FOLLOWERS TRIALS ON FOREST SITES — ESTABLISHMENT REPORT

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Report No. 41 May 1997

FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

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A review of silvicultural trials, (Coop report No 3; G.G. West, 1994) identified that there were insufficient trials addressing the issue of followers on forest sites. Consequently two response surface followers trials have been installed on forest sites. These trials utilise the same work plan and will augment the existing series of five followers trials on ex farm sites.

The trials, located at Kaingaroa and Conical Hill forest, were located so as to cover a range of site productivity factors and geographic locations. Each trial site is described and the installation procedure, treatment allocation, trial location, plot layout maps and current status are documented. The trial work plan is appended.

RADIATA PINE FOLLOWERS TRIALS ON TWO FOREST SITES

ESTABLISHMENT REPORT

INTRODUCTION:

Followers are an element of the stand that are carried for a later thinning. They are generally either unpruned or not pruned as intensively as the "crop" element. A series of five response surface trials have been installed on fertile ex farm sites. These trials will quantify the growth of followers and their effect on crop tree growth and log quality. Although the effect of followers grown on forest sites has been modelled in the EARLY growth model it is based on a limited data set from only a few trials which covered a narrow range of treatments.

In order to strengthen the current relationships of competition between pruned crop trees and the unpruned follower element a further two trials have been installed on forest sites at Kaingaroa and Conical Hills forests. Both trials are located on second rotation sites of moderate fertility. The site index at the Kaingaroa site is approximately 31 metres while the Conical hill site has an indicative site index of 28 metres.

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 significantly to production thinning costs. Piece size and recovered volume are largely influenced by the number of followers and the timing of the thinning, therefore they are examined in conjunction with one another.

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 should yield a Diameter over Stubs, (DOS), of 16-18 cm. Final stocking has been set at 270 stems per hectare.

Table 1: Treatment surface and the number of plots per treatment.

		Number of Followers (stems/ha)				
		103	140	230	320	357
Mean Top Height of final thinning(m)	12.4			1		
	14.0		1		1	
	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..	270	30	270	30	270	30	270	30	270	30
Total		103		140		230		320		357
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 have diameter bands marked with yellow paint. All plots will be measured annually for DBH and height. Where pruning or thinning falls due during the year all trees are to be measured again.

The trial sites and treatments applied are described in detail below.

FR 274 - KAINGAROA FOLLOWERS TRIAL

LOCATION: Cpt 1009. 04 - Kaingaroa forest.

OWNER: Fletcher Challenge Forests Limited

INTRODUCTION:

This trial is established on a nominally flat second rotation site on the western edge of central Kaingaroa. The site has a slight westerly aspect and is dissected by a shallow gully. The site was V bladed prior to planting in 1990. A nominal stocking of 350 stems/ha had been pruned to an average 2.3 metres pruned height prior to the trial being installed. Each plot was blocked according to mean top height at the time of trial installation. Within each block the treatments were randomly allocated.

Table 3: Treatment allocation and blocking.

Plot Number	Number of followers (stems/ha)	Prescribed MTH at final thinning (m)	MTH at trial installation (m)	Block
3 3 1	230	18	8.0	Blk1
0 0 2	Direct (0)	12	7.5	Blk2
0 0 3	Direct (0)	12	7.6	Blk2
2 2 4	140	14	7.6	Blk2
3 3 5	230	18	7.9	Blk2
3 3 6	230	18	7.7	Blk1
4 2 7	320	14	7.9	Blk1
3 3 8	230	18	7.6	Blk1
5 3 9	357	18	6.8	Blk2
3 1 10	230	12.4	6.6	Blk2
3 3 11	230	18	7.7	Blk1
1 3 12	103	18	8.2	Blk2
3 5 13	230	23.6	7.2	Blk1
0 0 14	Direct (0)	12	6.0	Blk1
2 4 15	140	22	7.6	Blk2
4 4 16	320	22	8.2	Blk1

YEAR PLANTED: 1990

SEEDLOT: GF 17 seedlings

PLANTED STOCKING: 884

GEOLOGY AND SOILS: Primary podsolic Taupo ash over Kaingaroa ignimbrite.

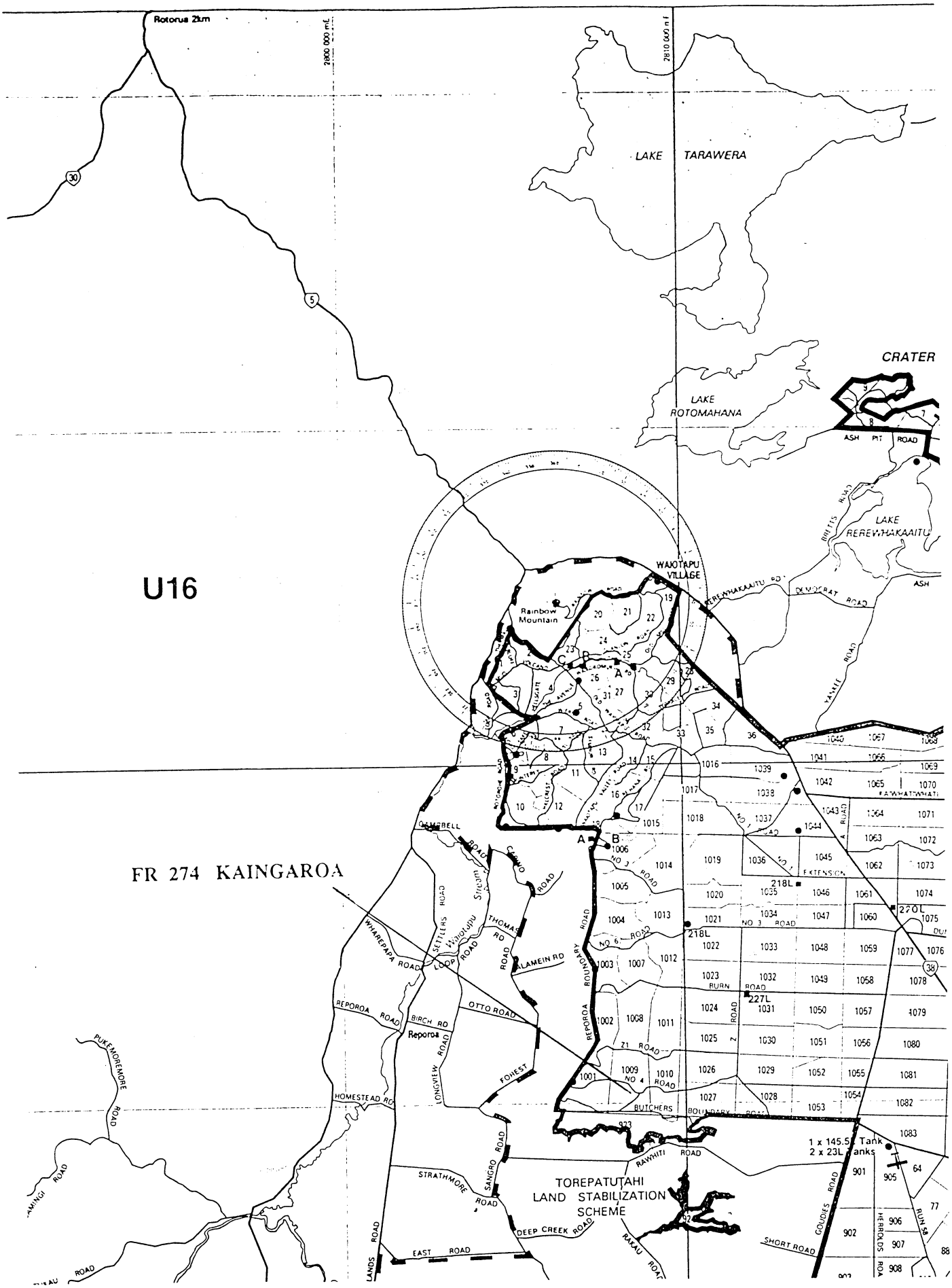
PREDICTED SITE INDEX: 30.9 m.

TRIAL INSTALLATION DATE: March 1996

TRIAL STATUS: The trial has received two pruning lifts. The first, in March 1996, was to equalise the pruning severity on each plot and left a plot average of 4.5 metres of green crown remaining. The second lift in March 1997 saw the trees variable lift pruned to leave 5.1 metres of green crown . The current mean crop height of the trial is 9.5 metres and the average pruned height is 4.3 metres. A further pruning lift scheduled for summer 1997/ 98 will complete the pruning.

Following the thin to waste operation at the time of trial installation the regrowth of Budlejah and native shrub hardwoods has been vigorous. In March 1997 the trial area was underscrubed by a group of Forestry Education Centre students carrying out a work experience module. The trial location and plot layout are shown in figure 1 and figure 2.

Figure 1: Trial location Map



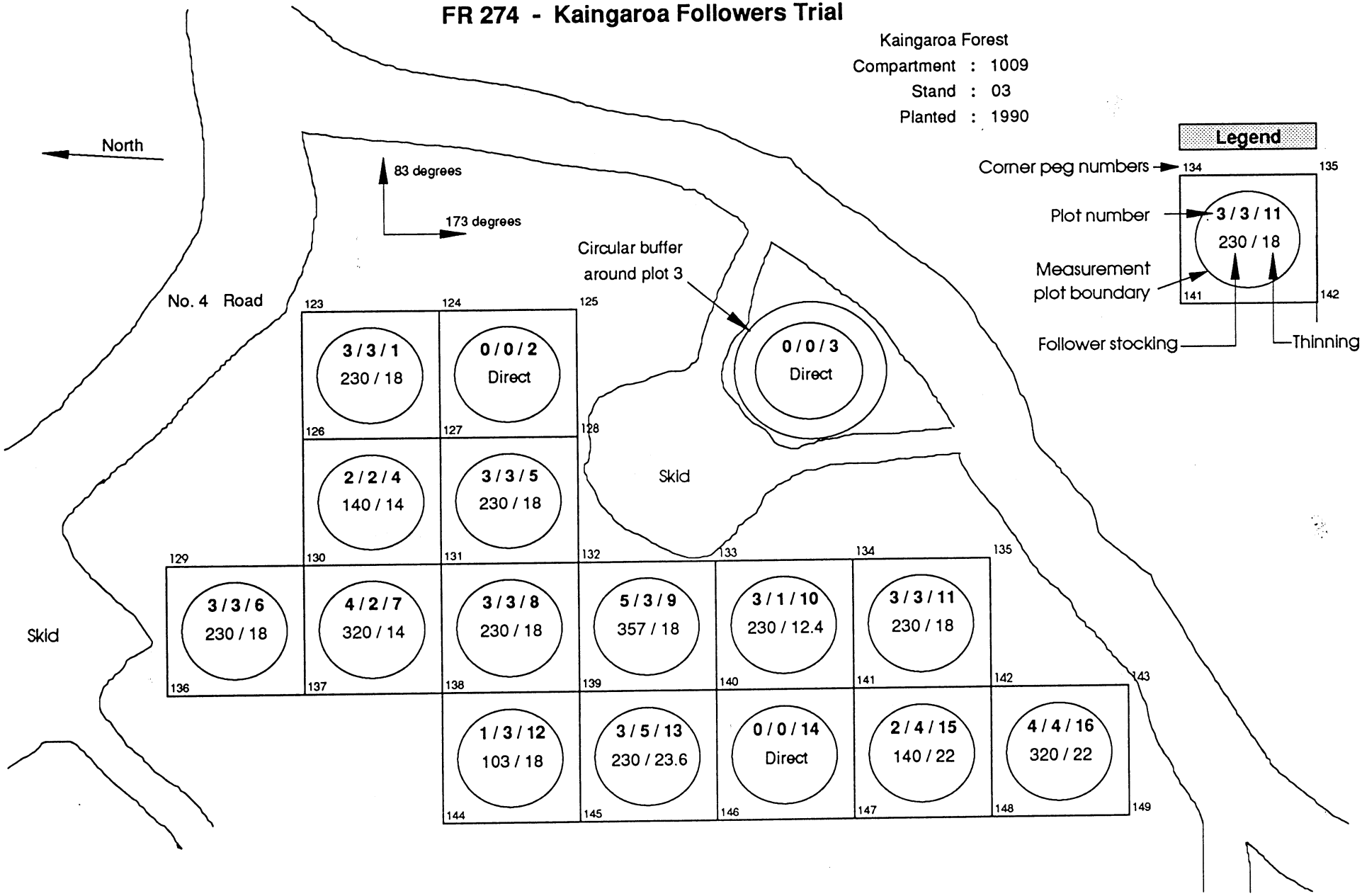


Figure 2: Plot layout map.

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FR 276 - CONICAL HILL FOLLOWERS TRIAL

LOCATION: Blue Mountain Forests, Conical Hill Block Cpt 320.

OWNER: Ernslaw One Limited

INTRODUCTION:

This trial is located on a gently sloping third rotation site with a north easterly aspect. The previous crop was 31 year old Radiata pine. The compartment was release sprayed with Velpar 90 in December 1989.
At the time of trial installation the compartment had a dense cover of radiata regeneration at 5- 10 thousand stems/ha and patches of broom. Prior to laying out the measurement plots the trial area was variable lift pruned pruned to 350 stems / ha to leave 5 metres of green crown remaining and regen thinned to a stocking of ~ 700 stems /ha.
Table 4 shows the allocation of treatments and stand parameters at the time of trial installation.. DBH and a 100 % height sample were taken of each plot and the treatments were randomly allocated using SAS to balance treatments across the range of initial Basal area.

Table 4: Treatment allocation and initial plot measurements

Plot Id.	Treatment No of followers/ht at final thining	Site Index	Total Sph	Mean		
				Height	Pr Ht	Cr Lgth
FR 276 0 0 11	Direct	29.1	350	8.0	2.7	5.3
FR 276 0 0 13	Direct	27.9	350	7.6	2.6	4.9
FR 276 0 0 16	Direct	27.8	350	7.7	3.1	4.6
FR 276 1 3 7	103 / 18	25.6	380	7.0	2.5	4.5
FR 276 2 2 4	140 / 14	27.8	420	7.7	2.8	4.9
FR 276 2 4 14	140 / 22	26.8	420	7.4	2.4	5.0
FR 276 3 1 10	230 / 12.4	28.2	510	7.8	2.4	5.4
FR 276 3 3 1	230 / 18	28.0	510	7.8	2.6	5.1
FR 276 3 3 2	230 / 18	28.0	510	7.8	2.9	4.9
FR 276 3 3 3	230 / 18	28.5	510	7.8	2.7	5.2
FR 276 3 3 9	230 / 18	27.8	510	7.4	2.2	5.2
FR 276 3 3 12	230 / 18	27.6	510	7.2	2.3	4.9
FR 276 3 6 17	230 / 18	26.6	510	6.7	2.0	4.8
FR 276 3 5 15	230 / 23.6	27.7	510	7.4	2.2	5.2
FR 276 4 2 8	320 / 14	27.1	590	7.1	2.1	5.0
FR 276 4 4 6	320 / 22	27.8	590	7.5	2.4	5.1
FR 276 5 3 5	357 / 18	26.6	630	7.0	1.9	5.1
	MEANS :	**27.6**		**7.5**	**2.5**	**5.0**

YEAR PLANTED: 1989

SEEDLOT: 6/3/87/02 GF 17 seedlings

PLANTED STOCKING: 1000 stems/ha

GEOLOGY AND SOILS: Hygrous Kaihiku lowland yellow brown earth (35aH) over Waipahi group Greywacke and Argillite substrate.

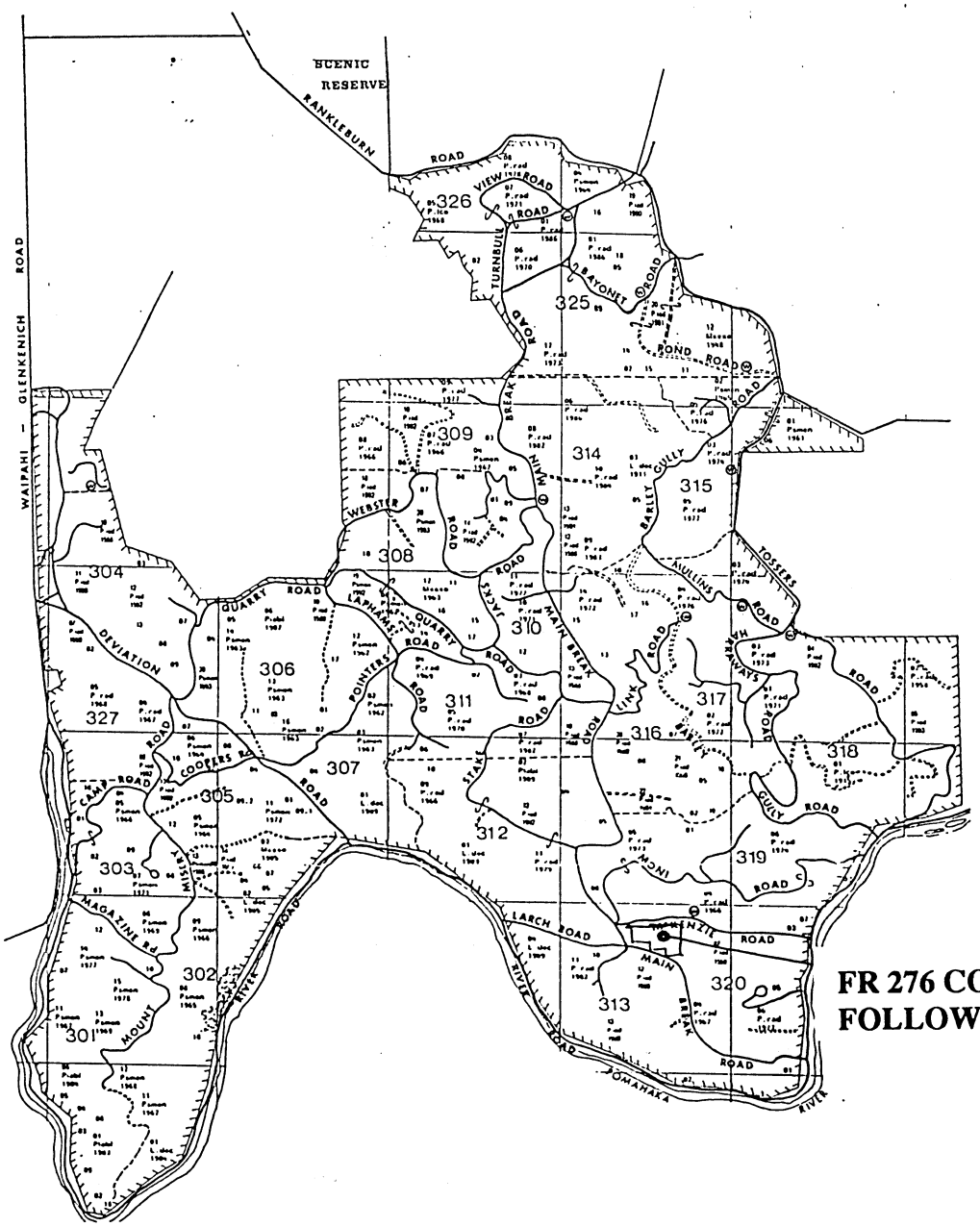
PREDICTED SITE INDEX: 27.6 m.

TRIAL INSTALLATION DATE: September 1996

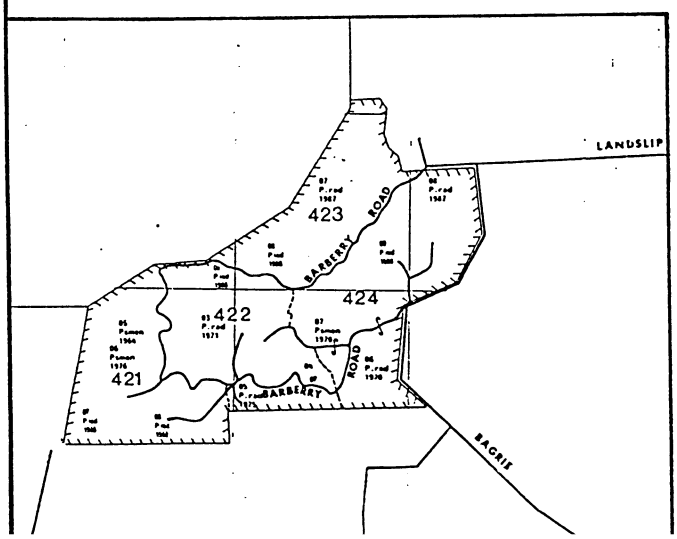
TRIAL STATUS: Following the allocation of treatments each plot was touch up pruned to a common stocking (350 stems/ha) and average green crown length remaining of 5.0 metres plus or minus 0.2 metres. Plot trees are well marked with yellow paint bans and tags. The trial boundary has been demarcated with yellow twine. The trial location is shown in figure 3 and the plot layout in figure 4.

Figure 3: Trial location Map

ERNSLAW ONE LIMITED



FR 276 CONICAL HILL FOLLOWERS TRIAL



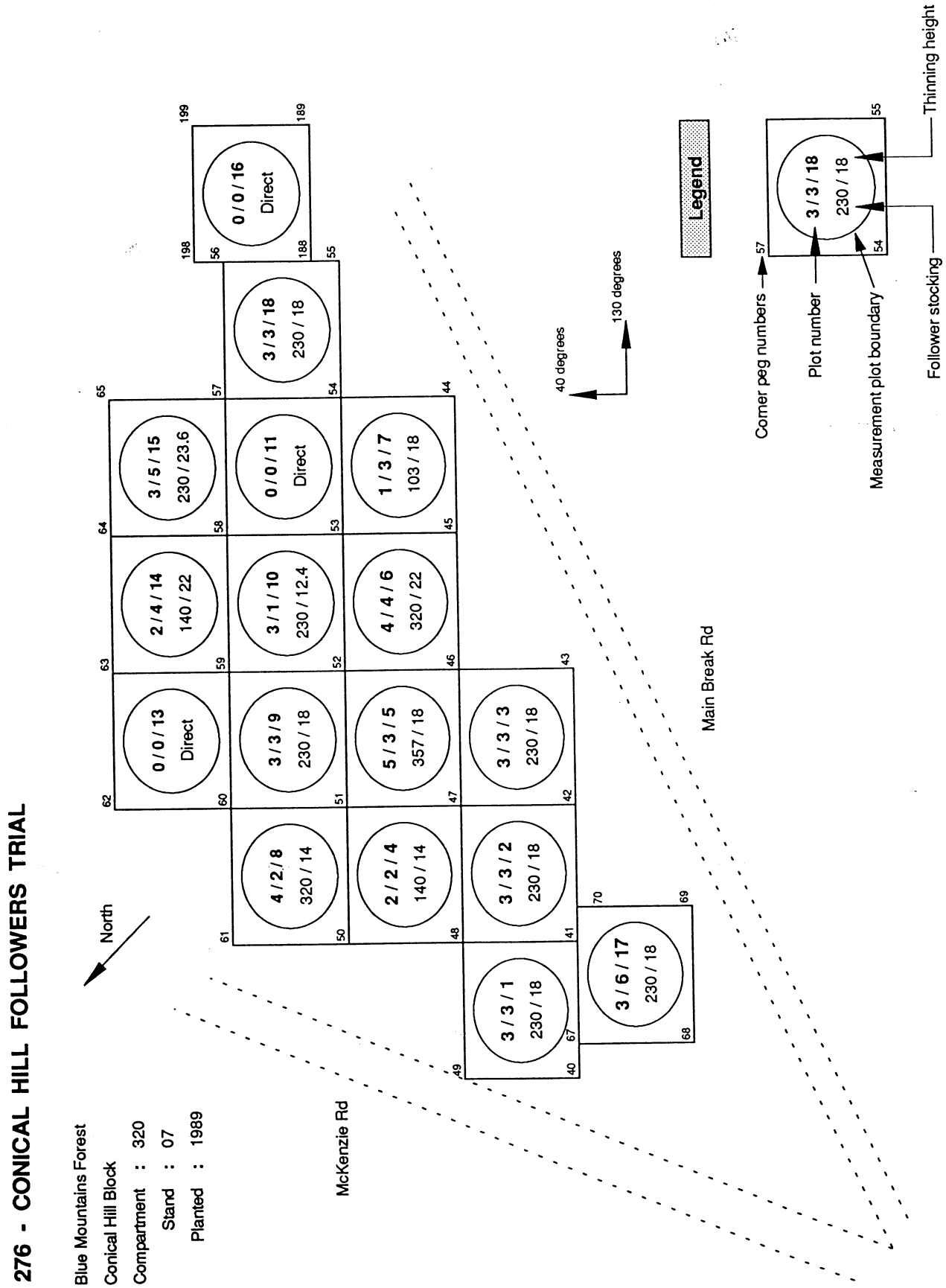
FOREST MAP
CONICAL HILL BLOCK

1km 0 1km 2km

LEGEND

Forest Boundary	
Native Bush	
Roads	
4 x 4 Tracks Dry Weather Only	
Comparment Boundary	
Water Supply Holding 15 000 litres or more	⊖

Figure 4: Plot layout map.



Appendix 1: Work Plan

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)	3
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	Follower	Crop	Follower	Crop	Follower	Crop	Follower	Crop	Follower
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.

RESPONSIBILITIES

This trial series has been initiated as a project within the Agroforestry Collaborative. As such FRI will contribute the design of the trial and assist with the establishment. Treatment of the trial, namely pruning and thinning, and remeasurement will be the responsibility of the forest owner.