

**PSP ESTABLISHMENT REPORT FOR THE 1990
SILVICULTURE/BREED TRIALS**

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EXECUTIVE SUMMARY

This report describes the basic field procedures which are being used for all silviculture/breed trials, and examines the actual pruning, thinning, and establishment of permanent sample plots (PSPs) in the seven trial sites planted in 1990 (Shorland & Lee 1991).

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

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 9 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 1990 plantings of the Silviculture/Breed series is fully documented in this report. The basic field procedures for pruning, thinning and establishment of PSPs in these trials are also documented. The Stand Growth Modelling Cooperative supports this work.

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

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

TRIAL LOCATIONS

Trials were planted at seven sites in 1990, in five regions, in the fourth series of the Silviculture/Breed trials (Table 1). The sites were chosen to cover a range of site qualities from high basal area to medium site index.

TABLE 1. Trial sites planted in 1990 as part of the Silviculture/Breed trial series.

Trial No.	Location	Forest Owner	Growth Region	Site Category	Current Site index
FR 121/1	Tungrove	Carter Holt Harvey Forests	Sands	Medium SI	31.8
FR 121/2	Atiamuri	Carter Holt Harvey Forests	Central North Island	Medium SI	38.7
FR 121/3	Gwavas	Pan Pac Forest Products	Hawkes Bay	Low SI	29.3
FR 121/4	Tirua	Carter Holt Harvey Forests	Auckland Clays	High SI	34.9
FR 121/5*	Hokonui	Rayonier NZ	Southland	High SI	-
FR 121/6	Tarawera	Fletcher Challenge Forests	Central North Island	High SI	33.3
FR 121/7	Huanui	Hikurangi Forest Farms	East Coast	High BA	31.4

* Trial Abandoned in November 1997

EXPERIMENTAL DESIGN

In the 1990 trials there is a core experimental design of seven treatments planted at each site (Table 2). An additional treatment was assigned at Atiamuri and treatment five was not included at Gwavas (see Tables 7, 10, 13, 16, 19 and 22 for the detailed experimental design for each site).

TABLE 2. Core experimental design for the 1990 Silviculture/breed trials.

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

* Treatment 5 not included at FR121/3, Gwavas Forest (see individual trial design).

Trial plantings took place between June and August 1990, but due to varying growth rates, PSPs were established over a period of 1.3 years, between October 1994 and December 1995 (Table 3).

TABLE 3. Planting and PSP establishment dates

Trial No.	Location	Planting Month 1990	Date of PSP Establish	Age (yrs) at PSP Establish	MCH (m) after thinning
FR 121/1	Tungrove	July	Sept 1995	5.3	7.2
FR 121/2	Atiamuri	June	Feb 1995	4.9	7.1
FR 121/3	Gwavas	July	Dec 1995	5.7	6.5
FR 121/4	Tirua	June	Oct 1994	4.4	7.3
FR 121/5*	Hokonui	August	Abandon Nov 1997	-	-
FR 121/6	Tarawera	July	Mar 1995	5.0	7.0
FR 121/7	Huanui	July	Nov 1994	4.6	6.0

There are four seedlots (GF7, 14, 16 and 25) which are planted at all sites and one seedlot (LI25 (GF13)) planted at five of the seven sites. A description of the seedlots planted is given in Table 4. In all 1990 trial plantings, the buffer rows are of the same stock as the experimental (PSP) plots for each planted plot.

TABLE 4. Seedlots used in the 1990 Silviculture/breeds trials.

Stock	Site	Seedlot Number	Seedlot Rating	Breeding Series	Description
Seedlings	All	FRI79/2320	GF7	'climbing select'	Kaingaroa climbing select
Seedlings	All	88/105	GF14	'850'	OP mix of '850' series
Seedlings	All	88/201	GF15	'268'	OP mix ex Brightwater orchard
Seedlings	All	89/708	GF25	'268'	CP mix of top 16 '268' clones
Seedlings	FR 121/1, 2,3,5,6	89/15	GF13(LI25)	'870'	OP mix of 7 long internode clones

BASIC FIELD PROCEDURES

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

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

The field work then proceeded as follows.

1) Pruning and marking for thinning

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

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 5 x 4m spacing (500stems/ha). Treatments 3, 5, 6 and 7, which were all planted at 5 x 2 spacing, had 162 trees in the original plots. The buffers in these plots were increased so that the inner PSP plot had a smaller number of trees (28, 36 and 50 respectively) reducing remeasurement time and costs. The size of the PSP plots range from 0.0500 to 0.1960 ha (Table 5 shows the plot establishment specifications at all trials).

TABLE 5. PSP Plot establishment specifications

Trt	Plot Area	Row x tree spacing	No. trees planted	Initial no. trees buffer : plot	Final no. trees buffer : plot	Thinning ratio	Pruning	No. PSP plots
1	0.1960	5 x 8	81	32 49	13 20	2.5 : 1	4m crown left	3
2	0.0980	5 x 4	81	32 49	13 20	2.5 : 1	4m crown left	5
3	0.0700	5 x 2	162	92 70	37 28	2.5 : 1	4m crown left	3
4	0.0980	5 x 4	81	32 49	13 20	2.5 : 1	None	3
5 #	0.0700	5 x 2	162	92 70	37 28	2.5 : 1	None	3
6	0.0600	5 x 2	162	102 60	60 36	1.7 : 1	None	3
7	0.0500	5 x 2	162	112 50	112 50	1 : 1	None	5
8 *	0.1607	5 x 2.8	117	40 77	17 32	2.4 : 1	None	5

Trial FR 121/3, Gwavas Forest, does not have the standard treatment 5 (see individual trial design).

* Treatment 8 is planted at FR 121/2, Atiamuri Forest only.

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

- The width of the buffer zone was determined (Table 6 shows the number of buffer rows for each treatment) and pegs were placed in the four corners of the permanent sample plot (Appendix 1).
- The northwest corner peg was labelled with the plot identification and seedlot GF rating.

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

3) Thinning

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

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

TABLE 6. Width of buffer zone for PSP plots

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

INDIVIDUAL TRIAL DESIGNS AND PSP ESTABLISHMENT REPORTS

FR 121/1 - TUNGROVE Forest, Northland

This trial was planted in July 1990 with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). The trial occupies 4.54 hectares. The compartment, including the trial area was fertilised by helicopter in September 1995.

The first measurements (of total height only), were taken in April 1992 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during September 1995 (age 5.3 years). The trial MCH at the time of plot establishment after thinning was 7.2m with a range of 6.2 to 8.0m.

Trial Design

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

TABLE 7. Trial design for FR 121/1, Tungrove Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
		Initial	Final	MCH (m)	Ratio	GF7 (FRI79/2320)	GF14 (88/105)	GF16 (88/201)	GF25 (89/708)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•

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

Pruning

Pruning of the 11 plots was carried out at age 5.3 (September 1995) by a Carter Holt Harvey Forest mensuration crew between the 11-15 September 1995 (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 4.2m (mean pruned height was 3m). Pruned heights and DOS measurements (DOS, DOS height and maximum branch diameter) of the selected height trees were measured at the time of plot establishment.

PSP Plot Establishment

Four Forest Research field crew established twenty-five permanent sample plots between 11-21 September 1995 (a total 30 mandays). Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7).

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

Thinning

Thinning was carried out by **Forest Research** field staff following plot establishment beginning on 19 September 1995. Twenty of the 25 plots were thinned as scheduled.

Trial Layout and Site Information

All twenty-five plots planted were established as PSPs at this site (see map, Figure 1). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6.

Regeneration was hand pulled at this site in April 1992, just prior to measuring the 2 year heights, with further regeneration removal in February 1994, September 1995 at the time of thinning and in April 1998 during plot remeasurement. Regeneration is now under control, but the southwest corner (particularly plots 1 and 2 which have only 100 stems/ha) of the trial has problems with thick gorse infestation and access to trees is difficult in places. The site also has a large amount of pampas and hardwood shrub undergrowth but this does not seem to be affecting growth.

A considerable amount of needle yellowing was noticed at plot establishment due to a nutrient deficiency. Fertilising by helicopter was carried out in September 1995 over the whole stand.

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

Altitude:	155m
Soil Type:	Awarua Clay series
Site Preparation:	Line raked at 5m centres, aerial sprayed in April 1990
Weeds:	Inkweed and small amounts of gorse
Regeneration:	Some Radiata
Slope:	Gentle slope up to 5°
Aspect:	West
Previous land use:	Radiata pine plantation
Site:	Medium fertility, ex forest site

Plot Data

Summaries (Tables 8 & 9) at the time of the first winter measurement in April 1996 (age 6 years) and the 1999 winter remeasurement (age 9 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 9 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 20.1cm and the average maximum branch diameter is 4.1cm.

The following trends were noted:

- The 'long internode' seedlot is inconsistent in diameter growth, relative to the other seedlots, between treatments
- The GF7 seedlot is performing well in the 400 stems/ha plots, where the diameter growth is equivalent to both the GF13 and GF25 seedlots
- At age 9, the GF25 seedlot is performing much better than all other seedlots for unthinned and 200 stems/ha treatments
- The mean crown height for the unthinned, unpruned plots has risen to 1.9m by age 9

FIGURE 1. Map showing plot locations, FR 121/1

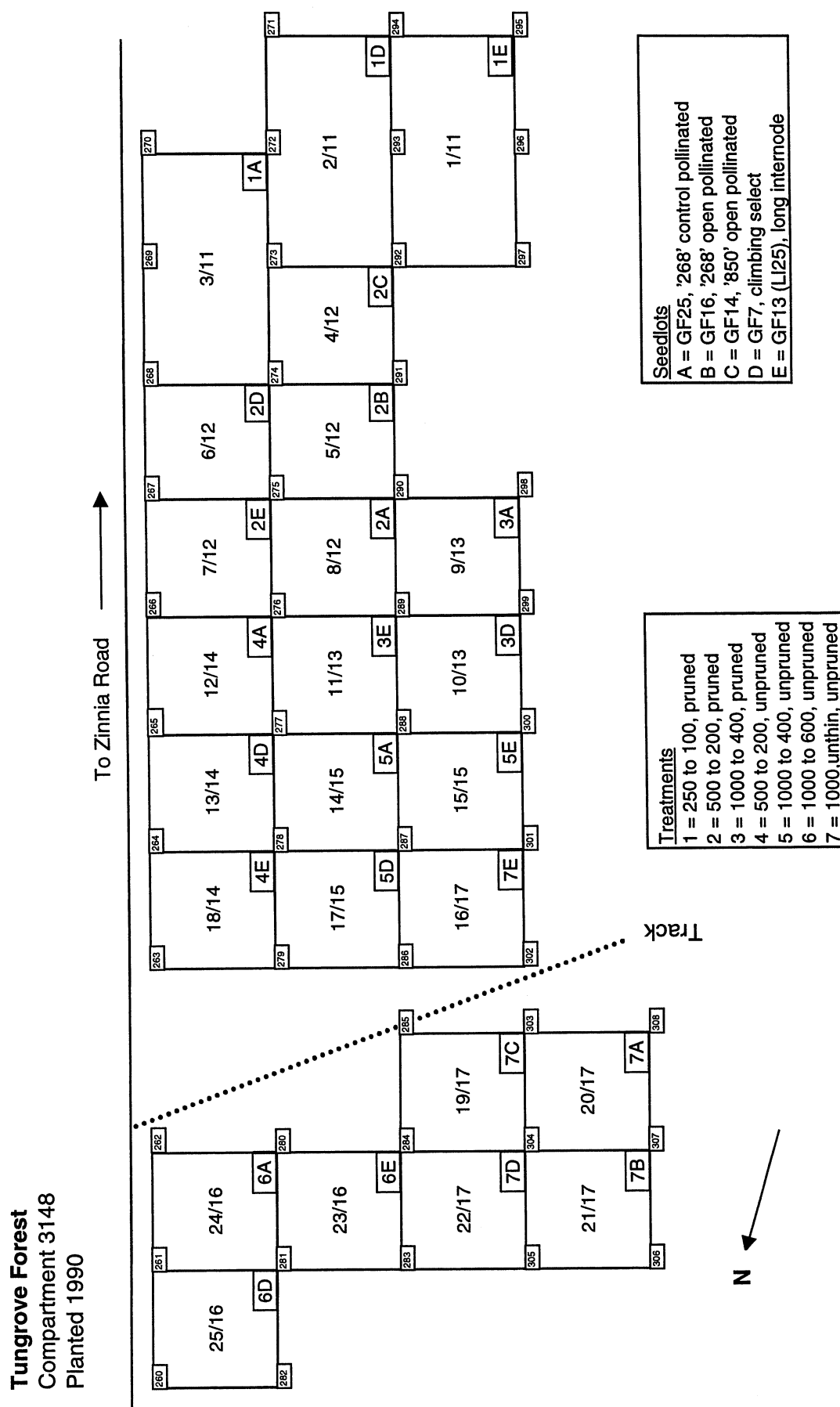


TABLE 8. FR 121/1: Trial data at the first winter measurement (April 1996) age 6.0

Trt	Seedlot	GF rating	SPH Estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS_HT	Max Branch
1	FRI79/2320	7	250	102	15.9	8.2	2.0	8.1	2.8	21.4	0.9	5.0
1	89/15	13	250	102	15.0	7.8	1.8	7.0	2.4	20.6	0.7	4.2
1	89/708	25	250	102	16.6	8.2	2.2	8.9	2.7	21.2	0.8	4.5
2	FRI79/2320	7	500	204	15.4	8.4	3.8	15.6	3.0	19.6	0.8	3.8
2	89/15	13	500	204	14.9	8.2	3.6	14.4	2.8	20.0	0.9	4.3
2	88/105	14	500	204	14.9	8.0	3.6	14.3	2.4	18.2	0.7	3.5
2	88/201	16	500	204	15.0	8.4	3.6	12.5	2.9	19.9	0.8	3.6
2	89/708	25	500	204	18.0	9.2	5.2	22.0	3.6	21.4	0.9	4.0
3	FRI79/2320	7	1000	400	14.5	9.3	6.6	29.1	3.6	20.3	0.8	4.4
3	89/15	13	1000	400	14.7	9.1	6.8	29.6	3.1	19.1	0.8	4.2
3	89/708	25	1000	400	15.1	9.4	7.2	31.8	3.5	19.7	0.9	3.6
4	FRI79/2320	7	500	204	14.5	7.9	3.4	13.5	0.0			
4	89/15	13	500	204	17.0	9.3	4.6	19.9	0.0			
4	89/708	25	500	204	16.9	8.3	4.6	18.4	0.0			
5	FRI79/2320	7	1000	386	15.8	9.7	7.6	34.8	0.0			
5	89/15	13	1000	400	14.3	9.4	6.4	29.3	0.0			
5	89/708	25	1000	414	15.0	8.7	7.3	30.8	0.0			
6	FRI79/2320	7	1000	600	13.3	8.6	8.4	36.2	0.0			
6	89/15	13	1000	600	14.8	9.9	10.3	47.9	0.0			
6	89/708	25	1000	600	14.2	8.9	9.6	41.4	0.0			
7	FRI79/2320	7	1000	800	14.2	9.7	12.6	58.3	0.0			
7	89/15	13	1000	980	12.6	9.3	12.2	54.4	0.0			
7	88/105	14	1000	760	14.7	9.3	12.9	59.4	0.0			
7	88/201	16	1000	1000	12.8	9.2	12.9	57.9	0.0			
7	89/708	25	1000	940	14.2	9.8	14.9	67.7	0.0			

TABLE 9. FR 121/1: Trial data from measurements at age 9.0 (April 1999)

Trt	Seedlot	No. plots	GF rating	SPH Etab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT
1	FRI79/2320	1	7	250	102	27.0	13.0	5.9	30.4	2.9
1	89/15 (LI25)	1	13	250	102	27.3	12.0	6.0	28.7	2.3
1	89/708	1	25	250	102	28.4	13.0	6.5	33.4	2.7
2&4	FRI79/2320	2	7	500	204	25.3	13.2	10.3	54.4	1.9
2&4	89/15 (LI25)	2	13	500	204	26.9	13.7	11.6	62.9	2.0
2	88/105	1	14	500	204	25.6	13.7	10.5	57.5	2.4
2	88/201	1	16	500	204	24.2	13.5	9.4	49.8	2.9
2&4	89/708	2	25	500	204	28.9	14.1	13.4	72.7	2.3
3&5	FRI79/2320	2	7	1000	393	23.8	15.6	17.4	106.9	2.2
3&5	89/15 (LI25)	2	13	1000	400	23.5	15.1	17.3	103.7	2.1
3&5	89/708	2	25	1000	407	23.5	14.4	17.6	101.0	2.7
6	FRI79/2320	1	7	1000	600	20.4	13.7	19.6	112.3	1.6
6	89/15 (LI25)	1	13	1000	600	22.2	16.1	23.3	149.0	1.9
6	89/708	1	25	1000	600	21.9	14.8	22.7	135.1	1.5
7	FRI79/2320	1	7	1000	800	20.4	15.8	26.2	166.4	1.6
7	89/15 (LI25)	1	13	1000	980	18.5	14.8	26.4	161.2	1.5
7	88/105	1	14	1000	740	21.4	15.7	26.7	172.6	1.9
7	88/201	1	16	1000	1000	18.2	15.3	26.1	164.9	2
7	89/708	1	25	1000	940	20.5	16.6	31.0	202.8	2.3

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

FR 121/2, ATIAMURI Forest, Central North Island

This trial was planted in June 1990 with an unbalanced split-split block design containing 27 rectangular 45 x 36m plots and 5 rectangular 45 x 72m plots (a total of 32 plots). The trial occupies 6.0 hectares.

The first measurements (of total height only) were taken in May 1992 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during February, 1995 (age 4.9 years). The trial MCH at the time of plot establishment was 7.1m, with a range of 6.2 to 8.2m.

Trial Design

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

TABLE 10 Trial design for FR 121/2, Atiamuri Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
		Initial	Final	MCH (m)	Ratio	GF7 (FRI79/2320)	GF14 (88/105)	GF16 (88/201)	GF25 (89/708)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	• ¹⁾			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•
8	"	722	300	6.2	2.4:1	•	•	•	•	•

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

¹⁾ Plot pruned illegally in October 1995 by local staff, treatment now equivalent to treatment 2

Pruning

Prior to silvicultural treatments and plot establishment, tracks were slashed by **Forest Research** staff through the thick blackberry undergrowth to allow easier access. This work increased the time taken to complete trial establishment.

Pruning was carried out by Carter Holt Harvey Forests contractors on 31 January 1995. The trial took eight people one day to prune. The average crown remaining of pruned plots was 4.7m (mean pruned height of 2.5m). Selection for thinning was carried out by **Forest Research** staff at the same time and only selected crop trees were pruned. Pruned heights and DOS measurements (DOS, DOS height and maximum branch diameter) of the selected height trees were measured at the time of plot establishment.

One plot (11/14) was mistakenly pruned by local staff after plot establishment, at the time the surrounding stand was being pruned (October 1995), this plot is now equivalent to treatment 2.

PSP Plot Establishment

Four Forest Research field staff established thirty-two permanent sample plots (38 mandays) with the help of Carter Holt Harvey contractors (12 mandays). Plot establishment, carried out over a three-week period, due to other commitments by field staff, was completed on February 22. Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-8).

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

Thinning

Thinning of the twenty-five plots was carried out by **Forest Research** staff and helped by Carter Holt Harvey contractors (2 days in total), immediately following the plot establishment. All thinned plots were established at the prescribed final crop stocking.

Trial Layout and Site Information

All 32 plots planted were established as PSPs at this site (see map, Figure 2). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6. At the time of planting no regeneration was present and blackberry was minimal, but by age 4 both were causing a problem.

In March 1994, regeneration was removed with slashers by GTI staff and Carter Holt Harvey Forest contractors. It was noted at the time that the trees were in good health and survival was also good but heavy blackberry covered most of the site, especially in the closely spaced plots. The blackberry was slashed heavily at the time of plot establishment, forming access tracks throughout the trial. The rapid growth of the blackberry has ensured that it has always been a major hindrance for measurement crews, but the trees appeared to be growing well still at the latest measurement in 1999. It was noted that there was evidence of bad *Dothistroma* in both 1996 and 1997, which may have caused an unusual rise in the green crown level.

The following information was recorded at the time of planting:

Altitude:	295m
Soil Type:	Central yellow/brown loam
Site Preparation:	Line raked and ripped to 5m centres
Weeds:	Small amount of blackberry
Regeneration:	Nil
Slope:	Gentle slope to 5°
Aspect:	North
Previous land use:	Radiata pine plantation
Site:	Medium fertility, ex forest site

Plot data

Summaries (Tables 11 & 12) at the time of the first winter measurement in August 1996 (age 5.2 years) and the 1999 winter remeasurement (age 9.2 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 9 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 17.5cm and the average maximum branch diameter is 3.4cm.

The effects of *Dothistroma* are seen in the unusually high green crown heights:

- In the pruned treatment 3, the green crown level increased from the pruned height of 3m to a crown height of 4.2m by age 9.
- Similarly in all the unpruned plots, the mean crown height had risen from zero to 4.2m by age 9.

The following trends were noted:

- The GF7 seedlot has the lowest diameter growth in all the treatments except 3 and 6.
- The GF14 seedlot is performing exceptionally well at the 200 stems/ha treatment by age 9, but this data only represents one plot.
- At age 9, the GF25 seedlot is performing better than all other seedlots for both diameter and height growth at all treatments.

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

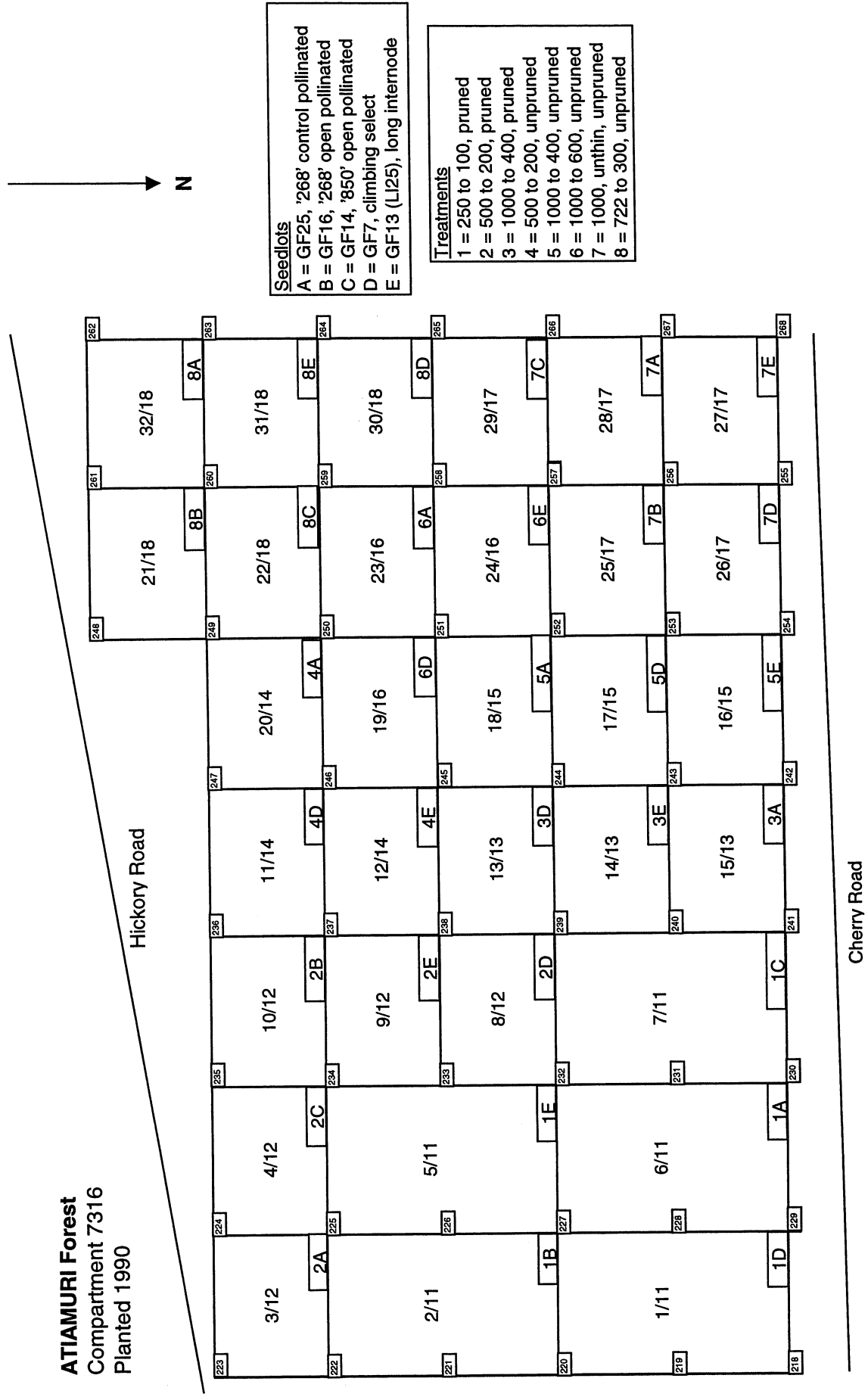


TABLE 11. FR 121/2: Trial data at the first winter measurement (August 1995) age 5.2

Trt	Seedlot	GF rating	SPH Estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS_HT	Max Branch
1	FRI79/2320	7	250	102	13.6	6.8	1.5	4.4	2.1	17.2	0.9	3.3
1	89/15	13	250	102	13.2	6.6	1.4	4.0	2.2	17.4	0.9	3.4
1	88/105	14	250	102	14.4	7.4	1.7	5.2	2.4	17.8	1.1	3.4
1	88/201	16	250	102	14.1	6.7	1.6	4.6	2.0	17.0	0.9	3.5
1	89/708	25	250	102	15.1	7.3	1.8	5.5	2.7	20.0	0.7	3.8
2	FRI79/2320	7	500	204	13.7	7.0	3.0	9.2	2.3	17.0	0.8	3.3
2	89/15	13	500	204	14.1	6.7	3.2	9.2	2.2	18.2	1.0	4.2
2	88/105	14	500	204	14.2	7.2	3.2	9.8	2.6	17.5	1.1	3.5
2	88/201	16	500	204	13.7	6.9	3.0	9.0	2.5	16.0	1.1	2.6
2	89/708	25	500	204	14.4	7.4	3.3	10.5	2.5	17.0	1.1	3.5
3	FRI79/2320	7	1000	386	13.1	7.8	5.2	17.0	2.8	17.3	0.9	3.1
3	89/15	13	1000	414	12.9	7.5	5.4	17.5	2.7	16.7	1.4	3.7
3	89/708	25	1000	400	14.6	8.6	6.7	23.4	3.4	19.0	1.0	3.0
4	FRI79/2320	7	500	204	13.2	7.2	2.8	8.7	0.0			
4	89/15	13	500	204	13.6	7.2	3.0	9.2	0.0			
4	89/708	25	500	204	14.7	7.7	3.5	11.0	0.0			
5	FRI79/2320	7	1000	400	14.9	8.1	7.0	23.7	0.0			
5	89/15	13	1000	400	15.1	8.2	7.1	24.5	0.0			
5	89/708	25	1000	400	15.7	8.3	7.8	26.4	0.0			
6	FRI79/2320	7	1000	600	12.9	7.3	7.8	24.5	0.0			
6	89/15	13	1000	600	13.7	7.3	8.8	27.7	0.0			
6	89/708	25	1000	600	13.7	7.7	8.9	29.2	0.0			
7	FRI79/2320	7	1000	960	12.4	7.1	11.5	37.9	0.0			
7	89/15	13	1000	960	13.3	7.8	13.4	43.1	0.0			
7	88/105	14	1000	980	13.5	8.0	14.0	47.4	0.0			
7	88/201	16	1000	1000	12.8	8.1	12.9	43.8	0.0			
7	89/708	25	1000	980	13.8	8.8	14.7	54.2	0.0			
8	FRI79/2320	7	722	300	14.8	8.1	5.2	17.3	0.0			
8	89/15	13	722	300	14.9	7.6	5.2	16.2	0.0			
8	88/105	14	722	300	14.9	7.7	5.2	16.6	0.0			
8	88/201	16	722	300	14.4	7.7	4.9	15.8	0.0			
8	89/708	25	722	300	15.5	8.2	5.7	19.1	0.0			

TABLE 12. FR 121/2: Trial data from measurements at age 9.2 (August 1999)

Trt	Seedlot	No. plots	GF rating	SPH Estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT
1	FRI79/2320	1	7	250	97	33.6	13.2	8.6	37.4	1.9
1	89/15	1	13	250	102	34.1	14.6	9.3	44.7	2.6
1	88/105	1	14	250	102	34.7	15.0	9.7	47.4	2.4
1	88/201	1	16	250	102	34.8	14.2	9.7	45.1	2.0
1	89/708	1	25	250	102	36.0	15.0	10.4	50.4	2.5
2&4	FRI79/2320	2	7	500	204	29.8	15.0	14.2	74.0	3.4
2&4	89/15	2	13	500	204	32.4	15.0	16.7	83.4	2.7
2	88/105	1	14	500	204	33.8	15.8	18.4	96.5	2.5
2	88/201	1	16	500	204	32.0	15.6	16.4	85.2	2.8
2&4	89/708	2	25	500	204	33.1	16.0	17.5	92.9	2.6
3&5	FRI79/2320	2	7	1000	393	28.0	16.3	24.2	136.2	4.4
3&5	89/15	2	13	1000	407	27.7	15.7	24.5	133.8	4.0
3&5	89/708	2	25	1000	400	29.9	16.9	28.1	162.8	4.8
6	FRI79/2320	1	7	1000	600	25.1	15.6	29.8	168.1	5.5
6	89/15	1	13	1000	600	23.7	15.9	26.4	155.2	4.6
6	89/708	1	25	1000	600	25.3	16.7	30.3	180.9	4.6
7	FRI79/2320	1	7	1000	960	20.8	15.8	32.7	196.6	4.7
7	89/15	1	13	1000	960	21.9	16.0	36.1	217.0	4.9
7	88/105	1	14	1000	960	21.9	16.6	36.1	219.3	5.8
7	88/201	1	16	1000	1000	20.8	16.7	33.9	207.8	4.9
7	89/708	1	25	1000	980	22.9	17.7	40.5	263.3	5.6
8	FRI79/2320	1	7	722	300	30.2	16.4	21.5	122.3	3.5
8	89/15	1	13	722	300	32.1	16.7	24.3	135.4	3.1
8	88/105	1	14	722	300	31.0	16.5	22.6	127.8	3.4
8	88/201	1	16	722	291	30.5	16.3	21.2	118.4	3.3
8	89/708	1	25	722	300	33.2	16.9	25.9	145.8	3.4

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

FR 121/3, GWAVAS Forest, Hawkes Bay

This trial was planted in July 1990, with an unbalanced split-split block design containing 19 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 22 plots). This trial occupies 4.1 hectares.

The first measurements (of total height only) were taken in June 1992 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during December 1995 (age 5.7 years). The trial MCH at the time of plot establishment was 6.5m, with a range of 5.9 to 7.7m.

Trial Design

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

TABLE 13. Trial design for FR 121/3, Gwavas Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF7 (FRI79/2320)	GF14 (88/105)	GF16 (88/201)	GF25 (89/708)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	•
5	"	1000	600	6.2	1.7:1	•			•	•
6	"	1000	1000	-	1:1	•	•	•	•	•

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

There is no unpruned treatment thinned from 1000 to 400 stems/ha at this site, as there was not enough contiguous land available at the site.

Pruning

Pruning was carried out by Carter Holt Harvey Forests contractors on 4 December 1995 (age 5.7 years). The trial took seven people one day to prune. Selection for thinning was carried out by **Forest Research** staff at the same time, and only selected crop trees were pruned. The average crown remaining of the pruned plots was 4.8m (mean pruned height was 2.6m). Pruned heights and DOS measurements (DOS, DOS height and maximum branch diameter) of the selected height trees were measured at the time of plot establishment.

PSP Plot Establishment

Forest Research staff established twenty-two permanent sample plots with the help of Carter Holt Harvey Forest contractors on the 5-6 December 1995. Establishment was carried out over 2 days (a total of 10 mandays). Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-4, 6, 7).

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

Thinning

Thinning was carried out by Carter Holt Harvey Forest contractors under supervision of **Forest Research** field staff, on 6 December 1995 (a total of 4 mandays). Seventeen of the 22 plots were thinned as scheduled.

All thinned plots had a significant number of dead or windthrown trees. In all cases, except plot 16/15, the prescribed stocking was achieved, although much fewer trees were actually felled. More than 50% of the trees in plot 16/15 were dead before plot establishment. The remaining plot stocking was 433 stems/ha instead of 600 stems/ha.

Trial Layout and Site Information

All twenty-two plots planted were established as PSPs at this site (see map, Figure 3). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6.

It was noted that blocks 4A and 6E (plots 15 and 18 respectively) have problems with water runoff from the farmland after heavy rain. There was some mortality particularly in block 4A, but as this block was to be thinned to 200 stems/ha this was accounted for in the thinning. There does not seem to be any significant growth differences at age 9.

Regenerating radiata pine was first removed by GTI staff at age 2, then again using slashers and chainsaws at age 5 (June 1995). There were some scattered patches of regeneration that were also removed at the time of plot establishment (December 1995).

At plot establishment, there were scattered toppled trees throughout the trial, which usually showed evidence of poor planting. Further toppling has occurred in 8 of the plots. Grazing at an early age possibly caused the mortality shown at plot establishment. This was significant in four of the five unthinned plots. These plots were

planted at 1000 stems/ha but had an average stocking of 700 stems/ha at plot establishment. Plot 22/16 had 50% mortality, consequently this plot should not be used in the analysis of the unthinned plots.

The following information was recorded at the time of planting:

Altitude:	410m
Soil Type:	Maungatahi sandy loam
Site Preparation:	Root raked of logging slash, burnt windrows
Weeds:	Broadleaf weeds and bracken fern
Regeneration:	Nil, possible in the future
Slope:	Gentle slope up to 5°
Aspect:	East-northeast
Previous land use:	Radiata pine plantation
Site:	Low fertility, ex forest site

Plot data

Summaries (Tables 14 & 15) at the time of the first winter measurement in May 1996 (age 6 years) and the 1999 winter remeasurement (age 9 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 9 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 20.7cm and the average maximum branch diameter is 4.4cm.

The following trends were noted:

- The green crown level on the pruned plots had not risen by age 9
- The green crown height of the unpruned plots in treatment 4 (200 stems/ha) remains at 0.5m, while the rest of the unpruned plots have had a small rise only in green crown (average 2.1m)
- The GF25 seedlot is not performing well at this site, particularly in height growth

FIGURE 3. Map showing plot locations, FR 121/3

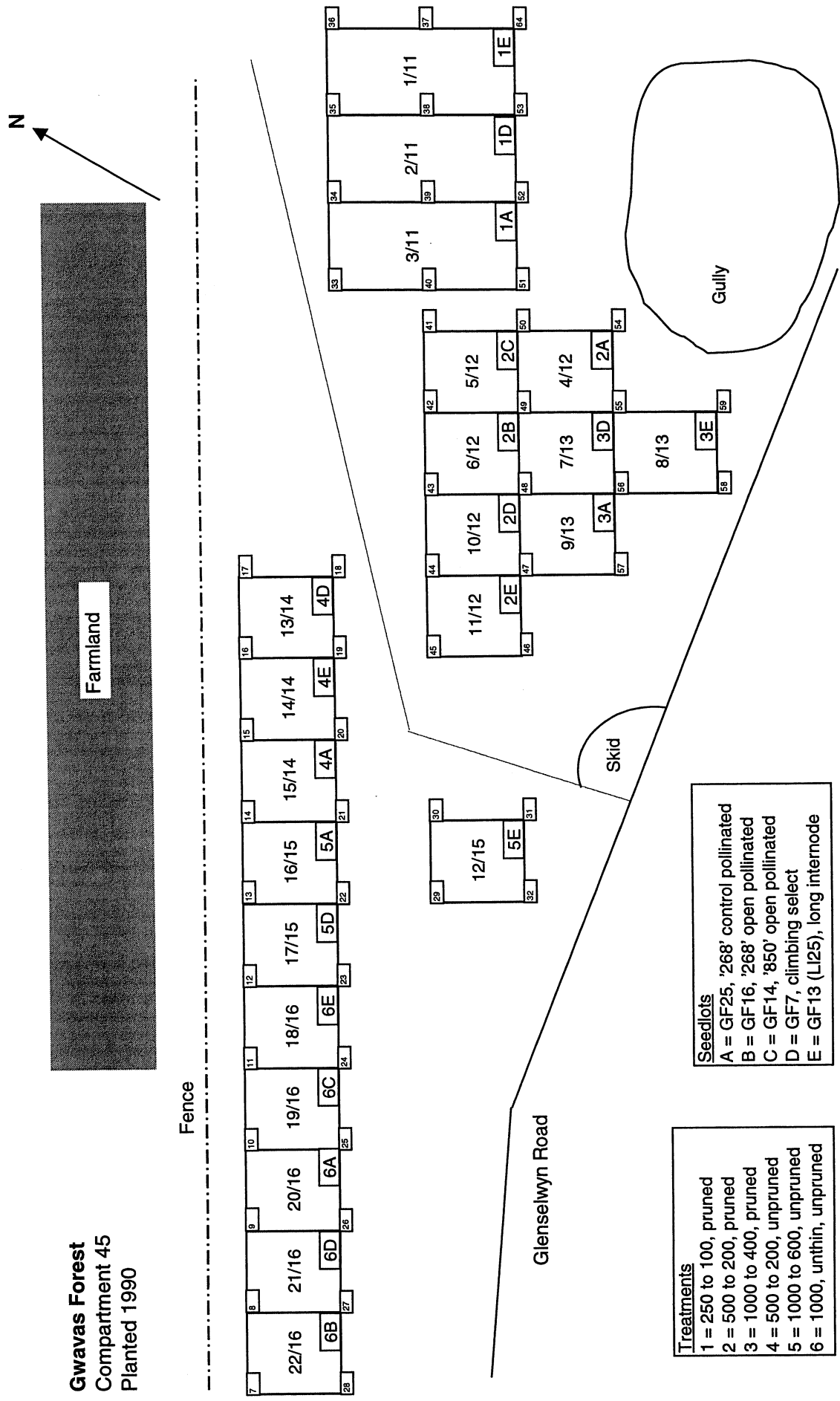


TABLE 14. FR 121/3: Trial data at the first winter measurement (May 1996) age 6.0

Trt	Seedlot	GF rating	SPH Etab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS_HT	Max Branch
1	FRI79/2320	7	250	102	14.9	6.4	1.8	5.3	1.8	20.0	0.7	4.6
1	89/15	13	250	102	15.4	6.3	1.9	5.7	1.9	20.9	0.5	4.4
1	89/708	25	250	102	16.6	6.9	2.2	6.8	2.3	21.6	0.8	4.5
2	FRI79/2320	7	500	204	16.1	7.6	4.1	14.0	2.7	20.5	0.8	4.5
2	89/15	13	500	204	15.1	7.5	3.7	12.6	2.6	20.2	0.8	4.9
2	88/105	14	500	204	16.0	7.2	4.1	13.4	2.6	21.9	0.8	4.6
2	88/201	16	500	204	16.7	7.6	4.5	15.0	2.8	22.3	0.6	5.3
2	89/708	25	500	204	16.4	7.3	4.3	14.2	2.7	21.1	0.6	4.6
3	FRI79/2320	7	1000	400	15.9	8.0	8.0	28.8	3.1	20.2	0.7	3.4
3	89/15	13	1000	400	15.1	8.5	7.2	27.0	2.9	19.8	0.7	4.1
3	89/708	25	1000	400	16.0	8.2	8.1	29.2	3.0	19.6	0.8	3.8
4	FRI79/2320	7	500	204	16.8	7.0	4.5	14.4	2.6	20.7	0.7	4.4
4	89/15	13	500	204	15.7	7.0	3.9	12.3				
4	89/708	25	500	204	16.5	7.4	4.4	14.2				
5	FRI79/2320	7	1000	600	15.7	8.1	11.6	41.4				
5	89/15	13	1000	600	16.8	8.8	13.4	51.0				
5	89/708	25	1000	417	15.7	7.6	8.1	28.1				
6	FRI79/2320	7	1000	700	14.6	7.5	11.7	39.5				
6	89/15	13	1000	860	14.4	8.2	14.0	50.3				
6	88/105	14	1000	940	15.0	9.0	16.6	65.8				
6	88/201	16	1000	500	14.6	6.9	8.4	26.1				
6	89/708	25	1000	720	15.6	8.2	13.7	48.8				

TABLE 15. FR 121/3: Trial data from measurements at age 9.0 (May 1999)

Trt	Seedlot	No. plots	GF rating	SPH Estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT
1	FRI79/2320	1	7	250	102	28.8	10.8	6.7	27.0	1.8
1	89/15	1	13	250	97	29.6	10.6	6.7	26.2	1.8
1	89/708	1	25	250	92	29.9	10.6	6.5	25.6	2.0
2&4	FRI79/2320	2	7	500	199	29.3	12.3	13.4	60.9	1.7
2&4	89/15	2	13	500	184	28.4	11.9	11.5	51.6	1.7
2	88/105	1	14	500	163	27.2	11.6	9.5	41.3	2.4
2	88/201	1	16	500	204	27.3	12.2	12.0	54.7	3.0
2&4	89/708	2	25	500	179	30.1	11.4	12.8	54.2	1.6
3	FRI79/2320	1	7	1000	400	25.5	12.2	20.4	96.2	3.2
3	89/15	1	13	1000	400	25.3	12.8	20.2	100.4	3.1
3	89/708	1	25	1000	400	26.0	12.4	21.3	100.9	3.2
5	FRI79/2320	1	7	1000	600	25.9	12.7	31.5	153.8	1.9
5	89/15	1	13	1000	600	26.8	12.8	33.9	165.8	2.3
5	89/708	1	25	1000	417	28.1	12.0	25.9	117.2	1.4
6	FRI79/2320	1	7	1000	700	23.4	12.1	30.1	141.8	2.3
6	89/15	1	13	1000	860	23.5	12.2	37.3	173.4	2.3
6	88/105	1	14	1000	940	23.1	13.4	39.4	205.1	2.9
6	88/201	1	16	1000	480	25.3	11.0	24.1	99.2	1.2
6	89/708	1	25	1000	720	24.2	12.8	33.1	161.8	2.1

FR 121/4, TAIRUA Forest, Auckland Clays

This trial was planted in June 1990 with an unbalanced split-split block design containing 16 rectangular, 45 x 36m plots and 2 rectangular 45 x 72m plots (a total of 18 plots). The trial occupies 2.02 hectares.

The first measurements (of total height only) were taken in August 1992 (age 2.1 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during October 1994 (age 4.4 years). The trial MCH at the time of plot establishment was 7.3m, with a range of 6.5 to 8.1m.

It was agreed to allow horse grazing in this trial (with extreme care) to alleviate the severe weed problem from pampas and wattle, at an early age. Grazing for weed control continued from age 1 to 4, but was not totally successful. Suppression of crop trees by the wattle occurred in all plots.

Trial Design

This trial was designed with seven silvicultural treatments and four different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 16).

The long internode seedlot, 89/15, was not planted at this site.

TABLE 16. Trial design for FR 121/4, Tairua Forest

Trt	Silviculture					Planting stock			
	Pruning	Stocking (stems/ha)		Thinning		Seedlings			
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF7 (FRI79/2320)	GF14 (88/105)	GF16 (88/201)	GF25 (89/708)
1	4m	250	100	6.2	2.5:1	•			•
2	"	500	200	6.2	2.5:1	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•
4	Unpruned	500	200	6.2	2.5:1	•			•
5	"	1000	400	6.2	2.5:1	•			•
6	"	1000	600	6.2	1.7:1	•			•
7	"	1000	1000	-	1:1	•	•	•	•

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

Pruning

Pruning of the 8 plots was carried out by Carter Holt Harvey contractors, beginning on 10 October, 1994. The average crown length remaining after pruning was 4.4m (mean pruned height 2.9m).

Pruning was slower than expected as ladders had to be used on some trees which were required to be pruned up to 4.0m. 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.

Several plots and buffers were mistakenly pruned by local staff, after plot establishment, at the time the surrounding stand was being pruned (summer 1994/95).

PSP Plot Establishment

Three **Forest Research** staff established eighteen permanent sample plots beginning on 11 October and completed on 19 October 1994. The undergrowth hindrance contributed to slow plot establishment. Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7).

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

Thinning

Thinning of the 14 plots was carried out by **Forest Research** field staff, following plot establishment and was completed by 19 October 1994. All plots were thinned according to the schedule. The Acacia (wattle) trees present at this time were also removed.

Several areas of buffer were mistakenly thinned by local staff, after plot establishment, at the time the surrounding stand was being thinned (summer 1994/95).

Trial Layout and Site Information

All eighteen plots planted were established as PSPs at this site (see map, Figure 4). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6. The long internode seedlot, 89/15, was not planted at this site.

Parts of this trial area were thinned and pruned in error by Carter Holt Harvey contractors after plot establishment (details are given under 'plot data').

A severe weed problem from pampas and wattle has persisted throughout the life of the trial up to the time of plot establishment, even though grazing was allowed in an attempt to reduce the problem. No grazing damage to trees was seen. There has been a recurrence of the pampas and acacia growth since the trial was cleared at plot establishment, although this does not seem to be affecting growth.

The following information was recorded at the time of planting:

Altitude:	4m
Soil Type:	Whangamata gravelly sandy loam
Site Preparation:	Burnt
Weeds:	Pampas, wattle, blackberry
Regeneration:	Coppicing of <i>Eucalyptus regnans</i> and Redwood
Slope:	Flat
Previous land use:	<i>Eucalyptus regnans</i> plantation
Site:	High fertility, ex forest site (oversown with lotus after the Eucalypt crop failed)

Plot data

Summaries (Tables 17 & 18) at the time of the first winter measurement in August 1995 (age 5.2 years) and the 1999 winter remeasurement (age 9.1 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 9 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 18.7cm and the average maximum branch diameter is 3.8cm.

All plots in treatments 1, 2 & 3 (originally low pruned) were medium pruned in error during the summer 1994/95. The mean prune height for these plots is now 4.7m. Also all the buffers around the unpruned plots were pruned and thinned at the same time.

At the time of plot establishment all plots had varying amounts of mortality from low to high. The final crop stocking in the thinned plots was always achieved though, although in some cases very few trees were felled. Mortality also occurred in the unthinned plots (treatment 7) which resulted in a mean stocking for the 1000 stems/ha plots of 725 stems/ha.

The following trends were noted:

- The green crown level has risen quickly in the unpruned plots. The average green crown height at age 9 is 4.2m, with one plot (17/17, unthinned at 1000 stems/ha) at 6.5m
- The rise in green crown level, particularly in the unthinned plots, is probably attributed to the dense undergrowth still present at age 9
- In all treatments, the GF25 seedlot is performing better than the GF7 seedlot for both diameter and height growth

FIGURE 4 Map showing plot locations, FR 121/4

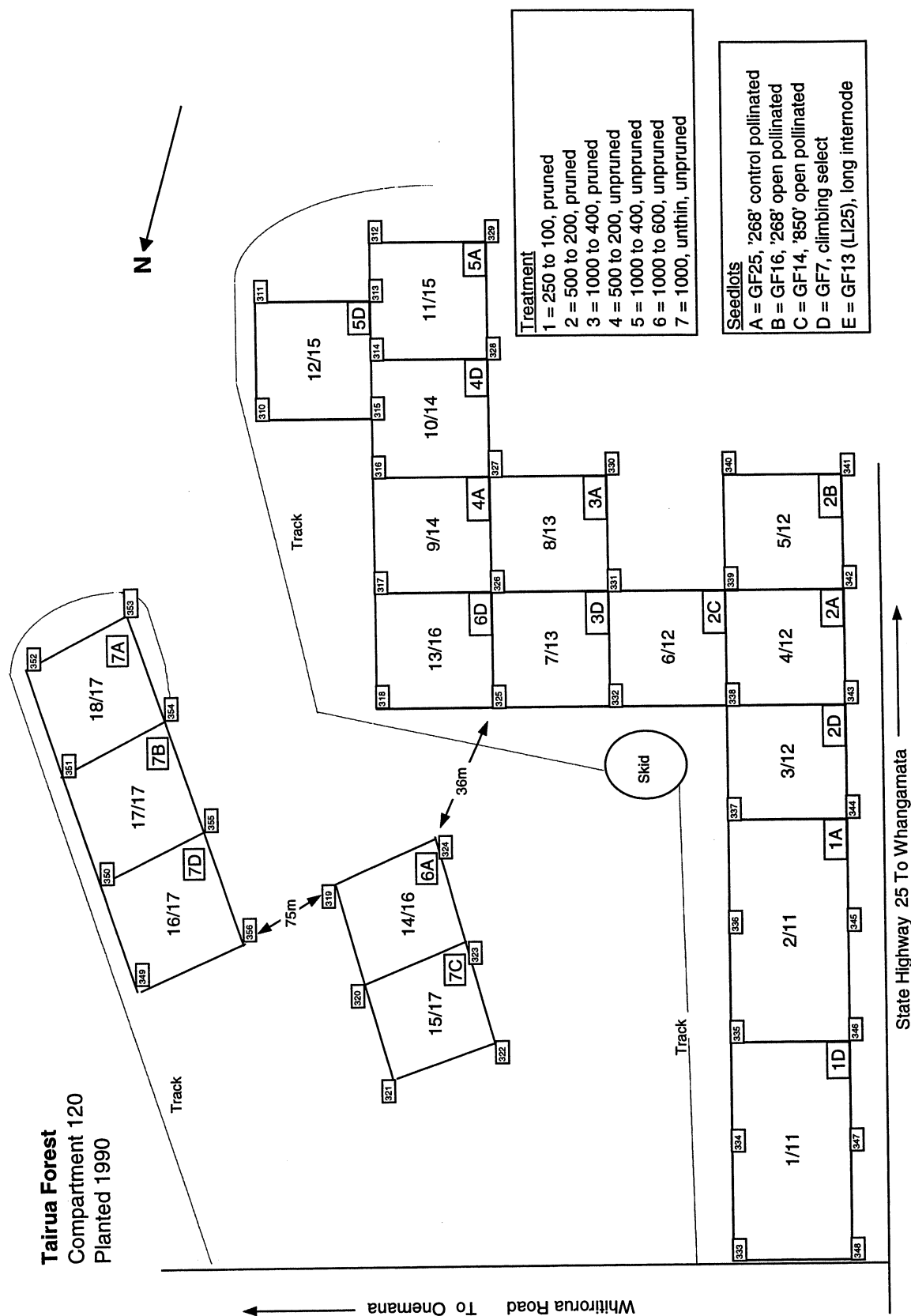


TABLE 17. FR 121/4: Trial data at the first winter measurement (August 1995) age 5.2

Trt	Seedlot	GF rating	SPH Etab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS_HT	Max Branch
1	FRI79/2320	7	250	102	13.3	6.8	1.4	4.5	2.4	18.0	0.9	4.4
1	89/708	25	250	102	13.8	6.9	1.5	4.9	2.4	19.3	1.0	4.6
2	FRI79/2320	7	500	204	12.2	7.1	2.4	7.7	3.0	19.3	0.8	4.1
2	88/105	14	500	204	12.5	7.0	2.5	8.0	2.4	19.3	0.6	3.5
2	88/201	16	500	194	13.2	7.5	2.6	8.9	3.0	19.6	0.6	3.6
2	89/708	25	500	204	13.5	7.2	2.9	9.4	3.1	19.3	0.7	3.8
3	FRI79/2320	7	1000	400	11.9	7.4	4.5	15.1	3.2	17.1	0.8	3.1
3	89/708	25	1000	400	12.5	8.1	4.9	17.7	3.7	17.9	0.7	3.1
4	FRI79/2320	7	500	204	12.8	7.0	2.6	9.0	0.0			
4	89/708	25	500	204	13.3	7.3	2.8	9.2	0.0			
5	FRI79/2320	7	1000	400	11.6	6.8	4.2	14.0	0.0			
5	89/708	25	1000	400	12.6	7.6	5.0	17.4	0.0			
6	FRI79/2320	7	1000	600	9.7	7.6	4.4	15.5	0.0			
6	89/708	25	1000	600	11.6	8.0	6.4	22.8	0.0			
7	FRI79/2320	7	1000	640	9.9	6.5	4.9	15.6	0.0			
7	88/105	14	1000	680	10.4	7.1	5.7	18.9	0.0			
7	88/201	16	1000	880	11.5	7.5	9.2	31.6	0.0			
7	89/708	25	1000	760	11.9	7.2	8.4	28.1	0.0			

TABLE 18. FR 121/4: Trial data from measurements at age 9.1 (July 1999)

Trt	Seedlot	No. plots	GF rating	SPH Estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT
1	FRI79/2320	1	7	250	82	31.5	14.2	6.4	32.1	3.8
1	89/708	1	25	250	97	34.3	15.1	8.9	47.3	4.3
2&4	FRI79/2320	2	7	500	184	32.3	15.6	15.3	85.2	3.6
2	88/105	1	14	500	194	28.2	15.5	12.1	67.8	4.2
2	88/201	1	16	500	194	30.4	15.8	14.1	79.6	4.7
2&4	89/708	2	25	500	204	32.6	15.8	17.0	94.8	4.3
3&5	FRI79/2320	2	7	1000	393	26.4	16.6	21.7	132.6	3.6
3&5	89/708	2	25	1000	400	28.1	17.2	25.1	156.7	4.3
6	FRI79/2320	1	7	1000	583	25.2	16.4	29.1	175.6	4.3
6	89/708	1	25	1000	600	26.6	17.7	33.2	213.6	4.3
7	FRI79/2320	1	7	1000	620	24.2	16.9	28.5	175.9	4.0
7	88/105	1	14	1000	560	26.5	17.1	31.0	188.8	3.6
7	88/201	1	16	1000	880	24.3	18.7	40.8	283.4	6.5
7	89/708	1	25	1000	740	25.8	18.5	38.8	260.4	4.7

FR 121/5, HOKONUI Forest, Southland

This trial was planted in August 1990 with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 5 rectangular 45 x 72m plots (a total of 27 plots). The trial occupies 5.2 hectares.

The following information was recorded at the time of planting:

Altitude:	80m
Soil Type:	Lowland yellow/brown earths
Site Preparation:	Line raked with 5m centres
Weeds:	Gorse and blackberry
Regeneration:	Nil
Slope:	10°
Aspect:	North
Previous land use:	<i>Pinus nigra</i> plantation
Site:	High fertility, ex forest site

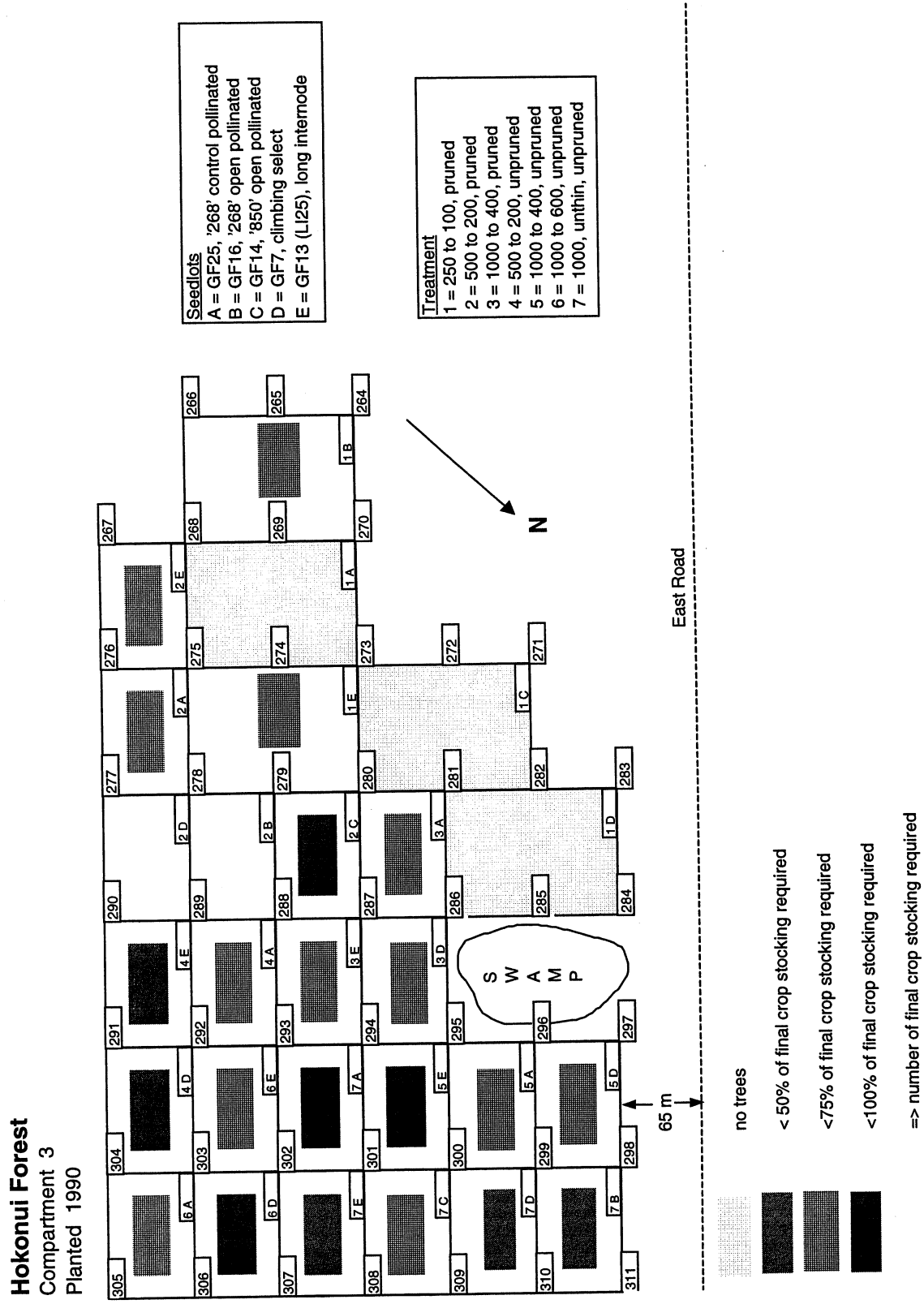
The first measurements of total height only were taken in June 1992 (age 2 years). It had been noted during **Forest Research** visits and on the six-monthly reporting forms that growth and survival in this trial was extremely variable. A heavy infestation of gorse and regeneration of other pine species compounded the problem of properly assessing the trial before plot establishment began.

In November 1997 (age 7) **Forest Research** staff and Rayonier NZ contractors began track cutting in the trial to establish plot boundaries and select trees for pruning. It was at this time that the severity of the mortality was discovered (see map of trial showing unstocked areas). Many of the trees had suffered from toppling and those trees that had been blown over recently had very poor root development. It is suspected that much of the mortality was due to windthrow, not suppression, and had occurred after the trial was measured for height at age two. The reason for this could be the lack of appropriate land preparation prior to planting.

Following consultation with Dr Sue Carson, the scientist responsible for the design and analysis of this series of silviculture/breed trials, and Rayonier NZ staff, it was agreed that the stocking in the trial was too low to establish plots at the prescribed final crop stocking, even without thinning. The results of any measurements taken at this trial could not justify any further costs by either Rayonier NZ or the Stand Growth Modelling Cooperative.

Regrettably this trial was abandoned in November 1997. No further measurements are planned.

FIGURE 5. Map showing loss of trees, FR 121/5



FR 121/6, TARAWERA Forest, Central North Island

This trial was planted in July 1990 with an unbalanced split-split block design containing 22 rectangular 45 x 36m plots and 3 rectangular 45 x 72m plots (a total of 25 plots). The trial occupies 4.5 hectares.

The first measurements of total height only were taken in April 1992 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during March 1995 (age 5 years). The trial MCH at the time of plot establishment was 7.0m, with a range of 6.2 to 8.0m.

Trial Design

This trial was designed with seven silvicultural treatments and five different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 19).

TABLE 19. Trial design for FR 121/6, Tarawera Forest

Trt	Silviculture					Planting stock				
	Pruning	Stocking (stems/ha)		Thinning		Seedlings				
	Crown remaining	Initial	Final	MCH (m)	Ratio	GF7 (FRI79/2320)	GF14 (88/105)	GF16 (88/201)	GF25 (89/708)	GF13 (LI25) (89/15)
1	4m	250	100	6.2	2.5:1	•			•	•
2	"	500	200	6.2	2.5:1	•	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•	•
4	Unpruned	500	200	6.2	2.5:1	•			•	•
5	"	1000	400	6.2	2.5:1	•			•	•
6	"	1000	600	6.2	1.7:1	•			•	•
7	"	1000	1000	-	1:1	•	•	•	•	•

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

Pruning

Pruning was carried out on 11 plots by Tasman Forestry contractors, under supervision by **Forest Research** staff, on 27 March 1995 (2 mandays work). Pruning was relatively easy due to small branches. 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 4.4m (mean pruned height 2.4m).

PSP Plot Establishment

Forest Research staff established twenty-five permanent sample plots between 26-29 March 1995 (a total of 17 mandays). Tasman forestry staff also assisted with the plot establishment. Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7). The trial had a large amount of small natural regeneration at the time of plot establishment. Tasman Forestry staff assisted in the removal by slashing and hand pulling all radiata pine regeneration at this time. Mortality in this trial was very low and was only noticeable in the unthinned (1000 stems/ha) plots.

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

Thinning

Thinning of the 20 plots was carried out by **Forest Research** field staff following plot establishment. All plots were thinned according to the schedule.

Trial Layout and Site Information

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

The following information was recorded at the time of planting:

Altitude:	60m
Soil Type:	Tarawera ash
Site Preparation:	Line raked and ripped to 5m centres
Weeds:	Nil
Regeneration:	Very little at time of planting
Slope:	Flat
Previous land use:	Radiata pine plantation
Site:	High fertility ex forest site

The trial has been oversown with grass and lotus. Radiata pine regeneration was not a problem at this site, although a large amount of very small trees were removed at the time of plot establishment. The overall condition of this trial is very good.

Plot data

Summaries (Tables 20 & 21) at the time of the first winter measurement in August 1995 (age 5.2 years) and the 1999 winter remeasurement (age 9.2 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 9 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 17.1cm and the average maximum branch diameter is 3.1cm.

The following trends were noted:

- The green crown level on the pruned plots had not risen by age 9 (average 2.5m)
- The green crown height of the unpruned plots in treatment 4 (200 stems/ha) had not risen, while the rest of the unpruned plots have had a significant rise in green crown (average 3.2m)
- The GF25 seedlot is not performing any better than the GF7 seedlot in treatment 1 (100 stems/ha)
- The GF25 seedlot is performing the best at all other treatments (nos. 2-7)
- The long internode seedlot, GF13, is performing very well, at age 9, in treatments 1 and 2

FIGURE 6 Map showing plot locations, FR 121/6

TARAWERA Forest

Compartment 30

Planted 1990

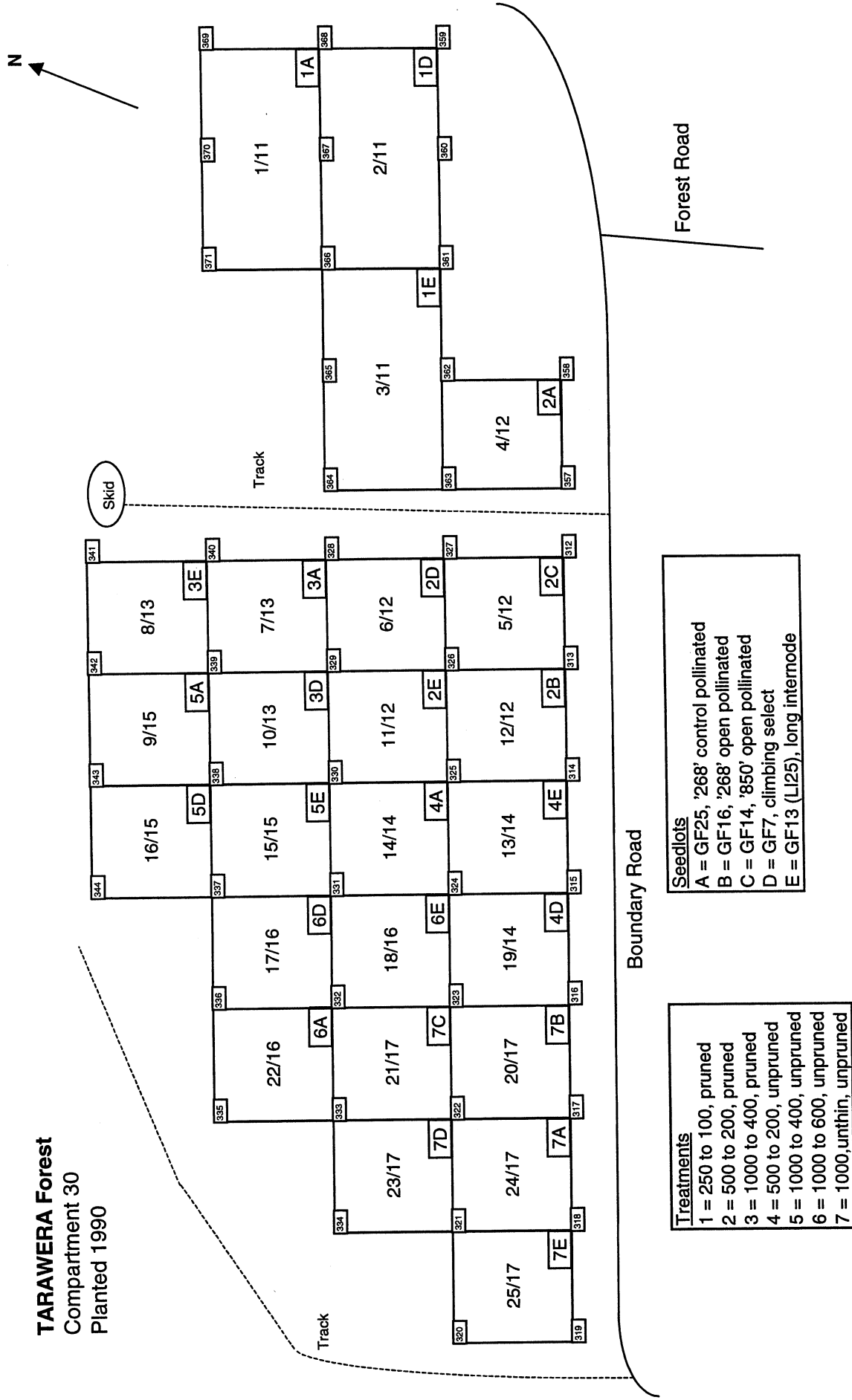


TABLE 20. FR 121/6: Trial data at the first winter measurement (August 1995) age 5.2

Trt	Seedlot	GF rating	SPH Etab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS_HT	Max Branch
1	FRI79/2320	7	250	102	11.7	6.2	1.1	3.1	2.1	17.5	0.6	3.2
1	89/15	13	250	102	12.4	6.6	1.2	3.6	2.2	19.3	0.6	3.7
1	89/708	25	250	102	12.1	6.5	1.2	3.4	2.4	17.1	0.8	3.4
2	FRI79/2320	7	500	204	11.6	7.1	2.1	6.8	2.4	16.5	0.7	3.2
2	89/15	13	500	204	12.0	7.0	2.3	7.4	2.2	17.9	0.7	3.3
2	88/105	14	500	204	12.9	7.0	2.7	8.1	2.6	17.0	0.7	2.9
2	88/201	16	500	204	12.7	6.9	2.6	7.8	2.5	16.7	0.7	2.9
2	89/708	25	500	204	12.3	6.8	2.4	7.3	2.5	16.7	0.7	2.6
3	FRI79/2320	7	1000	400	11.6	6.7	4.3	13.3	2.3	15.3	0.7	2.8
3	89/15	13	1000	400	11.6	7.2	4.3	13.8	2.6	17.2	0.9	3.4
3	89/708	25	1000	400	12.2	6.9	4.7	14.3	2.6	16.6	0.7	2.9
4	FRI79/2320	7	500	204	13.0	7.0	2.7	8.4	0.0			
4	89/15	13	500	214	12.7	6.7	2.7	8.0	0.0			
4	89/708	25	500	204	14.0	7.3	3.1	9.7	0.0			
5	FRI79/2320	7	1000	400	12.0	7.5	4.5	15.3	0.0			
5	89/15	13	1000	400	12.8	7.4	5.2	16.5	0.0			
5	89/708	25	1000	400	13.3	8.1	5.5	19.0	0.0			
6	FRI79/2320	7	1000	600	12.6	7.9	7.5	25.9	0.0			
6	89/15	13	1000	600	12.2	7.5	7.0	22.8	0.0			
6	89/708	25	1000	600	12.5	7.7	7.4	24.6	0.0			
7	FRI79/2320	7	1000	980	11.4	6.7	10.0	32.4	0.0			
7	89/15	13	1000	960	11.1	7.1	9.3	29.1	0.0			
7	88/105	14	1000	940	11.3	7.2	9.4	30.4	0.0			
7	88/201	16	1000	940	11.9	7.7	10.4	33.9	0.0			
7	89/708	25	1000	920	11.4	7.4	9.4	31.0	0.0			

TABLE 21. FR 121/6: Trial data from measurements at age 9.2 (August 1999)

Trt	Seedlot	No. plots	GF rating	SPH Estab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT
1	FRI79/2320	1	7	250	97	29.2	13.1	6.5	29.3	2.9
1	89/15	1	13	250	97	31.7	14.0	7.7	35.9	2.1
1	89/708	1	25	250	92	29.3	13.3	6.2	28.2	2.3
2&4	FRI79/2320	2	7	500	204	28.7	14.9	13.3	68.6	1.8
2&4	89/15	2	13	500	199	29.9	14.7	13.9	69.5	1.5
2	88/105	1	14	500	204	28.9	14.8	13.4	68.9	2.5
2	88/201	1	16	500	204	28.1	14.3	12.7	63.0	2.4
2&4	89/708	2	25	500	199	29.6	15.0	13.7	70.9	1.7
3&5	FRI79/2320	2	7	1000	400	24.9	15.5	19.5	107.8	2.8
3&5	89/15	2	13	1000	386	25.6	15.4	19.9	110.1	2.8
3&5	89/708	2	25	1000	393	26.1	15.6	20.9	116.5	2.9
6	FRI79/2320	1	7	1000	600	24.0	16.4	27.1	163.2	3.7
6	89/15	1	13	1000	600	24.1	16.1	27.3	156.3	2.9
6	89/708	1	25	1000	583	24.3	16.5	27.1	159.7	3.7
7	FRI79/2320	1	7	1000	940	20.3	15.3	30.3	180.3	3.2
7	89/15	1	13	1000	940	20.4	15.1	30.8	173.7	3.3
7	88/105	1	14	1000	920	20.7	15.9	31.0	184.5	3.1
7	88/201	1	16	1000	900	21.5	16.4	32.6	198.1	3.6
7	89/708	1	25	1000	880	21.4	16.4	31.7	194.6	3.6

FR 121/7, HUANUI Forest, Gisborne

This trial was planted in July 1990 with an unbalanced split-split block design containing 16 rectangular 45 x 36m plots and 2 rectangular 45 x 72m plots (a total of 18 plots). The trial occupies 3.2 hectares.

The first measurements of total height only were taken in June 1992 (age 2 years). Pruning, PSP plot establishment and thinning was carried out (as per the basic field procedures) during November 1994 (age 4.5 years). The trial MCH at the time of plot establishment was 6.0m, with a range of 4.9 to 6.6m.

Trial Design

This trial was designed with seven silvicultural treatments and four different seedlots (all seedlings), with seedlot/silvicultural treatment combinations unreplicated, i.e. one seedlot per treatment (Table 22).

The long internode seedlot, 89/15, was not planted at this site.

TABLE 22. Trial design for FR 121/7, Huanui Forest

Tt	Silviculture					Planting stock			
	Pruning	Stocking (stems/ha)		Thinning		Seedlings			
		Initial	Final	MCH (m)	Ratio	GF7 (FRI79/2320)	GF14 (88/105)	GF16 (88/201)	GF25 (89/708)
1	4m	250	100	6.2	2.5:1	•			•
2	"	500	200	6.2	2.5:1	•	•	•	•
3	"	1000	400	6.2	2.5:1	•			•
4	Unpruned	500	200	6.2	2.5:1	•			•
5	"	1000	400	6.2	2.5:1	•			•
6	"	1000	600	6.2	1.7:1	•			•
7	"	1000	1000	-	1:1	•	•	•	•

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

Pruning

Pruning was carried out on 8 plots by Hikurangi Forest Farm contractors, under supervision by **Forest Research** staff, on 22 November 1994 (5 mandays work). Pruning measurements (prune height, DOS, DOS height and maximum branch diameter) were recorded at the time of plot establishment. The average crown length remaining after pruning was 4.7m (mean pruned height 2.2m).

PSP Plot Establishment

Forest Research staff established eighteen permanent sample plots on 23 and 24 November 1994 (a total of 12 mandays). Students provided by Hikurangi Forest Farms also assisted with the plot establishment. Table 5 shows the plot establishment requirements for each of the assigned treatments (nos. 1-7).

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

Thinning

Thinning of the 14 plots was carried out by **Forest Research** field staff the week following plot establishment. All plots were thinned according to the schedule.

Trial Layout and Site Information

All 18 plots planted were established as PSPs at this site (see map, Figure 7). The original planting peg numbers are shown at the plot corners. A full description of each treatment and seedlot is given in Tables 4, 5 & 6. Also planted at the same site was a series of Guadalupe hybrid demonstration row plots. The long internode seedlot, 89/15, was not planted at this site.

The following information was recorded at the time of planting:

Altitude:	250m
Soil Type:	Mahoenui silt loam
Site Preparation:	Grasses
Regeneration:	Nil
Slope:	10 – 20°
Aspect:	North
Previous land use:	Farmland
Site:	High fertility, ex pasture site

This site was originally designated as a high fertility site, but it should be noted that the trial area is not representative of the surrounding forest. This is a very exposed site and consequently the site index is unusually low (31.4). Due to the exposure to wind this trial has many toppled trees. The damage is consistent over all treatments.

The trial is clean underfoot with no weed problems.

Plot data

Summaries (Tables 23 & 24) at the time of the first winter measurement in July 1995 (age 5.1 years) and the 1999 winter remeasurement (age 9.1 years), show data (mean diameter, mean height, basal area, volume and prune height/crown height) sorted by treatment and seedlot. No statistical analysis has yet been carried out and any trends in data may not persist over time. There is no replication of seedlot/treatment, except by assuming nil pruning effects in the 200 and 400 stems/ha treatments. The data at age 9 has been summarised without taking pruning into account, so that treatments 2 and 4, and 3 and 5, are averaged by seedlot.

The average DOS at this site is 18.7cm and the average maximum branch diameter is 3.6cm.

Because of the high incidence of toppling, most plots in this trial are less than the prescribed final crop stocking.

The following trends were noted:

- The green crown level on the pruned plots had not risen by age 9 (average 2.1m)
- The green crown height of the unpruned plots in treatment 4 (200 stems/ha) had not risen, while the rest of the unpruned plots have had a significant rise in green crown (average 2.9m)
- The GF25 seedlot is not performing as well as the GF7 seedlot in treatment 1 (100 stems/ha)
- The GF25 seedlot is performing the best at treatment 6 (thinned to 600 stems/ha)
- The GF14 seedlot is performing very well at both of the treatments it is planted in (thinned to 200 stems/ha and unthinned 1000 stems/ha)

FIGURE 7. Map showing plot locations, FR 121/7

HUANUI Forest
Compartment 18
Planted 1990

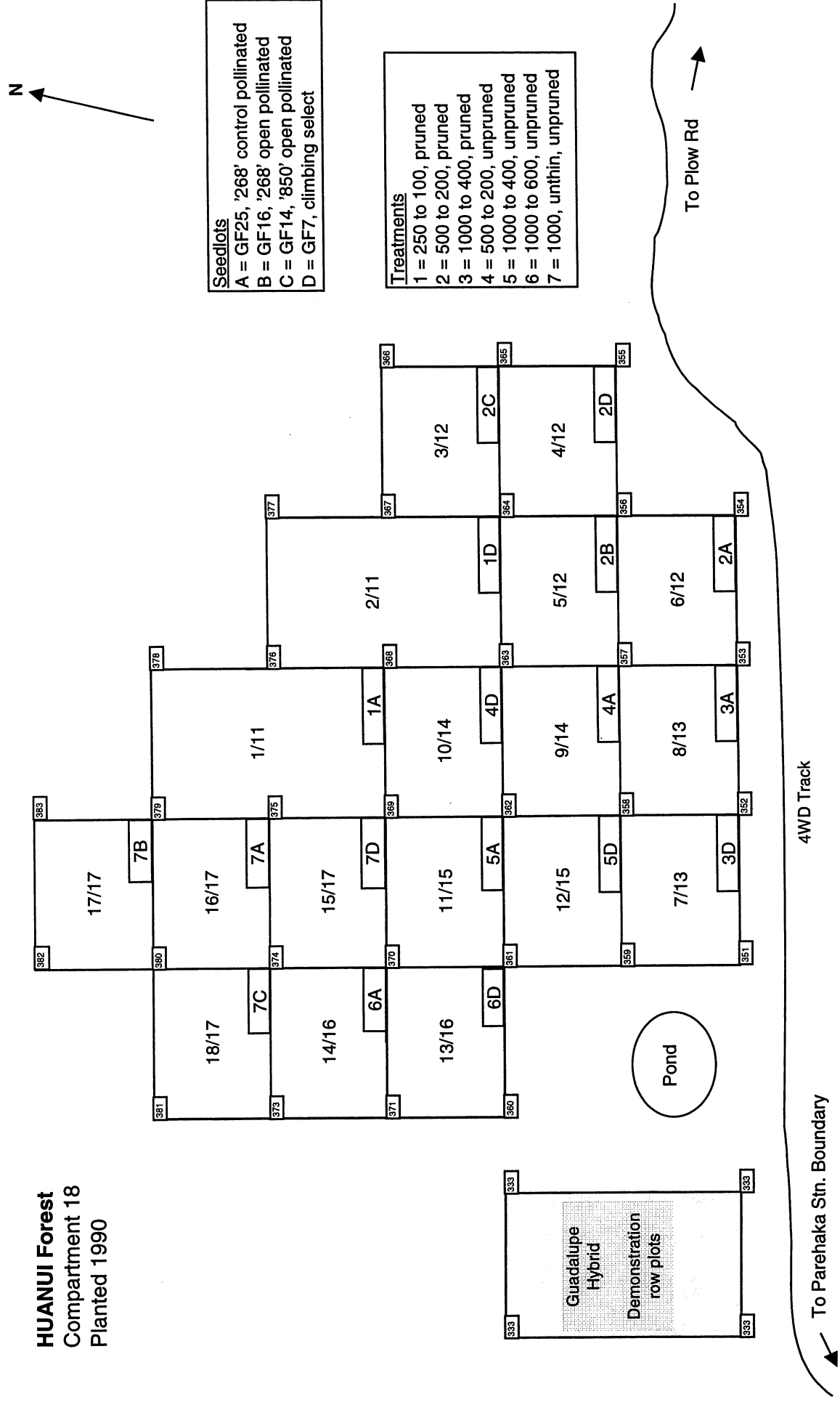


TABLE 23. FR 121/7: Trial data at the first winter measurement (July 1995) age 5.1

Trt	Seedlot	GF rating	SPH Etab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn PRHT	DOS	DOS_HT	Max Branch
1	FRI79/2320	7	250	102	15.5	6.3	1.9	6.4	1.8	17.6	0.7	3.9
1	89/708	25	250	102	15.9	6.8	2.0	6.9	2.3	17.6	0.7	3.7
2	FRI79/2320	7	500	204	16.1	7.0	4.2	14.6	2.2	17.7	0.9	3.7
2	88/105	14	500	204	17.2	7.5	4.8	17.1	2.4	21.1	0.7	3.6
2	88/201	16	500	204	15.4	6.5	3.8	12.9	1.8	17.8	0.8	3.5
2	89/708	25	500	204	17.8	7.1	5.1	17.4	2.3	21.9	0.6	4.0
3	FRI79/2320	7	1000	400	15.0	6.8	7.1	24.8	1.9	17.2	0.6	3.0
3	89/708	25	1000	400	16.9	7.4	8.9	33.0	2.5	18.6	0.7	3.3
4	FRI79/2320	7	500	204	14.5	6.1	3.4	11.3	0.0			
4	89/708	25	500	224	16.1	7.3	4.6	16.5	0.0			
5	FRI79/2320	7	1000	400	17.2	7.9	9.3	35.4	0.0			
5	89/708	25	1000	400	17.1	7.5	9.1	34.2	0.0			
6	FRI79/2320	7	1000	600	10.8	6.5	5.5	18.6	0.0			
6	89/708	25	1000	583	12.2	6.3	6.8	23.6	0.0			
7	FRI79/2320	7	1000	860	14.7	7.4	14.7	54.8	0.0			
7	88/105	14	1000	800	12.6	7.1	10.0	37.2	0.0			
7	88/201	16	1000	920	14.1	7.7	14.4	55.5	0.0			
7	89/708	25	1000	920	14.2	7.3	14.6	53.9	0.0			

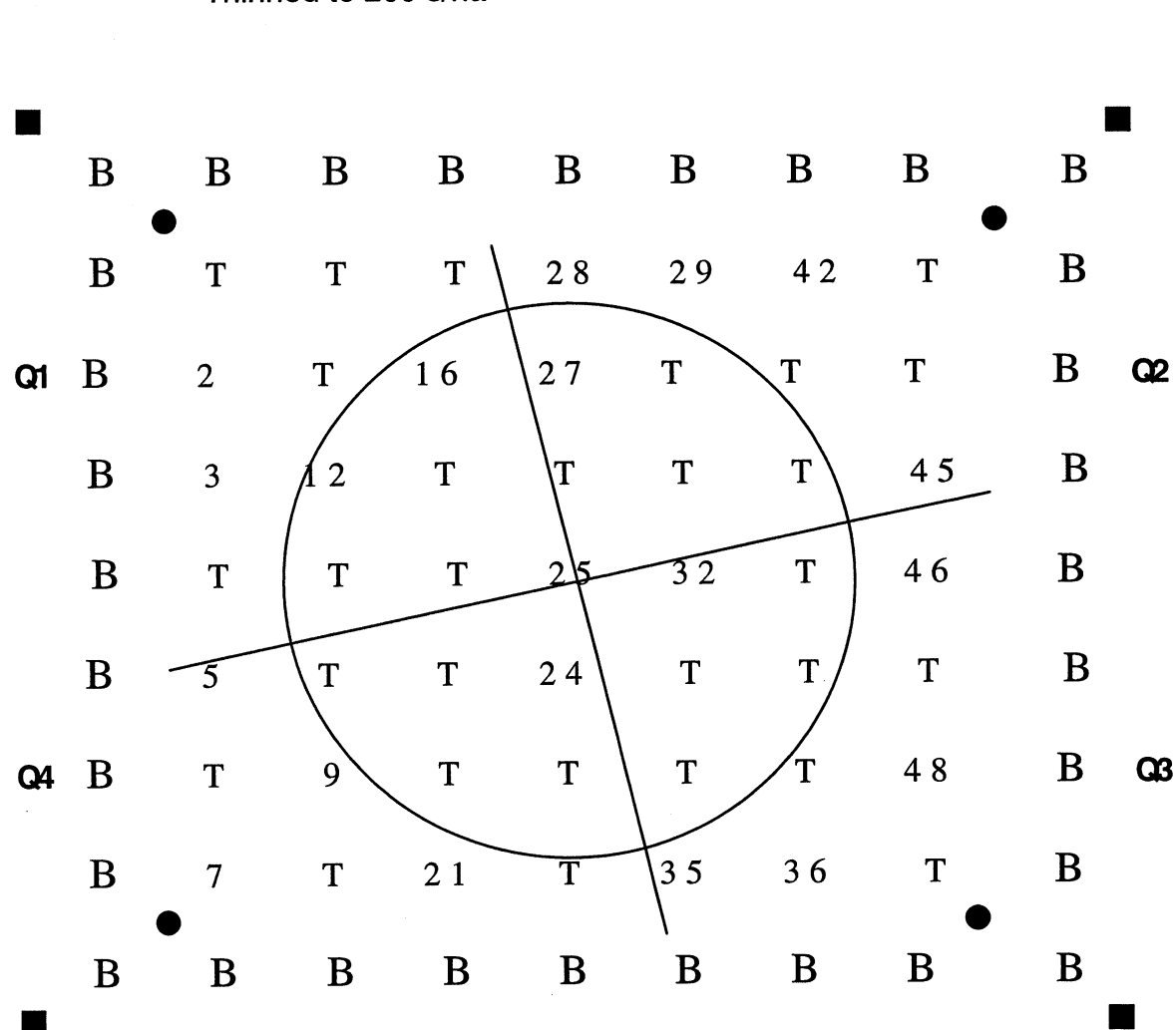
TABLE 24. FR 121/7: Trial data from measurements at age 9.1 (July 1999)

Trt	Seedlot	No. plots	GF rating	SPH Etab	SPH live	Mn DBH	Mn HT	Basal Area	Volume	Mn CRHT
1	FRI79/2320	1	7	250	77	35.1	13.2	7.4	38.4	2.1
1	89/708	1	25	250	77	34.3	13.6	7.1	38.3	2.0
2&4	FRI79/2320	2	7	500	179	33.0	13.5	15.3	82.1	1.4
2	88/105	1	14	500	163	36.3	13.4	16.9	86.6	2.4
2	88/201	1	16	500	153	30.5	12.2	11.2	55.6	1.6
2&4	89/708	2	25	500	184	34.8	13.6	17.5	92.1	1.6
3&5	FRI79/2320	2	7	1000	358	31.7	14.4	27.9	160.7	2.5
3&5	89/708	2	25	1000	379	32.8	14.8	31.7	189.6	2.9
6	FRI79/2320	1	7	1000	567	22.3	13.9	22.2	128.1	2.7
6	89/708	1	25	1000	533	26.3	14.9	28.9	178.8	2.2
7	FRI79/2320	1	7	1000	800	25.1	15.2	39.5	251.5	3.8
7	88/105	1	14	1000	660	25.5	15.1	33.6	211.4	2.8
7	88/201	1	16	1000	840	24.9	15.1	40.8	258.8	3.0
7	89/708	1	25	1000	880	25.1	15.3	43.7	281.9	3.0

Appendix 1

Location of Buffers and Permanent Sample Plots

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



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

Q1, Q2, Q3, Q4

Quadrants to determine the predominant height trees

B

Buffer tree

T

Thinned tree

1,4,7,

Plot trees

25

Plot centre



Planting corner peg

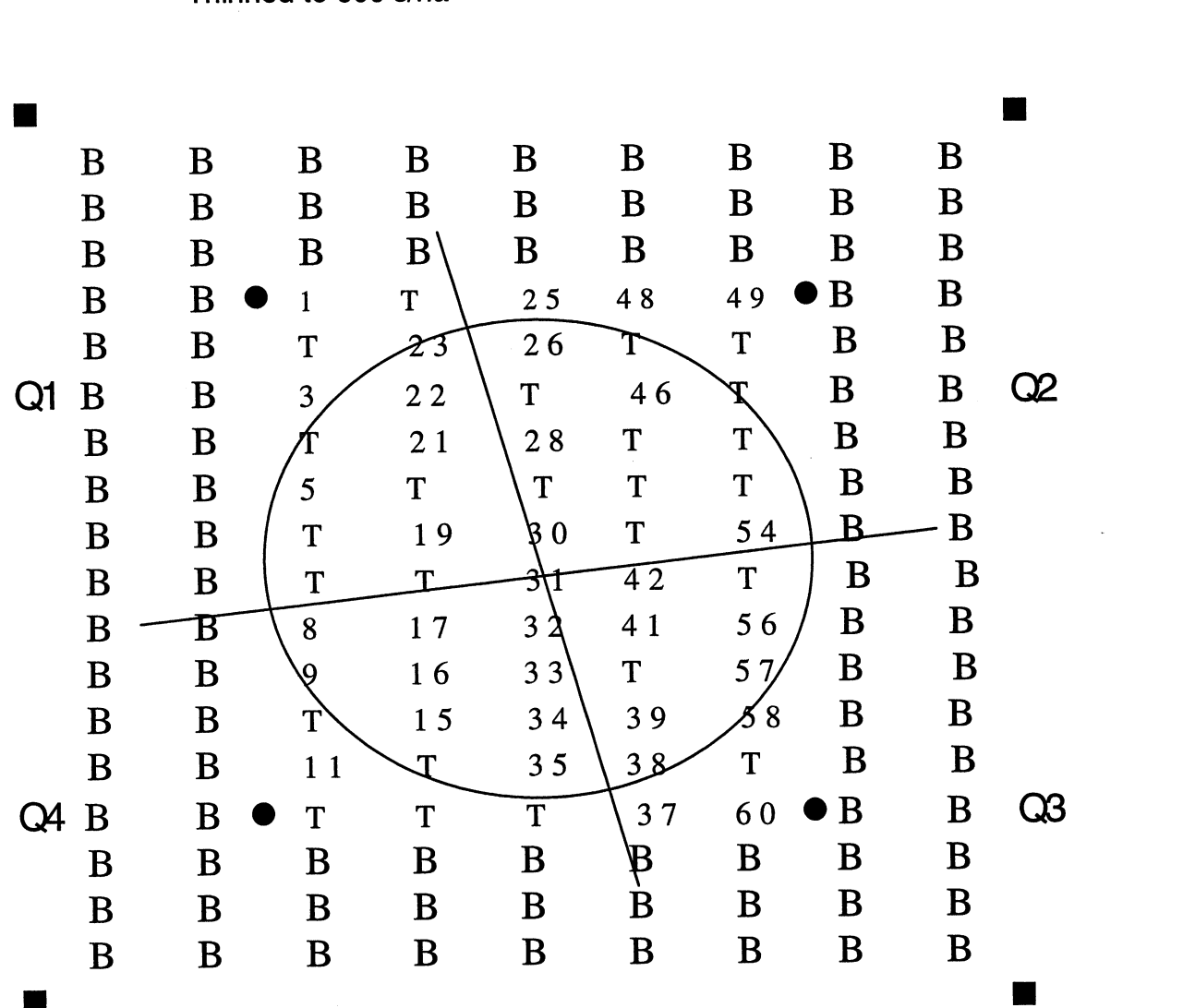


PSP Plot corner peg

Appendix 1 cont.

Location of Buffers and Permanent Sample Plots

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



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

Q1, Q2, Q3, Q4

Quadrants to determine the predominant height trees

B

Buffer tree

1,3,5,

Plot trees

31

Plot centre



Planting corner peg



PSP Plot corner peg

Appendix 2

Plot Numbering System

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

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

Thus FR 121/2/28/17 is plot 28 of trial FR 121/2. 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).

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(was Carter Holt Harvey Forests at the time of planting and plot establishment)

Rayonier NZ Ltd Trial FR 121/5

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