UNITED KINGDOM FALKLAND ISLANDS TRUST

TREE PLANTING AND ESTABLISHMENT IN THE FALKLAND ISLANDS

Report on additional technical work (Year 5) of a project grant assisted by the Falkland Islands Development Corporation

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tree95

TREE PLANTING AND ESTABLISHMENT IN THE FALKLAND ISLANDS

Report on Additional Work 1994/95

Summary

Growing trees is a long process and these trials have been largely concerned with initial establishment. Further assessment work of a longer term nature will be required.

A series of experiments were planted to investigate aspects of tree planting and establishment in the Falkland Islands. Experiments have been planted at 3 sites to investigate planting technique, tree nutrition and artificial shelter, at two sites to aid provenance selection and an experimental woodland plantation has been established.

Results are presented for two sites (Stanley and Fitzroy) for four years and one site (Keppel) for five years. Some preliminary conclusions on tree planting in the Falklands can be made but caution must still be exercised in interpreting results in what is, by necessity, a long term project.

To date the project has shown that, provided ground preparation and nutrition are attended to, trees can grow and be valuable in a wide variety of situations in the Falkland Islands. Individual tree shelters are beneficial in early establishment.

The growth of Lodgepole pine at the Fitzroy site is very encouraging. Surviving Lodgepole trees at the Stanley site are also now growing well so this species seems the best overall once established. Provided trees survive the first year of establishment, subsequent chances of survival seem high. Pit planting will likely prove essential on all sites and is definitely essential on dry sites. Once trees which have been slit planted and established, they seem to subsequently grow satisfactorily. The benefits of kelp compost added at planting are being felt at the Fitzroy site. The growth promoting benefits of applying liquid kelp extract as a foliar feed are starting to be seen on Lodgepole pine on the Fitzroy site. Lodgepole pine appears to respond better to foliar extracts than Sitka

spruce. Paraweb netting did not have an immediate beneficial effect, but there is an indication that benefits may come later.

Heavy losses of trees from the initial Dulverton planting are probably due to the severe winter weather and possibly tree type. Most survival was close to the boundary shelter fence. Replanting with a mixture of trees is recommended.

Outlines for projects on erosion and Tussac grass re-establishment are presented.

1. Background - the need for trees

Falkland Islanders have been interested in growing trees in Stanley and in the camp for many years. Although it would be undesirable to clothe large areas in coniferous woodland and tall forest giants will not be grown in the Falklands, there is a need for shelter for stock and gardens and to improve the visual appearance of Stanley.

Now that flocks are smaller and the national sheep flock is going to be substantially upgraded from improved stock imports, the need to reduce losses is all the more important. Strategically placed shelter around clippy pens or in ewe camps could be used over the critical times of lambing and shearing to make a very significant impact on lamb survival and on sheep recovery after stress.

Stanley is developing rapidly, and with new housing and small industries appearing there is a need to landscape the town. Trees are widely recognised as the most natural way to achieve this. With many new small settlements appearing, trees have a further shelter and landscape role. There is also an interest in erosion control and rehabilitation of eroded areas. Research has shown the erosion process to be a direct result of the windy climate.

Trees can form an important role in this context and further trials are necessary.

Plate 1. Healthy 5 year old Lodgepole pine trees well established at the Fitzroy Site (Photographs taken January 1995)

A wide range of reports and scientific papers were reviewed prior to commencing the programme (see Interim Technical Report - Year 1).

2. Introduction and Objectives

The objectives of the project (commenced in 1990) were as follows:

1. To determine the most suitable method for planting and establishing trees on a range of camp types in the Falkland Islands.

2. To provide information on species suitability for various situations in the Falkland Islands.

It is assumed that, initially, results would be more applicable to strategic tree planting situations - in the agricultural context around settlements, paddocks, clipped-sheep pens etc and in the landscape context, around gardens and public places in Stanley.

This report follows on from three interim technical reports and one final report on the project and contains a summary of follow up work and a continuation of measurements from the trials reported in the earlier reports. Results following sampling and measuring are available from three trial sites. Following the absence of a permanent resident on Keppel Island, regrettably only minimal measurement and tree management was possible. A further measurement of the remaining trees was carried out in early 1994 and in May 1995 courtesy of Aidan Kerr and Owen Summers, Department of Agriculture. All the field trials in connection with this project are now planted. However, as many of the trials are still in the establishment phase, detailed conclusions cannot be made at this stage. Available results are presented and conclusions drawn where practicable.

3. Experimental programme

a. Tree planting and establishment trials.

The major thrust of the project was geared towards determining tree planting and establishment techniques on a range of sites. The key issues involved are planting technique, shelter provision and tree nutrition. An experiment was designed involving the following treatments:

- Tree species - 2 (Lodgepole pine and Sitka spruce - largely selected because of local availability)
- Planting technique - Slit plant (quick and simple - standard UK Forestry technique)
  - Pit plant (as implied - small pit dug to disturb the soil)
- Nutrition - No fertiliser; phosphate only; kelp compost (in the pit); foliar feed of locally produced kelp extract)

The experimental design incorporated all combinations of three treatments in a fully replicated (3 reps per treatment) design. Each treatment plot contains 5 trees, representing a total of 600 trees per site. The experiment was planted at 3 sites:-

(i) Keppel Island - hard, dry "diddle-dee" camp
(ii) Fitzroy (Britannia) - whitegrass camp
(iii) Stanley (Mkt garden) - impoverished, shallow, wet peat

The Keppel Island site was planted in August 1989 and the other two sites in August 1990.

b. Production of liquid kelp extract.

One aspect of the experiment detailed above is an assessment of the value of locally produced liquid kelp extract. Previous trials (conducted by the UK FI Trust) had shown that bacterially activated, aerobic digestion is the simplest and cheapest way to produce kelp extract. Over the duration of the project, liquid seaweed extract was produced from the digester and was applied to some trees in the main establishment trial. It has not been possible to operate the digester during the 1994 season. The plant has now been shipped to Port Howard where it will be started up again to produce liquid kelp extract. Sam Miller has been asked to assist with setting up of the digester at Port Howard.

4. **Results**

A TREES

a. <u>Tree Planting and Establishment (Keppel Island, Fitzroy, Stanley)</u>

On all 600 trees at each site the following measurements have been made - tree height; a subjective assessment of general tree health (on a 0-5 scale); number of branches counted; foliage samples taken for chemical analyses of leaf nutrient levels. Measurements have been taken as follows:

	1989 (Jun)	1990 (Jun)	1990 (Oct)	1991 (May)	1991 (Nov)	1992 (Jul)	1992 (Nov)	1994 (Jan)	1995 (Jan)	1995 (May)
Keppel	/	/	/	/		/		/		/
Fitzroy			/	/	/		/	/	/	
Stanley			/	/	/		/	/	/	

The effects of planting technique, shelter, foliar spraying and species on tree height, health and survival are presented in the Tables. Data are presented for two sites in most cases.

However, since the trees on Keppel Island are no longer tended regularly (the island is now uninhabited) losses have increased. In July 1992 there were 250 trees still alive, a decrease in survival from 62% to 38% between May 1991 and July 1992 and these were measured. In January 1994 there were 101 trees still alive, twice as many Lodgepole pine (mean height 75 cm) surviving than Sitka spruce (mean height 51 cm). One tree was 180 cm tall. Overall the Lodgepole pine has grown 25 cm since 1992, the fastest growth of any site (Table 1). An assessment was carried out in April 1995 by Aidan Kerr and Owen Summers (Department of Agriculture). They estimated that overall 30% of trees were still surviving with a mean height of 73 cm (Lodgepole pine) and 66 cm (Sitka spruce) (Table 2). The discrepancy between the two assessments appear to have been the definition of what actually constituted a 'dead' tree. However, assuming the means to have been reasonably representative, Sitka spruce appear to have grown well over the years.

The Department of Agriculture team also report that overall survival of Sitka spruce seemed to be better than Lodgepole pine whereas early growth of Lodgepole pine was better than for Spruce. Trees suffered more from competition from grass than any other vegetation type and paraweb fencing had a beneficial effect up to about 5 m from the fence. The site was overgrown and suffering from neglect but the cattle did not appear to be causing an immediate threat.

(i) Species selection

Individual tree species growth, health and survival since planting are presented for the Fitzroy site (Figure 1) and Stanley site (Figure 2). It can be seen that

(a) Mean Tree height (cm)	Sheltered	Unsheltered	Mean
Lodgepole Pine	81	70	76
Sitka spruce	45	57	51
Mean	63	64	64

(b) Mean % Survival	Sheltered	Unsheltered	Mean
Lodgepole Pine	22	55	39
Sitka spruce	9	8	9
Mean	16	32	24

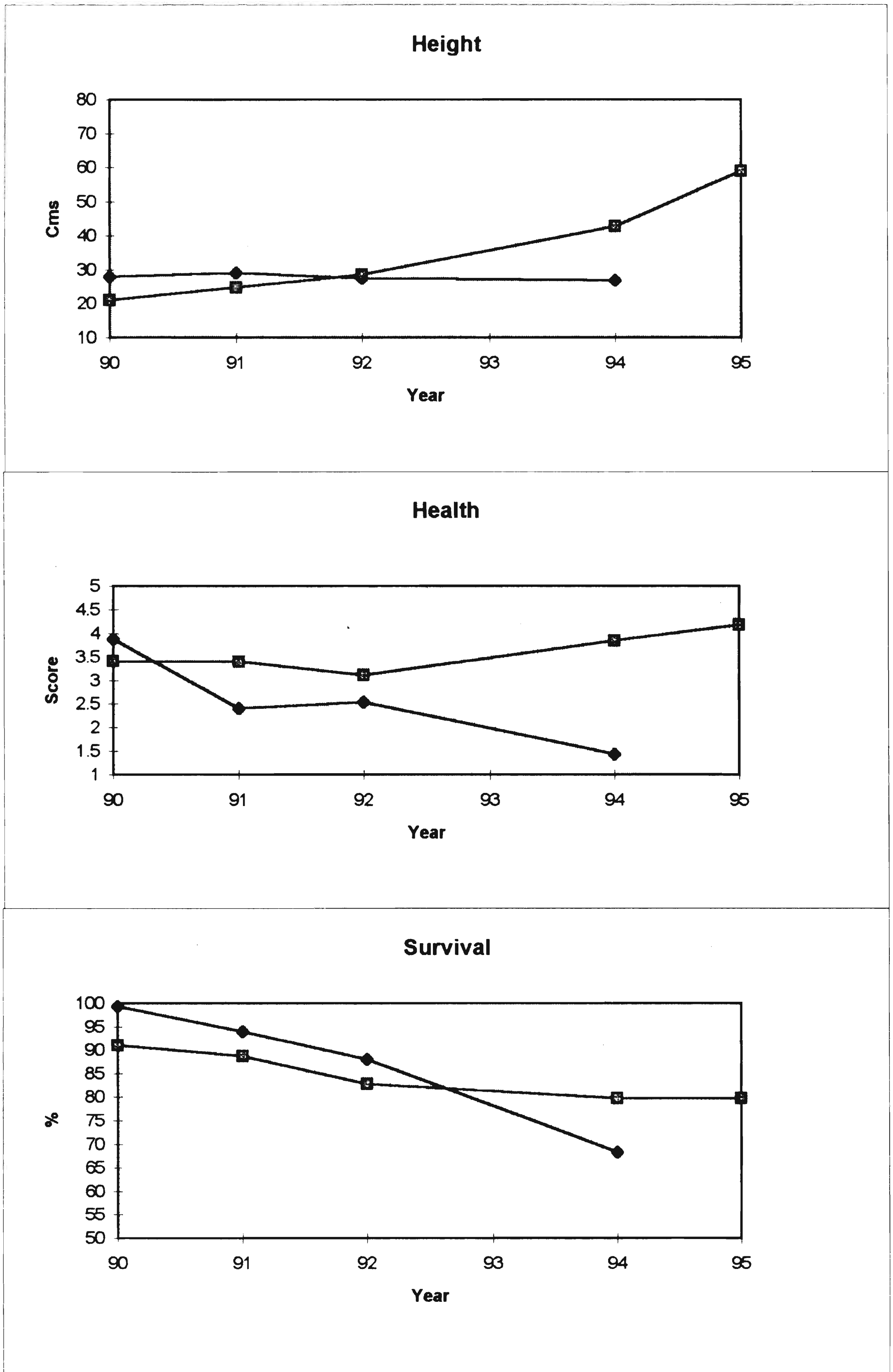
Table 1: Tree height and survival at Keppel Is (January 1994)

(a) Mean Tree height (cm)	Sheltered	Unsheltered	Mean
Lodgepole Pine	76	70	73
Sitka spruce	72	60	66
Mean	74	65	70

(b) Mean % Survival	Sheltered	Unsheltered	Mean
Lodgepole Pine	23	25	24
Sitka spruce	25	44	35
Mean	24	35	30

Table 2: Tree height and survival at Keppel Is (April 1995)

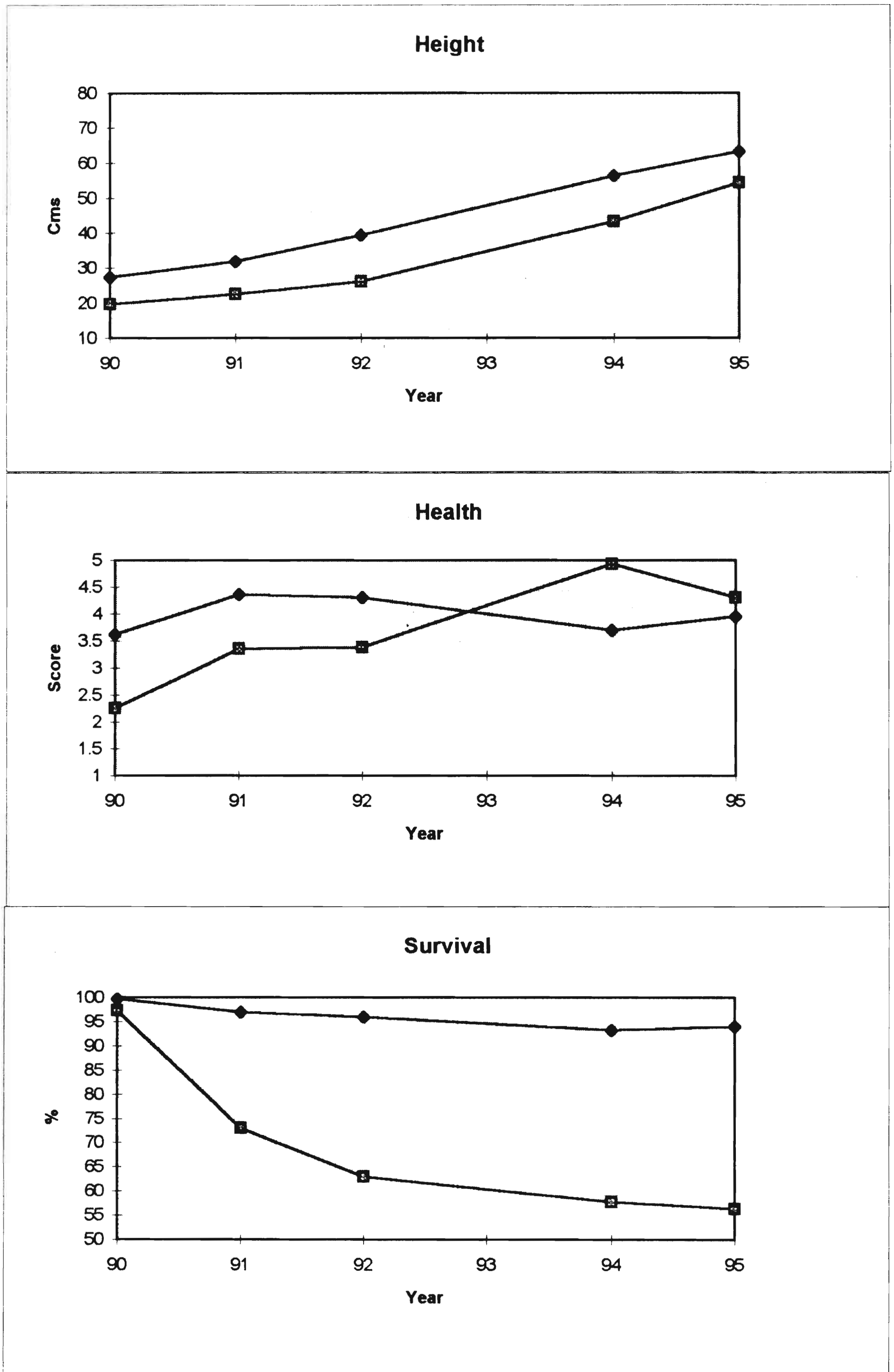
Fitzroy-Species



◆ Sitka Spruce □ Lodgepole Pine

Figure 1 The Growth, Health and Survival of trees planted at the Fitzroy site. Measurements on Sitka Spruce were terminated in 1995

Stanley-Species



◆ Sitka Spruce □ Lodgepole Pine

Figure 2 The Growth, Health and Survival of trees planted at the Stanley site

Lodgepole pine is performing best on the Fitzroy site and that growth has increased at a more rapid rate between 1994 and 1995 than any other year (Figure 1). The overall health of the trees also increased steadily since 1992 so they can be considered to have well established and be growing rapidly and healthily.

On the other hand, Sitka spruce had not increased in height since planting and their health status was gradually declining (Figure 1b) with trees gradually dying off (Figure 1c). Hence it was decided to discontinue assessment of Sitka spruce on this site.

On the wetter, less fertile Stanley site, both species are growing equally well and the rate of growth of Lodgepole pine is the same as for the Fitzroy site (Figure 2a). After the initial tree losses (up to 1992 - Figure 2c) few more Lodgepole pines have died and they are comparable in health to the Sitka spruce on that site (Figure 2b).

Hence, Overall it can be concluded that, once established, Lodgepole pine is a reliable species for any site whereas Sitka spruce only performed best on wetter sites and where there is less competition from grass.

(ii) Planting method

Comparisons can be made from both the Stanley and Fitzroy sites (Tables 3, 4 and 5 and Figures 3 and 4). Overall tree growth (Lodgepole pine) was significantly greater from pit planted trees than slit planted trees at the Fitzroy site (Table 3 and Figure 3). Five years after planting mean height of slit planted trees is 52 cm and of pit planted trees, 64 cm (Table 3). There was no significant effect on health, but all surviving trees on this site were healthy. In the past year, (94-95) trees have

		Fertiliser at Planting		
Site	Planting Technique	Zero	Phosphate	Kelp Compost
a. Height, Growth (cm)				
Stanley	Slit	48.6	80.2*	
(1989-1995)	Pit	59.6	74.6	53.4
Fitzroy	Slit	47.2	46.2	
(1989-1995)	Pit	63.1*	62.3*	66.1*
b. Health				
Stanley	Slit	3.6	4.4	
	Pit	3.9	4.1	3.9
Fitzroy	Slit	3.7	4.0	
	Pit	4.4	4.3	4.6

Table 3: The effect of fertiliser at planting and planting technique on tree growth and health from Fitzroy (Lodgepole pine) and Stanley (Sitka spruce) in January 1995. * indicated treatments which are significantly greater than control.

Standard errors of the mean:-		
	Height Stanley	4.64
	Height Fitzroy	4.87
	Health Stanley	0.28
	Health Fitzroy	0.31

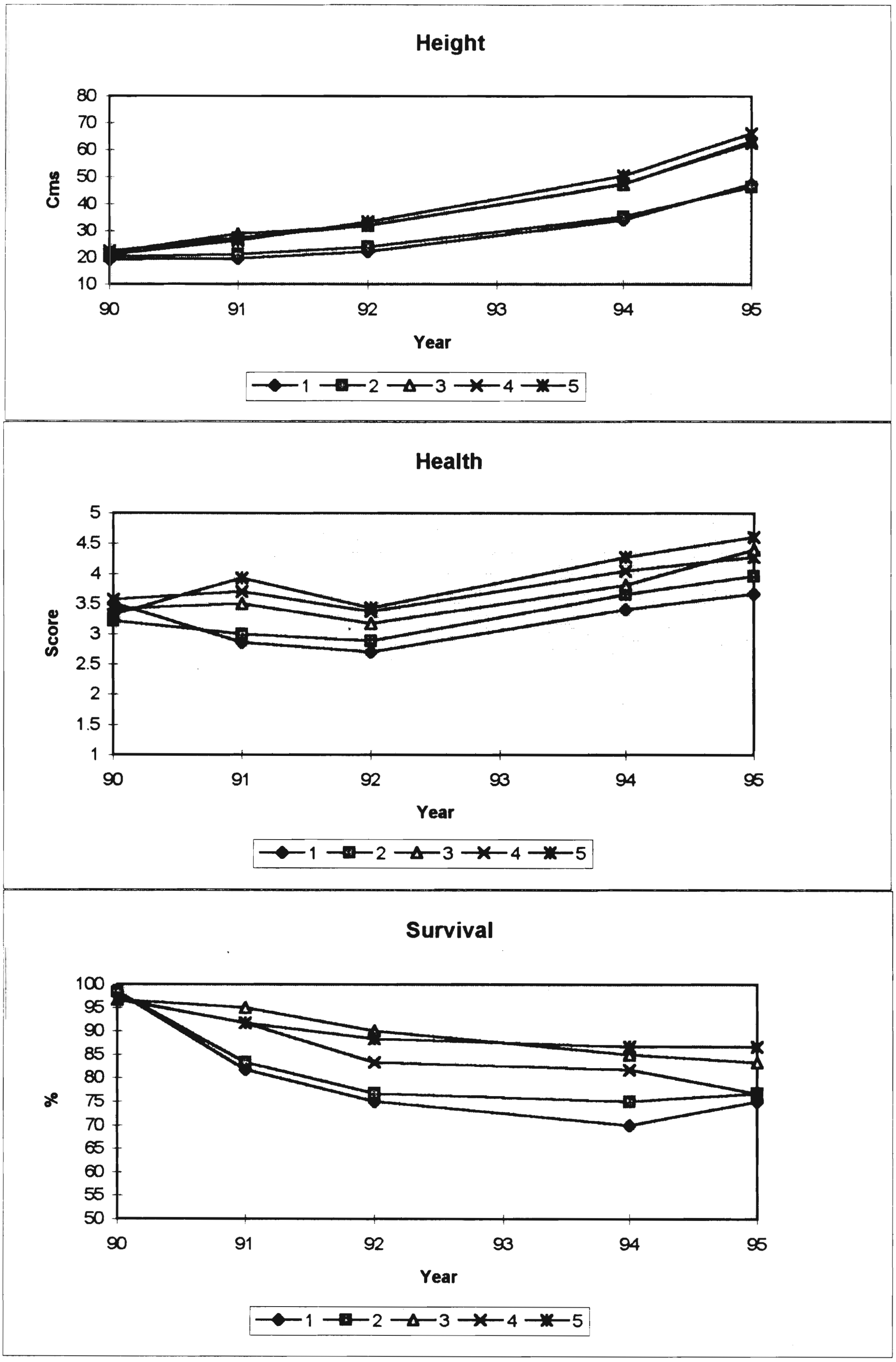
Planting Technique	Kelp Extract / Fertiliser	SITE: Fitzroy Applied	Fitzroy Zero	Stanley Applied	Stanley Zero
a. Height (cm)					
Slit	Zero	49.9	44.4	47.3	50.0
Slit	Phosphate	47.7	44.6	77.3	83.2
Pit	Zero	68.9	57.2	59.5	59.7
Pit	Phosphate	66.4	58.2	70.8	78.5
Pit	Kelp Compost	69.5	62.6	51.2	55.6
Mean		60.5	53.4	61.2	65.4
sem		6.89		5.45	
b. Health					
Slit	Zero	3.7	3.6	3.4	3.7
Slit	Phosphate	3.9	4.0	4.4	4.3
Pit	Zero	4.7	4.1	3.8	4.0
Pit	Phosphate	4.2	4.4	4.0	4.3
Pit	Kelp Compost	4.7	4.5	3.7	4.0
Mean		4.2	4.1	3.9	4.0
sem		0.43		0.26	
c. % Tree survival					
Slit	Zero	77	73	97	100
Slit	Phosphate	70	83	90	97
Pit	Zero	77	90	93	97
Pit	Phosphate	77	77	93	97
Pit	Kelp Compost	83	90	93	83
Mean		77	83	93	95
sem		8.9		5.6	

Table 4: The effect of planting technique, fertiliser at planting and kelp extract spray on tree height, health and survival of Sitka spruce at the Stanley site and Lodgepole pine at the Fitzroy site, January 1995.

Planting Technique	Kelp Extract / Fertiliser	SITE: Fitzroy Applied	Fitzroy Zero	Stanley Applied	Stanley Zero
a. Height Growth (cm)					
Slit	Zero	13.7	12.1	2.6	4.6
Slit	Phosphate	12.2	9.7	7.3	10.5
Pit	Zero	16.4	15.2	8.4	10.7
Pit	Phosphate	15.5	14.2	7.4	10.9
Pit	Kelp Compost	17.3	14.3	3.7	4.1
Mean		15.0	13.1	5.9	8.2
sem		2.70		2.21	
b. Health Change					
Slit	Zero	0.15	0.37	0.15	0.43
Slit	Phosphate	0.29	0.32	0.27	0.08
Pit	Zero	0.33	0.83	0.28	0.20
Pit	Phosphate	0.15	0.30	0.17	0.32
Pit	Kelp Compost	0.15	0.51	0.20	0.42
Mean		0.22	0.47	0.21	0.29
sem		0.220		0.185	
c. Change in % Tree survival					
Slit	Zero	3.3	6.7	0	0
Slit	Phosphate	3.3	0	0	0
Pit	Zero	0	-3.3	0	0
Pit	Phosphate	-3.3	-6.7	0	3.3
Pit	Kelp Compost	0	0	3.3	0
Mean		0.7	-0.7	0.7	0.7
sem		3.72		3.76	

Table 5: The effect of planting technique, fertiliser at planting and kelp extract spray on incremental growth, change in health status and survival of Sitka spruce at Stanley and Lodgepole pine at Fitzroy between January 1994 and January 1995.

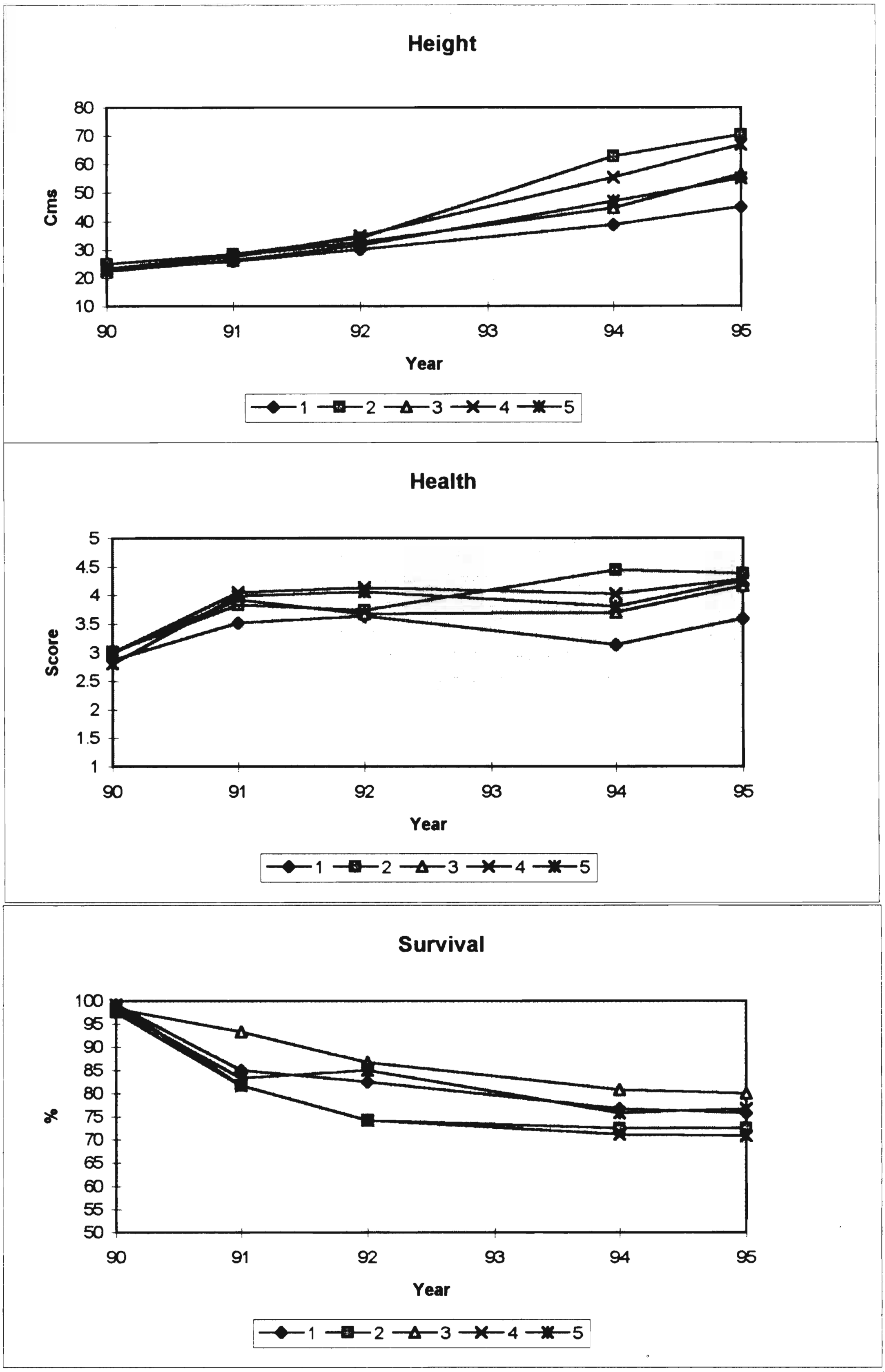
Fitzroy-Effect of Planting Technique



KEY 1 = Slit 2 = Slit + Phosphate 3 = Pit 4 = Pit + Phosphate 5 = Pit + Kelp

Figure 3 The effect of planting technique on Growth, Health and Survival of Lodgepole Pine trees planted at Fitzroy.

Stanley-Effect of Planting Technique



KEY 1 = Slit 2 = Slit + Phosphate 3 = Pit 4 = Pit + Phosphate 5 = Pit + Kelp

Figure 4 The effect of planting technique on Growth, Health and Survival of Lodgepole Pine and Sitka Spruce trees planted at Stanley.

grown approximately the same amount from both planting techniques (14-15 cm), (Table 5) the reduced growth from slit planting occurring in the first few critical years of establishment. This point was discussed in detail in the previous (yr 4) report. At the Stanley site, response to pit planting was less clear (Table 3 and Figure 4) and this may have been due to generally poor growth (Table 5 and Figure 2) or the fact that the site was ploughed up initially. Overall this site is less suitable for tree growth. The data highlights the need for good site selection.

(iii) Fertiliser at planting

The increased growth response to phosphate on the slit planted trees at Stanley in 1994 was further enhanced when the data was re-analysed for Sitka spruce alone in 1995 (Table 3). Trees were significantly higher in this treatment and were higher than any other treatment. Overall, by chance, these trees were taller at planting and this has, to some extent, followed through. Early response to fertilisers at the Fitzroy site had now disappeared and growth (94-95) over all treatments was similar (Table 5). At Fitzroy composted kelp in the pit at planting was beneficial with taller trees overall pit plantings (by 3 cm) (Table 4) and between 94-95 trees grew slightly faster (by 1 cm per annum) where kelp had been applied than where no kelp was applied (Table 5).

(iv) Foliar fertiliser application

Lodgepole pine at Fitzroy have grown better over the past year where foliar kelp extract was applied than where it was not (mean height 60.5 vs 53.4 cms respectively and mean growth 15.0 vs 13.1 cms respectively) (Tables 4 and 5). This result was only significant at the 6% level of significance - still not sufficient for biological significance (5%) but decreasing towards this level consistently (14% in 1993, 12% in 1994). Hence it is anticipated that if these trends continue, by next year kelp extract will be significantly increasing growth of Lodgepole pine on this site.

On the Stanley site, foliar application did not increase Sitka spruce height (Tables 4 and 5) and although trees were actually slightly smaller where no foliar kelp extract was applied, this can be attributed to different sizes at planting and was not significant. Lodgepole pine responded better than Sitka spruce to foliar extract at the Stanley site, indicating that Lodgepole pine with its longer and upward facing needles which prevent rapid runoff is more suited for foliar uptake of liquid-applied nutrient.

(v) Shelter netting

Observations at the Keppel site indicate that survival and growth of trees is better immediately at the lee of shelter webbing. Overall, at the other two sites, growth was only slightly better in the sheltered than the unsheltered trees but this is reversing an earlier trend of either no response at all or a negative response to shelter at the Fitzroy site (Table 6). Trees at the Fitzroy site are now significantly healthier in sheltered than unsheltered plots (Table 6). This may be due to absence of browning and scorch of leaves from the wind which would reduce the health score. At the Stanley site, trees still continue to respond well to shelter and are now, on average, 6 cm taller in sheltered than unsheltered plots (Table 6).

b. Conclusions from Establishment Trials

- Lodgepole pine is a better species to use than Sitka spruce over a wide range of sites in the Falklands.

	Stanley		Fitzroy	
	Sheltered	Unsheltered	Sheltered	Unsheltered
Tree height (cm)	66.2	60.4	57.2	56.7
Tree health	3.97	3.94	4.5	3.9*
Tree Survival (%)	91	97	84	75
Growth 94-95 (cm)	7.6	6.5	14.8	13.3

Table 6: The effect of artificial sheltering on tree growth, health and survival at Fitzroy (for Lodgepole pine) and Stanley (Sitka spruce) four years after planting (1995) and on tree height increment in the fourth full year of growth (1995), at Stanley and Fitzroy. Results with a * show significant difference at 5% level of significance.

- Pit planting is strongly recommended for adequate tree survival and growth on dry, hard sites. On wet sites early survival is better following pit planting but subsequent growth is unaffected. Trees which have been slit planted seem to subsequently grow satisfactorily once established.

- Where trees are pit planted, kelp compost should be used, its beneficial effects are carried into the second year after establishment and beyond

- The growth promoting benefits of liquid kelp extract on Lodgepole pine are becoming more pronounced.

- The benefits of paraweb netting as a minimal shelter provision are becoming more important as trees get taller and offer more wind resistance.

c. Woodland Plot at Port Howard

It was extremely disappointing to note that of the original (1993) planting, although 90% had survived year one, there had been a very high loss this spring (only 19% surviving). There were severe cold southerly winds in spring and many trees in the islands suffered. It is not known if this was the major cause of death - if it was, there are serious implications for the use of any progeny from the imported macrocarpa seed. Although it is only a subjective analysis, it can be seen from Figure 5, which shows the location of the surviving trees on the site, that most survival has been in the outer rows nearest the shelter. This might highlight the need for more windbreak protection for macrocarpa.

An analysis of the new plantings, carried out since the storms confirmed the above findings (Table 7). Of 217 trees planted, approximately 80% are still alive.

Original plants - August 1993 (1995 assessment)			
Row	No. of Trees	% Dead	No. Live
1	78	64	28
2	83	76	20
3	57	86	8
4	77	90	8
5	78	90	8
6	81	74	21
7	15	87	2
8	12	83	2
New Planting - August 1994 (1995 assessment)			
9	52	23	40
10	6	33	4
11	24	17	20
12	21	29	15
13	26	23	20
14	30	27	22
15	58	14	50

	New Planting	Original Planting
Total Planted	217	481
Total Live	171	97
% Dead	21%	80%
% Live	79%	20%

Table 7: Detailed Row assessment, Dulverton wood, February 1995.

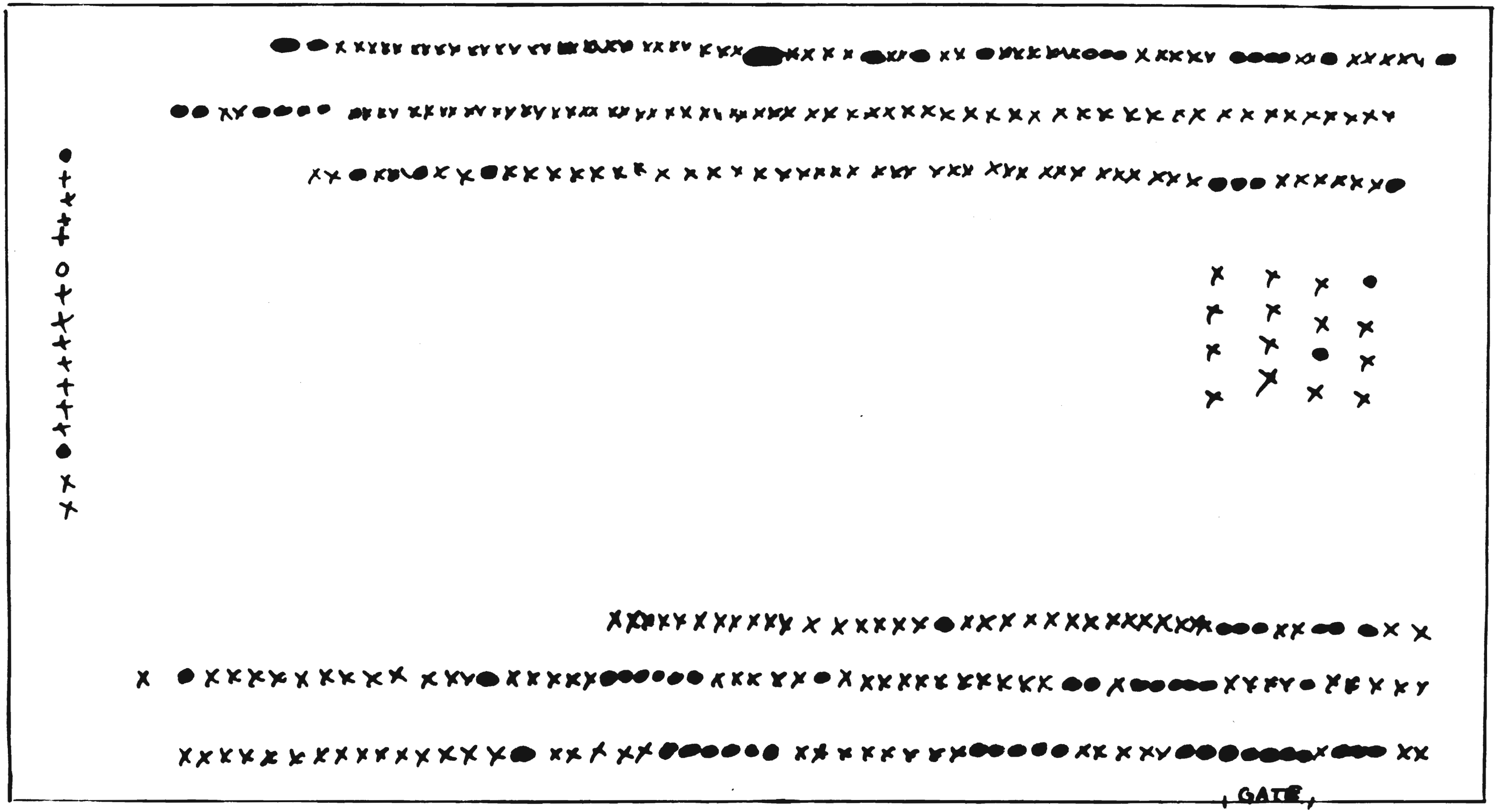


Figure 5: Approximate location of surviving (•) and dead (x) trees following the first planting (in Aug 93) in the Dulverton wood, Port Howard

It is planned to retain the site and replace the dead trees with live ones from the Market Garden. Additional 'baffle' rows of shelter webbing may need to be erected. The replanting cost will be low as pits will not need to be re-dug. Rodney Lee will arrange replanting. It is also proposed to try some other species in this woodland.

d. Alternative Sources of Trees

To date trees used in the Islands are either imported as whole plants (rarely now) or raised as seed in the Market Garden. There is a considerable forest industry around Punta Arenas (largely explotive) and it would be advantageous to compare conditions and benefit from experience in that region. Hence in late March early April I visited Punta Arenas for approximately two weeks in connection with my Department's wish to establish a link with the University of Magellanes in Punta Arenas. I spent most of my time at the Institute of Patagonia which is now the Faculty of Natural Sciences in the University and at the small Chilean agricultural research station (INIA - Kampenaike).

The most interesting and valuable contact I made was with the small Forestry Department at the Institute (Sra Consuelo Saez) which is able to produce excellent quality trees, seedlings of southern beeches which grow well in those latitudes and would grow well in the Falklands or at least would merit trial. These trees are cultured from seeds or from buds and are grown in small containers of sterile agar (a type of jelly) hence would satisfy the strict phytosanitary regulations concerning plant imports to the Falklands (they would have no soil on their roots). There are regular ships between Punta Arenas and the Falklands and trees could be imported in this fashion at approximately one third of the current cost. I propose that the Trust purchase a few hundred of these trees of several different varieties for trial purposes (within the current tree programme - the Trust has budgeted for replacement trees anyway within its current programme). These trees will probably cost 60-80p each. This information to be passed on to Tim Miller so that he could consider commercial arrangments with the Institute.

If a regular supply of good quality trees reared under the proper controlled conditions can be realised from Punta Arenas, it would considerably enhance the prospects for tree planting in the Islands. The current problem of seasonality when importing from Britain would be overcome. Punta Arenas also has to import grain and fertilisers so there is little to be gained from export to the Falklands. The region does import almost all of its vegetables and potatoes and there may be scope for considering export from the Falklands.

e. <u>Tree Advice</u>

Discussions on tree planting were had with various individuals particularly in respect of tree planting around houses or on farms. The new Chief Executive, Mr Andrew Gurr, and deputy Director of FIDC, Ian Dempster, have very ambitious plans for tree planting in the Islands. They envisage wide scale afforestation (combined with more cattle rearing, cereal growing and utilising kelp harvesting) on the whole Lafonia area (approximately 0.8 million acres of good land) which is owned by FIG essentially and managed by Falkland Landholdings Ltd. I can foresee some potential problems with this but by and large it shows a dramatic interest in tree planting - Mr Gurr is particularly interested in a forest-based industry. Both persons recognised the role that the Trust has had in promotion of trees, particularly in relation to the tree establishment project.

f. Hedging Projects (as approved by FIDC)

Some work was commenced on two new project areas under the general banner of the tree project - rehabilitation of cut-over peat areas on Stanley common with Willows and suitable plants for hedging. Approximately 200 willow cuttings of the variety found to be most suitable for the Falklands from the Trust's previous trial at Keppel Island - *Salix viminalis* cv Dasyclados were obtained from the Department of Agriculture for Northern Ireland's Plant Breeding Station, taken down and planted on the top and cut-over bottom of peat bogs on Stanley common. Following an extensive literature review in UK, other hedging plants were taken down which might prove successful. These were planted out in a sheltered garden and will be used to multiply for hedging trials next year.

B GRASSLAND PROJECTS

a. Marinure Trials

The usual assessments were made on the various grassland trial plots. When analyses are complete a more detailed report will be prepared.

b. Digester

The digester has been successfully shipped to Port Howard and discussions were held with Rodney Lee on its setting up and operation. As Sam Miller set up and ran the digester originally in Stanley for the Trust it seems sensible that he be sent out to Port Howard for a couple of days to set up the plant once again. Several local people enquired when fresh stocks of locally produced extract would be available.

c. Tussac grass/erosion

Work has commenced on this project. The Department of Agriculture have appointed a Research Assistant to work until October initially in the Islands on the project. Preliminary sites for erosion assessment and Tussac grass planting were selected with Aidan Kerr (DOA). A literature review has been carried out and some technical equipment bought. Full details of proposals for the project are appended (Appendix 1).

5. Further work

a. it is important to continue the programme of maintenance and measurement on the two tree establishment and Port Howard woodland sites. Replanting of the Port Howard site must be given priority. Tree growth can be a slow process so the ongoing nature of the work initiated by the Trust and funded by FIDC must be built on.

b. Purchase and import of trees from Punta Arenas should be investigated on a trial basis.

c. Additional trials using hedging plants, will continue. Trials on rehabilitation of cut-over peat banks on Stanley Common will be assessed.

d. The Tussac grass/erosion projects (jointly with the Department of Agriculture) should continue to be supported by the Trust as they are targeted towards the Trust's goal of sustainable agricultural development in the Islands.

Acknowledgements

The Trust is grateful to Owen Summers and Aidan Kerr, Department of Agriculture, Falkland Islands, Rodney Lee and Lionel Fell, Sam and Carol Miller, Tim Miller and to FIDC for financial assistance. Foliar analyses, computer services and willow trees were provided by the Department of Agriculture for Northern Ireland.

APPENDIX 1: TUSSAC/EROSION PROJECT DETAILS

Department of Agriculture, Stanley, Falkland Islands

and

United Kingdom Falkland Islands Trust

Joint Project on Erosion and Tussac Grass

Part 1: A study of the erosion of coastal Tussac grass sites

Part 2: A study of the erosion of coastal, sandy soils

OVERALL MANAGEMENT

Management team:	J A Kerr, DoA (Overall Co-ordinator) J McAdam, UKFIT R M Lee, UKFIT
Project staff:	J Fuller (principal worker) with time contribution of J A Kerr and other DoA staff J McAdam (UK support)

PROJECT OUTLINES

1. A study of the erosion of coastal Tussac grass sites

Aim:

To develop a strategy for the successful establishment of Tussac grass in the Falklands.

Objectives:

1. To determine the soil characteristics (both physical and chemical) which are best suited for the establishment of Tussac grass.

2. To determine the environmental factors which affect the growth of Tussac grass roots.

3. To determine the most suitable type of plant material for replanting.

4. To determine the cause of ill-health and death of Tussac grass.

Background:

Research has proven that Tussac grass, which has the ability to withstand desiccating winds and remain green throughout the winter, is the most nutritious grass in the Falkland Islands (McAdam and Walton, 1990). The decimation of Tussac grass cover in the last century (Strange *et al.*, 1988) has meant that few farmers are now able to utilise this valuable winter feed. The value of Tussac grass has been further enhanced by the sub-division of farms and the subsequent increase in diversification. In general, farms which have Tussac grass plantations have a more diverse wildlife fauna, (Woods, 1975; Strange, 1992) and therefore their tourism potential is greater than farms which have no Tussac grass. The potential of Tussac grass has long been recognised by the farming community and most farms have attempted to replant Tussac grass at some time in the last 50 years but few have been successful.

At a forum on Tussac grass and Sand grass Planting (July 1994) organised by the Farmers Association and the Department of Agriculture the need for clearer guidelines relating to soil type and planting material when replanting Tussac grass was highlighted.

This project will define in both physical and chemical terms the type of soil best suited to Tussac grass growth and will also examine the formation and growth pattern of Tussac grass roots and their importance in establishment.

Methods and Materials:

Objective 1

In order to determine what type of soil is most suitable for Tussac grass growth, soil samples will be taken from 4 different types of sites.

1. Sites where Tussac Grass occurs naturally.

2. Sites where Tussac grass has been successfully replanted.

3. Sites where Tussac grass replanting has been unsuccessful.

4. Hen runs with mature healthy Tussac grass.

Five of each site type will be sampled.

	Natural	Successful	Unsuccessful
1.	Coast Ridge	Mount Kent farm	Philomel farm
2.	Sea Lion Island	Sea Lion Island	Cape Pembroke
3.	Port Harriet	D Donnelly's farm	Port Harriet
4.	New Island	New Island	Port Howard
5.	Beaver Island	Beaver Island	

Unsuccessful sites are defined as areas where no plants have survived. Measurements of plant population density, height, basal circumference and health will be taken at natural and successfully replanted Tussac grass areas.

At the natural, successful and unsuccessful sites three soil samples will be taken along three transects which should transverse any natural variations at that site eg slope, distance from coast etc. Each sample will consist of five sub-samples taken at intervals along the transect. Using an auger, the soil samples will be taken from a depth of 0-10 cm.

In each hen run a single sample (which consists of 5 sub-samples) will be taken. Chemical analysis to determine the levels of elements

a) essential for plant growth (N, P, K); and

b) important in plant growth (Ca, Mg, Mn, Fe, Zn, Cu and NaCl)

will be carried out.

The following physical soil properties will also be measured.

a) Soil moisture content

b) Bulk density

c) Soil moisture stress

Outcome - Information on the soil factors likely to be associated with successful Tussac planting (August 1995).

Objective 2

Experiments will be carried out at QUB to examine the growth and function of roots in Tussac grass. The experiments will examine:

1. The growth rate and pattern of Tussac grass roots.

2. The function of different root types.

3. Plant response to varying root aeration conditions.

4. Plant response to varying soil moisture conditions.

5. Plant response to varying nutrient regimes and defoliation.

Materials and methods for these experiments will be based on those used for similar work on Whitegrass (Wilson, 1993).

Experiments 1 and 2 can be conducted in 1995 but the rest will depend on results of the soil survey which should determine the main factors likely to influence Tussac grass establishment. Experiments 3-5 will not begin therefore until 1996.

Outcome - Information on the growth of Tussac roots by 1995.
Information on how soil factors affect the root growth of Tussac grass by 1997.

In order to study the rooting systems of naturally occurring Tussac grass bogs, small seedlings plants will be excavated and their rooting pattern analysed.

Objective 3

Based on the results obtained from the work carried out during 1995 (soil analysis and preliminary rooting studies) trials will be set up on suitable sites to examine the most suitable type of material for replanting of:

a) Tillers vs Seeds.

b) Amount of roots on replants.

c) Effects of pretreatment prior to planting.

It is envisaged that these trials will commence in 1996/1997.

Outcome - Practical guidelines for the preparation of Tussac planting material by 1997.

Objective 4

Various factors which could possibly be responsible for the ill health of mature Tussac grass plants will be examined. These include:

1. Analysis of plants which have striped leaves for presence of virus.

2. Examination of the soil fauna around healthy and non-healthy (as defined by a plant health score) Tussac grass bogs and in hen runs to determine if there are any organisms present which could affect the Tussac roots. Soil samples will be taken from the top 20 cm of soil as this is generally where over 90% of soil invertebrates are found (Foth, 1978). Three samples will be taken from around healthy bogs and three samples from unhealthy bogs at three sites. Samples will also be taken from three hen runs with mature healthy Tussac bogs. Weighed samples will then be placed in Tullgren funnels to remove all invertebrates.

3. Climatic factors eg rainfall which may effect plant health.

Outcome - Information on the contribution of viruses and insect pests to the ill health of mature Tussac.

Materials:

Auger*, plastic bags, corer, Tullgren funnels (DoA equipment). Fencing*, erosion pins*, Data logger*, Trees and kelp*.

(* = Funded from UKFIT/FIDC grant).

Duration:

1995 - 2000.

2. A study of the erosion of coastal sandy soils

Aim:

To quantify the nature and extent of the erosion problem at sandy coastal sites and investigate techniques for long term re-vegetation.

Objectives:

1. To quantify the area affected by erosion.

2. To monitor the rate of this erosion.

3. To determine the role of climate in erosion and re-vegetation.

4. To investigate stabilization ad re-vegetation.

5. To examine the economics of erosion, its prevention and land restoration for the wool industry.

Background:

Farmers in the Falkland Islands are becoming increasingly concerned about the loss of vegetation cover on coastal areas as a result of erosion. At a forum organised by the Farmers Assocation and the Department of Agriculture on Tussac and Sand grass planting (July 1994) - farmers expressed concern about the increase in bare (and therefore unproductive) ground on coastal areas. Concern was also expressed about eroded materials contaminating fleeces and the possible economic implications of this. An assessment of soil erosion in the Falkland Islands found that the most extensive areas of eroded ground were at coastal sandy sites (Wilson *et al.*, 1993). This project will quantify the extent of erosion at sandy sites, assess the economic importance of such erosion and examine ways of combating the problem.

Method:

To assess variation in sand erosion three sites will be studied.

a) East Falkland - Smylies Farm

b) West Falkland - Stevelly Bay, Dunbar.

c) Offshore Islands - Beaver Island.

The sites were selected for a variety of reasons including their good geographical spread and because they are examples of different types of sand blown erosion.

eg Dunbar - coastal sand blow.
Smylies - inland sand blow (as opposed to beach sand blow).
Beaver - coastal sand blow on offshore island.

Another factor in the selection of the sites was farmer interest - the owners of all three sites contacted the Department for advice on erosion.

Objective 1

A comparison of aerial photographs taken in 1956 and 1983 will be undertaken using an Image Analyser under the supervision of Dr Peter Wilson. This analysis will reveal the change in ground cover at each site and will be used to estimate a figure for the whole of the Islands. Estimates of ground cover change since 1983 may be obtained using information from the land owners or from aerial photographs taken by the Department.

Outcome - information on the current area affected by erosion (January 1996).

Objective 2

In order to monitor the current rate of erosion at each site:

1. Erosion pins will be put in place and measured biannually.

2. Changes in plant cover in permanent quadrat at the leading edge of each sand blow will be recorded.

3. Sand trapping will be carried out to determine the amount of sand being transported at varying wind speeds.

Outcome - information on the annual and seasonal rate of erosion.

Objective 3

Weather stations will be set up at each site to record maximum and minimum daily temperatures, rainfall, windspeed and humidity.

Outcome - information on the effect of climate on the rate of erosion.

Objective 4

A randomized block design will be used in a trial to determine the optimum way of replanting Marram grass here. Four blocks measuring 45 x 5 m will be marked at each site. Each block will then be divided into five plots which will receive one of the following treatments:

1. Sand grass planted at 40 cm intervals.

2. Sand grass planted at 40 cm intervals with kelp used as a mulch.

3. Seed applied - ½ block will have seed broadcast and the other ½ will have seed planted in holes.

4. Kelp only applied.

5. Control - no treatment.

Two of the blocks at each site will be fenced off to assess the impact of livestock eg grazing and trampling.

Outcome - information on techniques for stabilization and re-vegetation.

Objective 5

The assistance of the agricultural economics section will be required to determine the economic effects of:

1. Contamination by sand/soil of various classes of wool clips from shearing until point of sale.

2. Comparative strategies to restore degraded land to productive capacity, These will use selected combination of fencing, de-stocking and re-planting and will be compared to the "do nothing" approach.