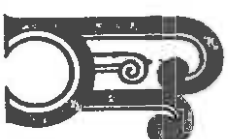


**PINGAO AND KAKAHO
ON THE MANAWATU/RANGITIKEI COAST
A SURVEY BY
PANEKE CONSERVATION TEAM**

PANEKE COMMUNITY DEVELOPMENT & TRAINING TRUST INC.



The word Paneke means to Advance forward
The Koru on the right represents growth forward
The Koru of the left, the Maori people
The Koru in the centre the Pakeha people
The arch represents a bridge
The Logo - Represents the Maori and Pakeha people moving forwards together, building firm, the bridge of love, peace and understanding.

TRUST

Paneke Community Development & Training Trust Incorporated is established and incorporated under the Charitable Trusts Act 1957.

CONSTITUTION

The Paneke Constitution is established under the Charitable Trusts Act 1957. The Constitution include many objects and purposes among which is 2(e).

2(e) To assist within the community any project or activity helpful towards the betterment of all people or cultures to work together in common cause to bring about a better future for coming generations of New Zealand's children.

BOARD

Chairman:	Mr K S Christensen BEM, AFSM A.M. Inst. M
Member:	Mr N R Aylward B Com ACA
Member:	Mr J R Moxon ACA
Member:	Mr F R Flavell
Member:	Mrs R M Flavell
Member:	Mr O H Topia
Life Honary Member:	Mr J Kamariera JP, L-E
Secretary:	Mrs J Harnett
By Appointment:	Minister Rev C M Rowlands

Project Supervisor: Mr M.P.M. Turoa
PO Box 7175
Palmerston North.

The Human Mind can be changed in thinking by other Human Minds, which when occurs, arouses the Manawa embedded deep within the pit of the stomach, and in turn brings bearing upon attitude and direction of a person, a group of people or a nation.

Let us all exercise the mind by being openminded and arouse the Manawa from the depths, and direct our attitude to enhance cultural understanding, togetherness, goodwill and harmony and build strongly upon the seeds of trust and love for the future of our mokopuna (children) and our nation.

Let us take active notice of the land, the sky, the air, the seas, the rivers, the forests and all those things that dwell within these realms of papatuanuku (earth), tawhirimatea (wind), Tangaroa (the sea) and Tane Mahuta (the forest & birds). Take charge o-people of today and allow the eyes of future generations to feast on its beauty.

Allow the preservation and conservation of our natural resources be our common goal and focus, to build on and allow the passages of the Treaty of Waitangi to be carried out. Allow this focus to be stepping stones to bring people together in collective cause, and give it challenge to stimulate the mind of a nation to purposefully work together, to enhance the environment and to enhance ourselves. Let peace and love, respect and dignity flourish from this focus.

Allow the natural resources that we destroy so easily and without thought, be the very strength upon which to build a caring people, a caring New Zealand.

He ao Te rangi ka uhia
He huruhuru te mana ka tau

As clouds deck the heavens
so feathers deck the bird.

CONTENTS

Contents	1.
Abstract	3.
Introduction	5.
Aims	7.
Background	
Cultural Aspects	9.
1. Pingao	9.
2. Toetoe Kakaho	11.
Relevant Issues	
1. Pingao	11.
2. Toetoe Kakaho	12.
3. Shell BP Todd Pipeline Proposal	12.
Biology and Distribution	
1. Pingao	12.
2. Toetoe Kakaho	14.
Survey Area	
1. Boundaries	16.
2. Land Tenure	16.
3. History	16.
4. Climate	19.
5. Topography	19.
6. Flora	21.
7. Fauna	22.
8. Human Impact	22.
Survey Method	
Phase I	25.
Phase II	26.
Results	
Phase I	31.
Phase II	34.
Discussion	
Discussion of Phase II Areas	43.
Distribution and Density	
1. Pingao	47.
2. Toetoe Kakaho	48.
Threats	48.
1. Pingao	48.
2. Toetoe Kakaho	51.
Areas for Reserves, Replanting and Harvesting	51.
Evaluation of Survey Method	53.

Recommendations	55.
Acknowledgements	57.
Bibliography	58.
Appendices	
Differences Between Toetoe Kakaho and Pampas Grass	59.
Phase I Recording Sheet	60.
Phase II Survey Recording Sheet	61.
Phase II Mapping sheet	63.
Phase II Area Summary Sheet	65.
List of Illustrations	66.

He toa takitini toa
Ehara i te toa takitahi

My heroism is not individual
It is collective

We have pleasure in preparing and presenting this report

Miss P.E. Swindells

Mr A. Taylor

Miss K.J. Mills

Miss R.W. Lewis

Miss R.J. King

Miss D.J. Samuel

Mr M.P.M. Turoa

PROJECT CONTACT PERSONS:

Mr M.P.M. Turoa Telephone (Work) 75.182 (Home) 79.067

Mr F.R. Flavell Telephone (Work) 67.463 (Home) 86.818

ABSTRACT

A survey of the distribution and density of the plants pingao (*Desmoschoenus spiralis*) and kakaho (native toetoes, *Cortaderia spp.*) was carried out along the Manawatu coastline between March and October 1989.

The first phase of the survey involved a walk through of the whole area from the Manawatu river mouth to the Whangaehu river mouth to make an initial evaluation of the distribution and density of these plants.

The survey showed that pingao is scattered along most of the coastline, but for a pingao area considered to be one of the best in the country, the plant is certainly not abundant. A number of threats to the plant were identified.

Kakaho was observed in several places along the survey area, mostly on flats behind the dunes. It appears to be threatened by the encroachment of pampas grass (introduced *Cortaderia spp.*).

In the second phase, a total of 12 areas were selected for a more detailed survey of pingao. These were the areas identified in Phase I (refer page 26) as those where pingao was most abundant.

From the results of both phases, areas best suited for reserves for both plants and for the replanting and harvesting of pingao were identified (refer page 52).

Recommendations are made (refer pages 55,56) in relation to further work in reserve establishment, moves to lessen the major threats to pingao and in making groups or individuals with coastal influence and responsibility aware of the significance and plight of both pingao and kakaho.

INTRODUCTION

The Paneke Conservation Project is one of twenty New Zealand Conservation Corps pilot projects being run in 1989/90. The projects are funded by the Ministry of Youth Affairs and are aimed at giving young people opportunities for personal development and skill acquisition through participation in conservation activities of lasting benefit to the community.

The project began in March 1989 and finished in March 1990 under the management of Paneke Community Development and Training Trust Incorporated. Project planning was done in conjunction with the Department of Conservation who offered advice and expertise where needed.

The aim of the Paneke Conservation Team's project is to stop the decline of the plants pingao and kakaho. These plants have a very important place in Maori mythology and culture. Both have long been used for weaving and in the construction of tukutuku panels which are used to line meeting houses. There are no substitutes for these, so it is vital that they be preserved and protected for future generations.

Pingao (*Desmoschoenus spiralis*) is a native sand-binding plant endemic to New Zealand. It was once one of the dominant plants of the New Zealand dunes but now its distribution is very limited and it is classified as a "vulnerable" plant. For some time various groups have expressed interest in and initiated projects on pingao in the Manawatu.

Kakaho refers to the stem and flowerhead only of New Zealand's native toetoes (*Cortaderia spp.*). There are four species of these, which are easily confused with the closely related introduced pampas grasses. In this report we shall refer to these four species collectively as toetoe kakaho, i.e. those *Cortaderia* species which produce kakaho.

A major part of this project was to survey the coastline from the Manawatu river mouth to the Whangaehu river mouth. This report contains the information gathered on this survey.

Other objectives of the project were propagation of pingao, community awareness through education programmes, establishing coastal test sites to assess propagation of pingao in its natural habitat and researching background information on biology and cultural aspects. On request a short course was devised by the Manawatu Polytechnic on basic horticultural skills for propagation.

The Paneke Conservation Team was supervised by Moetatua Turoa and consisted of the following people:

Rebecca King
Rachel Lewis
Kiri Mills
Doreen Samuel

Linda Strange
Paula Swindells
Adrian Taylor
Francis Van Hellemond

AIMS

The aims of the survey were:

1. To assess the distribution and density of pingao and toetoe kakaho along the coast between the Manawatu and Whangaehu river mouths.
 2. To evaluate the major threats to these plants.
 3. To identify suitable areas for reserves for the protection of both plants.
 4. To identify suitable areas for re-establishment and management of pingao.
 5. To produce a report to use as an educational and management resource to assist in protection of both pingao and toetoe kakaho.
-

BACKGROUND

CULTURAL ASPECTS

1. PINGAO

Pingao is a plant much favoured throughout Maoridom; it has a strong place in mythology and legend, and in the arts and crafts. Its leaves are highly prized and sought after for use in weaving and in making tukutuku panelling for lining the walls of the ancestral meeting houses.

The traditional weaver regards pingao as a plant material which inspires the maori artist to demonstrate the highest qualities of workmanship in form and function. With the renaissance of the Maori culture in the last few years, both in the weaving arts, and the refurbishing of marae, use of pingao has greatly increased.

In the past the harvesting and use of pingao were governed by strict rules, or Tikanga Maori, which preserved the plant and its habitat. This often meant putting a "rahui" (restricted area) on areas that were becoming depleted. The well-trained weaver could size the strands of pingao and assess the condition of the plant. All this was taken into consideration before cutting began. However the correct Tikanga concerning the harvesting of pingao is now known only to a few, which has led to the plants being harvested indiscriminately. Traditional sources have been vastly diminished as a result.

In Maoridom there is no substitute for pingao and any person in possession of anything made from pingao should take care of it and understand the uniqueness attached to it. Under the principles of the Treaty of Waitangi, Article II, the Maori people retain the right of possession of their much valued Taonga (treasures), in this case pingao. Control is clearly defined in the terms of the Treaty as exclusive and undisturbed possession by Chiefs and Tribes of New Zealand.

The Manawatu coastline has been well known for many years as an excellent place for harvesting pingao, because of both the quality - its golden colour - and the supposed abundance of the plant in this area. Today weavers from all over the country still come to this coast to collect pingao or have it sent to them from here. With the great increase in Maori art over recent years the demand on the pingao on this coast is increasing, hastening the depletion of the plant.

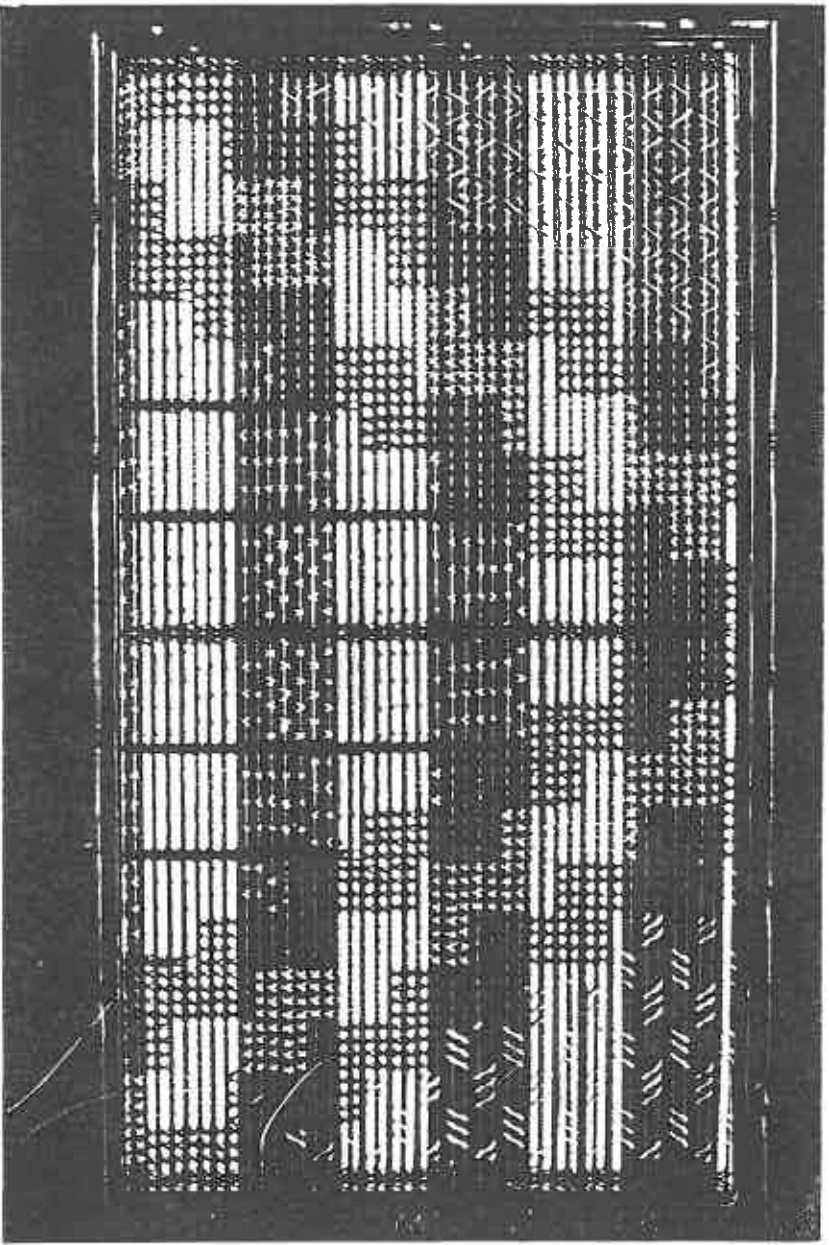


Fig 1: Tukutuku panel incorporating both pingao and toetoe kakaho

2. TOETOE KAKAHO

Toetoe kakaho has long been a part of maori crafts and medicine.

The early Maori used toetoe kakaho to line the walls of their ancestral meeting houses. From this developed the Tukutuku panel, which is a latticed panel of toetoe kakaho bound by decorative patterns of woven pingao, kie kie and flax.

Toetoe kakaho was also used in the kites made by the Maori, as the main frame onto which was bound raupo leaves to form the body of the kite. Short bound bundles of kakaho were used as underarm floats for children when they were learning to swim.

It is believed the flower head of toetoe kakaho was used to stop the flow of blood from wounds and the ashes of the plant were applied to burns as a poultice. For diarrhoea the lower part of the undeveloped leaf was eaten. Juice from the stem was used to clean the tongues of infants and the stem was chewed and swallowed for kidney trouble.

For the early Maori toetoe kakaho had a very valuable place in their culture with its broad range of uses. Today it still has many valuable uses, ranging from childrens crafts to being incorporated into modern sculptures.

RELEVANT ISSUES

1. PINGAO

Since 1971 there has been interest in reserving an area of pingao on the Manawatu - Rangitikei coast.

In August 1971 the Maori Womens Welfare League approached the Minister of Forests about reserving areas of natural pingao.

In April 1973 a request from the Director of the N.Z. Maori Arts and Crafts institute in Rotorua was made for an investigation of Raumai as a potential reserve for pingao. The investigation was seemingly never carried out by the Palmerston North Lands and Survey Department despite requests from Head Office.

In September 1987 in a letter to the Wanganui Regional Manager of the Department of Conservation, concern was expressed that the Foxton Beach rubbish dump was encroaching onto pingao-containing dunes, and the near by go-kart track was also damaging pingao and dunes. The letter also suggested implementation of a pingao survey to determine present status of population, to identify threats and to decide on means of management and protection.

During 1986 the MAF Horticultural Research Centre at Levin conducted some trials on pingao propagation. A plot was established at their outstation behind the Telecom radio station at Himatangi in order to examine the feasibility of growing an area of pingao specifically for harvesting purposes, thereby relieving the pressure on natural foredune pingao. The work was discontinued due to lack of funding.

2. TOETOE KAKAHO

Prior to the Paneke programme toetoe kakaho was not considered to be at risk as it is reasonably plentiful in most parts of the country, both inland and coastal. Since the beginning of the programme, evidence has suggested that pampas is increasingly occupying the same habitat as toetoe kakaho (D. Ravine, *pers. comm.*). This may be leading to the decline of toetoe kakaho and there is need of further close study.

3. SHELL BP TODD PIPELINE PROPOSAL

Shell BP and Todd Oil Services Limited have proposed to use an area of pingao habitat at Tangimoana for the construction of a gas pipeline. On completion the pipeline would be towed out to sea and used to join the Maui A and B gas platforms off the Taranaki Coast. The construction itself would not interfere with the dunes but before towing, an area of the dunes will need to be flattened to allow the pipeline through. This length of coastline should not be greater than 300 m. If the proposal goes ahead this stage would occur in early 1993.

Reconstruction of the area after this work would provide opportunities for the establishment of a reserve.

BIOLOGY AND DISTRIBUTION

1. PINGAO (*DESMOSCHOENUS SPIRALIS*)

1.1. *Biology:*

Pingao, sometimes called the "Golden Sand Sedge", belongs to the family Cyperaceae, many plants of which are used for weaving. It is a perennial herb with stiff, curled, three-ridged leaves ranging in colour from green to golden yellow. The inflorescence is a panicle (an upright central growth surrounded by clusters of flowers), and the flowers are self pollinating. The clusters of flowers, and later the seeds are arranged in a spiral, hence the species name *spiralis*. Pingao has a hard woody rhizome covered in old leaf sheaths. This provides a powerful means of vegetative propagation.

The natural habitat of pingao is the sand-dunes, particularly areas where there is moving sand and new dunes are being formed. It assists in this dune formation by trapping sand and other wind-blown particles around its stems and leaves. To avoid being buried the plant grows upward through the sand, extending its rhizome and sending up new shoots, thus assisting in the holding of each new layer of sand. Because of this a single plant can keep on growing indefinitely, keeping up with the movement of sand over it and developing into a colony.

Pingao has played a significant role in the stabilisation of much of New Zealand's dune country, particularly before the introduction of rival species by European settlers.

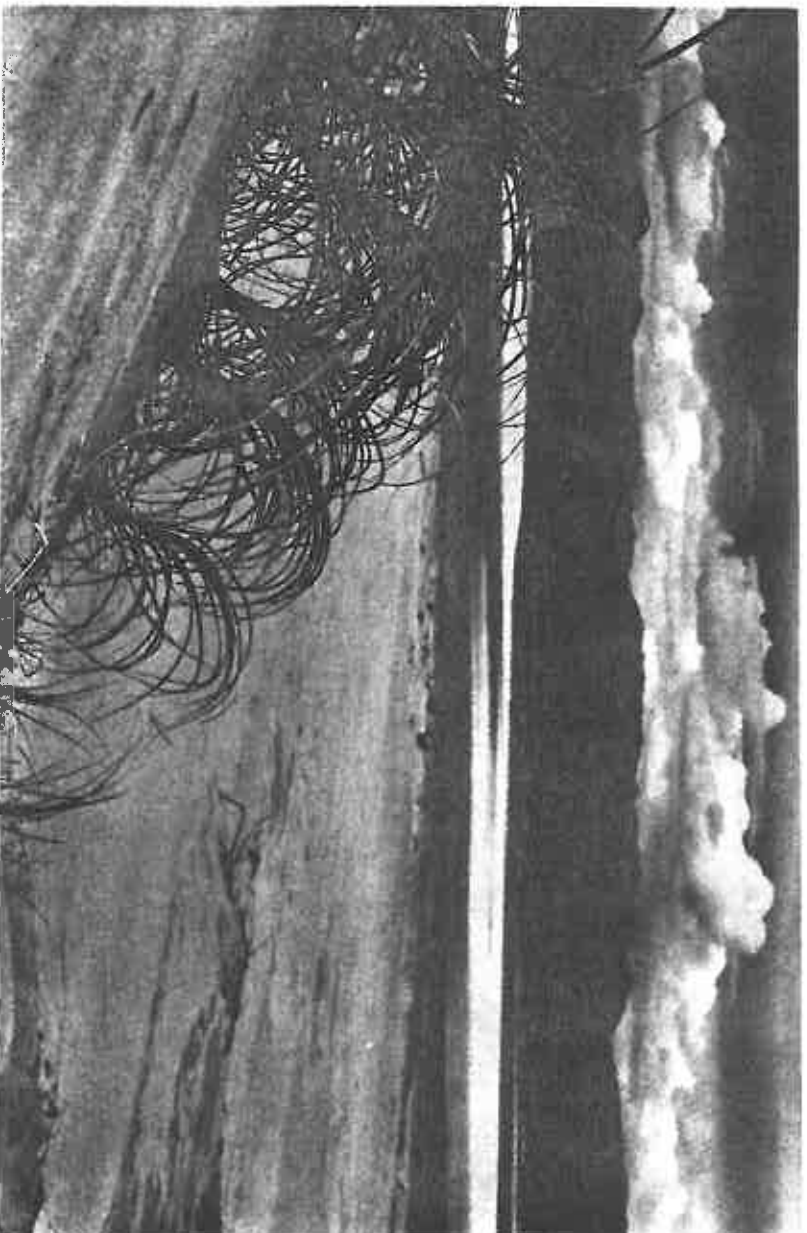


Fig 2 = Healthy pingao on the front of the foredune.

1.2. *Distribution:*

Before European colonisation pingao and spinifex, *raumo* (*Spinifex hirsutus*) were the most widespread and successful sand-binding plants on New Zealand sand dunes.

Today our natural dune systems have been reduced to a fraction of their former extent and are now one of our most endangered habitats. With most of the original coastal forests being replaced by farm land, stock and feral animals have been able to graze the dunes. This has caused a drastic decline to the extent that pingao has now disappeared from many areas and is vulnerable elsewhere.

With this decline of pingao, marram grass and lupin have been introduced to control dune land erosion. The suffocating spread of these plants, combined with intense recreational use of the dunes, coastal reclamation, subdivision, grazing and browsing, has greatly increased the rate of decline. Now classified as a vulnerable species¹ it is believed the pingao is at risk of moving into the endangered category in the near future if the factors causing its depletion continue.

¹ Based on categories established by the Threatened Plants Committee of the Survival Service Commission of the International Union for Conservation of Nature and Natural Resources (IUCN). Usually plants in this category are obviously diminishing in abundance or geographic range, as is pingao which is found in any abundance only in parts of North Auckland, the Manawatu coastline and Stewart Island.

2. TOETOE KAKAHO

2.1 *Biology:*

Kakaho is the name given to the stem and flowerhead of four New Zealand native toetoes. These four species, all belong to the genus *Cortaderia*, which is a member of the grass subfamily Arundinoideae.

The four species, collectively known as toetoe kakaho are *C. toetoe*, *C. splendens*, *C. fulvida* and *C. richardii*. In this report we use the name toetoe kakaho, meaning these four (native) *Cortaderia* species from which toetoe kakaho is gathered. Kakaho is not obtained from the pampas grasses, because their stems are too flexible.

New Zealand's native species of *Cortaderia* can be described as being dense perennial tussocks. They have numerous long, narrow, curving leaves which gradually taper to a fine point. The leaf margin is scarbrid (rough or harsh due to minute projections) and at the junction of the leaf blade and leaf sheath there is an outgrowth known as a ligule which is made up of a fringe of stiff hairs.

The flowers occur in large plume-like panicles on stems up to 6 m long. The panicles are made up of thousands of spikelets, each consisting of several flowers. The seeds are dispersed by wind, assisted by long fine hairs on one of two bracts surrounding each seed.

Toetoe kakaho is easily confused with the introduced South American pampas grasses, *Cortaderia jubata* and *Cortaderia selloana*. These plants were introduced as a supplement to cattle food, for shelter, for erosion control and as ornamental plants. In some areas these plants have spread very rapidly and they have become a serious weed problem, particularly in forests.

2.2. *Distribution:*

Cortaderia toetoe and *Cortaderia splendens* are usually found in coastal areas in the North Island; *Cortaderia toetoe* south of Tauranga, and *Cortaderia splendens* north of Kawhia. The habitat of *Cortaderia fulvida* and *Cortaderia richardii* is usually inland, around stream banks roadsides and forest clearings. *Cortaderia fulvida* is found in the North Island and northern South Island, and *Cortaderia richardii* in the South Island and Stewart Island.

As previously mentioned, evidence (D. Ravine *pers. comm.*) suggests that pampas is encroaching on the habitats of toetoe kakaho and may therefore lead to its decline.

It is very important that the features distinguishing the introduced pampas grasses from the native toetoe species be clearly known and understood so as to prevent unwarranted destruction of the native species in clearing the pampas grasses.

Appendix 1 (page 59) summarises the differences between these species.

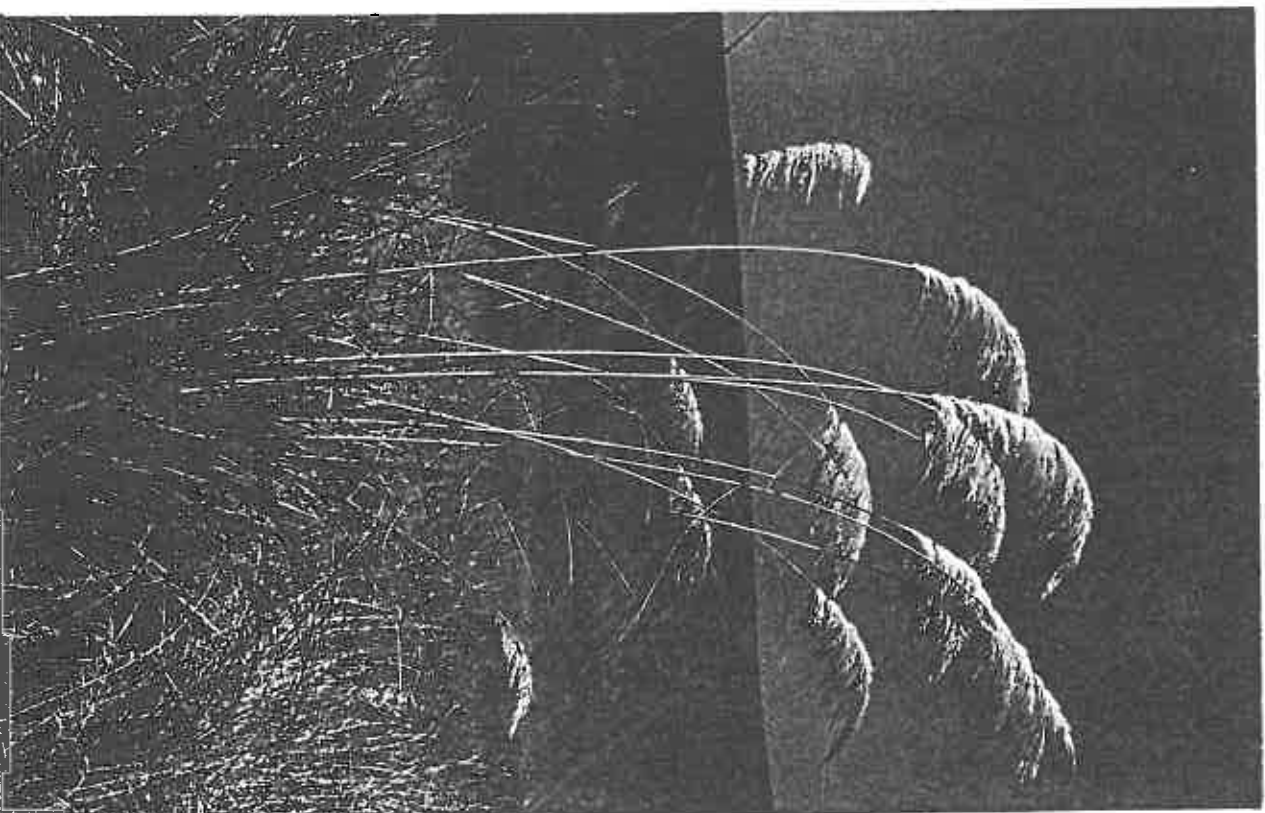


Fig 3 = Toetoe kakaho growing behind the dunes.

SURVEY AREA

1. BOUNDARIES

The area surveyed was the 50 kilometres of coastal dunes bounded by the Manawatu river in the south and the Whangaehu river in the north (see Fig 4). It covered those areas of dunes that have not been stabilised for farmland, forest or beach settlement, to a maximum distance of 1 kilometre inland.

2. LAND TENURE

The 21 km between the Manawatu river mouth and the Rangitikei river mouth contains 11.5 km of privately owned land and 9.5 km of crown owned land. Of this 18km is undeveloped beach and 3 km is inhabited (3 beach settlements).

The 29 km between the Rangitikei and Whangaehu river mouths is predominantly in crown ownership, the majority of this by Forest Corp (the Santoft Forest). Freehold and Maori land extends to the coast only in the Turakina and Whangaehu river areas. The 29 km area also includes two small beach settlements and a defence area at Raumai.

The survey covers portions of both Ngaii Raukawa and Ngaii Apa tribal areas.

Figure 5 shows land tenure.

3. HISTORY

There have been four distinct phases of dune building along the Manawatu coast. These have occurred in response to periods of rapid sand supply or renewed wind erosion of previously stabilised dunes. They are the Koputaroa phase (10,000 - 20,000 years ago); the Foxton phase, (2,000 - 4,000 years ago) related to the eruptions in the Taupo, Tongariro and Mount Taranaki districts; the Motuiti phase, (500 - 1,000 years ago), triggered by destruction of dune vegetation with the arrival of the Maori; and the Waitarere phase (from 120 years ago up until the present), started by destruction of vegetation upon European arrival (Cowie 1963).

There is little detailed description of the vegetation of the sand dune country at the time of settlement by the European, but forest clearing and grazing of cattle and feral animals has had a devastating affect on the dune system, causing erosion and huge inland sand drifts.

Cockayne in his Report on the Dune-Areas of New Zealand (1911) does not specifically discuss the vegetation of the dunes on the Manawatu coastline. However he does mention that from the mouth of the Manawatu river to the mouth of the Whangaehu river there was an average dune width of two and a half miles, the greatest width being six miles. In discussing the stabilisation of the dunes by plants he writes "Such stability is at the present time often the exception rather than the rule, certain dune-areas being for the most part made up of bare stretches of sand, protected by a very scanty plant covering and liable to be displaced by the wind. Man, with his introduced grazing animals, fires and methods of cultivation has further assisted to bringing this about upsetting the equilibrium of the dunes and rendering them still more desert-like."

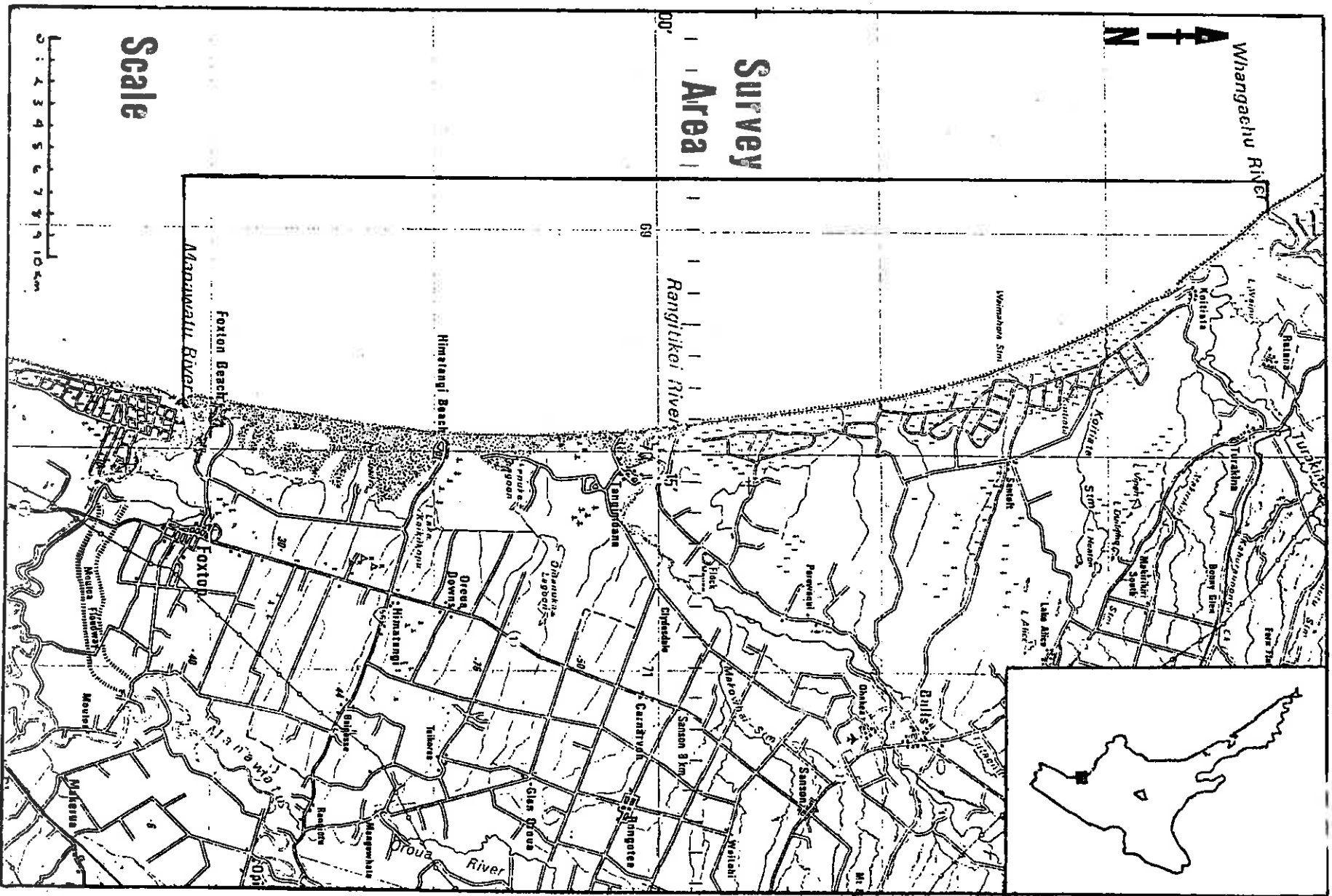


Fig 4 = Manawatu Coastline showing survey area

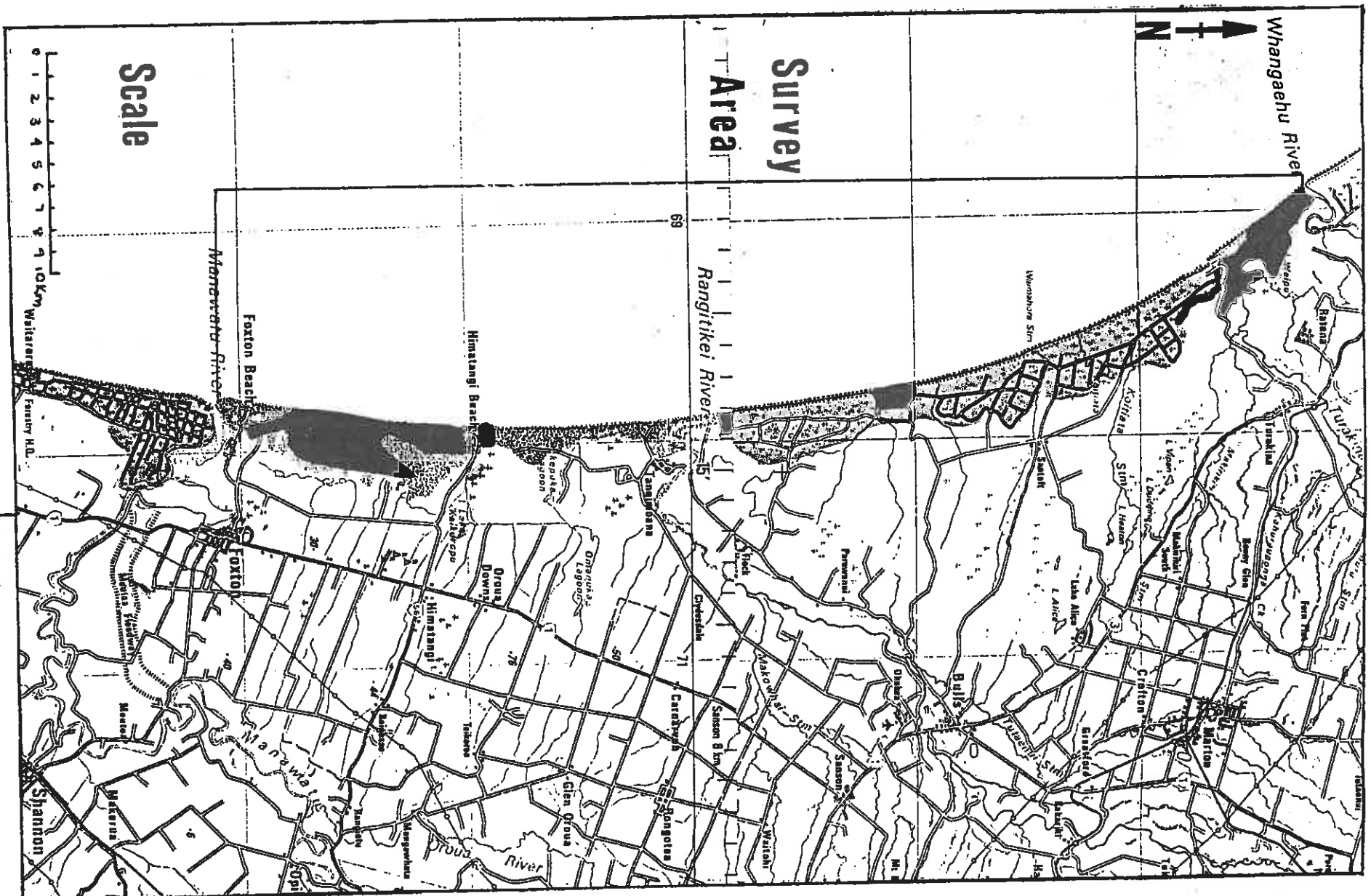


Fig 5 = Land Tenure

KEY

private land

crown land

To stop erosion and restabilise the dunes, the planting of marram grass (imported from Scotland) began in the 1890's and continues to this day. Early in the 1900's spinifex was totally grazed off the Manawatu coast but was later (around 1930) resown by hand north of Himatangi.

The planting of marram grass and the loss and re-establishment of spinifex has also done much to reshape the coastal dunes. Various sand restablation programmes are still being implemented today. An example of this is the Foxtangi Community Sand Stabilisation Programme which began in 1987 and is scheduled to run for 15 years. The aim of this scheme is the control and stabilisation of 850 ha of bare sand, behind and including parts of the foredunes between the Manawatu and Rangitikei rivers. Lupin and marram are being planted and these will be succeeded by forest and pasture.

4. CLIMATE

This portion of the Manawatu coastline experiences a mild climate with a low rainfall regular throughout the year and few significant times of drought. In the area between the Manawatu river mouth and the Rangitikei river mouth the average rainfall is 914 mm per year. Mean summer and winter temperatures are 17.6°C (February monthly average) and 8.3°C (July monthly average) Data from Foxton Beach from October 1982 to August 1983 gave a mean daily wind run of 295 km/24 hr (12 km/hr). Late spring and autumn experienced the highest mean wind run. The predominant winds are west to northwest.

Figures for the coast between the Rangitikei river mouth and the Whangaehu river mouth are similar, but the rainfall average is slightly lower (900 mm/year) and the predominant winds north to northwest.

5. TOPOGRAPHY

The Manawatu coastline between the Manawatu and Rangitikei river mouths consists of a complex series of sand dunes which extend in some places several kilometres inland. Dry sand is moved by wind and deposited in regular patterns consistent with the prevailing northwesterly winds. Figures 6 shows how the dunes of this part of the coastline have evolved over recent years.

Parabolic dunes (shown in Fig 7) are a particular feature of the Manawatu sand country. The arms are directed backward behind the moving dune as the mobility is restricted by vegetation.

From the Rangitikei river mouth north to the Whangaehu river mouth, 80% of the dune country is now controlled by Forest Corp. This country has undergone a stabilisation programme involving exotic plants, including marram grass, acacia and macrocarpa and behind these, pine trees have been planted to create the Santoft Forest. The dunes generally range from 60-100 m in width from the front of the dunes to the acacia and macrocarpa. They are mostly large and rounded, covered in marram grass, spinifex and some pingao, marram being dominant in many areas.

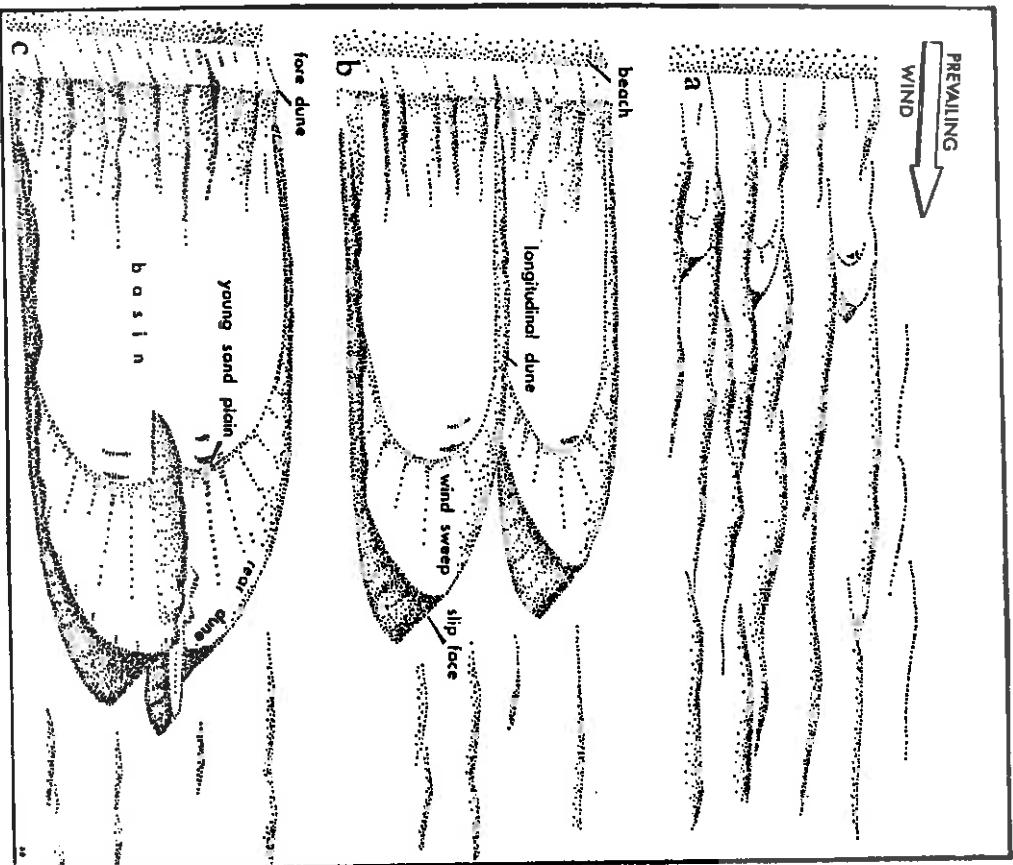
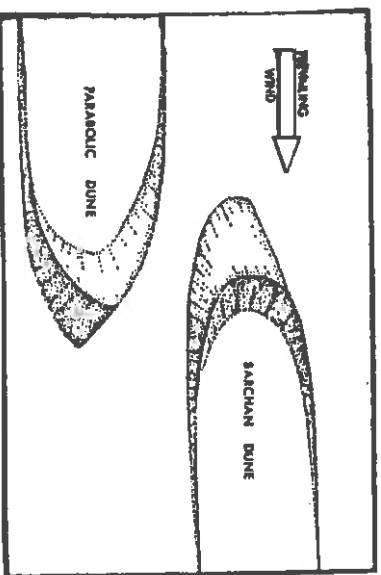


FIG 6: THE EVOLUTION OF MANAWATU COASTAL TOPOGRAPHY
 a. Aerial photographs taken in 1942 of the coast between Foxton Beach and Himatangi Beach show long, low, irregular dunes and no distinct fore dune.
 b. Later a fore dune developed and the minor sand plains behind it enlarged with the creation of parabolic dunes.
 c. A rear dune and large basin developed as adjoining parabolic dunes coalesced.

Fig 7: TWO FORMS OF MOVING DUNES

Barchan dunes develop to a very limited extent where vegetation is sparse or absent. Parabolic dunes are a feature of the Manawatu sand country. A light cover of vegetation causes the arms to trail behind the main body of the moving sand.



(Diagrams from: Botany of the Manawatu District New Zealand. A.E. Esler.)

The steepness and shape of individual dunes is directly related to the type of sand-binding plants present on them. Foredunes covered with spinifex generally have a gentle even slope and reach a height of up to 6 m. The spinifex is able to provide a good even cover spreading downwards in all directions and being able to quickly cover new deposits of sand.

Marram grass tends not to spread as much as spinifex and instead grows thickly, forming clumps. The dune that it forms is steep and reaches a height of up to 8 m. Because of this marram dunes are susceptible to being blown out particularly with the strong winds common along the Manawatu coastline.

Of the three main sand-binding plants the dunes formed by pingao are the lowest, rarely taller than 3 m, and like spinifex dunes they are gently sloping because the leaves grow up at intervals from the underground stems. Pingao grows well on dunes where sand is accumulating but where sand is being eroded it does not have much power to hold the dune.

6. FLORA

The pioneering plants that stabilise the foredunes are few in number but beautifully adapted for their strenuous life. First to establish on a new dune are pingao and the spinifex. Marram grass establishes once the dunes have been stabilised by the pingao and spinifex.

Behind the foredunes, as the plant cover becomes more continuous, a number of sand-fixing shrubs appear, including the dense wiry tarakupenga (*Coprosma acerosa*), the white-flowered aute taranga or sand daphne (*Pimelea arenaria*), and the tauhinu (*Cassinia leptophylla*). Behind these shrubs is commonly found the yellow-flowered tree lupin (*Lupinus arboreus*), an introduced sand binder. Further back where a humus cover with permanent vegetation has been established, the prominent plants are the drought-resistant shrubs such as poohuehue (*Muehlenbeckia complexa*), mingimingi (*Leucopogon fasciculatus*) and the toetoe kakaho (*Cortaderia toetoe*).

Other plants found in the dunes include:

Ice plants	(<i>Disphyma australe</i> and <i>Carpobrotus edulis</i>)
Sand Convolvulus	(<i>Cabstegia soldanella</i>)
Haretail	(<i>Lagurus ovatus</i>)
Carex grass	(<i>Carex pumila</i>)
Boxhorn	(<i>Lycium ferocissimum</i>)
Jointed rush	(<i>Leptocarpus similis</i>)
Pampas grass	(<i>Cortaderia selloana</i>)
Acacia	(<i>Acacia</i> sp.)

7. FAUNA

The most diverse group of native animals found on our natural dunelands are insects and spiders. Probably best known is the katipo (*Latrodectus katipo*), our most poisonous spider, which is found in dry places amongst driftwood or the tufts of dune plants.

The sand hopper and the sand beetle are common inhabitants of the seaward-facing foredunes and are both likely prey of the carnivorous beach centipede. They may also fall prey to the large native littoral earwig which is very common beneath driftwood.

Another common sand dweller is the nocturnal sand scarab beetle. The larvae resemble oversized huhu grubs and spend most of their time buried in moist sand feeding on rotten driftwood and the roots of pingao and spinifex.

Moths and butterflies are also encountered amongst the dunes with some species being entirely restricted to the dunes. The dunes support only a few native birds unless they are adjacent to estuaries or lagoons where they provide high tide roosts for a host of gulls and waders.

The New Zealand pipit and banded dotterel often frequent the dunes and can be seen racing along in search of sand hoppers and other food.

Introduced wildlife along the dunelands is confined mainly to common land mammals such as opossums, hedgehogs, rabbits, sambar deer and feral cats.

8. HUMAN IMPACT

8.1. Beach Settlements:

This area of the Manawatu coastline takes in five beach settlements - Foxton Beach, Himatangi, Tangimoana, Koitiata and Scotts Ferry. The largest of these is Foxton Beach with a population of 1440 (1986).

8.2. Waste disposal:

Two of the above settlements have rubbish dumps on the dune country. The Foxton Beach dump is located on the dunes on the northern side of the Manawatu river mouth, less than 250 m from the estuary. The dump is in places encroaching on areas of pingao. The Tangimoana dump is located approximately 400 m from the foreshore just off the main road to the beach. It is surrounded by some areas of unstable sand and an off-road vehicle area. Pingao is present in many places right at the dump face.

8.3. Recreation:

There is strong recreational pressure on the Manawatu coastline especially between the Manawatu and Rangitikei river mouths. Fishing, swimming, surfing, boating, walking, camping, picnicing, horseriding, recreational vehicles and off-road recreational areas all bring many people to the coast. The use of recreational vehicles is a concern because of the destruction of vegetation cover and the resultant blowouts and sand movement.

8.4. *Agriculture:*

Large areas behind the dunes, particularly south of the Rangitikei river, are at present being farmed. Instability of sand and erosion do pose some problems and often fence lines are buried. Because of this, damage to sand-dune vegetation by stock often occurs.

8.5. *Forestry:*

80% of the coastline between the Rangitikei and Whangaehu river mouths is planted in pine. Planting of introduced species for initial stabilisation has had a dramatic effect on the dune country.

8.6. *Raumai Bombing Range:*

This is situated approximately 12 km north of Moanarua and consists of a 2 km stretch of the coast in front of the Santoft forest. The area is used by the Air Force as a bombing range. It has restricted access and is overlooked by two surveillance towers.

8.7. *Harvesting:*

This area is known for the quality and relative quantity of its golden pingao. Continued unrestricted harvesting could contribute to it's depletion.

SURVEY METHOD

The survey involved two distinct phases. Phase I consisted of a reconnaissance of the entire 50 km of coastline to assess the distribution of pingao and toetoe kakaho and to identify areas worthy of closer investigation in Phase II. Phase II involved a detailed survey of the twelve areas from phase I where pingao was most abundant. The aim was to identify areas suitable for replanting, reserves and harvesting.

PHASE I

The survey began at the southern boundary of the survey area, the Manawatu river mouth. Working northwards, intervals of 1 kilometre were marked out with flags using the vehicle speedometer. Teams of two walked each kilometre along the top of the foredune, from where they had a good view of the dunes.

Recording sheets were filled out showing:

distribution and density of pingao
 condition of the pingao
 modifications to the pingao
 distribution and density of other plants present
 topography
 extent of bare sand, and other details.

See appendix 2 (page 60) for a phase I recording sheet.

The categories used to describe density were as follows:

Throughout	=	Plant approximately every 20 m
Common	=	Plant every 50 m approximately
Occasional	=	Plant every 100 m approximately
Sparse	=	1-5 plants per 500 m

It was found after the first day of the survey that intervals of one kilometre were difficult to sum up in one recording sheet, as much variation can occur in an interval this size. It was therefore decided to reduce the intervals to 500 metres.

Phase I began on the 4th of April and was completed on the 19th April 1989.

PHASE II

The twelve areas selected from phase I were labelled A-L as follows:

- A: 4 km north of Foxton Beach
- B: Five mile creek - 7 km north of Foxton Beach
- C: 1 km north of Foxton Beach
- D: Manawatu River mouth
- E: 1 km south of Himatangi
- F: 1 km south of Tangimoana
- G: Raumai Bombing Range - 9 km north of Moanaroa Beach
- H: Santoft Forest - 11 km north of Moanaroa Beach
- I: Fusilier shipwreck - 8.2 km south of Koitiata
- J: Koitiata - southside of Turakina River mouth
- K: Whangaehu - northside of Turakina River mouth
- P: Moanaroa Beach

Although area P was not surveyed with the others, it was evaluated on sight.

In each area selected, a compass bearing was taken from a permanent marker (e.g. a trig station) or if there was not a suitable marker present a baton was put in with the letter of the area marked on it. This will enable the survey to be repeated in the future.

A series of transect lines running grid east, each 50 metres apart was plotted on a 1: 25,000 scale map - these lines were physically marked out using tape measures, compasses and flags.

Survey teams of three people followed these lines inland from in front of the foredunes, using a string line for as far as the dunes went, or until reaching a forest or fenceline. At twenty-metre intervals an assessment of vegetation on the string line and to 2.5 metres to each side was completed.

Plants and areas of bare sand were given a cover class number according to the % of ground they covered.

<u>% Cover</u>	<u>Cover Class</u>
1-10	1
10-25	2
25-50	3
50-75	4
75-100	5

Survey recording sheets were filled out showing:

- Cover class of pingao, marram and spinifex
- Cover class for other plants present in significant amounts
- Height and condition of pingao plants
- Modifications to pingao plants

Vegetation and dune formation between transect lines were recorded on mapping sheets but in less detail, in order to help build a clear picture of the whole area.

Area Summary sheets were completed which included line summaries and an evaluation of the suitability of each area for reserve or replanting.

Pingao cover class averages for each line and each area were calculated. These figures can be used for comparison but are not a direct empirical measure of the amount of pingao in each line or area.

See appendices 3-5 (pages 61-65) for survey recording sheet, mapping sheet and Area Summary sheet respectively.

Phase II began on the 10th of May and was completed on the 16th of October 1989.

The Phase II recording sheets were then summarised into line summaries (see phase II Summary Sheet in appendix 5 page 65) These show:

Topography along the whole line
Vegetation
Average cover class of pingao
Condition of pingao
Other significant factors.

The line summaries were then used to derive an area summary of those factors which have modified the presence of pingao. The degree of modification is shown according to the following key:

- N = Nil: No damage observed.
- L = Low: Modification observed but little significant damage to the plants or their habitat.
- M = Medium: Some plants or their habitat show definite signs of damage.
- H = High: Damage to the majority of the plants or their habitat.

Figure 8 shows the Phase II areas surveyed.

1 2 3 4 5 6 kms

AREA D

AREA C

AREA A

AREA B

AREA E

AREA F

AREA P

Manawatu River

Foxton Beach

Himatangi Beach

Rangitikei River

Foxton

Himatangi

Oroua Downs

Tangimoana

Bainesse

Iaikorea

Carnarvon

Clydesdale

Rangitū

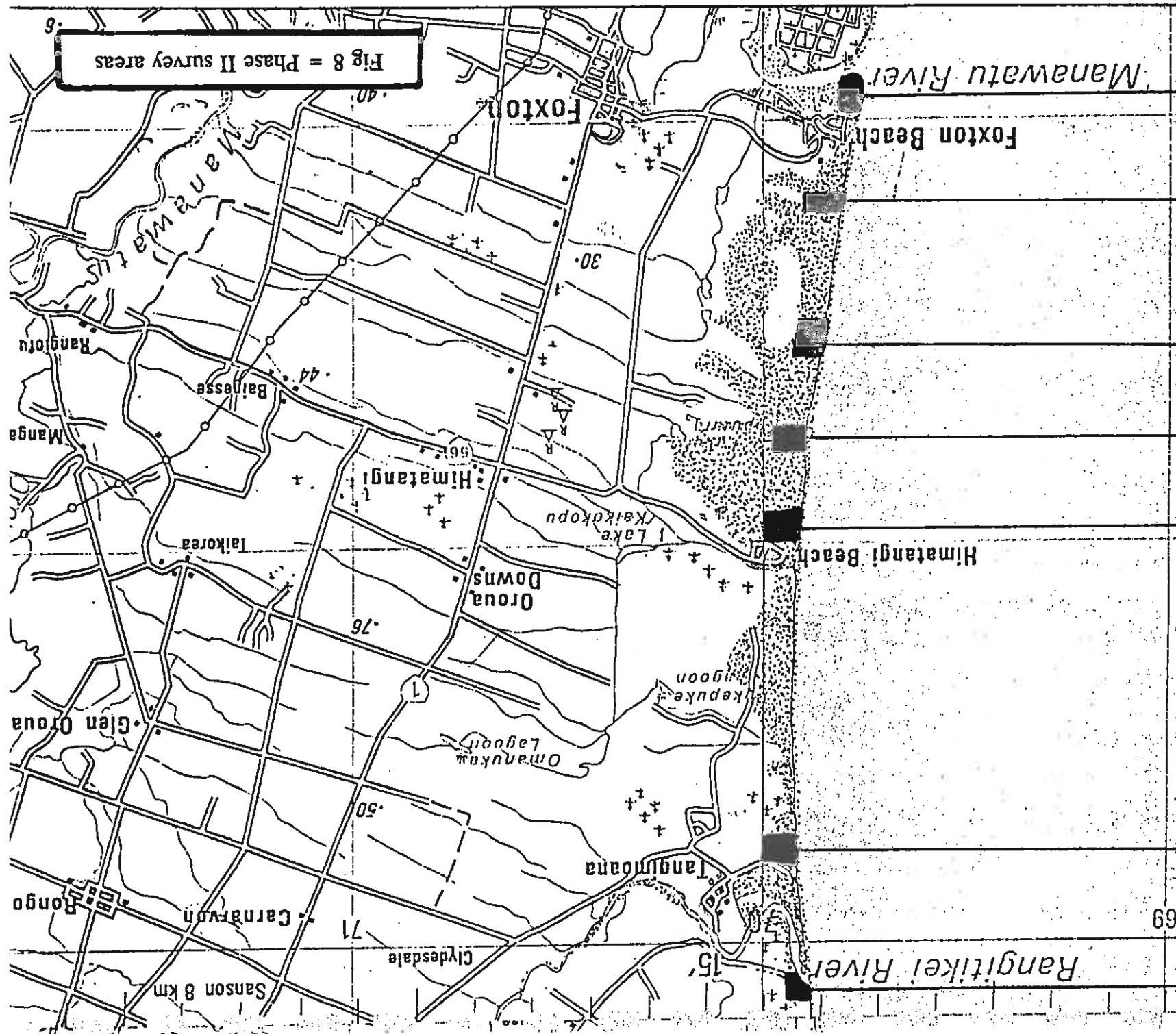
Manga

Glen Oroua

Rongo

Sanson 8 km

Fig 8 = Phase II survey areas



69

15'

71

.76

.50

30

.40

.44

.66

.6

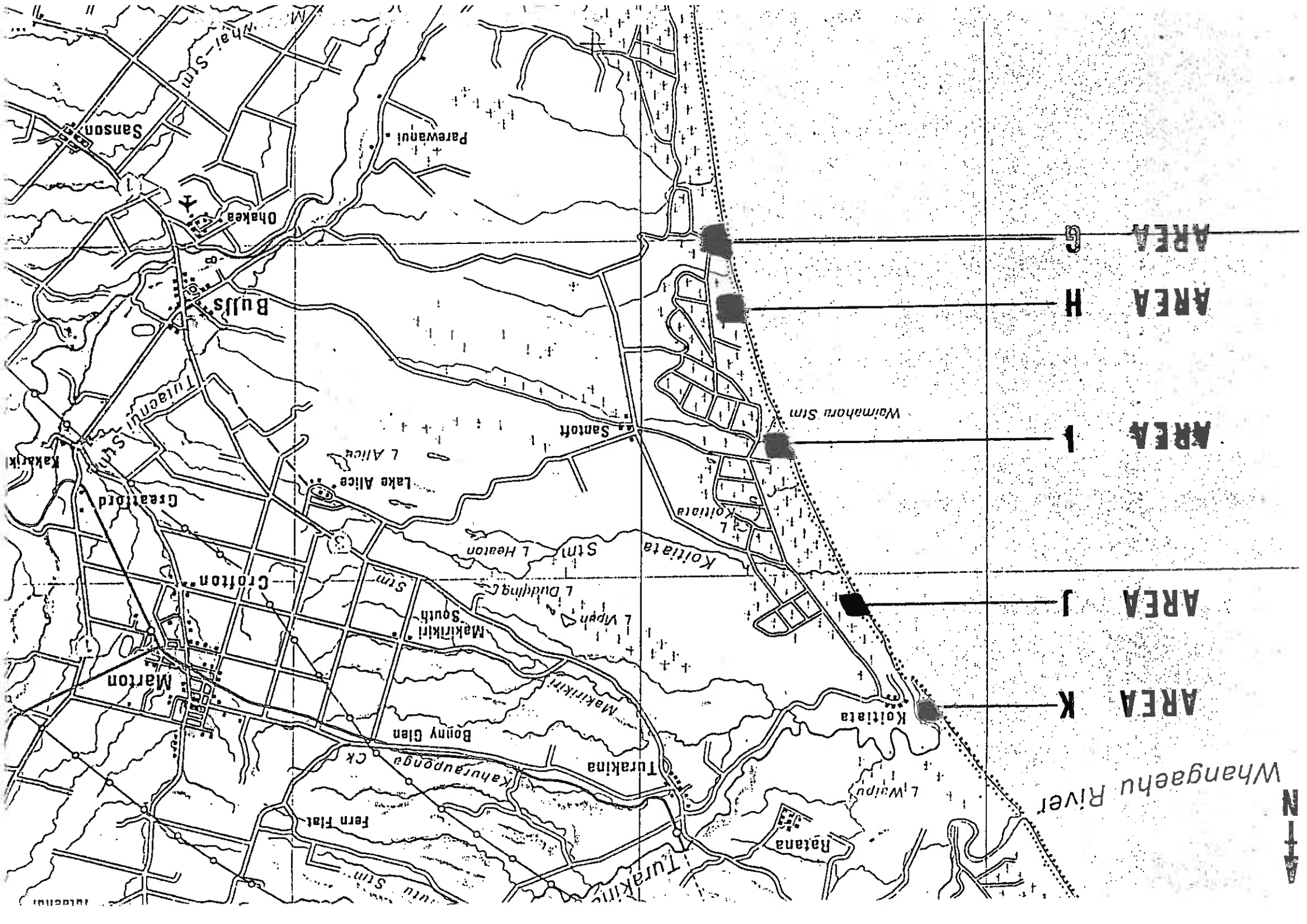




Fig 9 = Survey party at work.



RESULTS

PHASE I

The 60 km survey area has been divided into 5 areas for easy explanation.

1. MANAWATU RIVER MOUTH TO HIMATANGI

The dunes were mostly steep and quite high and there were many patches of bare sand. *Spinifex* and marram were the main plants present, *spinifex* being predominant. Behind the foredunes many other sand plants were present, particularly *cassinia*, sand daphne, sand coprosma and sand daisy.

Pingao was recorded as being 'throughout' in 73% of this area. It was generally healthy apart from some wind-blown areas where rhizomes had been uncovered. Damage from rabbits was obvious in many areas and some vehicle damage was observed particularly near the Foxton and Himatangi settlements. Some clumps of toetoe kakaho were noted further inland on the flats behind the dunes.

2. HIMATANGI TO TANGIMOANA

The dunes were more rolling and less steep than those of the previous area especially where the land behind is planted in pines. Most of the dunes were covered in vegetation, predominantly marram, with few areas of bare sand. Many other plants were common behind the foredunes, especially sand daisy, *cassinia*, acacia and *macrocarpa*.

'Common' and 'sparse' were the two major categories for pingao, only 25% of the area was recorded as being 'throughout'. The pingao was healthy although rabbit damage was quite significant. There was some evidence of vehicle and motorbike damage, mainly restricted to areas near the Himatangi and Tangimoana settlements. Areas of both pampas and toetoe kakaho were noted on the flats behind the dunes.

3. TANGIMOANA TO RAUMAI BOMBING RANGE

Most of the dunes were covered in vegetation, predominantly marram, but there was an occasional large area of bare sand. Moanaroa Beach (northern side of the Rangitikei River) has a large flat area between the dunes and the water and new dunes are beginning to form there. Many of these are covered in pingao.

70% of this area had 'occasional' or 'sparse' pingao. The pingao present was healthy but in many places there was evidence that it had been chewed by rabbits. There was a small amount of damage by vehicles. Most of the dunes were flattish and quite low with generally less than 100 m of dunes in front of acacia, *macrocarpa* and pine forest.

Toetoe kakaho and pampas were both present in the 'sparse' category, but there was more pampas than kakaho.

4. RAUMAI BOMBING RANGE TO KOITIATA

The dunes were quite high but tended to be more rolling than steep, and ranged in width from 50 to 150 m. *Spinifex* was the predominant plant especially on the front of the dunes. Marram grass was also abundant and there were many areas where bare sand had been recently planted in marram. Sand daisy and lupin were common and acacia and macrocarpa were planted in front of the forest.

Pingao was recorded as being 'throughout' in 73% of this area. It was healthy but rabbit damage was common. Near Koitaita there were vehicle tracks in places but they did not appear to be causing too much damage.

Near the Turakina River mouth there were some large areas of flats. Toetoe kakaho and pampas were found growing amongst flax, rush and marram. The toetoe kakaho was 'throughout' and the pampas was 'common'.

5. TURAKINA TO WHANGAHEHU RIVER MOUTH

The dunes were relatively steep but not very high. *Spinifex* was predominant on the foredunes and marram behind these. There were large areas of bare sand in places and dunes blown out. Boxhorn bushes were common.

The pingao ranged from 'throughout' at the Turakina River mouth to 'occasional' or 'sparse' closer to Whangaehu. There was considerable damage from rabbits and grazing. The area is not easily accessible and vehicle damage was not observed.

Both toetoe kakaho and pampas were present on flats behind the dunes, the pampas being recorded as 'throughout'.

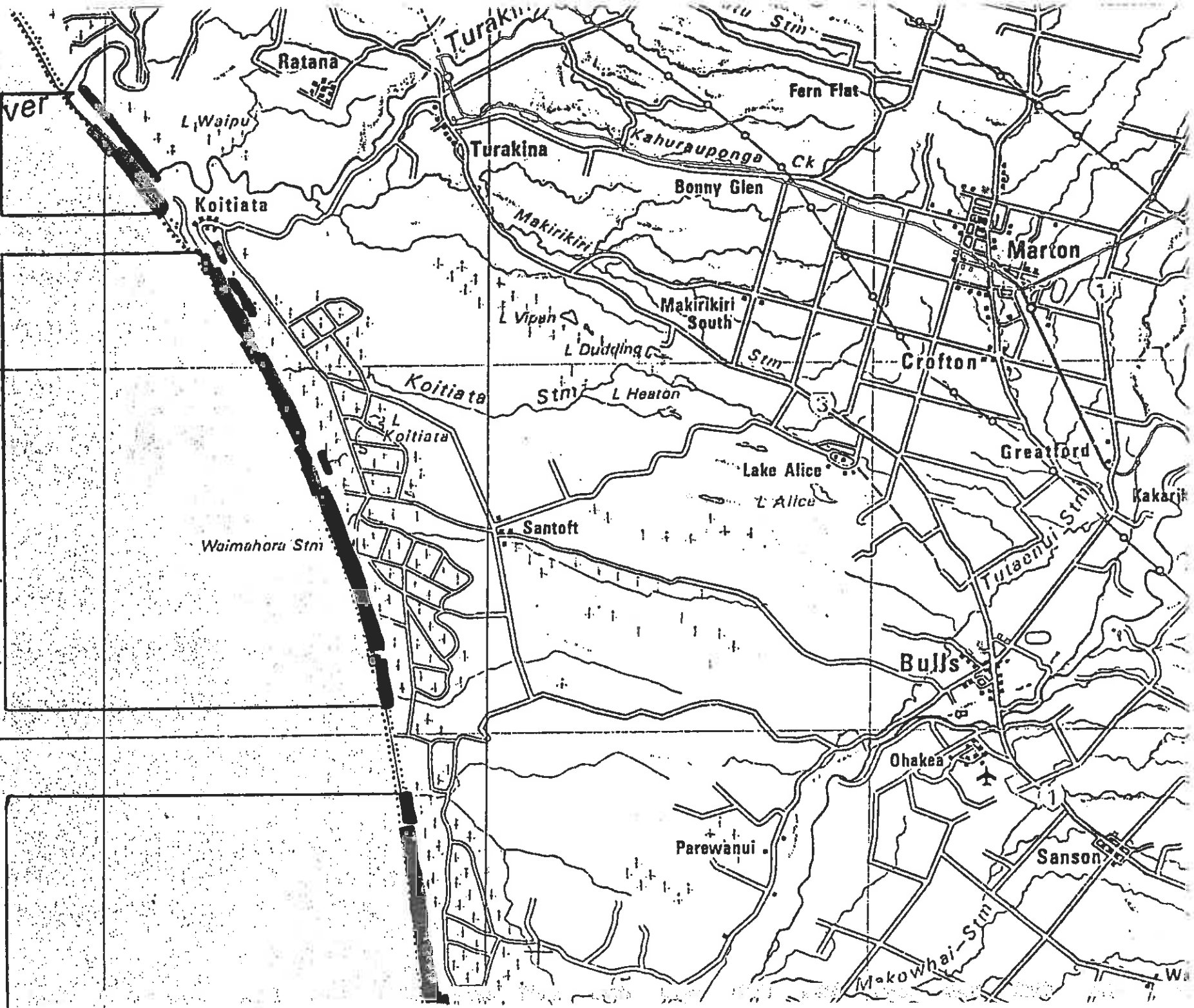
Figure 10 shows the distribution and density of pingao and the distribution of toetoe kakaho in the survey area.



**Koitiata
to
Whangaehu**

**Raumai
Bombing
Range
to
Koitiata**

**Tangimoana
to
Raumai
Bombing
Range**



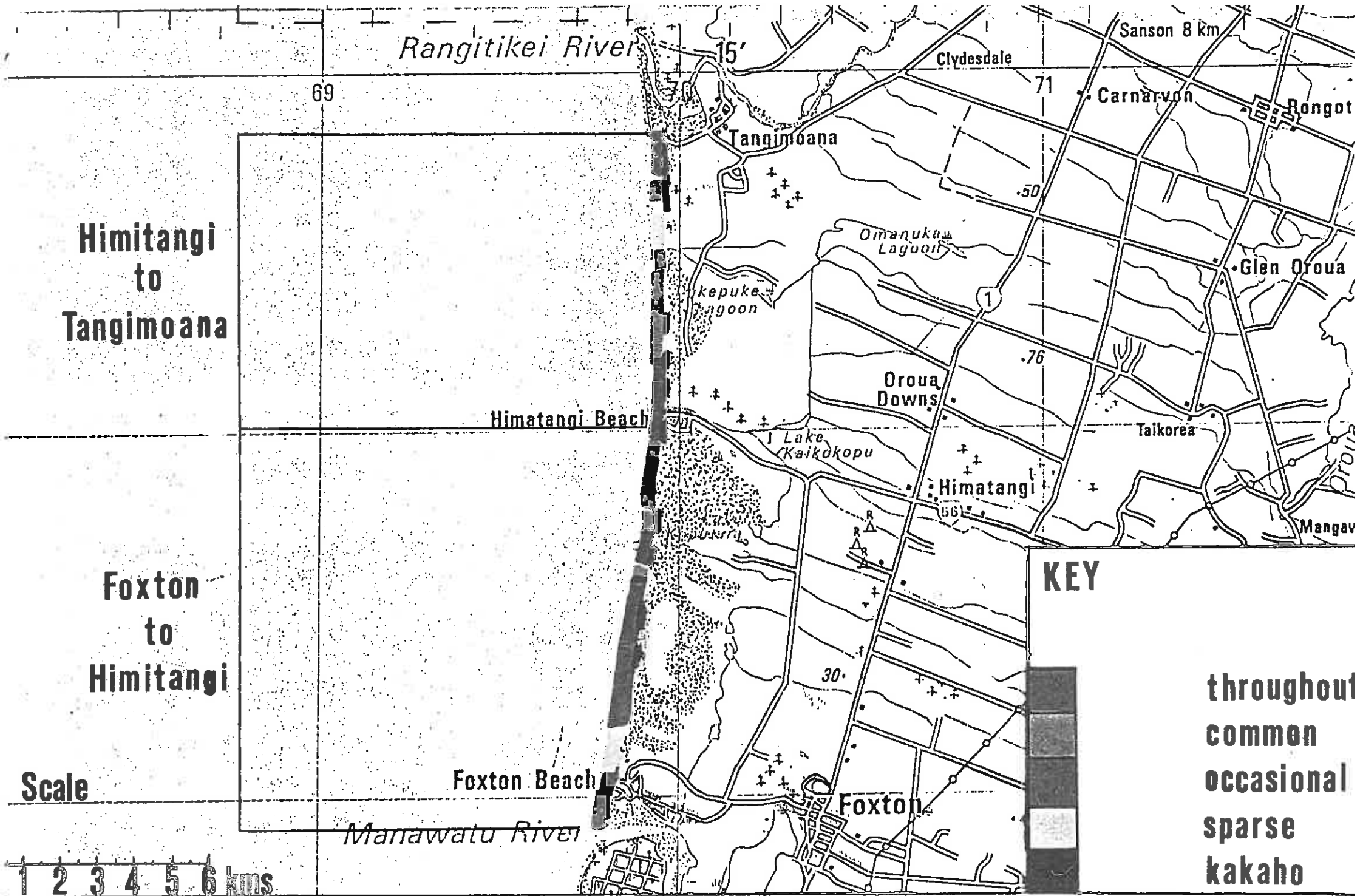


FIG 10 = DISTRIBUTION AND DENSITY OF PINGAO AND DISTRIBUTION OF TOETOE KAKAHO

PHASE II: SUMMARY OF OUR OBSERVATIONS

The following information was taken from Phase II survey recording sheets and area summaries.

AREA A: 4 KM NORTH OF FOXTON BEACH

Number of lines: 9

Average length of lines: 175 m

Number of lines containing pingao: 5

Pingao cover class average: 0.19

Notes: Mainly bare sand and spinifex.
Buried farm fences.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram Macrocarpa	M L
Animal damage	Chewed by rabbits Chewed by cows	H L
Dune erosion	High dunes blown out	M
Vehicle damage	Four-wheel drive vehicles	L
Other	-	N

AREA B: 5 MILE CREEK - 7 KM NORTH OF FOXTON BEACH

Number of lines: 12

Average length of lines: 210 m

Number of lines containing pingao: 10

Pingao cover class average: 0.28

Notes: Large areas of bare sand.
Fences buried.
Toetoe kakaho present.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	M
Animal damage	Chewed by rabbits Chewed by cows	M L
Dune erosion	Blown out areas	M
Vehicle damage	-	N
Other	-	N

AREA C: 1 KM NORTH FOXTON BEACH

Number of lines:	5
Average length of lines:	250 m
Number of lines containing pingao:	5
Pingao coverclass average:	0.3

Notes: Mainly spinifex dunes.
Some blown-out foredunes.
Walking tracks in the dunes.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	H
Animal damage	Chewed by rabbits	M
Dune erosion	Dunes blown out	M
Vehicle damage	Trail bikes	L
Other	Walking tracks in dunes	L

AREA D: MANAWATU RIVER MOUTH

Number of lines:	13
Average length of lines:	250 m
Number of lines containing pingao:	7
Pingao cover class average:	0.22

Notes: Bare sand areas.
Vehicle tracks in dunes.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	M
Animal damage	Chewed by rabbits	H
Dune erosion	Blown out areas	M
Vehicle damage	Four-wheel drive vehicles	H
Other	Rubbish dump encroaching on pingao	L

AREA E: 1 KM SOUTH OF HIMATANGI

Number of lines:	14
Average length of lines:	250 m
Number of lines contain pingao:	14
Pingao cover class average	0.36

Notes: Low dunes further back.
Some good sheltered areas.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	L
Animal damage	Chewed by rabbits	M
Dune erosion	Blown-out dunes	M
Vehicle damage	Four-wheel drive vehicles	L
Other	Evidence of picking	M

AREA F: 1 KM SOUTH OF TANGIMOANA

Number of lines:	14
Average length of lines:	250 m
Number of lines containing pingao:	9
Pingao cover class average:	0.22

Notes: Some bare sand areas.
Many vehicle tracks around the rubbish dump.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	M
Animal damage	Chewed by rabbits	M
Dune erosion	Some blown-out dunes and flat wind-blown areas	M
Vehicle damage	Vehicle area, many tracks	H
Other	Evidence of picked pingao Dump site	L M

AREA G: RAUMAI BOMBING RANGE - 9 KM NORTH OF MOANAROA BEACH

Number of lines: 20

Average length of lines: 110 m

Number of lines containing pingao: 10

Pingao cover class average: 0.25

Notes: Generally only 100 m of dune before flats of marram and then forest.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	H
Animal damage	Chewed by rabbits	M
Dune erosion	Few blown areas	M
Vehicle damage	Bike tracks	L
Other	-	N

AREA H: SANTOFT FOREST - 11 KM NORTH OF MOANAROA BEACH

Number of lines: 20

Average length of lines: 44 m

Number of lines containing pingao: 16

Pingao cover class average: 0.58

Notes: 80 m to acacia and macrocarpa then pines. Spinifex predominant on foredunes.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	M
Animal damage	Chewed by rabbits	H
Dune erosion	Some dunes blown	M
Vehicle damage	-	N
Other	One place possibly picked	L

AREA I: FUSILIER SHIPWRECK 8.2 KM SOUTH OF KOTTATA

Number of lines: 11
 Average length of lines: 49 m
 Number of lines containing pingao: 8
 Pingao cover class average: 0.71

Notes: Dunes only back 60 to 80 m before acacia, macrocarpas and pines.
 Spinifex mainly on foredunes.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	M
Animal damage	Severely chewed badly by rabbits	H
Dune erosion	Small amount	L
Vehicle damage		N
Other	Possible picking	L

AREA J: KOTTATA SOUTH SIDE OF TURAKINA RIVER MOUTH

Number of lines: 15
 Average length of lines: 76 m
 Number of lines containing pingao: 12
 Pingao cover class average: 0.59

Notes: Dunes low and rolling.
 Some bare sand areas.
 Strong growth of spinifex.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	M
Animal damage	Chewed by rabbits	M
Dune erosion	Relatively low	L
Vehicle damage	Occasional tracks	L
Other	-	N

AREA K: WHANGAHEHU NORTH SIDE OF TURAKINA RIVER MOUTH

Number of lines:	14
Average length of lines:	84 m
Number of lines contain pingao:	14
Pingao cover class average:	0.74

Notes: Cattle on dunes.
Mainly low spinifex dunes.

AREA SUMMARY

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome plants	Marram	L
Animal damage	Cattle grazing	H
Dune erosion	Some evidence	L
Vehicle damage	-	N
Other	-	N

AREA P: MOANAROA BEACH

Area P was not surveyed, but an assessment was made.

Pingao cover class average: No cover class average but good quantities of pingao.

Notes: Low open area.
New pingao and spinifex dunes forming.
Newly planted marram.

AREA SUMMARY:

<u>Modification</u>	<u>Specify & Comment</u>	<u>Degree of Modification</u>
Troublesome Plants	Newly planted marram	H
Animal damage	-	N
Dune erosion	-	N
Vehicle damage	Car track through middle	M
Other	New dunes forming	H

Discussion

DISCUSSION OF PHASE II AREAS

AREA A: 4 KM NORTH OF FOXTON BEACH

The average cover class of pingao on the lines in this area came out to be only 0.2 - where a value of 1 corresponds to between 1 and 10% of the total area. This was one of the lowest values of all the areas surveyed. Of the nine lines completed, four contained no pingao whatsoever, and of the other five lines none had an average greater than 0.7. Therefore none of the lines contained even 1% pingao.

In considering suitability for reserve, this area would not appear to be a good choice simply because of the limited quantity of pingao present. The majority of the area was bare sand and dune erosion was a problem in places resulting in areas of blown-out pingao. Much of the pingao present showed signs of being chewed by rabbits. The dunes stretched inland up to 400 m before a fence line or planted trees were encountered. The fences were buried by sand which could result in grazing animals wandering over the dunes.

The combination of these factors indicates that this area would not be a good area for reserve establishment.

The possibility of using the area for re-establishment could still have to be considered. This would depend on whether the lack of pingao is because the area is unsuitable for the plant or whether it could grow well if planted.

AREA B: FIVE MILE CREEK - 7 KM NORTH OF FOXTON BEACH

The mean average cover class was 0.3, a comparatively low value. 10 out of the 12 lines did contain some pingao, indicating that it was scattered over most of the area. Rabbits and cattle appeared to be causing some inhibition of growth and buried fences were noted in places. The dunes were predominantly bare sand and marram grass reaching inland to forest or farmland. Dune erosion was quite severe in places with many steep marram dunes falling away causing damage to the pingao.

This area would not be very suitable for a reserve because of the limited amounts of pingao and high occurrence of dune erosion.

There were, however, some vigorous stands of toetoe kakaho especially alongside the stream. There was also some pampas grass growing in this location.

AREA C: 1 KM NORTH OF FOXTON BEACH

The 0.22 average cover class was one of the lowest averages of all the areas. None of the line averages were greater than 0.3. Much of the pingao was rabbit damaged, and small. Marram grass and dune erosion in the area were quite extensive and the proximity to Foxton Beach has given rise to walking tracks in the dunes.

Because of these problems and the low density of pingao, this area would not be very suitable for a reserve. However it could possibly be developed into a useful area for regeneration of a range of native species including pingao.

AREA D: MANAWATU RIVER MOUTH

The 0.22 average cover class was one of the lowest area averages, but the area did contain some good stands of pingao. The area average was reduced by six lines that contained no pingao. The good stands of pingao were mainly in two areas. The first one was on a foredune and the second was behind a large open area behind the dunes used for recreational vehicles. Also behind the dunes in this area is the Foxton Beach rubbish dump. In places the rubbish was encroaching on healthy pingao. The pingao was healthy, but rabbit damage was high. Because the area is close to Foxton Beach township, many of the dunes are driven over by recreational vehicles resulting in damage to the pingao.

The predominant plant in this area was marram grass, and there were many blown out dunes and bare sand areas throughout.

This area was considered to be not very suitable for reserves or replanting. It has, however, good examples of the native dune shrubs cassinia, coprosma and pimelea. It certainly has value as a place to take school children and other interested groups because of the presence of pingao and the clear evidence of damage to the plant, the range of other dune plants present, the closeness to the estuary, and the ease of accessibility.

AREA E: 1 KM SOUTH OF HIMATANGI

The centre of Area E lies approximately 1 km south of the stream at Himatangi Beach. The mean line cover class for pingao was 0.36. This is about average for the areas studied. All 14 lines surveyed contained some pingao, indicating a uniform distribution throughout. Spinifex was predominant on the foredunes and marram was present throughout the area but not dominant. There were many large areas of bare sand. In some sheltered gullies pingao was often growing. There was some evidence of rabbit damage and in some places pingao had been picked. The dunes reached 200-300 metres inland. Behind them were flat areas covered mainly in rush, marram, hareetail and pampas grass. There were also some clumps of toetoe kakaho but the pampas was much more abundant. Pine trees had been recently planted on much of these flats. Although the dunes were mostly quite low there was some evidence of dune erosion and blown-out pingao.

An area obviously used for off road vehicles was noted immediately adjacent to the Himatangi township but apart from this little vehicle damage was observed.

As a potential reserve the area looked promising especially for re-establishment and building up of stocks for harvesting. The relatively low density of marram, the low dunes and the large areas of bare sand are all favourable factors. The sheltered gullies would most likely be excellent places for planting out pingao because of the closeness to the water table. Because the area is accessible it would be an excellent area for cultivating and harvesting pingao and it is in fact already being used for this purpose.

AREA F: 1 KM SOUTH OF TANGIMOANA

The 0.22 average cover class was one of the lower area averages, with lines ranging from no pingao to 0.88, the latter being found on a low, rolling spinifex foredune. Most of the pingao was healthy, but there was some rabbit damage and in many places it was blown out.

On the whole, the dunes were steep and blown out, but in some places the foredunes were low, with spinifex and pingao growing well. Behind the dunes was a large open area of flat bare sand, where four-wheel drive vehicle tracks were abundant. There was also the Tangimoana rubbish dump and both were encroaching on and destroying pingao in the near vicinity. Because of these problems and the possibility of the Shell BP Todd proposal going ahead, this area would not be suitable as a reserve or for replanting, at this stage. However with redevelopment of the dunes after completion of the pipeline, replanting of pingao will be very important, and the site could provide an ideal reserve.

AREA G: RAUMAI BOMBING RANGE 9 KM NORTH OF MOANAROA BEACH

Area G included part of the Raumai Bombing Range in front of the Santoft Forest. The average cover class for the pingao was 0.25, a low value. Of the lines within the range itself only 4 of the 11 surveyed contained pingao, compared to 6 out of 9 for the lines north of the range. The pingao in many places was severely damaged by rabbits. In other places it appeared brown and unhealthy. Often where there was quite a high concentration of other plants, particularly marram. It is likely the pingao is being encroached upon by these plants. Marram grass was the predominant plant in the area and in places it had been recently planted. Many of the dunes were steep, with blown out areas and there were large areas of bare sand in some places. Behind the dunes was a flatter area mainly covered in marram and rush and behind this was the forest.

At first it was originally thought that this area would be worth consideration for a reserve due to its isolation and restricted entry. However the limited amount of pingao, its poor condition, the high density of Marram and the dune erosion are all factors that indicate that it is not suitable.

AREA H: SANTOFT FOREST 11 KM NORTH OF MOANAROA BEACH

The average cover class of this area was 0.58. This included a wide range of values, from 0 in four lines up to 2.3 (10-25% Pingao). High values like this would be partly due to the narrowness of the dunes and the fact that pingao favours the foredunes. The pingao in this area was rabbit damaged and picking had occurred. Pingao was mostly found on the front and top of spinifex foredunes while further back there was a thick cover of marram grass. The dunes

were low with a sudden steep rise to the top where there were some patches of bare sand and minor dune erosion. This area could possibly be considered for a rahui (reserve) as it has some good pingao stands and is not easily accessible. The amount of marram grass and rabbit damage would be unfavourable factors.

AREA I: FUSILIER SHIPWRECK 8.2 KM SOUTH OF KOITATA

Area I began at the Fusilier shipwreck site in front of the Santoft Forest and extended south. The area recorded one of the two highest values for pingao cover, 0.7. The dunes extended inland only 60 to 80 m to planted areas of acacia and macrocarpa and then pine forest. In most areas there was just one row of quite high, rounded dunes. On most of these the seaward side was predominantly covered in spinifex or pingao, including some of the largest areas of pingao seen in the whole survey. Most of this pingao was very healthy although it was quite badly mowed in places. On the back of the dunes there was bare sand and marram, including some recently planted marram. Although the Fusilier is a popular place to visit, vehicle access to the beach in this area is limited to four-wheel-drive vehicles. Because of the good stands of pingao and the areas of bare sand for further planting, this area would be worth consideration as a reserve possibility. The inaccessibility and relatively low density of marram would also be favourable factors. The limited width of the dunes, however, would mean quite a large section of beach would be required to include a significant area of dunes.

AREA J: KOITATA SOUTH SIDE OF TURAKINA RIVER MOUTH

The average cover class for this area was 0.59 ranging from three lines with no pingao to one with 1.75. The 15 lines ranged from 40 to 80 metres in length and some had large healthy pingao. There was medium rabbit damage.

Most of the dunes were low and rolling with spinifex and areas of bare sand. Vehicle tracks were recorded but did not seem to be a significant problem.

The area seemed to be suitable for cultivating and harvesting because of its good pingao, dune shape and low rabbit damage. However, it's accessibility would necessitate protective measures such as fencing, if it were to be used for rahui or replanting.

Area J is on land designated as a recreational reserve, and therefore it may not be possible to establish a reserve - this would have to be looked into.

AREA K: WHANGAEHU NORTH SIDE OF TURAKINA RIVER MOUTH

The pingao cover class average for this area was 0.74 which was the best of all the areas surveyed. Every line contained pingao, with the line averages ranging from 0.5 to 2. The lines ranged from 40 to 100 metres inland and the pingao on them was in very good condition, with only small amounts of rabbit damage. However cattle had been able to graze on the dunes due to an unfenced paddock behind the dunes. The area was mostly open and flat with new dunes forming and some established low, rolling spinifex dunes. Marram grass was mainly confined

to a thin stretch of dune which backed onto the river. On the whole this area would be excellent for a rahui reserve. It is very inaccessible to the public and it already has good stands of pingao. This area would also provide the opportunity to study the formation of new pingao and spinifex dunes with little effect from marram, which could be controlled.

The only real problem in this area is cattle and fencing could easily prevent this.

AREA L: MOANAROA BEACH

A Phase II study of this area was not carried out. However a reconnaissance of the area was made. Between the marram-covered foredunes covered and the high tide level is a large area of river flat. In much of this new dunes are beginning to form, many with pingao, and others with spinifex and marram. The pingao on these dunes is very healthy, growing close together on mounds up to 25m². The area is possibly not suitable for a reserve because it is a public beach, but it would be a very good place to monitor the development of these new dunes.

DISTRIBUTION AND DENSITY

1. PINGAO

The Manawatu coastline has a reputation of being one of the best sites in the country for pingao. From Phase I an impression of the overall distribution of pingao was gained. Approximately 60% of the coastline was described as having pingao 'throughout', i.e., a density of one plant or clump for every 20 m of coast surveyed. After close study in Phase II however, it became apparent that the density of pingao was not high.

Most of the pingao was on the seaward side of the foredunes within the first 100 m inland. Behind this many other plants are able to become established and the habitat favoured by pingao i.e., free moving sand, is not so common. Pingao appeared to be growing most commonly on its own or amongst spinifex and, not so commonly, amongst other plants such as sand daisy and convolvulus. In places pingao was growing alongside or amongst marram but usually the two did not grow together well, as marram grows in thick clumps, crowding out the pingao. Marram builds high dunes prone to being blown out by wind. Pingao however grows best on dunes which are building up and does not appear to survive well when sand is removed from around its underground stem networks. There was much evidence of this in most areas along the coast.

The two sections of coast that had pingao recorded in the category 'throughout' for the highest percentage of their areas were Foxton to Himatangi and Raumai to Koitāta. The Foxton to Himatangi area probably has the greatest width of dunes and has remained the least altered.

The area from Raumai to Koitāta has been greatly altered by stabilisation programmes such as the planting of marram for forestry. However it appears that marram has not become totally dominant on these dunes so there is still a favourable habitat for pingao.

Two other areas of particular note are the flat areas of beach and river flat on the northern side of the Turakina and Rangitikei rivers. In both these areas new dunes are beginning to form, many with pingao. These would be excellent areas for monitoring dune growth especially if marram could be excluded to allow significant areas of pingao to become established.

2. TOETOE KAKAHO

The survey indicated the distribution of toetoe kakaho on this section of the coastline to be sparse. The species of toetoe kakaho usually found along this coastline is *Cortaderia toetoe*. Toetoe kakaho was found at the following locations:

From the Manawatu River mouth to Himatangi there were four areas behind the dunes where toetoe kakaho and pampas were growing amongst rush and marram.

From Himatangi to Tangimoana there were four areas of pampas and toetoe kakaho. Three were on flats behind the dunes and one beside Five Mile Creek.

From Tangimoana to the Raumai Bombing Range there was only one area of sparse toetoe kakaho and from Raumai Bombing Range to Koitata there were three areas of toetoe kakaho and pampas growing on flats behind the dunes.

The survey suggests that the toetoe kakaho is not found on the dunes themselves, but on the flats behind the dunes or alongside streams.

Because the survey concentrated mainly on the dunes themselves further study would be required to gain a better idea of the distribution and density of toetoe kakaho in this region.

THREATS

1.PINGAO

The survey clearly highlights a number of factors that are contributing to the steady decline of pingao on the Manawatu Coastline.

1.1. *Marram Grass*:

Marram grass is now the predominant plant on the dunes. With its fast rate of spread by both human planting and natural seeding, and its habit of forming a dense cover it is slowly excluding the pingao from its habitat. The marram's ability to hold and stabilise sand results in very high dunes which are very susceptible to being blown out by the strong coastal winds experienced in this region. These blow-outs can also cause vast lengths of pingao rhizomes to be exposed and die off, killing the plants.

1.2. *Rabbit Damage:*

A second major factor contributing to the decline of pingao on the dunes is rabbit damage. This may be having serious effects on the rate of growth of pingao. In many places the plants are being chewed to the ground. All but two phase II survey areas showed medium to high rabbit damage. However to accurately assess how growth of pingao is affected by rabbits, it would be necessary to impose control measures to keep an area rabbit free.

It was noticed that very few young pingao seedlings were found and it is possible that it is at this stage the rabbits are having the greatest impact.

1.3. *Vehicles:*

Four-wheel-drive vehicles and trail bikes are driven over the dunes. This activity is directly damaging to colonies of pingao causing plants to be torn up or flattened. This in turn reduces dune stability which can then result in blow-outs and dune erosion. Survey results show this problem to be mainly confined to areas of coastal settlement and high recreational use.

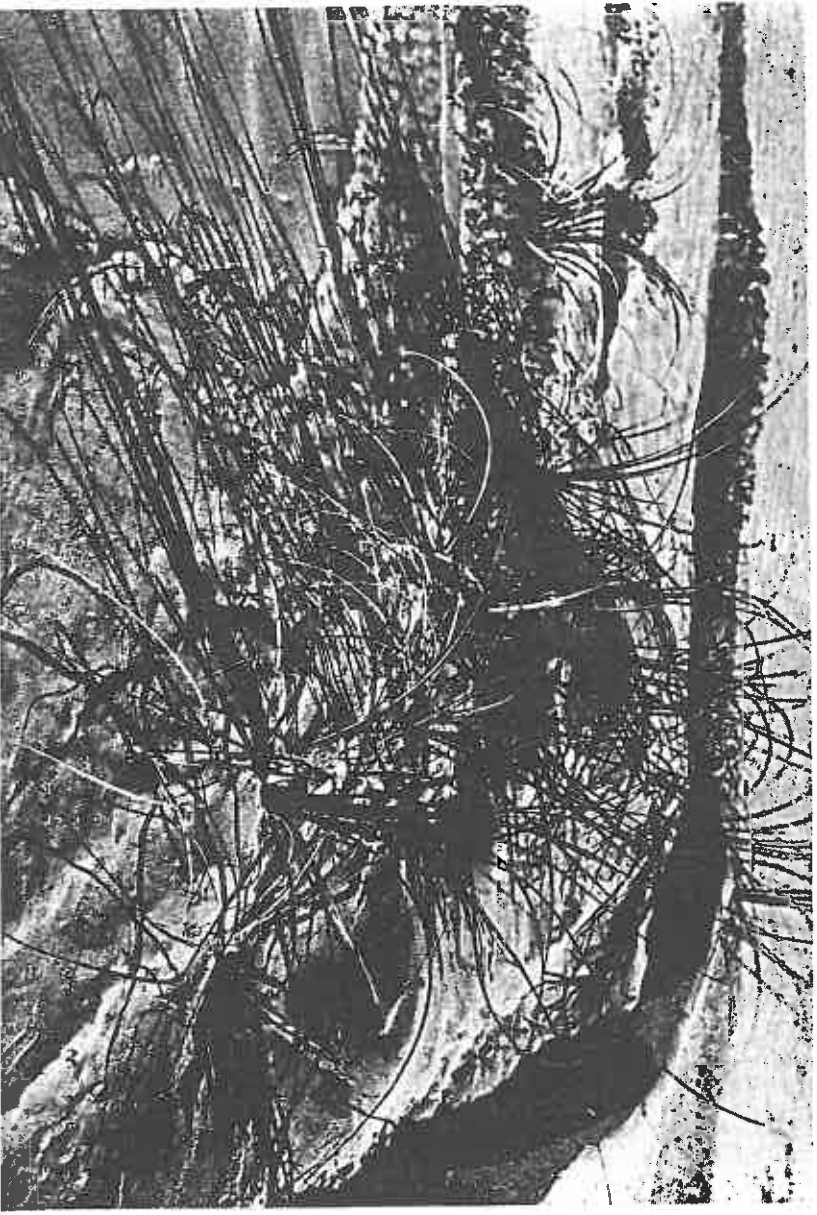


Fig 11 = Trail bike damage to pingao

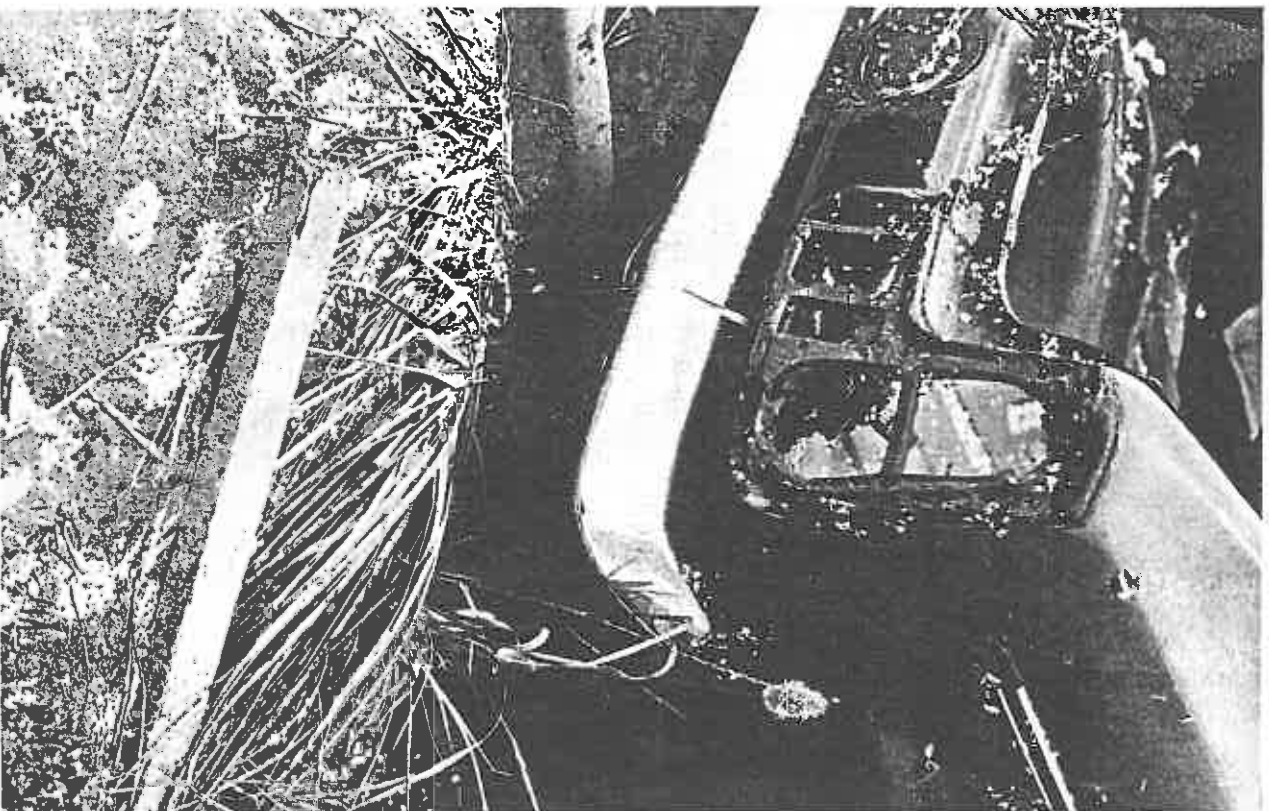


Fig 12 = Rubbish dump encroaching on pingao

1.4. *Rubbish Dumps:*

The rubbish dumps at Foxton Beach (area D) and Tangimoana (area F) are a threat to pingao, by encroaching onto colonies. This is already occurring.

1.5. *Cattle:*

In many areas of the coast, the dunes are backed onto by farm land. With the dunes being unstable and moving inland they are consequently burying fences, allowing cattle to graze in the dunes. Phase II survey results show two areas with buried fences and a further area where cattle were grazing freely on the dunes. In this latter area (on the north side of the Whangaehu River) we recorded the worst cattle damage.

1.6. *Harvesting:*

Three Phase II areas showed possible signs of harvesting. The extent to which the plants were damaged was difficult to ascertain. Incorrect harvesting can cause serious damage to the plant.

2. TOETOE KAKAHO

2.1 *Pampas Grass:*

The introduced pampas grass is now encroaching on the habitat of the native toetoe kakaho. This has been observed on the flats behind the foredunes - where once just toetoe kakaho would have been present, pampas is also present. In many places it is the pampas that is dominant.

The survey showed that out of ten sites where there was toetoe kakaho there was also pampas. In a further fifteen places there was only pampas.

2.2 *Eradication Programmes:*

Pampas grass is classified as a 'noxious weed'. Because of toetoe kakaho's similarity to pampas, it is easily mistaken for pampas, and is at risk of being accidentally destroyed.

AREAS FOR RESERVES, REPLANTING AND HARVESTING

The twelve Phase II areas were surveyed in order to identify those which had potential for reserves, re-establishment or harvesting. All the areas studied had advantages and disadvantages but some areas were more suitable than others. One important factor is accessibility. For a rahui reserve inaccessibility is a definite advantage as this minimises interference. However for harvesting, accessibility is important.

1. RESERVE:

Two areas stood out as being the most suitable.

1.1 *Area K: Whangaehu - north side of Turakina River mouth*

- Good quantities of pingao present
- Pingao regenerating and new dunes forming
- Low dunes
- Marram grass present but not dominant
- isolated.

The major problem with this area is that cattle are grazing behind the dunes and are not restricted by fences. This is causing considerable damage to the pingao and fencing would be important if the area was to be made a reserve. There was no toetoe kakaho present in this area.

1.2 *Area I: Fusilier shipwreck - 8.2 km south of Koitiata*

- Some excellent areas of pingao
- Spinifex predominantly on the front of the dunes, marram only further back.
- Relatively isolated
- Rounded dunes.

There are two main concerns with this area. Firstly the dunes are very narrow - generally only 60 to 80 metres wide - so a long stretch of coast would be required to include a reasonable area of dunes. Secondly, marram is being planted on large areas of bare sand to further stabilise the dunes and this could pose problems in the future as the marram becomes more abundant. There was no toetoe kakaho present in this area.

2. HARVESTING:

Three areas have possibilities for this purpose. One in particular (area E) stands out.

2.1 Area E: 1 km south of Himatangi

- uniform distribution of pingao
- easily accessible

The area would also be a good place for pingao re-establishment, particularly for building up stocks for picking.

2.2 Area J: Koititata - southside of Turakina River mouth

- good areas of pingao
- low rolling dunes, less likely to be blown out
- spinifex the predominant plant
- areas of bare sand
- toetoe kakaho present on the flats behind the dunes

2.3 Area B: Five Mile Creek - 7 km north of Foxton Beach

The area is not as suitable as the previous two because of the amount of marram present, the steep dunes, the dune erosion and the fact that fences between the dunes and the farmland behind are buried. However, the area did contain some good areas of both pingao and toetoe kakaho and it is easily accessible.

3. *Replanting:* Area E (already mentioned under harvesting) is suitable for this purpose because of the following factors:

- low dunes, close to water table and less likely to be blown out
- low density of marram
- large areas of bare sand
- sheltered gullies.

EVALUATION OF THE SURVEY METHOD

The survey method worked well toward fulfilling the initial aims. Some problems were encountered and the method was adjusted to accommodate for these.

In Phase I initially one sheet was filled out for every kilometre of coast covered, however it was found this distance was too great as much variation could occur within a kilometre. This resulted in a change to 500 m intervals, a more manageable distance.

The main problem with the Phase I method was the classification of pingao density as throughout/common/occasional/sparse. Because the pingao was so sparse we feel it may have been better to have different ranges on the categories. Even a classification 'throughout' did not necessarily mean pingao was particularly dense. Because of this a considerable number of areas were recorded as being 'throughout' and on closer study in Phase II it was found that many did not contain enough pingao for serious consideration as a reserve.

In Phase II the cover class system for densities of plants became quite confusing particularly in comparing averages. Most of the line averages and all the area averages were less than 1. This made comparisons difficult as 1 was the smallest category, corresponding to 1-10% pingao. Cover classes could have been made narrower to overcome this problem.

Another problem encountered with the Phase II section was that of map drawing. With each line surveyed a mapping sheet was used to show the topography and to summarise the area outside the line. Problems occurred in devising a uniform system of recording. Added written information would possibly have been simpler and just as informative.

RECOMMENDATIONS

1. THAT THE DEPARTMENT OF CONSERVATION
 - seek reservation for areas evaluated and recommended in this report as suitable for pingao reserves.
 - conduct further study on the requirements for protection of pingao and toetoe kakaho along the Manawatu coastline
i.e. research into rabbit and stock exclusion, weed control (particularly marram) and pingao establishment.
 - actively advocate the protection of native plants (especially pingao and toetoe kakaho) along the coastline.
 - liaise with tribal authorities, the Maruia Society, Paneke Trust Inc and other local interest groups in working toward preserving these plants.
 - reassess the Phase II Survey lines established in this study in five years time.
 - make available more resources for the protection of natural coastal communities, in this area.
2. THAT THE MANAWATU/WANGANUI REGIONAL COUNCIL
 - consider the results and recommendations of this report in the formulation of their Coastal Management Plan.
 - liaise with tribal authorities the Department of Conservation, Paneke Trust Inc. and local groups in working toward preserving these plants.
3. THAT IWI/HAPU AUTHORITIES (IN PARTICULAR NGATI RAUKAWA AND NGATI APA)
 - reassume charge of the management and distribution of these taonga within their respective tribal areas and revive tikanga with regards to harvesting.
 - notify all users outside of these tribal areas to make contact with the local Iwi/Hapu authorities prior to taking these resources from the area.
 - ensure younger generations are trained to manage these resources.

4. TO THE MINISTER OF YOUTH AFFAIRS

- this survey is repeated in other areas where pingao exists and is under threat.
- this project Save the Pingao and Kakaho be financially supported to continue. This survey has provided the information required as a foundation for work on re-establishment, propagation, controlling sanddune movement, establishment of coastal planting sites, establishment of reserves, elimination of threats, further action on toetoe kakaho and community awareness through education.

5. THAT TIMBERLANDS (WANGANUI DISTRICT)

- consider using native sand-binding plants for dune stabilisation rather than introduced species (especially marram grass).

6. THAT THE MINISTER OF EDUCATION

- make finance and resources available for education on natural dune areas, and native dune plants in particular, for schools on the Manawatu/Rangitikei coastline.

7. THAT THE NATURAL HERITAGE FOUNDATION

- compile a coastal package, which includes the plight of pingao and toetoe kakaho, as part of their educational materials on New Zealand's Natural Heritage.

8. THAT SHELL BP AND TODD OIL SERVICES LIMITED (if the Tangimoana pipeline proposal goes ahead)

- take pains to ensure damage to pingao and other dune plants is minimised during the course of the project.
- rehabilitate the affected sand dune area using pingao and other native sand-binding plants.

9. TO THE MINISTER OF THE ENVIRONMENT

- tribal authorities be given the necessary finance and resources to monitor, control and maintain natural resources along the coastline, in particular pingao and toetoe kakaho.
- that Regional Councils and territorial authorities consult with Iwi Authorities on matters affecting natural resources and the environment.

ACKNOWLEDGEMENTS

The Paneke Community Development and Training Trust (Inc.) wish to thank the following organisations and people:

1. Department of Conservation, Palmerston North personnel - especially Ross Cassells, Brent Lovelock and Don Ravine.
2. The Maruia Society, Palmerston North Branch, especially Mr Stan Jenkins for the photography.
3. Nga runanga Ngati Apa, Ngati Raukawa, Ngati Rangitane and Muapoko.
4. Timberlands and the many land owners who granted permission for surveying on their land.
5. Parauui Marae Committee and the people of St Michael's Church Marae Complex for their support.
6. Margaret Reihana for her advice on pingao propagation and support for the project as a whole.
7. Wendy Turoa for her typing over the year and Christine McAlpine for help with the editing of this report.

Bibliography

- Carlin, W.F; Turner, G.A.
Coastal Reserves Investigation. Report on Rangitikei County - Lands and Survey Dept. November 1975.
- Cockayne, L.
Report on the Dune-Areas of N.Z., their Geology, Botany and Reclamation. Department of Lands. Government Printer Wellington 1911.
- Courtney, S.
Our disappearing natural dune lands-Forest & Bird Magazine. August 1984. pp2-5.
- Cowie, J.D.
Dune-building Phases in the Manawatu District, New Zealand. N.Z. J. Geol Geophys 6: 268-80. May 1963.
- Ecroyd. C; Knowles, B.
Species of Cortederia in New Zealand. Bull. No 105. N.Z. Forest Research Institute. 1985.
- Ecroyd, C.E; Knowles, B;
Kershaw, D.G.
Pampas; Recognition of a New Forest weed, in Bull No 128 N.Z. Forest Research Institute, 1984.
- Eckroyd, C.E; Knowles, B;
Kershaw, D.G.
Pampas grass; a Weed of Plantation Forests. Supplement to Bull No 128. N.Z. Forest Res. Inst. Feb 1985.
- Esler, A.E.
Manawatu sand-dune vegetation. Proceeds of N.Z. Ecological Society: Vol 17: 41-6 1970.
- Esler, A.E.
Botany of the Manawatu District New Zealand. E.C. Keating, Govt printer, Wellington. N.Z.
- Given, D.R.
Rare and Endangered Plants of New Zealand A.H. & A.W. Reed, Wellington 1981.
- Moore, L.B.
"Our living Enviroment". Sand dune plants. Post Primary School Bulletin Vol 3. No 4. 1949.
- Oliphant, J.
"Propagation of Desmoschoenus Spiralis from seed" (paper).
- Stewart, P.
Research to the Rescue. Agrisearch June 1986 p 45.

Summary of differences between introduced pampas grasses and native toetoe

Toetoe

Leaves have distinct secondary veins between midrib and leaf edge (Plate 4).

Midrib continues into leaf sheath.

Leaves do not snap readily.

Leaf sheath with white waxy surface (Plate 5).

Dead leaf sheaths droop but do not form spirals.

Flower heads erect to drooping usually light golden-yellow.

Pampas grasses

Leaves have a conspicuous midrib but lack distinct secondary veins between midrib and leaf edge.

Midrib does not continue into leaf sheath.

Leaves snap readily when given a sharp tug.

Leaf sheath does not have white waxy surface.

Dead leaf sheaths hang down forming spirals. Mature plants surrounded by these dead sheaths which resemble wood shavings (Plate 6).

Flower heads erect and dense, colour variable generally white, pink or purple.

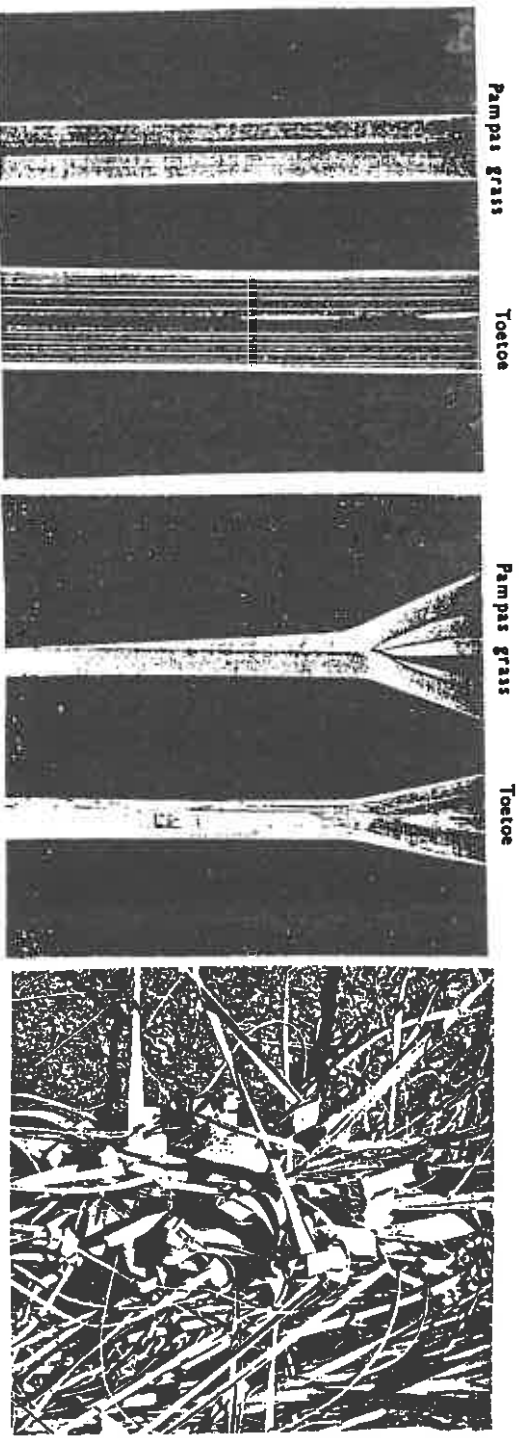


Plate 4-Leaf blades of pampas grass & toetoe Plate 5-Leaf bases of pampas grass & toetoe Plate 6-Leaf sheaths hang down forming spirals

APPENDIX 2 - PHASE I RECORDING SHEET

RECORDING SHEET - PHASE I

Date:

Recorded by:

Location:

Area of Coast _____ km to _____ km.

Visibility from route walked:

Prominent features/landmarks:

Topography:

Width of Dune/sand (estimate):

Pingao Present: Y N

Density: Throughout Common Occasional Sparse

Size of colonies: Small (.2m) Med. (2-10m) Large (.10m)

Distribution: 0-100 from foredune 100-200m Further inland

Weeds Present: (name and give density as above, eg: Marram T)

Weeds amongst pingao:

Modification:

Tick

Comments

- Vehicle Tracks

- rabbits
- grazing
- picked
- other (specify)

Condition: Healthy Sick Dead

Area of bare sand on dunes: Huge Med. Small

Foredune vegetation:

	0-200m	2-400m	4-600m	6-800m	8-1000m
Pingao					
Marram					
Spinifex					
Bare Sand					

APPENDIX 3 - PHASE II SURVEY RECORDING SHEET

SURVEY RECORDING SHEET - PHASE II

LOCATION:

RECORDED BY:

GRID REFERENCE:

DATE:

BEARING

LINE:

Distance	Pingao	Bare Sand	Marram	Spinifex	Other Plants Present	Height	Condition	Modifications	Comments
0 m									
20 m									
40 m									
60 m									
80 m									
100 m									

- 0 0
- 1-10 1
- 10-25 2
- 25-50 3
- 50-75 4
- 75-100 5

Other Plants

- Sand Coprosma (SC)
- Cassinia (C)
- Sand Daisy (D)
- Acacia (A)
- Boxhorn (B)
- Pimelia (P)
- Convolvulus (CN)
- Pine (PR)
- Macrocarpa (M)
- Lupin (L)
- Carex Grass (CG)
- Rush (R)

Height

- L < 0.5 m
- M 0.5-0.75 m
- L > 0.75 m

Condition

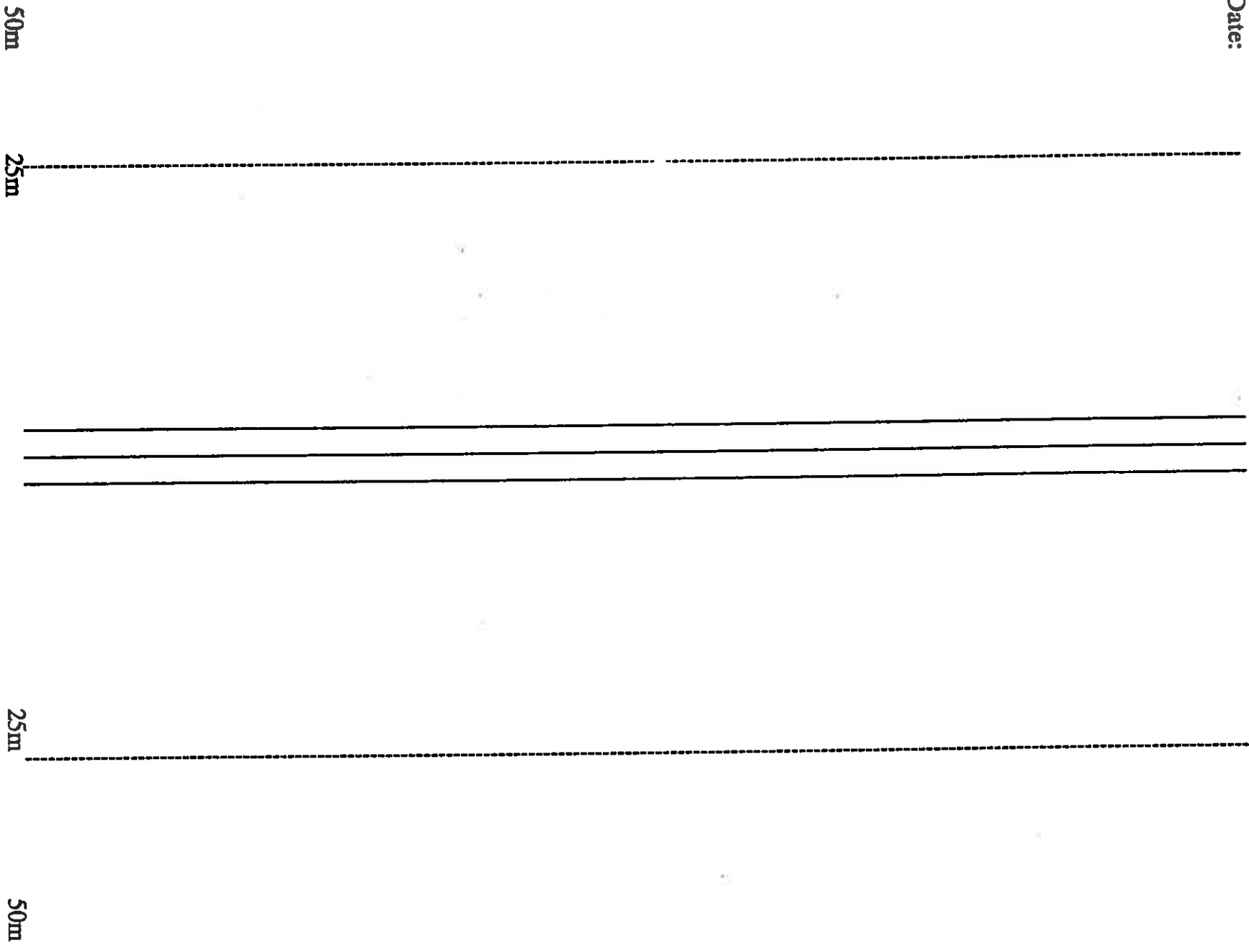
- Healthy (H)
- Sick (S)
- Dead (D)
- = Seed Heads

Modifications

- Vehicles (V)
- Picked (P)
- Rabbits (R)
- Grazed (G)

APPENDIX 4 - PHASE II MAPPING SHEET

Line:
Date:



APPENDIX 6 - LIST OF ILLUSTRATIONS

Fig 1 =	Tukutuku panel incorporating both pingao and toetoe kakaho	10.
Fig 2 =	Healthy pingao on the front of the foredune	13.
Fig 3 =	Toetoe kakaho growing behind the dunes	15.
Fig 4 =	Manawatu/Rangitikei Coastline showing survey area	17.
Fig 5 =	Land Tenure	18.
Fig 6 =	Evolution of Manawatu coastal topography	20.
Fig 7 =	Parabolic dune shape	20.
Fig 8 =	Map of Phase II survey areas	28.
Fig 9 =	Survey party at work	29.
Fig 10 =	Distribution and density of pingao and distribution of toetoe kakaho	33.
Fig 11 =	Trail bike damage to pingao	49.
Fig 12 =	Rubbish dump encroaching on pingao	50.