environment Bay of Plenty)

10.00am	– Registration & Morning tea
10.30 - 12.00	– Papamoa Domain *foredune area revegetated with pingao, spinifex, Austrofestuca* – Revegetation of Mount Maunganui *recent fire in gorse areas - where to next, manage new gorse or replant in natives?* – Mount Maunganui Beach Development Concept *revegetation of main Mount Beach foredune - structure designs - practicalities*
12.00 noon	– Lunch (provided), Ian Porteous Walkway *design aspects of access ways to beach*
1.00 - 5.00	– Thornton Beach - kanuka forest - back dune succession *regenerated after fire, is this species genetically different from other kanuka?* – Whakatane District Council Nursery *propagation of pingao and spinifex* – Coastlands Subdivision *replanted, windfences established, box thorn incompletely sprayed by developers - where to from here?* – Ohope - dune erosion - reserve *almost total lack of native plants - except for pohutukawa regeneration direct seeded into the sand dune*
7.00pm	Social time - Bluebiyou Café/Restaurant
7.30pm	Evening Meal - Bluebiyou Café/Restaurant

Thursday 12 March

Field Trip

2. REVEGETATION OF MOUNT MAUNGANUI (MAUAO)

Mauao is the land form icon of the Tauranga District. Tangata whenua and many other locals wish to see the "forest cloak" returned to Mauao. However regular fires through gorse dominated areas have severely reduced the likelihood of this ever occurring, negating the often quoted role of gorse acting as a nurse crop for native seedlings. The most recent fire on the 13 December 1997 burnt out about 7 hectares of gorse and pampas. Gorse was the only plant species to fuel the fire. Native plants suffered damage ranging from singeing of lower leaves to total destruction, but they did not burn or contribute to the intensity of the fire. In this fire some native species appeared to display a degree of natural fire resistance.

Suzy O'Neill Assistance Reserves Officer with Tauranga District Council, will present plans concerning the replanting of Mauao with native coastal shrubs and trees, whilst suppressing the regrowth of gorse.

3. MOUNT MAUNGANUI BEACH DEVELOPMENT CONCEPT

The main beach at the Mount is the focus of intensive activity all through the year. The dune system disappeared in the 1940's, resulting in sand being very unstable. During easterly storms sand is blown in large volumes onto Marine Parade, often resulting in closure of the road and disgruntled residents suffering sand blasting of their homes. A cunning plan has been formulated in an attempt to satisfy the diverse demands placed upon this area. These plans, which involve a new style of fence construction, will be presented for discussion. The aim is to allow intensive pedestrian access to the beach while protecting a revegetated dune system with aesthetically appropriate materials.

4. LUNCH AT THE IAN PORTEOUS WALKWAY

Linger over lunch in the shade provided by Mt Maunganui's ubiquitous Norfolk Island pines and Phoenix palms.

Then stroll down the access way built in memoriam to the first Bay of Plenty Coast Care Coordinator, Ian Porteous. Continual erosion problems at the seaward end of this important sand ladder resulted in excessively frequent maintenance. To remove this maintenance chore from the shoulders of our very willing Coast Care volunteers, steps were designed with medium term longevity in mind.

Willing assistance free of charge from a local pile driving contractor, plus construction by Mount Maunganui Rotary Club and Coast Care volunteers saw the quoted costs slashed by two thirds.

The resulting steps are built on a very substantial platform that should resist all but the worst of storms.

5. THORNTON BEACH KANUKA FOREST

The vegetation succession from foredune to the backdune swale is the only remnant of coastal dune succession vegetation in the Bay of Plenty. The kanuka trees are particularly interesting due to their growth habitat, and proximity to the sea. The divaricating branches are unusual for the genus, and may be the result of genetic variability compared to forest kanuka. The wind swept canopy is extremely dense and compressed, allowing only occasional shafts of sunlight to reach the ground.

The kanuka forest is largely on Whakatane District Council Esplanade Reserve land, which is leased to farmers for grazing. There is enthusiasm from some District Council people to improve the status of this land and thus help protect the forest.

6. WHAKATANE DISTRICT COUNCIL NURSERY

Jo Bonner the nursery manager will demonstrate the extremely high quality foredune plants currently in production. Jo has the knowledge and ability to reliably produce spinifex, pingao and other coastal species at competitive prices. Have your order books ready for 1999 purchase, you are too late for 1998!

7. COASTLANDS SUBDIVISION

The majority of dune lands in this area possess good populations of spinifex and pingao and are therefore stable. However some beach access-ways have dune erosion in close proximity due to trampling of dune plants. Sand trapping fences and revegetation of spinifex and pingao are turning the problem around, showing very positive results.

Boxthorn on the crest of the dune requires careful management. While it is a pest that ultimately should be removed, it is currently helping to stabilise the dune crest, and provide shelter to recently planted mid dune shrubs on the leeward side.

Height reduction, stump poisoning and revegetation with spinifex, pingao and *Muehlenbeckia* are proposed. The views of field day participants will be sought on this matter.

8. OHOPE RESERVE

The earlier extensive growth of lupins over two metres high is thought to have led to the destruction of native dune species in this area. The subsequent demise of lupins caused by self introduced lupin blight, has resulted in a huge area of weeds infesting these dunes. The main species present is sea couch (*Elytrigia pycnantha*), followed by hares tail, other grasses, lupins and pampas.

The absence of spinifex and pingao has resulted in negligible dune repair following erosion events, with loose sand simply blowing up and down the beach depending on wind direction. Accumulation of heavier sand in front of the dune scarp does occur, but dune repair would be far more effective if dune plants were available to complete the accretion cycle.

Natural establishment of pohutukawa in sand dunes is disputed by some, but two examples of such an occurrence will be viewed, however there is a twist in the tale which can be seen on site.

9. Return homeward after an exhausting but hopefully edifying day.

10. Re-hydration at the Blue Biyou.

Friday 13 March

Technical Session

Technical Session, Papamoa Surf Club — 8.30 -10.30am
Chairman Mr Harley Spence, Environment Waikato

1	Foredune fertiliser trials	(David Bergin/Greg Jenks)
2	Spinifex nursery propagation trials	(Fiona Ede/Ann Fair)
3	Coastal Dune Vegetation Network Technical Bulletin Series	(Fiona Ede/Libby Boak)
4	MSc project at Karekare	(Catherine Moss)
5	University of Otago, Dunelands database	(Jo Spence)
6	Directions for future research	(David Bergin/Fiona Ede)

ESTABLISHMENT OF A FERTILISER TRIAL ON SAND DUNES, MOUNT MAUNGANUI, OMANU AND PAPAMOA BEACHES, BAY OF PLENTY

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 # Coast Care, Environment BOP, Mount Maunganui

Introduction

Localised erosion of sand dunes is a recurring problem along many parts of the coastline throughout new Zealand. Spinifex (*Spinifex sericeus*), an indigenous sand binding species, has the best potential for rapid establishment of problem erosion sites in dunelands within its natural range in many regions of the North Island and northern parts of the South Island. It is able to trap sand and build low angle foredunes along exposed coastlines. Spinifex has open habit which allows establishment of other indigenous species including pingao (*Desmoschoenus spiralis*).

Spinifex is also native to eastern states of Australia. Experience there indicates that fertiliser treatment of existing spinifex colonies is an efficient way of improving the vigour and extent of spinifex stands (Barr & McDonald 1980; Barr et al. 1983) and led to the development of a fertilising strategy for spinifex for Australian conditions (McKenzie *et al.* 1989a). The effect of applying high nitrogen fertilisers to spinifex seedhead production was also investigated in Australian studies (McKenzie *et al.* 1989b). Based on Australian work, two trials were established in New Zealand at Matarangi Beach and Whiritoa Beach, Coromandel Peninsula, in which several fast-release, high nitrogen fertiliser types as well as several rates and timings of application were tested (Bergin & Herbert 1994). Urea fertiliser proved to be as effective as the other fertilisers tested in boosting growth of spinifex on the foredune.

In October 1997, an operational-scale fertilising of the foredunes was undertaken along some 50 km of the Bay of Plenty coast by the local Coast Care groups in collaboration with Environment BOP and the local District Councils. Ten tonnes of urea was donated to the BOP Coast Care programme by the local fertiliser company, Petrochem Ltd. The dunes along the beaches of Mount Maunganui, Omanu and Papamoa were fertilised by Coast Care groups but four sites were demarcated and left unfertilised during the operational programme. These sites were used to test a range of treatments with urea and provided an opportunity to evaluate the response of existing vegetation cover to fertiliser on a larger scale than was possible in the Coromandel trials. The operational areas of fertiliser will also allow evaluation of seed production in fertilised and unfertilised sections of the coast over the next 2-3 years.

Objectives

- To monitor a range of rates and timings of application of urea fertiliser broadcast on a spinifex-dominated foredune.

- To determine a cost-effective and practical technique for large-scale application of urea fertiliser on sand dunes.

- To add results to the database and publish results in the form of guidelines for coastal managers interested in use of fertilisers to enhance existing foredune vegetation and to improve dune erosion.

Method

Trial Sites

Four trial sites were established along the beaches of Mount Maunganui, Omanu and Papamoa. The location of each site is given in Figure 1.

The sites are typical of most of the Bay of Plenty coastline characterised by a wide flat beach below mean high water springs and relatively low undulating backdunes. At the time the trial was established in October 1997, an erosion scarp up to 1.5 m high occured along most parts of the beach where the toe of the foredune and vegetation has been removed by winter storms. Consequently, the fertilised zone is located immediately landward of the erosion scarp. This zone is mainly dominated by spinifex but significant colonies of pingao are present along the coast.

Trial Treatments

Urea, a nitrogen based fertiliser, was used on all of the four sites. This was applied at different rates, times and amounts to test the effect of the various treatments. Two control plots were left unfertilised in each site. Choice of fertiliser rate and timing of application was based on previous work in Australia (Barr et al. 1983) and recent trials on two Coromandel beaches in New Zealand (Bergin & Herbert 1997).

The treatments applied to each plot for the four sites are shown in Appendix 1. Rate of application included 100, 200, 400 and 800 kg N/ha that were applied in Spring 1997 with split treatments of 50/50, 100/100, 200/200 and 400/400 kg N/ha applied in Spring 1997 and the remaining half of the fertiliser rate to be applied in Autumn 1998. The operational-scale fertilising programme aimed at applying a split dose of fertiliser at 50/50 kg N/ha at similar times to the trial plots.

Trial Design

The trial consisted of four sites or replicates with 10 plots in each replicate. Each plot was 10 m x 10 m and extends across the width of the natural dune. Treatment combinations for each plot were allocated randomly within each block (Appendix 1). Treated wooden pegs (50 mm x 25 mm) were placed along the 100 m long baseline every 10 m. Compass bearings were taken of baselines to assist with future location. Distances and compass bearings of one end of each baseline were recorded from semi-permanent landmarks such as life buoy boxes or substantial fence posts of sand fences and accessways to aid in location if some or all of the pegs are removed within the duration of the trial.

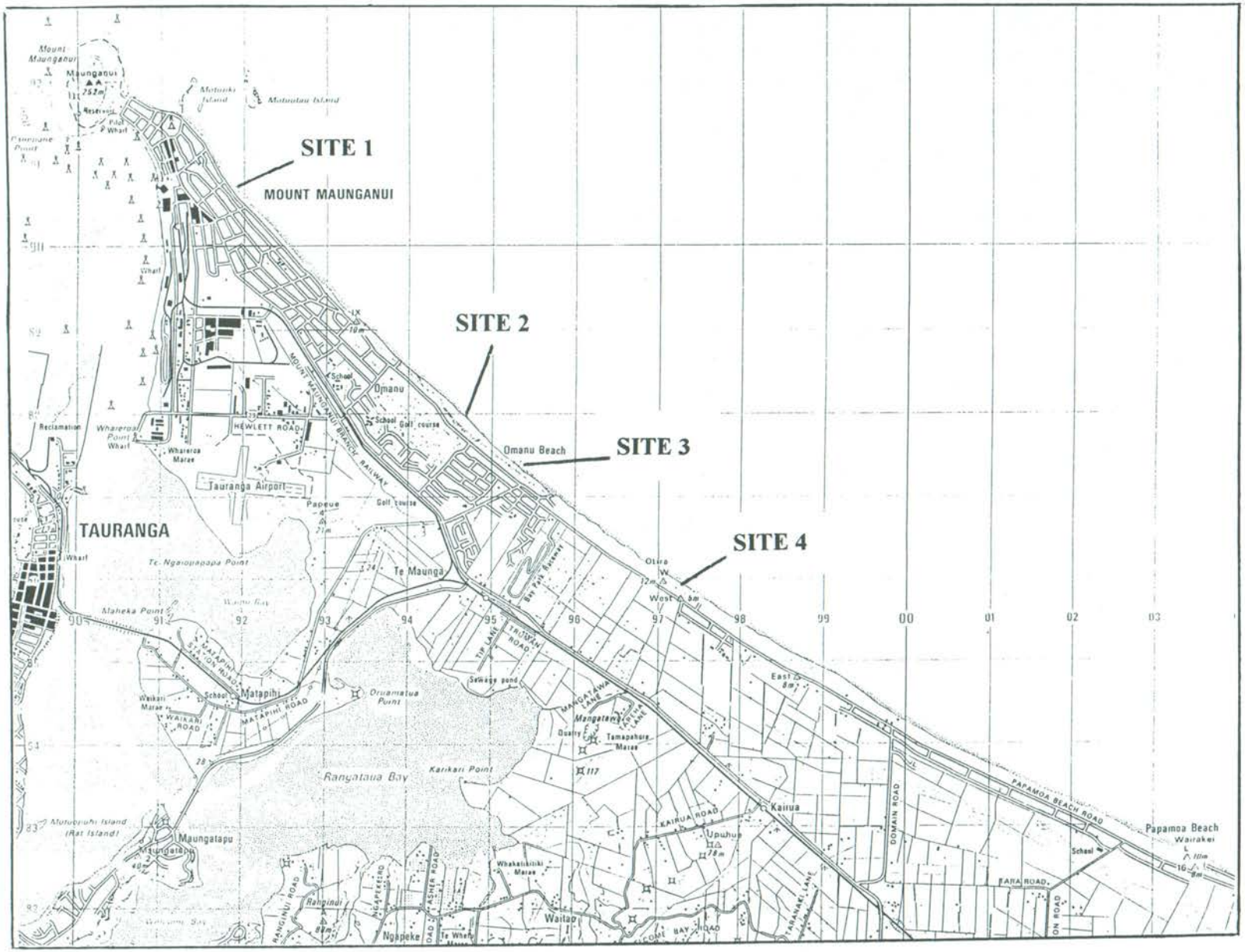

Figure 1: Location of the four fertiliser trial sites along the Mount Maunganui and Papamoa beaches, Bay of Plenty.

Fertiliser Application

The rate of fertiliser applied to each plot was calculated on the basis of N content of urea (46% N). The appropriate weight of fertiliser was applied to each plot by two persons hand broadcasting fertiliser from a bucket to give an even spread throughout each plot from the baseline to the seaward edge of vegetation, which coincided approximately with high watermark. For single applications, the full rate of fertiliser was applied in Spring (mid October 1997), whereas for split applications, half the fertiliser rate was applied in Spring and the remainder is to be applied in Autumn (March-April 1998) (Appendix 1).

Monitoring of Vegetation

In order to quantify the effect of fertiliser on vegetation, post-treatment vegetation cover was assessed using a point sampling frequency technique (Cullen 1965). The first assessment was carried out early February 1998, prior to the Autumn fertiliser treatment.

Vegetation cover was measured with a 2 m x 0.5 m sampling frame supporting 20 spring loaded needles with 60 cm of vertical movement. The frame was adjustable to allow for change in contour so that the correct height from the ground could be achieved above higher vegetation and the frame could be kept level on sloping ground.

A transect was laid out along the centre of each plot from foredune to backdune to avoid contamination that may have occurred from adjacent treatments along plot boundaries. Exact location of one side of the transect was located using compass bearing and measuring tape placed at 90° from the base line and 3m in from one side of the plot boundary. The first sampling frame station was taken on the baseline (0 m) then every 1.5 m. Where a walkway ran vertically through the plot the distance from the left hand side of the plot facing the sea was adjusted slightly to avoid a unrepresentative sample of the plot. This was the case on Site 1, plot 1 where the distance was adjusted to 3.5 m to avoid running the sampling machine down a narrow access path with modified vegetation.

The spring-loaded needles were depressed and initial vegetation intercept recorded by species for each of the 10 stations within each plot. Two hundred points per plot were sampled.

Spinifex is the dominant species and occurs frequently within the plots. Point intercepts for this species were recorded as brown or green depending on colour of vegetation intercepted. This distinction was not made for other species - all first intercepts were recorded by species whether live or dead. Intercepts with unidentifiable dead plant material, debris or sand were not recorded.

Interim Results

Dune vegetation

Average total vegetation cover on sand dunes at the Bay of Plenty trial sites was relatively high at 70.4% (Table 1). Sites 1 and 2 closest to Mount Maunganui had over 80% ground cover with Site 3 the lowest at 44.2% cover. Sites 1, 2 and 4 were dominated by spinifex with over 50% of the cover at each site. Site 3 was dominated by pingao at nearly 20% cover, almost double the spinifex cover at this site. All sites had a significant proportion of sand convolvulus (*Calystegia soldanella*). Ice plant (*Carpobrotus edulis*) and yellow tree lupin (*Lupinus arboreus*) were more common in Site 1 compared to the other sites. Herbaceous exotic weed species made up most of the remaining vegetation at all sites but all at relatively low levels of cover. A list of plant names is given in Appendix 2.

Table 1: ***Percentage total cover by species for each of the four fertiliser trial sites along the Mount Maunganui - Papamoa beaches. At this early stage of the trial, all plots were included in the cover figures.***

Species	Sites				All Sites
	1	2	3	4	
Spinifex sericeus (green)	16.4	18.4	5	22.4	15.5
Spinifex sericeus (brown)	45	43.4	5.4	27.2	30.2
Calystegia soldanella	5.9	11	10.7	11.1	9.7
Taraxacum officinale	2.6	2.3	1.2	1.4	1.9
Lupinus arboreus	5.3	2.1	0	0.9	2.1
Lagurus ovatus	1.1	0.1	0.2	1.2	0.7
Gazania rigens	0.4	0	0	0	0.1
Lachnagrostis filiformis	0.3	3.4	0.1	1.1	1.3
Senecio skirrhodon	0.8	0	0	0	0.2
Carpobrotus edulis	2.8	0.2	0	0	0.8
Cakile maritima	0	0.4	3.1	2	1.4
Muehlenbeckia complexa	0	1.6	0	1	0.7
Osteospermum fruticosum	0	0.9	0	0.1	0.3
Isolepis nodosa	0	0	0	0.1	0
Desmoschoenus spiralis	0	1.1	18.5	2.2	5.5
Total vegetation cover	**80.6**	**84.9**	**44.2**	**69.7**	**70.4**

Effect of fertiliser

Although the first assessment reported here is within four months of the initial fertiliser application, green spinifex foliage cover has doubled from approximately 10% to 20% cover where fertiliser has been applied (Table 2). This has occurred only where at least 200 kg N/ha has been applied with cover remaining constant at greater fertiliser rates (Fig. 2). There was no response in growth to fertiliser for all other species including pingao and spinifex classed as brown. Fertiliser has not increased the weed cover of dunes at this early stage.

Interim Conclusions

There is clearly an early boost to new growth of spinifex within four months of application of urea fertiliser. Inspection of fertilised sites within a few weeks of fertiliser application showed a greener spinifex cover compared to the light brown colour of spinifex in unfertilised plots.

The growth response of green spinifex foliage to fertiliser at the trial sites at Bay of Plenty beaches is similar to the boost in growth of spinifex measured within five months of fertiliser application in the two Coromandel trials. However, 70% average vegetation cover at the BOP beaches is considerably higher than with cover assessed at both the Matarangi Beach and Whiritoa Beach fertiliser trial sites where cover before fertilising was up to 20 percentage points less. The greater than 80% cover recorded at Sites 1 and 2 in the BOP trial may be due to the location of the fertiliser plots landward of the recently formed erosion scarp where a good cover of established vegetation exists. In contrast, the trials at Coromandel sites included the toe of the foredune which was less vegetated.

Table 2: ***Percentage cover by species averaged across all four trial sites for the range of fertiliser treatments. Urea fertiliser was applied at rates from 50 to 800 kg N/ha in one application in mid-October 1997. Code indicates broad grouping of the species (other than green and brown spinifex) as follows: W - exotic herbaceous weeds and grasses, O - other species, both indigenous and woody exotic.***

Code	Species	Fertiliser application rate (kg N/ha)						All Plots
		0	50	100	200	400	800	
	Spinifex sericeus (green)	10.8	10.7	11.1	20	20.2	22.3	15.5
	Spinifex sericeus (brown)	27.9	32.7	28.8	32.5	30.2	31.9	30.2
O	*Calystegia soldanella*	8.1	12.1	12	8.5	8.8	9.7	9.7
W	*Taraxacum officinale*	2.2	0.7	2.5	2.3	1.4	1.4	1.9
O	*Lupinus arboreus*	2.5	1.4	1.3	1.9	3	1.6	2.1
W	*Lagurus ovatus*	0.5	2.1	0.6	0.8	0.3	0.4	0.7
W	*Gazania rigens*	0.1	0	0.1	0.4	0.1	0	0.1
W	*Lachnagrostis filiformis*	1.8	2	0.4	1.2	1.4	0.7	1.3
W	*Senecio skirrhodon*	0.2	0	0	1	0	0	0.2
W	*Carpobrotus edulis*	0	0	3.2	0.6	0.1	0	0.8
W	*Cakile maritima*	0.8	0.5	2.4	1	0.6	3.1	1.4
O	*Muehlenbeckia complexa*	0.9	2	0	0.4	0.3	1.3	0.7
W	*Osteospermum fruticosum*	0.1	0	0	0.2	1	0	0.3
O	*Isolepis nodosa*	0	0.2	0	0	0	0	0
O	*Desmoschoenus spiralis*	6.1	7.9	4.8	4.4	5.1	5.3	5.5
	Total vegetation cover	**62.0**	**72.3**	**67.2**	**75.2**	**72.5**	**77.7**	**70.4**

Of interest is the lack of response of spinifex cover to the lowest rates of fertiliser where a minimum of 200 kg N/ha is required to boost growth at this early stage (Table 2; Fig. 2). The BOP operational-scale fertilising programme carried out at the same time that the trials were established aimed to broadcast approximately 50 kg N/ha in spring and a repeat application of 50 kg N/ha in autumn. Preliminary assessment of spinifex cover suggests that a greater rate of fertiliser than 50 kg N/ha should be applied if the aim is to ensure an immediate boost in green spinifex cover. The second application of fertiliser has yet to be carried out in mid-autumn in both the operational-scale programme and on selected plots in the trial sites. Results from the Coromandel trials indicate that it takes at least 12 months after the first application of fertiliser for above ground plant biomass to peak, and this is also likely to happen in the BOP trials.

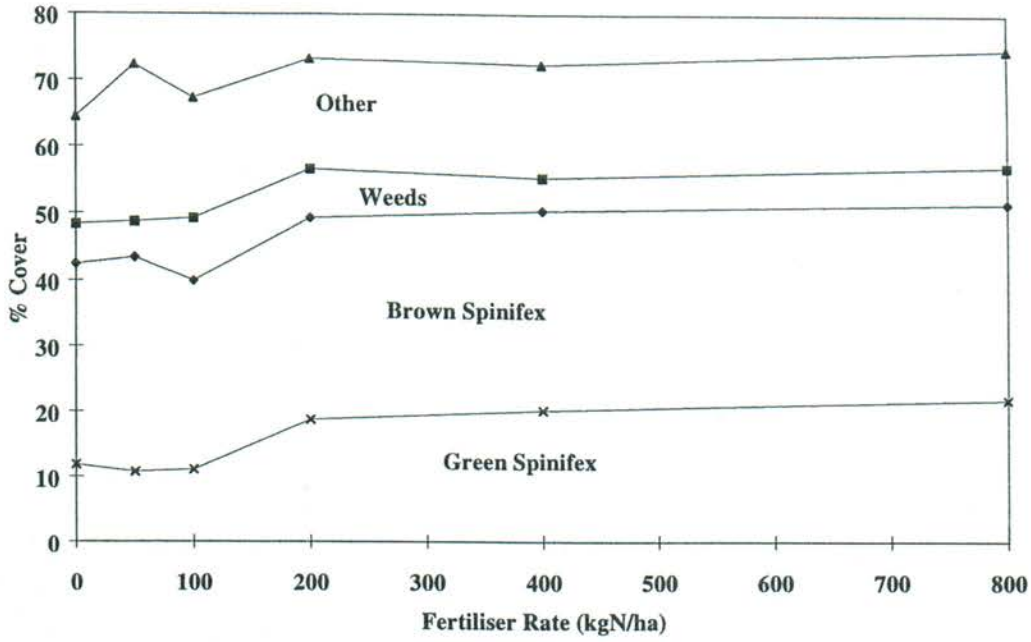

*Figure 2: **Percentage cover by major species and plant groups averaged across all four trial sites for the range of fertiliser treatments. Urea fertiliser was applied at rates from 50 to 800 kg N/ha in one application in mid-October 1997. Refer to Table 2 for broad groupings of weed (W) and other (O) categories.***

Future Research

With the current Mount Maunganui Beach-Papamoa Beach fertiliser trial, several aspects of research will require continuing and, where possible, further investigation. These include:

- Monitoring the response of vegetation cover to application of fertiliser for at least 2 further years to determine the most effective technique for fertilising degraded dunes.
- Producing guidelines for coastal managers interested in using fertilisers on foredunes to assist in improving vegetation cover and improving dune erosion.
- Comparing seedhead production and proportion of formed seed in large blocks of fertilised and unfertilised foredune.
- Determining the effect of fertiliser on both above and below ground plant biomass.
- Determining the pathway of nutrients in both dune vegetation and substrate after application of fertiliser.

The monitoring of the existing trials will continue with further funding from the Coastal Dune Vegetation Network (CDVN). This will include publishing guidelines on fertilising dunes which could be part of the CDVN Technical Bulletin series. The other research projects on seedhead production, biomass, and nutrition studies are part of research proposals to the Foundation for Research, Science and Technology planned for the 1998/99 ***Forest Research*** sand dune programme.

Acknowledgements

Fiona Ede and Helena Beeser assisted with establishment of the trial including application of fertiliser. Mark Kimberley helped with trial design and carried out analysis of the data. Jeremy Cox and Jessamy Herbert assisted with assessment of vegetation cover. Petrochem Ltd, part of the BOP Fertiliser group of companies, kindly supplied the urea fertiliser for the trials as well as the operational-scale fertilising of the foredunes from Waihi Beach through to the eastern beaches of Opotiki, a total treated area of 50 km.

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APPENDIX 1 - Fertiliser treatments for plots at the four sites located along Mount Maunganui and Papamoa Beaches, Bay of Plenty.

Plot No.	Site No.	Fertiliser Type	Fertiliser Rate (kg/ha)	Timing of application *	Fertiliser applied to each plot ** (kg)
1	1	Control			
2	1	Urea	400	single	8.696
3	1	Urea	400/400	split	8.696
4	1	Urea	50/50	split	1.087
5	1	Urea	100	single	2.174
6	1	Urea	400	single	8.696
7	1	Control			
8	1	Urea	200	single	4.348
9	1	Urea	800	single	17.392
10	1	Urea	100/100	split	2.174
1	2	Urea	200	single	4.348
2	2	Urea	400	single	8.696
3	2	Control			
4	2	Urea	800	single	17.392
5	2	Urea	50/50	split	1.087
6	2	Urea	400/400	split	8.696
7	2	Urea	100/100	split	2.174
8	2	Urea	100	single	2.174
9	2	Urea	200/200	split	4.348
10	2	Control			
1	3	Urea	50/50	split	1.087
2	3	Urea	400	single	8.696
3	3	Urea	200	single	4.348
4	3	Urea	100/100	split	2.174
5	3	Control			
6	3	Urea	100	single	2.174
7	3	Urea	200/200	split	4.348
8	3	Control			
9	3	Urea	800	single	17.392
10	3	Urea	400/800	split	8.696
1	4	Urea	100/100	split	2.174
2	4	Urea	400/400	split	8.696
3	4	Urea	100	single	2.174
4	4	Urea	400	single	8.696
5	4	Control			
6	4	Urea	200/200	split	4.348
7	4	Urea	50/50	split	1.087
8	4	Urea	800	single	17.392
9	4	Control			
10	4	Urea	200	single	4.348

* Timing of fertiliser application - for single applications, all fertiliser was applied in Spring (October 1997); for split applications half rate was applied in Spring (October 1997) with the remainder applied in Summer (February 1998).

**Indicates the actual amount of fertiliser applied to each plot in spring and summer where appropriate.

APPENDIX 2 - List of plant species found in the fertiliser trial plots, Mount Maunganui and Papamoa Beaches, Bay of Plenty.

Botanical name	Common or Maori name	Brief plant description
Spinifex sericeus (green)	spinifex	indigenous sand binding grass (green foliage)
Spinifex sericeus (brown)	spinifex	indigenous sand binding grass (light brown foliage)
Calystegia soldanella	sand convolvulus	indigenous sand dune creeper
Taraxacum officinale	dandelion	exotic herb common on stable dunes
Lupinus arboreus	yellow tree lupin	exotic woody shrub
Lagurus ovatus	harestail	exotic grass common on dunes
Gazania rigens	livingstone daisy	exotic herbaceous ground cover
Lachnagrostis filiformis		exotic grass
Senecio skirrhodon	gravel groundsel	exotic herb
Carpobrotus edulis	ice plant	exotic succulent ground cover
Cakile maritima	sea rocket	exotic herb often just above high tide level
Muehlenbeckia complexa	pohuehue	indigenous woody ground cover
Osteospermum fruticosum		exotic herb
Isolepis nodosa	knobby club rush	indigenous rush
Desmoschoenus spiralis	pingao	indigenous sand binding sedge

SPINIFEX PROPAGATION PILOT TRIAL

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#Naturally Native Plant Nursery, Tauranga

Introduction

One of the key research areas identified by members of the Network is the need for cheap, reliable methods of propagating spinifex (*Spinifex sericeus*) in large quantities. In recent years there have been a number of nurseries who have attempted to raise spinifex on an operational scale (Bergin & Herbert 1997). Largely anecdotal evidence from these nurseries around the country indicate that in some years it is relatively easy to raise large numbers of spinifex seedlings, but in other years, using similar procedures, there are very high failure rates. There also seems to be variable success with propagating the species using cuttings. In order for coastal managers to be able to plant sufficient spinifex on a large scale, the plants need to cost about $1 each. At this stage, the small number of plants that have been available can cost up to $5 each. Planting trials to date indicate that although nursery-raised seedlings establish readily especially with fertiliser, there can be significant losses of planted seedlings of sand binding species. Consequently, nursery techniques for large scale production of low-cost spinifex seedlings is therefore highly desirable.

Previous Work

In a review of propagation and establishment of spinifex, Bergin and Shaw (1991) indicated raising spinifex seedlings from either cuttings or seed was only successful on a small scale with little quantitative information on success and costs. Even in Australia where large scale dune revegetation programmes have been running for many years often using spinifex, the planting of nursery raised seedlings has only been on a small scale as seedlings are too expensive to raise compared to other techniques such as direct seeding and transplanting of cuttings (Bergin 1993).

Previous attempts has identified major difficulties in the raising of spinifex seedlings. The first of these is the very low proportion of formed seed in seed heads. The percentage of formed seed per head seems to vary on a geographic as well as on an annual basis. Secondly, the rate of germination of seeds varies from year to year. Thirdly, many nurseries have experienced unacceptable losses of seedlings at different stages of the nursery process - such as pricking out and hardening off.

Recent studies at ***Forest Research*** and elsewhere indicate that there are likely to be suitable techniques for overcoming some of the difficulties in raising seedlings. The Coastal Dune Vegetation Network and Naturally Native, a commercial nursery specialising in production of indigenous species, are collaborating in a project to determine low-cost, practical methods for large scale production of spinifex seedlings. The first stage of the project, reported here, aimed to evaluate in a pilot trial a range of refined seed preparation and nursery raising techniques, some of which have been previously tested on a small scale at the ***Forest Research*** Nursery, Rotorua. With the limited seed available at short notice, this also gave an opportunity for staff at Naturally Native further experience in handling spinifex. The second stage will involve demonstrating the feasibility of commercial production of the species using preferred seed and nursery techniques. Related studies include monitoring the performance of seedlings on dune sites evaluating size of planting stock and season of planting.

Objectives

- To establish a collaborative pilot seed preparation and nursery propagation trial at a commercial nursery.

- To determine cost-effective, practical methods for large-scale raising of spinifex seedlings under commercial nursery conditions.

- To collect seed from a range of North Island east and west coast sites and determine proportion of formed seed within each collection.

- To publicise results in the form of guidelines for use by other commercial nurseries including appropriate information for small-scale raising of spinifex by community-based interest groups.

MATERIALS AND METHODS

In the summer of 1997, seed was collected from four coastal sites in the Coromandel - Matarangi, Tairua, Whangamata and Whiritoa. The seed was stored at room temperature until 16th October 1997, when a trial involving a range of treatments (Table 1) was established on the propagation premises of Naturally Native, New Zealand Plants Ltd, Tauranga. The number of formed seed per spike was measured for 20 spikes for each seed source prior to trial establishment.

The medium used for sowing the seed was the nursery's normal free draining potting mix (Dalton's mix), with sand sprinkled on top of each tray to deter liverworts. Throughout the duration of the trial, standard nursery practises were carried out. Seed trays and pots were kept in an unheated glasshouse with automated misting facilities. The number of emergent seedlings was recorded on a regular basis until the seedlings were pricked out on 16th January 1998. The plants were removed from the glasshouse and placed outside on 20th February. Plant heights were measured on 26th February, by measuring the length of the longest green leaf.

The treatments applied to the seed ranged from minimal seed preparation (sowing entire seed heads) through to separating formed seed from the seed head by peeling off the husk and sowing only the naked seed. In addition, spikelets with formed seed were sown in a range of containers, to compare the effect of transplant shock on seedling growth with transplanting treatments.

Table 1: Treatments applied to spinifex seed from four Coromandel sites

Treatment	Description
1	Whole seed heads - 8 entire seed heads were placed on potting mix in a seed tray and covered with 1 cm of potting mix
2	Broken-up seed heads - 8 seed heads roughly broken up and broadcast over potting mix in tray, covered with 1 cm of potting mix
3	Broken-up seed heads, trimmed spines - 8 seed heads broken up, as much chaff as possible removed and spines trimmed to 3 cm long, broadcast over tray, covered with 1 cm potting mix
4	Broadcast single spikelets - 50 spikelets with formed seed separated from spike, trimmed with 1 cm spine remaining, broadcast over tray and covered with 1 cm potting mix
5	Sow single spikelets - 50 spikelets with formed seed separated from spike, trimmed with 1 cm spine remaining, sown upright in tray to depth of 1 cm
6	Spikelets into plugs (4 cm diameter, 5 cm deep) - 30 spikelets with formed seed separated from spike, trimmed with 1 cm spine remaining, sown upright and singly into plugs to depth of 1 cm
7	Spikelets into PB 1.5's - 36 spikelets with formed seed separated from spike, trimmed with 1 cm spine remaining, sown upright, three per PB, to depth of 1 cm
8	Spikelets into root trainers - 32 spikelets with formed seed separated from spike, trimmed with 1 cm spine remaining, sown upright, singly into root trainers to depth of 1 cm
9	Naked seed - 50 seed dissected from spikelets, with surrounding husk removed, broadcast onto tray and covered with 1 cm of potting mix

Interim Results

Quantity of Formed Seed

The percentage of spikelets with formed seed in a spike (i.e., a seedhead) for each seed source is shown in Table 2. It can be seen from these results that although there was little difference in the average number of spikelets per spike collected from the four sites, spikelets from spikes collected at Whiritoa had at least twice as many formed seeds as spikelets collected from any of the other sites.

Table 2: Number of spikelets with formed seed, in spikes from four Coromandel sites

Seed Source	Spikelets per Spike		Formed Seed Per Spike		
	Average	Range	Average	Range	Percentage
Matarangi	135	69 - 223	11.1	0 - 47	8.2%
Tairua	146	100 - 216	7.5	0 - 53	5.1%
Whangamata	140	98 - 195	16.6	2 - 36	11.9%
Whiritoa	148	104 - 230	35.3	2 - 62	23.9%

Timing

The quickest treatments to prepare for sowing were those involving whole seed heads (treatments 1 and 2). Preparing the 8 seed heads for treatment 3 took about 10 minutes. To sow the individual spikelets took a similar amount of time as setting cuttings. However, the slow part of the process for these treatments (4 - 8) was separating out the spikelets with formed seed from the spike. The time involved in selecting spikelets with formed seed depended on the individual spike and the seed source, with some spikes having very few formed seed and others containing a reasonable number. The slowest treatment to prepare was treatment 9, where spikelets with formed seed first had to be identified and then the outer layer of seed coat were stripped away from the seeds. This time consuming procedure adds to the total cost of preparing seedlings.

At the pricking out stage, the treatments that had a considerable amount of chaff still present (Treatments 1 and 2) were very slow to prick out, as it was difficult to remove the seedlings from amongst the chaff material. Pricking out of Treatment 1 was slower than for Treatment 2. Therefore the advantage of the speed of preparation of these two treatments at the time of sowing, in comparison with the other treatments, is negated by the amount of time required to prick out the seedlings later on.

Rates of Seedling Emergence

The rate of seedling emergence for the treatments involving whole seed heads were very slow (Fig. 1) with most seedlings emerging between day 40 and day 60. Treatment 1 had the slowest rate of emergence, and overall produced the fewest seedlings of these three treatments. It was not possible to determine the percentage of emerged seedlings as it was not known how many formed seed were sown in the treatments using entire seed heads. However, it should be noted that the number of seedlings for these treatments (Table 3) were initially spread over four standard seed trays, so the number of seedlings produced per tray ranged from 47 - 62 seedlings.

Of the remaining treatments (Treatments 4 - 9), Fig. 2 shows that the rate of seedling emergence was fastest in Treatment 9 - sowing naked seed, but after about 35 days no more seedlings emerged, with the result that less than 50% of these seeds sown produced viable seedlings. Seedlings originating from whole spikelets sown in various ways emerged more slowly than those from naked seed, but continued to emerge over a longer time period and produced greater percentages of viable seedlings (Fig. 2).

Sowing spikelets upright either into trays, PB 1.5's or root trainers produced the largest number of seedlings, with more than 70% of these seeds producing seedlings (Table 3). For Treatments 4 and 5, the seedlings were spread over two trays (so the average number of seedlings per tray was 60 - 71), while all the seedlings in Treatment 9 were in the same tray. In Treatment 7, where three seeds were sown into PB 1.5's, all but one PB had at least one seedling when height measurements were made in February. In 11 PB's one seedling was present, while 18 PB's had two seedlings and three seedlings were present in the remaining 18 PB's.

In Treatments 2 and 3, the seed heads collected from Whangamata produced almost twice as many viable seedlings as seed heads from any other site. Across the three treatments involving whole seed heads, the Whangamata sourced material produced the greatest number of seedlings, followed by the seed heads from Whiritoa, with Matarangi and Tairua sourced material producing the least seedlings (Fig. 3). This result is at variance to what would have been expected from the results presented in Table 2, where the percentage of viable seed per seed head was twice as high from Matarangi seed heads than from those collected at Whangamata.

Spikelets with formed seed from seed heads collected at Whiritoa tended to produced seedlings more often than those from seed heads collected elsewhere (Fig. 4), with at least at 80% of the Whiritoa spikelets producing seedlings in Treatments 4, 5 and 8. The Matarangi sourced spikelets produced the least number of viable seedlings in Treatments 4, 5, 7, 8 and 9.

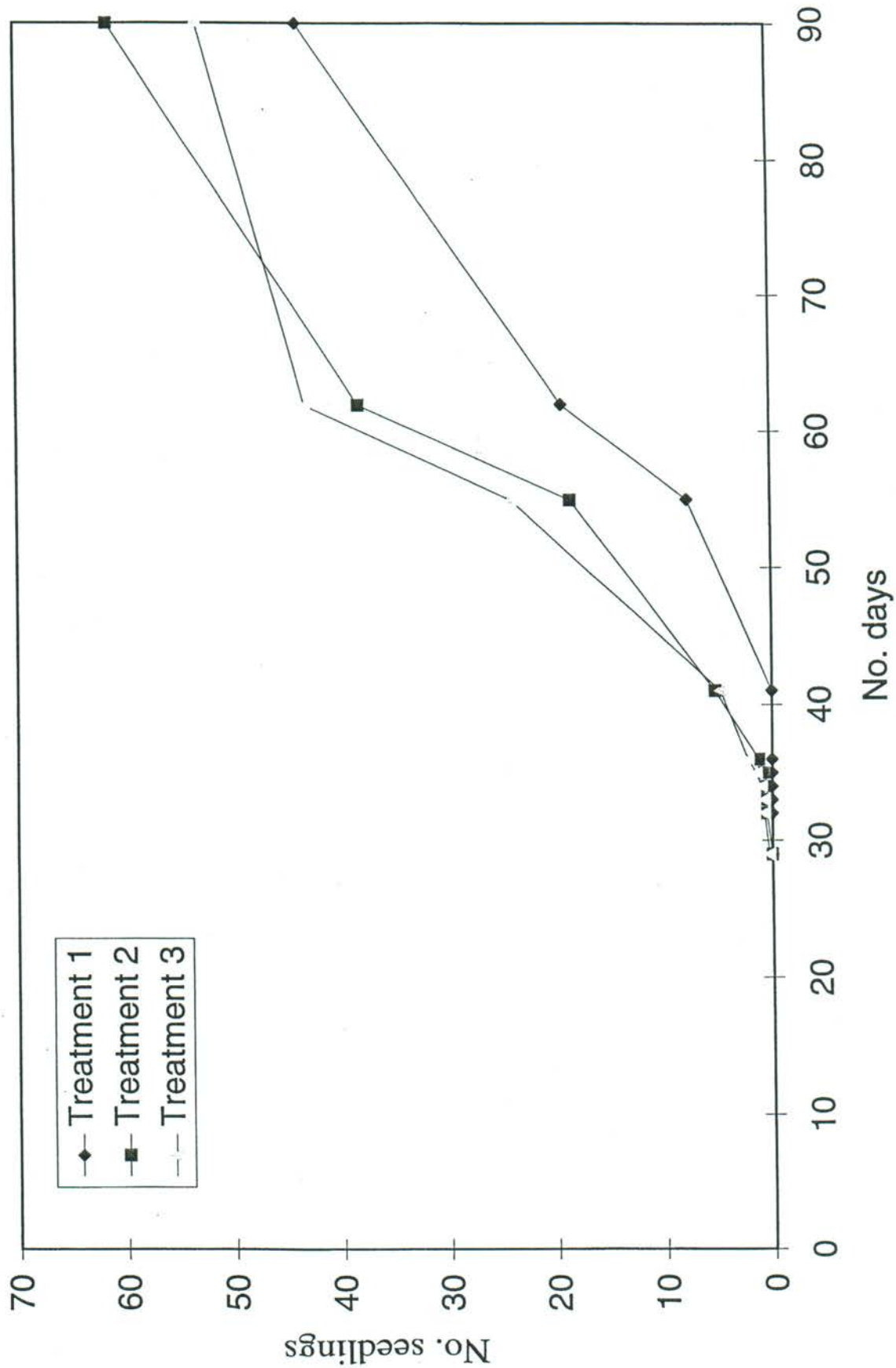


Figure 1. The number of seedlings produced over 90 days, in Treatments 1-3 for all seed collection sites

Figure 2. The number of seedlings produced over 90 days, across Treatments 1-3 for each of the seed collection sites

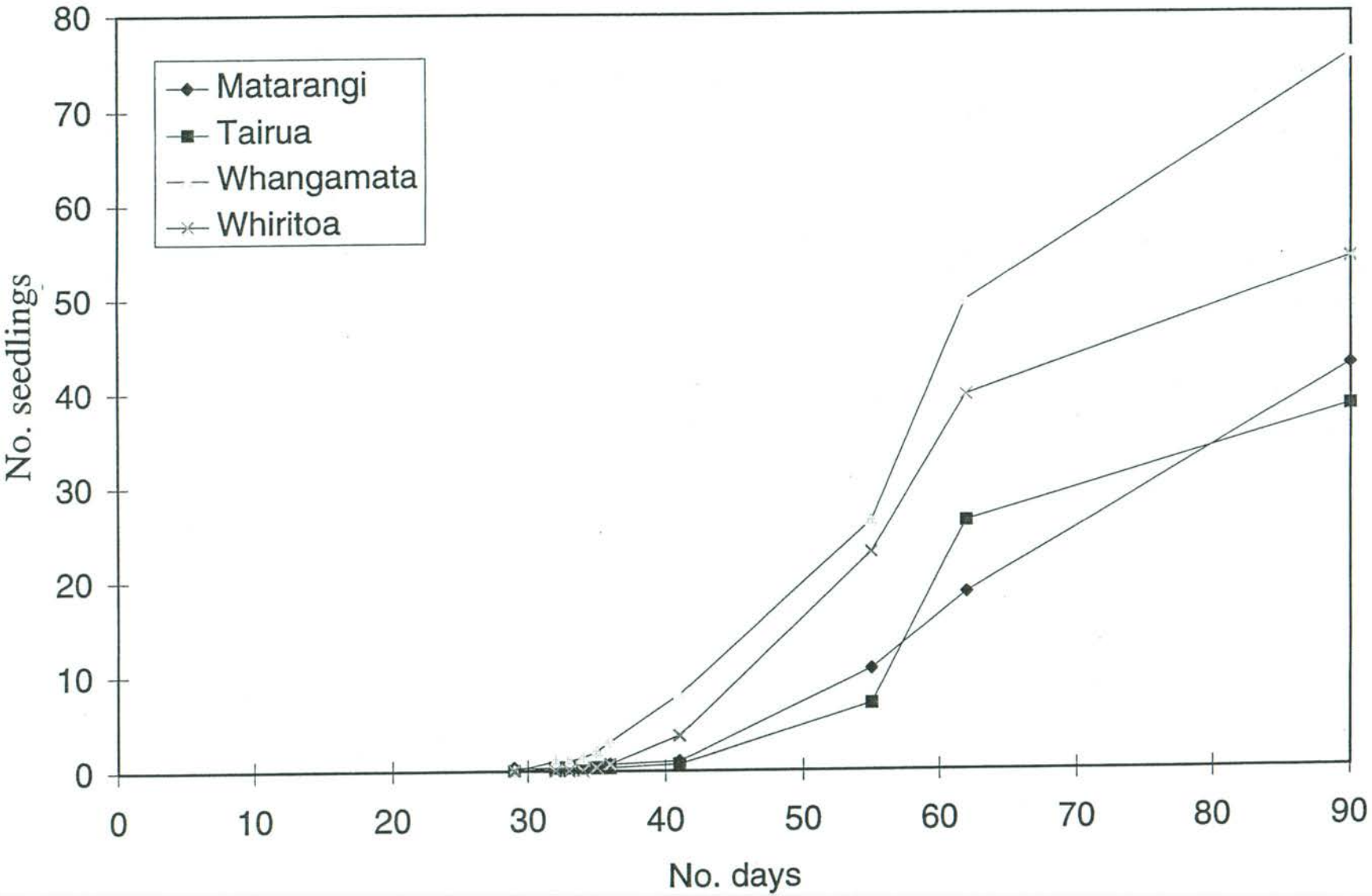


Figure 3. The percentage of sown seed that produced seedlings over 90 days, in Treatments 4-9 for all seed collection sites

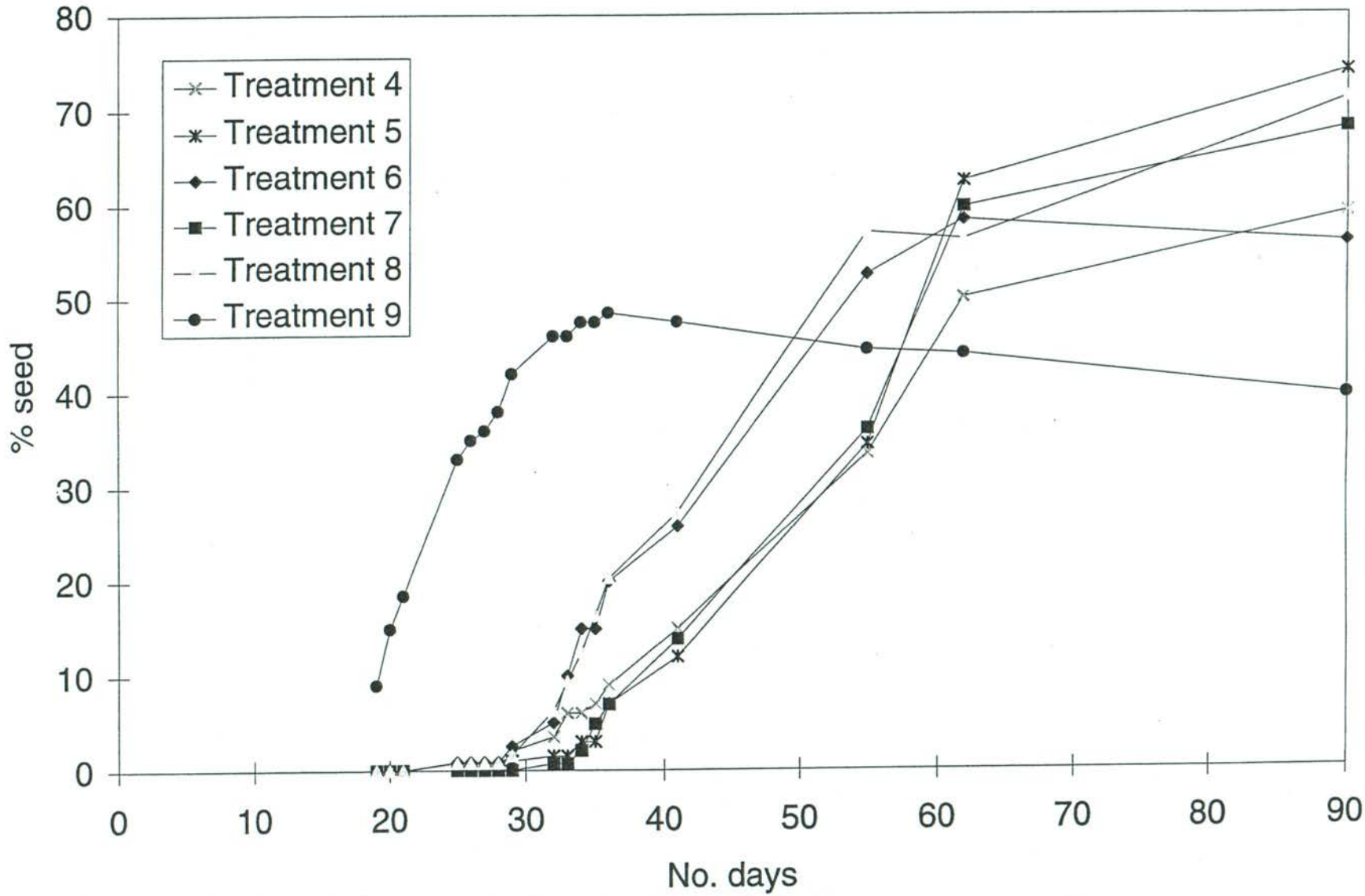
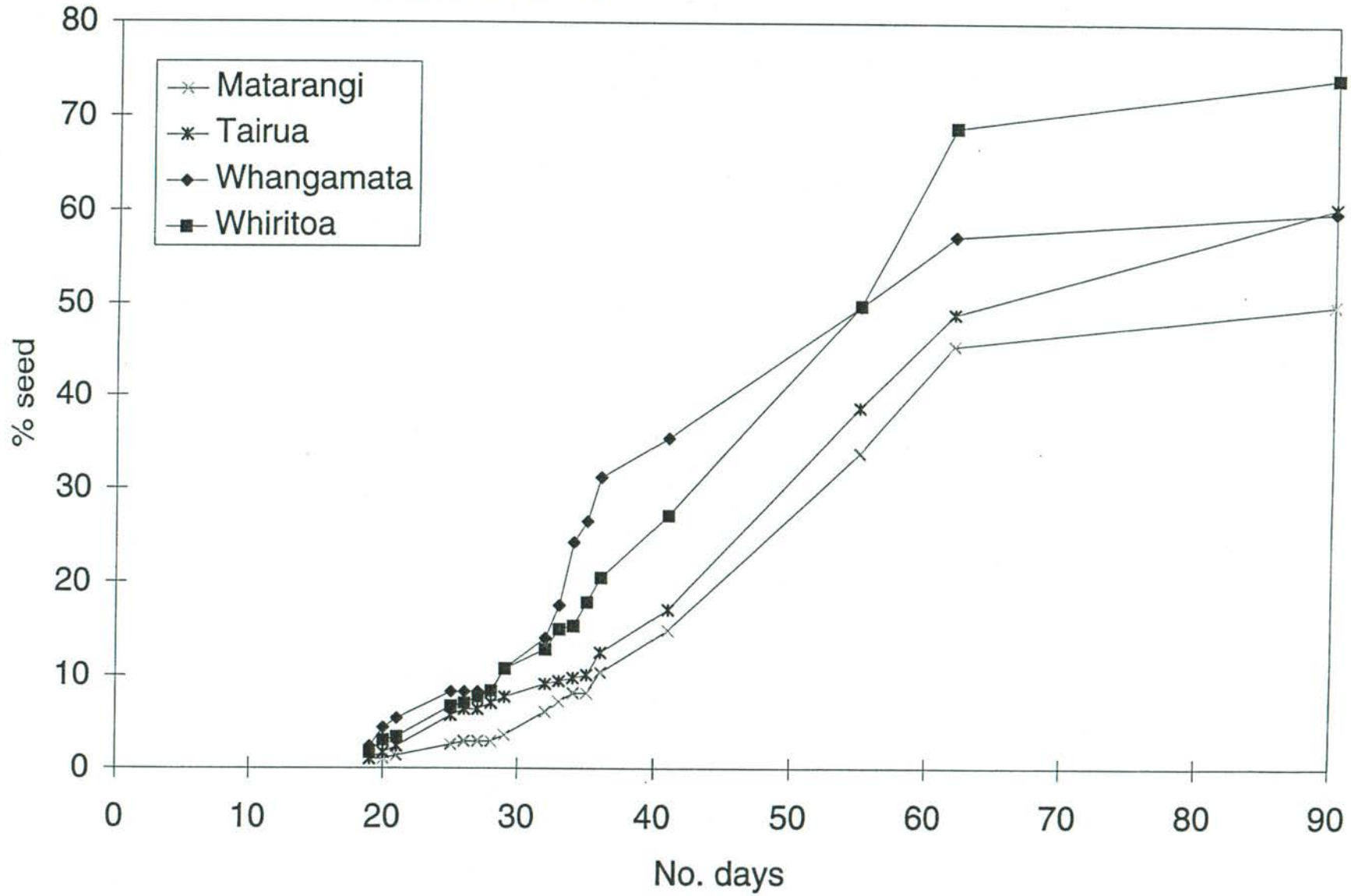


Figure 4. The percentage of sown seed that produced seedlings over 90 days, in Treatments 4-9 for each of the collection sites



Plant Height

The height of each of the 1,249 remaining plants was measured 6 weeks after pricking out. There were some losses after pricking out, ranging from 10% in Treatment 9 to 1% or less for Treatments 1, 2 and 3. It must be noted that there was no pricking out operation for Treatments 6, 7 and 8. The tallest plants were produced by sowing seeds directly into PB 1.5's (Treatment 7), while Treatments 1 and 5 produced the shortest plants (Table 3).

Table 3: Number of seedlings and average seedling height at 26 February, 1998

Treatment	Number of Seedlings	Percentage[1] Survival	Average Seedling Height (cm)
1	189	-[2]	44a[3]
2	243	-	49bc
3	224	-	52c
4	119	60%	52c
5	141	71%	45ab
6	65	54%	50bc
7	103	72%	67d
8	93	73%	54c
9	72	36%	49bc

1: The number of seedlings still surviving at 26 February expressed as a percentage of the number of seed sown in October.
2: Because the number of formed seed is unknown, it is not possible to calculate a percentage for these three treatments.
3: Figures in this column followed by the same letter are not significantly different at the 5% probability level.

There was no difference in plant height between seedlings produced from the four seed sources, but there about 100 more seedlings produced from the Whangamata and Whiritoa seed than from that collected at Tairua and Matarangi (Table 4).

Table 4: Number of seedlings and seedling height at 26 February, 1998 from seed collected at four Coromandel sites

Seed Source	Number of Seedlings	Average Seedling Height (cm)
Matarangi	249	50
Tairua	265	52
Whangamata	382	52
Whiritoa	353	49

Discussion

Seed viability

The variability in the amount of formed seed per spike from seed collections at the four Coromandel sites in 1997 is similar to that found previously (Bergin et al. in prep). Factors that affect the formation of sound seed in spinifex spikes are not known and is a major focus of the current ***Forest Research*** sand dune research proposal for funding to the Foundation for Research, Science and Technology. If it is found to be possible to improve seed yield by any economically sound method, it will contribute to decreasing the cost of producing viable spinifex seedlings in the long term.

Minimal seed preparation

In terms of a "cost-benefit" analysis of the time involved in preparing each treatment and the number and size of resultant seedlings, it is possible to determine which treatments are worth further investigation and those which should be discounted at this stage. Treatment 1 was initially quick to sow, but pricking out of seedlings was slow. When this is coupled with the slow rate of seedling emergence, the low numbers and small size of seedlings, it can be concluded that this technique is not worth repeating. Although the time involved in sowing and pricking out Treatment 2 was similar to Treatment 1, more seedlings resulted from this treatment, and emerged more quickly. By investing more time at the sowing stage, in Treatment 3, where as much chaff as possible was removed relatively quickly, time was saved later on at pricking out and the number and size of seedlings from this treatment was not dissimilar from that gained with Treatment 2. Where minimal seed preparation is desired, the most cost-effective technique therefore is to break up the seed heads, trim the spines and remove as much chaff as possible.

Sorting and sowing of formed seed

Sorting of formed seed from seedheads proved particularly time consuming particularly where there was a low proportion of seed in the collection such as with the Tairua and Matarangi provenances.

There was no difference in the time taken to prick out seedlings for Treatments 4 and 5 - although sowing seeds upright in the tray (Treatment 5) was slightly slower than broadcasting seed across the tray (Treatment 4). Sowing the spikelets produced more seedlings than broadcasting, but the seedlings were shorter. With the remaining treatments involving the sowing of trimmed spikelets, there was no pricking out involved as the spikelets were sown into their final containers, which decreases the time cost of these treatments in comparison with the other treatments.

Choice of container

The vigour of the seedlings growing in the plugs was not as good as those sown into other containers and the number of seedlings in this treatment was the lowest for all single spikelet treatments. Seedlings sown into PB 1.5's emerged more quickly than those sown into root trainers, although the final number of seedlings was similar. The earlier emergence of these seedlings may explain the significantly greater height of these seedlings in comparison with those in root trainers. The seedlings in PB 1.5's were taller than any other seedlings in the trial, which may be related to the increased volume of potting medium and space available for the roots. Because the height of the seedlings sown into root trainers and plugs was not different from those treatments where pricking out occurred, it is not possible to conclude that the act of transplanting the seedlings had a detrimental effect on seedling growth.

The results of sowing single spikelets in this trial show that sowing spikelets in PB 1.5's produced the tallest plants, without the extra cost of pricking out. However, this must be balanced against other costs. The greater size of these containers means they require more potting mix to fill, take up more room in the nursery and are more cumbersome to deal with in the field. It is relatively easy to carry 32 seedlings in root trainers in a wire basket, but carrying a similar number of seedlings in PB 1.5's is more difficult. The trade-off between ease of cartage in the field and the size of seedlings to be planted out must be considered for each situation. Because of high survival, there was no advantage in sowing more than two formed seed in the final container.

Naked Seed

The final treatment using naked seeds had the highest cost associated with the sowing stage, but other costs were similar to single spikelet treatments that required pricking out. The seedlings emerged more quickly than for any other treatment, but the number of seedlings produced was lower than for the single spikelet treatments. The seedlings were of a similar size to those in other treatments.

Seed Collection Site

In this trial, the influence of the site of collection of the seed heads was limited to the number of seedlings produced. The rate of seedling emergence and seedling height were not affected by collection site. This means that the costs associated with processing seed heads collected from any of these sites is related only to the number of formed seeds per seed head.

Future Trials

This pilot trial is ongoing and performance of seedlings will be monitored for several months. Although seedlings are around 50 cm tall within 4 months of sowing, they are generally 2-3 leaves with a root collar diameter of only 2-3 mm. If seedlings have increased significantly in size by late autumn 1998, some will be planted on a foredune site and their performance will be compared with seedlings planted in spring. The next stage of trial work, due to be installed in autumn 1998, will use seed collected this summer to validate the techniques that have initially proved successful on a larger scale.

Conclusions

Although these results are from seed collected from one season only so far, it is possible to offer a choice of propagation techniques for nursery operations which may be successful. If time is limited at the sowing stage, and the seed heads being used have a high percentage of formed seed, then breaking up whole seed heads and removing as much chaff as possible before broadcasting the seed heads is a viable option. If there is time to sort out spikelets with formed seed, but time is limited at the pricking out stage of operations, then sowing the spikelets directly into root trainers or PB's are the best options. In order to decrease the space taken by PB 1.5's, it is possible to use smaller PB's (eg. 0.75's), which would also make later transportable easier. However, it must be noted that there are no guarantees at this stage and that it is expected that there will be variable results with any of these techniques from year to year and from nursery to nursery.

Acknowledgements

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TECHNICAL BULLETIN - DUNE MORPHOLOGY

One of the major aims of the Coastal Dune Vegetation Network is to facilitate the flow of information between participants and to provide "high-quality, timely, research-based information and management outcomes to members" (Objective 5.4 in the constitution). One means of achieving this goal is the production of technical bulletins, covering topic areas which are of interest and concern to members.

In the prioritisation process in 1997, financial members voted to set aside $5,000 from the current year's budget to pay for the production costs of a technical bulletin detailing dune morphology and dune processes. At the same time, Forest Research is contracted to the Ministry for the Environment to produce three publications (one each on growing pingao, spinifex and sand fescue) over the next two years, with the first of these publications nearing completion.

The format of all of these publications has been discussed by the coordinating committee and a range of options considered. In the long term, it is seen as desirable to have a comprehensive set of technical bulletins that were each "stand alone" in their own right but together became part of a whole - a type of coastal management manual. Each bulletin would have a similar format and layout, and would be issued with an ISSN number for cataloguing purposes. The bulletins would be produced on high quality A4 paper so they could be used in the field as a reference guide. The bulletins could be easily stored in a ring binder folder, with new bulletins added to the series over time, and updated versions replacing older bulletins as new information came to hand. The contents of each bulletin would be scientifically based, but written in such a way as to be accessible to people with a working knowledge of coastal issues - council staff, Beach and Coast Care coordinators, consultants etc. Each bulletin would be refereed by appropriate people and would be produced by the editorial staff at Forest Research.

The first draft of the first Network bulletin dealing with geomorphological processes has been written by Libby Boak of ARC and we are very grateful to her for undertaking that job. This draft is currently being reviewed by Dr Patrick Hesp, a coastal geographer at Massey University and it is expected that a number of other Network members will also have input into the contents of that bulletin. Because the coordinating committee felt that it was important to discuss the technical bulletin concept and format with all the membership of the Network, we have not proceeded further with finalising the format of this bulletin. If Network members are in agreement that we go ahead with the concept of an integrated series of bulletins, then we will proceed. However, it is unlikely that this bulletin will be able to be produced before 30 June, 1998 and so we are asking the financial members for permission to carry over the $5,000 set aside for production costs to the 1998/1999 financial year. We would also like all members to think about what other topics they would like to see presented in this format, so that we can begin to plan a series of publications that meet the needs of members and of all coastal managers.

COASTAL SAND DUNE VEGETATION AND GEOMORPHOLOGY OF KAREKARE, WEST COAST, AUCKLAND.

Catherine Moss
MSc thesis, University of Auckland

Introduction

This presentation summaries findings from my thesis, completed in February 1998, as part of a MSc in Environmental Science, Auckland University. The thesis explores the historical development and current state of vegetation and geomorphology of coastal sand dunes at Karekare.

Karekare

Karekare is situated on the west coast of Auckland, 37km south west of Auckland city and 8km north of the entrance to the Manukau Harbour. It is one of a sequence of sandy beaches, which are divided by headlands and cliffs on the west coast. This coast is well known for its rugged beauty, black sand and wild, wind-swept surf beaches. These west coast beaches are currently believed to be at a stable, equilibrium position, although, sand dune migration inland occurs in some parts.

Karekare is a sandy, embayed beach, surrounded by steep hills and headlands at both ends. It has a highly dissipative morphodynamic beach type. That is, it is subject to high wave energy, has a wide beach, a low beach gradient, a macro (greater than 4m) tidal range and a large sand supply. Waves break by spilling and dissipating progressively whilst crossing a wide surf zone (Healy, 1995; pers. comm. Parnell, 1997).

Maori have probably been present at Karekare since the 11th century. Te Kawerau a Maki are tangata whenua and hold the mana whenua of the area. With the arrival of Europeans, the Karekare region was first farmed in 1850s. In the late 1800 and early 1900 timber mills were established, milling timber from Karekare Valley. Karekare was relatively isolated because of poor road access but gradually more visitors and residents have come to Karekare as roads and transport improved. Focus has moved from farming and timber milling to recreation and the beach lifestyle. Now a small coastal village is located at Karekare with a permanent population of about 300.

Karekare is part of the Auckland Centennial Memorial Park, managed by Auckland Regional Council Parks Service (ARCPS). Under the Waitakere Ranges Regional Parkland Management Plan (ARCPS, 1992) Karekare is categorised as a medium use area and further major development is not considered appropriate. The major threats identified are weeds and possums.

Other threats to the Karekare include recreational use and water quality. Many people are largely unaware of their impact on the coastal environment through their recreational activities. Damage to dune systems resulting from recreational use includes damage to sand dunes and their plants due to trampling and increased levels of litter. Demand for the use of the coastal environment will only grow in the future. Increased recreational and residential use at Karekare has also resulted in decreased water quality in the streams in the past 10-15 years. Monitoring of water quality by Waitakere City Council (WCC) show high levels of bacteria, which have been linked to ineffective septic tanks and soakage field systems (City Design, 1997).

Methods

Aerial photographs and historical information were first used to gain a historical perspective of dune development. Percentage cover abundance of vegetation was sampled and topography was surveyed along transects that ran inland and perpendicular to the shoreline. Plant communities were determined using TWINSPAN, and relationships between vegetation cover abundance and bio-topographic parameters were determined using a regression procedure in the SAS system. Finally, species cover abundance and topography within the dune system area were mapped using the gridview programme in the Generic Mapping Tool system.

Vegetation of Karekare

Historically the Karekare dune system was flat and relatively unvegetated, with minimal evidence of sand binding plants. However, Pohutukawa Glade, at the south east edge of the system, has been vegetated since European occupation. It was bordered by a low, partially vegetated sand dune.

Planting was undertaken in the 1960s by ARCPS along Pohutukawa Glade. Initially this was to provide shade trees, such as *Metrosideros excelsa* (pohutukawa), *Sophora microphylla* (kowhai), *Vitex lucens* (puriri), *Myoporum laetum* (ngaio). In 1970 planting to stabilise sand movement through the Glade occurred. A sand fence was erected and marram grass and yellow tree lupin was planted on the sand dune bordering Pohutukawa Glade. This altered the direction of wind flow, stabilised sand movement, and formed dunes in front of the sand fence, towards the coast. It also facilitated the regeneration of native vegetation. Growth of the sand dunes and stabilisation with native sand binders occurred from the original dune to the front, without any further planting or sand fences (pers. comm. Beveridge, 1997). If planting had not stabilised the original dune, the Karekare dune system may still be mobile now. However, after initial human intervention natural processes now predominate.

At present over 53% of the sand dunes at Karekare has no vegetation cover. *Spinifex sericeus* (spinifex) is the most dominant dune species, covering 11.3% of the dunes, followed by *Muehlenbeckia complexa* (wire vine) (8.2%), both of which are natives. Introduced species *Ammophila arenaria* (marram grass) and *Leontodon taraxacoides* (hawkbit) are the next most abundant (3.5%), followed by *Stenotaphrum secundatum* (buffalo grass) (3.3%). In total, native species cover 25.1% of the dunes and introduced species vegetate 16.7%. Given that initial establishment of dunes was by exotic species the dune system at Karekare has a good proportion of native plant species. However, some exotic species, such as *S. secundatum* and *Lupinus arboreus* (yellow tree lupin), are out-competing and displacing natives.

Vegetation of the Karekare sand dunes can be classified into two main groups. These groups can be considered to be vegetation typical of the fore/mid dunes and the rear dunes. Fore/mid dune communities include the *Spinifex sericeus* community, which contains *S. sericeus* and bare sand. The *Cassina leptophylla* (cottonwood, tauhinu) community includes the ground-cover species *Sonchus oleraceus* (sow thistle), the native herb *Calystegia soldanella* (shore convolvulus). Finally, in the fore/mid dunes is *Leontodon taraxacoides* which is classified in a plant community on its own. In between the mid and rear dunes is a sand basin which is unvegetated.

Rear dune communities include the *Carex pumila* (sand sedge)/*Lachnagrostus billardierei* community. It consists of those two native species as well as extremely low levels of *Cotula coronopifolia* (bachelor's button, native) and *Hypochoeris radicata* (catsear, exotic). The *Ammophila arenaria/Lupinus arboreus* community, also includes many exotic species, such as *S. secundatum, Lagurus ovatus* (harestail), *Briza maxima* (quaking grass), *Senecio jacobaea* (ragwort), *Lotus* species and *Conyza albida* (fleabane). The *Muehlenbeckia complexa* community, includes the introduced grass *Holcus lanatus* and low abundances of *Isolepis nodosa* (knobby clubrush, wiwi) and native shrubs and trees *Melicytus ramiflorus* (mahoe), *Myrsine excelsa* (mapou), *Macropiper excelsa* (kawakawa), *Pittosporum crassifolium* (karo), and *Kunzea erocoides* (kanuka).

A vegetation gradient occurs at Karekare. In the foredunes, where the habitat is dominated by sand movement and salinity, a specialised foredune community, a low sparse monoculture of *S. sericeus* occurs. *S. sericeus* stabilises the sand which, once stabilised, allows more diverse communities to develop. Species diversity and amount of cover starts to increase in the mid dunes and then greatly increases in the rear dunes, with typical rear dune species, such as *M. complexa.* The result is a vegetation gradient with increasing community complexity inland, that is, increasing species diversity, cover and abundance of less tolerant or specialised species. However, this broad environmental gradient is complicated by the presence of the sand basin, planting programmes, and microclimates that exist in a dune system. Microclimates form due to such factors as shelter and distance from water table, seasonal fluctuations and disturbance. The result is a complex mosaic of species distribution patterns.

Water availability is an important factor as it helps stabilise areas of sand and provides elements essential for growth. Species that generally occur in slacks at Karekare occur in the *C. pumila/L. billardierei* and *M. complexa* communities in the mid/rear dune area. These communities are a more diverse plant assemblage compared to the adjacent mid dune *C. leptophylla* community.

It appears that planting has facilitated the invasion of weeds into the rear dunes. *A. arenaria* and *L. arboreus* are apparently now restricted in distribution due to their physiological traits and to environmental conditions.

The following parameters have significant effects on plant species distribution on the dunes:

- distance from coast and sand burial and movement, for example *S. sericeus* and *M. complexa*
- their placement with planting, such as with *A. arenaria* and *L. arboreus*
- $aspect_2$, a biotopographical factor.

Regression analysis shows that, given the right conditions, many species can occur in very different positions from where they are at present,. For example, models predict that *A. arenaria*, *C. leptophylla*, *L. arboreus*, *M. complexa*, and *S. secundatum* could all occur on the foredunes. This means that either the conditions in these alternative positions are not optimal at the present time or that other factors, such as competition or inability to migrate, prevent establishment at these locations.

Geomorphology of Karekare

As a fully dissipative morphodynamic beach type, the Karekare sand dune complex has potential to have very high, wide foredunes and dune field. The foredunes of Karekare are approximately 9.5 to 12m high and 60-90m wide. Therefore, whilst the Karekare foredunes occur in conditions where they could be large, they are comparatively moderate in size.

According to the Short and Hesp (1982) classification of foredune types, using percentage vegetation cover and morphology, Karekare is a Fc type foredune (the intermediate state). The fore dunes at Karekare are partially vegetated with 12-57% cover. They are hummocky, that is, there is no series of distinct coast-parallel ridges alternating with dune hollows. Sand patches on the foredunes occur on the top and leeward slopes. Small blowouts occur and lee side sand accumulation is occurring at Karekare. Variation in foredune topography alongshore is evident. Due to short-term variations in sea currents and prevailing winds and stream undercutting, the foredune is eroding at the north end and accreting at the south. According to Hesp's (1983) classification, the Karekare foredunes change from a ramp morphology in the south, to a terrace in the middle then to a ridge at the northern end, within a corresponding decrease in vegetation cover. Where stream undercutting does not occur as a complicating factor, the foredunes are of the type described by Hesp with low density spatially variable plant densities - lower, wider dunes.

The sand basin is an avenue for sand to be transported in and out of the dune system, in a cyclic, continuous fashion. The sand basin is a sand transportation zone, whereby topographically modified onshore winds channel sand from the beach and seaward dunes, northward to the stream, which transports the sand back to the beach.

Management of Karekare Sand Dunes

Despite human intervention and development, natural processes dominate the coastal sand dunes at Karekare. The natural character of Karekare is still predominantly intact. It has dynamic, functioning coastal processes, the presence of indigenous vegetation, and largely unmodified coastal landforms with little evidence of human structures.

The Karekare sand dunes are of a type (vegetated and stable) that are the most fragile, they are sensitive to most classes of impact (Rust & Illenberger, 1996). Therefore, Karekare is potentially a fragile dune system, readily damaged by overuse, unsuitable activities and development and the influence of introduced plants and animals. Appropriate management is required to minimise and prevent detrimental effects of human activities, in order to maintain natural processes in dune system and preserve Karekare relatively unspoilt natural character this wild, dynamic environment.

Management Guidelines

Vegetation

The sand dunes have been sufficiently vegetated through natural processes and do not require any further planting. Management instead, should focus on the protection of the native plant communities.

However, more planting at Pohutukawa Glade and in the main carpark could be undertaken. Any planting should use appropriate eco-sourced native plants, ensuring that plants are located within their natural plant communities. Appropriate coastal shrubs and trees to plant would include *Beilschmiedia tarairi* (taraire), *Corynocarpus laevigatus* (karaka), *Metrosideros excelsa* (pohutukawa), and *Pittosporum crassfolium* (karo).

Any weed eradication programmes should be carefully managed and monitored. Removal of large areas of weed would allow the invasion of more weeds into the area, especially at the edges of the system, and could result in sand erosion and dune instability.

Facilities/Development
The limited amount of facilities offered at Karekare at present should be maintained. This reflects the wilderness nature of the area, and may reduce the number of visitors to the beach. Car parking facilities in particular should not be extended, as current car park capacity restricts the number of visitors on the beach at any one time to a maximum of approximately 2000 people. No new development should occur at Karekare.

Access
Access to Karekare beach is via two paths, both bordering the edge of the dunes. These two access ways are the most direct paths to the beach and people rarely walk through the dunes. However, other tracks do exist on the foredunes, and these should be discouraged. The development of a network of paths and tracks has the potential to result in blowouts and general dune instability. Any fences to stop access to the dunes would be impractical and would infringe on the wild unmodified appearance of the dunes.

Public Education
Signs already exist at Karekare, however, these do not adequately explain the fragility, instability and dynamic nature of the sand dunes and its vegetation. Improved signs should not be imposing, but rather be interesting and educational and designed to convey information quickly. Special mention should be made of the adverse effects of vegetation trampling and tracks through the dunes.

Consultation
Continued consultation with the community regarding the management and activities of Karekare is advised. Tangata whenua should also be involved in management decisions.

Water Quality
Monitoring of water quality of the Karekare Streams by WCC should continue. Every effort should be made to improve the water quality of these streams.

References

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Parnell, K. 1997. Geography Department, University of Auckland. Informal Conversation. 9 December.

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Rust, E.C. & Illenberger, W.K. 1996. Coastal dunes: sensitive or not? *Landscape and Urban Planning* 34: 165-169.

Business Session

Business Session, Papamoa Surf Club 11.00am -1.00pm
Chairman Mr Harley Spence, Environment Waikato

1 Apologies

2 Network Coordinator's Report

3 Financial Statement

4 Research Programme
- methods for setting research priorities
- ongoing Spinifex research
- use of exotic species as potential nurse plants
- funding for monitoring restoration work
- research priorities for South Island
  eg dune slope/vegetation cover research
- marine rubbish at Long Bay
- pohutukawa establishment on shingle beaches
- other topics

5 Agenda Items
- membership issues
- CDVN logo/technical bulletin format
- information dissemination
- adequacy of hazard zone provisions

6 General Business

CDVN Coordinators Report 1997 - 1998

F.J. Ede

Introduction

I am thrilled to be able to welcome so many people to this inaugural Annual General Meeting of the Coastal Dune Vegetation Network and I think the level of attendance is an indication of the success of the Network in its first year of operation. The Network arose out of contacts made over several years between researchers and various coastal managers. The process of formalising these existing relationships into a research collaborative structure involved the meeting of interested parties in Rotorua in March, 1997, where we felt that there was enough support to proceed. A coordinating committee was set up to oversee the drawing up of a contract and constitution for the Network and to finalise the budget for the first year of operation.

The Network formally came into being on 1 July, 1997, with 12 financial members and several collaborators working in association with ***Forest Research*** (formerly FRI). It is timely here to reiterate the mission statement for the Network:

"To provide a forum for the free exchange of information on sustainable management of coastal dune ecosystems with emphasis on the use of vegetation to restore natural character, form and function."

In order to fulfil these aims, a number of projects have been initiated and are ongoing.

Technology Transfer

To facilitate the flow of information between Network participants, a twice yearly newsletter is being produced at ***Forest Research*** which documents items of interest for the Network. David Bergin has taken responsibility for editing the newsletter and he welcomes any contribution from members. It is anticipated that the newsletter will be sent out in June and December each year, so if there is anything of interest happening in your locality, then please let David know.

A current mailing list of all Network participants will be sent out with the newsletters, for use by members. However, please be aware that the mailing list is confidential to Network members and cannot be passed on to others outside the organisation.

As part of the longer term strategy of the Network, it is anticipated that production of a series of technical bulletins over the next five or more years, will result in a coastal management manual which will be made available to all coastal managers. ***Forest Research*** currently has a contract with the Ministry for the Environment to produce three technical bulletins - one each on the propagation and establishment of pingao, spinifex and sand fescue. The Network has undertaken to produce a bulletin detailing dune morphology processes, as was discussed in the technical session. These bulletins will be available, free of charge, to all interested parties.

Research Projects

The network is currently funding two research projects, as outlined in the technical session. We are extremely grateful to the assistance of Naturally Native nursery in Tauranga, particularly Ann Fair and her team, who have done a marvellous job with the spinifex trial. The nursery is willing to continue with this work and provide facilities and labour for the next trial in this project, which is greatly appreciated.

We are also indebted to Environment Bay of Plenty and Greg Jenks in particular, for assistance in setting up the fertiliser trial. The financial members of the Network voted on the research priorities in July, and an operational-scale fertiliser trial was third equal on that priority list. In the initial budgeting undertaken by the coordinating committee in August, it was anticipated that the Network would have a budget of $30,000 and so could only fund the top two priorities in the current year. When it later became clear that the budget was in fact $36,000 and that Environment BoP had received a substantial gift of urea fertiliser from Petrochem, Forest Research staff decided that it was appropriate to spend the additional $6,000 on establishing a fertiliser trial along the Bay of Plenty coastline.

Both these research projects are complemented by the proposed research programme submitted to the Foundation for Research, Science and Technology (FRST) in November, 1997. The sand dune revegetation programme joined forces this time with related programmes from HortResearch and AgResearch, to strengthen our case to the Foundation. The research proposed for sand dune revegetation includes mapping the ratio of male:female spinifex plants at three or more sites to ascertain if there is a relationship between this ratio and the production of formed seeds in the seed heads. The effect of nitrogen fertiliser on the proportion of formed seed is also included in the programme. Assessment of the fertiliser trial established by the Network will be ongoing under the FRST programme and will include analysis of the nitrogen concentration in the soils and above ground biomass, as well as measurements of plant size and vigour, and plot coverage by the sand binders.

The programme also aims to start to gain a deeper understanding of some aspects of the complex interactions of plants in the sand dune community and with the physical environment. This will involve whole plant harvests of both indigenous and nitrogen-fixing species to determine the allocation of plant resources to above and below ground biomass components. In addition to this, there is work planned to determine successful strategies for replanting marram-dominated backdune sites with indigenous communities, on the Canterbury coast, and to study succession in other indigenous communities. In the longer term, the programme will quantify some of the changes in physical factors (soil temperature and moisture levels, extent of sand movement etc) that occur with different types of vegetation cover.

As part of the bidding process, the programme was submitted to seven independent referees for evaluation and most were very positive about the proposed work. It was very gratifying for two of the referees to specifically mention the importance of the role of the Coastal Dune Vegetation Network in the programme, particularly in technology transfer. So we have already seen some success with one of the stated objectives of the Network - providing leverage to attract FRST funding. We have requested $150,000 of funding annually for four years, but it will be early April before we learn how successful we have been in securing that funding. We will let you know in the June newsletter.

For myself and for the other researchers involved in both the Network programme and the FRST programme, there is a great deal of satisfaction to be gained by being involved in the two research programmes that complement each other so well. I hope that you will agree that there are real benefits to be gained by maintaining the interaction between the two programmes. I look forward to what is in store for the Network in the coming year and I am confidant that the Network will continue to go from strength to strength.

COASTAL DUNE VEGETATION NETWORK

FINANCIAL STATEMENT 1 JULY 1997 - 1 MARCH 1998

Revenue

12 annual subscriptions at $3000 each	**$36,000.00**

Budget	$
1) Administration	15,000.00
2) Spinifex research project	10,000.00
3) Technical bulletin production	5,000.00
4) Fertiliser trial	6,000.00
Total	**$36,000.00**

Expenditure		$
1) Administration		
- Personnel	6,111.00	
- Mailout costs (including newsletter)	500.00	
- Meeting costs	1,500.00	8,111.00
2) Spinifex		
- Personnel	6,857.00	
- Operating	200.00	7,057.00
3) Technical bulletin		
- Publication costs	0.00	0.00
4) Fertiliser trial		
- Personnel	5,355.00	
- Operating	300.00	5,655.00
Total		**$20,823.00**

MEETING PARTICIPANTS

Libby Boak Harvey Brookes Erika Kuschel Andy Spence Jo Morriss	**Auckland Regional Council** Private Bag 68-912 Newton Auckland
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Jo Spence	**University of Otago**
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Diane Patrick	**Waitakere City Council** Private Bag 93-109 Waitakere City
Philippa Hooper	**Wellington City Council** Berhampore Nursery Emerson St Berhampore Wellington

RELATED PUBLICATIONS

Over the past year, the following publications have been produced from the Forest Research Sand Dune Revegetation Programme:

Bergin, D.O., Fitzsimmons, P., Freeman, C., Herbert, J.W., Kesby, N.A. 1997:
Management of marram grass in the restoration of indigenous coastal dune vegetation in Australia and New Zealand.
Proceedings of the Combined Australasian Coastal Engineering and Ports Conference (Pacific Coasts and Ports '97), Christchurch, September, 1997. Vol 1: 431-436

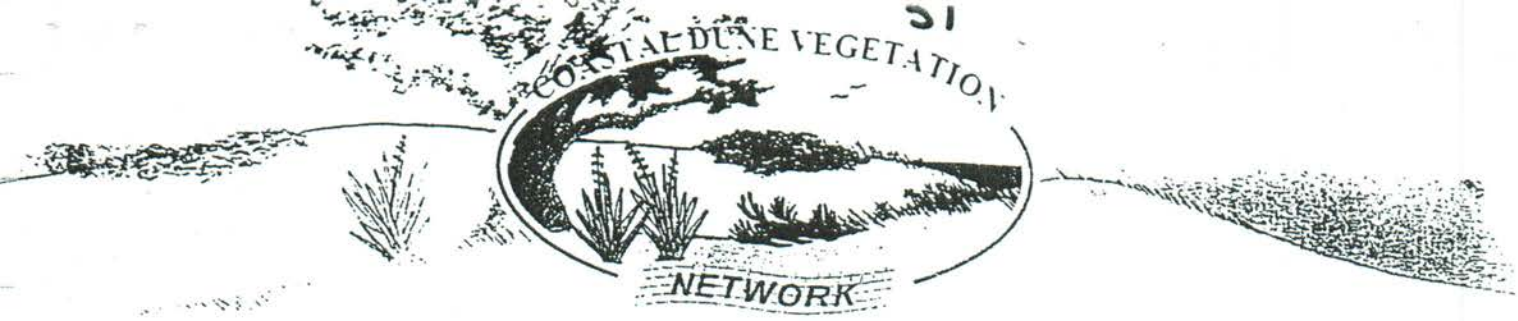
Bergin, D.O., Herbert, J.W. 1997:
Revegetation of sand dunes in New Zealand using indigenous species.
Proceedings of the Combined Australasian Coastal Engineering and Ports Conference (Pacific Coasts and Ports '97), Christchurch, September, 1997. Vol 1: 425-430

Bergin, D.O., Herbert, J.W., Kimberley, M.O. 1997:
Rehabilitation of coastal sand dunes using indigenous sand binding species.
Paper submitted to Department of Conservation *Science for Conservation* series. 22 p

Ede, F.J., Gadgil, R.L., Douglas, G.B., Lowe, A.T., Smith, C.T. 1997:
Stabilising sand dunes by revegetation: The role of nitrogen-fixing plants.
Proceedings of the Combined Australasian Coastal Engineering and Ports Conference (Pacific Coasts and Ports '97), Christchurch, September, 1997. Vol 1: 437-442

Gadgil, R.L., Ede, F.J. 1998:
Application of scientific principles to sand dune management in New Zealand - Past progress and future needs.
Land Degradation and Development - in press.

Wanjiku, J., Mead, D.J., Goh, K.M., Gadgil, R.L. 1998:
Biological nitrogen fixation by three legumes in a coastal sand dune forest, estimated by an isotope dilution technique.
New Zealand Journal of Forestry Science 27 (1): 39-50



No 1, December 1997

INTRODUCTION

Welcome to the Coastal Dune Vegetation Network. The Network was officially launched on 1 July, 1997 with 12 financial members and several collaborators. A list of all members is included with this first newsletter. The objectives of the network are to consult with coastal resource managers and interest groups to prioritise research needs on restoration of sand dunes; to provide and attract funding for research; and to provide quality, timely, research-based information to CDVN members through field trips, meetings, and a series of technical bulletins.

A co-ordinating committee made up of representatives of members and of FRI has met twice since the inaugaral meeting of interested parties in March. This committee has drawn up a constitution and contract for members, which you should have received in addition to minutes from our meetings. The committee has also decided on the allocation of Network funds, based on the voting process undertaken by financial members. Funds have been provided for seeding trials with spinifex; the publication of a pamphlet about dune geomorphology; and the establishment of fertiliser trials. Further information about these projects can be found elsewhere in the newsletter.

We want this newsletter to provide a forum for the exchange of ideas and information among all Network members, so we welcome any contributions people wish to make. If you have any queries or suggestions about the Network, then please don't hestitate to contact either me, or the Network secretary, Greg Steward. I look forward to working with you all towards finding solutions for sustainable dune management.

Dr Fiona Ede, Manager, CDVN

The CDVN: a perspective from an industry member, Ernslaw One Ltd

Ernslaw One Ltd is a forestry company managing 29 km of coastal sand dunes, just south of Wanganui. This zone is essential for sheltering Santoft and Tangimoana forests that contain 4,700 hectares of commercial *Pinus radiata*.

One of the major problems facing management is sand dune 'blow-outs'. Current practice is to use heavy machinery to fill in the holes created by the blow-outs and then to reform the dune. The site is then planted with marram grass from a near-by marram nursery. Parts of the sand dune system are also fertilised during an annual programme.

A problem associated with marram grass is senescence. As a consequence Ernslaw One is particularly interested in the CDVN project that studies the phenology, seeding and nursery propagation of spinifex. Spinifex is a better sand binder than marram on the seaward face of the foredune, but at present seedlings cannot be raised in large numbers at low cost. If the project can refine techniques to help develop a cost-effective seedling resource, our company could then replant the sand dune blow-outs with spinifex, which would encourage a more gently sloping, and therefore more stable foredune. This would lower the chance of blow-outs recurring.

Also of interest are the operational fertiliser trials and the management of marram-dominated sites.

The CDVN is also a great mechanism for sharing information and ideas. It is developing an open and informative culture, and Ernslaw One looks forward to being a part of it.

AGM

Mark it in your diaries now!! The first AGM of the CDVN will be held at the Papamoa Surf Club on 12 and 13 March, 1998. Day 1 will involve a field trip looking at programmes under way along the Bay of Plenty Coast, while Day 2 will include technical and business sessions. We'll send more information to all interested in attending in the New Year.

NEW ZEALAND
FOREST RESEARCH INSTITUTE
LIMITED

CDVN Manager: Dr Fiona Ede
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ROTORUA

CDVN-Funded Research Projects — Progress to date

Three projects that were prioritised by financial members have been initiated by FRI and CDVN collaborators.

Spinifex seeding trial

A pilot trial has been set up to determine cost-effective methods of propagating spinifex from seed, in conjunction with Naturally Native New Zealand Plants Ltd., of Tauranga. The trial is situated in the propagating house of the nursery and they have supplied materials and labour for both trial installation and trial monitoring over the next few months. The Network is very grateful to Naturally Native for their very generous assistance with this project.

The seed used in the trial was collected from four Coromandel beaches during the summer of 1997. Nine sowing treatments were tested, ranging from sowing whole seed heads, to sowing individual spikelets in different containers, to sowing naked seed. After three weeks, some of the naked seed had germinated, but there was no evidence of germination in any of the other treatments. Anne Fair and her team at Naturally Native are monitoring germination and early growth and a larger scale trial will be installed next autumn, using seed collected in February 1998.

Dune morphology technical bulletin

To complement a series of comprehensive technical bulletins on guidelines for using the key indigenous sand binders already under way at FRI, a bulletin on the form and function of dune systems was given high priority by CDVN members. A draft has already been produced by Libby Boak (Auckland Regional Council), and ideas for the content and further input into the bulletin have been discussed with Jim Dahm (Environment Waikato). Dr Patrick Hesp (Massey University), who has considerable experience with dune morphology and has widely published in this area, will also collaborate in the production, which will be funded by CDVN.

Fertiliser trials on dunes

A further research project that was identified by the CDVN as a priority was operational-scale fertiliser trials on existing degraded foredune vegetation. This technique of broadcasting fast-release, high-nitrogen fertilisers to improve vegetation cover on foredunes, particularly where spinifex is dominant, is a proven method used on an operational scale in many parts of Australia. FRI trials on two Coromandel beaches have indicated that foredune vegetation responds positively to applications of fertiliser, and this work needs to be expanded to testing the preferred options for timing and rates of application as part of a large-scale fertiliser operation.

In collaboration with Greg Jenks, Coast Care Co-ordinator for the Bay of Plenty, and fertiliser supplied by Petrochem, a subsidiary company of Bay of Plenty Fertiliser, a fertiliser trial was established at four sites along the Mount Maunganui-Papamoa coast in October 1997. Each of the four trial sites is 100 m long by 10 m wide, running along the foredune just above Mean High Water Springs. Plots 10 x 10 m have been treated with different rates of urea fertiliser ranging from 100 kg to 800 kg nitrogen per hectare. Some plots were treated with a full quantity of fertiliser while others received only half quantity. The second half will be applied in late summer. There were also unfertilised control plots.

Sites will be monitored over the next 2 years to determine the optimum rate and timing of fertiliser application. Monitoring techniques will include sampling of vegetation cover and aerial photography.

FRST Bid

The FRI Sand Dune Revegetation Programme funded by the Foundation for Science, Research and Technology (FRST) was rebid this year, with applications for funding closing on 3 November, 1997. The programme is funded under the "Conservation Plants" topic in the Horticulture output and it was decided that collaboration with similar programmes from HortResearch and AgResearch would enhance the possibility of a successful outcome for our research programme. We have asked for increased funding, but won't know the result until April. The work programme that we outlined in the bid complements some of the work partially funded by the CDVN, and includes mapping spinifex plants for male:female ratios to determine if there is an effect on the subsequent production of viable seed; ongoing assessment of factors which enhance establishment and growth of native species on the foredune and backdune; effect of N fertiliser on pingao and spinifex growth; and techniques for modifying marram-dominated sites. It is hoped that the funding we receive from FRST will allow us to undertake research of direct relevance to Network members.