

**ESTABLISHMENT REPORT FOR THE 1992
SPECIAL-PURPOSE BREED TRIALS**

J. D. HAYES

REPORT NO. 101

MAY 2001

**NOTE : Confidential to participants of the Stand Growth Modelling Cooperative.
: This is an unpublished report and must not be cited as a literature reference.**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 special-purpose breed trials (similar to the silviculture/breed trials), and examines the actual pruning, thinning, and establishment of permanent sample plots (PSP) in five of the six trial sites planted in 1992 (Stovold 1995).

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). In 1999, there was agreement between Stand Growth Modelling Cooperative and the Radiata Pine Breeding Cooperative (now Radiata Pine Breeding Company) to jointly support a further series of trials to compare the performance of special-purpose breeds across regions. The trial described in this document was designed in 1991 and planted in 1992 (FR Workplan 2151).

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 for 4 years following plot establishment, then every two years following. Growth data from these trials at the first measurement 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	4
Pruning	4
PSP Establishment.....	4
Thinning.....	6
INDIVIDUAL TRIAL DESIGNS AND ESTABLISHMENT REPORTS.....	7
<u>FR 172/1, Woodhill Forest</u>	7
<u>FR 172/2, Riverhead Forest</u>	13
<u>FR 172/3, Kaingaroa Forest</u>	15
<u>FR 172/4, Kinleith Forest</u>	21
<u>FR 172/5, Takitoa Forest</u>	27
<u>FR 172/6, Otago Coast Forest</u>	33
APPENDIX 1	41
APPENDIX 2.....	43
REFERENCES.....	44
ACKNOWLEDGMENTS	45

INTRODUCTION

Trials were planted in 1992 and 1994 to evaluate special-purpose breeds. These trials, when combined, represent four growth regions and seven different forest sites. These series of trials were designed to compare the performance of special-purpose seedlots of radiata pine, test their response to differing final crop stocking and thinning strategies, and to compare their performance across regions. The original design was similar to the silviculture/breed trials to quantify genetic gain in growth. Large plot trials were established to test seedlots of the highly multinodal, long internode, high and low wood density breeds on contrasting sites.

The Stand Growth Modelling Cooperative (SGMC) and the Radiata Pine Breeding Company (RPBC) jointly support this work which will extend knowledge gained from the genetic gain and silviculture/breed trials (Hayes and Carson 1998). 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.

PSP establishment, thinning and pruning of the 1992 plantings of the special-purpose 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.

TRIAL LOCATIONS

Trials were planted at six sites in 1992, in four growth regions (Table 1). The sites were chosen to cover a range of site qualities from high to low site index. By age 6, the site at Riverhead Forest was heavily gorse infected and the cost of clearing this was too high to justify plot establishment.

TABLE 1. Trial sites planted in 1992 as part of the Silviculture/Breed trial series.

Trial No.	Forest Name	Forest Owner	Growth Region	Site Category	Current Site index
FR 172/1	Woodhill	Carter Holt Harvey Forests	Auckland Sands	Low SI	25.6
FR 172/2*	Riverhead	Carter Holt Harvey Forests	Auckland Clays	High SI	NA
FR 172/3	Kaingaroa	Fletcher Challenge Forests	Central North Island	Medium SI	31.6
FR 172/4	Kinleith	Carter Holt Harvey Forest	Central North Island	High SI	34.1
FR 172/5	Takitoa	City Forests	Southland	High BA	29.8
FR 172/6	Otago Coast	Wenita Forest Products	Southland	Medium SI	29.0

* Trial abandoned before plot establishment due to heavy gorse infestation

EXPERIMENTAL DESIGN

Re-design of treatments

The original experimental design (Table 2) in the 1992 trials included seven treatments, 3 pruned and 4 unpruned at various initial and final stockings, with no replication within site. In July 1999 a joint sub-committee of the SGMC and RPBC agreed upon the final trial design where by there was a consolidation of treatments to provide better on-site replication. The treatment planted at 250sph was abandoned and no PSPs will be established as this regime had proved to be unsatisfactory (much top damage due to the open spacing) in the silviculture/breed trial series. An unthinned / unpruned treatment will be allocated to the 500sph planted plots to reflect current practices (particularly of Carter Holt Harvey Forests) and the remaining plots planted at 1000sph will all be pruned for access only and thinned to 400sph. This design (Table 3) is the same at all sites.

TABLE 2. Original core experimental design for the 1992 Silviculture/breed trials.

Trt	Pruning	Thinning at age 8			
		Initial Planting	Final Crop Stocking	Initial Spacing	Plot area (ha)
1	✓	250	100	5 x 8	0.100
2	✓	500	200	5 x 4	0.050
3	✓	1000	400	5 x 2	0.049
4	X	500	200	5 x 4	0.050
5	X	1000	400	5 x 2	0.049
6	X	1000	600	5 x 2	0.049
7	X	1000	1000	5 x 2	0.049

TABLE 3. Revised core experimental design for the 1992 Silviculture/breed trials.

Trt	Pruning	Thinning at age 8			
		Initial Planting	Final Crop Stocking	Initial Spacing	Plot area (ha)
1	X	500	500	5 x 4	0.050
2	✓	1000	400	5 x 2	0.049

Trial plantings took place in July 1992 and plot establishment was planned for a MCH of 6m. Due to lack of agreement for funding until July 1999 the plot establishment was delayed and MCH was somewhat larger in all trials (Table 4).

TABLE 4. Planting and PSP establishment dates

Trial No.	Location	Date of PSP Establish	Age (yrs) at PSP Establish	MCH (m) After thinning	Range of MCH
FR 172/1	Woodhill	Feb 2001	8.8	11.8	9.6 – 13.7
FR 172/2	Riverhead	Abandon 1999	-	-	-
FR 172/3	Kaingaroa	Nov 1999	7.6	10.3	8.2 – 11.6
FR 172/4	Kinleith	Dec 1999	7.6	10.0	7.8 – 11.3
FR 172/5	Takitoa	Feb 2000	7.8	9.6	8.5 – 10.7
FR 172/6	Otago Coast	Feb 2000	7.8	9.1	7.9 – 10.0

There are six seedlots (GF7, 14, 18, 27, 28 and GF13 (LI25)) which are planted at all sites. At one site in Southland, plots were also planted using GF17 tissue culture plants. A description of the seedlots planted is given in Table 5. In all 1992 trial plantings, the buffer rows for each plot are of the same stock as the experimental (PSP) plots.

TABLE 5. Seedlots used in the 1992 special-purpose breed trials.

Stock	Seedlot Number	Seedlot Rating	Breeding Series	Breed	Description
Seedlings	88/102	GF7	Climbing select	Climbing select	Kaingaroa & Rotoehu climbing select
Seedlings	88/105	GF14	'850'	'850' orchard	OP mix of '850' series from Gwavas, Kaingaroa and Waimihia
Seedlings	91/523	GF18*	'268'	High density	OP Kaingaroa seed orchard
Seedlings	91/296, 91/297 mix	GF27*	'268' x '875'	Highly multinodal	CP Proseed mix
Seedlings	91/294	GF28*	'850' x '268'	Low density	CP mix of top 16 '268' clones x 850.55
Seedlings	89/15	GF13(LI25)	'870'	Uninodal	OP Tikokino mix of 7 clones
Tissue culture		GF17		Multinodal	TeTeko

* Only a small number of parents have contributed to the seedlot mix, thus less confidence should be placed on the GF rating

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 access pruned only to 2m (Table 6).
- b) Trees were marked for thinning in all treatment 2 plots. 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 treatment 2 were pruned. **Forest Research** field staff supervised the pruners. Periodic height and pruned height measurements were taken to ensure that the pruning requirements were being met.

TABLE 6. Results of the pruning operation for each site

Trial No.	Forest Name	Mean crown length (m)	Mean prune height (m)	Average DOS (cm)	Average DOS HT (m)	Max Branch diameter (cm)
FR 172/1	Woodhill	10.2	2.1	22.7	0.9	3.2
FR 172/2*	Riverhead	-	-	-	-	-
FR 172/3	Kaingaroa	8.7	2.1	22.6	0.7	2.6
FR 172/4	Kinleith	7.7	2.2	20.5	1.2	2.7
FR 172/5	Takitoa	7.7	2.2	25.7	0.6	3.7
FR 172/6	Otago Coast	6.9	2.3	23.1	0.9	3.8

* Trial abandoned

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). The buffer in Treatment 1 plots was increased so that the inner PSP had a smaller number of trees (25) reducing remeasurement time and costs, but not compromising the data analysis. Table 7 shows the generic plot establishment specifications for all trials.

TABLE 7. PSP 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. PSPs*
1	0.050	5 x 4	81	56 25	56 25	1 : 1	Unpruned	9
2	0.049	5 x 2	81	32 49	13 20	2.5 : 1	2m	18

* this number differs at some sites

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 16 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 8 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 (or plastic) 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 treatment 2) 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 16, 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.

- a) All unpruned trees and/or trees marked for culling were felled (no thinning in treatment 1 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 8. Width of buffer zone for PSPs

Trt	Planted plot area	PSP plot area	No. rows planted	No. rows in PSP	No. rows in buffer
1	0.162	0.050	9 x 9	5 x 5	2 x 2
2	0.081	0.049	9 x 9	7 x 7	1 x 1

INDIVIDUAL TRIAL DESIGNS AND PSP ESTABLISHMENT REPORTS

FR 172/1 - WOODHILL Forest, Auckland Sands

This trial was planted in July 1992 with 18 rectangular 45 x 18m plots, 9 rectangular 45 x 36m plots and 5 rectangular 45 x 72m plots (a total of 32 plots). The trial occupies 4.54 hectares.

Pruning, PSP establishment and thinning was carried out (as per the basic field procedures) during February 2001 (age 8.8 years). A total of 27 plots were established - the 5 plots planted at 250sph were not included in the trial design. The trial MCH at plot establishment, after thinning, was 11.8m with a range of 9.6 to 13.7m.

Trial Design

This trial was re-designed before plot establishment (see section on 'experimental design' page 2). It now consists of two silvicultural treatments, six different seedlots (all seedlings), with two replications for treatment 1 and four replications for treatment 2 (Table 9).

TABLE 9. Trial design for FR 172/1 Woodhill Forest

Trt	Silviculture				Planting stock					
	Pruning	Stocking (stems/ha)		Thinning	Seedlings					
	Access only	Initial	Final	Ratio	GF7 (88/102)	GF14 (88/105)	GF18* (91/523)	GF27* (91/296- 297)	GF28* (91/294)	GF13 (LI25) (89/15)
1	Unpruned	500	500	1:1	•		••	••	••	••
2	2m	1000	400	2.5:1		••	••••	••••	••••	••••

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

* only a small number of parents have contributed, thus less confidence should be placed on the GF rating

Pruning

Pruning of the 18 plots was carried out by Carter Holt Harvey Forests contractors (a total of 6 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 10.2m (mean pruned height was 2.1m). 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 Establishment

Twenty seven permanent sample plots were established by four **Forest Research** field crew beginning on 12 February 2001 (a total 19 mandays). Table 7 shows the plot establishment requirements for each of the treatments (nos. 1 & 2). One tree in plot 27/21 (an unthinned treatment plot) was accidentally felled during regeneration treatment. This was a very suppressed tree and will be treated as mortality.

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

Thinning

Thinning was carried out by Carter Holt Harvey contractors on 15 February 2001, following plot establishment (a total of 3 mandays). Eighteen of the 27 plots were thinned, as scheduled, from 1000 to 400sph. The whole trial was regen treated (all regenerated trees were thinned out) at the same time as the prescribed thinning.

Trial Layout and Site Information

All of the twenty-seven plots in the new plot design were established as PSPs at this site (see map, Figure 1). The five plots planted at 250sph were abandoned as per the re-design. The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 3, 5 & 7.

Before planting the slash was roller crushed. All plots suffered some mortality, although all the thinned plots are at the prescribed stocking of 400sph. Five of the nine unthinned have suffered more than 25% mortality. The trees that remain in the trial are of good size, form and health.

Although there were no regeneration problems anticipated at the time of planting, the trial required treatment by age 8 at the time of plot establishment.

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

Altitude:	0m – sea level
Soil Type:	Sand
Site Preparation:	Roller crushing of slash
Weeds:	Lupin
Regeneration:	None
Slope:	Flat
Previous land use:	Radiata pine plantation
Site:	Sandy, low site index

The trial has easy access and good underfoot conditions.

Plot Data

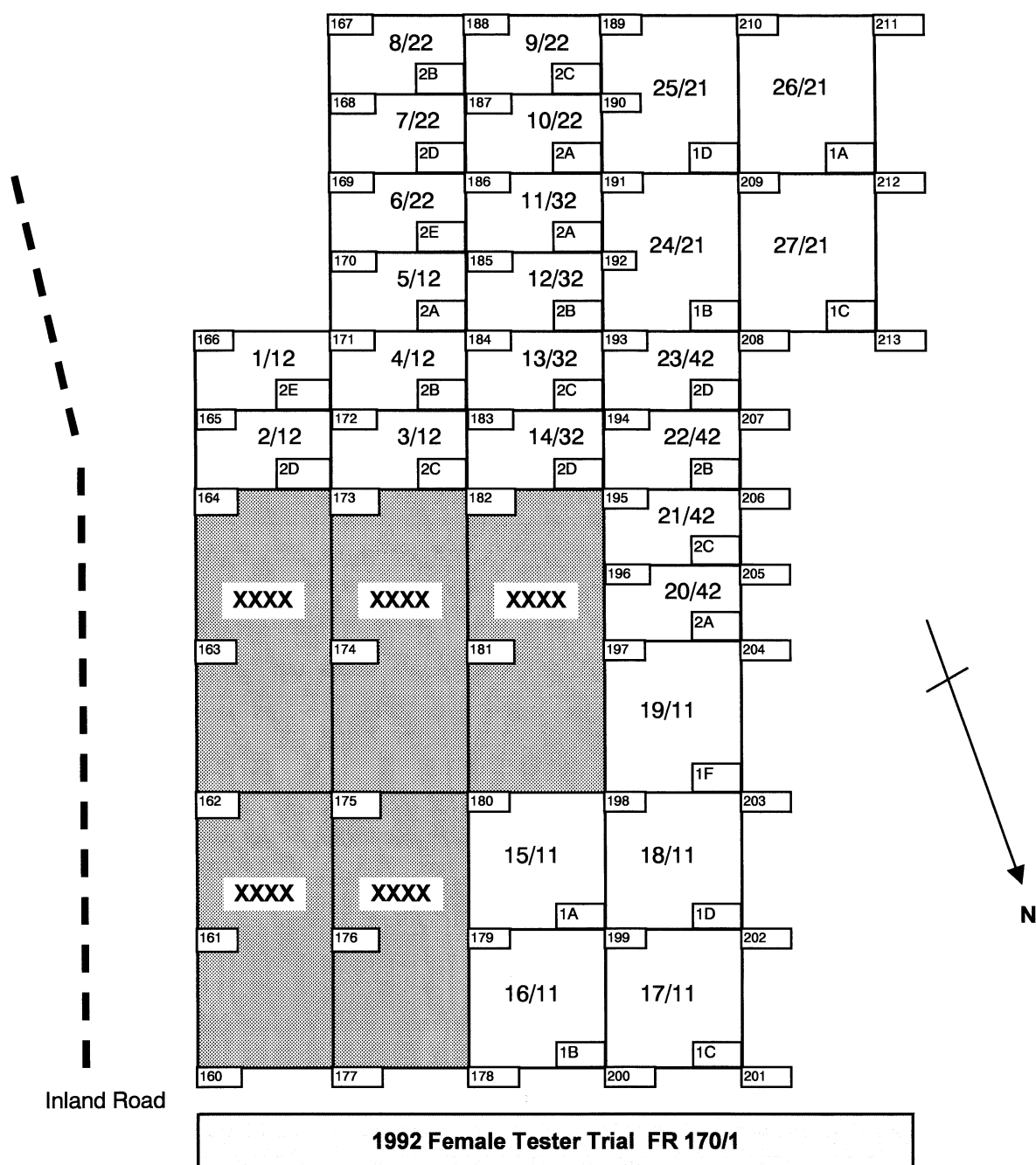
A summary (Table 10a) at the time of the first measurement in February 2001 (age 8.9 years), shows data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. Means by replication are shown in Table 10b. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The average DOS at this site is 22.7cm and the average maximum branch diameter is 3.2cm.

The following trends were noted:

- The average maximum branch diameter is largest in the GF14 seedlot (3.7cm) and smallest in the GF27, highly multinodal, seedlot (3.0cm)
- The GF14 seedlot is performing best on average for both diameter and height growth within the treatment 2 (thinned) plots
- The long internode seedlot (GF13) has the smallest growth on average for both diameter and height in the thinned plots
- The unthinned plots (500sph) where there has been mortality at an early age reducing stocking to < 300sph, are performing best for diameter growth
- The unthinned GF7 plot is performing well for height growth and on average is the largest for diameter and height growth in the unthinned plots

FIGURE 1. Map showing plot locations, FR 172/1



TREATMENT

1 = 500 stems/ha unthinned, unpruned
2 = 1000 - 400 stems/ha thinned, pruned

Plotno/Subplot = plotno/rep|treatment
1C = Treatment/Seedlot

XXXX = PSP Plots not established

SEEDLOT

A = GF27, Highly multinodal
B = GF13 (LI25), Long Internode
C = GF18, High wood density
D = GF28, Low wood density
E = GF14, Gwavas seed orchard
F = GF7, Climbing select

TABLE 10a. FR 172/1: Trial data at the first measurement (age 8.9 years)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	MnCRHT	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	500	360	20.9	12.2	12.4	61.2	0.3				
1	89/15(LI)	13	500	280	22.3	11.1	10.9	51.9	0.3				
1	89/15(LI)	13	500	500	16.6	9.6	10.8	43.9	0.3				
1	91/523	18	500	360	18.4	10.8	9.6	44.4	0.3				
1	91/523	18	500	440	16.7	10.3	9.6	41.9	0.3				
1	91/296-297	27	500	460	22.0	12.1	17.5	87.4	0.3				
1	91/296-297	27	500	380	17.5	10.1	9.2	40.5	0.3				
1	91/294	28	500	240	23.5	11.4	10.4	51.1	0.3				
1	91/294	28	500	460	17.8	10.6	11.5	50.0	0.3				
2	89/15(LI)	13	1000	408	17.7	12.8	10.1	50.9	2.2	2.1	21.5	0.8	3.0
2	89/15(LI)	13	1000	408	16.8	11.9	9.0	43.4	1.9	2.0	20.9	0.9	2.7
2	89/15(LI)	13	1000	408	17.7	11.5	10.0	46.5	2.1	2.1	22.8	0.8	3.3
2	89/15(LI)	13	1000	408	16.4	12.0	8.6	40.9	2.1	2.2	21.1	0.8	3.7
2	88/105	14	1000	408	22.2	13.7	15.8	86.4	2.4	2.3	25.8	0.9	3.9
2	88/105	14	1000	408	18.7	12.4	11.2	55.9	2.1	2.0	21.4	0.9	3.5
2	91/523	18	1000	408	19.7	13.5	12.4	66.1	2.1	2.1	23.9	0.9	3.0
2	91/523	18	1000	408	16.5	10.8	8.7	38.4	2.1	2.1	21.4	0.8	3.2
2	91/523	18	1000	408	17.5	11.8	9.8	46.3	2.1	2.1	22.0	0.9	3.1
2	91/523	18	1000	408	18.1	12.2	10.6	51.5	2.0	2.1	22.7	0.7	2.9
2	91/296-297	27	1000	408	20.3	12.8	13.2	67.6	2.2	2.2	24.9	0.9	2.7
2	91/296-297	27	1000	408	16.6	11.5	8.8	40.7	2.1	2.2	20.5	0.9	3.0
2	91/296-297	27	1000	408	19.1	12.2	11.7	57.5	2.1	2.0	23.5	0.9	3.3
2	91/296-297	27	1000	408	19.9	12.4	12.7	63.4	2.1	2.0	24.2	1.0	3.0
2	91/294	28	1000	408	21.5	12.9	14.8	76.7	2.1	2.1	26.8	0.8	3.4
2	91/294	28	1000	408	19.0	12.6	11.6	58.3	1.9	1.9	22.4	0.9	3.0
2	91/294	28	1000	408	17.0	12.1	9.3	45.2	2.1	2.1	20.9	0.9	2.6
2	91/294	28	1000	408	17.5	11.3	9.9	45.1	2.2	2.2	22.4	0.8	3.4

TABLE 10b. FR 172/1: Trial data averaged by treatment and seedlot replication (age 8.9 years)

Trt	Seedlot	GF rating	No. of reps	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	1	20.9	12.2	12.4	61.2				
1	89/15(LI)	13	2	19.5	10.4	10.8	47.9				
1	91/523	18	2	17.6	10.6	9.6	43.2				
1	91/296-297	27	2	19.8	11.1	13.4	64.0				
1	91/294	28	2	20.7	11.0	10.9	50.6				
2	89/15(LI)	13	4	17.2	12.1	9.4	45.4	2.1	21.6	0.8	3.2
2	88/105	14	2	20.5	13.1	13.5	71.2	2.2	23.6	0.9	3.7
2	91/523	18	4	18.0	12.1	10.4	50.6	2.1	22.5	0.8	3.1
2	91/296-297	27	4	19.0	12.2	11.6	57.3	2.1	23.3	0.9	3.0
2	91/294	28	4	18.8	12.2	11.4	56.3	2.1	23.1	0.9	3.1

FR 172/2, RIVERHEAD Forest, Auckland Clays

This trial was planted in July 1992 with 18 rectangular 45 x 18m plots, 9 rectangular 45 x 36m plots and 5 rectangular 45 x 72m plots (a total of 32 plots). The total trial area occupies 4.54 hectares.

This site was assessed in 1997 (age 5) with the average height being 4-6m depending on seedlot. By this time there were major problems with gorse growth up to 2m. It was agreed that the difficulties of establishing plots and the probable suppression of growth due to the gorse infestation did not justify the costly exercise of establishing and remeasuring PSPs.

Trial Layout and Site Information

This trial was abandoned, before plot establishment, in 1999.

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

Soil Type:	Clay
Site Preparation:	Ripped to 70cm and 4m intervals, oversown with grasses and maku
Weeds:	Gorse
Regeneration:	None
Slope:	0-5°
Aspect:	West
Previous land use:	Radiata pine plantation
Site:	Highly fertile

FR 172/3, KAINGAROA Forest, Central North Island

This trial was planted in July 1992 with 18 rectangular 45 x 18m plots, 9 rectangular 45 x 36m plots and 5 rectangular 45 x 72m plots (a total of 32 plots). The total trial area occupies 4.53 hectares.

Pruning, PSP establishment and thinning was carried out (as per the basic field procedures) during November 1999 (age 7.5 years). A total of 27 plots were established - the 5 plots planted at 250sph were not included in the trial design. The trial MCH after thinning, at the time of plot establishment, was 10.3m with a range of 8.2m to 11.6m.

Trial Design

This trial was re-designed before plot establishment (see section on 'experimental design'). It now consists of two silvicultural treatments and six different seedlots (all seedlings), with two replications for treatment 1 and four replications for treatment 2 (Table 11).

TABLE 11. Trial design for FR 172/3 Kaingaroa Forest

Silviculture					Planting stock					
Trt	Pruning	Stocking (stems/ha)		Thinning	Seedlings					
	Access only	Initial	Final	Ratio	GF7 (88/102)	GF14 (88/105)	GF18* (91/523)	GF27* (91/296- 297)	GF28* (91/294)	GF13 (LI25) (89/15)
1	unpruned	500	500	1:1	•		••	••	••	••
2	2m	1000	400	2.5:1		••	••••	••••	••••	••••

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

* only a small number of parents have contributed, thus less confidence should be placed on the GF rating

Pruning

Pruning of the 18 plots was carried out by Fletcher Challenge Forest contractors (a total of 8 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 8.7m (mean pruned height was 2.1m). 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 Establishment

Twenty-seven permanent sample plots were established by six **Forest Research** field crew beginning on 11 November 1999. Plot establishment was carried out over 3 days (a total of 19 mandays). Table 7 shows the plot establishment requirements for each of the treatments (nos. 1 & 2). There were problems working out tree positions in this trial as the trees had not been planted in very straight rows, consequently plot establishment took longer than expected. All trees are now identified correctly.

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

Thinning

Thinning was carried out, two weeks after plot establishment, by Fletcher Challenge Forest contractors on 25 November 1999 (2 mandays). Eighteen of the 27 plots were thinned, as scheduled, from 1000 to 400 sph.

Most thinned plots had a significant number of dead trees, but the prescribed stocking was achieved in all plots, although much fewer trees were actually felled. A few trees in the trial area had been felled in 1998 for experimental purposes. Only one plot tree was affected – tree 14 in plot 11/21.

Trial Layout and Site Information

All of the twenty-seven plots in the new plot design were established as PSPs at this site (see map, Figure 2). The five plots planted at 250sph were abandoned as per the re-design. The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 3, 5 & 7.

The following information was recorded at the time of planting:

Altitude:	450m
Soil Type:	Black scoria (Tarawera Ash)
Site Preparation:	Tordon/Escort pre-planting and oversowing with Lotus
Weeds:	Grass, toitoi and buddleia
Regeneration:	Nil
Slope:	5-20°
Aspect:	Various (generally north)
Previous land use:	Radiata pine plantation
Site:	Medium fertility, ex forest site

Most plots suffered some mortality, although all the thinned plots are at the prescribed stocking of 400sph. Six of the nine unthinned have suffered more than 20% mortality. The trees that remain in the trial are of good size and form. This trial has not had a problem with regeneration.

Plot data

A summary (Table 12a) at the time of the latest winter measurement in April 2001 (age 9 years) shows data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. Means by replication are shown in Table 12b. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The average DOS at this site is 22.6cm and the average maximum branch diameter is 2.6cm.

The following trends were noted:

- The average maximum branch diameter is largest in the long internode seedlot (3.0cm)
- The GF27 seedlot is performing very well for diameter growth in all treatment 2 (thinned) plots. The average (26.0cm) is substantially larger than all other seedlots
- The GF18 seedlot has the tallest trees in the thinned treatment (14.5m on average)
- In the unthinned plots, the GF7 and long internode seedlots are performing well for height growth
- Diameter growth is reasonably consistent within seedlot replications for the thinned treatment plots.

FIGURE 2. Map showing plot locations, FR 172/3

SEEDLOT

A = GF27, Highly multinodal
 B = GF13 (LI25), Long Internode
 C = GF18, High wood density
 D = GF28, Low wood density
 E = GF14, Gwavas seed orchard
 F = GF7, Climbing select

TREATMENT

1 = 500 stems/ha unthinned, unpruned
 2 = 1000 - 400 stems/ha thinned, pruned

XXXX = PSP Plot not established

Plotno/Subplot = plotno/rep|treatment

1C = Treatment/Seedlot

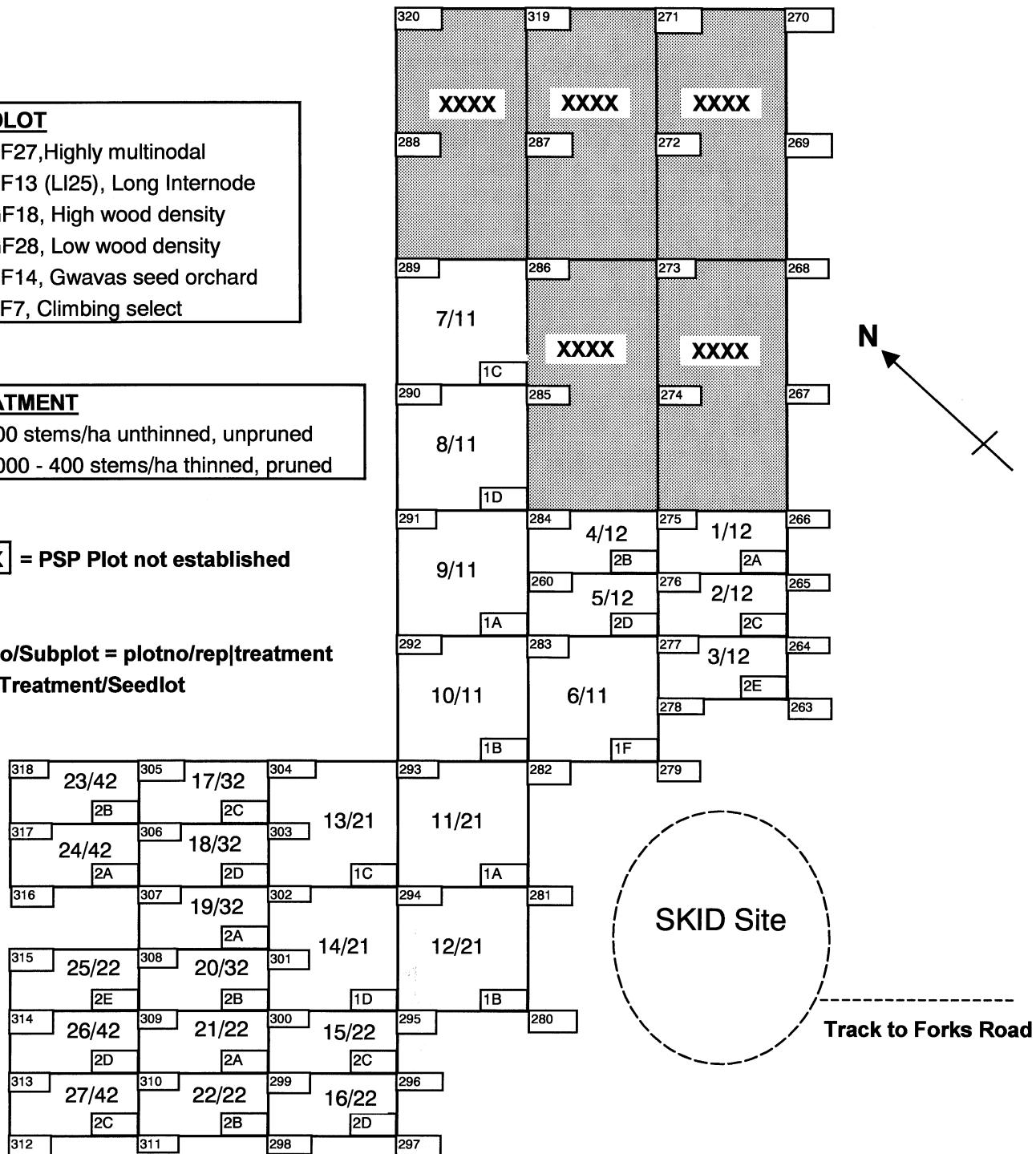


TABLE 12a. FR 172/3: Trial data at the latest winter measurement (age 9.0 years)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	500	400	21.8	13.8	15.0	75.8	2.2				
1	89/15(LI)	13	500	380	21.9	13.1	14.3	67.4	1.8				
1	89/15(LI)	13	500	480	24.9	14.7	23.3	119.5	2.4				
1	91/523	18	500	440	18.9	12.0	12.3	55.4	1.7				
1	91/523	18	500	500	21.6	13.8	18.3	93.1	2.2				
1	91/296-297	27	500	380	23.9	12.9	17.0	80.7	2.8				
1	91/296-297	27	500	420	23.2	13.5	17.8	86.1	2.3				
1	91/294	28	500	380	20.4	12.7	12.4	58.5	2.1				
1	91/294	28	500	400	23.3	13.1	17.1	82.2	2.2				
2	89/15(LI)	13	1000	408	20.9	13.2	14.0	70.0	2.0	2.0	20.1	0.6	2.7
2	89/15(LI)	13	1000	408	23.4	13.9	17.5	90.1	2.0	2.0	22.3	0.8	2.9
2	89/15(LI)	13	1000	408	23.7	13.7	18.0	91.2	2.1	2.0	23.0	0.7	3.6
2	89/15(LI)	13	1000	408	22.3	13.3	16.0	81.0	2.1	2.0	21.1	0.7	2.9
2	88/105	14	1000	408	23.0	13.5	17.0	84.9	2.1	2.1	20.4	0.7	2.5
2	88/105	14	1000	408	24.7	14.5	19.6	104.9	2.1	2.1	22.5	0.7	2.2
2	91/523	18	1000	388	24.1	14.5	17.8	91.1	2.1	2.1	22.6	0.7	2.5
2	91/523	18	1000	388	24.5	14.4	18.2	94.8	2.1	2.1	22.3	0.6	1.9
2	91/523	18	1000	408	23.9	14.6	18.2	96.8	2.1	2.1	21.9	0.9	2.5
2	91/523	18	1000	408	23.5	14.4	17.7	94.4	2.2	2.2	23.4	0.8	3.0
2	91/296-297	27	1000	408	25.3	14.9	20.5	107.8	2.1	2.1	22.8	0.7	1.9
2	91/296-297	27	1000	408	26.3	14.0	22.2	110.3	2.0	2.0	24.7	0.8	2.9
2	91/296-297	27	1000	408	27.5	14.4	24.3	122.0	1.9	2.0	24.8	0.9	2.3
2	91/296-297	27	1000	408	24.9	13.3	19.8	95.7	2.1	2.1	22.9	0.9	2.9
2	91/294	28	1000	408	24.3	14.2	19.0	97.6	2.1	2.1	22.3	0.5	1.7
2	91/294	28	1000	408	23.1	14.0	17.2	91.7	2.1	2.1	24.6	0.6	2.2
2	91/294	28	1000	408	23.5	14.0	17.7	91.6	2.1	2.1	22	0.8	2.6
2	91/294	28	1000	408	23.6	14.1	17.8	92.6	2.1	2.1	22.9	0.8	2.9

TABLE 12b. FR 172/3: Trial data averaged by treatment and seedlot replication (age 9.0 years)

Trt	Seedlot	GF rating	No. of reps	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	1	21.8	13.8	15.0	75.8				
1	89/15(LI)	13	2	23.4	13.9	18.8	93.5				
1	91/523	18	2	20.3	12.9	15.3	74.3				
1	91/296-297	27	2	23.6	13.2	17.4	83.4				
1	91/294	28	2	21.9	12.9	14.7	70.4				
2	89/15(LI)	13	4	22.6	13.5	16.4	83.1	2.0	21.6	0.7	3.0
2	88/105	14	2	23.9	14.0	18.3	94.9	2.1	21.5	0.7	2.4
2	91/523	18	4	24.0	14.5	18.0	94.3	2.1	22.6	0.8	2.5
2	91/296-297	27	4	26.0	14.2	21.7	109.0	2.1	23.8	0.8	2.5
2	91/294	28	4	23.6	14.1	17.9	93.4	2.1	23.0	0.7	2.4

FR 172/4, KINLEITH Forest, Central North Island

This trial was planted in July 1992 with 18 rectangular 45 x 18m plots, 9 rectangular 45 x 36m plots and 5 rectangular 45 x 72m plots (a total of 32 plots). The total trial area occupies 4.54 hectares.

Pruning, PSP establishment and thinning was carried out (as per the basic field procedures) during December 1999 (age 7.6 years). A total of 27 plots were established - the 5 plots planted at 250sph were not included in the trial design. The trial MCH at the time of plot establishment after thinning was 10.0m with a range of 7.8m to 11.3m.

Trial Design

This trial was re-designed before plot establishment (see section on 'experimental design'). It now consists two silvicultural treatments and six different seedlots (all seedlings), with two replications for treatment 1 and four replications for treatment 2 (Table 13).

TABLE 13. Trial design for FR 172/4 Kinleith Forest

Silviculture					Planting stock					
Trt	Pruning	Stocking (stems/ha)		Thinning	Seedlings					
	Access only	Initial	Final	Ratio	GF7 (88/102)	GF14 (88/105)	GF18* (91/523)	GF27* (91/296- 297)	GF28* (91/294)	GF13 (LI25) (89/15)
1	unpruned	500	500	1:1	•		••	••	••	••
2	2m	1000	400	2.5:1		••	••••	••••	••••	••••

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

* only a small number of parents have contributed, thus less confidence should be placed on the GF rating

Pruning

Pruning of 18 plots was carried out by Carter Holt Harvey Forests contractors (a total of 8 mandays help). The average crown length remaining after pruning was 7.7m (mean pruned height 2.2m). 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 Establishment

Twenty-seven permanent sample plots were established by five **Forest Research** staff, between 7-9 December 1999 (a total of 18 mandays). Table 7 shows the plot establishment requirements for each of the assigned treatments (nos. 1 & 2). Plot establishment would have been a major task had it not been for 'in kind' help from Carter Holt Harvey Forests contractors, who spent almost 5 manweeks slashing tracks through the thick blackberry in the week prior to plot establishment. Movement around this trial is still slower than normal.

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

Thinning

Thinning was carried out by Carter Holt Harvey Forests contractors during the week following plot establishment (3 mandays). Eighteen of the 27 plots were thinned, as scheduled, from 1000 to 400sph. The whole trial was regen treated (all regenerated trees were thinned out) at the same time as the prescribed thinning.

Trial Layout and Site Information

All twenty-seven plots in the new plot design were established as PSPs at this site (see map, Figure 3). The five plots planted at 250sph were abandoned as per the re-design. The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 3, 5 & 7.

Due to a major problem with blackberry growth in this trial help was required to gain access to the trees. All treatment 1 plots were bulldozer crushed early in 1999 to allow access for **Forest Research** staff for form assessments. In addition to this all treatment 2 plots were line slashed just prior to PSP establishment to allow access to each individual tree for tagging and DBH measurements.

The following information was recorded at the time of planting:

Altitude:	380m
Soil Type:	unknown
Site Preparation:	Nil
Weeds:	Buddleia
Regeneration:	Yes
Slope:	3-14°
Aspect:	Various (often easterly)
Previous land use:	Radiata pine plantation (2 rotations)
Site:	High fertility, ex forest site

All plots suffered some mortality, although all the thinned plots are at the prescribed stocking of 400sph. Only one of the nine unthinned plots suffered more than 20% mortality though. The trees that remain in the trial are generally of good form and health.

Plot data

A summary (Table 14a) at the time of the latest winter measurement in May 2000 (age 8 years) shows data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. Means by replication are shown in Table 14b. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The average DOS at this site is 20.5cm and the average maximum branch diameter is 2.7cm.

The following trends were noted:

- The average maximum branch diameter is largest in the long internode seedlot (3.0cm) and smallest in the GF27, highly multinodal, seedlot (2.5cm)
- The GF28 seedlot is performing best on average for both diameter and height growth within treatment 1 (unthinned)
- The tallest average height in treatment 2 (thinned) is the GF18 seedlot, and the largest average diameter the GF27 seedlot
- Plot 8/22, (LI seedlot, treatment 2) has noticeably slower growth for both diameter and height than any other plot in the trial.

FIGURE 3 Map showing plot locations, FR 172/4

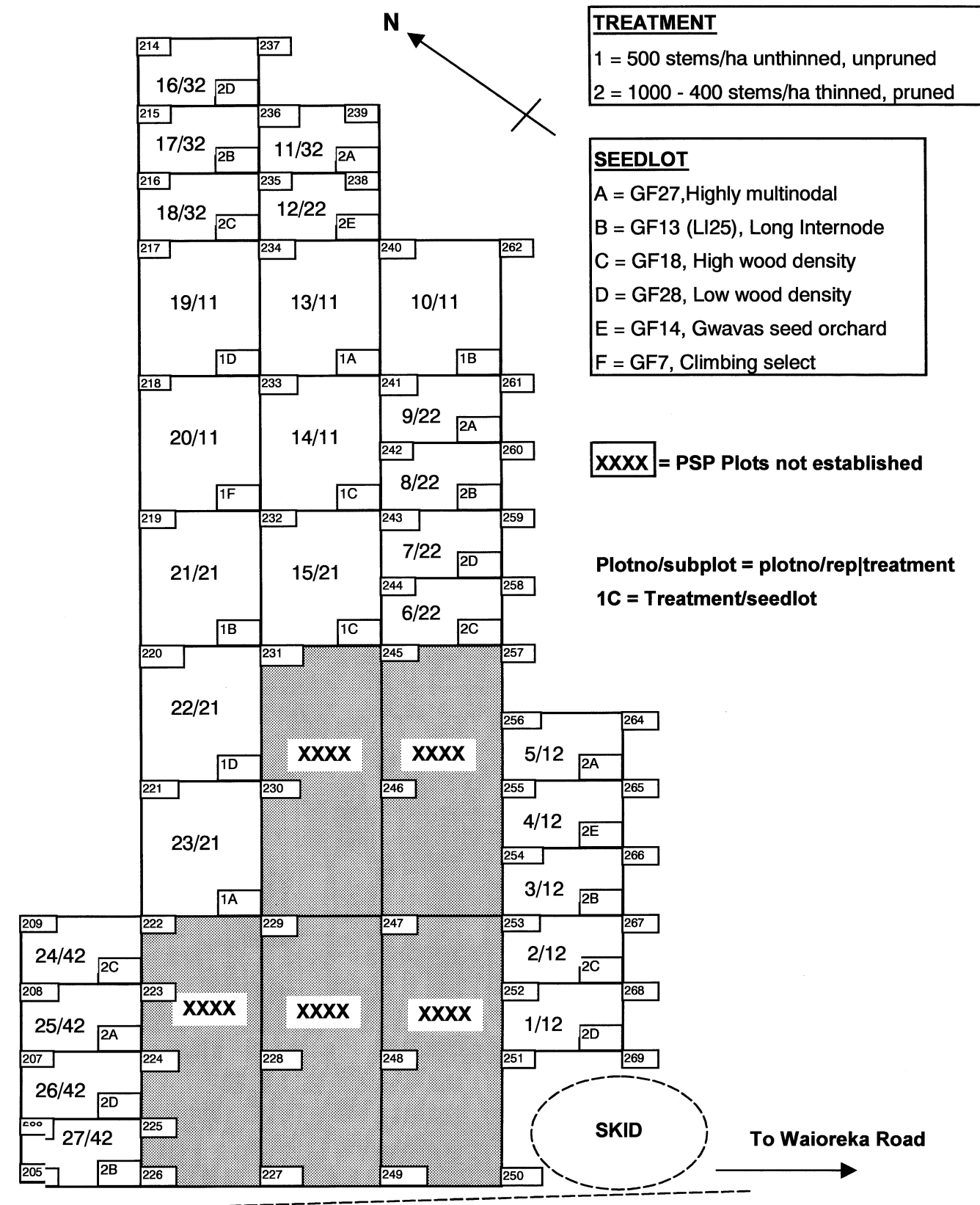


TABLE 14a. FR 172/4: Trial data at the latest winter measurement (age 8.0 years)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	500	440	18.8	10.5	12.2	59.5	2.4				
1	89/15(LI)	13	500	420	19.0	11.0	11.9	58.8	2.6				
1	89/15(LI)	13	500	460	19.7	11.5	14.0	73.1	2.3				
1	91/523	18	500	420	18.0	10.4	10.7	53.0	2.8				
1	91/523	18	500	460	20.8	11.0	15.7	76.9	2.8				
1	91/296-297	27	500	380	21.4	11.4	13.7	68.2	2.0				
1	91/296-297	27	500	360	18.5	9.6	9.7	43.9	1.6				
1	91/294	28	500	480	19.2	11.2	13.9	70.6	2.1				
1	91/294	28	500	460	22.3	12.1	17.9	97.0	2.7				
2	89/15(LI)	13	1000	408	18.4	10.4	10.9	52.9	2.1	2.2	19.8	1.3	2.9
2	89/15(LI)	13	1000	408	13.7	8.3	6.0	27.3	2.4	2.2	15.5	1.1	2.5
2	89/15(LI)	13	1000	408	18.9	11.3	11.5	58.6	2.3	2.3	20.9	1.1	3.1
2	89/15(LI)	13	1000	408	18.3	10.2	10.7	50.6	2.4	2.3	20.7	1.0	3.3
2	88/105	14	1000	408	19.4	11.5	12.1	61.5	2.2	2.2	21.2	1.3	3.0
2	88/105	14	1000	408	17.0	9.9	9.3	44.3	2.3	2.3	18.1	1.2	2.5
2	91/523	18	1000	408	18.4	11.8	10.9	57.6	2.2	2.2	20.6	1.3	2.8
2	91/523	18	1000	408	19.3	11.1	11.9	59.5	2.1	2.1	21.8	1.3	3.0
2	91/523	18	1000	408	18.7	11.8	11.2	59.4	2.3	2.3	20.1	1.0	2.2
2	91/523	18	1000	408	19.6	11.4	12.3	62.9	2.4	2.4	21.1	1.4	2.6
2	91/296-297	27	1000	408	21.0	11.4	14.1	70.7	2.4	2.2	23.5	1.2	2.7
2	91/296-297	27	1000	408	18.6	10.5	11.1	53.4	2.6	2.3	20.3	1.1	2.1
2	91/296-297	27	1000	408	18.1	9.8	10.4	48.1	2.1	2.1	19.5	1.3	2.6
2	91/296-297	27	1000	388	22.4	11.2	15.3	73.4	2.3	2.3	23.8	1.2	2.6
2	91/294	28	1000	408	19.2	10.7	11.9	58.9	2.2	2.1	21.3	1.2	3.6
2	91/294	28	1000	408	18.6	11.1	11.1	57.3	2.2	2.2	19.9	1.1	2.6
2	91/294	28	1000	408	17.9	10.9	10.3	51.4	2.3	2.2	19.4	1.0	2.4
2	91/294	28	1000	408	19.8	10.7	12.5	60.3	2.2	2.3	20.8	1.0	2.4

TABLE 14b. FR 172/4: Trial data averaged by treatment and seedlot replication (age 8.0 years)

Trt	Seedlot	GF rating	No. of reps	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	1	18.8	10.5	12.2	59.5	2.4				
1	89/15(LI)	13	2	19.4	11.3	13.0	66.0	2.5				
1	91/523	18	2	19.4	10.7	13.2	65.0	2.8				
1	91/296- 297	27	2	20.0	10.5	11.7	56.1	1.8				
1	91/294	28	2	20.8	11.7	15.9	83.8	2.4				
2	89/15(LI)	13	4	17.3	10.1	9.8	47.4	2.3	2.3	19.2	1.1	3.0
2	88/105	14	2	18.2	10.7	10.7	52.9	2.3	2.3	19.7	1.3	2.8
2	91/523	18	4	19.0	11.5	11.6	59.9	2.3	2.3	20.9	1.3	2.7
2	91/296- 297	27	4	20.0	10.7	12.7	61.4	2.4	2.2	21.8	1.2	2.5
2	91/294	28	4	18.9	10.9	11.5	57.0	2.2	2.2	20.4	1.1	2.8

FR 172/5, TAKITOA Forest, Southland

This trial was planted in July 1992 with 26 rectangular 45 x 18m plots and 14 rectangular 45 x 36m plots (a total of 40 plots). The total trial area occupies 4.37 hectares.

Pruning, PSP establishment and thinning was carried out (as per the basic field procedures) during February 2000 (age 7.8 years). A total of 35 plots were established. Five other plots included by request of the forest owner at time of planting were not established. The trial MCH at the time of plot establishment after thinning was 9.6m with a range of 8.5 to 10.7m.

Trial Design

This trial was re-designed before plot establishment (see section on 'experimental design'). Some plots were pruned to the original silvicultural prescription, altering the new trial design for this site. There is also one extra plot in the GF14 seedlot and 7 plots with a local GF17 seedlot at this site. The trial consists of three silvicultural treatments and seven different seedlots (6 seedlings, 1 tissue culture) (Table 15).

TABLE 15. Trial design for FR 172/5 Takittoa Forest

Silviculture					Planting stock						
Trt	Pruning	Stocking (stems/ha)		Thinning	Seedlings						Tissue culture
		Initial	Final	Ratio	GF7 (88/102)	GF14 (88/105)	GF18* (91/523)	GF27* (91/296-297)	GF28* (91/294)	GF13 (LI25) (89/15)	GF17 (TeTeko)
1a	unpruned	500	500	1:1			•	•	•	•	••
1b	pruned	500	500	1:1	•	•	•	•	•	•	•
2	2m	1000	400	2.5:1		•• ¹	•••• ¹	•••• ¹	•••• ¹	•••• ¹	•••• ¹

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

¹ One plot in each of these seedlots was pruned early

* only a small number of parents have contributed, thus less confidence should be placed on the GF rating

Pruning

Initial pruning was carried out in 1998 as per the original workplan (Table 2, WP No. 2151) i.e. treatments 2 and 3 (one plot in each seedlot) were pruned to leave 4.5m of green crown (approximately a 2m prune). Six plots in the 1000sph treatment were pruned at this time. The early pruning also resulted in seven of the treatment 1 plots (500sph unthinned, unpruned) being low pruned (now treatment 1b). It was considered that the pruning would not unduly affect the growth data. The remaining 16 plots in the revised treatment 2 (1000 to 400sph and pruned)

were access pruned by City Forests contractors at the time of plot establishment in February 2000 (a total of 4 mandays help). 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 for plots pruned at the time of plot establishment. The average crown length remaining after pruning was 7.7m (mean pruned height 2.2m). Plots that had been pruned early had their prune height recorded as crown height.

PSP Establishment

Thirty-five permanent sample plots were established by three **Forest Research** staff and one City Forests contractor, between 1-3 February 2000 (a total of 17 **Forest Research** mandays + 2 mandays in kind). Table 7 shows the plot establishment requirements for each of the assigned treatments (nos. 1 & 2). There were seven plots (5/11, 6/21, 7/21, 8/11, 9/11, 10/11 & 31/11) in treatment 1 (now 1b), that were pruned in 1998 prior to plot establishment. These plots were left unthinned at 500sph. Six plots (11/12, 12/12, 13/12, 14/12, 15/12 & 32/12) in the thinned and pruned treatment were also pruned in 1998, prior to plot establishment.

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

Thinning

Thinning was carried out by City Forests contractors during the last day of plot establishment (2 mandays). Twenty-two of the 35 plots were thinned, as scheduled, from 1000 to 400sph. A few of the badly windthrown trees in the unthinned treatment were also cut out at the same time.

Trial Layout and Site Information

A total of thirty-five plots 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 3, 5 & 7 although some plots received early pruning treatments. At the time of plot establishment in 2000, half the plots in treatment 1 were pruned, contrary to the new trial design (Table 15, treatment 1b). Also six plots in treatment 2 were pruned early.

This trial was planted with several 'extra' plots. Seven plots were planted with tissue culture plants from Te Teko – PSPs were established in this seedlot. Five plots planted were not included in the revised design: plots designated as Hps and Hpm were planted as investigative plots to monitor the effects of planting in rips and were not established as PSPs; plots designated as seedlot code G had an unknown GF rating and were also not considered for PSPs.

Exposure is a problem in this trial particularly with planting into the ripped lines. In 1994 most trees were staked, which helped reduce mortality at this trial, but many trees were badly effected by wind resulting in a major

problem with butt sweep. Local forest owners believe the tissue culture plants were more wind firm and are performing better than the seedlings. Further toppling occurred during a Cyclone in 1998. There was very little actual mortality in this trial and all the plots thinned to 400sph had the right amount of crop trees selected. Only one of the 13 unthinned plots suffered more than 20% mortality. The trees that remain in the trial are in good health, although form is variable, with branch size larger than other trials in the North island. There is good access and under foot conditions, so trial remeasurements will not be difficult.

The following information was recorded at the time of planting:

Altitude:	50m
Soil Type:	unknown
Site Preparation:	Ripping with 5m centres
Weeds:	Improved pasture (grass)
Regeneration:	None
Slope:	3-18°
Aspect:	Various (mainly westerly)
Previous land use:	Farm pasture
Site:	High basal area, ex forest site

Plot data

A summary (Table 16a) at the time of the first winter measurement in June 2000 (age 8 years), shows data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. Means by replication are shown in Table 16b. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The average DOS at this site is 25.7cm and the average maximum branch diameter is 3.7cm.

The following trends were noted:

- The average maximum branch diameter is largest in the long internode seedlot (4.4cm) and smallest in the GF27 & GF28 seedlots (3.3cm)
- The GF14 seedlot (one plot only) is performing best on average for diameter in both the thinned and unthinned treatments. It is also performing best for height in the unthinned treatment
- The GF28 seedlot is the worst performer on average for diameter in both treatments
- The tissue culture plants (GF17) are performing well in both treatments
- Overall in this trial, there are only small growth differences between all seedlots (80% of plots are between 20 – 22cm diameter)

FIGURE 4 Map showing plot locations, FR 172/5

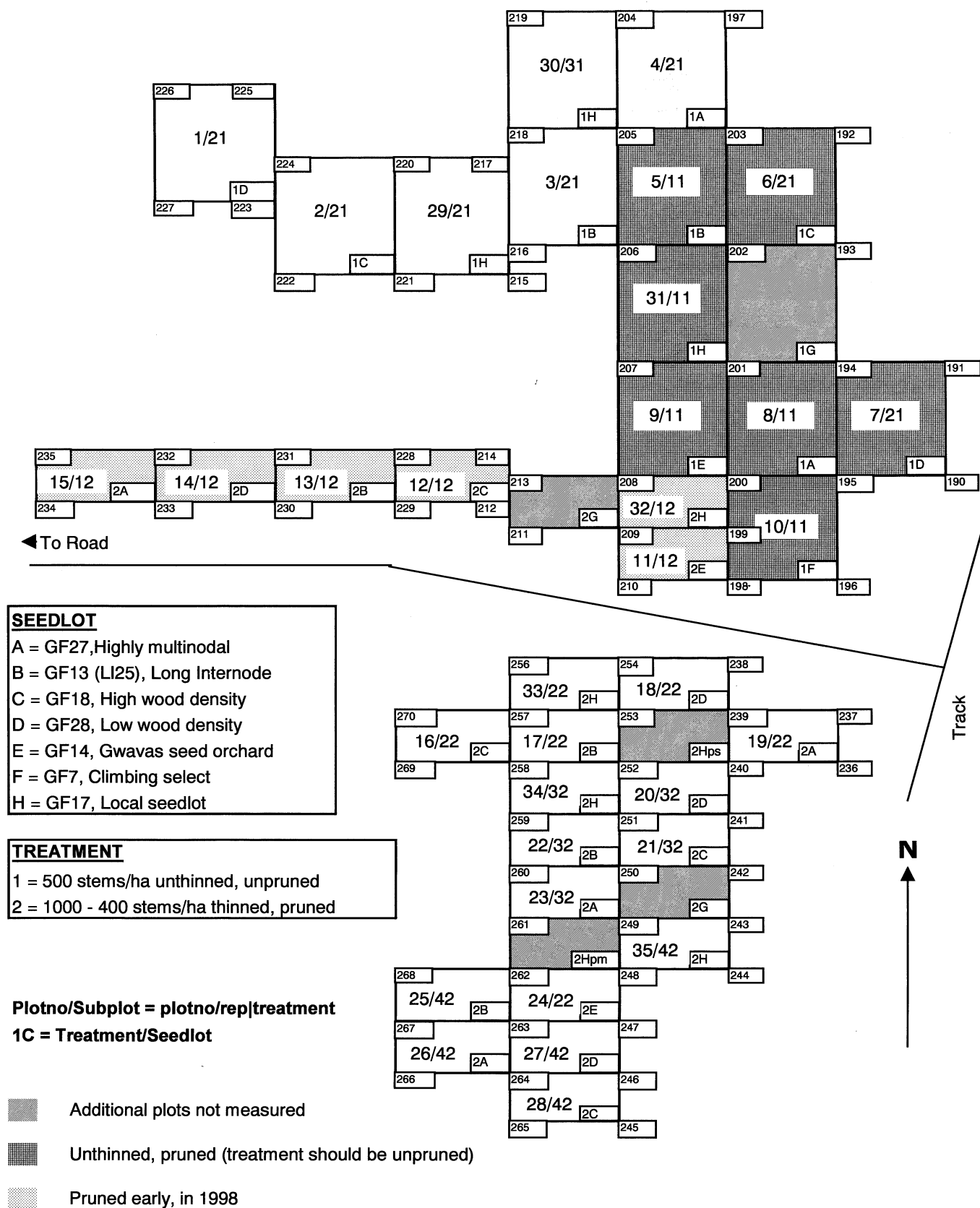


TABLE 16a. FR 172/5: Trial data at the latest winter measurement (age 8.0 years)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	500	460	21.0	9.2	15.9	59.9	1.9				
1	89/15(LI)	13	500	500	22.0	9.2	19.0	69.9	0.5				
1	89/15(LI)	13	500	460	21.6	8.9	16.8	60.3	1.7				
1	88/105	14	500	400	24.0	9.8	18.2	70.2	2.0				
1	91/523	18	500	500	21.0	9.6	17.4	66.4	0.3				
1	91/523	18	500	460	20.8	9.4	15.6	60.4	1.9				
1	91/296-297	27	500	580	19.5	9.2	17.3	64.0	0.2				
1	91/296-297	27	500	400	23.0	9.7	16.6	63.6	2.0				
1	91/294	28	500	500	20.2	9.4	17.3	65.1	0.3				
1	91/294	28	500	440	21.1	8.9	15.4	55.5	1.9				
2	89/15(LI)	13	1000	408	20.8	10.8	13.9	59.9	2.2				
2	89/15(LI)	13	1000	408	20.6	10.1	13.6	54.9	2.2	2.2	26.5	0.7	4.2
2	89/15(LI)	13	1000	408	20.1	9.9	13.0	52.2	2.2	2.2	26.1	0.6	4.6
2	89/15(LI)	13	1000	408	21.3	10.6	14.5	61.2	2.2	2.2	26.7	0.6	4.5
2	88/105	14	1000	408	21.7	10.4	15.1	62.9	2.2				
2	88/105	14	1000	408	21.7	10.5	15.1	62.5	2.1	2.1	26.2	0.6	3.5
2	91/523	18	1000	408	20.5	11.0	13.5	59.4	2.2				
2	91/523	18	1000	408	21.1	10.9	14.2	61.8	2.1	2.1	26.6	0.6	3.9
2	91/523	18	1000	408	20.2	10.6	13.1	55.7	2.2	2.2	25.3	0.4	3.5
2	91/523	18	1000	408	20.5	10.2	13.5	56.1	2.2	2.2	25.4	0.6	4.0
2	91/296-297	27	1000	408	20.3	9.2	13.3	49.5	2.3				
2	91/296-297	27	1000	408	21.9	10.3	15.3	63.0	2.2	2.2	26.6	0.5	3.0
2	91/296-297	27	1000	408	20.9	9.9	14.0	55.7	2.1	2.1	25.7	0.7	3.5
2	91/296-297	27	1000	408	21.9	10.8	15.4	65.6	2.1	2.1	26.9	0.6	3.5
2	91/294	28	1000	408	21.6	11.0	15.0	65.5	2.4				
2	91/294	28	1000	388	19.3	10.6	11.4	48.9	2.4	2.4	22.9	0.6	3.2
2	91/294	28	1000	388	20.1	10.6	12.3	52.1	2.2	2.2	24.7	0.4	3.1
2	91/294	28	1000	408	20.3	10.1	13.2	54.2	2.2	2.2	25.5	0.4	3.6

TABLE 16a. continued

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT	Mn PRHT	DOS	DOS HT	Max Branch
1	TC	17	500	480	23.1	9.5	20.1	77.8	0.3				
1	TC	17	500	460	23.6	10.4	20.2	80.6	0.2				
1	TC	17	500	440	22.0	9.4	16.8	64.7	2.0				
2	TC	17	1000	408	21.5	10.6	14.9	63.3	2.2				
2	TC	17	1000	408	21.1	11.0	14.3	62.6	2.3	2.3	24.9	0.6	3.6
2	TC	17	1000	408	21.2	10.6	14.5	60.9	2.2	2.2	26.3	0.6	3.9
2	TC	17	1000	408	21.2	10.5	14.5	60.2	2.2	2.2	25.9	0.6	4.0

TABLE 16b. FR 172/5: Trial data averaged by treatment and seedlot replication (age 8.0 years)

Trt	Seedlot	GF rating	No. of reps	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	88/102	7	1	21.0	9.2	15.9	59.9				
1	89/15(LI)	13	2	21.8	9.1	17.9	65.1				
1	88/105	14	1	24.0	9.8	18.2	70.2				
1	TC	17	3	22.9	9.8	19.0	74.4				
1	91/523	18	2	20.9	9.5	16.5	63.4				
1	91/296-297	27	2	21.3	9.5	16.9	63.8				
1	91/294	28	2	20.7	9.2	16.4	60.3				
2	89/15(LI)	13	4	20.7	10.4	13.8	57.1	2.2	26.4	0.6	4.4
2	88/105	14	2	21.7	10.5	15.1	62.7	2.2	26.2	0.6	3.5
2	TC	17	4	21.3	10.7	14.5	61.8	2.2	25.7	0.6	3.8
2	91/523	18	4	20.6	10.7	13.6	58.3	2.2	25.8	0.5	3.8
2	91/296-297	27	4	21.3	10.1	14.5	58.5	2.2	26.4	0.6	3.3
2	91/294	28	4	20.3	10.6	13.0	55.2	2.3	24.4	0.5	3.3

FR 172/6, OTAGO COAST Forest, Southland

This trial was planted in July 1992 with 18 rectangular 40 x 20m plots and 10 rectangular 40 x 40m plots (a total of 28 plots). The total trial area occupies 3.07 hectares. Plots were planted at 8X10 trees rather than the standard 9X9 trees.

Pruning, PSP establishment and thinning was carried out (as per the basic field procedures) during February 2000 (age 7.8 years). A total of 25 plots were established. The trial MCH at the time of plot establishment after thinning was 9.1m with a range of 7.9 to 10.0m.

This trial was badly infested with gorse by the time of plot establishment and much discussion regarding the cost of gorse clearance for plot establishment and future gorse control took place in February 2000. It was agreed that the value of the data to be collected was worth the cost of the initial gorse control.

Trial Design

This trial was re-designed before plot establishment (see section on 'experimental design'). Some plots were pruned to the original silvicultural prescription, altering the new trial design for this site. There is also one extra plot in the GF14 seedlot at this site (although the PSP was abandoned). The trial now consists of three silvicultural treatments and six different seedlots (Table 17).

TABLE 17. Trial design for FR 172/6 Otago Coast Forest

Silviculture					Planting stock					
Trt	Pruning	Stocking (stems/ha)		Thinning Ratio	Seedlings					
		Initial	Final		GF7 (88/102)	GF14 (88/105)	GF18* (91/523)	GF27* (91/296- 297)	GF28* (91/294)	GF13 (LI25) (89/15)
1a	Unpruned	500	500	1:1	▲	▲	•	•	•	•▲
1b	Pruned	500	500	1:1			•	•	•	
2	2m	1000	400	2.5:1		•• ¹	•••• ¹	•••• ¹	•••• ¹	•••• ¹

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

Each ▲ represents an abandoned plot.

¹ One plot in each of these seedlots was pruned early

* only a small number of parents have contributed, thus less confidence should be placed on the GF rating

Pruning

Initial pruning was carried out in April 1999 by Wenita Forest Products as per the original workplan (Table 2, WP No. 2151), i.e. treatments 2 and 3 (one plot in each seedlot) were pruned to leave 4.5m of green crown (approximately a 2m prune). Five plots in the 1000sph treatment were pruned at this time, which resulted in 5 of the treatment 2 plots being pruned earlier than the rest of the plots. The early pruning also resulted in three of the treatment 1 plots (500sph unthinned, unpruned) being low pruned (now treatment 1b). It was considered that the pruning would not unduly affect the growth data. The remaining 13 plots in the revised treatment 2 (1000 to 400sph and pruned) were access pruned by Wenita Forest Products contractors at the time of plot establishment in February 2000 (a total of 5.5 mandays help). 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 for plots pruned at the time of plot establishment. The average crown length remaining after pruning was 6.9m (mean pruned height 2.3m). Plots that had been pruned early had their prune height recorded as crown height.

PSP Establishment

Twenty-five of the twenty-eight planted plots were established as permanent sample plots by **Forest Research** staff between 7 - 9 February 2000 (a total of 15 mandays). One person from Wenita Forestry also assisted with the plot establishment (3 mandays). Table 7 shows the plot establishment requirements for each of the assigned treatments (1 and 2). There were three plots in treatment 1 that were pruned and thinned to 200sph in 1999 prior to plot establishment. As this altered the unthinned status these plots were not established as PSPs and were consequently abandoned (Figure 5). There were also three plots (20/21, 21/21 and 22/21) in treatment 1 (now 1b) that were pruned in 1999 prior to plot establishment. These plots remained unthinned.

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

Thinning

Thinning of the 20 plots was carried out by Wenita Forest Products contractors on 9 February 2000 (a total of 2 mandays). All plots were thinned according to the schedule. Unfortunately three of the unthinned plots had to be abandoned due to an accidental thinning (500 – 200sph) in April 1999 during a regeneration removal exercise. Five plots in treatment 2 (1/12, 2/12, 3/12, 4/12 & 5/12) were pruned and thinned to 500sph before plot establishment. Final thinning to 400sph was carried out at the time of plot establishment.

Trial Layout and Site Information

Twenty-five of the twenty-eight plots planted were established as PSPs at this site (see map, Figure 5). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 3, 5 & 7, although some plots received early pruning treatments. At the time of plot establishment in 2000, three plots in treatment 1 were pruned, contrary to the new trial design (Table 15, treatment 1b). Also five plots in treatment 2 were pruned early.

It was noted in 1999 that plots 1B, 1E & 1F were poorly stocked. As these were the plots that were abandoned due to an accidental thin, this will not effect trial results.

As in trial FR172/5, toppling was a major problem resulting in extensive staking of young trees (by 1997 this was reasonably successful). The trial was successfully regeneration thinned prior to 1999, but by 1999, gorse was a major problem (up to 3m high). In the week prior to PSP establishment, Wenita Forestry organised for a bulldozer to crush the gorse between the planted rows. This worked very successfully for the plot establishment and first winter remeasurement, but gorse hindrance may still be a problem in future years of plot remeasurement before crown closure takes effect.

The following information was recorded at the time of planting:

Altitude:	140m
Soil Type:	Kaitangata Hill Soils
Site Preparation:	Windrowing of slash, sprayed Escort/Roundup
Weeds:	None
Regeneration:	Yes
Slope:	range 4-28°
Aspect:	Various (mainly westerly)
Previous land use:	Radiata pine plantation
Site:	Medium fertility, ex forest site

All plots suffered some mortality, although this was very low in the unthinned 500sph plots. All the thinned plots are at the prescribed stocking of 400sph, but in ten of the eighteen plots more than 15% of the trees were removed due to mortality rather than thinning. The trees that remain in the trial are of good size, although branch size is larger (as expected) than the North Island sites.

Plot data

A summary (Table 18a) at the time of the latest winter measurement in June 2000 (age 8.0 years) shows data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. Means by replication are shown in Table 18b. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The average DOS at this site is 23.1cm and the average maximum branch diameter is 3.8cm.

The following trends were noted:

- The average maximum branch diameter is largest in the long internode seedlot (4.3cm) and smallest in the GF28 seedlot (3.4cm)
- The GF27 seedlot is performing best on average for both diameter and height growth within the treatment 1 (unthinned) plots
- In treatment 2 (thinned plots) the GF14 seedlot is performing best for diameter and the GF28 seedlot for height growth.

FIGURE 5. Map showing plot locations, FR 172/6

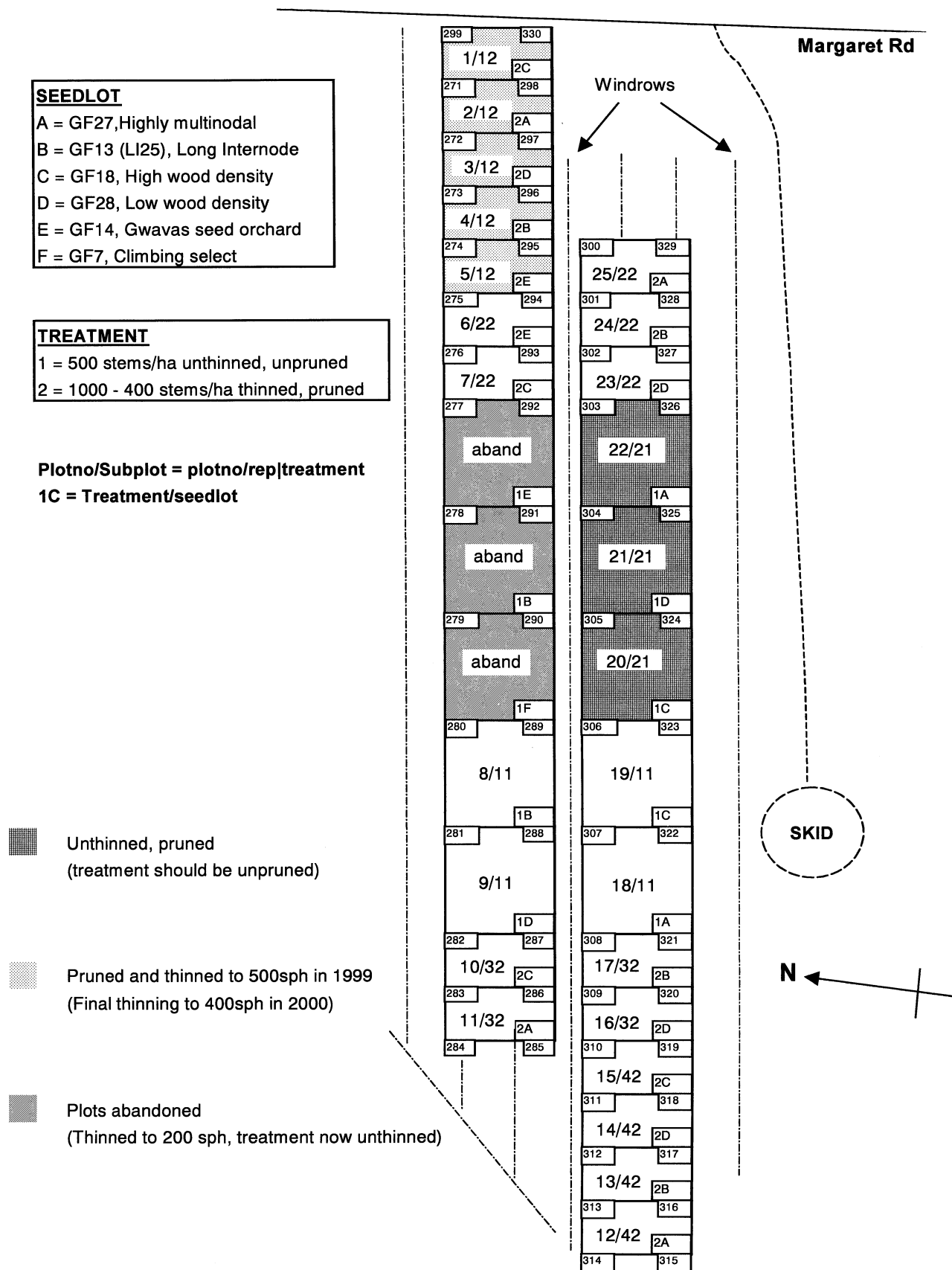


TABLE 18a. FR 172/6 Trial data at the first winter measurement (age 8.0 years)

Trt	Seedlot	GF rating	SPH estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT	Mn PRHT	DOS	DOS HT	Max Branch
1	89/15(LI)	13	500	440	18.4	8.8	11.7	41.4	0.3				
1	91/523	18	500	420	17.6	8.8	10.2	36.9	0.3				
1	91/523	18	500	460	18.7	8.8	12.6	45.4	2.3				
1	91/296-297	27	500	440	21.7	10.0	16.2	62.6	0.3				
1	91/296-297	27	500	440	21.7	9.8	16.3	62.1	2.3				
1	91/294	28	500	380	16.6	8.8	8.3	29.5	0.3				
1	91/294	28	500	460	19.8	10.3	14.2	56.7	2.7				
2	89/15(LI)	13	1000	408	17.9	9.0	10.3	37.8	2.5				
2	89/15(LI)	13	1000	408	18.6	10.1	11.1	44.8	2.3	2.3	24.4	0.7	4.2
2	89/15(LI)	13	1000	429	17.0	9.1	9.8	37.4	2.3	2.3	21.3	1.0	4.2
2	89/15(LI)	13	1000	388	19.9	9.7	12.1	46.1	2.5	2.5	25.2	0.8	4.6
2	88/105	14	1000	408	20.2	9.8	13.1	50.1	2.6				
2	88/105	14	1000	408	19.0	9.2	11.6	43.1	2.4	2.4	24.3	0.8	4.2
2	91/523	18	1000	408	17.6	8.4	9.9	33.8	2.4				
2	91/523	18	1000	408	18.9	9.8	11.4	45.6	2.5	2.5	23.7	0.6	3.6
2	91/523	18	1000	408	16.4	9.1	8.6	32.9	2.3	2.3	21.2	0.8	4.0
2	91/523	18	1000	408	17.2	9.6	9.5	38.2	2.1	2.2	22.0	1.1	3.8
2	91/296-297	27	1000	408	19.5	9.0	12.2	43.8	2.5				
2	91/296-297	27	1000	408	18.0	9.7	10.4	40.5	2.2	2.2	21.6	0.9	3.3
2	91/296-297	27	1000	408	19.4	9.4	12.1	45.4	2.3	2.2	24.6	0.9	3.8
2	91/296-297	27	1000	408	19.9	10.4	12.7	52.1	2.3	2.2	25.3	0.9	3.9
2	91/294	28	1000	408	19.5	9.2	12.2	45.1	2.5				
2	91/294	28	1000	408	18.0	10.2	10.4	41.9	2.4	2.3	22.2	0.7	3.5
2	91/294	28	1000	408	19.8	10.0	12.5	49.7	2.4	2.3	23.7	0.8	3.8
2	91/294	28	1000	408	18.4	10.3	10.9	45.2	2.4	2.3	21.2	1.1	3.0

TABLE 18b. FR 172/6: Trial data averaged by treatment and seedlot replication (age 8.0 years)

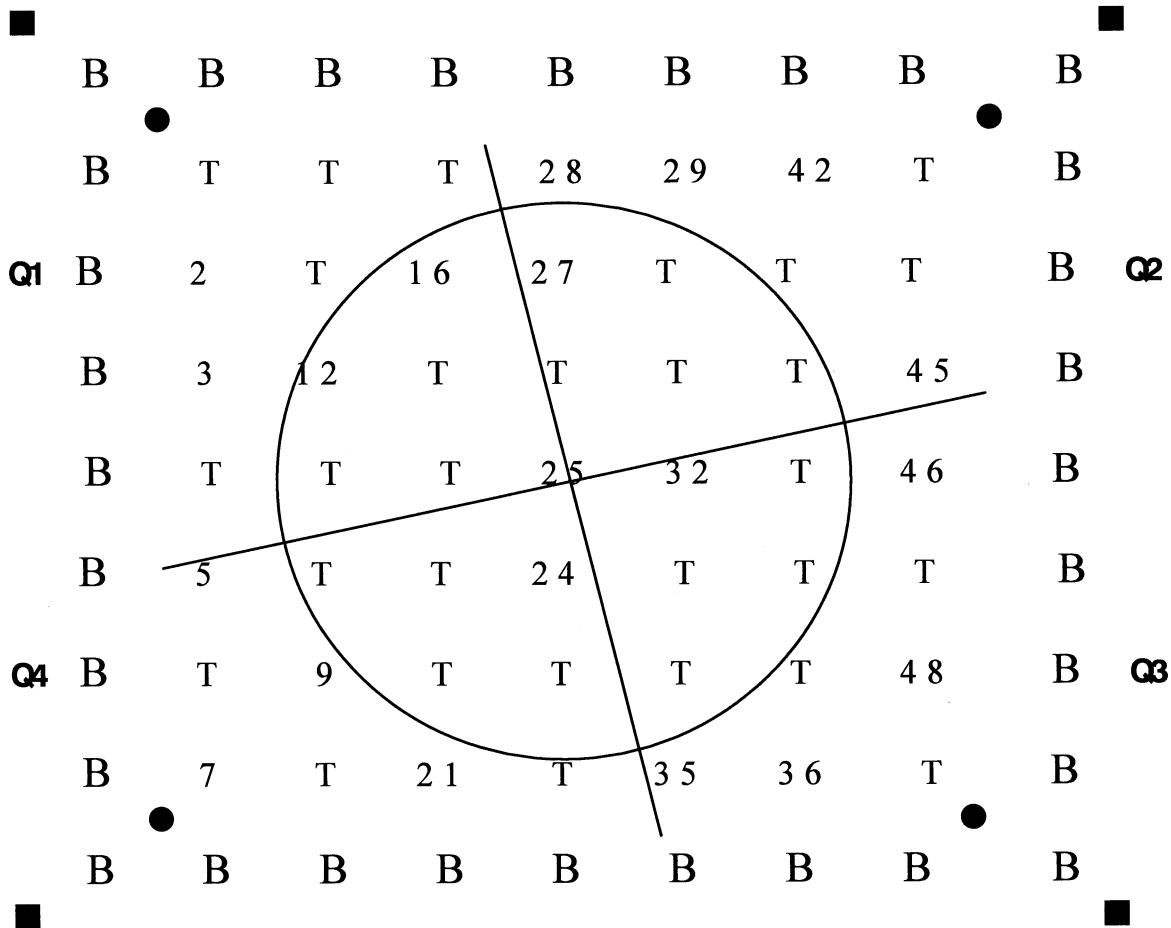
Trt	Seedlot	GF rating	No. of reps	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS HT	Max Branch
1	89/15(LI)	13	1	18.4	8.8	11.7	41.4				
1	91/523	18	2	18.2	8.8	11.4	41.2				
1	91/296-297	27	2	21.7	9.9	16.2	62.4				
1	91/294	28	2	18.2	9.6	11.2	43.1				
2	89/15(LI)	13	4	18.4	9.5	10.8	41.5	2.4	23.6	0.8	4.3
2	88/105	14	2	19.6	9.5	12.3	46.6	2.5	24.3	0.8	4.2
2	91/523	18	4	17.5	9.2	9.9	37.6	2.3	22.3	0.8	3.8
2	91/296-297	27	4	19.2	9.6	11.9	45.5	2.3	23.8	0.9	3.7
2	91/294	28	4	18.9	9.9	11.5	45.5	2.4	22.4	0.9	3.4

Appendix 1

Location of Buffers and Permanent Sample Plots

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

N
↗



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

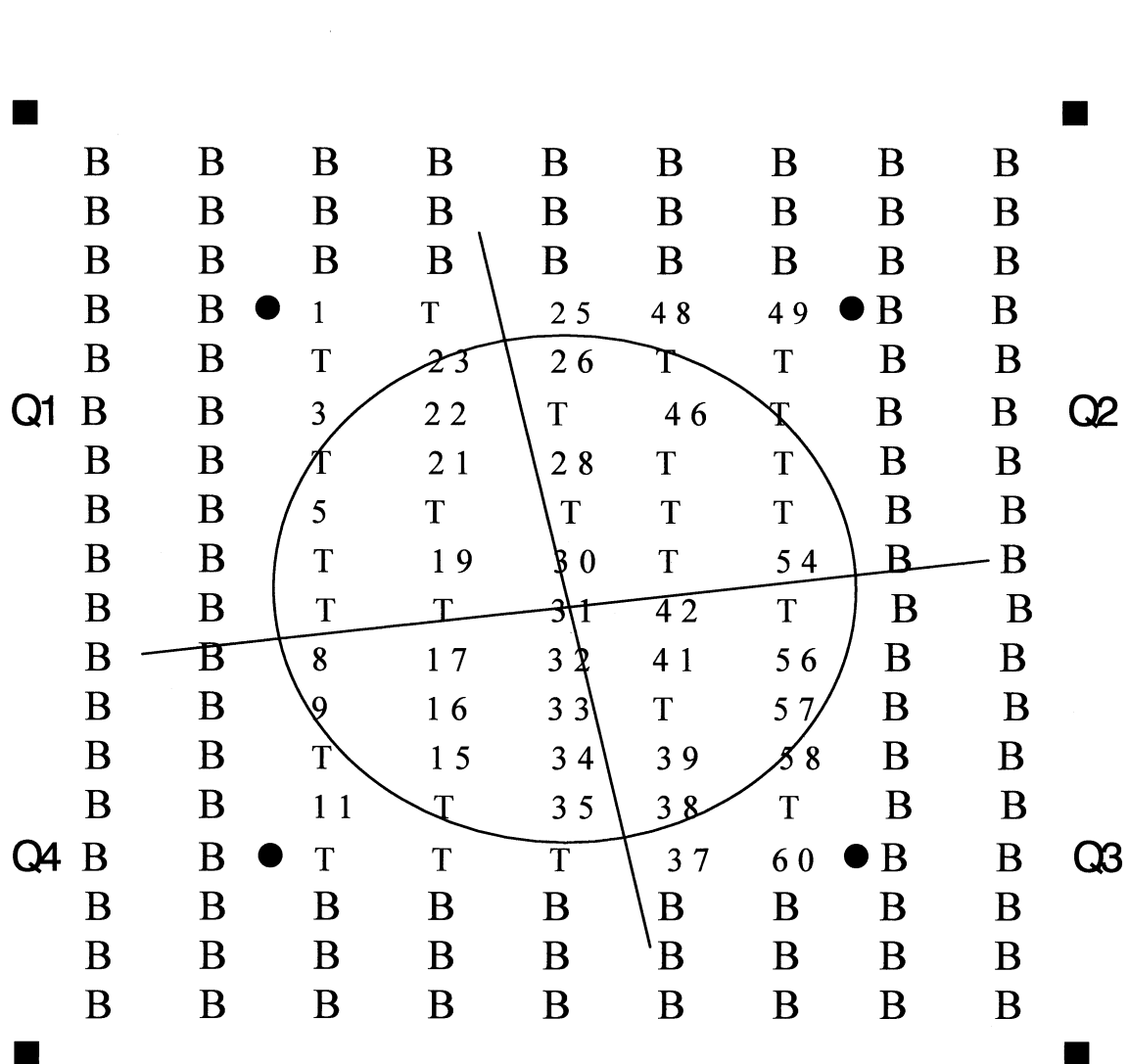


PSP corner peg

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 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 172/2/25/17 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 172/2/25/17 is plot 25 of trial FR 172/2. 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).

REFERENCES

- Carson S.D.; M.J. Carson; P.L. Wilcox; M. Kimberley. 1991. Trials designed to quantify growth and yield gains from genetically improved radiata pine. SGM Cooperative Report No. 24.
- Carson S.D.; O. Garcia; P.L. Wilcox; M. Kimberley. 1994. Genetic gain in radiata pine expressed as growth rate multipliers. SGM Cooperative Report No. 35.
- Carson S.D.; O. Garcia; J.D. Dunlop. 1997. Second estimation of genetic gain multipliers using data from 1978-80 large-block genetic gain trials. SGM Cooperative Report No. 53.
- Carson S.D.; O. Garcia; Judy D. Hayes. 1999. Realised gain and prediction of yield with genetically improved *Pinus radiata* in New Zealand. *Forest Science* 45(2) 1999.
- Dunlop J.D. 1995. Permanent sample plot system - User Manual. **Forest Research** Bulletin No. 187.
- Dunlop, J.D.; S.D. Carson. 1995. Trials designed to quantify growth and yield gains from genetically improved radiata pine - 2nd Revision. SGM Cooperative Report No. 40.
- Ellis J.C.; J.D. Hayes. 1997. Field Guide for Sample Plots in New Zealand Forests. **Forest Research** Bulletin No. 186.
- Hayes, J.D. 2000. PSP establishment report for the 1990 silviculture/breed trials. SGM Cooperative Report No. 83.
- Hayes, J.D.; S.D. Carson. 1998. Trials designed to quantify growth and yield gains from genetically improved radiata pine - 3rd Revision. SGM Cooperative Report No. 70.
- Miller, M.A. 1991. Establishment of special-purpose breeds performance trials. **Forest Research** Workplan 2151
- Skinner J.A.; S.D. Carson. 1994. Trials designed to quantify growth and yield gains from genetically improved radiata pine - An update. SGM Cooperative Report No. 24a.
- Skinner J.A.; J.D. Dunlop; S.D. Carson. 1995. PSP establishment report for the 1987 silvicultural/breed trials. SGM Cooperative Report No. 32.
- Stovold, G. 1995. Special-purpose Radiata pine breeds performance trials – establishment report. RPB Cooperative Report No.10

ACKNOWLEDGMENTS

Forest Research would like to acknowledge the help they received from the following companies in all stages of the development of these trials and subsequent remeasurements:

Carter Holt Harvey Forests Ltd	Trials FR 172/1, FR 172/4
--------------------------------	---------------------------

Fletcher Challenge Forests Ltd (was Forestry Corporation at the time of planting)	Trial FR 172/3
--	----------------

City Forests Ltd	Trial FR 172/5
------------------	----------------

Wenita Forest Products Ltd	Trial FR 172/6
----------------------------	----------------

The author would like to acknowledge Sue Carson (Forest Genetics) and Bob Shula (**Forest Research**) for their advice and direction in establishing PSPs and carrying out the silviculture in these trials.

