

**PSP ESTABLISHMENT REPORT FOR THE 1991
SILVICULTURE/BREED TRIALS**

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: This is an unpublished report and must not be cited as a literature reference.

***Forest Research* / INDUSTRY RESEARCH COOPERATIVE**

EXECUTIVE SUMMARY

This report describes the basic field procedures which are being used for all silviculture/breed trials, and examines the actual pruning, thinning, and establishment of permanent sample plots (PSPs) in the seven trial sites planted in 1991 (Stovold & Shorland 1991).

The Stand Growth Modelling Cooperative supports a series of genetic gain trials for the purpose of quantifying genetic gain in growth for radiata pine in New Zealand (Carson et al. 1994, 1997, 1999). This project coordinates the efforts of tree breeders and forest mensurationists, in order to ensure that the information required to meet genetic gain objectives is obtained in an efficient and productive manner (SGMC Report Nos 24, 24a, 40 and 70). One group of trials, known as the Silviculture/Breed series, was designed and planted specifically to compare the performance of genetically improved breeds planted at a variety of stocking levels, and to provide growth data for growth modelling. Twenty-eight trial sites were planted between 1987 and 1991 (SGMC Report Nos 32, 46, 71 and 83).

Seedlings for these trials were raised at the ***Forest Research*** nursery, where nursery effects were eliminated through randomisation of seedlots in 5 replications across nursery beds.

Plot establishment and silvicultural treatment has been completed according to plan in most cases. PSPs are measured annually starting from the first winter after plot establishment. Each trial, once established, is measured during the same winter month each year. Growth data from these trials at the first winter measurement and 8 years old is presented in the document. There has been no statistical analysis yet, and any trends in data may not persist over time.

CONTENTS

INTRODUCTION	1
TRIAL LOCATIONS.....	1
CORE EXPERIMENTAL DESIGN.....	2
BASIC FIELD PROCEDURES	3
Pruning.....	3
PSP Establishment	4
Thinning	5
INDIVIDUAL TRIAL DESIGNS AND ESTABLISHMENT REPORTS	7
FR 121/8 - MANGATU Forest.....	7
FR 121/9, SANTOFT Forest	13
FR 121/10, BLUE MOUNTAINS Forest	19
FR 121/11, SHELLOCKS Forest.....	24
FR 121/12, ASHLEY Forest.....	29
FR 121/13, GOLDEN DOWNS Forest	35
APPENDIX 1	41
APPENDIX 2	43
REFERENCES	44
ACKNOWLEDGMENTS.....	45

INTRODUCTION

PSP establishment, thinning and pruning of the 1991 plantings of the Silviculture/Breed series is fully documented in this report. The basic field procedures for pruning, thinning and establishment of PSPs in these trials are also documented. The Stand Growth Modelling Cooperative supports this work.

Trials in the Silviculture/Breed series were planted from 1987 to 1991 inclusive. These trials, when combined, will represent New Zealand's eight major forest growing regions with up to four levels of site quality tested within each region (Dunlop and Carson 1995). This series of trials is designed to compare the performance of genetically improved breeds of radiata pine at varying levels of initial and final crop stockings on sites with varying qualities to provide data for growth modelling.

The primary objective of the 1991 plantings is to extend the trials established in 1987 (Skinner et al. 1994), 1988 (Dunlop and Carson 1996), 1989 (Hayes and Andersen 1998) and 1990 (Hayes 2000) over a wider range of sites, for the purpose of quantifying genetic gain in growth rate and other traits, over the eight major forest growing regions in New Zealand. Also, the testing of specific treatments (e.g. initial stockings) relevant to particular locations is incorporated into the trials to provide further management information. Data collected from these and other trials in the series will give a better understanding of the growth and performance of the improved breeds so that growth models can be developed or modified to reflect growth increase due to genetic improvement.

TRIAL LOCATIONS

Trials were planted at six sites in 1991, in five regions, in the fourth series of the Silviculture/Breed trials (Table 1). The sites were chosen to cover a range of site qualities from high to low site index.

TABLE 1. Trial sites planted in 1991 as part of the Silviculture/Breed trial series.

Trial No.	Forest Name	Forest Owner	Growth Region	Site Category	Current Site index
FR 121/8	Mangatu	Rayonier NZ Ltd	East Coast	Medium SI	32.4
FR 121/9	Santoft	Ernslaw One Ltd	Wellington Sands	Low SI	21.1
FR 121/10	Blue Mountains	Ernslaw One Ltd	Southland	Low SI	24.2
FR 121/11	Shellocks	Selwyn Plantation Board	Canterbury	Low SI	23.5
FR 121/12	Ashley	Carter Holt Harvey Forests	Canterbury	Med/High SI	28.5
FR 121/13	Golden Downs	Weyerhaeuser NZ Ltd	Nelson	High SI	30.1

EXPERIMENTAL DESIGN

In the 1991 trials the experimental design of seven treatments planted at each site (Table 2) is the same at all sites.

TABLE 2. Core experimental design for the 1991 Silviculture/breed trials.

Trt	Pruning	Thinning at MCH 6.2 m			
	4m crown remaining	Initial Planting	Final Crop Stocking	Initial Spacing	Plot area (ha)
1	✓	250	100	5 x 8	0.196
2	✓	500	200	5 x 4	0.098
3	✓	1000	400	5 x 2	0.070
4	x	500	200	5 x 4	0.098
5	x	1000	400	5 x 2	0.070
6	x	1000	600	5 x 2	0.060
7	x	1000	1000	5 x 2	0.060

Trial plantings took place in July and August 1991, but due to varying growth rates, PSPs were established over a period of 3.1 years, between January 1996 and March 1999 (Table 3).

TABLE 3. Planting and PSP establishment dates

Trial No.	Location	Planting Month 1991	Date of PSP Establish	Age (yrs) at PSP Establish	MCH (m) after thinning
FR 121/8	Mangatu	August	Jan 1996	4.8	6.6
FR 121/9	Santoft	July	Nov 1997	6.4	6.2
FR 121/10	Blue Mountains	July	Mar 1999	7.9	7.1
FR 121/11	Shellocks	July	Feb 1999	7.8	7.1
FR 121/12	Ashley	July	Nov 1996	5.6	5.9
FR 121/13	Golden Downs	July	Feb 1997	5.9	6.9

There are five seedlots (GF6, 14, 16, 25 and LI25(GF13)) which are planted at all sites. A description of the seedlots planted is given in Table 4. In all 1991 trial plantings, the buffer rows for each plot are of the same stock as the experimental (PSP) plots.

TABLE 4. Seedlots used in the 1991 Silviculture/breeds trials.

Stock	Site	Seedlot Number	Seedlot Rating	Breeding Series	Description
Seedlings	All	88/102	GF6	'climbing select'	Kaingaroa & Rotoehu climbing select
Seedlings	All	88/105	GF14	'850'	OP mix of '850' series from Gwavas, Kaingaroa and Waimihia
Seedlings	All	88/201	GF15	'268'	OP mix ex Brightwater orchard
Seedlings	All	90/294	GF25	'268'	CP mix of top 16 '268' clones
Seedlings	All	89/15	GF13(LI25)	'870'	OP mix of 7 long internode clones

BASIC FIELD PROCEDURES

This section outlines the field procedures used for pruning, PSP establishment, and thinning of the silviculture/breed trials. Departures from these procedures are detailed in the individual trial sections.

First, all numbered pegs in the trials were located (see trial maps), released and repainted where necessary. A check was also done to ensure that the plot location map is correct.

The field work then proceeded as follows.

1) Pruning and marking for thinning

- a) **Forest Research** field staff met with the pruning gang and explained the pruning specifications to be used. Trees, including those in buffer rows, were pruned to leave a 4m crown.
- b) Trees were marked for thinning in all plots except treatment 7 (unthinned, unpruned). Crop tree selection criteria were based on size, form and spacing, in that order, with an emphasis of 50:40:10. Buffer rows were also thinned to the prescribed stocking.
- c) Trees marked for thinning were not pruned. All the remaining trees in treatments 1, 2 and 3 were pruned. **Forest Research** field staff supervised the pruners. Height poles were used to show the exact position of 4m from the top of the tree. Periodic height and pruned height measurements were taken to ensure that the pruning requirements were being met. Measurements were taken from the lowest remaining whorl, which was closest to the point, four metres from the top of tree.

Results of the pruning operation for each site were as follows:

Trial No.	Forest Name	Mean crown length (m)	Mean prune height (m)	DOS (cm)	Max Branch diameter (cm)
FR 121/8	Mangatu	4.0	2.4	16.8	3.5
FR 121/9	Santoft	4.2	2.5	18.9	3.9
FR 121/10	Blue Mountains	4.3	2.6	23.8	4.8
FR 121/11	Shellocks	4.2	2.7	18.5	3.3
FR 121/12	Ashley	4.1	1.7	14.8	2.6
FR 121/13	Golden Downs	4.5	2.6	14.5	2.1

2) PSP Establishment

The original planted plots are rectangular with pegs at each corner. The permanent sample plots are also rectangular and are located within the original plot with a buffer zone of at least one row of trees on each side of the plot, Appendix 1, shows an example of a plot with 5x4m spacing (500stems/ha). Treatments 3, 5, 6 and 7 which were all planted at 5x2m spacing had 162 trees in the original plots. The buffers in these plots were increased so that the inner PSP plot had a smaller number of trees (28, 36 and 50 respectively) reducing remeasurement time and costs. The size of the PSP plots range from 0.0500 to 0.1960 ha (Table 5 shows the plot establishment specifications at all trials).

TABLE 5. PSP Plot establishment specifications

Trt	Plot Area	Row x tree spacing	No. trees planted	Initial no. trees buffer : plot	Final no. trees buffer : plot	Thinning ratio	Pruning	No. PSP plots
1	0.1960	5 x 8	81	32 49	13 20	2.5 : 1	4m crown left	3
2	0.0980	5 x 4	81	32 49	13 20	2.5 : 1	4m crown left	5
3	0.0700	5 x 2	162	92 70	37 28	2.5 : 1	4m crown left	3
4	0.0980	5 x 4	81	32 49	13 20	2.5 : 1	None	3
5	0.0700	5 x 2	162	92 70	37 28	2.5 : 1	None	3
6	0.0600	5 x 2	162	102 60	60 36	1.7 : 1	None	3
7	0.0500	5 x 2	162	112 50	112 50	1 : 1	None	5

Each plot is numbered consecutively within each trial with unique plot numbers (Appendix 2). A subplot number specifies the replication and treatment number. Seedlot number and GF rating were specified as PSP database variables 'Seedlot' and 'Improvement rating' (Dunlop, 1995). Husky HUNTER data loggers were used by field staff to record all measurements. Establishment followed a standard procedure (Ellis & Hayes, 1997):

- a) The width of the buffer zone was determined (Table 6 shows the number of buffer rows for each treatment) and pegs were placed in the four corners of the permanent sample plot (Appendix 1).
- b) The north-west corner peg was labelled with the plot identification and seedlot GF rating.
- c) The diameter of all trees within the plot was measured and recorded before thinning. A diameter band was painted with spray paint at the appropriate level. A numbered aluminium tag was stapled above the diameter band onto all crop trees (i.e. those not marked for thinning). Trees were numbered consecutively from the north-west corner, up and down the planted rows. Dead trees and those to be felled were included in the numbering but did not get tagged.
- d) The total number of tagged trees was counted to make sure that the correct stocking would remain after thinning. If necessary, extra trees were pruned (in treatments 1, 2 and 3) and/or marked for culling to correct the number of final crop trees. The trees, which were recorded as being alive on the Husky HUNTER, were also counted to make sure they corresponded with the required number of live trees remaining after thinning.
- e) Twelve height trees were selected from the crop element. Four of these were the tallest trees within each 0.01 ha quadrant (used to calculate predominant mean height, PMH). The predominant height trees were found by dividing the plot into quadrants with an 11.3m radius and measuring the tallest tree within each quadrant (Appendix 1). The remaining eight trees were selected to cover the range of diameters present in the plot and were referred to as sample height trees. Trees with dead or broken tops or unusually large diameters were not included as sample height trees. Each height tree, whether predominant or sample, was measured for total height, pruned height, DOS, DOS height and maximum branch diameter (pruning measurements taken only if applicable). These measurements were recorded along with the tree diameter.

3) Thinning

Thinning was carried out by forestry contractors and /or **Forest Research** field staff.

- a) All unpruned trees and/or trees marked for culling were felled (no felling in treatment 7 plots).
- b) Buffer trees were felled into the plots wherever possible to ensure subsequent easy location of boundaries and access to plots.
- c) All naturally regenerated stems in all plots were also felled.

TABLE 6. Width of buffer zone for PSP plots

Trt	Planted plot area	PSP plot area	No. rows planted	No. rows in PSP plot	No. rows in buffer
1	0.324	0.1960	9 x 9	7 x 7	1 x 1
2	0.162	0.0980	9 x 9	7 x 7	1 x 1
3	0.162	0.0700	9 x 18	5 x 14	2 x 2
4	0.162	0.0980	9 x 9	7 x 7	1 x 1
5	0.162	0.0700	9 x 18	5 x 14	2 x 2
6	0.162	0.0600	9 x 18	5 x 12	2 x 3
7	0.162	0.0500	9 x 18	5 x 10	2 x 4

INDIVIDUAL TRIAL DESIGNS AND PSP ESTABLISHMENT REPORTS

FR 121/8 - MANGATU Forest, East Coast

This trial was planted in August 1991 with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). The trial occupies 4.54 hectares.

The first measurements (of total height only), was attempted in October 1993 (age 2 years). The trial was found to be in bad condition due to large amounts of pine regeneration and poplar saplings. Another height only measurement was completed in December 1994 (age 3.7 years) following several attempts to remove the regeneration. Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during January 1996 (age 4.8 years). The trial MCH at the time of plot establishment after thinning was 6.6m with a range of 6.1 to 7.2m.

Trial Design

This trial was designed with seven silvicultural treatments and five different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 7).

TABLE 7. Trial design for FR 121/8, Mangatu Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF6 (88/102)	GF14 (88/105)	GF16 (88/201)	GF25 (90/294)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	▲			•	•
5	"	1000	400	6.2	2.5:1	▲			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•

Each • represents one PSP plot with a buffer which receives the same treatment as the inner PSP plot.

Each ▲ represents an abandoned plot.

Pruning

Pruning of the 11 plots was carried out by a mensuration crew contracted to Rayonier NZ, 16-17 January, 1996 (a total of 10 mandays help). Selection for thinning was carried out by **Forest Research** staff at the same time, and only selected crop trees were pruned. The average crown remaining of the pruned plots was 4.0m (mean pruned height was 2.4m). Pruned heights and DOS measurements (DOS, DOS height and maximum branch diameter) of the selected height trees were measured at the time of plot establishment.

Plots 2/16, 3/16 and 4/16 had 3 trees in the outside row accidentally pruned after plot establishment. This should not effect the results.

PSP Plot Establishment

Twenty three permanent sample plots were established by three **Forest Research** field crew and 4 Rayonier contractors between 15-24 January, 1996 (a total 30 mandays for **Forest Research** staff and 7 mandays for the contractors). Two plots were abandoned before plot establishment (plots 6/14 and 10/15) because of difficulty locating tree rows and the lack of crop trees. The large amount of poplar in this region contributed to the early mortality. Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7).

Measurements were taken and recorded as described in the section on 'Basic field procedures'.

Thinning

Thinning was carried out by **Forest Research** field staff following plot establishment beginning on 22 January 1996. Eighteen of the 25 plots were thinned (the two abandoned plots were not thinned).

Trial Layout and Site Information

Twenty-three of the twenty-five plots planted were established as PSPs at this site (see map, Figure 1). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6. The trial contains two swampy ponds which were planted up with surround stock (a GF17 seedlot).

There was no ground preparation before planting, but due to hauler harvesting of the previous crop, there is a lot of residue on the ground which meant that planting rows were not always straight. Cutty grass is wide spread in the swampy areas as well as large amounts of poplar (covers 25% of the trial).

Regeneration was removed by **Forest Research** late 1992, with further regeneration removal 1993 and 1994. Up until this time planting lines were difficult to identify, consequently the first measurement of height only was delayed until December 1994. The small poplars were slashed by Rayonier staff in Nov 1992 and 1993. Both

radiata and poplar regeneration were again removed at the time of plot establishment and thinning in 1996. Poplar regrowth still remains a problem in the lower half of the trial.

It was noted that the site of this trial is not representative of the rest of Mangatu forest. The site is very wet (at times waterlogged) in all but the upper row of plots. This may contribute to the good growth seen here, despite the poplar problem, as the trees are not drought stressed in summer.

In spite of reservations about this trial earlier, 80% of the trial is now in good condition.

The following site information was recorded at the time of planting:

Altitude:	250m
Soil Type:	Arowhana sandy loam
Site Preparation:	None
Weeds:	None (at time of planting)
Regeneration:	None (at time of planting)
Slope:	10-15°
Aspect:	Southwest
Previous land use:	Radiata pine plantation
Site:	Medium fertility, ex forest site

Plot Data

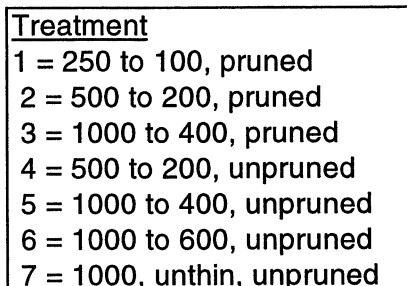
Summaries (Tables 8 & 9) at the time of the first winter measurement in August 1996 (age 5.2 years) and the 1999 winter remeasurement (age 8.2 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 8.2 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 16.8cm and the average maximum branch diameter is 3.5cm.

The following trends were noted:

- The 'long internode' seedlot (GF13) is inconsistent in diameter growth, relative to the other seedlots, within treatments
- At age 8, the GF25 seedlot is performing better than all other seedlots except in treatment 1 (100 stems/ha)
- The GF7 seedlot is performing well in the 400 stems/ha plots, where the diameter growth is equivalent to both the GF13 and GF25 seedlots
- The mean height of this trial at age 8 is 13.5m and no treatment/seedlot is significantly higher at this age.
- The mean crown height for the unthinned, unpruned plots has risen to 3.7m by age 8

Mangatu Forest
Compartment 10
Planted 1991



Seedlots
A = GF25, '268' control pollinated
B = GF16, '268' open pollinated
C = GF14, '850' open pollinated
D = GF6, climbing select
E = GF13 (LI25), long internode

TABLE 8. FR 121/8: Trial data at the first winter measurement (August 1996) age 5.2

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	6	250	102	14.0	7.2	1.6	6.0	2.2	17.3	0.7	3.9
1	89/15 (LI25)	13	250	102	13.8	7.6	1.5	5.9	2.5	17.8	1.0	3.5
1	90/924	25	250	102	13.9	7.0	1.6	5.7	2.2	16.2	0.7	3.1
2	88/102	6	500	214	13.9	7.7	3.3	12.9	2.7	18.4	0.9	3.8
2	89/15 (LI25)	13	500	204	14.4	7.2	3.3	12.3	2.6	18.7	0.9	3.9
2	88/105	14	500	204	14.3	7.3	3.3	12.3	2.5	17.0	1.0	3.3
2	88/201	16	500	204	13.8	7.2	3.1	11.7	2.5	15.8	1.0	3.1
2	90/924	25	500	194	14.4	7.1	3.1	11.5	2.3	17.8	0.7	3.8
3	88/102	6	1000	400	12.7	7.4	5.0	19.8	2.3	15.2	1.2	3.2
3	89/15 (LI25)	13	1000	400	13.0	7.2	5.3	20.9	2.3	16.3	0.9	3.7
3	90/924	25	1000	400	12.7	7.5	5.0	19.7	2.5	14.4	1.1	2.9
4	89/15 (LI25)	13	500	204	14.9	7.6	3.6	13.6	0.0			
4	90/924	25	500	204	17.1	8.1	4.7	18.3	0.0			
5	89/15 (LI25)	13	1000	386	14.6	8.0	6.5	26.5	0.0			
5	90/924	25	1000	400	14.5	7.8	6.6	26.5	0.0			
6	88/102	6	1000	600	14.1	7.5	9.3	36.0	0.0			
6	89/15 (LI25)	13	1000	567	13.8	7.8	8.5	33.5	0.0			
6	90/924	25	1000	583	15.3	8.1	10.7	42.9	0.0			
7	88/102	6	1000	920	13.8	7.8	13.8	54.8	0.0			
7	89/15 (LI25)	13	1000	880	13.2	7.8	12.1	48.1	0.0			
7	88/105	14	1000	780	12.7	7.8	9.8	39.0	0.0			
7	88/201	16	1000	920	13.0	7.9	12.3	48.8	0.0			
7	90/924	25	1000	920	14.3	8.6	14.8	61.8	0.0			

TABLE 9. FR 121/8: Trial data from measurements at age 8.2 (August 1999)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn Crown HT
1	88/102	6	250	92	27.9	13.1	5.6	30.5	2.6
1	89/15 (LI25)	13	250	97	24.1	13.2	4.4	24.9	2.6
1	90/924	25	250	102	27.6	13.0	6.1	32.7	2.4
2	88/102	6	500	214	25.4	13.6	10.9	62.5	2.9
2&4	89/15 (LI25)	13	500	204	27.5	13.2	12.1	65.4	1.8
2	88/105	14	500	204	27.9	13.2	12.5	67.8	2.5
2	88/201	16	500	194	26.2	13.1	10.5	58.6	2.6
2&4	90/924	25	500	199	29.6	13.4	13.8	75.6	1.8
3	88/102	6	1000	400	22.3	13.3	15.6	90.0	2.5
3&5	89/15 (LI25)	13	1000	386	24.0	13.6	17.4	102.5	2.7
3&5	90/924	25	1000	400	23.6	13.9	17.4	104.7	3.3
6	88/102	6	1000	600	21.9	13.3	22.5	131.0	3.5
6	89/15 (LI25)	13	1000	567	22.4	13.9	22.3	133.2	3.4
6	90/924	25	1000	583	23.9	13.8	26.1	153.1	3.8
7	88/102	6	1000	920	20.4	14.0	30.2	185.9	4.1
7	89/15 (LI25)	13	1000	880	20.7	13.3	29.5	170.2	3.9
7	88/105	14	1000	740	20.2	14.2	23.6	142.3	3.9
7	88/201	16	1000	900	20.2	13.9	28.8	172.3	3.7
7	90/924	25	1000	920	21.8	14.1	34.2	207.9	4.1

Note: Treatments 2 and 4, and 3 and 5, have been averaged by seedlot, without taking pruning into account

FR 121/9, SANTOFT Forest, Wellington Sands

This trial was planted in July 1991 with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). The trial occupies 4.54 hectares.

The first measurements (of total height only) were taken in April 1993 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during October 1997 (age 6.4 years). The trial MCH at the time of plot establishment was 6.2m, with a range of 4.3 to 7.7m.

Trial Design

This trial was designed with eight silvicultural treatments and five different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 10).

TABLE 10 Trial design for FR 121/9, Santoft Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
		Initial	Final	MCH (m)	Ratio	GF6 (88/102)	GF14 (88/105)	GF16 (88/201)	GF25 (90/294)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•

Each • represents one PSP plot with a buffer which receives the same treatment as the inner PSP plot.

Pruning

Pruning was carried out by Ernslaw One contractors on 21 October 1997. The trial took four people one day to prune. The average crown remaining of pruned plots was 4.2m (mean pruned height of 2.5m). Selection for thinning was carried out by **Forest Research** staff at the same time and only selected crop trees were pruned. Pruned heights and DOS measurements (DOS, DOS height and maximum branch diameter) of the selected height trees were measured at the time of plot establishment.

PSP Plot Establishment

Twenty-five permanent sample plots were established by **Forest Research** field staff (a total of 22 mandays) with the help of Ernslaw One contractors (4 mandays). Plot establishment took place between 21-23 October 1997. Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7).

Measurements were taken and recorded as described in the section on 'Basic field procedures'.

Thinning

Thinning of the twenty plots was carried out by Ernslaw One contractors (4 mandays), immediately following the plot establishment. All thinned plots were established at the prescribed final crop stocking. Radiata pine regeneration was removed at this time in 1997.

Trial Layout and Site Information

The ground was roller crushed prior to planting which may have increased regeneration in the planting lines. The crushed lines do not always match the plant lines. Survival at age one was 85-90%, probably due to the variable re-growth of lupin and some animal browsing. In the early years, part of this trial suffered flood damage following several very wet winters. Trees in this area are noticeably smaller with some mortality.

All 25 plots planted were established as PSPs at this site (see map, Figure 2). Although all the required crop trees were available, they were often bunched together in the better part of the plot. The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6.

As expected, regeneration appeared after planting and in 1998 and 1999 this was removed with chainsaws by Ernslaw One contractors. Bark stripping was first noticed in 1995 (assumed to be Samba deer) and by 1999 the damage was very prevalent. This has been recorded at the 1999 measurement for the worst effected trees.

The following information was recorded at the time of planting:

Altitude:	20m
Soil Type:	Sand
Site Preparation:	Roller crushed along planting lines
Weeds:	Lupin and grasses
Regeneration:	Some P.radiata expected
Slope:	Flat
Previous land use:	Radiata pine plantation
Site:	Low fertility, ex forest site

Plot data

Summaries (Tables 11 & 12) at the time of the first winter measurement in April 1998 (age 7 years) and the 1999 winter remeasurement (age 8 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 8 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 18.9cm and the average maximum branch diameter is 3.9cm.

The following trends were noted:

- Maximum branch size is consistent across stocking with plots planted at the higher stocking (1000 stems/ha) having significantly smaller branches (DOS also follows this pattern)
- The mean maximum branch diameter for all plots in treatment 3 (planted 1000 stems/ha) was 3.1cm, but 3.9 and 4.8cm respectively for treatments 2 and 1. The mean DOS for treatment 3 was also much lower than other plots
- The 'long internode' seedlot (GF13) is has very inconsistent growth between treatments. In treatment 6 it is significantly greater than the GF25 seedlot for both diameter and height; in treatment 7 it is lower than all other seedlots for both diameter and height
- At age 8, the GF25 seedlot is significantly larger than all other seedlots in treatment 7 (unthinned, unpruned)
- The GF6 seedlot is performing better than the GF25 on average for both diameter and height in the 200 stems/ha plots
- The mean height of this trial was only 8.5m at age 8, the heights ranged from 7.1 to 10.2m
- The crown height had risen above 1m in only one of the unpruned plots by age 8
- The overall growth in this trial is very slow with a mean site index of 21.1m

FIGURE 2. Map showing plot locations, FR 121/9

Santoft Forest
Compartment 108
Planted 1991

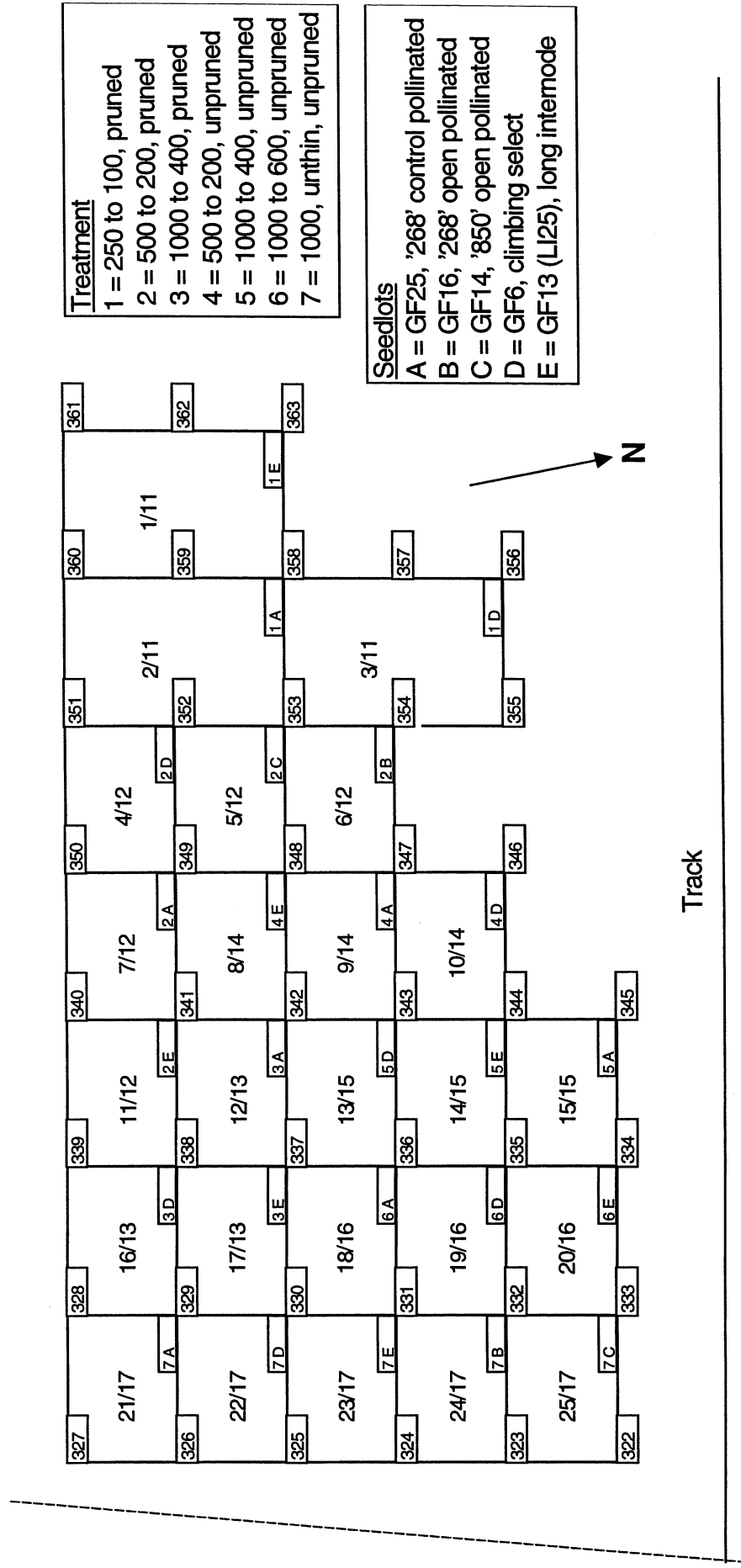


TABLE 11. FR 121/9: Trial data at the first winter measurement (April 1998) age 7.0

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	6	250	102	16.4	7.6	2.2	7.9	2.9	21.1	0.6	4.1
1	89/15 (LI25)	13	250	102	15.5	7.3	1.9	6.8	2.6	21.3	0.7	5.0
1	90/294	25	250	102	15.3	7.2	1.9	6.6	2.7	21.5	0.5	5.2
2	88/102	6	500	204	13.5	7.1	2.9	10.4	2.3	17.3	0.8	3.2
2	89/15 (LI25)	13	500	204	13.4	7.3	2.9	10.5	2.1	18.1	0.8	3.8
2	88/105	14	500	204	16.0	8.3	4.1	16.0	3.2	20.7	0.9	4.4
2	88/201	16	500	204	13.4	7.2	2.9	10.4	2.3	18.3	0.5	3.6
2	90/294	25	500	204	14.0	6.5	3.1	10.9	1.8	18.6	0.7	4.4
3	88/102	6	1000	400	13.1	7.7	5.4	20.7	2.7	16.6	0.7	3.2
3	89/15 (LI25)	13	1000	364	13.5	7.4	5.2	19.7	2.4	17.6	0.8	3.1
3	90/294	25	1000	400	13.8	8.0	6.0	24.1	2.7	17.1	0.7	3.0
4	88/102	6	500	204	14.9	7.5	3.6	13.6	0.0			
4	89/15 (LI25)	13	500	204	14.6	7.1	3.4	12.1	0.0			
4	90/294	25	500	204	13.1	6.6	2.7	9.5	0.0			
5	88/102	6	1000	400	10.0	6.5	3.2	11.4	0.0			
5	89/15 (LI25)	13	1000	400	9.2	5.5	2.7	8.6	0.0			
5	90/294	25	1000	386	13.6	7.1	5.6	20.8	0.0			
6	88/102	6	1000	583	8.7	6.1	3.4	11.5	0.0			
6	89/15 (LI25)	13	1000	600	14.1	8.3	9.3	37.6	0.0			
6	90/294	25	1000	583	10.0	6.0	4.6	15.0	0.0			
7	88/102	6	1000	840	10.7	6.6	7.5	26.6	0.0			
7	89/15 (LI25)	13	1000	860	8.5	5.6	4.9	16.2	0.0			
7	88/105	14	1000	800	12.3	8.1	9.6	37.0	0.0			
7	88/201	16	1000	960	9.7	6.9	7.0	26.1	0.0			
7	90/294	25	1000	980	13.8	8.5	14.6	61.0	0.0			

TABLE 12. FR 121/9: Trial data from measurements at age 8.0 (April 1999)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn Crown HT
1	88/102	6	250	102	19.2	8.4	3.0	11.3	2.8
1	89/15 (LI25)	13	250	102	18.6	8.3	2.8	10.4	2.6
1	90/294	25	250	102	18.1	8.2	2.6	9.9	2.7
2 & 4	88/102	6	500	204	17.4	8.5	4.9	19.5	1.5
2 & 4	89/15 (LI25)	13	500	204	17.5	8.2	4.9	18.6	1.2
2	88/105	14	500	204	18.6	8.9	5.6	22.3	3.1
2	88/201	16	500	204	15.9	8.4	4.1	16.2	2.3
2 & 4	90/294	25	500	204	16.8	7.4	4.5	16.5	1.1
3 & 5	88/102	6	1000	400	14.0	8.3	6.2	25.2	1.8
3 & 5	89/15 (LI25)	13	1000	382	14.2	8.0	6.1	24.6	1.6
3 & 5	90/294	25	1000	393	16.3	9.0	8.2	35.3	1.6
6	88/102	6	1000	583	11.2	7.5	5.7	21.1	0.6
6	89/15 (LI25)	13	1000	600	16.9	10.2	13.5	63.6	1.1
6	90/294	25	1000	583	12.8	7.6	7.5	28.1	0.6
7	88/102	6	1000	840	12.9	8.3	11.0	44.4	0.3
7	89/15 (LI25)	13	1000	860	11.1	7.1	8.3	30.7	0.3
7	88/105	14	1000	800	14.6	9.7	13.4	58.7	0.3
7	88/201	16	1000	960	12.0	8.7	10.9	47.1	0.3
7	90/294	25	1000	980	15.7	10.2	19.0	89.9	0.3

Note: Treatments 2 and 4, and 3 and 5, have been averaged by seedlot, without taking pruning into account

FR 121/10, BLUE MOUNTAINS Forest, Southland

This trial was planted in July 1991, with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). This trial occupies 4.54 hectares.

The first measurements (of total height only) were taken in June 1993 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during March 1999 (age 7.9 years). The trial MCH at the time of plot establishment was 7.1m, with a range of 6.4 to 7.8m.

Trial Design

This trial was designed with six silvicultural treatments and five different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, ie. one seedlot per treatment (Table 13).

TABLE 13. Trial design for FR 121/10, Blue Mountains Forest

Tt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF6 (88/102)	GF14 (88/105)	GF16 (88/201)	GF25 (90/294)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	▲
2	"	500	200	6.2	2.5:1	▲	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	▲
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	▲			•	•
7	"	1000	1000	-	1:1	•	▲	•	•	•

Each • represents one PSP plot with a buffer which receives the same treatment as the inner PSP plot.

Each ▲ represents an abandoned plot.

Pruning

Pruning was carried out by Ernslaw One contractors on 2 March 1999 (age 7.9 years). Only 9 of the scheduled 11 plots were pruned (4 mandays). Selection for thinning was carried out by **Forest Research** staff at the same time, and only selected crop trees were pruned. The average crown remaining of the pruned plots was 4.3m (mean pruned height was 2.6m). Pruned heights and DOS measurements (DOS, DOS height and maximum branch diameter) of the selected height trees were measured at the time of plot establishment.

PSP Plot Establishment

Forest Research field crew established twenty permanent sample plot starting on 1 March 1999. Plot establishment was carried out over 3 days (a total of 16 mandays). Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-4, 6, 7). There was a problem with mortality and five plots were not established as PSPs.

Measurements were taken and recorded as described in the section on 'Basic field procedures'.

Thinning

Thinning was carried out by Ernslaw One contractors under supervision of **Forest Research** field staff, on 3 March 1999 (a total of 3 mandays). Sixteen of the 20 plots were thinned as scheduled.

Most thinned plots had a significant number of dead trees, but the prescribed stocking was achieved in 16 of the 20 plots, although much fewer trees were actually felled.

Trial Layout and Site Information

This trial is planted on the top of a hill and is exposed to wind and snow. The presence of a large population of hares at this site may have also contributed to the high mortality in some plots. Many of the trees are short and stubby due to the open grown conditions, particularly at the lower planting stockings.

Only twenty of the twenty-five plots planted were established as PSPs at this site (see map, Figure 3). Plots with less than 70% of the prescribed stocking remaining were abandoned. This included plots 1/11, 10/14, 14/12, 17/16 and 22/17. The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6.

This trial has not had a problem with regeneration.

The following information was recorded at the time of planting:

Altitude:	300m
Soil Type:	Pukekoma yellow brown earth
Site Preparation:	Windrowing
Weeds:	None at planting
Regeneration:	Nil
Slope:	Flat
Previous land use:	Pinus nigra plantation
Site:	Low fertility, ex forest site

Plot data

A summary (Table 14) at the time of the first and latest winter measurement in March 1999 (age 8 years) shows data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. These treatments have not been averaged together in this summary, as there is only one measurement summary.

The average DOS at this site is 23.8cm and the average maximum branch diameter is 4.8cm.

The following trends were noted:

- Maximum branch size is consistent across stocking with plots planted at the higher stocking (1000 stems/ha) having smaller branches
- The average DOS and maximum branch diameter are large at this site (consistent with the observation of short, stubby trees)
- The 'long internode' seedlot (GF13) has very inconsistent growth for diameter and height within treatments
- At age 8, the GF25 seedlot is larger than the GF6 seedlot for all treatments for diameter growth
- Overall, height growth is inconsistent between seedlots/treatments at age 8
- The mean height of this trial was only 7.3m at age 8, but in contrast the mean diameters were large, an average of 15.2cm
- The crown height had risen above 1m in only one of the unpruned plots by age 8

TABLE 14. FR 121/10: Trial data at the first and latest winter measurement (June 1999) age 8.0

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	6	250	102	16.7	7.1	2.2	6.9	2.7	25.7	0.5	5.7
1	90/294	25	250	102	16.9	6.6	2.3	6.9	2.4	24.0	0.5	4.4
2	89/15 (LI25)	13	500	194	14.5	6.5	3.2	9.5	2.4	22.5	0.6	5.2
2	88/105	14	500	204	16.4	7.4	4.3	13.6	2.7	26.2	0.4	5.3
2	88/201	16	500	194	16.1	7.2	3.9	12.4	2.6	22.9	0.5	5.2
2	90/294	25	500	184	16.2	6.6	3.8	11.2	2.3	23.7	0.6	5.3
3	88/102	6	1000	400	15.4	7.2	7.4	23.9	2.7	21.1	0.7	3.8
3	89/15 (LI25)	13	1000	400	17.3	8.0	9.4	31.7	3.1	24.5	0.5	4.1
3	90/294	25	1000	400	16.0	7.3	8.1	25.7	2.8	23.6	0.6	4.2
4	88/102	6	500	204	15.4	7.4	3.8	12.2	0.0			
4	90/294	25	500	204	16.8	7.1	4.5	14.2	0.0			
5	88/102	6	1000	400	13.9	7.2	6.1	19.2	0.0			
5	89/15 (LI25)	13	1000	400	15.2	7.3	7.3	24.2	0.0			
5	90/294	25	1000	400	15.8	7.7	7.8	26.4	0.0			
6	89/15 (LI25)	13	1000	600	14.9	7.7	10.5	34.1	0.0			
6	90/294	25	1000	600	16.5	7.7	12.8	42.0	0.0			
7	88/102	6	1000	780	15.1	7.3	13.9	44.7	0.0			
7	89/15 (LI25)	13	1000	720	14.8	7.0	12.5	39.1	0.0			
7	88/201	16	1000	820	15.1	7.6	14.8	48.9	0.0			
7	90/294	25	1000	840	15.8	7.5	16.4	53.9	0.0			

FR 121/11, SHELLOCKS Forest, Canterbury

This trial was planted in July 1991 with an unbalanced split-split block design containing 22 rectangular, 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). The trial occupies 4.54 hectares.

The first measurements (of total height only) were taken in May 1993 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during February 1999 (age 7.8 years). The trial MCH at the time of plot establishment was 7.1m, with a range of 5.6 to 8.6m.

Trial Design

This trial was designed with seven silvicultural treatments and five different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 15).

TABLE 15. Trial design for FR 121/11, Shellocks Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF6 (88/102)	GF14 (88/105)	GF16 (88/201)	GF25 (90/294)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•

Each • represents one PSP plot with a buffer which receives the same treatment as the inner PSP plot.

Pruning

Pruning of 11 plots was carried out by Selwyn Plantation Board staff, beginning on 23 February 1999 (8 mandays). The average crown length remaining after pruning was 4.2m (mean pruned height 2.7m). The quality of pruning was not good at this site due to the inexperience of the pruners. Many branches were not pruned off flush and the DOS is larger than it should be. Selection for thinning was carried out by **Forest Research** staff at the same time, and only selected crop trees were pruned. Pruning measurements (prune height, DOS, DOS height and maximum branch diameter) were recorded at the time of plot establishment.

PSP Plot Establishment

Twenty-five permanent sample plots were established by three **Forest Research** staff, between 23-26 February 1999 (a total of 16 mandays). Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7).

Measurements were taken and recorded as described in the section on 'Basic field procedures'.

Thinning

Twenty plots were thinned by Selwyn Plantation Board staff following plot establishment on 24-25 February 1999 (2 mandays) – thinning times were limited by fire risk consequently thinning was completed over two days. All plots were thinned according to the schedule. The *Acacia dealbata* (wattle) trees present at this time were also removed.

Trial Layout and Site Information

All twenty-five plots planted were established as PSPs at this site (see map, Figure 4). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6.

This trial was damaged by goats at an early age, but the trees recovered and grew well after the goats were eliminated in Spring 1992. There was significant growth of *Acacia dealbata* (wattle) trees. These were rotary slashed in 1997 and again prior to plot establishment in 1999. Most plots suffered some mortality but all the thinned plots are at the prescribed stocking. Plot 22/17 suffered the most and is now at 700 sph (originally 1000 sph unthinned). Overall the trial is in good condition.

The following information was recorded at the time of planting:

Altitude:	115m
Soil Type:	Lismore
Site Preparation:	Windrowed, ripping at 4m centres
Weeds:	<i>Acacia dealbata</i>
Regeneration:	<i>Acacia</i> expected
Slope:	Flat
Previous land use:	<i>Pinus radiata</i> / <i>Eucalyptus</i> sp. plantation
Site:	Low fertility, ex forest site

Plot data

A summary (Table 16) at the time of the first and latest winter measurement in May 1999 (age 8 years) shows data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. These treatments have not been averaged together in this summary, as there is only one measurement summary.

The average DOS at this site is 18.5cm and the average maximum branch diameter is 3.3cm.

At the time of plot establishment all plots had varying amounts of mortality from low to high. The final crop stocking in the thinned plots was always achieved though. Mortality also occurred in the unthinned plots (treatment 7) which resulted in a mean stocking for the 1000 stems/ha plots of 825 stems/ha. This site was slow growing as predicted (low site index) consequently PSPs did not get established until age 7.8.

The following trends were noted:

- Maximum branch size is consistent across stocking with plots planted at the higher stocking (1000 stems/ha) having smaller branches
- The 'long internode' seedlot (GF13) has very inconsistent growth for diameter and height within treatments
- At age 8, the GF25 seedlot is larger for diameter growth than the GF6 seedlot for all treatments, except treatment 6 (thinned to 600 stems/ha)
- Overall, height growth is inconsistent between seedlots/treatments at age 8
- The GF16 seedlot, planted at two treatments only, is doing very well at this site
- The trees overall are much smaller in diameter and height compared to the other sites at the same age
- The crown height in the unpruned plots is still at ground level, thus has not risen by age 8

FIGURE 4 Map showing plot locations, FR 121/11

Shellocks Forest

Compartment 36
Planted 1991

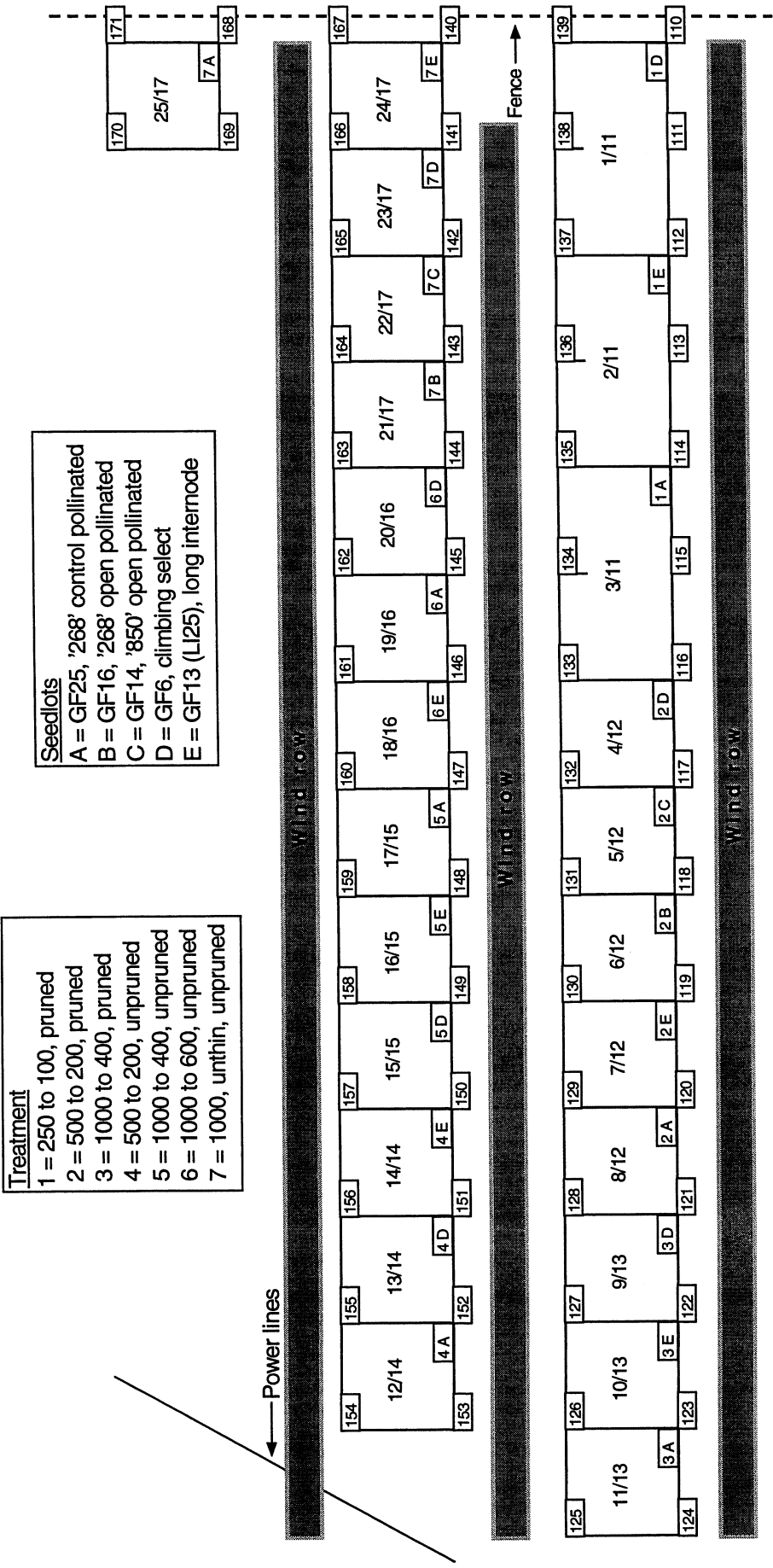


TABLE 16. FR 121/11: Trial data at the first and latest winter measurement (May 1999) age 8.0

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	6	250	102	11.9	5.7	1.1	3.3	1.8	16.5	0.7	3.5
1	89/15 (LI25)	13	250	102	12.8	6.7	1.3	4.1	2.2	19.0	0.6	4.5
1	90/294	25	250	102	13.4	6.4	1.4	4.4	2.1	19.3	0.5	3.5
2	88/102	6	500	204	13.8	7.0	3.1	10.0	2.5	18.6	0.5	3.3
2	89/15 (LI25)	13	500	204	14.6	7.5	3.4	11.6	2.8	20.8	0.5	3.6
2	88/105	14	500	204	13.7	6.5	3.0	9.5	2.3	18.0	0.6	3.1
2	88/201	16	500	204	14.2	7.9	3.3	11.4	3.2	18.7	0.6	2.9
2	90/294	25	500	204	13.8	7.5	3.0	10.3	2.8	19.1	0.5	4.1
3	88/102	6	1000	386	12.5	7.9	4.7	16.6	2.9	16.5	0.6	2.8
3	89/15 (LI25)	13	1000	400	12.9	7.7	5.2	18.3	2.9	16.8	0.7	2.7
3	90/294	25	1000	400	15.4	8.9	7.4	28.6	3.8	20.2	0.6	2.8
4	88/102	6	500	204	14.8	8.0	3.5	12.6	0.0			
4	89/15 (LI25)	13	500	194	15.3	8.3	3.6	13.0	0.0			
4	90/294	25	500	214	16.2	8.4	4.4	16.4	0.0			
5	88/102	6	1000	400	14.1	8.6	6.2	24.0	0.0			
5	89/15 (LI25)	13	1000	400	14.4	8.6	6.5	24.7	0.0			
5	90/294	25	1000	400	14.2	8.6	6.4	24.3	0.0			
6	88/102	6	1000	600	12.9	8.4	7.8	29.2	0.0			
6	89/15 (LI25)	13	1000	600	13.1	8.0	8.1	28.8	0.0			
6	90/294	25	1000	600	12.5	7.5	7.3	25.1	0.0			
7	88/102	6	1000	860	11.0	6.5	8.2	25.8	0.0			
7	89/15 (LI25)	13	1000	880	11.4	7.1	9.0	29.6	0.0			
7	88/105	14	1000	700	10.8	6.7	6.5	20.3	0.0			
7	88/201	16	1000	900	11.5	7.3	9.4	32.4	0.0			
7	90/294	25	1000	820	11.2	7.0	8.1	26.5	0.0			

FR 121/12, ASHLEY Forest, Canterbury

This trial was planted in July 1991 with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). The trial occupies 4.54 hectares.

The first measurements of total height only were taken in May 1993 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during November 1996 (age 5.6 years). The trial MCH at the time of plot establishment was 5.9m, with a range of 4.5 to 7.1m.

Trial Design

This trial was designed with seven silvicultural treatments and five different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 17).

TABLE 17. Trial design for FR 121/12, Ashley Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF6 (88/102)	GF14 (88/105)	GF16 (88/201)	GF25 (90/294)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•

Each • represents one PSP plot with a buffer which receives the same treatment as the inner PSP plot.

Pruning

Pruning was carried out on 11 plots by a Carter Holt Harvey contractor and **Forest Research** staff, on 13-14 November 1996 (2 mandays 'in kind' work). Pruning was difficult due to dense gorse preventing easy access to the trees. Pruning measurements (prune height, DOS, DOS height and maximum branch diameter) were recorded at the time of plot establishment. The average crown length remaining after pruning was 4.1m (mean pruned height 1.7m).

PSP Plot Establishment

Twenty five permanent sample plots were established by **Forest Research** staff 13-14 November 1996 (a total of 32 mandays included pruning and thinning supervision). Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7). The trial has a severe gorse problem, consequently plot establishment was slow. Carter Holt Harvey contractors line cut the gorse with chainsaws at the time of plot establishment (5 mandays 'in kind', 2.5 mandays paid time).

Measurements were taken and recorded as described in the section on 'Basic field procedures'.

Thinning

Thinning of the 20 plots was carried out by **Forest Research** field staff and Carter Holt Harvey contractors on 19 November 1996. All plots were thinned according to the schedule.

Trial Layout and Site Information

All 25 plots planted were established as PSPs at this site (see map, Figure 6). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6.

This trial has a severe problem with gorse. Two successful spot sprays prior to 1994 maintained high survival rates throughout the trial. The lower half of the trial (plots 1-4) was more suppressed than the top half. The MCH at plot establishment was 5.0m in the lower half and 6.1m in the top half. Some of the thinned plots had mortality but the prescribed stocking was still achieved. None of the unthinned plots suffered any mortality (they were all situated in the top half of the trial), despite the gorse problems. In 1998 a Carter Holt Harvey crew chainsaw cut regeneration now present and maintained the tracks through the gorse to allow access for plot remeasurement.

The following information was recorded at the time of planting:

Altitude:	200m
Soil Type:	Makerikeri
Site Preparation:	None
Weeds:	Gorse, likely to be heavily infested
Regeneration:	None expected
Slope:	10-20°
Aspect:	Northwest
Previous land use:	Pinus nigra plantation
Site:	Medium/high fertility, ex forest site

Plot data

Summaries (Tables 18 & 19) at the time of the first winter measurement in May 1997 (age 6 years) and the 1999 winter remeasurement (age 8 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 8 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 14.8cm and the average maximum branch diameter is 2.6cm.

The following trends were noted:

- Maximum branch size is variable across treatments
- The 'long internode' seedlot (GF13) has very inconsistent growth for diameter and height within treatments, sometimes growing better than the GF25 and sometimes worse than the GF6
- At age 8, the GF25 seedlot is generally performing better than the GF6 seedlot for diameter growth.
- There is an exception for the GF25 seedlot in treatment 7 (unthinned, unpruned) where this seedlot is performing worst for both diameter and height
- The GF14 seedlot, planted at two treatments only, is growing very well at this site
- The crown height in the unpruned plots has risen slightly to 0.8m by age 8

FIGURE 5 Map showing plot locations, FR 121/12

Ashley Forest

Compartment 19/05

Planted 1991

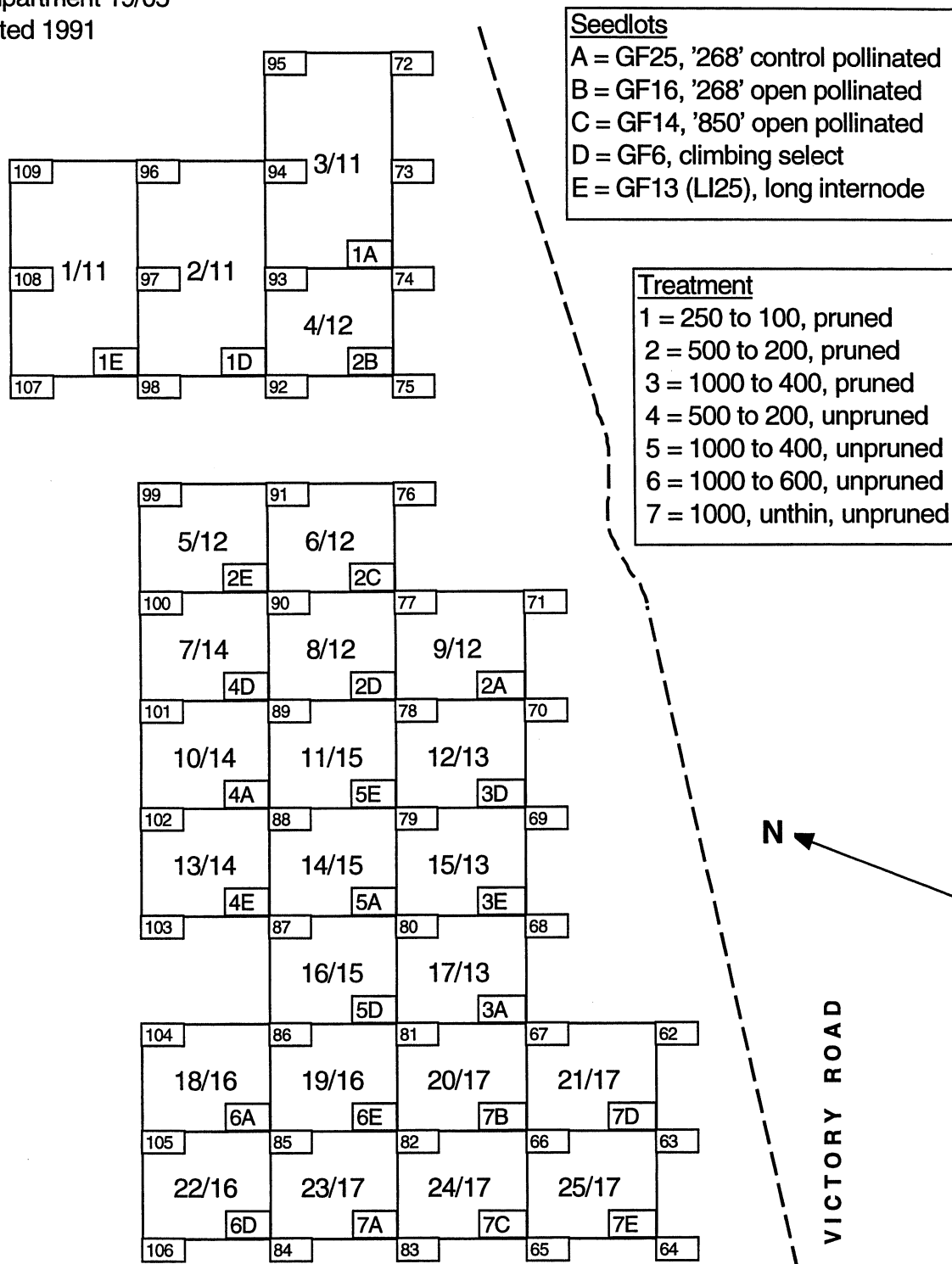


TABLE 18. FR 121/12: Trial data at the first winter measurement (May 1997) age 6.0

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	6	250	102	10.5	5.5	0.9	2.5	1.1	11.6	0.4	2.3
1	89/15 (LI25)	13	250	102	10.3	5.4	0.8	2.3	1.0	11.2	0.6	1.7
1	90/294	25	250	102	12.8	6.4	1.3	4.0	1.4	14.9	0.7	2.8
2	88/102	6	500	204	13.2	6.7	2.8	8.9	1.8	16.5	0.7	3.4
2	89/15 (LI25)	13	500	204	11.9	6.2	2.3	6.9	1.4	14.4	0.7	2.9
2	88/105	14	500	204	12.3	6.5	2.4	7.7	1.5	14.3	0.6	2.4
2	88/201	16	500	204	12.0	6.3	2.3	6.9	1.5	13.3	0.3	1.5
2	90/294	25	500	204	14.0	6.9	3.2	10.3	1.9	17.1	0.7	3
3	88/102	6	1000	400	13.4	7.6	5.6	19.4	2.2	15.3	0.8	2.8
3	89/15 (LI25)	13	1000	400	14.3	8.1	6.4	23.0	2.5	17.6	0.8	3.5
3	90/294	25	1000	400	14.3	8.0	6.4	22.9	2.7	16.1	0.9	2.8
4	88/102	6	500	204	12.1	6.7	2.4	7.5	0.0			
4	89/15 (LI25)	13	500	204	12.0	6.6	2.3	7.3	0.0			
4	90/294	25	500	204	11.7	6.2	2.2	6.6	0.0			
5	88/102	6	1000	400	10.1	5.9	3.2	9.6	0.0			
5	89/15 (LI25)	13	1000	400	12.3	7.2	4.8	15.7	0.0			
5	90/294	25	1000	400	12.2	7.5	4.7	15.8	0.0			
6	88/102	6	1000	600	11.6	6.9	6.3	20.6	0.0			
6	89/15 (LI25)	13	1000	600	10.3	6.0	5.0	15.1	0.0			
6	90/294	25	1000	600	11.7	7.1	6.4	21.2	0.0			
7	88/102	6	1000	960	12.8	8.4	12.3	44.4	0.0			
7	89/15 (LI25)	13	1000	1020	12.8	7.9	13.1	44.8	0.0			
7	88/105	14	1000	940	13.2	8.0	12.8	43.9	0.0			
7	88/201	16	1000	940	9.8	6.7	7.1	22.3	0.0			
7	90/294	25	1000	1020	10.7	6.8	9.3	29.1	0.0			

TABLE 19. FR 121/12: Trial data from winter measurement at age 8.0 (May 1999)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn Crown HT
1	88/102	6	250	97	15.8	7.9	1.9	6.8	1.1
1	89/15 (LI25)	13	250	92	16.2	7.4	1.9	6.3	1.0
1	90/294	25	250	102	19.6	8.9	3.1	11.7	1.4
2&4	88/102	6	500	174	18.0	8.8	4.4	16.6	1.1
2&4	89/15 (LI25)	13	500	199	17.6	9.7	4.8	19.4	1.0
2	88/105	14	500	204	18.2	9.3	5.3	21.0	1.6
2	88/201	16	500	194	17.6	8.7	4.7	17.8	1.3
2&4	90/294	25	500	184	18.5	9.4	5.0	19.7	1.2
3&5	88/102	6	1000	393	16.8	9.4	8.8	35.3	1.4
3&5	89/15 (LI25)	13	1000	386	18.7	10.1	10.6	44.2	1.7
3&5	90/294	25	1000	386	18.4	10.4	10.3	44.0	1.9
6	88/102	6	1000	600	16.2	9.7	12.4	50.6	0.6
6	89/15 (LI25)	13	1000	600	15.2	8.7	10.9	41.0	0.7
6	90/294	25	1000	583	16.9	10.2	13.0	54.9	0.8
7	88/102	6	1000	960	16.5	11.0	20.6	90.7	1.0
7	89/15 (LI25)	13	1000	1020	16.8	10.0	22.5	92.1	1.1
7	88/105	14	1000	940	17.2	10.9	21.7	93.0	1.0
7	88/201	16	1000	940	14.1	9.7	14.6	58.2	0.5
7	90/294	25	1000	1000	14.6	9.6	16.8	66.8	1.0

Note: Treatments 2 and 4, and 3 and 5, have been averaged by seedlot, without taking pruning into account

FR 121/13, GOLDEN DOWNS Forest, Nelson

This trial was planted in July 1991 with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). The trial occupies 4.54 hectares.

The first measurements of total height only were taken in May 1993 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during February 1997 (age 5.9 years). The trial MCH at the time of plot establishment was 6.9m, with a range of 5.6 to 8.2m.

Shortly after plot establishment the forest was sold by Tasman Forestry to Weyerhaeuser NZ Inc.

Trial Design

This trial was designed with seven silvicultural treatments and five different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 20).

TABLE 20. Trial design for FR 121/13, Golden Downs Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF6 (88/102)	GF14 (88/105)	GF16 (88/201)	GF25 (90/294)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•

Each • represents one PSP plot with a buffer which receives the same treatment as the inner PSP plot.

Pruning

Pruning was carried out on 11 plots by Tasman Forestry contractors, under supervision by **Forest Research** staff, on 10-11 February 1997 (5 mandays work). Pruning measurements (prune height, DOS, DOS height and maximum branch diameter) were recorded at the time of plot establishment. The average crown length remaining after pruning was 4.5m (mean pruned height 2.6m).

PSP Plot Establishment

Twenty-five permanent sample plots were established by **Forest Research** staff between 11-14 February 1997 (a total of 31 mandays included pruning and thinning supervision). Tasman Forestry contractors also assisted with the plot establishment. Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7).

Measurements were taken and recorded as described in the section on 'Basic field procedures'.

Thinning

Thinning of the 20 plots was carried out by **Forest Research** field staff on 13-14 February 1997 (5 mandays work). All plots were thinned according to the schedule.

Trial Layout and Site Information

All twenty-five plots planted were established as PSPs at this site (see map, Figure 7). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6.

There was good identification of plot trees thanks to regular planting lines and good upkeep of the trials by forest owners. Mortality in this trial is very low despite the very heavy bracken undergrowth. Plot measurement is hindered but plot growth has not been affected. This trial has the smallest DOS and mean branch diameter of all the sites in the 1991 series.

The following information was recorded at the time of planting:

Altitude:	450m
Soil Type:	Moutere gravels
Site Preparation:	None (ex hauler)
Weeds:	None, expect bracken regrowth
Regeneration:	None, expect <i>Pinus radiata</i> later
Slope:	25°
Aspect:	West
Previous land use:	Radiata pine plantation
Site:	High fertility, ex forest site

Plot data

Summaries (Tables 21 & 22) at the time of the first winter measurement in July 1997 (age 6.1 years) and the 1999 winter remeasurement (age 8.1 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 8.1 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 14.5cm and the average maximum branch diameter is 2.1cm.

The following trends were noted:

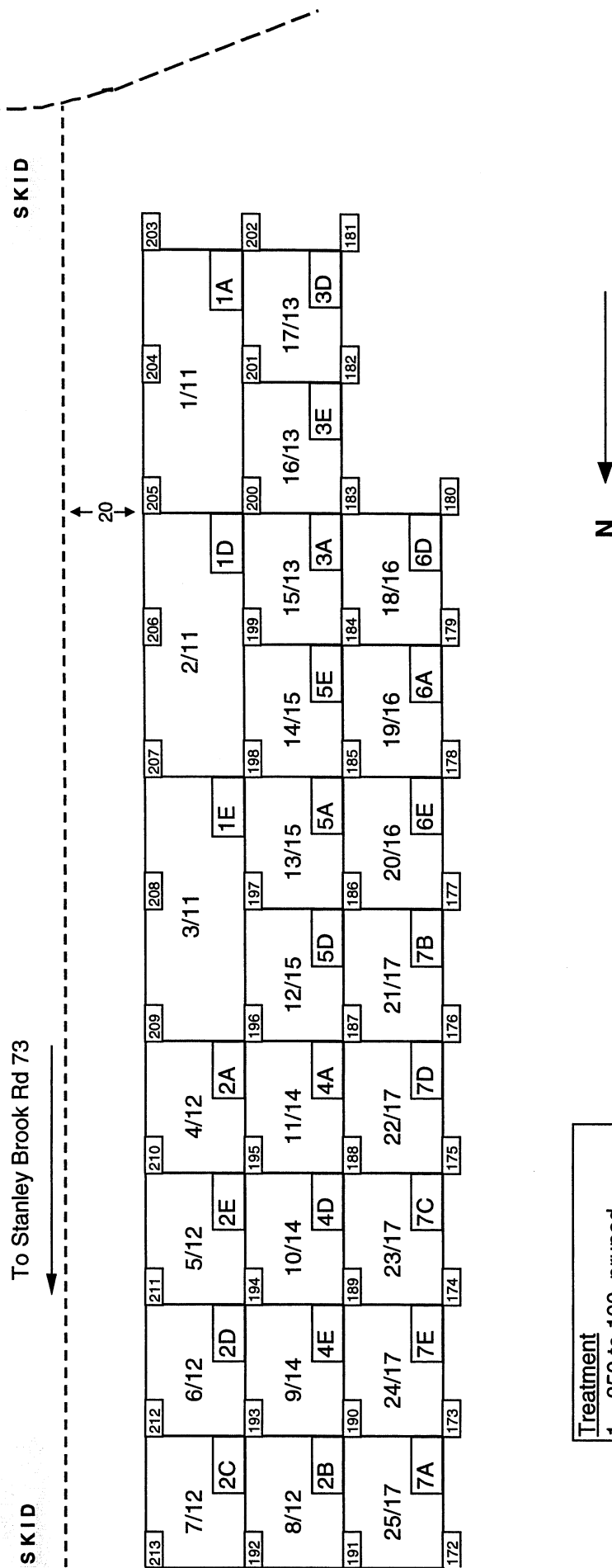
- Maximum branch size is consistent across stocking with plots planted at the higher stocking (1000 stems/ha) having very small branches (mean max branch 1.3cm)
- The 'long internode' seedlot (GF13) has very inconsistent growth for diameter and height within treatments
- At age 8, the GF25 seedlot is performing better for diameter growth than the GF6 seedlot for all treatments, except treatment 6 (thinned to 600 stems/ha)
- Height growth of the GF25 seedlot is lower than most other seedlots in treatments 2, 4 and 6
- Overall, there is only a small difference in diameter growth between the seedlots at age 8, except for treatment 1 (thinned to 100stems/ha)
- The crown height in the unpruned plots has risen slightly to 0.8m by age 8

FIGURE 6. Map showing plot locations, FR 121/13

Golden Downs

Compartment 133

Planted 1991



Treatment
 1 = 250 to 100, pruned
 2 = 500 to 200, pruned
 3 = 1000 to 400, pruned
 4 = 500 to 200, unpruned
 5 = 1000 to 400, unpruned
 6 = 1000 to 600, unpruned
 7 = 1000, unthin, unpruned

Seedlots
 A = GF25, '268' control pollinated
 B = GF16, '268' open pollinated
 C = GF14, '850' open pollinated
 D = GF6, climbing select
 E = GF13 (LI25), long internode

TABLE 21. FR 121/13: Trial data at the first winter measurement (July 1997) age 6.1

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	6	250	102	12.1	7.1	1.2	3.9	2.5	15.8	0.8	2.6
1	89/15 (LI25)	13	250	102	11.8	7.2	1.1	3.7	2.4	14.4	0.8	2.6
1	90/294	25	250	102	13.8	7.7	1.5	5.3	3.0	16.5	0.9	3.1
2	88/102	6	500	204	10.7	7.2	1.8	6.2	2.4	12.8	1.1	2.2
2	89/15 (LI25)	13	500	204	11.5	7.0	2.1	7.0	2.0	14.0	0.9	2.3
2	88/105	14	500	204	11.1	6.9	2.0	6.4	2.3	13.9	1.0	2.2
2	88/201	16	500	204	11.4	7.3	2.1	7.0	2.4	13.1	1.3	2.0
2	90/294	25	500	204	11.2	7.0	2.0	6.6	2.4	14.7	0.6	2.3
3	88/102	6	1000	400	11.6	7.8	4.3	15.1	3.2	13.9	1.4	0.9
3	89/15 (LI25)	13	1000	414	11.8	8.6	4.5	17.2	3.1	15.7	0.8	1.5
3	90/294	25	1000	400	11.9	8.4	4.5	16.4	3.2	14.3	0.8	1.4
4	88/102	6	500	204	11.7	7.3	2.2	7.5	0.0			
4	89/15 (LI25)	13	500	204	10.9	6.9	1.9	6.3	0.0			
4	90/294	25	500	204	11.4	6.8	2.1	6.6	0.0			
5	88/102	6	1000	429	10.7	6.9	3.8	12.8	0.0			
5	89/15 (LI25)	13	1000	386	11.6	7.6	4.1	14.1	0.0			
5	90/294	25	1000	400	11.3	7.5	4.0	14.2	0.0			
6	88/102	6	1000	600	9.8	7.7	4.5	16.0	0.0			
6	89/15 (LI25)	13	1000	600	10.4	7.6	5.1	17.4	0.0			
6	90/294	25	1000	600	9.7	7.4	4.5	15.3	0.0			
7	88/102	6	1000	1000	9.1	6.0	6.5	20.2	0.0			
7	89/15 (LI25)	13	1000	920	9.3	6.4	6.2	19.8	0.0			
7	88/105	14	1000	920	11.0	7.6	8.7	30.4	0.0			
7	88/201	16	1000	980	9.6	7.1	7.1	23.6	0.0			
7	90/294	25	1000	1000	9.5	7.0	7.1	24.2	0.0			

TABLE 22. FR 121/13: Trial data from winter measurement at age 8.1 (July 1999)

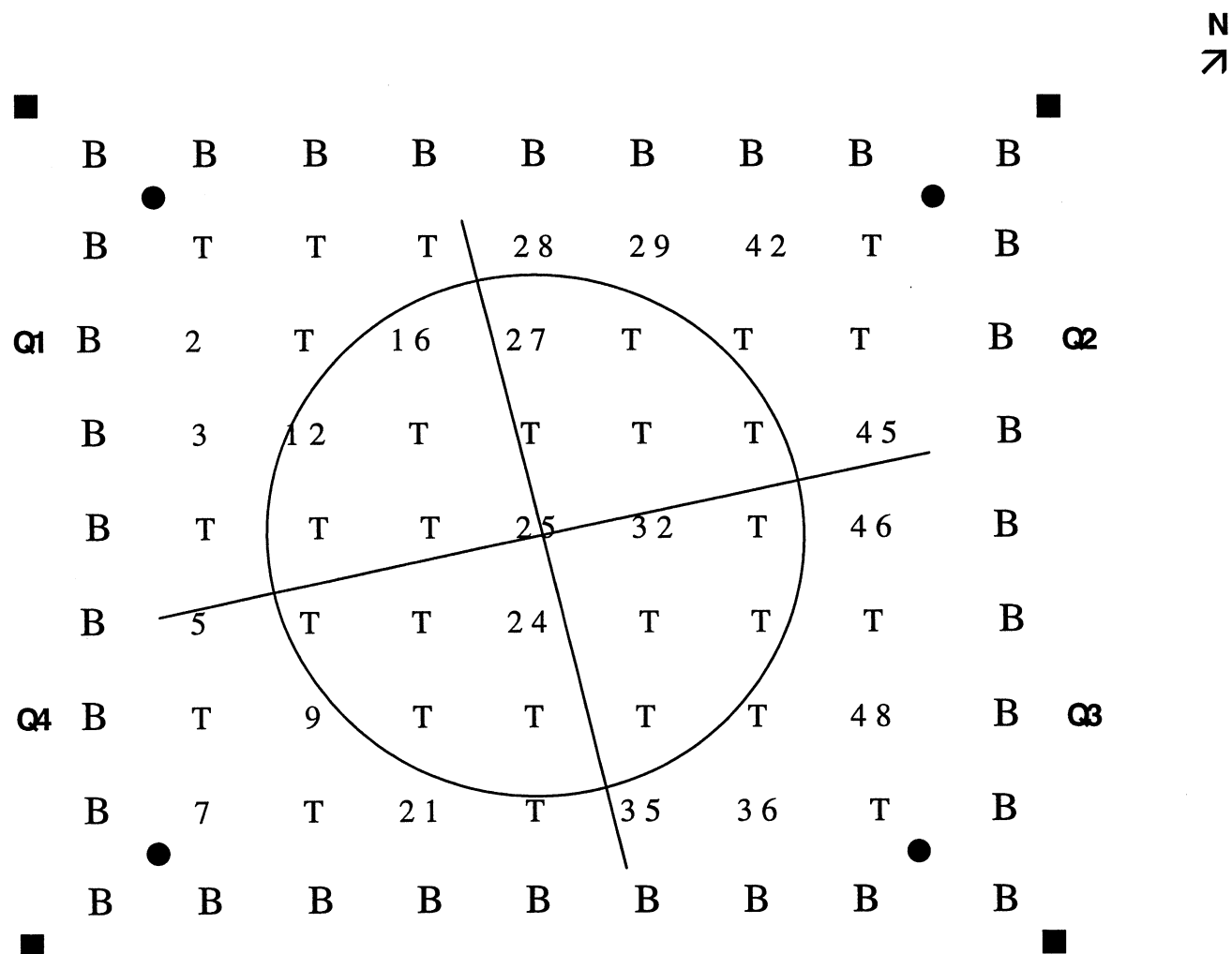
Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn Crown HT
1	88/102	6	250	102	18.7	10.0	2.8	11.4	2.5
1	89/15 (L125)	13	250	102	17.6	10.4	2.5	10.5	2.4
1	90/294	25	250	102	20.4	10.6	3.3	14.0	3.1
2&4	88/102	6	500	204	17.5	10.9	4.9	22.0	1.8
2&4	89/15 (L125)	13	500	204	17.8	10.7	5.1	22.0	1.5
2	88/105	14	500	204	17.4	10.1	4.8	19.9	2.2
2	88/201	16	500	204	17.6	10.8	5.0	21.7	2.5
2&4	90/294	25	500	204	17.7	10.3	5.0	20.7	1.5
3&5	88/102	6	1000	407	16.8	10.7	9.0	39.6	1.9
3&5	89/15 (L125)	13	1000	400	17.5	11.7	9.6	44.9	1.6
3&5	90/294	25	1000	400	17.3	11.2	9.4	42.6	2.1
6	88/102	6	1000	600	15.3	11.2	11.0	50.5	1.0
6	89/15 (L125)	13	1000	600	15.8	11.2	11.7	53.1	0.8
6	90/294	25	1000	600	15.2	10.9	10.9	48.4	0.6
7	88/102	6	1000	1000	13.7	9.7	14.8	62.8	0.8
7	89/15 (L125)	13	1000	920	14.2	10.0	14.6	62.4	0.8
7	88/105	14	1000	920	16.4	11.2	19.6	87.3	1.0
7	88/201	16	1000	980	14.5	10.8	16.2	72.0	1.0
7	90/294	25	1000	1000	14.5	10.9	16.4	75.2	0.9

Note: Treatments 2 and 4, and 3 and 5, have been averaged by seedlot, without taking pruning into account

Appendix 1

Location of Buffers and Permanent Sample Plots

Example 1 Treatment 2
5 x 4 m spacing
Thinned to 200 s/ha



Inner circular plot, 11.3m radius, to determine position of predominant height trees

Q1, Q2, Q3, Q4

Quadrants to determine the predominant height trees

B

Buffer tree

T

Thinned tree

1,4,7,

Plot trees

25

Plot centre



Planting corner peg

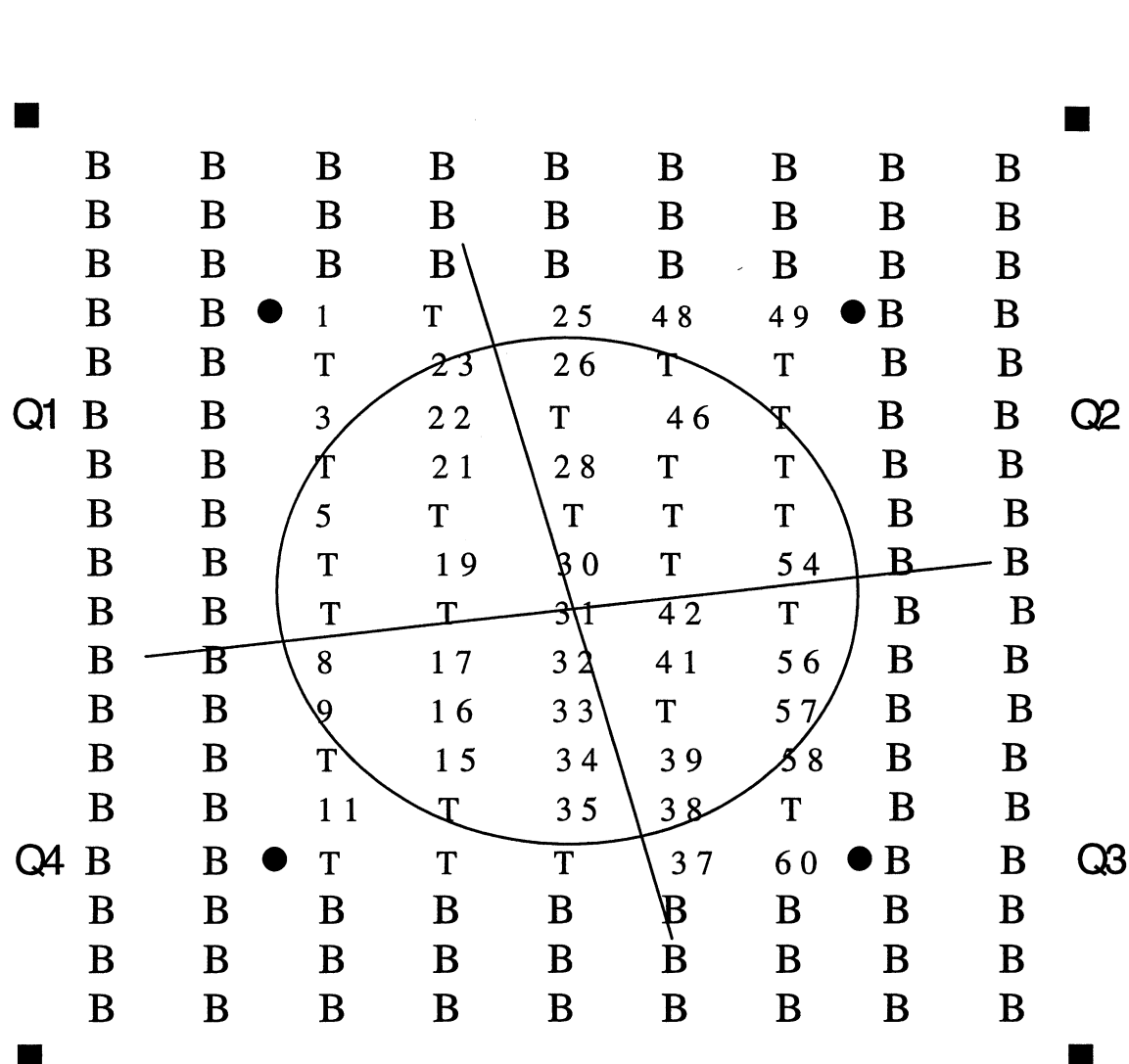


PSP Plot corner peg

Appendix 1 cont.

Location of Buffers and Permanent Sample Plots

Example 2 Treatment 6
5 x 2 m spacing
Thinned to 600 s/ha



Inner circular plot, 11.3m radius, to determine position of predominant height trees

Q1, Q2, Q3, Q4

Quadrants to determine the predominant height trees

B

Buffer tree

1,3,5,

Plot trees

31

Plot centre



Planting corner peg



PSP Plot corner peg

Appendix 2

Plot Numbering System

The plot identification number is a combination of five variables, making up a unique number combination for each plot. FR 121/2/28/17 is made up of the following fields:

CODE	=	Regional/Controller Code
EXPNO	=	Experiment / trial number as allocated by Forest Research
SUBEXP	=	Sub-experiment number related to the experiment
PLOTNO	=	Actual plot number within the trial allocated in a sequential manner
SUBPLOT	=	Replication number is the first digit Treatment number is the second digit

Thus FR 121/12/25/17 is plot 25 of trial FR 121/12. The plot replication number is 1 and the treatment is 7.

In addition, Seedlot is stored in the PSP system as the variable 'Seedlot' and 'Improvement Rating' (Dunlop, 1995).

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