

**PSP ESTABLISHMENT REPORT FOR THE 1989
SILVICULTURE/BREED TRIALS**

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***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 five trial sites planted in 1989.

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. 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.

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 age 6 and 8 years is presented in the document. There has been no statistical analysis yet, and any trends in data may not persist over time.

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INTRODUCTION

PSP establishment, thinning and pruning of the 1989 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. This work is supported by the Stand Growth Modelling Cooperative.

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 1989 plantings is to extend the trials established in 1987 (Skinner et al. 1994) and 1988 (Dunlop and Carson 1996) 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 (eg. initial crop 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 five sites in 1989, in three regions, in the third series of the Silviculture/Breed trials (Table 1). The sites were chosen to cover a range of site qualities from high basal area to medium site index.

TABLE 1. Trial sites planted in 1989 as part of the Silviculture/Breed trial series.

Trial No.	Location	Forest Owner	Region	Site Category
FR 77	Tikokino	NZ Forest Research Institute Ltd	Hawkes Bay	High SI
FR 78	Gwavas	Hawkes Bay Forests Ltd	Hawkes Bay	Med SI
FR 84	Kawerau	Carter Holt Harvey Forests Ltd	Central North Island	High BA
FR 85	Kaingaroa	Fletcher Challenge Forests Ltd	Central North Island	Medium SI
FR 86	Golden Downs	Weyerhaeuser NZ Inc	Nelson	Medium SI

EXPERIMENTAL DESIGN

In the 1989 trials experimental design varied at each site and was largely dependent on the area available for planting the trial (see Tables 4,7,10,13 & 16 for the detailed experimental design for each site). Trial plantings took place between April and July 1989, but due to varying growth rates, PSPs were established over a period of 1.5 years, between November 1993 and February 1995 (Table 2).

TABLE 2. Planting and PSP establishment dates

Trial No.	Location	Planting Month 1989	Date of PSP Establish	Age (yrs) at PSP Establish	MCH (m) at PSP Establish
FR 77	Tikokino	Apr/July	Nov 1994	5.6	6.9
FR 78	Gwavas	Apr/July	Jan 1995	5.8	6.7
FR 84	Kawerau	June	Nov 1993	4.4	8.3
FR 85	Kaingaroa	July	Jan 1994	4.8	7.0
FR 86	Golden Downs	July	Feb 1995	5.9	6.7

There are two seedlots (GF5 & GF16) which are planted at all sites. All sites have a GF25 rated seedlot, which differs between sites. A description of the seedlots planted at different sites is given in Table 3. In all 1989 trial plantings, the buffer rows on each plot are of the same stock as the experimental (PSP) plots.

TABLE 3. Seedlots used in the 1989 Silviculture/breeds trials.

Stock	Site	Seedlot Number	Seedlot Rating	Breeding Series	Description
Seedlings	All	88/101	GF2	'bulk'	Unimproved seed
Seedlings	All	88/6	GF16	'850','268','875'	Gwavas + Kaingaroa, open-pollinated
Seedlings	All *	88/2	GF23	'268'	Amberley Top 16, control-pollinated
Cuttings	FR 77, 78	88/1	GF25	'268'	Amberley Top 16, control-pollinated
Cuttings	FR 84	6/6/87/25	GF25	'268'	Olsens, control-pollinated
Seedlings	FR 84	88/1	GF25	'268'	Amberley Top 16, control-pollinated
Seedlings	FR 85	88/7	GF18	'850'	Kaingaroa, open-pollinated
Cuttings	FR 85	6/6/87/21	GF22	'268'	Amberley Top 16, control-pollinated
Cuttings	FR 85	6/6/87/20	GF25	'850','268'	Amberley, control-pollinated
Seedlings	FR 85	88/4	GF25	'850','268'	Amberley, control-pollinated
Seedlings	FR 86	88/868	GF6	'870'	Tikokino, open-pollinated (LI27)

* All sites except Kawerau (FR 84)

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. Plots that were to receive treatment were surrounded with cruising tape to prevent accidental pruning or thinning.

The field work then proceeded as follows.

1) Pruning and marking for thinning

- a) *Forest Research* Mensuration 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. 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) Only trees not selected for thinning were pruned. *Forest Research* Mensuration field staff supervised the pruners for at least a day. 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.

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 size of the PSP plots range from 0.0912 to 0.1204 ha. The plots are 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 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 (ie. 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 were counted to make sure that the correct stocking would remain after thinning. If necessary, extra trees were pruned 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 contractors to the forest owners unless otherwise noted in the individual trial sections.

- a) All unpruned trees and/or trees marked for culling were felled (with no felling in unpruned/unthinned treatments).
- 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.

INDIVIDUAL TRIAL DESIGNS AND PSP ESTABLISHMENT REPORTS

FR 77 - TIKOKINO Forest

This trial was planted in April and July 1989 with a split-plot design containing 36 rectangular 45 x 36m plots, with plots with the same stocking grouped within a replication. The trial occupies 5.8 hectares. The GF25 root trainer seedlings and cuttings were planted in the summer (April) with the remainder of the trial planted in July. The summer plantings were watered at the time of establishment and were established on a site suffering from a prolonged drought. Persistent rain following planting rendered the 'summer' establishment meaningless.

A row plot trial of the six different seedlots, with 12 blocks of 5 treatments with 6 trees (of each seedlot) per row was also planted at the same time. The total area was 0.864 hectares.

The first measurements (of total height only), were taken in August 1991 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during early November 1994 (age 5.6 years). The trial MCH at the time of plot establishment was 6.9m with a range of 5.6 to 8.1m.

Trial Design

This trial was designed with four silvicultural treatments and six different seedlots (3 seedlings and 3 cuttings), with two of the seedlot/silvicultural treatment combinations (trts. 2 and 4) replicated twice (Table 4). For these treatments, seedlots were randomly allocated to plots to be of a specific stocking within field replications. All other treatments have only one plot per seedlot (Table 4).

Pruning

Pruning was carried out (beginning 31 October, 1994) by four *Forest Research* staff over a two week period. This took more time than estimated due to the trees being taller than the prescribed 6.2m at the time of establishment. Consequently many trees were pruned higher than 2m (some reached 4m) to achieve the required 4m of crown remaining. Selection for thinning was carried out by *Forest Research* staff at the same time, and only selected crop trees were pruned. The pruning gave an average crown remaining of 3.8m (mean pruned height was 3.1m) over the whole trial. 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.

TABLE 4. Trial design for FR 77, Tikokino forest

Trt	Pruning	Silviculture			Planting stock					
		Thinning (stems/ha)		MCH (m)	Seedlings			Cuttings		
		Initial	Final		GF2 (88/101) US	GF16 (88/6) OS	GF25 (88/1) RS	GF23 (88/2) OC	GF25 (88/1) RC	DFC
1	✕	500	500	-	•	•	•	•	•	•
2	✓	500	200	6.2	••	••	••	••	••	••
3	✓	500	200	20	•	•	•	•	•	•
4	✓	500	400	6.2	••	••	••	••	••	••

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

Each ▲ represents one planted plot, but no PSP plot was established.

US = unimproved seedling

OS = Open grown seedling

RS = root trainer seedling

OC = open grown cutting

RC = root trainer cutting

TABLE 5. Plot establishment specifications, FR 77, Tikokino Forest

Trt	Plot Area	Spacing	No. trees planted	Initial no. trees buffer : plot	Final no. trees buffer : plot	Thinning ratio	PSP Plots	Pruning
1	0.0980	5 x 4	81	32 49	32 49	1 : 1	6	None
2	0.0980	5 x 4	81	32 49	13 20	2.5 : 1	12	4m crown
3	0.0980	5 x 4	81	32 49	32 49	2.5 : 1	6	4m crown
					13 20	late thin		
4	0.0980	5 x 4	81	32 49	26 39	1.25 : 1	12	4m crown

PSP Plot Establishment

Thirty five permanent sample plots were established by four *Forest Research* field crew between 6-14 October, 1994 (a total 22 mandays). Table 5 shows the plot establishment requirements for each of the assigned treatments. Measurements were taken and recorded as described in the section on 'Basic field procedures'.

Thinning

Thinning was carried out by *Forest Research* staff beginning on 14 October, 1994 (a total 4 mandays). Twenty three of the 35 plots were thinned as scheduled (Table 4, treatments 2 & 4). Six plots (treatment 3) are still to receive a late thinning at MCH 20m. Thinning took less time than expected as much of the required thinning was accounted for by mortality. In treatment 2 all plots were thinned to the final crop stocking of 200 stems/ha. In treatment 4, 4 plots had no thinning but mortality resulted in a final crop stocking less than 300 stems/ha (prescribed to 400 stems/ha).

Trial Layout and Site Information

Thirty five of the original 36 plots planted were established as PSPs at this site (see map, Figure 1). Plot 1/12 was not established due to inconsistent planting spacing, high mortality and malformation. The original planting peg numbers are shown at the plot corners, also codes for treatment and seedlot (Tables 4 & 5).

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

Altitude:	240m
Soil Type:	Kopua series
Site Preparation:	Wind rowing of logging slash
Weeds:	Nil
Regeneration:	Nil
Slope:	Flat
Previous land use:	Radiata pine seed orchard cutover
Site:	High fertility, ex-pasture

This is a flat grassy site, grazed by sheep from around age four. The site does receive strong winds from the south and is subject to drought particularly in the summer. The high mortality initially (64% of plots had > 100 stems/ha mortality at the time of plot establishment) was due to the poor quality of the seedlings. The remaining trees are now generally very healthy and of good form. Some dying tops were noticed in May 1998, possibly as the result of summer 1997 drought.

Plot Data

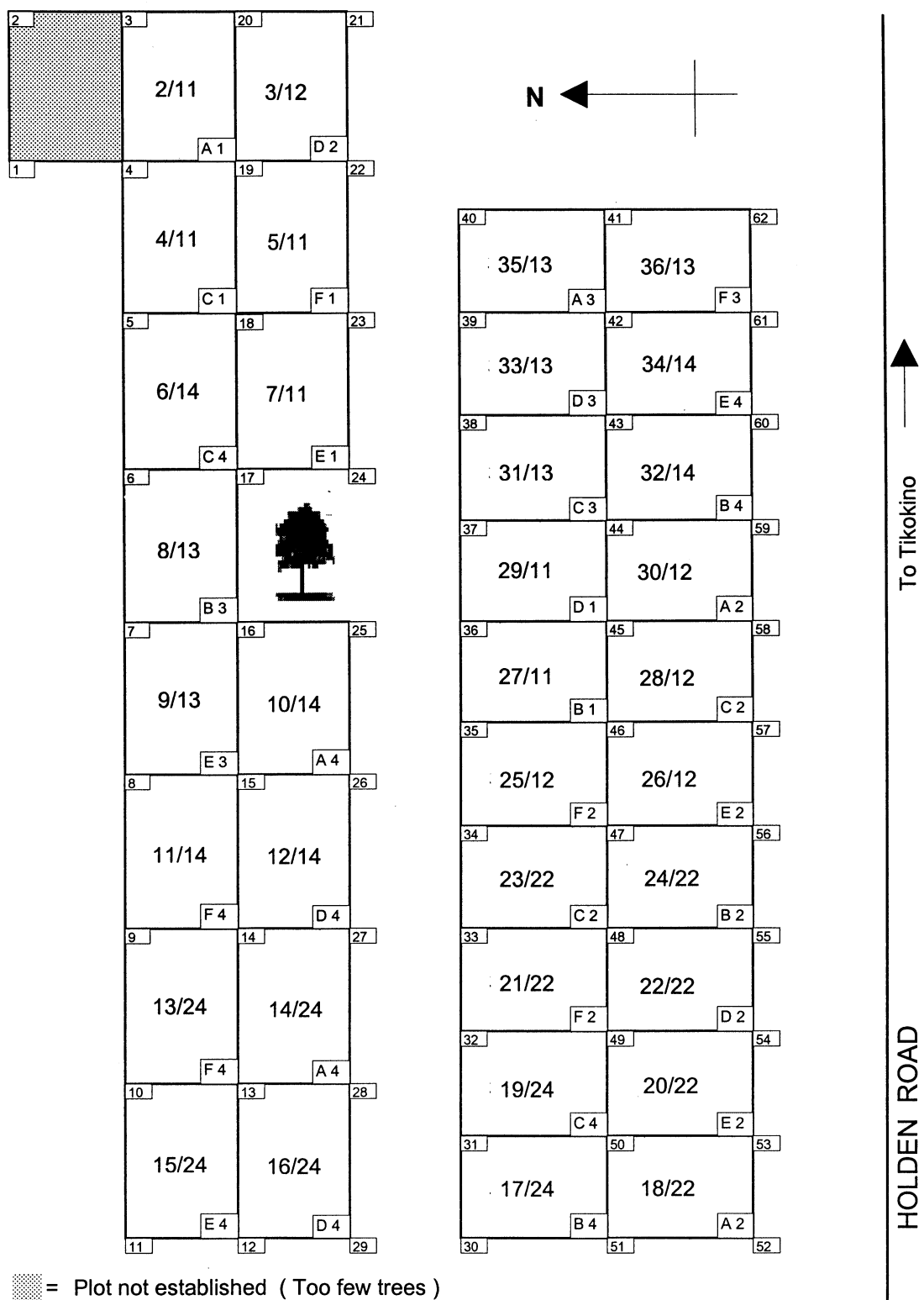
Summaries (Tables 6a, 6b) at the time of the first winter measurement (age 6 years) and the 1997 winter remeasurement (age 8 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) summarised by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time.

Unthinned plots (treatment 1) have high mortality - on average they are now at 323 stems/ha, originally planted at 500 stems/ha. Treatment 3, which is to have a late thinning at MCH 20m, also has significant mortality with the current average stocking at 380 stems/ha. Treatment 4, all plots are close to the prescribed final crop stocking of 400 stems/ha.

The following trends were noted:

- The GF25 root trainer seedlings are not growing as well as the GF25 root trainer cuttings for either diameter or height for all treatments. In the unthinned treatments mortality is higher in the seedlings, which may be affecting growth.
- At age 6 years, the direct field cuttings are performing the worst for both diameter and height for all treatments, except treatment 2 where the growth is equivalent to the GF5 seedlot.
- At age 8 years, the diameter growth of the direct field cuttings has improved and is ranked above the GF5 seedlot for all treatments.
- Treatments 1 and 3 are currently both unthinned, with treatment 1 pruned and treatment 3 unpruned. Unfortunately the differences in growth cannot be compared easily because there is high mortality which has effectively reduced the plots to an equivalent thinned treatment.

Figure 1. Map showing plot location, FR 77, Tikokino Forest



Seedlots

- A = GF2, Unimproved seedlings
- B = GF16, Open-grown seedlings
- C = GF25, Root-trainer seedlings
- D = GF23, Open-grown cuttings
- E = GF25, Root-trainer cuttings
- F = Direct field cuttings

Treatments

- 1 = 500 unpruned, unthinned
- 2 = 500 to 200, pruned
- 3 = 500 to 200, late thin, pruned
- 4 = 500 to 400, pruned

TABLE 6a. FR 77: Trial data at the first winter measurement age 6.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	PSPH* Estab	SPH Live	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Prune Ht (m) #
1	88/101	2	1	500	500	429	13.4	6.6	6.0	18.2	0.0
1	88/6	16	1	500	500	439	16.5	7.8	9.4	31.3	0.0
1	88/2	23	1	500	500	398	17.5	7.9	9.6	32.7	0.0
1	88/1 RC	25	1	500	500	276	17.5	7.8	6.6	22.8	0.0
1	88/1 RS	25	1	500	500	204	13.4	5.8	2.9	8.4	0.0
1	DFC		1	500	500	194	12.7	5.8	2.5	6.9	0.0
2	88/101	2	2	500	200	194	15.4	7.1	3.6	11.4	2.7
2	88/6	16	1	500	200	204	18.3	8.5	5.4	19.0	3.8
2	88/2	23	2	500	200	204	17.3	7.6	4.8	15.8	3.3
2	88/1 RC	25	2	500	200	209	18.2	8.1	5.4	18.9	3.6
2	88/1 RS	25	2	500	200	204	16.6	7.3	4.4	14.4	3.0
2	DFC		2	500	200	204	15.8	7.2	4.0	12.7	2.6
3	88/101	2	1	500	500	327	13.9	6.8	5.0	15.3	2.2
3	88/6	16	1	500	500	418	15.4	8.1	7.8	27.6	3.8
3	88/2	23	1	500	500	429	16.5	7.6	9.2	29.6	3.1
3	88/1 RC	25	1	500	500	480	17.3	8.3	11.3	40.0	3.5
3	88/1 RS	25	1	500	500	316	15.9	7.6	6.3	20.9	3.1
3	DFC		1	500	500	224	13.3	6.4	3.1	9.4	2.1
4	88/101	2	2	500	400	347	15.7	7.4	6.7	22.9	3.0
4	88/6	16	2	500	400	393	16.0	7.5	7.9	26.1	3.3
4	88/2	23	2	500	400	393	17.3	8.1	9.3	32.5	3.6
4	88/1 RC	25	2	500	400	393	18.1	8.6	10.1	36.6	4.0
4	88/1 RS	25	2	500	400	250	14.7	7.0	4.2	13.3	2.5
4	DFC		2	500	400	235	15.0	6.8	4.0	12.4	2.6

* PSPH = Prescribed stocking at establishment
Mean prune ht 0.0 = unpruned plot

TABLE 6b. FR 77: Trial data from measurements at age 8.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	Residual SPH	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Crown Ht (m)
1	88/101	2	1	500	418	21.4	10.4	15.0	61.6	0.9
1	88/6	16	1	500	439	24.4	11.4	20.5	90.7	0.9
1	88/2	23	1	500	418	25.6	11.9	21.5	96.5	0.9
1	88/1 RC	25	1	500	265	26.9	12.0	15.1	68.2	0.7
1	88/1 RS	25	1	500	194	22.4	9.5	7.7	29.4	0.8
1	DFC		1	500	184	22.3	9.8	7.2	27.6	0.8
2	88/101	2	2	500	184	24.1	10.6	8.4	34.3	2.7
2	88/6	16	1	500	204	26.3	11.5	11.1	48.4	3.6
2	88/2	23	2	500	204	25.8	11.3	10.6	46.2	3.4
2	88/1 RC	25	2	500	199	26.8	11.9	11.2	50.8	3.6
2	88/1 RS	25	2	500	199	25.6	11.2	10.2	44.1	3.0
2	DFC		2	500	204	25.1	11.1	10.1	43.1	2.7
3	88/101	2	1	500	306	22.3	11.0	12.0	54.5	2.2
3	88/6	16	1	500	398	22.5	11.8	15.8	73.5	3.6
3	88/2	23	1	500	408	24.5	11.6	19.3	85.4	2.9
3	88/1 RC	25	1	500	480	24.4	11.9	22.4	102.4	3.8
3	88/1 RS	25	1	500	316	24.0	11.8	14.3	65.4	3.2
3	DFC		1	500	224	22.4	10.6	8.8	36.3	2.2
4	88/101	2	2	500	316	23.5	11.8	13.7	63.2	3.1
4	88/6	16	2	500	393	23.6	11.3	17.2	75.8	3.3
4	88/2	23	2	500	388	24.6	12.0	18.5	86.1	3.6
4	88/1 RC	25	2	500	393	25.2	12.6	19.6	94.8	4.1
4	88/1 RS	25	2	500	225	23.9	11.1	10.1	43.5	2.7
4	DFC		2	500	225	23.8	10.9	9.8	41.6	2.6

FR 78, GWAVAS Forest, Compartment 59

This trial was planted in April and July 1989 with a split-plot design containing 36 rectangular 45 x 36m plots, with plots with the same stocking grouped within a replication. The GF25 root trainer seedlings and cuttings were planted in the summer (April) with the remainder of the trial planted in July. The site suffers from a prolonged drought, but the summer plantings were watered at the time of establishment and rain was persistent following planting.

The first measurements (of total height only) were taken in August 1991 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during January, 1995 (age 5.8 years). The trial MCH at the time of plot establishment was 6.7m, with a range of 6.0 to 7.6m.

Trial Design

This trial was designed with four silvicultural treatments and six different seedlots, with two of the seedlot/silvicultural treatment combinations (trts. 2 and 4) replicated twice (Table 7). For these treatments, seedlots were randomly allocated to plots designated to be a specific stocking within field replications. All other treatments have only one plot per seedlot (Table 7). Windrowing of the site prior to planting restricted the placement of the trial to some extent, hence the disjointed layout.

Pruning

Pruning was carried out by Carter Holt Harvey Forests contractors beginning on 16 January 1995. The trial took three people three days to prune. Chainsaws were used for pruning because of the large branching. The average crown height remaining after pruning was 4.1m (mean pruned height of 2.6m). 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.

Two plots (16/11 & 28/11) were mistakenly pruned by local staff, after plot establishment, at the time the surrounding stand was being pruned.

PSP Plot Establishment

Twenty four permanent sample plots (of the total 36 plots planted) were established by five *Forest Research* field staff (27 mandays) with the help of Carter Holt Harvey staff (17 mandays), beginning on 20 January, 1995. Table 8 shows the plot establishment requirements for each of the assigned treatments.

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

TABLE 7. Trial design for FR 78, Gwavas Forest

Trt	Silviculture			Planting stock					
	Pruning	Thinning (stems/ha)		Seedlings			Cuttings		
		Initial	Final	MCH (m)	GF2 (88/101) US	GF16 (88/6) OS	GF25 (88/1) RS	GF23 (88/2) OC	GF25 (88/1) RC DFC
1	✕	500	500	-	•	•	▲	•	• ▲
2	✓	500	200	6.2	••	••	▲▲	••	•• ▲▲
3	✓	500	200	20	•	•	▲	•	• ▲
4	✓	500	400	6.2	••	••	▲▲	••	•• ▲▲

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

Each ▲ represents one planted plot, but no PSP plot was established.

US = unimproved seedling OS = Open grown seedling RS = root trainer seedling

OC = open grown cutting RC = root trainer cutting

TABLE 8. Plot establishment specifications, FR 78, Gwavas Forest

Trt	Plot Area	Spacing	No. trees planted	Initial no. trees buffer : plot	Final no. trees buffer : plot	Thinning ratio	PSP Plots	Pruning
1	0.0980	5 x 4	81	32 49	32 49	1 : 1		None
2	0.0980	5 x 4	81	32 49	13 20	2.5 : 1		4m crown
3	0.0980	5 x 4	81	32 49	32 49	2.5 : 1		4m crown
					13 20	late thin		
4	0.0980	5 x 4	81	32 49	26 39	1.25 : 1		4m crown

Thinning

Thinning of the twenty plots was carried out by *Forest Research* staff, immediately following the plot establishment. Thinning took less time than expected as much of the required thinning was accounted for by mortality. All thinned plots were established at the prescribed final crop stocking.

Trial Layout and Site Information

Only 24 of the original 36 plots planted were established as PSPs at this site (see map, Figure 2). The original planting peg numbers are shown at the plot corners, also codes for treatment and seedlot (Tables 7 & 8). Due to the restrictiveness of the windrows, the orientation of the blocks alters throughout the trial so that all the necessary blocks could be fitted in. The trial area has been grazed periodically by sheep.

The following information was recorded at the time of planting:

Altitude:	470
Soil Type:	Sandy loam
Site Preparation:	Windrowing
Weeds:	Nil
Regeneration:	Nil
Slope:	Flat
Previous land use:	Radiata pine seed orchard cutover
Site:	Medium fertility

The plots that were not established were due to poor survival rates of the GF25 root trainer seedlings and the directly planted field cuttings. Both these seedlots were planted in the summer, but it was considered that poor stock rather than lack of water attributed to the mortality. There was some mortality in other plots (46% of the plots established had > 100 stems/ha mortality), but survival was considered large enough to establish permanent plots.

Plot data

Summaries (Tables 9a, 9b) at the time of the first winter measurement (age 6 years) and the winter 1997 measurement (age 8 years) show data (mean diameter, mean height, basal area, volume and prune height/crown height) summarised by treatment and seedlot.

Unthinned plots (treatment 1) have some mortality. On average they are now at 400 stems/ha, while originally planted at 500 stems/ha. Treatment 3, which is to have a late thinning at MCH 20m has some mortality with the current average stocking at 380 stems/ha. Plots of treatment 4, are all close to the correct final crop stocking of 400 stems/ha. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The following trends were noted:

- At all treatments, the GF23 seedlot (cuttings) was not performing as well as the GF16 seedlot for diameter or height.
- The GF16 seedlot was also performing better than the GF25 seedlot for diameter growth in treatment 1.

Figure 2. Map showing plot location, FR 78, Gwavas Forest, Compartment 59

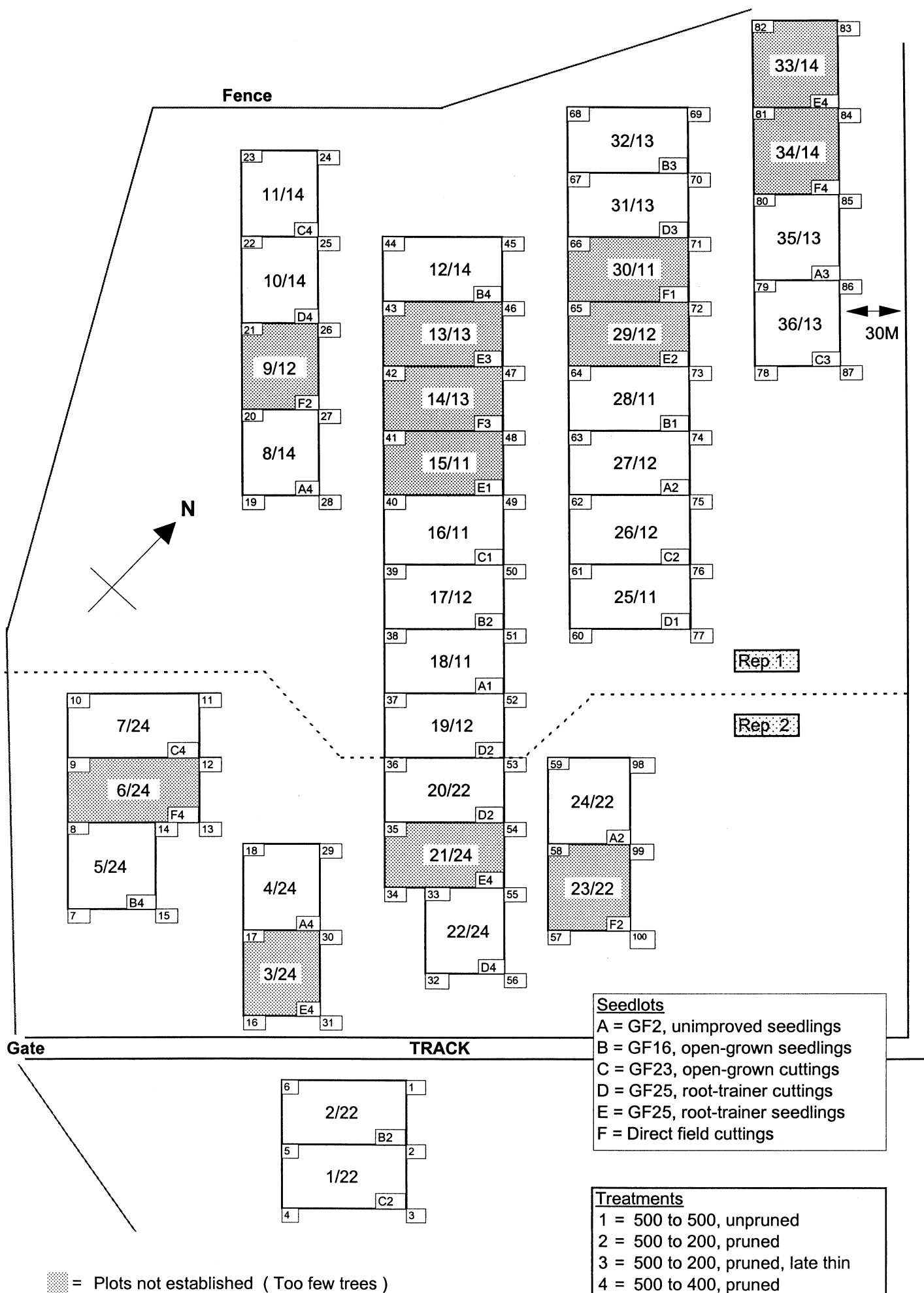


TABLE 9a. FR 78: Trial data at the first winter measurement age 6.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	PSPH * Etab	SPH Live	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Prune Ht (m) #
1	88/101	2	1	500	500	378	14.1	7.1	5.9	19.7	0.0
1	88/6	16	1	500	500	429	17.3	7.6	10.1	33.0	2.6
1	88/2	23	1	500	500	439	15.5	6.9	8.3	26.7	2.5
1	88/1	25	1	500	500	388	16.7	8.1	8.5	30.4	0.0
2	88/101	2	2	500	200	204	13.9	6.7	3.1	9.7	2.2
2	88/6	16	2	500	200	199	15.7	7.4	3.9	12.8	2.8
2	88/2	23	2	500	200	209	15.7	7.1	4.0	13.0	2.6
2	88/1	25	2	500	200	204	16.3	8.1	4.2	14.9	3.2
3	88/101	2	1	500	500	337	13.7	7.1	5.0	16.1	2.3
3	88/6	16	1	500	500	378	16.7	7.6	8.3	27.8	3.0
3	88/2	23	1	500	500	459	15.0	7.3	8.1	26.6	2.4
3	88/1	25	1	500	500	439	15.7	8.0	8.5	30.2	2.8
4	88/101	2	2	500	400	393	14.3	7.0	6.3	20.4	2.2
4	88/6	16	2	500	400	373	15.5	7.4	7.0	23.3	2.6
4	88/2	23	2	500	400	383	14.9	7.2	6.6	21.8	2.4
4	88/1	25	2	500	400	378	15.9	7.5	7.5	25.0	2.7

* PSPH = Prescribed stocking at establishment
Mean prune ht 0.0 = unpruned plot

TABLE 9b. FR 78: Trial data from measurements at age 8.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	Residual SPH	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Crown Ht (m)
1	88/101	2	1	500	367	22.4	10.7	14.5	61.0	2.6
1	88/6	16	1	500	429	25.9	11.2	22.5	96.6	2.9
1	88/2	23	1	500	429	24.1	10.5	19.6	80.9	2.7
1	88/1	25	1	500	378	26.1	11.9	20.1	93.0	2.3
2	88/101	2	2	500	204	22.7	9.9	8.2	32.1	2.3
2	88/6	16	2	500	194	24.7	10.4	9.3	37.2	2.8
2	88/2	23	2	500	199	23.7	10.1	8.7	34.7	2.5
2	88/1	25	2	500	204	25.1	11.0	10.1	42.8	3.4
3	88/101	2	1	500	327	22.4	10.5	12.9	53.3	2.3
3	88/6	16	1	500	337	24.4	10.5	15.7	64.3	3.1
3	88/2	23	1	500	459	23.3	10.7	19.6	81.3	2.4
3	88/1	25	1	500	429	23.6	11.2	18.8	83.0	2.9
4	88/101	2	2	500	393	22.7	10.6	15.9	66.2	2.2
4	88/6	16	2	500	373	23.8	10.8	16.5	69.6	2.8
4	88/2	23	2	500	398	23.6	10.3	17.4	71.2	2.5
4	88/1	25	2	500	378	24.3	11.1	17.6	75.5	2.8

FR 84, Kawerau Forest, Compartment 7

This trial was planted in June 1989, with a randomised complete block design containing 36 rectangular 45 x 36m plots and occupying 5.8 hectares. Because the trial was ripped before pegging, widths between the rows vary considerably, hence no fixed rectangular space was used. Instead, a fixed number of seedlings were planted (rather haphazardly) per 0.162 hectare block. A row plot trial was also planted in 1989 at this site using the same seedlots.

The first measurements (of total height only) were taken in June 1991 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during October/November, 1993 (age 4.4 years). The trial MCH at the time of plot establishment was 8.3m, with a range of 7.4 to 9.5m.

Trial Design

This trial was designed with four silvicultural treatments and four seedlots (3 seedlings and 1 cuttings), with two of the seedlot/silvicultural treatment combinations replicated three times, one replicated twice and one (the unpruned treatment) unreplicated (Table 10). All treatment combinations were randomly allocated within field replications.

TABLE 10. Trial design for FR 84, Kawerau Forest

Trt	Silviculture				Planting stock			
	Pruning	Stocking (stems/ha)		Thinning	Seedlings			Cutting
		Initial	Final		GF2 (88/101)	GF16 (88/6/2)	GF25 (88/1)	GF25 (6/6/87/25)
1	✓	600	250	6.2	•••	•••	•••	•••
2	✓	600	250	20	•••	•••	•••	•••
3	✗	600	600	-	•	•	• ¹⁾	•
4	✓	600	600	-	••	••	••	••

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

1) Plot was pruned after plot establishment and the treatment is now equivalent to treatment 4.

Pruning

Clearing vegetation and locating the plot pegs began with *Forest Research* staff in September 1993. Blackberry was a major problem at this site. Pruning was carried out by eleven PF Olsen pruners and supervised by Forest Research staff to ensure that the correct prescription, to leave 4m of crown, was achieved. Pruning

started on 26 November 1993, taking 3½ days for the 32 plots. 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. The average crown length remaining after pruning was 5.2m (mean pruned height of 3.1m). Plot 2/13 was mistakenly pruned after plot establishment by local staff, at the time the surrounding stand was being pruned.

PSP Plot Establishment

Thirty-six permanent sample plots were established by *Forest Research* field crew. Normal plot establishment techniques could not be used because of the irregular planting. The following procedure was followed:

- corner planting pegs were located,
- plot corner pegs were placed 3.9m diagonally towards the centre of the plot, from the planting pegs,
- a sight was taken down to each new peg line to determine which trees were in the plot,
- a measurement down each of the peg lines established a plot centre,
- a peg was placed at the plot centre.

Establishment, carried out over 7 days (a total of 34 mandays) and, was very slow due to the irregular spacing and the blackberry undergrowth. Due to the irregular spacing and some half rows in plots, the number of trees in the unthinned plots varies. (Table 10). Table 11 shows the plot establishment requirements for each of the assigned treatments.

TABLE 11. Plot establishment specifications, FR 84, Kawerau Forest

Trt	Plot Area	Spacing	No. trees planted	Initial no. trees buffer : plot	Final no. trees buffer : plot	Thinning ratio	PSP Plots	Pruning
1	0.1204	not fixed	approx 97	25 72	10 30	2.4 : 1	12	4m crown
2	0.1204	not fixed	approx 97	25 72	25 72 10 30	2.4 : 1 late thin	12	4m crown
3	0.1204	not fixed	approx 97	25 72	25 72	1 : 1	4	Unpruned
4	0.1204	not fixed	approx 97	25 72	25 72	1 : 1	8	4m crown

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

Thinning

Thinning was carried out by *Forest Research* field staff on 4/5 November, 1993 (a total of 2 mandays). All plots were thinned according to the schedule. Thinning of the buffers was a problem, as trees were not planted in straight rows. The buffers were thinned to an average stocking of the two plots on either side.

Trial Layout and Site Information

Thirty six plots are established as PSPs at this site (see map, Figure 3). The original planting peg numbers are shown at the plot corners, also codes for treatment and seedlot (Tables 10 & 11). This site has been planted in several blocks, with aspect varying from south/ south east to north/ north west. Growth is very similar between all blocks irrespective of plot aspect. The height growth here has been very impressive. The trial was established somewhat later than scheduled (MCH 8.3m) as it was not realised just how fast it was growing. Blackberry has always hindered plot measurements. In 1996 tracks were slashed through the plots to help access to the trees. Also all unpruned plots were low pruned for access - ie. dead branches were pruned off up to maximum of 2m. In 1998 the blackberry was beginning to be suppressed by crown closure, with the problem expected to diminish for future measurements.

The following information was recorded at the time of planting:

Altitude:	61 - 80m
Soil Type:	Volcanic scoria
Site Preparation:	Roller crushing, burnt and ripped in shallow valleys
Weeds:	Blackberry and bracken fern
Regeneration:	Low
Slope:	Range 2 - 12°
Aspect:	Varied
Previous land use:	Scrubland / farm site
Site:	Highly fertile scrubland

Plot data

Summaries (Tables 12a, 12b) at the time of the first winter measurement (age 5 years) and the 1997 winter remeasurement (age 8 years), show data (mean diameter, mean height, basal area, volume and prune height) summarised by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The following trends were noted:

- By age 8, the crown height on the unpruned plots had risen to 4.1m on average. This is equivalent to the mean prune height of the plots pruned at PSP establishment.
- As GF rating of the seedlots increases, the diameter and height growth also increases.
- The GF25 seedlings are not performing as well as the GF25 cuttings for treatments 1 and 4.
- In the unthinned treatments (2,3,& 4) mortality is higher in the GF25 seedlings than the equivalent cuttings.

Figure 3. Map showing plot location, FR 84, Kawerau Forest, Compartment 7

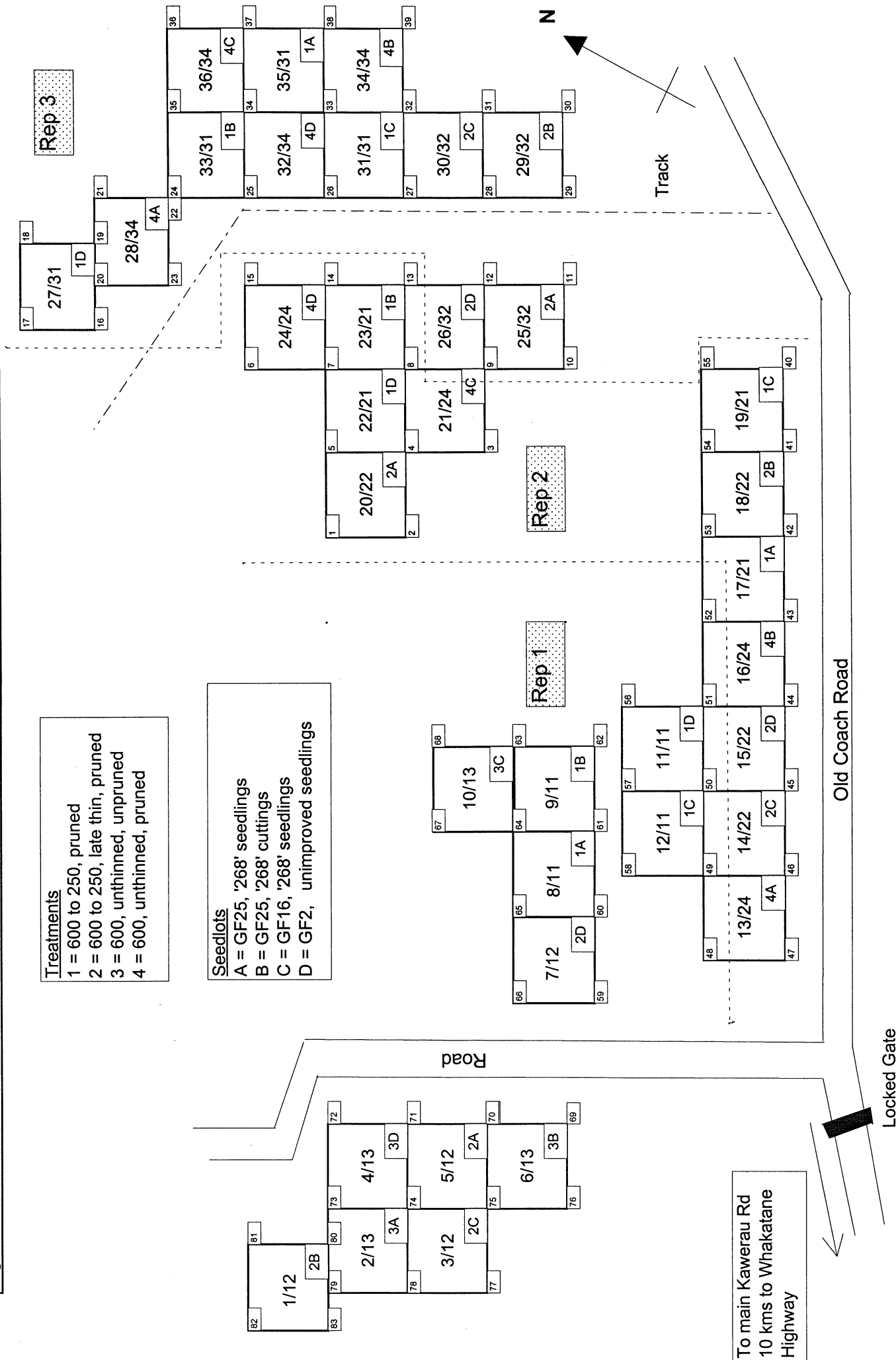


TABLE 12a. FR 84: Trial data at the first winter measurement age 5.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	PSPH * Estab	SPH Live	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Prune Ht (m) #
1	88/101	2	3	600	250	246	15.6	9.2	4.7	17.6	2.8
1	88/6/2	16	3	600	250	249	16.3	9.5	5.2	19.7	3.2
1	6/6/87/25 (C)	25	3	600	250	249	18.1	10.0	6.4	25.1	3.3
1	88/1 (S)	25	3	600	250	249	17.4	9.9	6.0	23.5	3.2
2	88/101	2	3	600	600	570	15.3	9.2	10.4	38.8	2.8
2	88/6/2	16	3	600	600	651	16.2	9.8	13.4	52.4	3.0
2	6/6/87/25 (C)	25	3	600	600	612	16.6	10.1	13.4	55.5	3.2
2	88/1 (S)	25	3	600	600	551	17.3	10.1	12.9	51.4	3.2
3	88/101	2	1	600	600	598	15.9	9.8	11.9	46.7	0.0
3	88/6/2	16	1	600	600	581	15.6	9.6	11.1	42.5	0.0
3	6/6/87/25 (C)	25	1	600	600	664	17.5	10.3	15.9	63.8	0.0
3	88/1 (S)	25	1	600	600	548	17.9	10.5	13.8	55.0	3.0
4	88/101	2	2	600	600	553	15.8	9.7	10.9	42.0	3.0
4	88/6/2	16	2	600	600	660	16.2	9.7	13.6	53.0	3.0
4	6/6/87/25 (C)	25	2	600	600	640	16.8	10.5	14.2	59.0	3.3
4	88/1 (S)	25	2	600	600	561	16.3	9.7	11.7	45.4	3.2

* PSPH = Prescribed stocking at establishment

Mean prune ht 0.0 = unpruned plot

C = cuttings S = seedlings

Illegal prune

TABLE 12b. FR 84: Trial data from measurements at age 8.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	Residual SPH	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Crown Ht (m)
1	88/101	2	3	600	246	28.3	15.2	15.5	82.1	2.8
1	88/6/2	16	3	600	246	29.4	15.8	16.8	91.3	3.1
1	6/6/87/25 (C)	25	3	600	244	32.1	16.9	19.8	113.8	3.3
1	88/1 (S)	25	3	600	249	30.8	16.4	18.6	104.1	3.3
2	88/101	2	3	600	568	24.8	15.9	27.3	155.9	3.3
2	88/6/2	16	3	600	648	25.0	16.6	31.8	190.2	4.3
2	6/6/87/25 (C)	25	3	600	612	26.5	17.6	33.8	215.0	4.1
2	88/1 (S)	25	3	600	548	27.3	17.8	32.2	201.0	3.9
3	88/101	2	1	600	573	24.3	16.1	26.5	153.6	3.6
3	88/6/2	16	1	600	573	24.8	16.9	27.7	164.1	4.1
3	6/6/87/25 (C)	25	1	600	673	27.7	17.4	40.4	241.3	4.8
3	88/1 (S)	25	1	600	548	27.6	17.6	32.8	203.3	4.0
4	88/101	2	2	600	540	25.1	16.1	26.7	153.1	3.5
4	88/6/2	16	2	600	656	25.0	16.6	32.1	192.3	4.0
4	6/6/87/25 (C)	25	2	600	640	26.8	17.2	36.1	222.3	4.2
4	88/1 (S)	25	2	600	557	26.9	17.0	31.5	188.7	3.4

C = cuttings S = seedlings

FR 85, Kaingaroa Forest, Compartment 1187

This trial was planted in July 1989 with a split plot design containing 42 rectangular, 45 x 36m plots and occupying 6.8 hectares.

Radiata pine regeneration was removed in both February 1990 and 1991. The first measurements (of total height only) were taken in May 1991 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during January, 1994 (age 4.8 years). The trial MCH at the time of plot establishment was 7.0m, with a range of 5.4 to 8.6m.

Trial Design

This trial was designed with three silvicultural treatments and seven different seedlots (5 seedlings and 2 cuttings), with each seedlot/silvicultural treatment combination replicated twice (Table 13). Seedlots were randomly allocated to plots designated to be of a specific stocking within field replications.

Pruning

Pruning was carried out on 28 plots by Forestry Corporation contractors, under supervision by *Forest Research* staff beginning on 24 January, 1994. There were no problems encountered in this trial. 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 2.9m).

The top buffer row around the trial had an accidental prune in 1997, but this did not affect any trees in the PSP plots (only buffer trees).

PSP Plot Establishment

Forty two permanent sample plots were established by three *Forest Research* staff, beginning on 24 January (a total of 51 mandays including thinning of 14 plots) and completed on 28 January, 1994. Table 14 shows the plot establishment requirements for each of the assigned treatments.

It was difficult to identify all plot trees in plot 35/23 at the time of regeneration removal, therefore it is questionable as to whether all trees in this plot are of GF22 origin.

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

TABLE 13. Trial design for FR 85, Kaingaroo Forest

Silviculture		Planting stock										
Trt	Pruning	Stocking (stems/ha)		Thinning		Seedlings				Cuttings		
		Initial	Final	MCH (m)	Ratio	GF2 (88/101)	GF16 (88/6)	GF18 (88/7)	GF23 (88/2)	GF25 (88/4)	GF22 (6/6/87/21)	GF25 (6/6/87/20)
1	✓	833	250	6.2	3.3:1	••	••	••	••	••	••	••
2	✓	833	250	20	3.3:1	••	••	••	••	••	••	••
3	✗	667	667	-	1:1	••	••	••	••	••	••	••

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

TABLE 14. Plot establishment specifications, FR 85, Kaingaroo Forest

Trt	Plot Area	Spacing	No. trees planted	Initial no. trees buffer : plot	Final no. trees buffer : plot	Thinning ratio	PSP Plots	Pruning
1	0.0912	6 x 2	126	50 76	16 25	3.1 : 1	14	4m crown
2	0.0912	6 x 2	126	50 76	50 76	3.1 : 1	14	4m crown
					16 25	late thin		
3	0.0960	6 x 2.5	108	44 64	44 64	1 : 1	14	Unpruned

Thinning

Thinning of the 14 plots was carried out by *Forest Research* field staff following plot establishment and was completed by 11 February, 1994. All plots were thinned according to the schedule.

Trial Layout and Site Information

All 42 plots planted were established as PSPs at this site (see map, Figure 4). The original planting peg numbers are shown at the plot corners as well as codes for treatment and seedlot (Tables 13 & 14).

Regeneration was removed in the early years at this site, and further regeneration was again removed at plot establishment and the first winter remeasurement. Heavy undergrowth of buddleia and other broadleaves is currently causing a problem for height measurements. Despite the tall undergrowth, all trees appear to be growing well and are healthy.

The following information was recorded at the time of planting:

Altitude:	553m
Soil Type:	Volcanic ash
Site Preparation:	Herbicide application
Weeds:	Thistle, toetoe and buddleia
Regeneration:	High
Slope:	Range 3-7°
Aspect:	South
Previous land use:	Medium fertility forest

Plot data

Summaries (Tables 15a, 15b) at the time of the first winter measurement (age 5 years) and the winter 1997 measurement (age 8 years) show data (mean diameter, mean height, basal area, volume and crown/prune height) summarised by treatment and seedlot. There was almost no mortality in this trial. A few plots in treatment 2 had a stocking higher than prescribed stocking mainly due to forking of trees below breast height. No statistical analysis has yet been carried out and any trends in data may not persist over time.

The following trends were noted:

- By age 8, the crown height on the unpruned plots had risen to 3.2m on average. This is equivalent to the mean prune height of the plots pruned at PSP establishment.
- The GF25 seedlings are not performing as well as the GF25 cuttings in treatments 1 & 2, but they are performing better in the unthinned, unpruned treatment (treatment 3).
- The GF16 seedlot in treatment 3 is performing equally as well as all other higher rated seedlots.

Figure 4. Map showing plot location, FR 85, Kaingaroa Forest, Compartment 1187

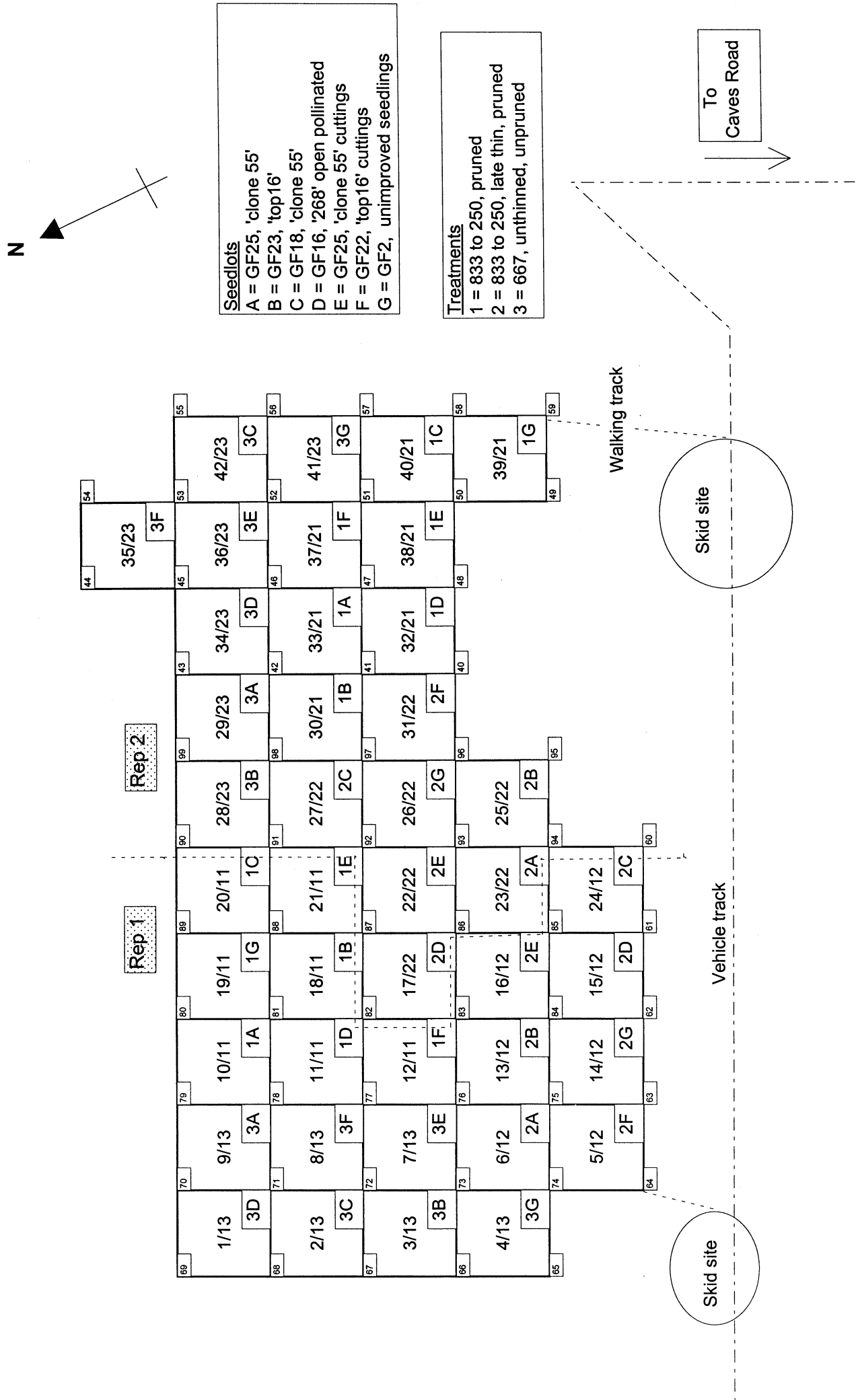


TABLE 15a. FR 85: Trial data at the first winter measurement age 5.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	PSPH * Estab	SPH Live	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Prune Ht (m) #
1	88/101	2	2	833	250	274	11.0	6.8	2.6	8.2	2.2
1	88/6/2	16	2	833	250	274	13.0	7.5	3.6	11.9	2.8
1	88/7/2	18	2	833	250	274	12.0	7.5	3.1	10.4	3.1
1	6/6/87/21	22	2	833	250	280	13.1	7.6	3.7	12.2	2.9
1	88/2	23	2	833	250	269	13.0	7.9	3.6	12.1	3.0
1	6/6/87/20 (C)	25	2	833	250	280	13.9	8.5	4.2	15.3	3.5
1	88/4 (S)	25	2	833	250	274	12.9	8.0	3.6	12.2	3.1
2	88/101	2	2	833	833	729	10.3	6.8	6.0	18.7	2.2
2	88/6/2	16	2	833	833	795	10.8	7.2	7.5	24.8	2.6
2	88/7/2	18	2	833	833	839	11.2	8.1	8.3	28.8	3.1
2	6/6/87/21	22	2	833	833	839	10.9	7.1	7.8	25.2	2.5
2	88/2	23	2	833	833	850	11.4	7.6	8.5	29.1	3.0
2	6/6/87/20 (C)	25	2	833	833	806	12.3	8.4	9.5	34.2	3.5
2	88/4 (S)	25	2	833	833	828	11.8	7.9	9.0	31.0	2.9
3	88/101	2	2	667	667	646	10.2	6.9	5.3	16.4	0.0
3	88/6/2	16	2	667	667	669	12.3	7.3	7.9	24.8	0.0
3	88/7/2	18	2	667	667	667	11.6	7.4	7.0	22.6	0.0
3	6/6/87/21	22	2	667	667	667	11.7	7.0	7.1	22.3	0.0
3	88/2	23	2	667	667	677	11.8	7.4	7.3	23.5	0.0
3	6/6/87/20 (C)	25	2	667	667	683	11.7	7.6	7.2	24.1	0.0
3	88/4 (S)	25	2	667	667	679	12.8	8.1	8.7	29.6	0.0

* PSPH = Prescribed stocking at establishment

Mean prune ht 0.0 = unpruned plot

C = cuttings S = seedlings

TABLE 15b.

FR 85: Trial data from measurements at age 8.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	Residual SPH	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Crown Ht (m)
1	88/101	2	2	833	269	19.0	11.2	7.6	33.5	2.5
1	88/6/2	16	2	833	274	22.6	12.1	11.0	48.7	2.9
1	88/7/2	18	2	833	274	20.4	12.1	9.0	40.9	3.1
1	6/6/87/21	22	2	833	274	22.2	12.2	10.6	47.8	4.0
1	88/2	23	2	833	269	22.4	12.8	10.5	49.8	3.2
1	6/6/87/20 (C)	25	2	833	274	23.6	13.1	12.0	57.8	3.9
1	88/4 (S)	25	2	833	269	22.2	12.9	10.4	48.8	3.3
2	88/101	2	2	833	729	16.4	11.6	15.3	70.5	2.6
2	88/6/2	16	2	833	790	16.9	12.0	17.7	84.4	2.8
2	88/7/2	18	2	833	828	16.8	12.7	18.4	91.8	3.3
2	6/6/87/21	22	2	833	833	17.6	12.7	20.3	99.3	3.5
2	88/2	23	2	833	828	17.3	12.6	19.3	96.3	3.3
2	6/6/87/20 (C)	25	2	833	806	18.5	13.6	21.6	112.5	3.8
2	88/4 (S)	25	2	833	822	18.1	12.7	21.1	103.5	3.9
3	88/101	2	2	667	646	16.7	11.7	14.1	63.2	2.7
3	88/6/2	16	2	667	669	20.0	12.5	20.9	98.0	3.3
3	88/7/2	18	2	667	662	18.7	12.6	18.1	86.4	3.1
3	6/6/87/21	22	2	667	667	19.9	12.3	20.7	97.2	3.1
3	88/2	23	2	667	677	19.7	12.5	20.4	95.4	3.1
3	6/6/87/20 (C)	25	2	667	683	19.6	13.2	20.4	101.1	3.1
3	88/4 (S)	25	2	667	679	20.4	13.4	22.1	109.6	4.4

C = cuttings S = seedlings

FR 86, Golden Downs Forest, Compartment 112

This trial was planted in July 1989 with 16 rectangular 45 x 36m plots and occupying 2.6 hectares. The area surrounding the trial was planted in GF16 Radiata pine (seedlot 88/6). The compartment, including the trial area, was fertilised with Ulexite @ 60 Kg/ha in May 1994.

The first measurements of total height only were taken in December 1991 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during February, 1995 (age 5.9 years). The trial MCH at the time of plot establishment was 6.7m, with a range of 5.5 to 8.1m.

Trial Design

This trial was designed with three silvicultural treatments and four different seedlots, with each seedlot replicated twice for treatment 1 only, in a split-plot design (Table 16). For this treatment, seedlots were assigned randomly to plots designated as having specific stockings within replications. Treatments 2 & 3 have only one plot per seedlot. There is only one planting stocking (667 s/ha) at this site.

TABLE 16. Trial design for FR 86, Golden Downs Forest

Trt	Silviculture					Planting stock			
	Pruning	Stocking (stems/ha)		Thinning		Seedlings			
		Initial	Final	MCH (m)	Ratio	GF2 (88/101)	GF16 (88/6)	GF23 (88/2)	LI27(GF6) (88/868)
1	✓	667	250	6.2	2.5:1	••	••	••	••
2	✗	667	600	-	1:1	•	•	•	•
3	✓	667	600	-	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 12 plots by Tasman Forestry contractors, under supervision by *Forest Research* staff, beginning on 7 February, 1995. It took 8 pruners 2 days to complete. Pruning took longer than expected due to the large amount of regeneration in the trial hampering movement. 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 4.2m (mean pruned height 2.5m). One plot, 3/12, had an illegal low prune by local staff after plot establishment (May 1996).

PSP Plot Establishment

Two days were spent by *Forest Research* staff locating the trial pegs, which was difficult because of the dense (bracken) undergrowth. An access track was cut through the centre of the southern block of plots. Sixteen permanent sample plots were established by four *Forest Research* staff on the 9/10 February (a total of 16 mandays including thinning of 8 plots). Tasman forestry staff also assisted with the plot establishment (3 mandays). Table 17 shows the plot establishment requirements for each of the assigned treatments.

TABLE 17. Plot establishment specifications, FR 86, Golden Downs Forest

Trt	Plot Area	Spacing	No. trees planted	Initial no. trees buffer : plot		Final no. trees buffer : plot		Thinning ratio	PSP Plots	Pruning
1	0.0960	6 x 2.5	108	44	64	16	24	2.5 : 1	8	4m crown
2	0.0960	6 x 2.5	108	44	64	44	64	1 : 1	4	Unpruned
3	0.0960	6 x 2.5	108	44	64	44	64	1 : 1	4	4m crown

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

Thinning

Thinning of the 8 plots was carried out by *Forest Research* field staff following plot establishment.

Trial Layout and Site Information

All 16 plots planted were established as PSPs at this site (see map, Figure 5). The original planting peg numbers are shown at the plot corners as well as codes for treatment and seedlot (Tables 16 & 17).

Considerable radiata pine regeneration was removed at plot establishment, but planted trees were easy to distinguish because the regeneration was significantly shorter. Chest high bracken continues to be a hindrance for remeasurements, but it does not seem to be affecting growth of the crop trees. There is very little mortality or tree damage at this trial and the trees are of good form.

There are two distinct areas in the trial, one with 8 plots on the south facing slope and the other with 8 plots on the north facing slope. The growth on the north facing slope is noticeably better and will be confounded with seedlot differences. At plot establishment the average MCH was 7.5m on the north face and 5.8m on the south face.

The following information was recorded at the time of planting:

Altitude:	600m
Soil Type:	Moutere gravel
Site Preparation:	Herbicide application
Weeds:	Bracken fern and blackberry
Regeneration:	Medium
Slope:	20° (north face), 22° (south face)
Aspect:	8 plots North, 8 plots South
Previous land use:	Low/medium fertility forest

Plot data

Summaries (Tables 18a, 18b) at the time of the first winter measurement (age 6 years) and the winter 1997 measurement (age 8 years) show data (mean diameter, mean height, basal area, volume and crown/prune height) summarised by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time.

As previously described the north and south facing aspects show distinct differences in growth (on average 1.7m taller in the north facing slope). The site aspect is shown on Table 18b for the individual plots in treatments 2 and 3. Plots in treatment 1 have replicates on each aspect so the mean statistics represent a high and low growth for each seedlot. Plots in treatments 2 and 3 do not have replicates on each aspect, so seedlot and stocking treatment are confounded.

Figure 5. Map showing plot location, FR 86, Golden Downs Forest, Compartment 112

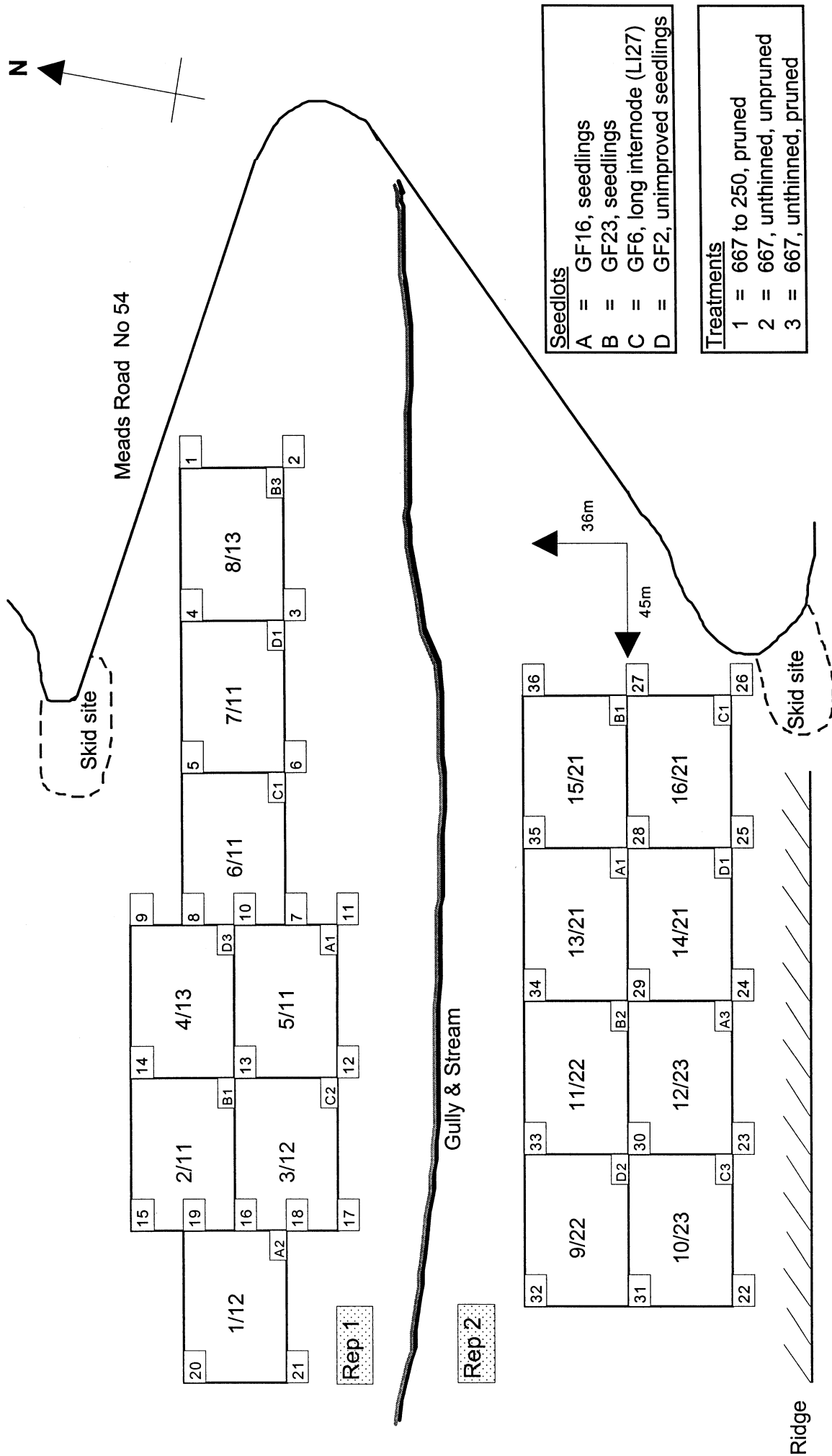


TABLE 18a. FR 86: Trial data at the first winter measurement age 6.0

Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	PSPH * Estab	Residual SPH	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Prune Ht (m) #
1	88/101	2	2	667	250	245	11.6	7.2	2.6	9.0	2.7
1	88/868	6	2	667	250	250	11.7	7.5	2.7	9.3	2.3
1	88/6	16	2	667	250	250	11.4	7.2	2.5	8.6	2.6
1	88/2	23	2	667	250	250	12.5	7.5	3.0	10.5	2.8
2	88/101	2	1	667	667	646	9.9	7.0	5.0	16.4	0.0
2	88/868	6	1	667	667	531	9.4	5.8	3.7	10.7	2.2
2	88/6	16	1	667	667	667	10.4	6.4	5.6	17.5	0.0
2	88/2	23	1	667	667	646	11.5	7.7	6.7	24.6	0.0
3	88/101	2	1	667	667	625	9.1	6.0	4.1	11.9	1.5
3	88/868	6	1	667	667	656	11.2	7.9	6.5	23.5	3.0
3	88/6	16	1	667	667	667	11.9	8.2	7.4	26.6	3.0
3	88/2	23	1	667	667	594	9.2	6.1	3.9	11.7	1.8

* PSPH = Prescribed stocking at establishment
Mean prune ht 0.0 = unpruned plot

Illegal prune

TABLE 18b.

FR 86: Trial data from measurements at age 8.0

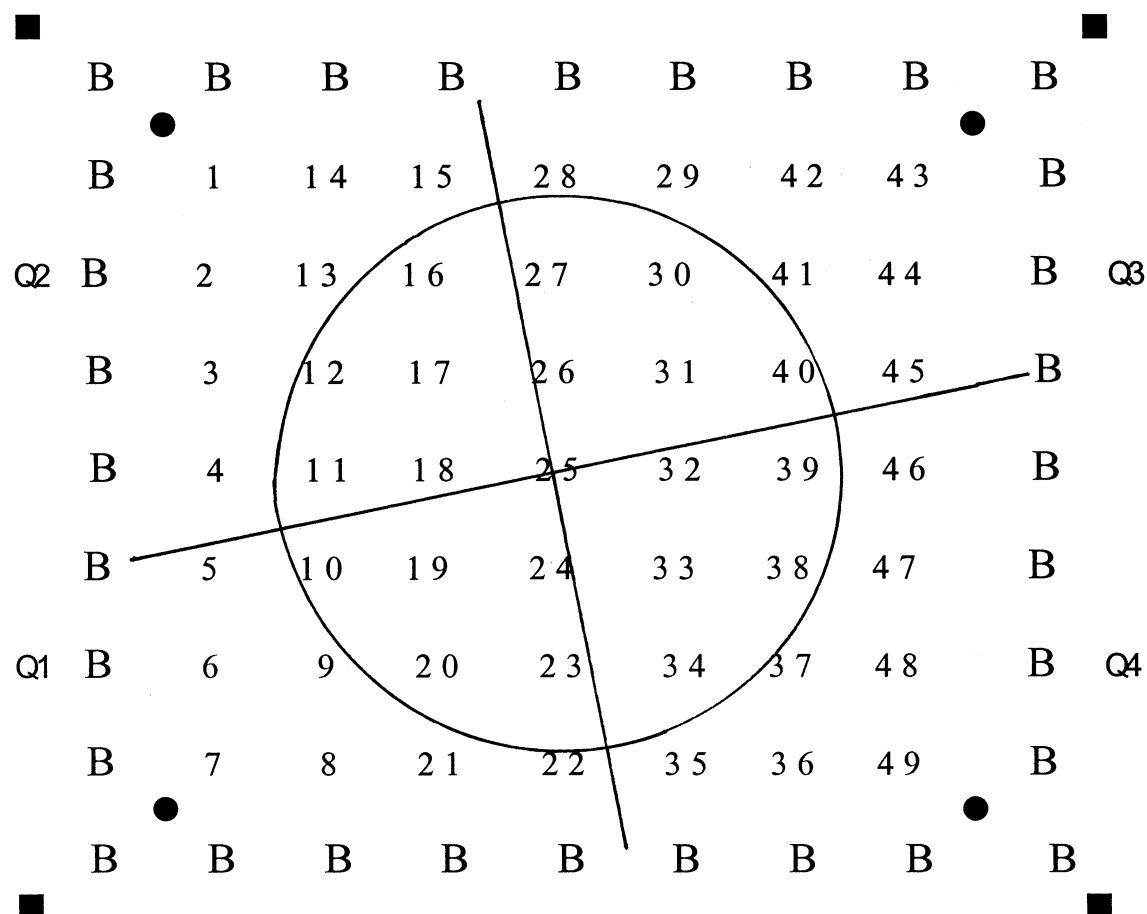
Treatment No.	Seedlot	GF Rating	No. Plots	Initial SPH	Residual SPH	Mean DBH (cm)	Mean Ht (m)	Basal Area (m ²)	Volume (m ³)	Mean Crown Ht (m)
1	88/101	2	2	667	245	17.4	10.8	5.8	26.1	2.7
1	88/868	6	2	667	250	17.5	10.7	6.0	26.5	2.2
1	88/6	16	2	667	250	17.0	10.6	5.7	24.9	2.7
1	88/2	23	2	667	250	18.8	11.0	6.9	30.7	2.8
2	88/101	2	1	667	646	15.1	11.2	11.5	52.7	1.8
2	88/868	6	1	667	531	14.3	9.7	8.6	35.3	2.2
2	88/6	16	1	667	667	15.9	10.1	13.3	55.8	2.3
2	88/2	23	1	667	646	17.2	12.2	15.0	75.2	2.0
3	88/101	2	1	667	625	14.1	9.4	9.7	37.7	1.6
3	88/868	6	1	667	656	15.7	11.4	12.7	59.8	3.2
3	88/6	16	1	667	667	16.6	12.0	14.4	68.2	3.0
3	88/2	23	1	667	594	14.4	9.7	9.7	39.6	1.8

Appendix 1

Location of Buffers and Permanent Sample Plots

Example 1 Treatment 2
4 x 5 m spacing
Unthinned at 500 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

1,4,7,

Plot trees

25

Plot centre



Planting corner peg



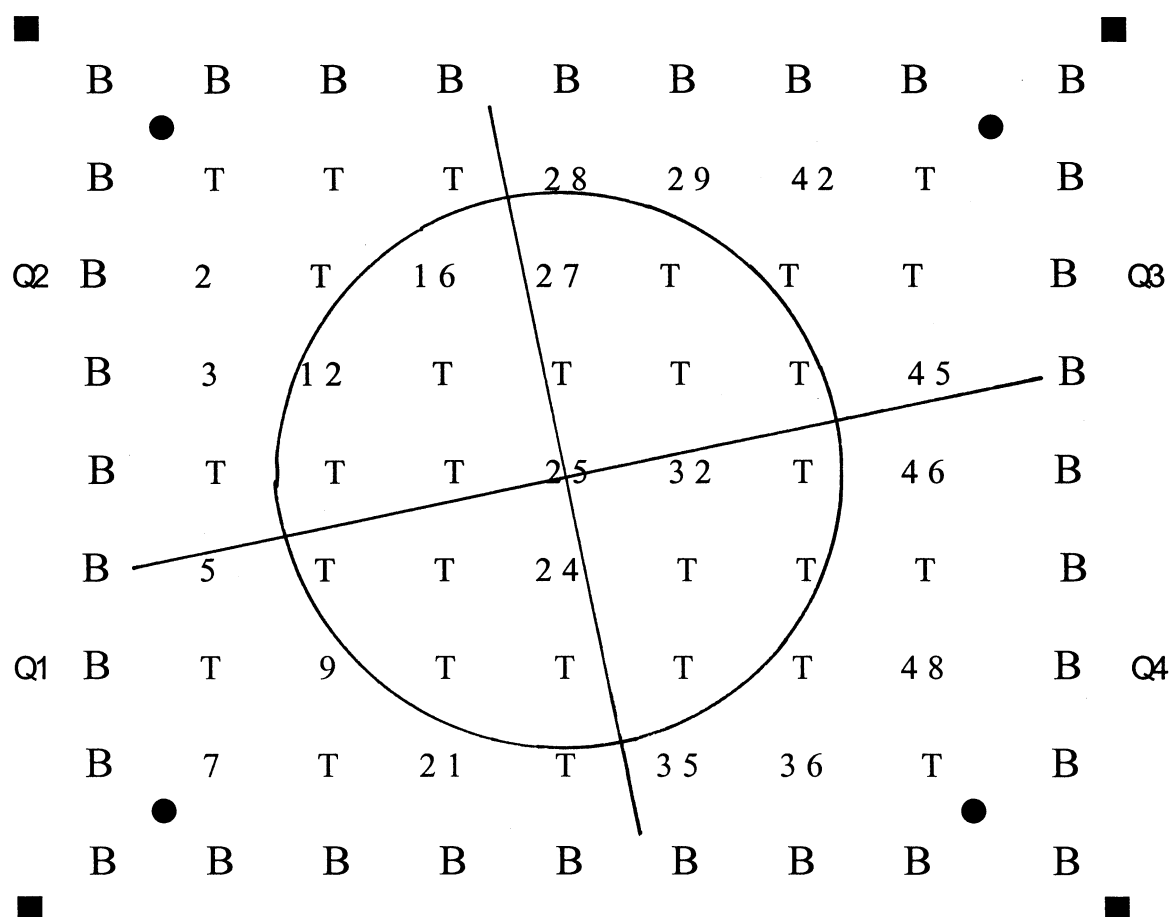
PSP Plot corner peg

Appendix 1 cont.

Location of Buffers and Permanent Sample Plots

Example 2 Treatment 2
4 x 5 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

 $1, 4, 7, \dots$

Plot trees

25

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 84/0/28/34 is made up of the following fields:

CODE	=	Regional/Controller Code
EXPNO	=	Experiment / trial number as allocated by FRI
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 84/0/28/34 is plot 28 of trial FR 84. The plot replication number is 3 and the treatment is 4.

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

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Forestry Corporation NZ Ltd	Trial FR 85
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Tasman Forestry Ltd	Trial FR 86
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