

**RADIATA PINE FOLLOWER TRIALS
ESTABLISHMENT REPORT**

M. DEAN

REPORT NO. 2

NOVEMBER 1993

FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

RADIATA PINE FOLLOWERS TRIALS — ESTABLISHMENT REPORT

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Radiata pine follower trials have been installed on farm sites located at Kaikohe, Paengaroa, Napier, Dipton and Te Anau. The trials are designed to examine the effect of the ratio of followers (unpruned or partially pruned non-final crop trees) to final crop stockings and the timing of thinning in the growth and quality of radiata pine. The trials were installed in existing stands at the time of first pruning. Pruning and thinning treatments will be implemented up until a mean top height of 23.6 metres is reached.

RADIATA PINE FOLLOWERS TRIALS: ESTABLISHMENT REPORT

INTRODUCTION:

Followers are an element of the stand that are carried for a later thinning. They are either unpruned or not pruned as intensively as the "crop" element. The growth of followers and their effect on crop trees has been modelled for forest sites in the EARLY growth model. However for farm sites no growth data on this aspect of early silviculture has been collected.

Because of the high fertility and rapid growth on these sites it is not known whether the current relationships of competition between pruned crop trees and the unpruned follower element is valid. To answer this question a number of replicated experiments have been installed to clarify the trade-off on farm sites of keeping a follower element for a later commercial thinning or thinning directly to release the pruned crop. Data collected will be analysed for use in improving the EARLY growth model.

TREATMENTS:

The trials are designed to examine two issues related to followers:

1. The number of followers per hectare.
2. The timing of thinning to final crop stocking.

The volume of thinnings and the piece size of the thinnings are two factors that contribute to production thinning costs. Piece size and recovered volume are largely influenced by the number of followers and the timing of the thinning, therefore these two factors are examined in conjunction.

In order to limit the trial design to these two variables it was necessary to keep variables such as final stocking, pruning severity and selection ratio as constants. Therefore the trials will be managed within broad guidelines to leave 3 to 5 metres of green crown remaining following pruning. This will yield a Diameter over Stubs, DOS., of 16-18 cm. Final stocking has been set at 275 stems per hectare.

Table 1: Plot Numbers per Treatment.

		Number of Followers (stems/ha)				
		123	160	250	340	377
Mean Top	12.4			1		
Height of	14.0		1		1	
final thinning(m)	18.0	1		5		1
	22.0		1		1	
	23.6			1		

The trials test five densities of followers and five different timings of thinning as shown in table 1. In addition to the thirteen plots receiving various thinning treatments three plots at each site are managed on a direct regime with no unpruned followers being left after the first pruning and final thinning being carried out immediately following the final pruning lift.

All plots are to be variable lift pruned to 6.5 metres in three or four lifts, depending on the site.

TRIAL DESIGN:

Because the data from this series of trials will be used in the construction of growth models a design suited to regression analysis techniques has been used rather than the traditional Analysis of Variance method. Therefore a two factor response surface design has been used for its suitability to regression analysis, economy of plots and the consequent ease of replication on a number of sites.

Table 2: Typical regimes by treatment.

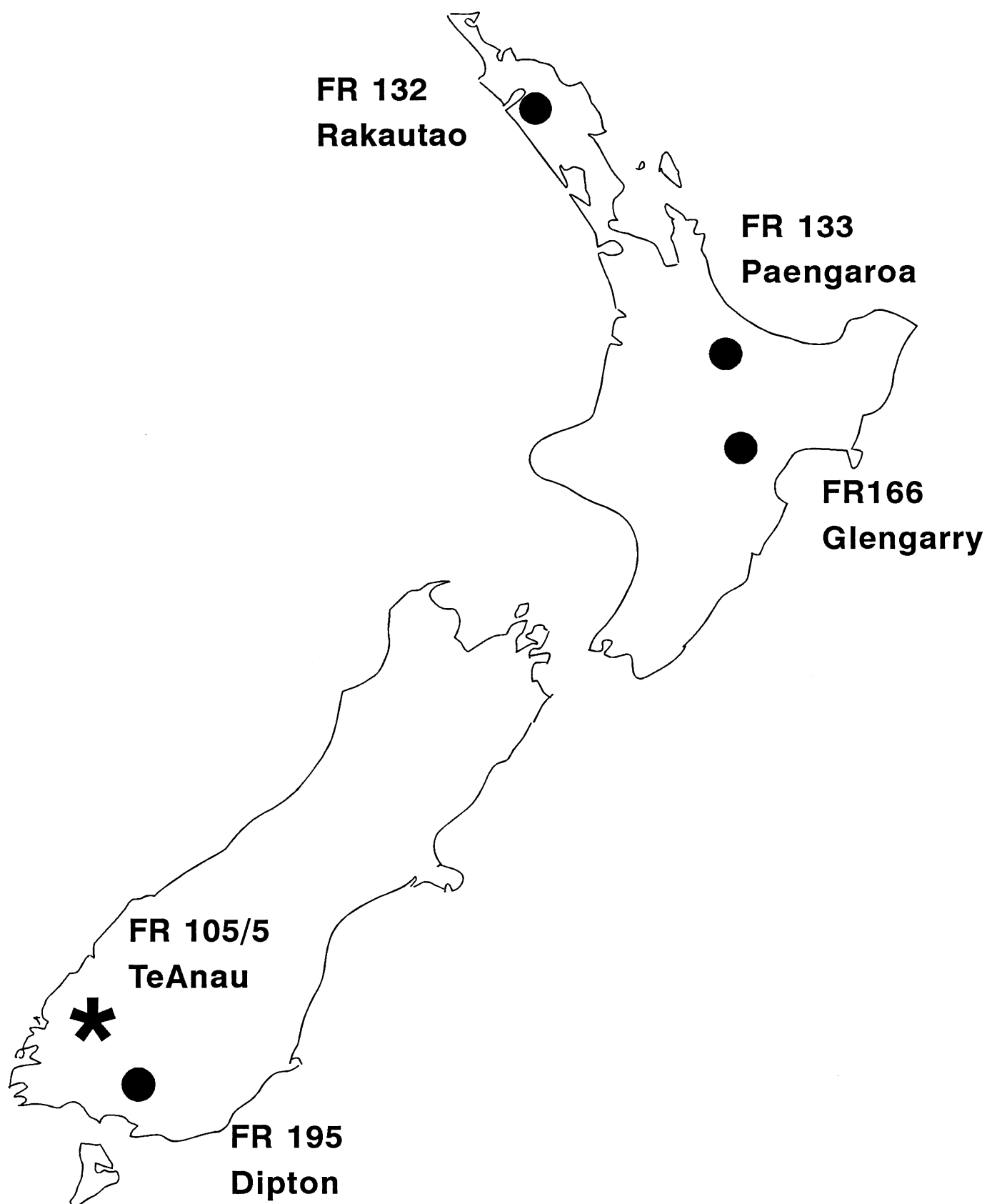
Stems / ha per treatment										
	Crop	Foll- ower	Crop	Foll- ower	Crop	Foll- ower	Crop	Foll- ower	Crop	Foll- ower
No planted	1200		1200		1200		1200		1200	
1st prune 2.4m	350	23	350	60	350	150	350	240	350	277
2nd Prune 4.2m	300	50	300	50	300	50	300	50	300	50
3rd Prune 6.5m..	275	25	275	25	275	25	275	25	275	25
Total		98		135		225		315		352
MTH of production thinning (m)		18.0		14.0 22.0		12.0, 18.0, 23.6		14.0 22.0		18.0

Each treatment plot is 55.6 metres square (0.309 ha) with a 0.1000 ha circular measurement plot established in the centre. All the trees in the measurement plot are tagged and measured annually for DBH and height. Where pruning or thinning falls due during the year all trees are measured again.

To date three follower trials on farm sites in the North Island have been established. These are at Rakautao, (near Kaikohe), Paengaroa (BOP), and Glengarry (Hawkes Bay). A trial has been installed at Dipton in Southland and a further stepout trial has been installed at Te Anau.

The trials are described in more detail below.

Location of P.Radiata Followers Trials



FR 132 - RAKAUTAO FOLLOWERS TRIAL

LOCATION: Rakautao forest 15 kilometres SE of Kaikohe.

INTRODUCTION:

This is a joint trial between Carter Holt Harvey Forests Ltd and FRI. The trial was established in August 1990. The site is retired farm land and comprises a flat valley floor dissected by drains and sidlings. Plots were blocked according to initial height as measured at the time of plot installation. In practice this meant blocks were either on the flat or hill sidlings. Within each block the treatments were randomly allocated.

plots are blocked as follows:

Plot	Block
3/3/1	valley
0/0/2	valley
3/3/3	valley
3/3/4	valley
3/3/5	Hill
3/3/6	Hill
2/4/7	valley
2/2/8	valley
4/2/9	valley
4/3/10	valley
3/1/11	Hill
5/3/12	Hill
3/5/13	Hill
0/0/14	Hill
1/3/15	Hill
0/0/16	Hill

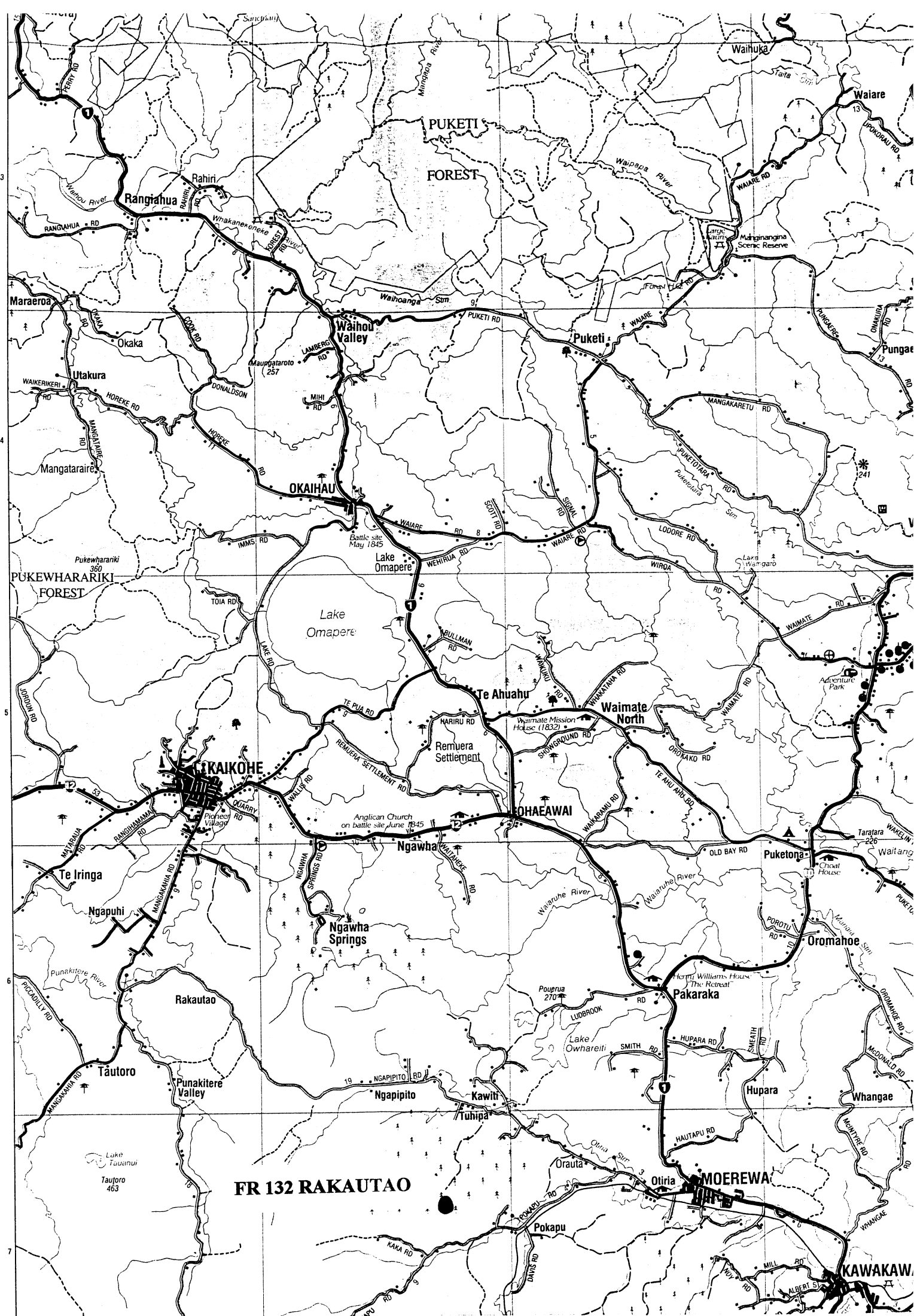
YEAR PLANTED: 1986 Seedlot: 3/3/85/01 ex Gwavas Seed Orchard.

GEOLOGY AND SOILS: Secondary podzol being Waiotira clay loam, hill soil.

SITE INDEX: 33.5 m.

TRIAL STATUS: The trial has recieved three pruning lifts the last one being to 6.5 metres in September 1993. The direct plots were thinned to a final crop stocking of 275 stems/hectare immediately following high pruning. The final thin for the 12.4 metre thin treatment , - plot 3/1/11, was scheduled for July 1993 and carried out on that date. All plots have been measured annually in 8/1990, 7/1991, 6/1992, and 10/1993. Treatments completed and immediately pending are summarised below.:

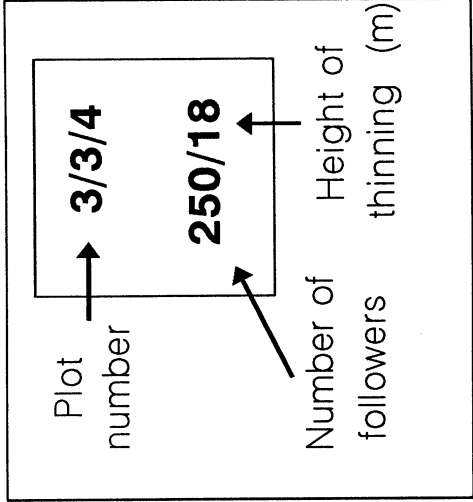
Operation	Date	Details
Prune 1;	8/1990	350 stems to 2.3m
Prune 2;	6/1992	300 stems to 4.6m
Prune 3;	9/1993	275 stems to 6.5m
Thin to waste	7/1993	direct sawlog treatment.



FR 132 - RAKATAU FOLLOWERS TRIAL CPT 17

NO 7 ROAD

LEGEND



0/0/16
Direct

0/0/14
Direct

1/3/15
123/18

STREAM

3/3/3 250/18	3/3/4 250/18	2/2/8 160/14	4/2/9 340/14	3/5/13 250/23.6	5/3/12 377/18
0/0/2 Direct		2/4/7 160/22	4/3/10 340/22		
	3/3/5 250/18	3/3/6 250/18	3/1/11 250/12.4		
3/3/1 250/18					



FR 133 - PAENGAROA FOLLOWERS TRIAL

LOCATION: Ridge Road forest. 10 kilometres South West of Paengaroa in the Eastern Bay of Plenty.

INTRODUCTION: This trial is located on Tasman Forestry ltd. land and is a particularly high producing ex farm site typical of much of the rolling Pongakawa hill country. The trial was established in December 1991 on a valley floor and toe slopes. As at June 1993 it has been pruned in three lifts to 6.5 metres.

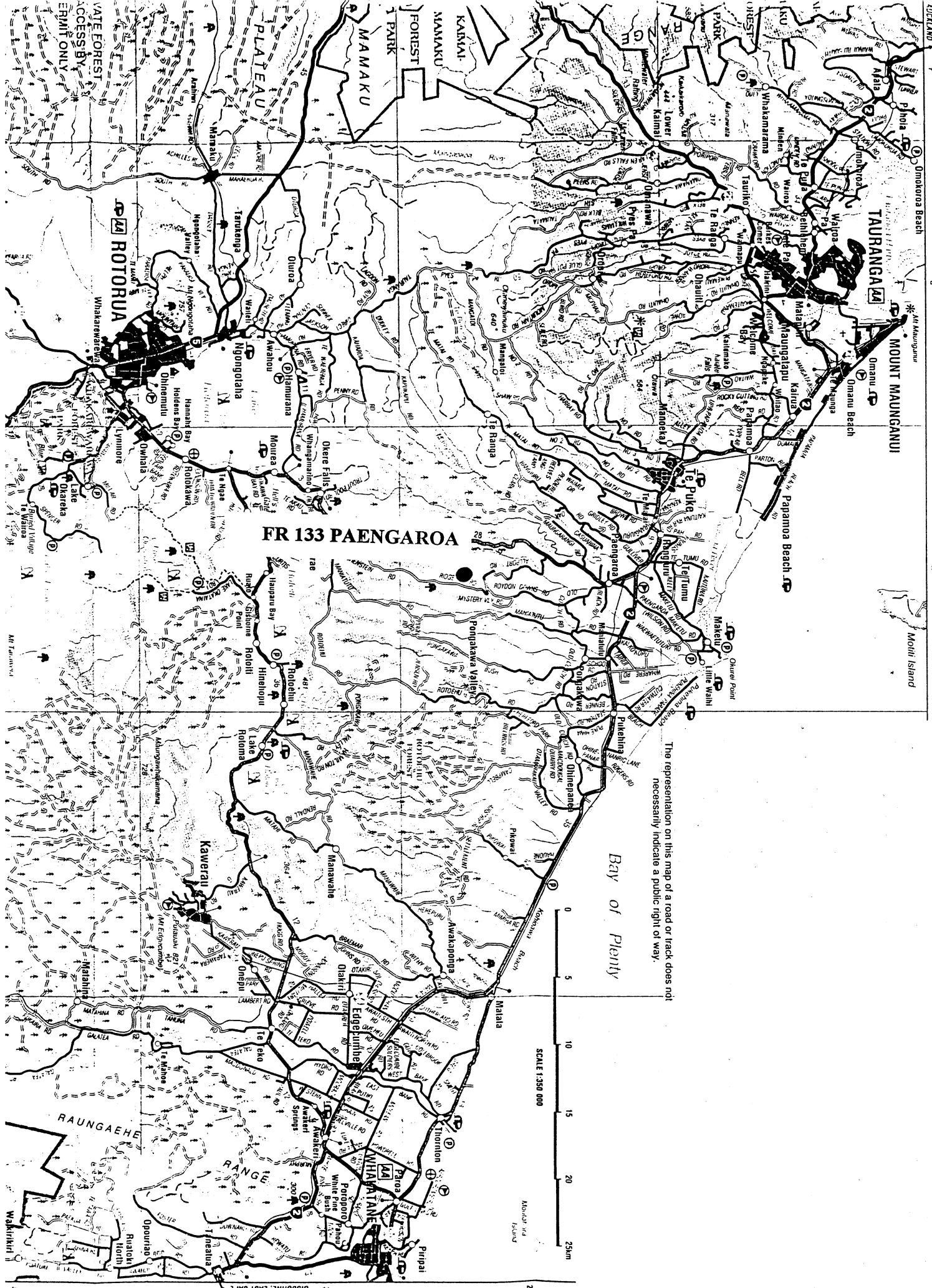
YEAR PLANTED: 1987 - GF17 seedlings.

GEOLOGY AND SOILS: Volcanic ash soils being Paengaroa sand on gravelly sand , hill soil, derived from Kaharoa Ash.

SITE INDEX: 38 metres.

TRIAL STATUS: The trial has been pruned in 3 lifts to 6.5 metres and has recieved its first thinning treatment at 12.4 metres. Diameters and heights have been measured for 3 years. Treatments completed and immediately pending are summarised below.:

Operation	Date	Details
Prune 1;	4/1991	350 stems to 2.4m
Prune 2;	6/1992	300 stems to 4.7m
Prune 3;	6/1993	275 stems to 6.5m
Thin	7/1993	plots 0/0/5, 0/0/9, 0/0/11, & 3/1/16.



FR 133 PAENGAROA

The representation on this map of a road or track does not necessarily indicate a public right of way.

SCALE 1:350 000

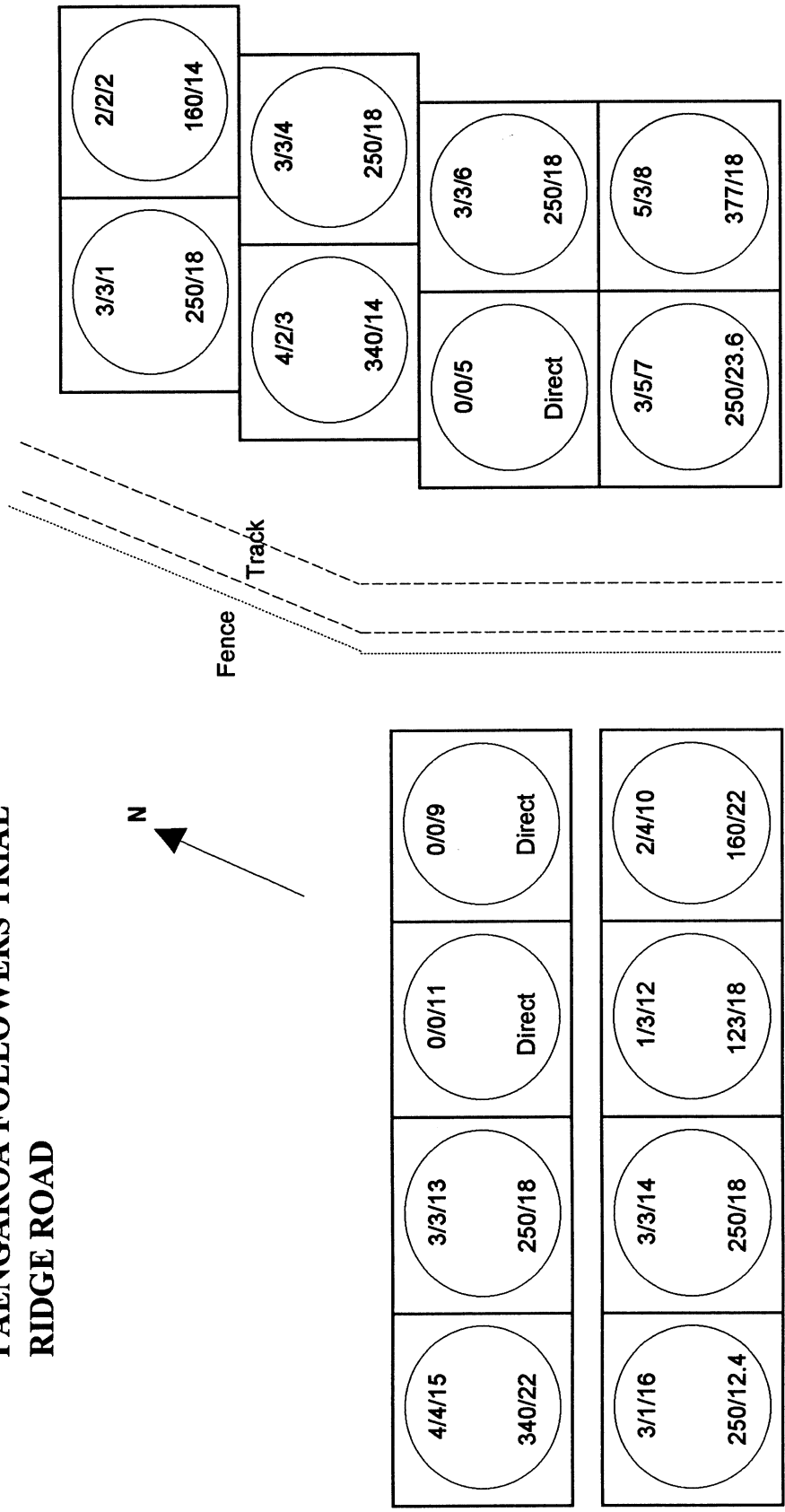


Abundant
Island

FR 133

PAENGAROA FOLLOWERS TRIAL

RIDGE ROAD



Note:

Map is not to scale

Top number in each plot represents Plot number

Bottom number represents Treatment, ie stocking (stems/ha) and height at time of thinning (m)

FR 166 - GLENGARRY FOLLOWERS TRIAL

LOCATION: Glengarry forest 30 kilometres West of Napier on the Napier /Taupo Highway.

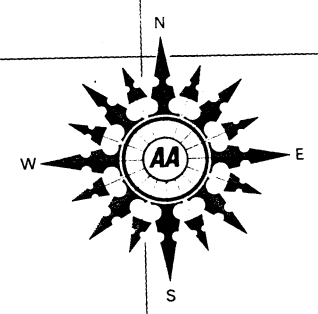
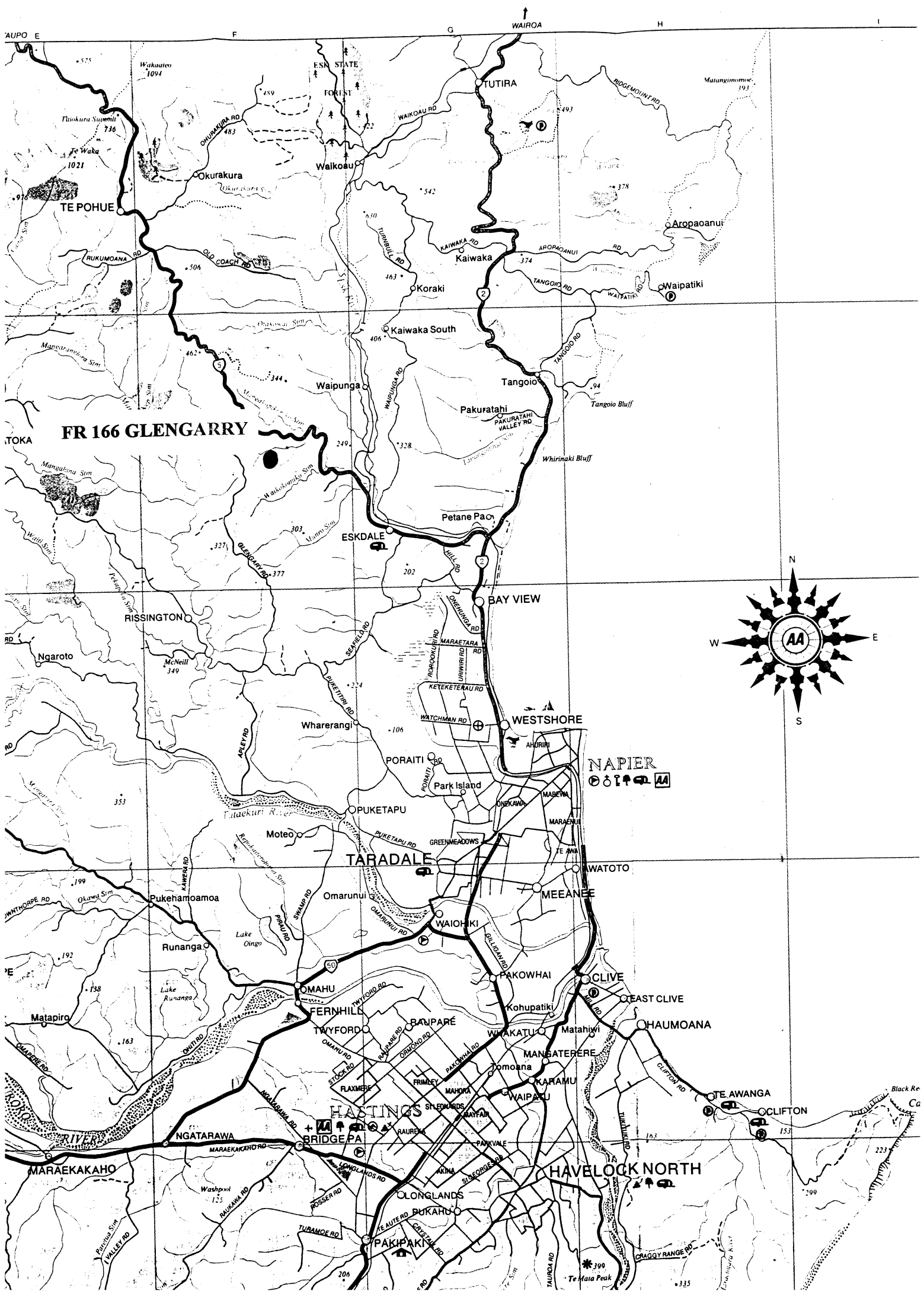
INTRODUCTION: Glengarry is owned by Carter Holt Harvey Forests Ltd. Hawkes Bay Region. The trial is situated on a nominally flat fertile valley floor. The land has a long history of farming and fertiliser. The trial was installed in March 1992. It has been pruned once and is due for its second lift now. An extra treatment was installed at this trial at the owners request. There are three plots over above the 16 established in the core trial in which 750 followers have been left until an as yet unspecified Mean Top Height before thinning.

YEAR PLANTED: 1987 - GF 17 seedlings.

GEOLOGY AND SOILS: Immature Taupo Ash hill soils typical of large areas of northern Hawkes Bay.

SITE INDEX: 37.5

TRIAL STATUS: All plots have been pruned twice to 5.3 metres. The most recent pruning lift occurred in August 1993. The first thinning treatment will be applied in February 1994. Diameters and heights have been measured for 2 years.



FR 166 GLENGARRY

NAPIER

TARADALE

HAVELOCK NORTH

HASTINGS

TOKA

RISSINGTON

WESTSHORE

ESKDALE

BAY VIEW

PORAITI

MEEANEE

OMAHU

PAKOWHAI

CLIVE

Runanga

WAKATU

HAUMOANA

BRIDGE PA

KARARUA

TE AWANGA

PAKIPAKI

CLIFTON

CLIFTON

MARAERAKAHO

NGATARAWA

FERNHILL

BAUPARE

TE AWANGA

Matapiro

WYFORD

WAKATU

TE AWANGA

WINTHORPE

OMARUNUI

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FR166 Glengarry Followers Trial

Cpt
210

2/4/8 160/22	3/3/9 250/18
3/3/7 250/18	0/0/10 250/7
3/3/6 250/18	0/0/11 250/7
5/3/5 377/18	6/7/12 900/25

Plot
number

2/4/8
160/22

Number of
followers

Height of
Thinning

3/5/2 250/23.6	3/1/4 250/12.4	0/0/13 250/7	
6/7/1 900/25	4/2/3 340/14	6/7/14 900/25	1/3/15 123/18

4/4/18 340/22	3/3/17 250/18	2/2/16 160/14
3/3/19 250/18		

FR 195 - DIPTON FOLLOWERS TRIAL

LOCATION: Dipton Forest - 60 kilometres North West of Invercargill on State Highway 6

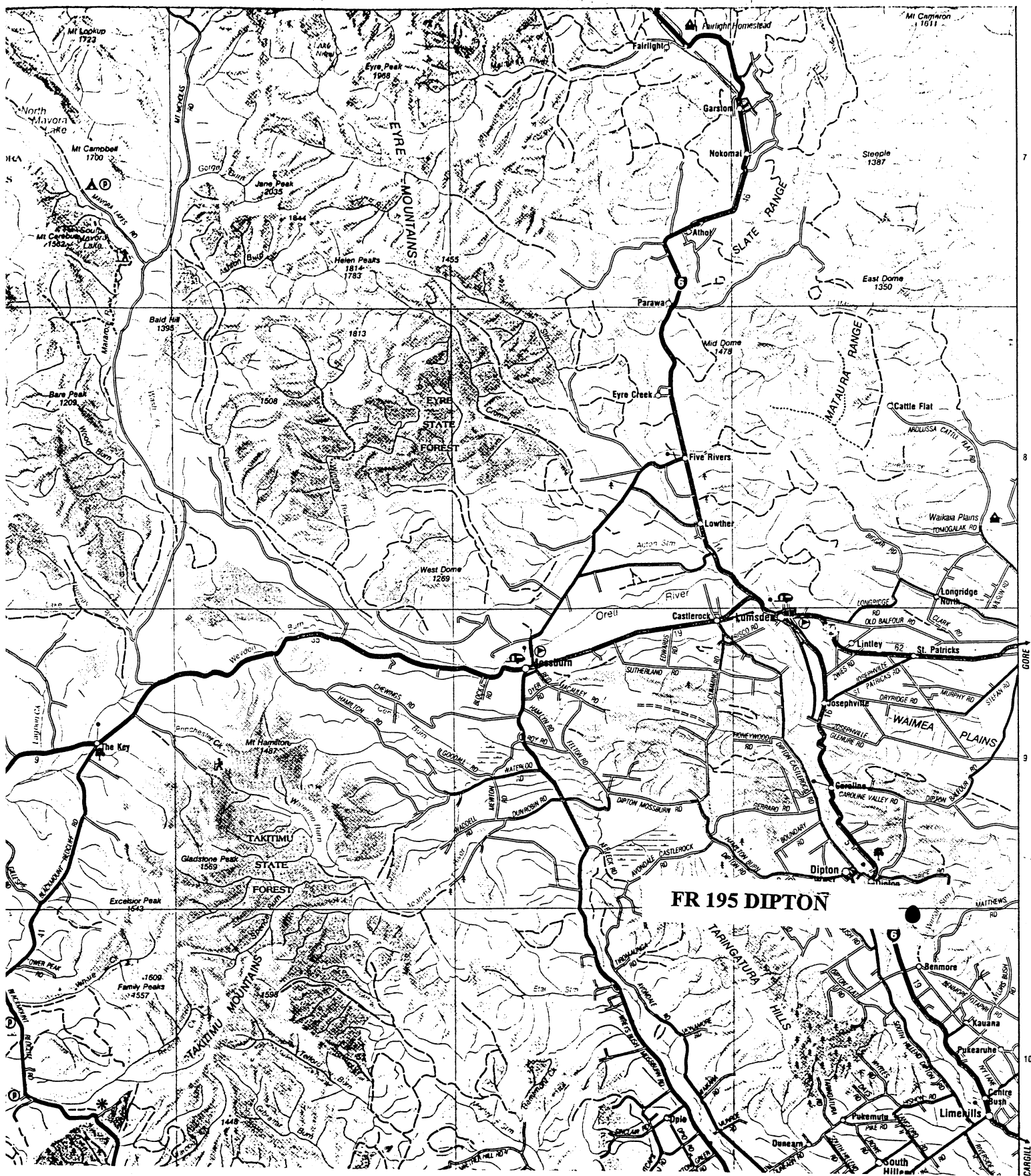
INTRODUCTION: This trial was installed in May 1993 on the property of the Southland District Council. The land is fertile rolling Southland hill country. The land has a long history of farming and this is the first rotation in trees. The trial is situated approximately 400 metres above sea level on an Easterly aspect.

YEAR PLANTED: 1987

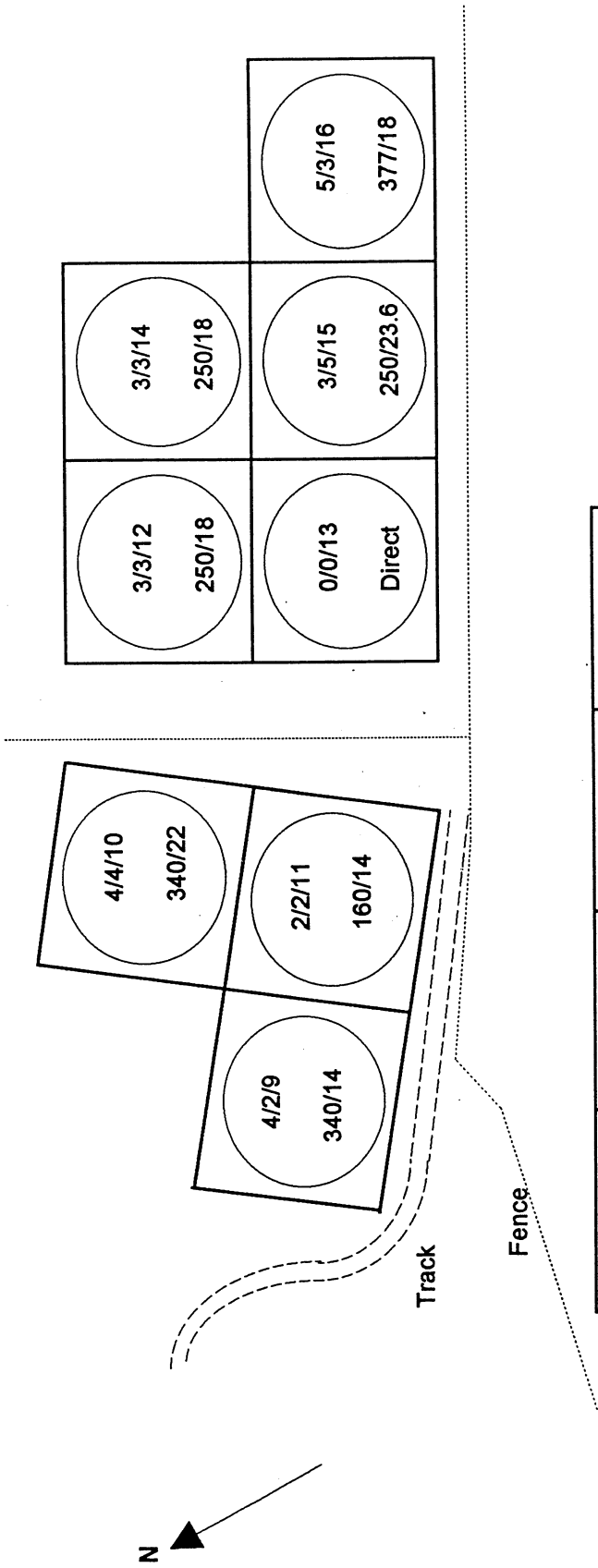
GEOLOGY AND SOILS: Mossburn Yellow brown Earth soils overlying Greywacke Conglomerate. The rainfall is 850 mm per annum.

SITE INDEX: 27.5 m

TRIAL STATUS: The plots were layed out in May 1993 and the first pruning and thinning to innitial treatment stockings was carried out in August 1993.



FR 195 DIPTON FOLLOWERS TRIAL



Note:
 Map is not to scale
 Top number in each plot represents the Plot number
 Bottom number represents Treatment, ie stocking (stems/ha) and height at time of thinning (m).

0/0/1 Direct	1/3/3 123/18	2/4/5 160/22	3/3/7 250/18
3/3/2 250/18	3/3/4 250/18	0/0/6 Direct	3/1/8 250/12.4

FR 102/5 - TE ANAU FOLLOWERS TRIAL STEP-OUT

LOCATION: The Te Anau trial is situated on Stephens Farm a Land Corp property 12 kilometres South of Te Anau.

INTRODUCTION: Stephens Farm is Owned By Landcorp Farming Ltd and the trial is in one of the many managed Radiata stands owned by that company in the Te Anau basin. The trial does not have all the treatments included in the main trial series so is in fact a step - out of two treatments from the design and one other treatment peculiar to this site. The treatments applied are;

1. Direct regime.
2. 225 followers thinned at 18.0 metres.
3. 750 followers thinned at 14 metres.

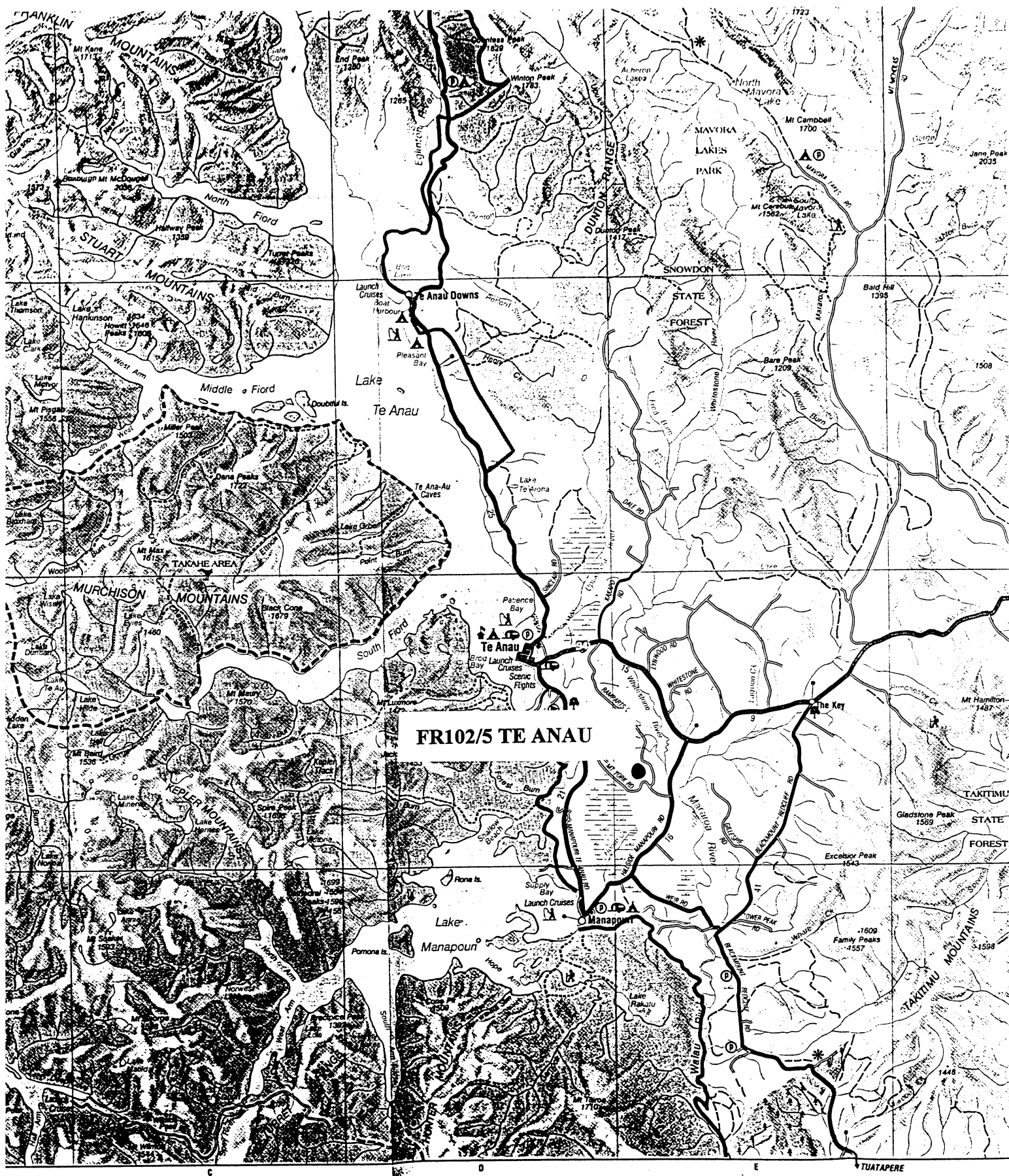
Each treatment was randomly allocated and is replicated three times.

YEAR PLANTED: 1984

GEOLOGY AND SOILS: Te Anau yellow Brown loam over Glacial outwash Gravels.

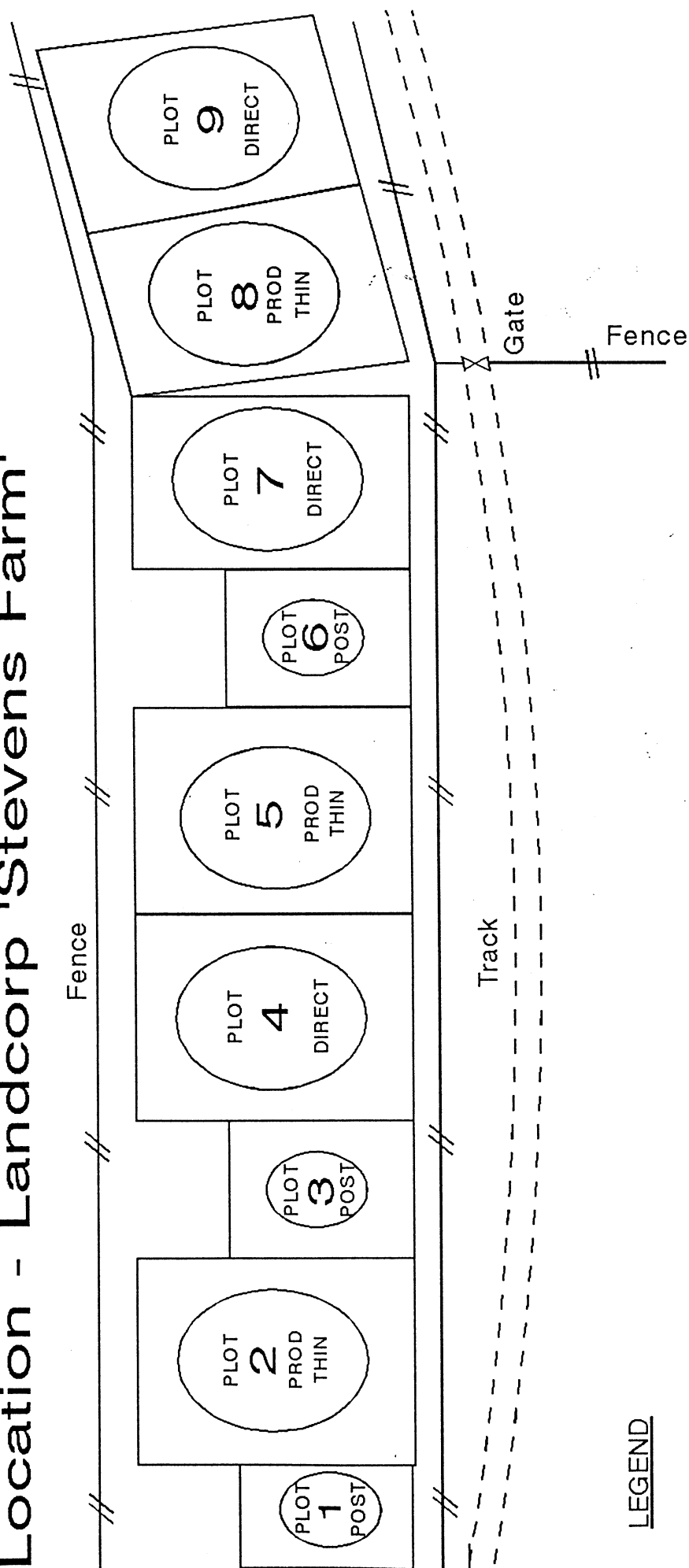
SITE INDEX: 28 m

TRIAL STATUS: The crop trees have been pruned to 2.7 m and are due for pruning to 6m in spring 1993. Diameters and heights have been measured for 2 years.



FR 102/5 - Te Anau Followers Trial

Location - Landcorp 'Stevens Farm'



LEGEND

POST = 1200 stems/ha thin to 250 stems/ha at 14m high.

PROD THIN = 500 stems/ha thin to 250 stems/ha at 18m high.

DIRECT = Thinned to 250 stems/ha at 8m high..

APPENDIX 1

PROJECT	EFM 60
TITLE	FOLLOWERS TRIAL
OBJECTIVE	TO MEASURE THE GROWTH INTERRELATIONSHIPS OF CROP, FOLLOWERS AND TIMING OF THINNING ON FERTILE SITES.

INTRODUCTION

Farm sites are commonly used by forest companies to grow high yielding production thinning regimes. To date all FRI tree growth plots on farm sites monitor direct regimes. Hence, when the EARLY growth model was made, no data on the effect of followers was available from farm sites. The function put into EARLY assumes that the follower effect on farm sites will be the same as that derived for forest sites.

An evaluation of regimes for production thinning involves the careful calculation of a trade off between earning early revenue from thinnings at the expense of later revenues at clearfelling.

Although the present follower effect in EARLY may be satisfactory, it is felt that it can certainly be improved, given better data. Whether crop and follower relationships are different on farm sites is unknown. It is felt by some growers that the higher fertility of farm sites and the associated faster growth rates may favour high stockings without undue growth loss of the pruned crop trees.

LOCATION

This trial design has been limited in the number of plots involved so that it can be easily repeated on a range of sites. Two farm sites have so far been offered for this trial. One is in Rakautao forest in Northland (CHH Forest Ltd); the other is Paengaroa forest (Tasman Forestry Ltd) in the Bay of Plenty.

It is intended that this trial be repeated in several other major forestry regions, particularly Hawkes Bay and Nelson/ Marlborough.

TREATMENTS

Although a large number of issues such as final crop stocking, pruning severity, and selection ratio could be built into the treatments of this trial, it is important to concentrate on only the major factors involved and limit plot numbers to a practical level.

Pruning severity has been rationalised by most growers to leaving 3-5 m of crown with a DOS of 16-18 cm. Final crop stocking for pruned stands is generally within the range of 200-300 stems/ha. Selection ratio is an issue that is dependent on site and tree breed. Hence pruning, final crop stocking and selection ratio can all be left out of this trial.

The volume of thinnings and the piece size of thinnings are two factors that contribute to production thinning costs. Piece size and thinning volume are largely influenced by the number of followers and the timing of thinning. It is therefore the number of followers and the timing of thinning that this trial series should concentrate on.

TRIAL DESIGN

The data derived from these trials will mainly be used for building growth models. Therefore the trial design will need to suit regression analysis techniques rather than the typical comparison between treatments by analysis of variance. Therefore a response surface design was chosen for its suitability to regression analysis and its economy in plot numbers. Numbers of followers and height of thinning have been included in a two-factor design that is calculated around a central regime of 250 followers thinned at 18 m mean crop height. Table 1 gives the treatments and allocation of plot numbers. Table 2 gives the stockings pruned and thinned for each regime. This design will be augmented with a direct regime treatment to act as a site benchmark to be compared with existing trials.

TABLE 1 - Plot numbers per treatment

		Number of followers (stems/ha)				
		123	160	250	340	377
Height of final thinning (m)	12.4			1		
	14.0		1		1	
	18.0	1		5		1
	22.0		1		1	
	23.6			1		

Total number of plots per site

Response surface	13
Direct thin (no followers)	<u>3</u>
Total	16
	==

The direct regime will take the central treatment and thin to waste at first and third pruning lifts.

TABLE 2 - Stems/ha per treatment

	Crop	Foll- ower	Crop	Foll- ower	Crop	Foll- ower	Crop	Foll- ower	Crop	Foll- ower
No. planted	1000		1000		1000		1000		1000	
Prune 2.4 m (P1) unpruned followers	350	23	350	60	350	150	350	240	350	277
Prune 4.2 m (P2) P1 followers	300	50	300	50	300	50	300	50	300	50
Prune 5.8 m (P3) P2 followers	250	50	250	50	250	50	250	50	250	50
Total	250	123	250	160	250	250	250	340	250	377
Ht of production thinning (m)		18		14,22		12.4,18,23.6		14,22		18

METHODS

Plot layout

Plot shape will consist of a square (55.6 m x 55.6 m) within which a circular plot is established containing those trees to be measured. Plot size of the circular measurement plot will be 0.1 ha (17.8 m radius). This design gives a minimum buffer of 10 m.

Table 3 gives the number of trees measured in each follower treatment. 25 pruned crop trees will be measured in all treatments. Treatments will be allocated randomly to plots. If site differences are indicated the design may be laid out as two statistical blocks.

TABLE 3 - Number of trees measured

Treatment	123	160	250	340	377
Final crop	25	25	25	25	25
Unpruned follower	2	6	15	24	27
P1 follower	5	5	5	5	5
P2 follower	5	5	5	5	5

MEASUREMENTS

All trees will have a numbered tag 5 cm above the measurement point for DBH. Tags should be located so that a measurement can be taken free of nodal swelling, but as close as possible to 1.4 m above ground on the uphill side.

All plots will be measured annually, in winter, for DBH, height, and green crown height. At the time of pruning DBH, height, pruned height and DOS will be measured. When thinning, all DBHs will be recorded including those trees to be felled.

Dothistroma will be assessed annually in each plot.

DURATION OF THE TRIALS

The trial will be reviewed 3 years after the last final thinning has occurred.