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COASTAL DUNE VEGETATION NETWORK
ANNUAL GENERAL MEETING
CHRISTCHURCH
29 - 31 MARCH 2000

compiled by
G.A. Steward, F.J. Ede

Head Office
581.5265 COA

SUPPORTING ORGANISATIONS

The Coastal Dune Vegetation Network would like to acknowledge and thank the following organisations who have supported the Coastal Dune Vegetation Network Annual General Meeting

Department of Conservation
Te Papa Atawhai

CANTERBURY REGIONAL COUNCIL

coast·care
CHRISTCHURCH CITY COUNCIL PARKS UNIT

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MISSION STATEMENT

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.

NETWORK OBJECTIVES

The objectives of the Network are:

1. **To provide direct funding support, from Financial Members, for prioritised research projects.**
2. **To provide leverage through Members contributions to attract Public Good Science Funds and optimise returns to the Coastal Dune Vegetation Network.**
3. **To respond to coastal resource managers and user-sourced research priorities through a process of mutual prioritisation in consultation with collaborators.**
4. **To provide high quality, timely, research-based information and management outcomes to Coastal Dune Vegetation Network membership through field trips, meetings, workshops, and by other appropriate means.**

AGENDA

Venue: New Brighton Working Mens Club, Christchurch

Wednesday 29 March
Technical Session 1

9.00	Registration and set up of displays
10.00	Formal welcome
	Introduction to Canterbury coastline
11.00	CDVN Project Reports – Spinifex; fertiliser; revegetating difficult sites trials

Field Trip 1*(lunch provided on bus)*

12.30	North Canterbury beaches: Ashworths and Leithfield - Access conflict, including 4WD disturbance of dunes. - Land management issues – DoC/Regional Council/Local authorities. - Solutions - plantings, Coast Care community groups, regulation.
5.00	Return to Working Mens Club

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7.30 - 9.00	Optional Fieldtrip: Twilight 4WD beach tour from South Shore to Waimakariri River Mouth (for first 25 people who register and indicate interest). Weather dependent.

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AGENDA

Thursday 30th March
Technical Session 2

8.30	Future of CDVN; Research priorities
10.30	Morning tea

Field Trip 2

11.00 Christchurch beaches: Walk along New Brighton and North Beach

- Foredune management
- Sand fences
- Monitoring of dunes and planting
- 1990's Backdune planting

12.30 Lunch

Business Session

1.30 CDVN Business

Technical Session 3

2.30 – 5.00 Open workshop - Updates on coastal vegetation projects and South Island news, issues and initiatives. An opportunity to exchange ideas, problems and solutions.

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7.00pm Dinner at "On the Beach" Restaurant, Sumner (transport supplied)

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AGENDA

Friday 31 March
Field Trip 3

9.00 – 4.00	Kaitorete Spit: New Zealand's number one sand dune ecosystem. DoC and plant ecologists will help us explore the largest remaining indigenous dune ecosystem in New Zealand.
	Motukurara Nursery: DoC nursery specialises in growing plants for restoration projects around the South Island.

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Field Trips Notes

FIELD TRIP 1 – Wednesday 29th March, 12.30 p.m.

PEGASUS BAY BEACHES

Overview

Pegasus Bay stretches for 50 km and is located in the lee of Banks Peninsula. Due to the sheltering effect of the peninsula, Pegasus Bay is largely protected from southerly storm waves, and hence it has been a depositional environmental in recent geological time. Since the maximum Holocene sea levels of approximately 6000 years before present, the shoreline has advanced seaward by 8 km in Christchurch (from approximately where Cathedral Square is located) and by 1 km at its northern end. During our outward trip towards Waikuku Beach we will travel through relic dune fields and coastal lagoons.

Shoreline movements over the past 140 years have been calculated by the Canterbury Regional Council to be in the order of 0.3 m/yr to 1.1 m/yr, with the maximum advance occurring in the middle of the bay adjacent to the Waimakariri River. This river is the dominant source of sediment to the bay, contributing an estimated 400,000 m^3/yr of sand to the coastal sediment budget. Although the Waimakariri is a major gravel-bearing river, this coarse material does not find its way to the coast. The sand material from the Waimakariri River is transported in both directions away from the river mouth. The southern 40 km of the bay is characterised by sandy beaches, however there is a distinctive change to mixed sand and gravel beach ridges in the northern-most 10 km.

Regional Coastal Environment Plan

When initial decisions were being made about the form of the Regional Coastal Plan for the Canterbury Region it was felt that an integrated approach should be adopted to the issue of coastal erosion. Most Regional Coastal Plans prepared in New Zealand only deal with issues seaward of Mean High Water Mark Springs (The Coastal Marine Area). However, in the interests of integration it was decided to prepare a Regional Coastal Environment Plan incorporating a region wide approach to coastal erosion issues. As a consequence, the Regional Coastal Environment Plan contains Rules controlling activities within areas considered to be at risk from coastal erosion in the period 0-50 years and 50-100 years. As might be expected, this includes most active beach systems and most of the "soft coast" of the Region. This gives the Canterbury Regional Council an active interest in the maintenance of "natural" defence systems such as dunes and in attempts by groups to remove these or "manage" them.

Waikuku Beach/Ashley River Mouth

During the Holocene (the last 10,000 years), the position of the Ashley River mouth has varied between 8 km south and 6.5 km north of Waikuku. Historically, northward river mouth migration is documented as being a recurring process. Migration rates exceed 200 m per year. The principal cause of migration is the erosion of the true left (north) bank of the river, at the mouth, as the Ashley River-Saltwater

Creek estuary drains during the ebb tide, and the subsequent transportation of sediment north by longshore drift.

In 1993 a 1500 m^3sec^{-1} flood in the Ashley River caused a major breach of Ashworths Spit with a realignment of the river mouth to a position 1000m north of the Waikuku Beach surf club. A result of this northward mouth migration was an increased potential for the sand spit being breached at a low point adjacent to the Waikuku Beach settlement. In September 1993 a series of nylon sand fences were constructed to trap wind blown sand at this low point in attempt to raise the height of the beach and mitigate any potential flood effects.

The fences consist of two sets of three rows, 13 to 18 metres apart in an arrowhead formation. Fences on the southern side run SW-NE and on the northern side run SE-NW. Topographic surveys of the sand fences were carried out in:

- **September 1993 (7 days after construction)**
- **December 1993 (3 months after construction)**
- **January 1994 (4 months after construction)**
- **November 1995 (14 months after construction), and**
- **November 1997 (4 years and 2 months after construction).**

From the initial survey (September 1993), to the most recent (November 1997) sand volumes within the common boundary (3890 m^2) increased by 1057.2 m^3. This is equivalent to an 11.3% increase from the pre-fence

volume calculation. The most significant accumulation rates were experienced within the first 12 months, with 60% of the total accumulation occurring within the first four months at a rate of 156.6 m^3 per month.

The mean height of the beach within the sand fences has grown from 2.44 m in 1993 to 3.0 m above mean sea level in 1997. This is an average increase of 0.56 m. Maximum height is along fence 3 where sand levels are 4.77 m above mean sea level. This is an increase in height of 2.3 m from when the fence was first installed. Sand heights along the most seaward fences are around the 4 m mark. These seaward fences have trapped sand blown from the dominant easterly direction while fence 3 has trapped wind blown sand from the northwest. Although not perpendicular to the predominant winds, sand levels are higher along fence 3 due to the natural establishment of sand binding vegetation (marram) which has enabled further sand accumulation above the level of the fence.

The Waikuku sand fences are now considered to be at capacity. Without vegetation or lifting of the fences it is unlikely that sand volumes and heights will increase from present levels. Beach levels at the Waikuku sand fences are still significantly lower than the surrounding dunes. There still exists a possibility of a breach in the beach if the river should avulse.

Access to the Coastal Marine area – Pegasus Bay

Canterbury Regional Council's Regional Policy Statement (RPS) addresses the need for identifying areas within the coastal environment where access to the coastal area should be controlled to protect areas of value, public safety, and from coastal erosion. On the other hand access should be enhanced to provide for recreational opportunities and Tangata Whenua values while avoiding conflict with land owners.

In the 1998-1999 financial year Waimakariri and Hurunui districts were the focus of a monitoring programme to determine where current access is not meeting RPS requirements. There is significant pressure on the coastal area in these districts leading to sand dune degradation. Proximity to Christchurch City, and restrictions on activities on the city beaches, has led to increasing pressure on the soft sand beaches to the north. Degradation of the beaches, primarily the dune systems, is thought to be associated with an increase in use of four-wheel drive vehicles for recreation.

Meetings have been held with four-wheel drive, fisher, motorbike, and windsurfer clubs. Horse trainers who use the beach were also contacted. Additional meetings were held with the beach communities at Leithfield and Amberley. The response to the meeting held at Leithfield was extremely good with 80 people attending. District and Regional staff members, along with Councillors of both organisations, facilitated discussion of the issues, and also worked with groups to identify what is working and what is not.

One of the overriding concerns community participants identify, is increased usage of four-wheel drive vehicles and motorbikes on the beach. This appears to be correlated to a general increase in ownership of these vehicles. This has been a common theme among community members and is the crux of related concerns such as;

- **Damage to marram habitat and subsequent effects on birdlife**
- **Safety on the beach related to vehicle speed**
- **Erosion of the dunes**
- **Fire risk**
- **Depletion of sea food**
- **Increased risk of inundation associated with dune erosion**

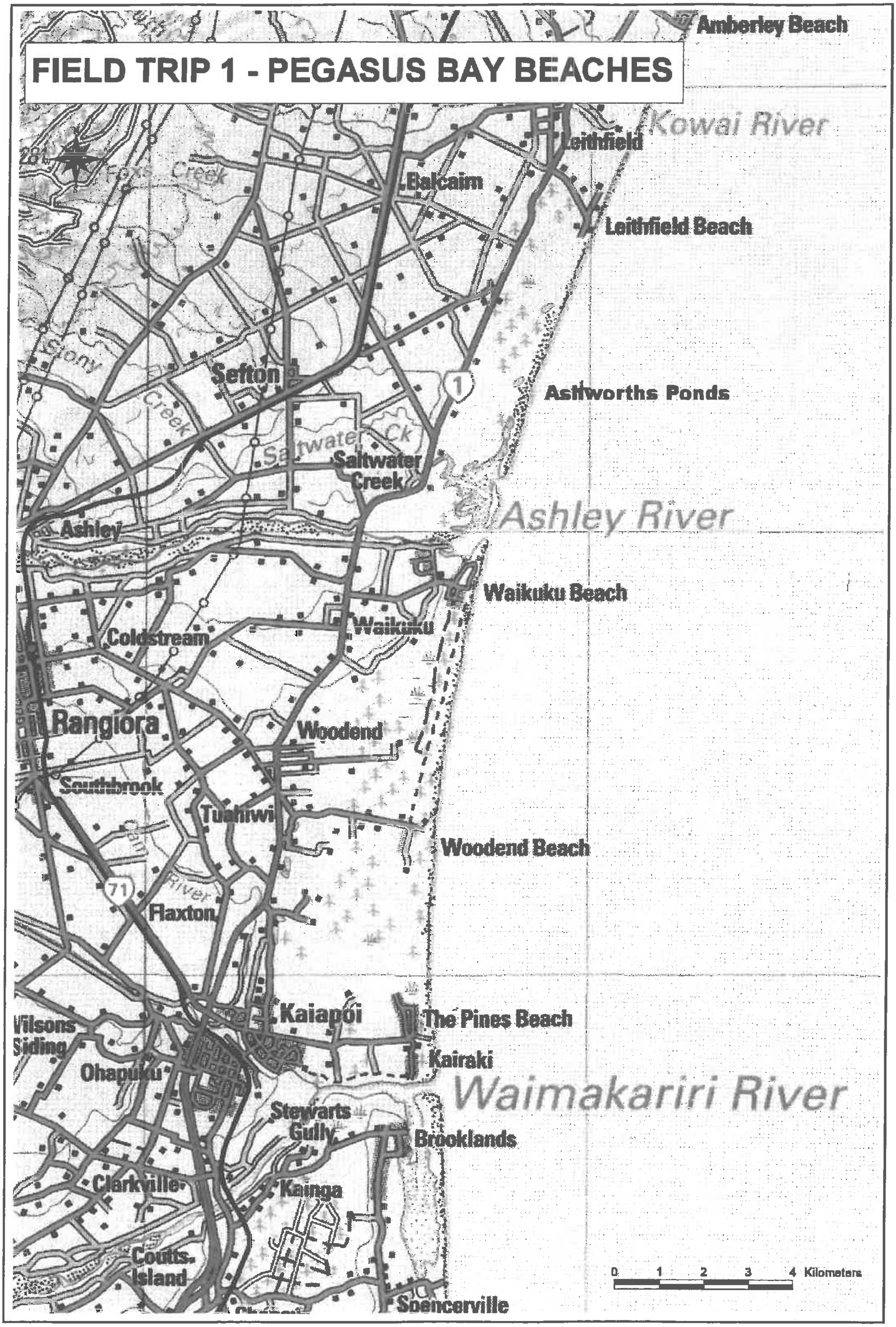
The outcome of discussions on continued pressure in the coastal area north of Christchurch is the formation of two coast care groups and the development of a Pegasus Bay Coast Care concept. The public face of the Pegasus Bay Coast Care concept is a series of pamphlets and a format for signage that all parties have agreed to use throughout Pegasus Bay. There is an informal agreement between staff involved with coastal activity in the Waimakariri, Hurunui, Christchurch and Regional Councils and the Department of Conservation to support this and the efforts of the groups.

To date, group activities have mostly been focussed around the development of plans for beach access. These are then presented back

to the wider community for comment. The Leithfield /Ashworths Beach Coastcare Group has also installed 2 gates, although these are not closed, and is currently forming an Incorporated Society.

It is widely accepted that a unified approach to the Pegasus Bay area is the only way that access problems can be resolved. At a meeting held in late February between representatives from off-road vehicle clubs and community, agreement was reached as to the problems and issues, and possible solutions will be discussed further at a follow-up meeting in March.

FIELD TRIP 1 - PEGASUS BAY BEACHES



FIELD TRIP 2 – Thursday 30th March, 11.00 a.m.

NEW BRIGHTON AND NORTH BEACH

Overview

Christchurch beaches are characterised by a relatively high, partially vegetated foredune and an undulating 50-120 m wide backdune strip dominated by dense marram grass (*Ammophila arenaria*). Roading and residential development lie behind the backdune. In places, carparks and Surf Club buildings intrude onto the foredune. The 8 m high foredune has a steep seaward slope often devoid of vegetation except at the crests. It is directly exposed to the prevailing easterly winds. Blowouts originating on the seaward-face are the source of large volumes of sand, which are blown inland at intervals and can reach the road and other developed areas. The stable backdune has a continuous cover of tall marram grass with widely scattered exotic shrubs and trees.

Problems of dune instability have stemmed from the historical use of the dune system and settlement patterns behind it. The dunes are physically constrained by the close proximity of roads and by residential development landward of the dunes. Further north, the dunes are not constrained and have developed into a more complete system consisting of a series of secondary ridges and hollows spread further inland. The impact of early European settlers with the introduction of fire and grazing has greatly contributed to the loss of the native pingao and spinifex cover that once stabilised these dunes.

The main method by which early settlers sought to rectify the problems of dune destabilisation was by planting marram. Marram has been planted along the North Beach dunes since the 1870s and has now almost completely replaced pingao. One of the main results of planting marram has been the creation of higher, steeper and more irregular dunes than those usually formed by pingao. This means that the dunes currently at North Beach, for example, present a greater obstacle to the wind and suffer many blowouts.

Another of the major causes of blow-out development has been the concentration of pedestrian traffic on tracks through the dunes opposite the end of roads that lead to the beach. For many years, marram grass and introduced ice plant (*Carpobrotus edulis*) have been used in an effort to reduce erosion of the foredune. Both species are available locally at low cost, are easy to establish on a large scale, and grow vigorously on exposed sites.

Coast Care: An Enhancement Programme for the Coastline of Christchurch

Coast Care Christchurch is an ongoing programme of the Christchurch City Council's Parks Unit to protect and enhance the city's coastal environment. The programme developed out of the 1995 Christchurch Beaches and Coastal Parks Management Plan. Coast Care implements the policies of the plan, which aims to stabilise and protect the sand dunes, and generally enhance the coastal environment from the Waimakariri River mouth to the Lyttelton Harbour. The programme

makes extensive use of subsidised labour such as Task Force Green and Adult Community Employment schemes, as well as Conservation Corps and the Wai Ora Trust.

The main function of the programme, the stabilisation of damaged and eroding sand dunes is being achieved through several methods. Resource consents have been obtained from the Canterbury Regional Council to manage severe erosion using mechanical dune re-contouring and regrading methods. Presently full dune re-contouring to address severe "blowouts" is underway at sites from Bottle Lake through to South Brighton. For dune erosion that is less severe but still a potential problem, and unsuitable for planting or access development, dune frontslope regrading is implemented. Most of the coastline, however, will not need re-contouring or regrading to achieve stabilisation. This can be achieved more simply through the use of sand fences, formed pedestrian access tracks and intensive revegetation.

The Coast Care programme has as its first major objective the ecological restoration and protection of the coastal environment. This is being achieved through the revegetation of the dune frontslopes with sand binders, and the backslopes and dune slack areas with coastal native shrubs and trees. Frontslope planting involves the use of such native species as spinifex and pingao. For practical purposes, usually following dune re-contouring, the planting of the ice plant and marram is also used. Planting in the backslope and dune slack areas will continue along the whole coastline, with intensive initial watering, releasing and mulching required to ensure high planting success.

The second major objective of the programme is the enhancement of the recreational, scenic and amenity values of the coastline. This includes upgrading and defining formed access tracks through the dunes to the beach from the road, increased signage and educational information, improving car park, picnic and litter facilities. Wooden boardwalks are used to protect the dune while improving the ease of access for pedestrians.

The Southern Pegasus Bay Track is also being formed to enable walkers to pass along the sheltered dune backslopes area without walking on the road edge and also includes some dune crest sections to give views of the coastline. This will enable use by walkers and in some cases mountain bikers and horse riders. The track will tie in to the already extensive walkway system in Bottle Lake Forest Park.

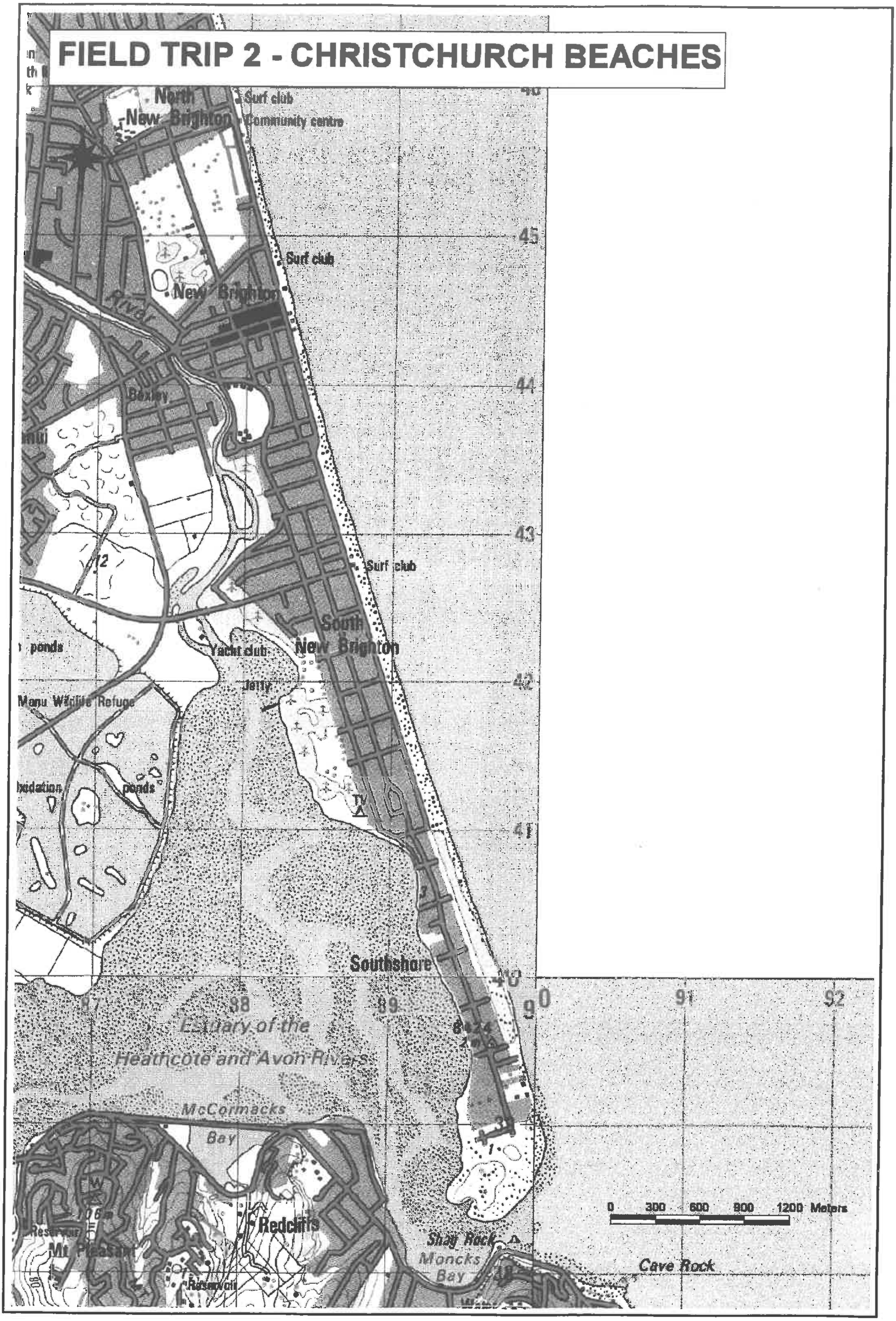
The third objective of the Coast Care Programme is to seek increasing community involvement and a sense of ownership of activities associated with coastal enhancement and protection. Community "Coast Care" groups have been formed for each Beach Park community. The groups differ in their involvement, some in practical activities such as dune planting and access formation through working bees, others prefer to be involved at the planning stage. All groups are consulted on annual work programmes. An "Adopt-a-Pingao" initiative is presently underway with local residents propagating the rare native sandbinder for later dune planting. This provides a great

forum for community interaction and it also gives people a real guardianship role for their Beach Park environment.

Monitoring of Dune Profiles and Vegetation Cover

In collaboration with the Canterbury Regional Council, a pilot vegetation monitoring system has been developed for application to the 45 transects located along the Christchurch coast. The system allows collection of data on long-term changes in vegetation composition in relation to sand movement on these dune systems. The role that marram grass has in sand movement on the Christchurch dunes is of particular interest.

FIELD TRIP 2 - CHRISTCHURCH BEACHES



FIELD TRIP 3 – Friday 31st March, 9.00 a.m.

KAITORETE SPIT

Overview (taken from Trevor Partridge's paper "Vegetation recovery following sand mining on coastal dunes at Kaitorete Spit, Canterbury, New Zealand")

Kaitorete Spit is a sand/gravel barrier complex that separates brackish Lake Ellesmere from the Pacific Ocean. The complex is only about 5,000-7,000 years old, and the product of rapid growth, as it is now 28 km long and up to 3.2 km wide at the eastern end. Continuous sand dunes occur on the seaward side at an average width of 220 m. An older, inactive, discontinuous series of sand dunes occurs a further 100 m inland. The eastern half of the spit's dunes has a stable to slowly accreting seaward margin, while the western half is eroding under wave attack, and a number of parabolic dune blowouts have occurred. Inland of the dunes is dry grassland dominated by introduced species and especially the grass *Stipa nodosa*. The whole dune system is subjected to frequent winds from both the south (moist, cool, especially in winter) and northwest (dry, warm, mostly in summer). Moderate rainfall coupled with the coarse base material, makes the area very drought-prone.

Sand-mining has taken place in a confined area of the central section of the dunes and to the east of Kaitorete Scientific Reserve, beginning on a small scale in 1952. Records were started in 1964 with the granting of the first licence, and at that time some 6,000 m^3 were removed per

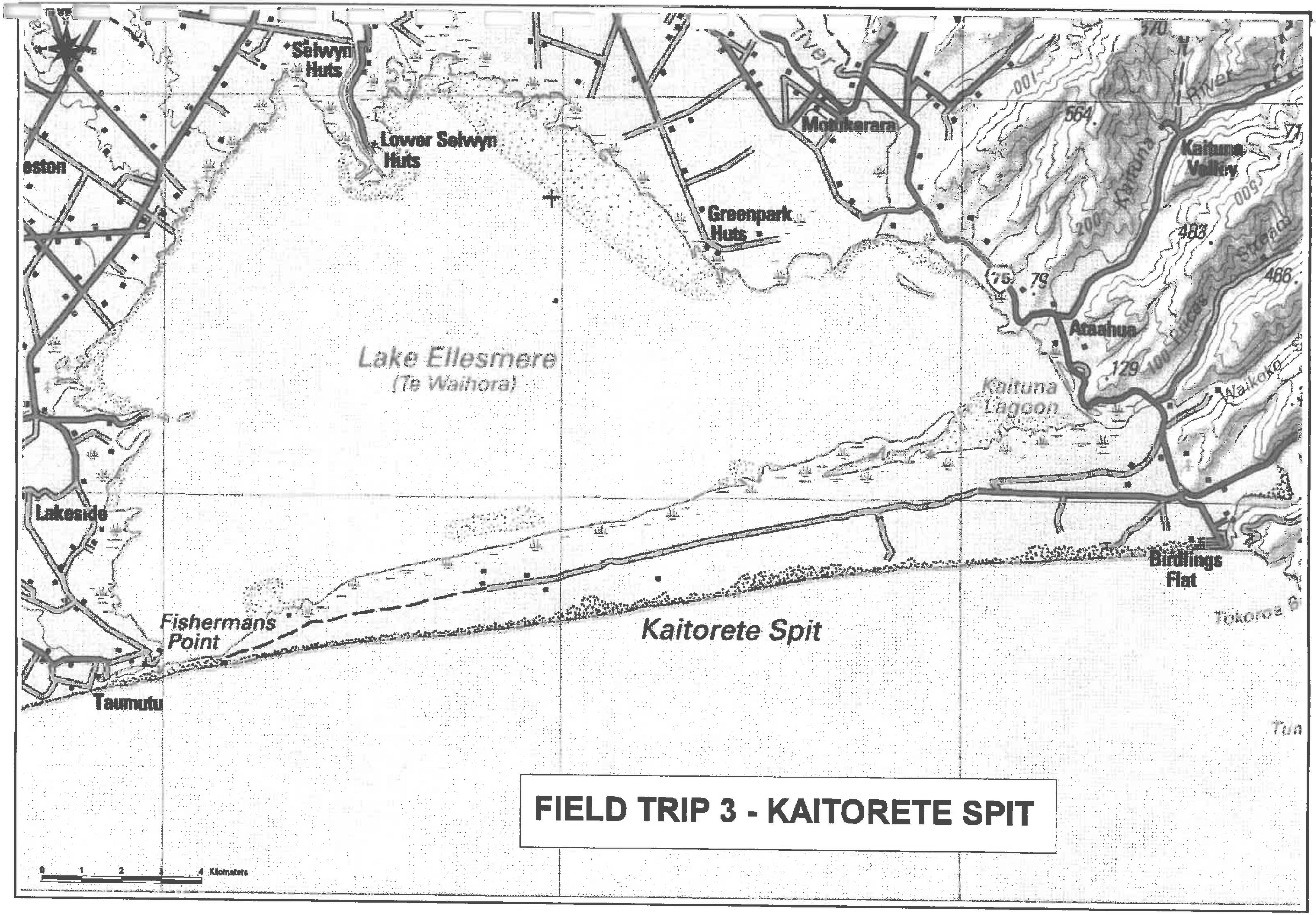
annum. Removal of sand peaked in 1974 when 33,000 m^3 were extracted. Restrictions on amounts and areas available considerably reduced the extraction of sand in the 1980s. The total length of dunes mined by 1990 was approximately 1,300 m. Sand has been mostly removed from the central section, but at the peak extended from close to the front dune almost to the grass flats.

The dunes are important for conservation values, being one of the few remaining systems in New Zealand where the indigenous sand-binding sedge, pingao (*Desmoschoenus spiralis*), still dominates. This species has declined considerably, initially through destruction of the indigenous dune cover by burning and grazing that accompanied the arrival of Europeans in New Zealand 150 years ago. Most dune systems were subsequently stabilised by extensive planting of the introduced sand binder marram *Ammophila arenaria*, a species that has further displaced much of the remaining pingao where the two come into competition. Kaitorete Spit therefore rates as one of New Zealand's most botanically valuable dune systems.

<u>Field Trip Activities</u>

During the field trip we will visit the scientific reserve and view the unique plant assemblages that occur on this dune system. Landcare scientist Dr Trevor Partridge and DoC staff will be present to highlight the conservation importance of this area, such as endemic and/or nationally threatened species. We will visit an old sand mine site and

discuss the ecological problems associated with human activities on the Spit. We will also look at various management initiatives being undertaken to restore and maintain this important indigenous dune ecosystem.


Selwyn Huts
Lower Selwyn Huts
Motukarara
Greenpark Huts
River
Kaituna
Kaituna Valley
River
Lake Ellesmere
(Te Waihora)
Kaituna Lagoon
Ataahua
Lakeside
Fishermans Point
Taumutu
Kaitorete Spit
Birdlings Flat
Tokoroa
FIELD TRIP 3 - KAITORETE SPIT
0 1 2 3 4 Kilometers

Notes for Field Excursion to Kaitorete Barrier

Trevor Partridge - Landcare Research

Kaitorete Barrier is Canterbury's only duneland system with values that make it a national priority. On the trip we will be seeing many of those values, as well as examining some of the threats they are under. This will involve us walking through the Kaitorete Scientific Reserve from the eastern end to the western, and if time permits there may be the opportunity to see some low gravel/sand dunes at Birdlings Flat.

The trip will commence where the area that has been mined for sand meets the reserve. We will be able to clearly see the impacts of the mining on dune structure and vegetation, as well as the failure of many species to re-establish. The spraying of marram and its original impact will be seen both here and at the start of the reserve. We will see how pingao has been displaced, and how little has re-invaded after marram spraying. Plantings of pingao have been undertaken here, and we will see the role of sand movement in their success and failure.

From atop the dunes we will be able to clearly see the dune structure. Of special interest will be deflation dunes, and their effect on the older dune ridge inland that is in decline. The changing composition of the dune flora on different dune structural elements will be examined along with the distinctive dune hollow vegetation and the remarkable structure of the grass *Zoysia*.

By proceeding westwards through the reserve we will be able to see many other interesting structural, cultural and vegetational features. We will see strangely-shaped erosion dunes, capped with heads of *Muehlenbeckia complexa*. We will find many of the rarer species such as *Craspedia* and *Austrofestuca*. We will see the bizarre occurrence of ngaio and akeake. The role of tree lupin and its disease will also become clear. Finally we should be able to see the plants behind the dunes, especially the threatened *Muehlenbeckia astonii*.

If we are able there will be a brief stop at the reserve at the eastern end of the barrier. There we will see low dunes of different structure, quite different vegetation patterns, and some new species such as *Muehlenbeckia ephedroides*. We will also be able to visit the remarkable shrub and grass vegetation of the old beach ridges that make up Kaitorete at this end.

Wednesday 29 March

COASTAL DUNE VEGETATION NETWORK

AGENDA

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- Access conflict, including 4WD disturbance of dunes.
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- Solutions - plantings, Coast Care community groups, regulation.

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7.30 - 9.00 Optional Fieldtrip: Twilight 4WD beach tour from South Shore to Waimakariri River Mouth (for first 25 people who register and indicate interest). Weather dependent.

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- In general, the correlation analysis indicates that both number and distance of male plants are implicated in seed formation. Various ways of combining these effects were tested, with the highest correlation achieved when both the number and the distance of male plants were combined in a single index, $SSD = \sum 1/\sqrt{maledist + 1}$. When SSD is high, the female plants will generally be surrounded by several nearby males. When the index is low, there will be few, if any neighbouring males. Plants with higher SSD values produced a higher proportion of formed seed than those with a lower value (Table 4).

- The size of the female colony is negatively correlated with the proportion of formed seed in seedheads, with increasing colony size producing seedheads with fewer formed seeds. This is likely to be due to the exclusion of male plants in the local area.

- A multiple regression analysis determined, however, that once SSD is taken into account, all other factors (eg, number of male colonies, distance to closest male, size of female colony) are no longer significant.

- Only one factor, the width of the female colony zone, was significantly correlated with seed germination. This may be because of the wider spinifex zone at Tairua (more than 100 m in some places) and the result that seed from Tairua had a significantly higher germination rate.

Table 3: Correlations between proportion of formed seed in seedheads, rate of germination of seed and spinifex stand/site factors.

Factor	Correlation coefficient+	
	Formed seed (%)	Germination (%)
Female colony size	-0.36*	0.11
Zone width	0.01	0.33*
Height	-0.10	0.14
Distance to sea	0.13	0.05
Female vigour	0.18	0.16
Distance to closest male	-0.44**	0.13
Number of males	0.46**	-0.27
SSD (male distance/size index)	0.56**	-0.15
Male colony size[a]	-0.04	0.34
Mean male vigour	0.15	0.22

+ Spearman rank correlation coefficient. Zero indicates no correlation, high values (positive or negative) indicate a strong correlation.
* Significant at p = 0.05
** Significant at p = 0.01
[a] Only measured at Papamoa beach

Table 4: Effect of number of male spinifex plants and distance to females on proportion of formed seed in seedheads using the SSD divided into 3 classes.

SSD class	No. plants	Mean proportion of formed seed (%)	Standard error
<1	13	19.9	3.1
1-2	24	25.5	1.6
>2	8	44.6	4.2

Direction of male plants

- The direction of each male plant was noted in 45° steps from seaward. The most seaward point was set at 0° with the landward direction at 180°.

- For each female plant, SSD, the index relating to number of male plants and distance of those plants from the female was summed within each 45° step. A multiple regression was used to predict seed formation from the resulting eight SSD variables. The coefficients for this regression (+/- standard errors) are shown in Figure 1.

- All coefficients are positive, indicating that male plants from any direction have some positive effect on the number of formed seed found in seedheads. However, a peak is apparent at 135°, indicating that male plants on the landward side of the female colony had twice the effect on seed formation as those in other directions.

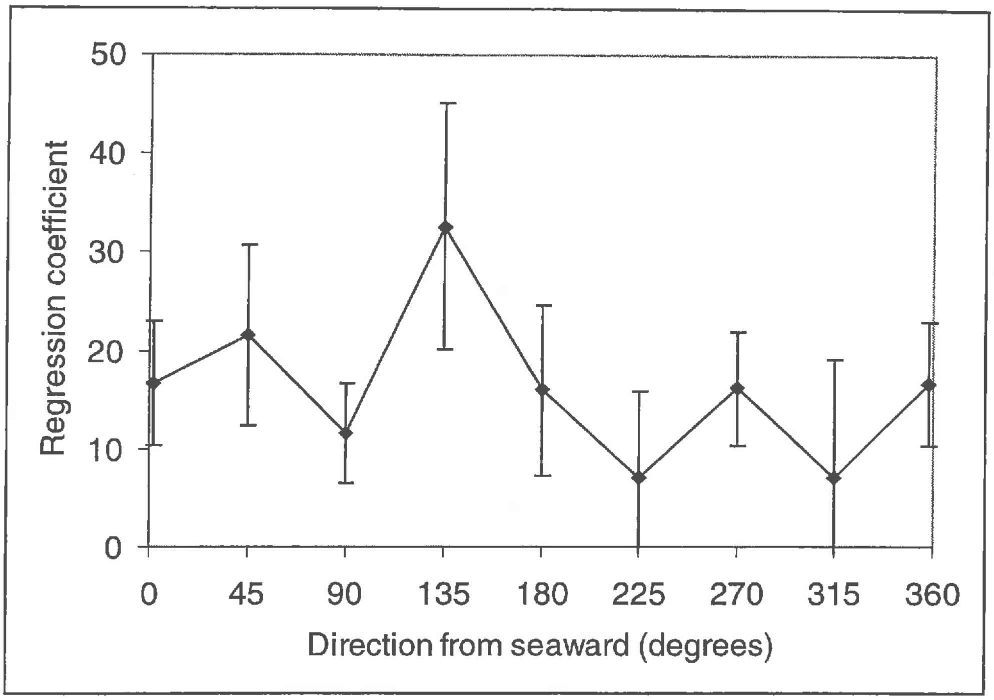

Figure 1: Effect of location of male plants in relation to females on the dune fitted to regression coefficients for proportion of formed seed in seedheads.

CONCLUSIONS

- The proportion of formed seed in seedheads were similar at all three beaches investigated.
- This survey confirms studies in Australia that fertilising of dunes does not increase proportion of formed seed. The Australian studies indicated that although seedhead production is increased with application of fast-release fertiliser, there is no increase in the proportion of formed seed (McKenzie *et al.* 1989).
- The proportion of formed seed in seedheads increases where female colonies are in close proximity (within 3 m) to several male colonies. The proportion of formed seed increases from 20% in females isolated from males to 45% in females in close proximity to males.
- Large female colonies have significantly lower seed formation probably due to the exclusion of male plants in the local area.
- The location of male and female plants in relation to prevailing wind patterns during time of pollination in October may influence the proportion of viable seed.

- Germination of formed seed averaged 60%, which is similar to results found in other studies (e.g. Bergin 1999). This also confirms that the method of pressing seed between thumb and forefinger for sorting formed seed is consistent between collection sites and that on average, six out of 10 seeds will germinate. Germination rates were not strongly affected by any site or spinifex stand characteristic.

FUTURE RESEARCH

- Comparison of seedheads collected from several female colonies in close proximity to males with seedheads collected from a number of female colonies isolated from males could help validate the results of this study.

- Interplanting male spinifex plants, raised from cuttings or grown on in the nursery, amongst female-dominated areas of dunes should be investigated as a method of improving the proportion of formed seed produced.

- The influence of weather patterns at time of pollination during spring on seed formation, including wind direction and occurrence of rain, requires further investigation.

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Bergin, D. O. 1999. Spinifex on coastal sand dunes. Guidelines for seed collection, propagation, establishment and management. *Coastal Dune Vegetation Network Technical Bulletin No. 2.* New Zealand Forest Research Institute Limited. 28p.

Bergin, D.O., Ede, F.J., Kimberley M.O., Beeser H.F.. 1999. Progress report - flowering and seeding of spinifex. Paper presented to Coastal Dune Vegetation Network Annual General Meeting and Field Trip, 18-19 March. ***Forest Research*** unpublished report. p43-46.

McKenzie, J. B., Mason, B. J., Sultmann, S. D. 1989. Seed production of sand spinifex grass. Pp. 87-100 *in* Beach Protection Authority of Queensland. Dune Stabilisation and Management Research Programme. Report Number D 02.29.

PROGRESS REPORT:

PROPAGATION OF SPINIFEX

F.J. Ede[1], D.O. Bergin[1], H.F. Beeser[1], J. Bonner[2]
[1]*Forest Research*, Rotorua
[2]Naturally Native New Zealand Plants Ltd., Whakatane Nursery

INTRODUCTION

The commercial operation of raising spinifex seedlings by the Naturally Native New Zealand Plants Ltd. nursery has moved from the Oropi site near Tauranga to their new coastal nursery at Whakatane (visited on the field trip of the first CDVN meeting, held at Papamoa). The techniques used to raise the seedlings are based on the results of trials undertaken in the previous two seasons, as reported in the 1998 and 1999 CDVN documents.

In late winter 1999, seedheads from a number of sites around the North Island were sorted by hand, and the formed seeds were separated out from the rest of the seedhead material. These seeds, with the spine and layers of seed covering still intact, were sown upright into Tinus root trainers filled with a light potting mix, with two seeds sown into each root trainer. The root trainers were placed into (bird-proof!) tunnel houses, with bottom heat provided in one tunnel house, but not in a second. Germination commenced within six weeks for the seeds provided with bottom heat, and within 12 weeks without bottom heat. All seedlings were moved outside in early January 2000 to harden off, and by February more than 30,000 vigorous seedlings were well established. Those seedlings initiated with bottom heat will be ready to plant out in April 2000 (eight months after sowing), while the remainder of the seedlings will be ready for planting out two months later.

By sowing two seeds per root trainer, the number of empty root trainers is decreased (see below). It was proposed that seedlings from root trainers containing two seedlings could be pricked out into root trainers without seedlings. However, it has been found that removing the two seedlings from the root trainer during the pricking out process damaged the roots of the seedlings and survival was affected. A more successful solution has been to grow a limited number of seedlings in seed trays and prick these seedlings out into the empty root trainers.

In addition to this operation, a number of collaborative trials between ***Forest Research*** and Naturally Native nursery were undertaken in the 1999 season, and results from these trials are reported here.

SEED TRIALS
1) Seed Treatment

A small trial testing the effect of seed treatment prior to sowing on germination rates was undertaken. One set of treatments tested the effect of different storage techniques - comparing moist stratification (storing the seeds packed in moist sphagnum moss in the fridge) and cool storage (storing the seeds in dry conditions in the fridge) with the usual method of storing seed in dry conditions at room temperature. All seeds were initially stored at room temperature, but those that underwent the stratification or cool storage treatment were placed in these conditions one month prior to seed sowing. A second set of treatments compared the germination of seeds that had been soaked for either 48 or 72 hours in sea water, fresh water or in a solution of washing soda.

The seeds used in the trial had been hand sorted from seedheads, and each still had the spine and outer dry coating material over the seed (bracts) attached. The seeds were sown into root trainers filled with a light potting mix and placed into a tunnel house on 15 October 1999. The number of seeds that had germinated by 10 November 1999 is shown in Table 1.

There was no replication of treatments within this trial, so it is not possible to undertake any statistical analyses of the results. However, it appears from this trial that there is little benefit in either stratifying or cool-storing spinifex seed as there was no large increase in germination with those treatments.

Table 1: Effect of Seed Treatment on Germination Rate of Spinifex Seed

Treatment	Number of Seeds	% Germination
Control - 9 months dry, room temperature	100	43%
Moist stratification - 1 month	100	49%
Cool store - 1 month	100	43%
Sea water soak - 48 hours	50	42%
Sea water soak - 72 hours	50	52%
Fresh water soak - 48 hours	50	72%
Fresh water soak - 72 hours	50	28%
Washing soda soak - 48 hours	50	62%
Washing soda soak - 72 hours	50	64%

There was some variability in the results of soaking the seed for varying times in the three different solutions, with a small increase in germination rate when seeds were soaked for 72 hours in sea water, but not when only soaked for 48 hours. Soaking the seeds for either period in washing soda solution increased the rate of germination from 43% in the controls to 62-64%. However, the biggest increase in germination rate occurred when seed was soaked for 48 hours in fresh water, with 72% of the seeds germinating, but continued soaking in fresh water in this trial led a large decline in germination rate (to 28%).

Previous trials in New Zealand and in Australia have found little improvement in germination rates with soaking spinifex seed in various solutions. However, in the natural environment, spinifex seedheads get blown onto the beach and periodically soaked in sea water, and it is possible that this soaking does soften the outer layers of the seed covering and allow a more rapid germination of seeds. As germination in this trial was assessed less than four weeks after sowing, and was low in comparison to the expected rate of approximately 60-70%, it may be that the soaking treatments increased the rate at which seeds germinated, rather than the final extent of germination.

In order to more fully investigate the effects seen in this preliminary trial, a replicated trial using the same treatments is recommended. The results from this trial suggest that storing spinifex seed at room temperature in dry conditions is sufficient to maintain germination rates, but that soaking the seed prior to sowing for a short period may lead to an increase in the rate of germination and perhaps increase the percentage germination.

2) 1996 Seed

Seed collected and hand sorted in February 1996 from Papamoa Beach had been stored at room temperature in dry conditions in an unsealed plastic bag and was analysed in June 1999 to determine if there was any deterioration in seed quality over the storage period. The spikelets were intact with spines, and bracts covering the seed. When initially collected, the proportion of formed seed within 50 seedheads was found to be high, at 42%, but germination tests were not undertaken on this seed lot at the time.

After three years in storage 1,890 spikelets were reassessed for the presence of a formed seed, and a number of seeds were dissected and the embryos examined for any signs of damage. Using the method of pressing the seed end of the spikelet between thumb and forefinger to determine the presence or absence of a formed seed, it was found that in approximately 10% of the spikelets it was not possible to ascertain whether or not a seed was present. About half of these spikelets were dissected and in 25% of cases, an embryo was present but showed signs of slight to moderate shrivelling, while no embryo was found in 7 of the spikelets. The remainder of this sample contained healthy embryos. In addition, a selection of spikelets which appeared to have plump seeds was dissected and in 5 of the 50 seeds sampled, there were signs of very slight shrivelling of the embryos. The embryos in the remaining seeds were very healthy. No insect damage was detected on any of the spikelets examined.

A hundred intact spikelets were then selected at random from the remaining spikelets and sown in a seed tray in August 1999. When assessed two months later, 69 of these seeds had germinated, giving a germination rate of 69%.

It can be concluded from this small trial that the storage of dry seed at room temperature over a three-year period does not adversely affect the ability of that material to germinate and produce healthy seedlings. There was little deterioration in embryo health over that period and although the germination rate of the seed when freshly collected was not determined, the germination rate of the seed after three years of storage was similar to that gained from freshly collected seed. From an operational perspective, it appears that sorted seed of spinifex can be successfully stored over a reasonable time period, if it is not required immediately. Although spinifex seeds every year at most sites, there are differences in the proportion of viable seed in seedheads from one year to the next, and quantities of seedheads also vary annually. Storage of seed is therefore a practical option for ensuring the continuity of seed supply for ongoing nursery programmes to cover years when seed quality may be poor or seed collection from a particular cannot be undertaken.

3) Seed from Phenology Study

Analysis of the correlation between spinifex colony factors, seed production and germination rates at various sites at Matarangi, Papamoa and Tairua Beaches from the phenology study are presented elsewhere in this document. To determine germination rates of seeds from each of the study sites, 160 seeds per site were sown into root trainers filled with a light potting mix, in August 1999. Two seeds were sown into each root trainer. When total number of seedlings was assessed to determine the germination rate in October 1999, the number of root trainers which contained zero, one or two seedlings was also noted and these data are presented in Table 2.

Overall germination from these seedlots was approximately 60%, and so sowing one seed per root trainer would result, on average, with 60% of the root trainers containing one seedling. If two seeds were sown into each container, then statistically 85% of root trainers would be expected to contain at least one seedling. This expected result is supported by the results of this trial, where 80-88% of the root trainers contained at least one seedling (Table 2).

Table 2: Germination of Sorted Spinifex Seed Where Two Seeds Were Sown in Each Root Trainer

Seed Source	Overall Germination (%)	Root Trainers with 0 Seedlings (%)	Root Trainers with 1 Seedling (%)	Root Trainers with 2 Seedlings (%)	Containers with at least 1 Seedling (%)
Matarangi	61	20	39	41	80
Papamoa	59	18	46	36	82
Tairua	69	12	39	49	88

It is possible to prick out additional seedlings into the approximately 15% of empty root trainers, to increase the efficiency of the nursery operation by maximising the use of nursery space and materials. At Naturally Native nursery seedlings grown in seed trays are used in this operation and pricked out when these seedlings are about 15 - 20 cm tall.

The roots of these seedlings develop laterally along the base of the seed tray making it easier to remove the seedlings without damaging the roots. As has been found previously, spinifex seedlings are very susceptible to transplant shock and any pricking out operation must ensure minimum root disturbance to optimise seedling survival. Because of this reason, for the 40% of root trainers that contain two seedlings, it is recommended that thinning to one seedlings is not undertaken, but that both seedlings are retained in the root trainer for planting out later.

There is an additional cost to sowing two seeds per root trainer, in that twice as many seeds need to be sorted to provide sufficient seeds. With seedheads that contain a high proportion of formed seed this cost will be lower than for seedheads with low numbers of formed seeds. Sowing three seeds per root trainer would only increase the number of root trainers with containing one seedling by 5-10%, and it is not considered economically worthwhile, when blanking can be successfully done with seedlings grown in seed trays.

Although commercial development is still at an early stage, hand sorting of spinifex seed and sowing two seeds per root trainer, as recommended by Bergin (1999), followed by blanking, does appear to be a commercially viable operation.

4) Seed Cleaning Treatments

As noted above, the commercial propagation of spinifex seedlings has been streamlined so that it is possible to raise large numbers of healthy seedlings. However, there is still a considerable cost associated with raising those seedlings that reflects the time required to sort the formed seed from seedheads by hand, particularly for seed lots with a low proportion of formed seed.

In order to decrease the cost of individual spinifex seedlings, it has been suggested that mechanical threshing of seedheads is a viable alternative to hand sorting. The results of a trial investigating the effect of different levels of mechanical seed cleaning techniques are reported here.

Seedheads collected during the phenology study at Matarangi, Papamoa and Tairua Beaches were used in this trial. Seedheads from all study sites at each beach were bulked together and sent to the "Seed Technology Centre" at Massey University for cleaning. Four levels of processing were used (Table 3), ranging from solely using a threshing device through to cleaning the seed of all dried bract material covering the seed (resulting in naked seed). These seed were then sown at Naturally Native nursery at Whakatane in September 1999. Additional treatments included hand-sorted seed. Seedling numbers were assessed two months later.

Table 3: Seed Cleaning Treatments Applied to Spinifex Seed Heads

Treatment	Description	Resultant Material	Sowing Technique
1	Seedheads passed through peg-tooth drum thresher	Large quantities of chaff and other material	Broadcast material onto seed tray
2	Seedheads passed through peg-tooth drum thresher + dehuller thresher	Large quantities of chaff and other material	Broadcast material onto seed tray
3	Seedheads passed through peg-tooth drum thresher + dehuller thresher + air-screen cleaner	Separate spikelets, seed covering intact	Broadcast material onto seed tray
4	Seedheads through peg-tooth drum thresher + dehuller thresher + air-screen cleaner + rubbed to bare seed	Naked seed - removed bracts covering seed	Broadcast material onto seed tray
5	Seedheads broken up by hand	Significant quantities of chaff and other material	Broadcast material onto seed tray
6	Spikelets with formed seed hand-sorted from seedheads	Separate spikelets, seed covering intact	Broadcast material onto seed tray
7	Spikelets with formed seed hand-sorted from seedheads	Separate spikelets, seed covering intact	2 spikelets sown into root trainers

A considerable amount of material resulted from the processing of the seedheads in Treatments 1, 2 and 5, so the equivalent of 10 seedheads was sown in each of these treatments. All material from Treatments 3 and 4 was used, but the results presented in Table 4 are standardised to 10 seedheads. However, in Treatment 3 sowing all the available material resulted in a large number of seedlings emerging in each seed tray, making it difficult to accurately determine seedling numbers. In Treatment 6, 100 seeds were sown, and in Treatment 7, 96 seeds were sown.

There was no replication of treatments in this experiment and so statistical analyses were not able to be performed on the data. However, it was possible to make a very rough estimate of how many seedlings would have been expected to arise from each of the first five treatments, based on the germination rate in Treatment 6 (also sown in a seed tray) and the average number of spikelets with formed seed in seedheads from each of three beach sites. These data are presented in Table 5, but it must be emphasised that the numbers representing the expected number of seedlings are estimates only.

The germination rate of hand-sorted seed from all sites when broadcast over seed trays was relatively low, ranging from 27% at Papamoa to 54% at Tairua, but increased when seeds were sown upright into root trainers for the seed sourced from Papamoa and Tairua, although not for the Matarangi seed (Table 4).

Table 4: Effect of Seed Cleaning Treatment on Number of Seedlings

Treatment	Number of Heads/Seeds	Number of Seedlings		
		Matarangi	Papamoa	Tairua
1: 1 level of threshing	10 heads	88	51	109
2: 2 levels of threshing	10 heads	69	47	85
3: 2 x threshing + air clean	10 heads	99	78	111
4: naked seed	10 heads	14	16	19
5: hand-broken seedheads	10 heads	40	100	147
6: hand-sorted formed seed	100 seeds	43%	27%	54%
7: hand-sorted formed seed	96 seeds	32%	40%	73%

The greatest number of seedlings resulted from Treatment 3 (two levels of threshing + air-screen cleaning) for the Matarangi seed, although all treatments with this seed lot produced less seedlings than theoretically expected (Table 5). For both the Papamoa and Tairua seed, hand-sorting the seedheads and broadcasting all the material across the seed trays produced the most seedlings, with as many or more seedlings produced than expected (Table 5). For these two seed lots, Treatment 3 was the next most successful treatment. It is interesting to note from Table 4 that for all three seed lots, the seedheads that underwent only one level of threshing (Treatment 1) produced more seedlings than those which underwent two levels of threshing (Treatment 2). However Treatment 3, which removed most of the chaff material to leave only intact spikelets was more successful than either of the first two treatments, despite these seedheads having had two levels of threshing. The presence of large quantities of chaff material in seed trays in previous trials has made the pricking out operation difficult as seedling roots become enmeshed in the chaff.

Table 5: Actual and Estimated Number of Seedlings from Seed Cleaning Treatments

Treatment	Matarangi		Papamoa		Tairua	
	Actual	Expected	Actual	Expected	Actual	Expected
1	88	120	51	68	109	157
2	69	120	47	68	85	157
3	99	120	78	68	111	157
4	14	120	16	68	19	157
5	40	120	100	68	147	157

The naked seed that resulted from Treatment 4 had the poorest germination rate of any of the treatments, for all seed lots (Table 4). About 2-3% of the seeds had been broken in the cleaning process. However, these results suggest that removing the bracts covering spinifex seeds may do damage to the seed that is not easily visible, preventing successful germination. It is also possible that physical or chemical factors related to the presence of these seed coverings are required for successful germination. In the natural situation, the seed is likely to be buried with these layers intact. The rate of germination of this naked seed was between 12% and 24% of that calculated (Table 5), and confirms results from other trials with naked seed which had low germination rates (e.g. Ede *et al.* 1998). Spinifex seed sourced from the Levin area, cleaned by the method used in Treatment 4 and then sown in the difficult sites trial at Santoft (FR 360/1), had a germination rate of 25%, when assessed in spring 1999.

The cost of mechanically cleaning all the seedheads from each seed lot by the four techniques used in this trial totalled about $150, with 30 seedheads processed in each treatment. The costs of cleaning 30 seedheads for each individual treatment is not known at this stage, but it is anticipated that it would be more expensive to produce naked seed than to undertake only one level of threshing. A very preliminary estimate of the mechanical seed cleaning cost per seedling, averaged over the three seed lots and four cleaning techniques, suggests a cost of about 20 cents per seedling.

Further work with mechanically cleaned seed is required to validate the results from this pilot trial. Seedheads collected in summer, 2000 will be sent to the seed cleaning unit and will undergo the same cleaning treatments, with the resultant material assessed in a fully replicated trial at Naturally Native nursery. This trial will also compare the cost per seedling of the various seed cleaning options - both mechanical and hand sorting treatments.

It is possible to conclude from this trial that of the mechanical seed cleaning techniques used, Treatment 3 which involved two levels of threshing plus an air-screen cleaning produced the greatest number of seedlings. This material was relatively free of chaff and sorted out individual spikelets, although there was no attempt to determine if formed seed was present in the spikelets.

In a commercial operation, these spikelets are likely to be directly sown into final containers, rather than broadcast onto seed trays so as to avoid the requirement for pricking out, and thus it is expected that an even greater number of seedlings would develop from this material. It may eventuate that the most efficient (and cost-effective) way to sort spinifex seed is a combination of mechanical and hand processes, with the seedheads initially cleaned by the techniques used in Treatment 3, and then the spikelets hand-sorted to remove those without a formed seed, prior to sowing into final containers.

ACKNOWLEDGEMENTS

The considerable contribution of Naturally Native New Zealand Plants Ltd. to this research work, through the provision of labour, expertise, materials and growing space, is gratefully acknowledged.

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PROGRESS REPORT:

PERFORMANCE OF SPINIFEX SEEDLINGS, SEED AND RUNNERS ON SAND DUNES, TAIRUA BEACH, COROMANDEL PENINSULA

D. O. Bergin, M. O. Kimberley & F. J. Ede
***Forest Research*, Rotorua**

INTRODUCTION

Spinifex seedlings produced as part of the large-scale propagation project initiated in 1997 (Ede *et al.* 1998) were planted at three Coromandel sites in 1998 for evaluation of performance on sand dunes. The field trials involved a comparison of the survival and growth of nursery-raised seedlings, direct sowing of seed and planting of runners. Details of trial establishment and initial performance are given in (Bergin *et al.* 1999). This report outlines plant performance 15 months after establishment of the trial in April 1998 at Tairua Beach. Plant survival and growth in the trials at Whiritoa and Whangamata have been affected to some degree by erosion and sand movement as reported previously (Bergin *et al.* 1999) and will not be covered in this report.

The Tairua spinifex trial site was a largely unvegetated long sloping foredune in which nearly 60 small plots were established, comparing seedlings, seed and runners with and without application of the slow-release fertiliser Magamp at planting or sowing. The trial was established and monitored in collaboration with the Tairua Beach Care group and Environment Waikato.

RESULTS

Overall performance

- The performance 15 months after trial installation of spinifex plants established from nursery-raised seedlings, from directly sown seed and from transplanted runners is presented in Table 1.

- The most successful method of establishment was the planting of nursery-raised seedlings where there was almost 94% survival over this period.

- Only one-third of seed spots (where seedheads were sown directly into the sand) resulted in germination of at least one seedling and only 20% of runners survived.

- All growth parameters showed the better performance of nursery-raised seedlings and runners, with the higher survival of seedlings resulting in a higher rate of vegetation coverage across plots. This is reflected in the maintenance of sand levels in these plots compared with plots which were direct seeded or planted with runners.

- The number of runners produced was similar in plots with nursery-raised seedlings and those with transplanted runners, but runner length was greater in the latter plots.

Table 1: A comparison of the performance of spinifex established on foredunes from planting of nursery-raised seedlings, direct sowing of seed, and planting of runners 15 months after establishment at Tairua Beach.

Type	Survival (%)	Height (cm)	Spread+ (cm)	Vigour*	Runners per plant: Total length (m)	Runners per plant: Average length (m)	Runners per plant: Number	Plot Cover (%)	Change in sand level (cm)
Seedlings	93.8	34.4	38.6	3.4	2.27	0.62	1.64	45.4	0.3
Seed	32.5	12.1	15.6	2.2	0.03	0.03	0.06	7.6	-4.8
Runners	20.0	28.0	43.3	3.3	4.51	0.90	1.72	15.0	-2.9

* Vigour score : 1 - weak, 2 - unthrifty, 3 - average, 4 - good, 5 - robust.
\+ Plant spread calculated as square root of (length x breadth)

Effect of fertiliser

- Plant performance with and without the application of slow-release Magamp fertiliser at planting or sowing is given in Table 2.

- There were no statistically significant differences in survival between fertilised and non-fertilised plants established from seedlings, direct sowing or runners. In contrast, there were significant increases in all measures of plant growth where fertiliser had been applied.

- All fertilised plants from nursery-raised seedlings had multiple runners (average of more than 3 per plant) with many exceeding 3 m in length. The highest recorded number of runners on any one plant was 11 runners and the longest runner measured was 9 m.

- As a result of the high survival (over 95%) and vigorous plant spread, the vegetation cover provided by nursery-raised seedlings, planted with fertilised, far exceeds the cover provided by plants arising from directly sown seed or transplanted runners with or without fertiliser, or from nursery-raised seedlings planted without fertiliser.

- Survival of spinifex from planted seedlings, sown seed and planted runners is given in Figure 1 while average plant spread is shown in Figure 2.

Table 2: A comparison of the performance of spinifex established on foredunes from planting of seedlings, direct sowing of seed, and planting of runners with and without application of fertiliser at planting or sowing15 months after establishment at Tairua Beach.

Type	Fertiliser	Survival (%)	Height (cm)	Spread+ (cm)	Vigour*	Stolons			Plot Cover (%)	Increased sand level (cm)
						Total length (m)	Average length (m)	Number		
Seedlings	No	91.7	22.4	14.3	2.2	0.03	0.03	0.07	8.4	-0.9
Seedlings	Yes	95.8	46.3	62.9	4.7	4.50	1.20	3.22	82.5	1.4
Seed	No	36.7	7.8	3.0	1.2	0.00	0.00	0.00	1.0	-4.8
Seed	Yes	28.3	16.3	28.3	3.2	0.06	0.06	0.13	14.3	-4.8
Runners	No	25.0	21.3	25.6	2.3	0.05	0.05	0.11	11.7	-3.0
Runners	Yes	15.0	34.7	61.0	4.3	8.97	1.74	3.33	18.3	-2.8

* Vigour score : 1 - weak, 2 - unthrifty, 3 - average, 4 - good, 5 - robust.
+ Plant spread calculated as square root of (length x breadth)

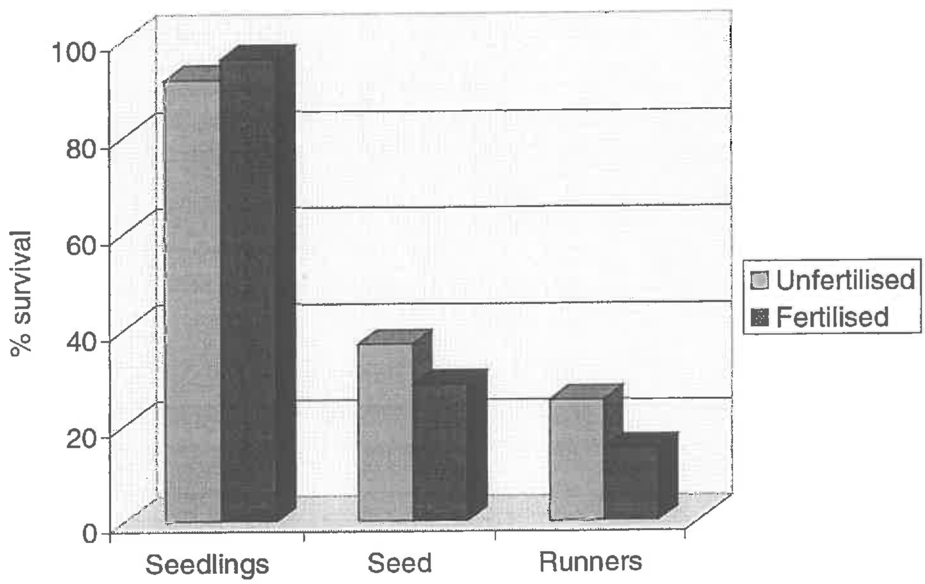

Figure 1: Survival of planted seedlings, sown seed and planted runners of spinifex 15 months after establishment on foredunes, Tairua Beach, Coromandel Peninsula

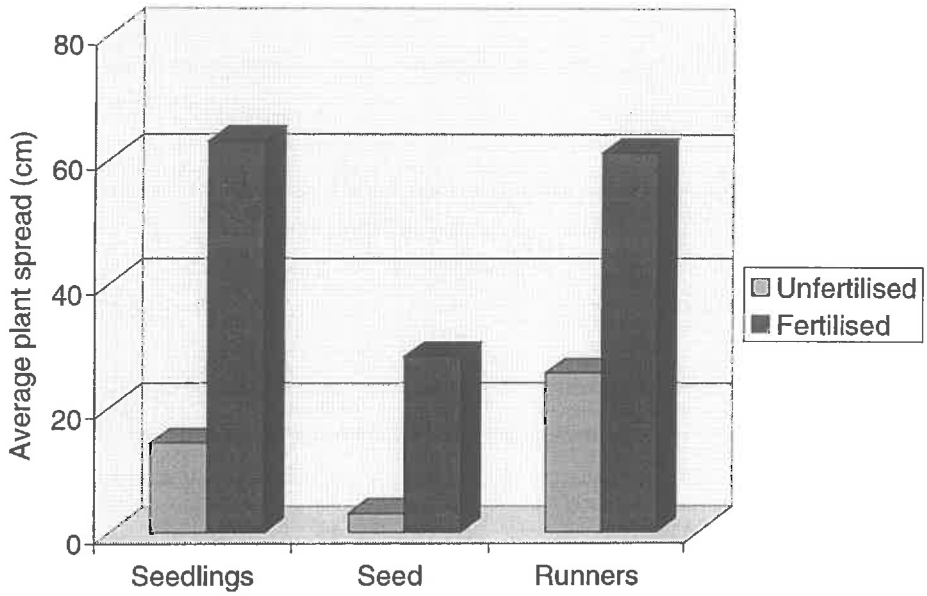

Figure 2: Spread (calculated as square root of length x breadth) of planted seedlings, sown seed and planted runners of spinifex 15 months after establishment on foredunes, Tairua Beach, Coromandel Peninsula

CONCLUSIONS

Nursery-raised seedlings

- Results from this trial confirm findings from previous planting trials (Bergin & Kimberley 1999) that nursery-raised spinifex seedlings can be successfully established on bare foredunes on the eastern coastal sites of the Coromandel Peninsula.

- Spinifex seedlings responded positively to application of the slow-release fertiliser Magamp at the rate of 30 g per plant incorporated with the sand at time of planting.

- At the 60 cm wide plant spacing in this trial, plants were merging to form dense stands within 15 months of planting and multiple runners were extending on average 1.2 m in all directions from these plot.

Seed and runners

- Compared with previous trials where only 10% of seed burial spots have at least one seedling (Bergin & Kimberley 1999), seed sown directly on dunes at the Tairua Beach trial has shown that 30% of seed spots have produced at least one seedling which survived more than one year.

- There has also been greater survival of runners at the Tairua Beach trial compared with previous trials but survivals of only 20% indicate that this labour-intensive method is not practical on a large scale.

- Where plants from seed or runners do survive, growth is improved by application of Magamp fertiliser.

RECOMMENDATIONS

- The planting of nursery-raised spinifex seedlings with fertiliser will give considerably greater success on a wide range of sites in most years and is therefore likely to remain the preferred method for revegetation of bare dunes.

- Where high survival is expected, spinifex seedlings could be planted at spacings of at least 1 m apart.

- Overall results indicate that direct seeding or transplanting of cuttings for spinifex may be practical on some sheltered sites in favourable years.

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PROGRESS REPORT:

RESPONSE OF FOREDUNE VEGETATION TWO YEARS AFTER APPLICATION OF FERTILISER, BAY OF PLENTY

D. O. Bergin & M. O. Kimberley
***Forest Research*, Rotorua**

INTRODUCTION

Four sites along the Bay of Plenty beaches of Mount Maunganui, Omanu and Papamoa were used to test a range of fertiliser treatments. Single (spring 1997) and split applications (spring 1997 and autumn 1998) were tested at a range of rates from 0 to 800 kg N/ha. The response of existing vegetation cover to fertiliser has been monitored over the last two years. Detailed background and rationale for these trials as well as the trial design and initial assessments are given in a report to the 1998 CDVN Annual Meeting (Bergin *et al.* 1998) and response to fertiliser application after one year is given at the 1999 CDVN Annual Meeting (Bergin & Kimberley 1999). This progress report briefly presents results from assessment of vegetation nearly two and a half years after initial application of fertiliser.

RESULTS

Overall response to fertiliser

- The response in vegetation cover found in the previous two assessments continues to be apparent 28 months after the initial application.

- Total vegetation cover increases from approximately 50% with no fertiliser to over 70% cover at the 400 kg N/ha rate with not further response at the 800 kg N/ha rate (Fig. 1).

- As with earlier assessments, spinifex has had the greatest response to fertiliser increasing cover from 33% in non-fertilised plots to over 55% where 800 kg N/ha has been applied.

- As with previous assessments, there was no significant increase in weeds or other indigenous species with application of fertiliser.

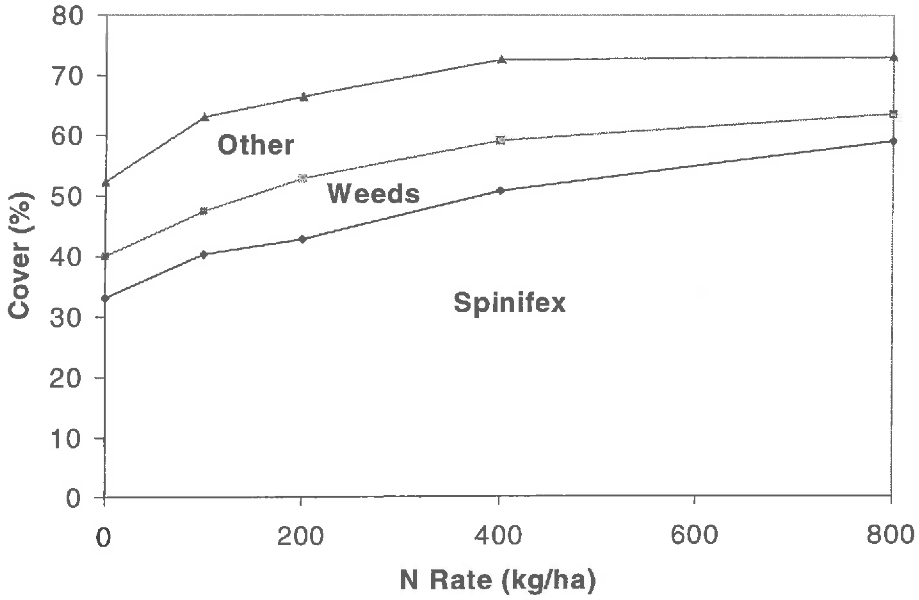

Figure 1: Average response to fertiliser of spinifex, weed species, and other indigenous plants at the February 2000 assessment. Urea fertiliser was applied in October 1997 and in March 1998.

Response of spinifex over time

- Spinifex has remained the dominant cover at all four plots during the almost two and half years since fertilising (Fig. 2).

- Greatest impact of fertiliser was at the February 1999 assessment, and in the latest assessment, cover has decreased back to levels recorded at the first assessment.

- Compared to non-fertilised plots, there has been an overall boost in spinifex cover from 100 to 800 kg N/ha rates and this has been maintained into the third year.

- All assessments show a decreasing rate of response to fertiliser at the highest application rate of 800 kg N/ha.

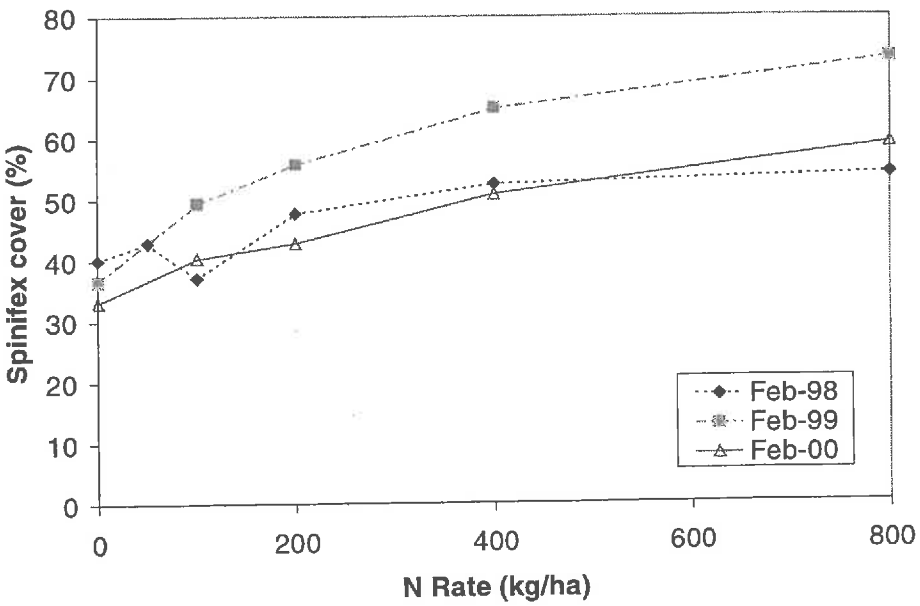

Figure 2: Average response of spinifex cover to application of urea fertiliser across all sites for each assessment in February 1998, February 1999 and February 2000. Urea fertiliser was applied in October 1997 and in March 1998.

Response of pingao

- Analysis of the single site where pingao was a significant component of the cover, gives an indication that pingao does respond to application of fertiliser especially at rates between 100 and 400 kg N/ha (Fig. 3).

- Response in growth was not evident until the second assessment 12-16 months after fertiliser application.

- The large decrease in pingao cover at the highest rate of 800 kg N/ha may indicate high fertiliser rates adversely affects survival and growth.

- Further research is required to determine optimum rates for application of urea to pingao dominated dunes and in particular to determine whether high rates are detrimental to pingao growth.

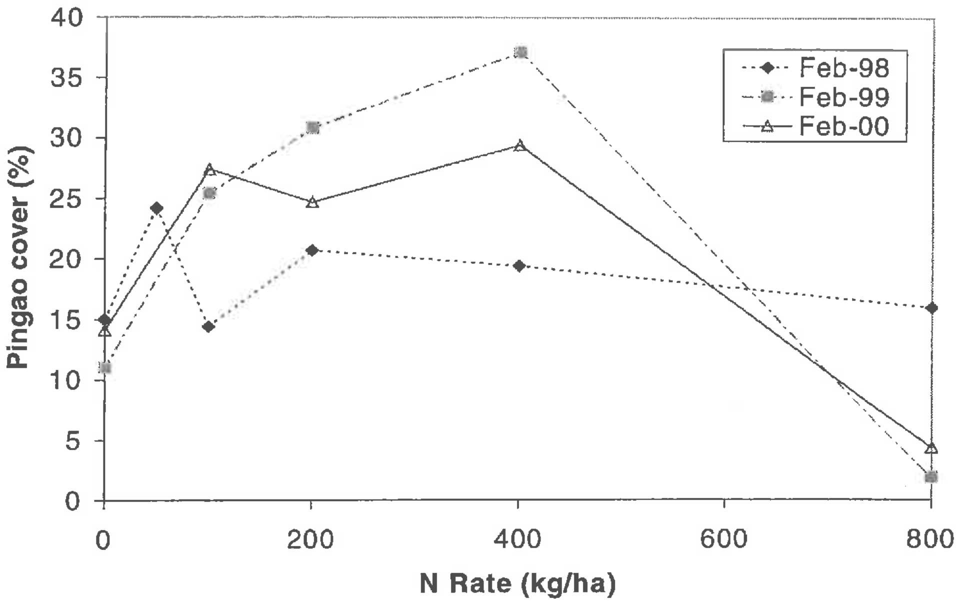

Figure 3: Average response of pingao to fertiliser at site 3 for the three assessments. Urea fertiliser was applied in October 1997 and in March 1998.

CONCLUSIONS

- An assessment of the vegetation cover 28 months after initial application of fertiliser indicates that the effect of fertiliser is beginning to decrease. However, fertilised plots had a greater cover of vegetation than non-fertilised plots.

- The fertilising strategies recommended after the second assessment remain valid. A minimum of 200 kg N/ha of urea should applied to the foredune where an immediate boost to growth is required. For a maximum boost in vegetation cover, an application of up to 400 kg N/ha is required.

- Application rates above 400 kg N/ha level are not likely to give additional benefit.

- The latest assessment indicates that repeat fertiliser applications are not required for at least three years after first applications and this is consistent with Australian studies (Barr *et al.* 1983).

Effect on weeds

- As with earlier trials in the Coromandel, fertilising dunes with fast-release fertilisers do not significantly increase the weediness of the site (Bergin & Herbert 1997).

- Fertiliser increases the cover of spinifex probably due to the taller stature of the plant compared many of the exotic herbaceous and grass species present.

Fertilising pingao

- Further investigation is required on the response of pingao to application of fertiliser to existing stands. This is particularly relevant for many of the South Island sand dunes where pingao is (or was) the dominant indigenous sand binder.

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PROGRESS REPORT:

RESTORATION OF EXPOSED SITES TRIAL SERIES FR 360

F.J. Ede[1], D.O. Bergin[1], G.B. Douglas[2]
[1]*Forest Research*, **Rotorua**
[2]AgResearch Grasslands, Palmerston North

INTRODUCTION

It has been recognised that many of the successful coastal sand dune revegetation programmes with indigenous species have been relatively small scale and in areas where the physical factors in the environment have not been limiting to plant establishment and growth. However, in many areas of the west coast of the North Island and along the Canterbury coastline, physical constraints such as frequent high winds, and storm events have limited the success of a number of revegetation programmes in the past, resulting in large areas of unstable dunes. A series of research trials in some of these locations has been designed to identify dune management techniques that can optimise the success of dune stabilisation programmes in these areas.

This trial series (coded as the FR 360 series) is jointly funded by the FRST Sand Dune Revegetation Programme and the CDVN. The trials are being established in collaboration with local communities and managing agencies. Consultation before and during trial establishment ensures that local knowledge and expertise regarding appropriate treatment options is incorporated into the trials wherever practicable. Substantial "in-kind" contributions, in the form of materials and labour, enable the establishment of large-scale trials at these sites, testing a comprehensive range of treatments.

This report will focus on the first trial in the series which was installed at Santoft Beach in June 1999, and will discuss the results from the first eight months of this trial. A brief outline of proposals for the remaining three trials in the series is also included.

and the second row spinifex plants, with this alternating pattern repeated throughout the plot.

The planting material consisted of sets of marram grass, comprising of a number of tillers (culms), which were harvested some days earlier and stored in mounds of sand until required. The spinifex plants were seedlings raised in potting mix in small pots, from seeds sourced near Levin. Professional marram planters planted both species using standard techniques. A hole was dug in the sand by inserting a planting spade to a depth of approximately 50 cm and forming a V-shape by moving the spade back and forth. For treatments involving Magamp, a container of the fertiliser was applied to the bottom of the planting hole and the marram grass or spinifex plant placed into the hole and firmed in with the foot. The plants were positioned at the base of the planting hole, burying the lower portion of the stem. Film canisters provided a useful container for applying the fertiliser as when full, they contain approximately 30 g of coarse grade Magamp. Urea applications were made by broadcasting the urea across the plots.

Spinifex seed were sown in the central area of two plots for Treatment 6. Six rows of naked seeds (cleaned of all seed coverings) were sown between the marram grass plants, in six positions per row. In the lower three rows, six seeds were sown per position, and in the upper three rows, 12 seeds were sown per position. To sow the seeds, a 30 cm hole was dug and 30 g of Magamp applied to the base of this hole. It was then covered with 20 cm of sand which was firmed down, the seeds were sown and then covered with sand.

E) Monitoring

i) Sand Movement

The positioning of a row of reference pegs at 3 m intervals in the centre of each plot, along the profile from the high water mark to the rear of the recontoured dune, allows an ongoing analysis of changes in sand height. Eight rows of these 1.2 m long pegs were inserted to a depth of 60 cm at the time of trial installation. Surveying of the site has also been ongoing.

ii) Vegetation Assessment

Each plot contains two, 3 m by 3 m permanent sampling quadrats for ongoing vegetation assessment, with each of these quadrats containing nine plants. The initial assessment of vegetation, at the completion of trial establishment, involved determining plant vigour on a scale of 1 - 3 (with 1 denoting a plant with 0 - 30% of green material; 2 denoting 30 - 70% green material; and 3 denoting a plant with 70 - 100% green material). In addition to this assessment, the diameter of the plant at ground level was measured, and the number of tillers recorded for the spinifex plants. Plant cover of the quadrat areas was not determined at this time because in all cases it was much less than 5% of the area, and there were no obvious differences between plots.

A second assessment of plants in the trial was made in November 1999. At this time, plants within the permanent quadrats were assessed for vigour as before, and the height and diameter of each plant within the quadrat were measured. The number of tillers was recorded for the spinifex plants. Plant survival was measured for two complete rows of each species in each plot. The height of sand against the reference pegs was also measured at this time.

The trial was remeasured in late February 2000, but the growth of volunteer marram grass in many of the plots made it very difficult to determine which plants had been deliberately planted in the trial and which had grown from marram grass tillers disturbed during the reshaping operation. After considering the options, it was decided that the most useful measure of treatment effectiveness at this stage of the trial was to measure the extent of vegetation cover in each of the two permanent quadrats. Individual plant height and diameter were not measured, and because the majority of the plants were extremely vigorous in their growth, plant vigour was not recorded at this time. However, the length of runners produced by the spinifex plants was measured, as was plant survival in the same rows as previously, and sand height against the reference pegs.

Table 1: Treatments Incorporated into Trial FR 360/1 at Santoft Beach, June 1999

Tmt	Species	Magamp (at planting)	Urea (spring & autumn)	Comments
1	marram	x	✓	Current practice Plant spacing: 1 m x 1 m
2	marram	✓	x	Plant spacing: 1 m x 1 m
3	marram + spinifex	x	✓	Plant spacing:1 m x 1 m - alternate rows Spinifex on seaward 15 m only
4	marram + spinifex	✓	x	Plant spacing:1 m x 1 m - alternate rows Spinifex on seaward 15 m only
5	marram	✓	✓	Plant spacing: 1 m x 1 m
6	marram + spinifex seed	x[1]	✓	Plant spacing:1 m x 1 m; 6 or 12 seeds sown 1 m from plants, in central 6 m x 6 m portion of plot

Note 1: In Treatment 6, Magamp was applied to the spinifex seed sown, but not to the marram grass at time of planting.

RESULTS

A) Peg Heights

At the time of trial establishment, the height of each peg was 60 cm above the surface of the sand. In November a number of pegs in the first two rows in the trial had been removed or destroyed, so these were replaced at that time. The data presented in Table 2 does not include the sand heights from these replacement pegs.

In some areas of the trial, sand has blown out of the plots from a westerly direction (the direction of the prevailing on-shore wind) from the base of the dune. However, there is no consistent pattern of sand loss or gain across the trial. Plot 5 is at the base of a well-vegetated hillock that was left intact during the recontouring process, and that area has gained the greatest quantity of sand, with one peg now only 15 cm above the sand surface. On the southern side of this hillock, however, there has been a loss of sand (Row 6, Table 2). The other major area of sand loss is in the middle row of plots at the northern end of the trial: Plots 9 - 12. The sand level on one peg in Plot 9 has dropped by 35 cm between November and February.

Table 2: Height of Reference Pegs in November 1999 and February 2000

Position of Peg Row	**Average Peg Height[1] 3rd November 1999 (cm)**	**Average Peg Height 24th February 2000 (cm)**	**Net Change in Sand from June to February**
1st row - through plots 1, 9, 15	67 range: 64 - 72 cm	60 range: 57 - 80 cm	No change
2nd row - through plots 2, 10,16	68 range: 57 - 80 cm	63 range: 40 - 83 cm	3 cm loss
3rd row - through plots 3,11,17	70 range: 59 - 86 cm	66 range: 50 - 85 cm	6 cm loss
4th row - through plots 4,12,18	68 range: 59 - 80 cm	65 range: 49 - 79 cm	5 cm loss
5th row - through plot 5	54 range: 38 - 66 cm	25 range: 15 - 32 cm	35 cm gain
6th row - through plots 6,13	72 range: 55 - 84 cm	75 range: 49 - 90 cm	15 cm loss
7th row -through plots 7,14	63 range: 53 - 69 cm	50 range: 33 - 66 cm	10 cm gain
8th row - through plot 8	75 range: 59 - 85 cm	74 range: 52 - 87 cm	14 cm loss

Note 1: The peg height above the surface of the sand at trial installation was 60 cm.

B) Vegetation Assessments

i) Plant Survival

In the eight months since trial installation, the survival of the marram grass in the rows assessed has been close to 100%, while about 80% of the spinifex has survived (Table 3). Plant survival did not change between November and February, and was not affected by fertiliser treatment or any other factor in the trial.

ii) Plant Size and Vigour

The sets of marram grass plants planted in June had an average diameter of 47 cm (Table 3) which equates to about 35 individual stems being planted in the clump. These plants tended to be quite brown at the time of planting, with many only receiving a vigour score of 1. However, within five months, the average diameter of these plants had increased by approximately 50% to 69 cm, and the average vigour score had also increased slightly (Table 3). Most of the plants assessed had produced a number of new green shoots from the original planting material.

Although the spinifex plants were smaller at the time of planting than the marram grass plants, they tended to be more vigorous, with more green foliage material on the plants. The vigour of these plants declined slightly over the five months between trial establishment and the November assessment (Table 3), but when assessed in February, the majority of these plants were extremely healthy and had increased in size considerably, with many plants forming large clumps. Plant diameter increased by 75% on average between June and November and, although not measured in February, was continuing to increase. When measured in November, the spinifex plants in the trial were about half as tall as the marram grass plants (Table 3).

At the time of the November assessment, no spinifex seedlings had established from the seeds sown in Plots 11 and 13. In fact, there had been sufficient sand movement in those plots to remove the sand covering the seeds and fertiliser, with fertiliser granules visible on the surface of the sand. However, one small spinifex seedling was found in Plot 13 in February. It is not possible to determine if this seedling established from seed sown in the plot as part of the trial, or from naturally occurring seed in the plot area, as there is a very well established female spinifex colony next to the plot which may be been the source of the seedling.

Table 3: Survival, size and vigour of marram grass and spinifex plants, measured at trial establishment (June 1999), in November 1999 and in February 2000.

Plant Parameter	Marram Grass	Spinifex
Survival in Nov (%)	99	81
Survival in Feb (%)	98	80
Plant diameter in June (cm)	47	16
Plant diameter in Nov (cm)	69	28
Change in plant diameter (cm)	22	12
Plant height in Nov (cm)	61	34
Plant vigour in June[1]	1.4	2.2
Plant vigour in Nov	1.6	2.0

Note 1: Plant vigour was scored on a scale of 1 (0-30% of plant green) to 3 (70-100% plant green).

There was no effect of treatment or position in the trial on the size or vigour of either the marram grass or the spinifex plants in June or in November. However, there were a number of correlations between the size and vigour of the plants at trial establishment on subsequent plant size and vigour, that were statistically significant. The higher the vigour score for the marram grass plants at trial establishment, the greater the change in diameter, plant height and vigour score at the time of the November assessment. The diameter of marram grass sets at time of planting was also positively correlated with plant diameter in November, but negatively affected the extent of the change in diameter and plant vigour scored in November. These results suggest that smaller, more vigorous (greener) sets of marram grass tend to increase in diameter and vigour more readily than do larger sets of marram grass.

The diameter of the spinifex plants at the time of planting had a positive effect on the height of plants in November, but a negative effect on the change in diameter over the five months between measurements. The number of tillers on the spinifex plants was also negatively correlated with the change in diameter. It appears that for spinifex, as for marram grass, that smaller plants with fewer tillers are able to increase their size more rapidly than larger plants.

iii) Plot Cover and Vegetation Spread

When the trial was established and again in November, it was not possible to accurately assess the vegetation cover over the quadrats because there was so little vegetation (only 1-2% cover) and there were no differences between plots. However, the exceptional growth of both the marram grass and the spinifex plants over the summer made it possible to assess plot cover in February. There was no difference in the extent of coverage of the 9 m^2 quadrats assessed between any of the treatments - meaning that there was no effect due to fertiliser or due to the species planted in each plot (either marram grass alone or spinifex and marram grass).

On average, 85% of the area of individual plots was still bare sand, with only 15% of the plot areas being covered by vegetation. In the marram grass only plots, all of this cover was provided by marram grass (there are no other adventitive species in the trial area), and in the plots with a mixture of species, 9% of the plot was covered by marram grass, and 6% by spinifex.

The growth habits of these two sand-binding species are quite different. The marram grass plants grow upright, with tightly clumped tillers (stems) and spread from the base, as the clump of plant material grows. However, spinifex tillers are much more loosely arranged and tend to fall across the sand. When the plants were planted in June, each plant had an average of 2.8 tillers, and by November that number of tillers had increased to 4.1 per plant. In addition to the increase in the number of upright stems, spinifex produces horizontal stems, runners, that grow out from the parent plant and root at the nodes, eventually producing a large colony. Approximately 35% of the spinifex plants in this trial had produced a runner at the time of the February assessment (although no plants had produced more than one runner). The length of these runners ranged from 52 - 220 cm, with an average length of 90 cm.

CONCLUSIONS

- The weather patterns over the first eight months of this trial has encouraged exceptional plant growth in both species, with very few high wind or storm events (as illustrated by the peg height and survey data), and moderate rainfall which appears to have been sufficient to sustain plant growth at a high level.

- There is no difference in plant growth or survival for either species as a result of fertiliser treatment at this stage of the trial, so it would be possible in future operations at this beach to plant spinifex and marram and fertilise with urea on a twice annual basis, as occurs operationally.

- The results from this trial to date have shown that it is possible to successfully interplant marram grass and spinifex on recontoured dunes, with both species thriving. Ongoing assessments of this trial will determine whether one or other species becomes dominant in the long term. Observations of natural regeneration of foredunes along this coast indicate that spinifex will become dominant along the lower slopes of the seaward facing dune and marram will dominate dune areas landward.

- It would be interesting to undertake further trials in this area to determine how the two species perform with different fertiliser regimes (ranging from no fertiliser to different rates of different fertilisers). Plant spacing is another treatment that should be included in future trials, as it is suggested that 60 cm between plants is the optimum spacing in this locality. It would also be interesting to include a 'spinifex only' treatment.

- Results to date indicate that establishment of spinifex from seed is not likely to succeed where there are significant changes in sand level in the first few months after sowing (as has also been found in trials on eastern North Island sites). The sowing of seed in dunes where good shelter and sand stability is provided by a cover of marram grass (as is practiced in NSW) should be investigated.

ACKNOWLEDGEMENTS

The team from Ernslaw One Ltd.- Pat McCarthy and Greg Herrick, have been involved in this trial from the outset and helped with site selection, trial design and installing the trial. As well as their invaluable assistance, there has been significant input from horizons.mw by Lachie Grant, Aaron Madden and David Harrison, who provided plants, labour and input into the planning stages of the trial. Lex Foote from AgResearch was involved in installing the trial and in the ongoing assessments. Patrick Hesp also helped with trial design and site selection, and he and Lachie have undertaken the survey work in the trial. Mark Kimberley from ***Forest Research*** helped with trial design and undertook the statistical analyses.

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APPENDIX 1: FR 360/1 AT SANTOFT BEACH

Figure 1: Plot Layout of Trial

N

Plot 15 Tmt 2	Plot 16	Plot 17 Tmt 1	Plot 18 Tmt 5				
Plot 9 Tmt 5	Plot 10	Plot 11 Tmt 6	Plot 12 Tmt 1		Plot 13 Tmt 6	Plot 14 Tmt 2	
Plot 1 Tmt 4	Plot 2 Tmt 1	Plot 3 Tmt 2	Plot 4 Tmt 3	Plot 5 Tmt 2	Plot 6 Tmt 3	Plot 7 Tmt 1	Plot 8 Tmt 4

Plots 1 - 4 form Block 1
Plots 5 - 8 form Block 2
Plots 9,11, 15 and 17 form Block 3
Plots 12,13,14 and 18 form Block 4

SURVEYS OF THE SANTOFT TRIAL

Patrick Hesp and Lachie Grant

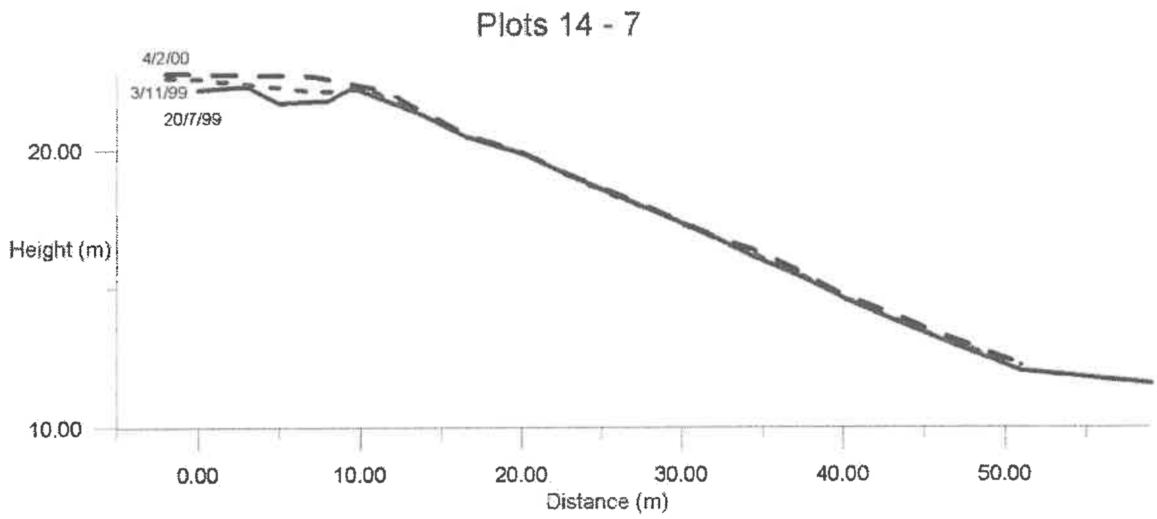
The trial is set up such that there are two areas of trial plots separated by a spinifex knoll. Plots 15, 16, 17 and 18 are the upper (foredune crest) plots while plots 9, 10, 11 and 12, and plots 1, 2, 3 and 4 are below these respectively. Plot 5 lies on the seaward stoss toe of the foredune and provides a link between the above plots and plots 13 and 14 which lie above plots 6, 7 and 8.

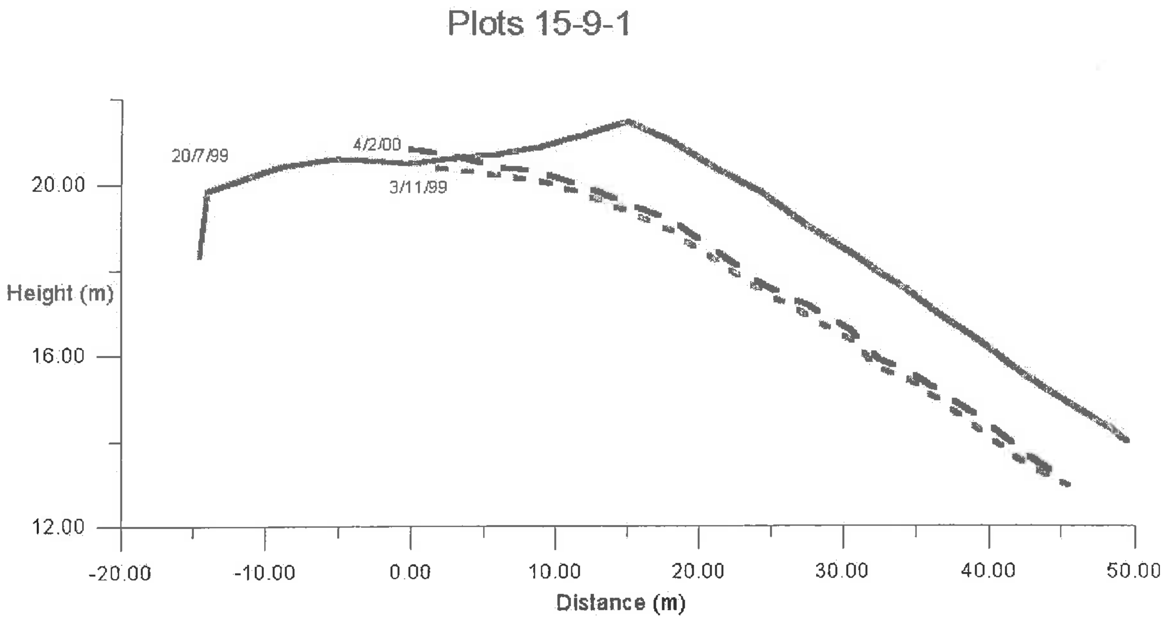
Irregular surveys of the centrelines of plots 15 - 9 - 1 (these are all in line down the dune), 18-12-4, and 14-7 have been carried out on three occasions, while the peg heights of all plot centerlines have been measured four times.

The centerline surveys show that there has been a slight trend towards accretion in plots 18-12-4 and 14-7. Some erosion has occurred between plants (not obvious on the surveys below) because the culms were planted at spacings of around 1 metre, a spacing in excess of that required to stabilise the surface in this region.

There has been significant erosion on the upper foredune slope in several plots adjacent to the 18-12-4 and 14-7 plots, and throughout plots 15-9-1. A good proportion of the sediment eroded from the 15-9-1 plots was deposited on the landward crest of the foredune.

Overall, there has probably been less erosion than would have occurred in a "normal" lower west coast windy year. Wind run was down by around 20% of normal in the Manawatu last year and significant NW, W and SW storms were few.

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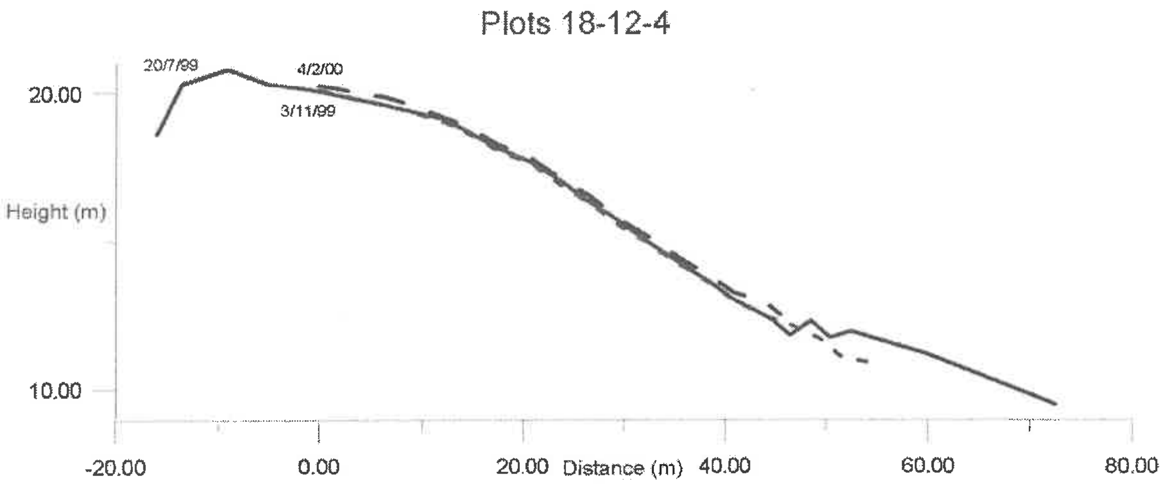
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60.00
80.00

Thursday 30 March

COASTAL DUNE VEGETATION NETWORK

AGENDA

Thursday 30th March
Technical Session 2

8.30	Future of CDVN; Research priorities
10.30	Morning tea

Field Trip 2

11.00 Christchurch beaches: Walk along New Brighton and North Beach

- Foredune management
- Sand fences
- Monitoring of dunes and planting
- 1990's Backdune planting

12.30 Lunch

Business Session

1.30 CDVN Business

Technical Session 3

2.30 – 5.00 Open workshop - Updates on coastal vegetation projects and South Island news, issues and initiatives. An opportunity to exchange ideas, problems and solutions.

****

7.00pm Dinner at "On the Beach" Restaurant, Sumner (transport supplied)

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BUSINESS SESSION

Apologies

Stephen Burton	Anntons Nursery
Grant Douglas	AgResearch
Jo Fagan	Wellington Regional Council
Kathryn Howard	Waitakere City Council
Greg Lowe	Franklin District Council
Andrew Moor	Franklin District Council
Colin Ogle	Department of Conservation
Dave Phizacklea	Department of Conservation
Paul Pope	Dunedin City Council

CDVN COORDINATORS REPORT 1999 - 2000

F.J. EDE

As most of you are aware, in recent months the sand dune revegetation research programme at ***Forest Research*** and the Coastal Dune Vegetation Network have faced a number of challenges. Initially, the enthusiasm and vitality generated at the highly successful meeting in New Plymouth in March 1999 continued into the planning of the research programme at the beginning of the new financial year. Progress was being made on a number of fronts, with ongoing work in spinifex and other areas, and the installation of the first of the restoration of difficult sites trials at Santoft Beach, with planning well underway for the remaining trials in that series.

However, in September it was decided that the funding from the Foundation for Science, Research and Technology (FRST), which had been allocated to the sand dune revegetation programme at ***Forest Research***, would be redirected to other areas of business within the Institute, as part of an institute-wide reorganisation. This money ($90,000 per annum) would no longer be available to support dune revegetation work. Network members had always recognised that this FRST funding provided a significant underpinning to the whole sand dune revegetation programme, and that the contribution by the financial members of the Network was insufficient to support a stand-alone research programme.

In the ensuing months, a number of meetings and discussions were held between Network members, ***Forest Research*** management and FRST staff, concluding in the decision that the $90,000 would remain available for the sand dune revegetation research area.

I believe that one of the positive aspects of this situation has been the whole-hearted commitment Network members have demonstrated to the CDVN and to the revegetation research programme. This has reiterated to the research team that the Network is a successful organisation that is meeting the needs of members and that the research work undertaken in this programme is making an essential contribution to sustainable coastal management. However, there are still many questions unanswered and so there is a need for an ongoing research programme in this area.

Unfortunately, in October, the research team lost the services of the long serving technician, Helena Beeser, who was made redundant as part of ***Forest Research's*** internal restructuring. I want to acknowledge her significant contribution to the research programme over a period of five years, and we have missed her input into many areas of the research already, particularly as she was developing the spinifex nursery work with Naturally Native nursery.

As well, I have decided to resign from my position at ***Forest Research*** and will be pursuing other career opportunities across the Tasman as my husband and I settle in

Melbourne, where he has a new job with CSIRO. Although I am very sorry to be leaving my involvement with the research programme and with the Network, I know I leave it in good heart. The Network will continue to go from strength to strength as new members and other researchers become involved.

So in closing I want to say "Thank You" to each of you for your support to me during my time with the programme and I want to wish the Network as a whole, and every individual member of it, all the very best for the ongoing task of managing our coastal resources in the most appropriate ways. I am heartened by the level of commitment to this goal that continues to be evident and I wish you all every success in pursuing that goal.

COASTAL DUNE VEGETATION NETWORK

FINANCIAL STATEMENT 1 JULY 1999 - 28 FEBRUARY 2000

Revenue for Full 1999 - 2000 Year	
15 annual subscriptions at $3,000 each	**$45,000**

Budget for Full 1999 - 2000 Year	
1) Network management	$15,000
2) AGM costs	$3,000
3) Spinifex propagation project	$5,000
4) Spinifex phenology project	$6,000
5) Restoration of exposed sites	$13,000
6) Fertiliser trial	$3,000
Total	**$45,000**

Expenditure to date:	
1) Network management	$10,500
2) AGM costs	$1,090
3) Spinifex propagation	$3,200
4) Spinifex phenology	$480
5) Restoration of exposed sites	$8,721
6) Fertiliser trial	$2,100
7) Chairman's costs	$1,645
Total	**$27,736**

Notes:

1) All figures exclude GST.
2) The funds contributed by the CDVN to the research programme (items 3 - 6) represent a portion of the costs required to undertake this work. Other funds are provided by the government funding through FRST and from the "in kind" contributions of materials, labour, sites, expertise and other resources from various organisations and companies. The budget of the overall sand dune research programme for the 1999-2000 year is $144,000 (excluding "in kind" contributions).
3) Included in the costs of "Network management" has been the time required to compile the document reference list included with the AGM document.

TECHNICAL SESSION 3: OPEN WORKSHOP

ECOLOGICAL RESEARCH STUDIES ON CANTERBURY DUNELANDS

Trevor Partridge
Landcare Research
Lincoln

The sand dune vegetation inventory of New Zealand identified only one dune system in Canterbury as having conservation values of National Importance, the remaining systems having only local values, if any. That system is at Kaitorete Barrier, on the seaward margin of that 28 km long gravel and sand spit that separates Te Waihora (Lake Ellesmere) from the Pacific Ocean. Conservation based ecological research on dunelands in Canterbury has concentrated on this area, and there are many interesting questions being addressed there.

Values

To illustrate the importance of the Kaitorete dunes, the following comprises a brief list of some of the conservation values. The barrier holds New Zealand's longest continuous pingao (*Desmoschoenus spiralis*) dominated dune system by far. The other dune binder spinifex (*Spinifex sericeous*) never occurred this far south. There are native plant species found only here; the sprawling shrub *Carmichaelia appressa*, an undescribed species of *Craspedia*, and possibly an undescribed *Galium* species. Just behind the dunes there is the last remaining substantial population of the shrub *Muehlenbeckia astonii*, and the rare grass *Austrofestuca littoralis* is frequent on the dunes. There are endemic insects on the barrier. The system contains deflation dunes and sand plains dominated by *Zoysia pungens*, such situations being rare in New Zealand today.

Issues

Many of these values are under threat, and those threats have been the focus of research at Kaitorete Barrier. The introduced sand binder marram (*Ammophila arenaria*) is present, and indeed dominates some areas. Research funded by the Department of Conservation has focussed on what happens when marram invades pingao dunes, and what can be done to repair the situation. It was found that virtually as soon as it invades, marram replaces pingao, especially where the native binder is moribund. Competition for surface moisture seems to be the cause, with marram being more effective at obtaining this resource in a dry climate. Left unchecked, marram would eventually displace pingao from all but a few areas where the superior salt tolerance of the native binder would give it an advantage such as at the strandline. Also, hand-pulling of marram, which was the early technique of control, was shown to actually rejuvenate the grass unless it was undertaken very frequently.

Parts of the dunes have been mined for sand, and this has caused problems for the re-establishment of native vegetation. Research has shown that although pingao (and marram) establishes well on mined dunes, it fails to spread and re-build dunes because there is limited supply of sand. The result is a sand plain with scattered clumps of binders, but with abundant scabweed (*Raoulia australis*). Modelling the dynamics of marram, pingao and scabweed clearly demonstrated the importance of sand supply.

Other weeds are threatening the biological values, especially tree lupin (*Lupinus arboreus*) and bracken (*Pteridium esculentum*), although, so far, no research has focussed on the latter. In the early 1990s, tree lupin was invading some areas and displacing pingao with a dense growth of shrubs. During the time that one particular stand was being monitored, a destructive outbreak of kowhai moth was measured on that stand, followed by its recovery, only for it to be devastated later by an outbreak of the root fungus that has damaged tree lupin stands elsewhere in New Zealand. Tree lupin is now a much more scattered weed on Kaitorete, just keeping ahead of the disease. The original areas of dense tree lupin have however never been re-invaded by anything but ephemeral weeds. Threatened species research has so far focussed on *Muehlenbeckia astonii* behind the active dunes. This stand has been described as a "living museum" as there are no signs of shrub establishment. It seems that grazing by sheep and perhaps hares, limits establishment, but fencing only causes vigorous growth of herbs, especially *Acaena agnipila*, which probably limits establishment through competition. Taxonomic studies are being undertaken on other endemic species and once their status is resolved, conservation research into maintaining their populations may commence.

Actions

As the result of the research studies, a number of actions are being undertaken to restore lost values. In particular an extensive spraying regime has been undertaken to control marram. This has been especially successful, but has not resulted in much obvious pingao re-establishment. Planting of pingao seedlings has occurred, and this has demonstrated that establishment is best where there is sand movement. Kaitorete sand is of coarse texture and moves little, so re-invasion will be a slow and patchy process. Plantings will concentrate on situations such as blowouts in future. Rabbit-proof fencing has also been trialed to promote pingao seedling survival, and has been successful in allowing plants to reach beyond the palatable stage.

Sand mining has ceased, and various rehabilitation trials have been undertaken. However, the absence of a supply of sand has shown that there will be little change for some considerable time. The tree lupin disease has meant that there is little to be done regarding that weed, but others that are occasional such as gorse and broom are regularly removed when discovered.

Apart from an unsuccessful attempt to fence off a section of dunes dominated by the undescribed *Galium*, little action has so far been undertaken to enhance the rare species of Kaitorete Barrier. Fortunately the most famous endemic, that is the native broom, is abundant and performing well. There is concern however that *Austrofestuca* is being mistaken for marram during spraying.

A DECADE AFTER A 1990s SAND DUNE PLANTING AT NEW BRIGHTON

Colin D Meurk
Landcare Research and Christchurch City Council

Background

1990 was the sesquicentennial of the founding of the New Zealand Nation – 150 years since signing of the treaty of Waitangi. Many community groups around the country were funded for projects to commemorate this anniversary. In Christchurch, two 1990's committees were formed to promote projects specifically designed to celebrate their local natural heritage. One was associated with the former Heathcote County and involved four sites along the Heathcote River and one on the Port Hills. The other group (Rawhiti 1990s committee) planned to re-establish indigenous coastal bush communities on two sand dune sites – one in North Brighton opposite Thompson Park, the other in South Brighton on the wider dunes opposite Tovey and Jervois Streets. In 1991, the North Brighton Playcentre also commissioned a native landscaping of their grounds.

The northern dune site was characterised as having a steep foredune, with undulating top, sloping back down to Marine Parade. The southern site similarly had a fore dune, oversteepened by coastal erosion, and a broad sand flat running back to Marine Parade - which deviates further inland at this point. The dominant resident vegetation was marram grass, tree lupin, purple groundsel, catsear, yarrow, and a few other exotic grasses and herbs (see table for nomenclature). The only remnant native plants within a few km of these sites at the time of the planting was sand convolvulus, some tauhinu to the south, piripiri, a few NZ flax and cabbage trees, and three-square in some seasonally brackish wet places. North towards Brooklands is a greater diversity of regionally rare sand slack species and even a few remnant ngaio and akeake trees. The Playcentre site is a flat sand plain, 0.75 km from the coast on Leaver Terrace. The cover there was mown grass, a line of young macrocarpa and a couple of young Monterey pines.

Originally there would have been pingao and some spinifex on the foredune slope, scattered shrubs of sand coprosma, tauhinu, shrub pohuehue, with sand plains and seasonal swamps dominated by NZ flax, toetoe, cabbage trees, manuka, possibly with occasional mikimiki, marsh ribbonwood, three-square and knobby clubrush. The dunes in general also supported a scattering of dry woodland species – ngaio, akeake, kowhai, matagouri, NZ broom, etc. All these were swept away by fire, grazing and subsequent planting of marram, tree lupin, and pines in the first 50 years of European settlement.

The two sand dune sites were planted in late autumn of 1990 by hundreds of school children and other community volunteers. I carried out the design and planning with the help of the Rawhiti Committee, the ordering of plants, and oversaw the implementation. Most plants were in root trainers with some in bags provided by the City Council, DoC, and Waiora Nurseries. A few of the ngaio supplied were of Australian provenance and in the 'melee' were not immediately noticed. All other species were of local North Canterbury origin. Taupata and karaka are not truly indigenous to Canterbury, but have been spread in pre- or early post European times and are now well naturalised. Despite attempted control of the operation inevitably the planting standard was variable - some were planted on the beach near high tide mark and some root trainer stock were placed together in tight groups or even within the containers in a few cases! It was a learning experience for everyone. The soft, moist sand allowed for ease of planting and generally they would have been planted deep enough. However, in some cases transplant shock ensued as nursery grown plants in peat would lose moisture to the sand, especially if the surface, dry sand was used to repack the planting hole.

Christchurch experienced some of the driest weather on record during the subsequent decade. The City Council laid on a water supply and some hose and bucket watering (more on the northern site) was carried out by the Rawhiti volunteers. The Playcentre grounds were also irrigated in the early years. The flats at the southern site had unexpected frosts and, combined with drought, resulted in very poor establishment and survival. Only a limited selection of very hardy tussock and shrub species survived - cabbage trees, tauhinu, NZ flax and toetoe being the best performers. During the early years another unexpected impact was vandalism and theft. Sadly and frustratingly, some of the best established plants were taken - by the trailer-load - and although subsequent planting attempted to fill the gaps, the combination of harsh conditions and human disturbance has resulted in overall patchy effect. Perhaps this mimics the natural pattern anyway. High seas eroded all the minor pingao and spinifex plantings of the foredune, but these have subsequently been reinstated by *CoastCare* together with fencing and stabilising plantings primarily using African ice plant. *CoastCare* have also been supplementing the sparsely established southern site in the past couple of years and carrying out some weed control. They have used ngaio, cabbage tree, NZ flax, tauhinu and also karo and Chatham Island olearia which are growing.

The Playcentre plantings have had closer care, but at the same time are subjected to the trampling of tiny feet and other robust body contact. The larger pine trees at the Playcentre and also across the road from the northern dune site in Thompson's Park have probably provided shelter and protection from frost, although may also exacerbate localised water stress.

Results

Many of the tree species are now 3-4 tall in the sheltered back slopes of the dunes and most species have flowered and fruited over several years. Only a handful of species have self propagated - euphorbia vegetatively in the open sand of the foredune crest, NZ spinach likewise to the leeward of the crest, and possibly NZ linen flax by seed. This last season (one of the wettest and coolest on record) a handful of karamu seedlings have appeared at the base of a parent female bush.

In the last summer, a fire was lit at the North Brighton site and the Australian ngaio and a few coprosmas were burnt. The ngaio is resprouting. As the table shows, growth rates averaged over the 10 year period (or their period of survival) have ranged between *ca.* 10 and 45 cm per year. The latter higher figures are confined to the irrigated Playcentre site.

sand convolvulus	*Calystegia soldanella*	*				
sand coprosma	*Coprosma acerosa*	*	5.0	6.0c	+	
sand coprosma (D)	*Coprosma acerosa*	*	11.7	14.8c	+	
sand fescue	*Austrofestuca littoralis*	*	+		+	
sand sedge	*Carex pumila*	*				
scrambling pohuehue	*Muehlenbeckia complexa*	*		6.9c	10.0	
scrambling pohuehue (D)	*Muehlenbeckia complexa*	*		51.7c	51.7	
shining karamu	*Coprosma lucida*	*	7.5			
shrub pohuehue	*Muehlenbeckia astonii*	*			+	
silver tussock	*Poa cita*	*	+		+	+
spinifex	*Spinifex sericeus*	*		-	-	
tauhinu	*Cassinia leptophylla*	*	7.5	8c	7.7	9.6
taupata	*Coprosma repens*	*	46.8	17.2	11.9	-
three-square	*Schoenoplectus pungens*	*	(for slacks)			
toetoe	*Cortaderia richardii*	*		+	+	+
tree lupin	*Lupinus arboreus*					
tutu	*Coriaria sarmentosa*	*				
yarrow	*Achillea millefolium*					

[1] * locally indigenous and/or can be considered for use or trialing in dry coastal environments.
Also indicated is average annual height growth (cm) of well-established plants at the;
[2] (PC) Playcentre
[3] (NB) North Brighton sand dune (superscript 'c' = on exposed crest)
[4] (SBd) South Brighton sand dune
[5] (SBp) South Brighton plain
[6] '+' indicates the species was tested and survived or performed well at least temporarily
[7] '-' indicates planting and no survival.
[8] (D) after the species name refers to those for which the diameter not height increment is quoted.

MARRAM GRASS CONTROL IN SOUTHERN NEW ZEALAND

Mike Hilton
Department of Geography
University of Otago
PO Box 56, Dunedin

1. New Zealand's Southern Dunes

Southern New Zealand contains dune systems of exceptional conservation value and geomorphic interest. They are not, however, evenly distributed around the Otago and Southland coasts. The Sand Dune and Beach Vegetation Inventory (Johnson, 1992) identifies 30 sites considered of national importance. Only two are in Otago (Tautuku and Tahakopa). Most are located along the Fiordland and Stewart Island coasts (10 and 9) respectively. A further four occur along the mainland coast of Fouveaux Strait. At least one of these (Long and Dummy's Beach) has been degraded by cattle since fieldwork for the Inventory was completed in the 1980s.

The dunelands of Otago are probably the most degraded in New Zealand. The area of duneland has declined by about 41 per cent since World War II, which is well below the national average of 70 per cent (Hilton *et al.*, in press). However, all Otago dunelands are now dominated by marram grass (*Ammophila arenaria*), to the detriment of natural dune processes and the distribution and diversity of the native dune flora and fauna. Pingao (*Desmoschoenus spiralis*) is a useful indicator of dune flora diversity. Tahakopa Beach contains the largest area of pingao between Kaitorete Spit and Fortrose Spit. The total area of pingao is, only 139 m^2, compared with approximately 79,000 m^2 of marram grass (Barnes *et al.*, 1999). Marram grass thrives in southern New Zealand as a result of the relatively cool climate and the availability of suitable habitat. Remaining pingao and other dune species will likely be lost from the southern mainland without intensive management.

The dune systems of Fiordland and Stewart Island (Rakiura) have been somewhat less affected by marram grass. The dunes of these coasts are of exceptional botanical and geomorphic importance. Compared with most mainland sites these systems exhibit a high degree of naturalness. This naturalness is due to the relatively late arrival of marram grass, the absence of most human use and development pressures and a successful marram grass control program run by the Department of Conservation. The dune systems of Stewart Island are distinctive in at least three respects: (1) the widespread occurrence of both representative and rare plant species; (2) the presence of complete dune systems and extensive dune landscapes; and (3) the wide range of dune landforms present. In future they will provide one of the few opportunities to experience and study the natural character of large, intact, dune systems.

Marram grass is the only significant threat to the natural character, ecology and conservation values of Stewart Island dune systems, although other species are locally invasive (e.g. gorse, *Ulex europaeus*). Marram grass displaces native dune species by agressively colonising areas of sand deposition in dynamic dune environments (Hilton and Duncan, 2000). The grass may also outcompete native species for nutrients in stable or semi-stable situations (Partridge, 1995), but this process appears less important in the Stewart Island context. Marram grass also disrupts the natural development of dunelands by accelerating the onset of substrate stability and vegetation succession. The impact of marram grass on the diversity of the native dune flora of Stewart Island is the subject of ongoing research at the University of Otago.

Marram grass was introduced to Mason Bay and Doughboy Bay by farmers early last century, probably around the 1930s; but it may also have been carried across Fouveaux Strait by the Southland current. Further small-scale plantings took place in Mason Bay in the 1960s. By the late 1980s marram grass was rapidly invading all Stewart Island dune systems. For example, between 1958 and 1998 the area dominated by marram grass in central Mason Bay increased from 1.4 to 74.9 ha, an increase of 5,204 per cent. Over the same period the area of dune habitat without marram grass decreased from 253.5 ha to 137.0 ha, a decrease of 50.5 per cent (Jul *et al.*, 1999). Marram grass dominates the foredune complex in Mason Bay. Jul *et al.* (1999) estimate marram grass will become the dominant vegetation cover in the Mason Bay study area between 2023 (worst case) and 2043 (best case). Marram grass is already the dominant vegetation cover within most of Doughboy Bay - although some very important dune plant communities are still present. In the above research marram grass was identified as the 'dominant' species when it comprised more than 50 per cent of the vegetation cover.

2. Overview of Dune Restoration in Southern New Zealand

Marram grass control and dune habitat restoration in Otago and Southland has largely been undertaken by the Department of Conservation. Regional councils and territorial local authorities have shown little interest, with the exception of individual staff. Most southerners are unfamiliar with pingao and many would consider marram grass to be a native dune species. Most local authority staff and politicians would probably concur.

There are significant differences in the approaches of the Otago and Southland conservancies of DoC. The Southland Conservancy commenced a programme of marram grass control soon after DoC was established in 1987. This programme covered the north and west coasts of Stewart Island and the dunelands of Fiordland. Over a period of about 10 years marram grass has been reduced to zero density in some of the nations most important dunelands, including Smoky Beach, East Ruggedy, West Ruggedy, Little Hellfire, Big Hellfire and the above Fiordland dunelands. These beaches are still visited occasionally to locate and destroy reinfestations of marram grass. Total eradication is not yet viable because of the large areas of marram remaining on Stewart Island and in the wider Southland region.

The local eradication of marram grass from the above Stewart Island and Fiordland beaches is one of the most significant events in the history of dune management and conservation in New Zealand. The achievements to date owe much to the persistence of DoC field staff shrub and tree species is likely. There is no likelihood of further colonisation by pingao unless there is significant destabilisation and sand movement.

The marram dominated dunes, landward of the storm scarp, contain a remarkable diversity of native plant species compared to marram dominated dunes at most Otago and Southland locations. Many common native dune plant species are present including: *Colobanthus muelleri*; *Acaena novae-zelandiae*; *Gentiana saxosa*; *Coprosma acerosa*; *Luzula banksiana var. acra*; *Hydrocotyle americana*; *Gnaphalium luteo-album*; *Pimelea lyallii*; *Lagenifera pumila*; *Hydrocotyle microphylla* (?); *Myosotis pygmaea var. pygmaea*; *Ranunculus recens*; and *Selliera radicans*. Other species include Catsear (*Hypochoeris radicata*) and prickly puha (*Sonchus kirkii*).

This diversity is related to the depositional history of the southern dunes - namely that the dunes prograded very rapidly and very recently. Moreover, there has been little subsequent disturbance of the primary dunes. Such disturbance would have resulted in the burial and loss of many of the native plant species. These species have apparently colonised the foredune ridges as the barrier prograded. In contrast, the foredune complex between Duck Creek and Martin's Creek in Mason Bay is constantly modified by the erosion and then stabilisation of minor blowouts. Rates of sedimentation in the foredune complex are high and native plant species have been virtually eliminated. If marram grass is not removed from the dunes of the study area the diversity of natives will decline over time as a result of episodes of dune disturbance and deposition related to infrequent storm events. Each episode of instability is likely to both bury native species and favour fresh marram growth.

The stability of the barrier following marram grass invasion has favoured the invasion of gorse. Gorse has been present in the study area for at least 20 years but until recently was restricted to the landward margins of the barrier. Approximately 360 m^2 of gorse was present in the study area in December 1999. Gorse appears to be establishing in more exposed conditions across sections of the old storm scarp and may be expected to spread to the hollows between the sequence of foredune ridges unless eradicated.

Marram Control Operation, February 1999

The southern dunes were sprayed with Gallant NF (plus additives) on the 8 February 1999 using a Robinson helicopter equipped with spray boom. A total of 140 litres of Gallant NF was applied at a dilution of 15 ml/litre across an area of approximately 6.9 ha. The herbicide was, therefore, applied at the rate of 2 ml/m^2.

The area sprayed was revisited in June 1999 by which time the leaf matter had turned brown. The site was again visited in December 1999. Regrowth was apparent along the foredune, in patches across the northern third or so of the barrier and scattered across the remainder of the dunes. Analysis of data from permanent quadrats and comparison of purpose-flown colour aerial photographs suggests the February 1999 operation killed about 70 per cent of the marram grass. Clearly some plants received a sub-lethal dose of herbicide and sprouted from buds on the rhizomes during the spring of 1999.

The Doughboy operation was successful, despite some marram regrowth. Marram grass was killed over a wide area. Several factors may have contributed, in isolation or collectively, to the survival of some plants including: (1) burial of marram grass by sand along the face of the foredune prior to the operation; (2) stress and morphological adaptations (rolled leaf) during the drought of 1998/99; (3) low uptake of herbicide by non-thrifty plants behind the foredune; and (4) the rhizomatous character of marram grass.

4. Discussion

The February 1999 operations resulted in the widespread death of marram grass across the southern dunes of Doughboy Bay. The use of helicopters to apply herbicide across large areas of dune appears significantly more efficient than the use of manual knapsack sprayers. *Ammophila arenaria* is, however, a very difficult species to eradicate. Agencies involved in marram control in southern New Zealand must anticipate an operation spanning at least five years, regardless of the initial method of herbicide application. Periodic re-spraying will be required thereafter. The manual spray operations of the 1990s demonstrate the fundamental importance of persistence in marram grass control operations.

Careful monitoring of the Doughboy Bay marram grass programme should provide new information on how dune morphology and vegetation cover change during a marram control operation. The February 1999 work resulted in minor dune disturbance and sedimentation. The face of the foredune eroded during winter but quickly reformed as marram reestablished from viable rhizomes across the stoss face of the foredune. Any process that enhances sedimentation, the process of erosion, transportation and deposition of sand, appears to favour marram grass invasion. Marram grass regrowth in the study area during spring 1999 was greatest in those areas that are experiencing the highest rates of sedimentation - the stoss face of the foredune and the relatively exposed (to wind) and dynamic northern area of the barrier.

A "Catch-22" is manifest. Marram grass loses vigour in conditions of substrate stability and interspecies competition. In the southern dunes of Doughboy Bay this process has apparently been exacerbated by the rapid colonisation of the dunes by a range of native and exotic plant species. The "catch" is that the initial death of marram grass following herbicide application is likely to destabilise the surface sands of the foredune and so create ideal habitat for surviving marram plants. Initial die-back and decay of the tillers exposes the substrate which is then eroded to rhizome or root level by onshore winds. The sand eroded is deposited as lobes in the lee of the foredune. Surviving tillers receive a significant boost from the arrival of fresh, nutrient-rich, sand. The accumulation of sand in the lee of the foredune also reduces competition by burying and killing most native species.

The southern dunes of Doughboy Bay are particularly exposed to winds from the west to northwest, so sand erosion is likely to follow marram eradication. The marram grass control operation of February 1999 has so far had little impact on the native dune flora of the study area because marram regrowth has prevented general destabilisation of the foredune. It is likely follow-up marram control operations will result in more general dune destabilisation, the decay of the current ridge and swale landscape and the loss of those native species poorly adapted to burial. The outcome will be a new landscape and vegetation cover, most likely dominated by pingao, with a less diverse assemblage of native species seaward of the old pingao dune. If sand blows across the old dune we would expect both renewed pingao growth and necrosis of most of the existing backdune species, including manuka, inaka and *Pernettya macrostigma*. The current phase of vegetation succession would be reversed. Destabilisation may, therefore, be a desirable and necessary process in the restoration of the southern dunes if the goal is to restore the pre-marram dune community. This community was likely dominated by a relatively small number of species more tolerant of sand burial, namely pingao, *Pimelea lyallii*, *Coprosma acerosa* and *Austrofestuca littoralis*, with another 20 or so native species occurring in more stable and/or moist locations. If destabilisation of the marram-dominated dunes and concomitant burial of natives is an inevitable and desirable result of a dune restoration initiative (using Gallant NF) there may be merit in using a cheaper, non-selective, herbicide, at least in certain areas.

Periodic disturbance is a primary characteristic of dunelands. Moreover, disturbance is a necessary condition if succession and loss of the dune habitat is to be avoided. From time to time conditions will favour the establishment of plant communities favouring stable substrates, where previously there was sparsely vegetated, semi-stable, sands. This vegetation cover may be periodically disturbed and the cycle reinitiated, as has occurred at least three times, at a macro scale, over the last 1,800 years or so. Marram grass may interupt this cycle by accelerating the onset of stability and inhibiting further instability. Were a non-selective herbicide to be employed, the destabilising effect may simply mirror the impact of forces that naturally destabilise dunelands. If the goal is to restore the biota of dunelands the natural function and character of dunelands must also be restored.

Conclusions

The dunelands of southern New Zealand have been particularly affected by marram grass. The Southland Conservancy of the Department of Conservation is committing significant resources to a programme of ongoing marram grass control in Fiordland, Stewart Island and at Fortrose Spit. This work is of tremendous importance to the preservation of the natural character of the sandy coasts of southern New Zealand. The Otago Conservancy recently undertook marram control at Tahakopa Bay, the best surviving duneland in Otago.

DoC Southland recently commenced marram grass control at Doughboy Bay, by far the largest operation to date. The effectiveness and effects of this operation are being carefully monitored. The results should assist the Department plan for the eradication of marram grass from Mason Bay, by far the largest marram-infested site on Stewart Island.

Marram grass is difficult to eradicate in southern New Zealand. The operation to eradicate marram grass from the southern dunes of Doughboy Bay will take at least five years.

Dune disturbance is an inevitable and probably desirable consequence of marram grass eradication in southern New Zealand. In the Doughboy case an initial decline in native species diversity will likely follow marram eradication. Were marram grass control not to continue the diversity of native species would decline in any case. Most southern dunelands dominated by marram grass contain only a handful of native species.

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MEETING PARTICIPANTS

Name	Organisation or Location	E-mail	Phone
Joye Adams	Tauranga District Council	dulcief@tauranga-dc.govt.nz	07 575 5185
Arthur Adcock	Christchurch City Council		
Sandra Adcock	Christchurch City Council		
Bryan Aptekar	University of Otago	c/- Mike Hilton	
Lynnaire Avers	Department of Conservation		07 578 7677
Johnathan Barran	Johnathan Barran Photography Ltd	john.barran@jbphoto.co.nz	07 348 1048
Leonardo Bastos	University of Otago	c/- Mike Hilton	
Dorothy Batchelor	Southshore Ratepayers Assoc.	batchelorl@xtra.co.nz	03 388 2012
Les Batchelor	Southshore Ratepayers Assoc.	batchelorl@xtra.co.nz	03 388 2012
Sean Bellamy	University of Otago	c/- Mike Hilton	
Alan Benson	Medland Beach Care Group	gracealan.b@xtra.co.nz	09 846 4511 09 429 0227
David Bergin	***Forest Research***	david.bergin@forestresearch.co.nz	07 343 5899
David Blair	Yellow-eyed Penguin Trust & Pingao Recovery Group	dblairs@xtra.co.nz	03 487 7756
Jane Boulton	University of Otago	c/- Mike Hilton	
Olivia Campbell	University of Otago	c/- Mike Hilton	
Anne Carroll	Shirley/Papanui Community Board	comcare@clear.net.nz	03 355 2906
Catherine Carter	University of Otago	c/- Mike Hilton	
Rodney Chambers	Christchurch City Council	rodney.chambers@ccc.govt.nz	
Don Clark	horizons.mw	don.clark@horizons.govt.nz	06 327 7189
Justin Cope	Canterbury Regional Council	justinc@crc.govt.nz	03 365 3828
Brian Cosslett	Waiora Trust	jbcos@xtra.co.nz	03 359 7407
Kelly Crandle	Hutt City Council	crandle@huttcity.govt.nz	04 570 6774
Jim Dahm	Environment Waikato	jimd@wairc.govt.nz	
Mark Davis		m.davis@clear.net.nz	03 332 2685
Trish Davidson	New Plymouth District Council	davidsont@npdc.govt.nz	06 759 6060 ext 8870
Mark Dean	Naturally Native NZ Plants Ltd	mark@naturallynative.co.nz	07 543 1494
Esme Dean	Naturally Native NZ Plants Ltd	esme@naturallynative.co.nz	07 543 1494

Stacey Devine	Auckland Regional Council	sdevine@arc.govt.nz	09 366 2000 ext 8401
Peter Dunbar	New Brighton Pier & Foreshore Society		03 358 3623
Mitchell Dyer	Taranaki Regional Council	mitchell.dyer@trc.govt.nz	06 769 7127
Fiona Ede	***Forest Research***	fiona.ede@forestresearch.co.nz	07 343 5899
Carole Evans	Christchurch City Council	carole.evans@ccc.govt.nz	03 388 5137
Phillip Eyles	University of Otago	c/- Mike Hilton	
Chris Freeman	Christchurch City Council	chris.freeman@ccc.govt.nz	
Paul Freeland	University of Otago	c/- Mike Hilton	
Judith Earl-Goulet	Southern Institute of Technology	juditheg@sit.ac.nz	03 218 2500
Lachie Grant	horizons.mw	lachie.grant@horizons.govt.nz	06 345 0705
David Gregory	Canterbury Regional Council	davidg@crc.govt.nz	03 365 3828
David Harrison	horizons.mw	dave.harrison.1@horizons.govt.nz	06 327 7189
Greg Herrick	Ernslaw One Ltd	gregh@ernslawtga.co.nz	06 322 1558
Patrick Hesp	Massey University	p.a.hesp@massey.ac.nz	06 350 2499
Michael Hilton	University of Otago	mjh@geography.otago.ac.nz	03 479 8778
Yuet Ching Ho (Loretta)	University of Otago	c/- Mike Hilton	
Sally Hobson	Hawke's Bay Regional Council	sally@hbrc.govt.nz	06 844 2495
Kay Holder	Christchurch City Council	kay.holder@ccc.govt.nz	
Philippa Hooper	Wellington City Council	philippa.hooper@wcc.govt.nz	04 389 9729
Greg Jenks	Environment Bay of Plenty	gregj@envbop.govt.nz	07 574 8810
Jenny Lineham	New Brighton Pier – Foreshore Promotion Society Inc		03 388 6628
Campbell Larking	University of Otago	c/- Mike Hilton	
Lyle Mason	Invercargill		03 246 8406
Pat McCarthy	Ernslaw One Ltd	patm@ernslawtga.co.nz	06 322 1558
Kate McCombs	Christchurch City Council		
Kate McKeowen	Christchurch City Council	kate.mckeowen@ccc.govt.nz	
Craig McKibbin	University of Otago	c/- Mike Hilton	
Colin Meurk		colin.Meurk@ccc.govt.nz	
Jacob Meimban	University of Otago	c/- Mike Hilton	
Michael Moore	University of Otago	c/- Mike Hilton	
Kathy Mortimer	Northland Regional Council	kathym@nrc.govt.nz	09 438 4639

Glenys Mullooly	Whangarei District Council	glenysm@wdc.govt.nz	09 438 4879 09 430 7221
Dean Nelson	Department of Conservation	dnelson@doc.govt.nz	03 477 0677
Craig Oliver	Christchurch City Council	craig.oliver@ccc.govt.nz	
Suzy O'Neill	Tauranga District Council	suzyo@tauranga-dc.govt.nz	07 577 7123
Trevor Partridge	Landcare Research, Lincoln	partridget@landcare.cri.nz	03 325 6700
Mike Peters	New Zealand Ecological Restoration Network	office@bush.org.nz	03 338 5451
Amy Reid	University of Otago	c/- Mike Hilton	
Helen Ricketts	NZ Landcare Trust	helen@landcare.org.nz	03 349 2640
Jason Roberts	Christchurch City Council	jason.roberts@ccc.govt.nz	
Don Ross	NZ Landcare Trust	don@landcare.org.nz	03 349 2630
Mark Ross	Christchurch City Council	mark.ross@ccc.govt.nz	
Ken Schischka	New Plymouth District Council	schischkak@npdc.govt.nz	06 759 6060 ext 8864
Andre Schmid	University of Otago	c/- Mike Hilton	
Gail Sheriff	Christchurch City Council	gail.sheriff@ccc.govt.nz	03 388 5137
Philip Smith	Taupo Native Plant Nursery	tauponpn@voyager.co.nz	07 378 5450
Harley Spence	Coastline Consultants Ltd	harley@coastline.co.nz	025 2785646
Christopher Staite	University of Otago	c/- Mike Hilton	
Kelly St Clair-Newman	University of Otago	c/- Mike Hilton	
Greg Steward (Secretary)	***Forest Research***	greg.steward@forestresearch.co.nz	07 343 5899
Bill Steans	Timaru District Council	bills@timdc.govt.nz	03 684 2203
Ngaire Sullivan	Auckland Regional Council	nsullivan@arc.govt.nz	09 366 2000 ext 7019
Patrick Thorp	Auckland City Council	thorpp@akcity.govt.nz	09 372 5923
Sharon Thurlow	University of Otago	c/- Mike Hilton	
Sharyn Westlake	Opus International Consultants Ltd	sharyn.westlake@opus.co.nz	04 471 7394
Melanie White	Christchurch City Council	melaniewhite@xtra.co.nz	03 388 6913
Chrissie Williams	Burwood Pegasus Community Board	chrissiew@netaccess.co.nz	03 388 0798
David Wright	Department of Conservation	dwright@doc.govt.nz	09 425 7842
Brodie Young	Canterbury Regional Council	brodiey@crc.govt.nz	03 365 3828

APPENDIX I

LIST OF CDVN PUBLICATIONS AND NEWSLETTERS

Publications:

Bergin, D.O. and Herbert, J.W. 1998. Pingao on Coastal Sand Dunes. Guidelines for seed collection, propagation and establishment. Coastal Dune Vegetation Network Technical Bulletin No.1. New Zealand Forest Research Institute Limited.

Bergin, D.O. 1999. Spinifex on Coastal Sand Dunes. Guidelines for seed collection, propagation and establishment. Coastal Dune Vegetation Network Technical Bulletin No.2. New Zealand Forest Research Institute Limited.

Bergin, D.O. 2000. Sand Tussock on Coastal Sand Dunes. Guidelines for seed collection, propagation and establishment. Coastal Dune Vegetation Network Technical Bulletin No.3. New Zealand Forest Research Institute Limited.

Newsletters:

Coastal Dune Vegetation Network Newsletter No.1, December 1997.

Coastal Dune Vegetation Network Newsletter No. 2, September 1998.

Coastal Dune Vegetation Network Newsletter No. 3, December 1998.

Coastal Dune Vegetation Network Newsletter No. 4, July 1999.

Coastal Dune Vegetation Network Newsletter No. 5, December 1999.

APPENDIX II

COASTAL DUNE VEGETATION REFERENCE LIST

The following reference list was compiled from a number of sources. At present the list contains over 350 references, but it is far from complete and will be an evolving document. Therefore, you are invited to contact the CDVN Secretary (Greg.Steward@forestresearch.co.nz) to add, delete, update or correct references, it would be preferable if alterations could be sent electronically, where possible. The reference list is presented in a number of very broad categories including sections on Coastal Vegetation (Sand Tussock, Backdune vegetation and Coastal Forest, Marram, Pingao, Spinifex, General), Fertilisers, Geomorphology, Wildlife (Birds, Invertebrates, General), General Coastal Issues, Coastal Policy and two specific locations (Kaitorete Spit and Australia). Other categories will be added, as references become available.

Important notice: The CDVN secretariat does not hold copies of all the listed references. Therefore, in the first instance, you should attempt to obtain required references through normal library sources or by contacting the author or the publishing organisation. The Network cannot guarantee that any or all references will be available. Users of this list should also be aware that there might be a financial charge for the cost of supplying some references from some sources.

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