

## Skid site rehabilitation - tree growth trials, results up to age 7



Figure 1 – Skid site (landing) in Kaingaroa Forest (at age 2), rip and return soil/debris section on left and rip only on right.

### ABSTRACT

*Analysis of the early growth results from three skid site rehabilitation trials revealed that the treatments of returning topsoil and debris gave significantly improved growth responses compared to ripping only.*

*In the Kaingaroa trial the rip and return soil and debris treatment has shown growth similar to that of the surrounding cutover (Diameter -3%, Height -8%, Survival +18%, Basal Area +13%).*

*At Golden Downs the most intensive (and expensive) treatment (rip and fertilise and return slash) has shown the best growth on the skid sites but was still significantly less than the cutover growth (Diameter -30%, Height -18%, Survival +3%, Basal Area -48%).*

*In Berwick, there were significant differences between treatment responses and for planting stock type. The 1.5 year old planting stock has given better height and diameter growth regardless of treatment. The rip and return soil treatment was giving significantly better growth than the rip only treatment, but significantly less than the cutover (Diameter -26%, Height -18%, Basal Area -43%).*

## INTRODUCTION

The area of productive forest land that is seriously affected by harvesting operations can be substantial. This area is that occupied by skid sites (logging landings) and major extraction tracks. Skid sites can occupy between 4% and 6 % of the forested area (Krag 1992, Hall 1993). This does not include the area occupied by access roads and major tracks.

The impacts on these sites are often severe, with the topsoil and organic matter being stripped off, and the subsoil severely compacted. Typically trees planted on these sites do not grow well (Murphy 1983, Hall 1995), even if the soil is ripped to ameliorate the compaction. The sub-soil, now on the surface of the skids, is often deficient in critical nutrients and trace elements (Nitrogen, Phosphorous, Potassium). Fertilising is required to get trees to perform well immediately after planting. The skid surfaces have minimal organic matter and repeat applications of fertiliser would be required for much of the rotation.

Trees planted on skids which have received rip only treatments, tend to have yellowed foliage, and to be smaller in both height and diameter than the trees on the surrounding cutover. Given the area of land loss, rehabilitation of these sites to a level of production similar to the surrounding cutover is desirable (Shuster, 1979).

To determine the cost effectiveness of some rehabilitation treatments, which address these problems, Liro established three skid site rehabilitation trials. These trials were designed to provide growth results from treatments which dealt with the soil compaction and topsoil removal associated with skid sites. The costs of the treatments were determined when the trials were installed (Riddle 1994). A cost-benefit analysis will be possible when the trials reach age 10. This report presents growth results for the three skid rehabilitation trials to age 5 at Berwick, 6 at Golden Downs and 7 at Kaingaroa.

## ACKNOWLEDGEMENTS

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## METHODS

The trials were established at three locations:

- Kaingaroa Forest - Central North Island, planted in 1992, age 7 (pumice soil) - 10 skid sites. Treatments were: rip-mound the skid surface (R), rip-mound the skid surface and return soil/debris to the skid surface (RS), Cutover/Control (CO). This site was on flat terrain, which had been logged by a ground-based system.
- Golden Downs Forest - Nelson, planted in 1993, age 6 (Moutere gravel) - 9 skid sites. Treatments: rip skid surface (R), rip and fertilise (RF), rip and return slash and soil (RS), rip and fertilise and return slash (RFS), Cutover/Control (CO), (Figure 2).

The Golden Downs trial was on steep terrain (hauler logged). The skids were cut out of the hill sides and the topsoil removed during the skid formation was not accessible for the rehabilitation treatments.

- Berwick Forest - Otago, planted in 1994, age 5 (clay loam soil) - 8 skid sites. Treatments: rip skid (R), rip skid and return soil and debris (RS), Cutover/Control (CO). An additional factor in this trial, was the use of two different planting stock types: one year old and 1.5 year old radiata pine seedlings. This site had rolling terrain, which was logged by a ground-based system.



*Figure 2 - Skid site in Golden Downs with rehabilitation plots (age 2)*

Each skid was split into two or more plots, and together with a cutover plot next to each skid, formed a block. Individual plot sizes varied, depending on the size of the skid, but were a minimum of 30 trees.

The trials have been measured annually. Measurements taken were height and root collar diameter (until trees were large enough to have diameter at breast height (DBH) measured). A subjective assessment of health and form was made of each tree on a scale of one to five. Health: 1 = very healthy, to 5 = dead. Form: 1 = single straight leader to, 5 = toppled or severely butt swept.

Uniform weed control has been maintained across each trial.

Analysis of the annual growth data for treatment differences was by analysis of variance and by a least significance difference test (Duncans).

## RESULTS

### Kaingaroo, trial at age 7

#### DBH and DBH Increment

There was no significant difference in DBH and DBH increment between the cutover and the rip and return soil treatment. However, both the cutover and rip and return soil were significantly larger than the rip only treatment. This was a continuation of the trends seen in previous years and suggests that the cutover (CO) and rip and return soil (RS) treatments are divergent from the rip (R) treatment (Figure 3).

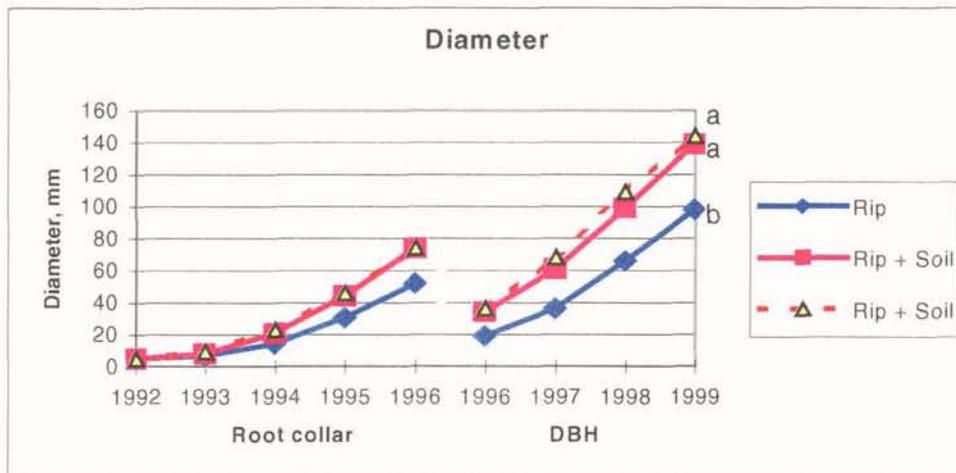


Figure 3 - Diameter by treatment, Kaingaroo

Note: The letters at the end of each data series line on the graphs denote statistically significant differences ( $P < 0.05$ ). Lines with the same letter are **not** significantly different, lines with different letters are significantly different.

#### Height and Height Increment

The CO and RS treatment were not different to each other but were different to the R treatment for height (Figure 4). There were no differences by treatment for height increment.

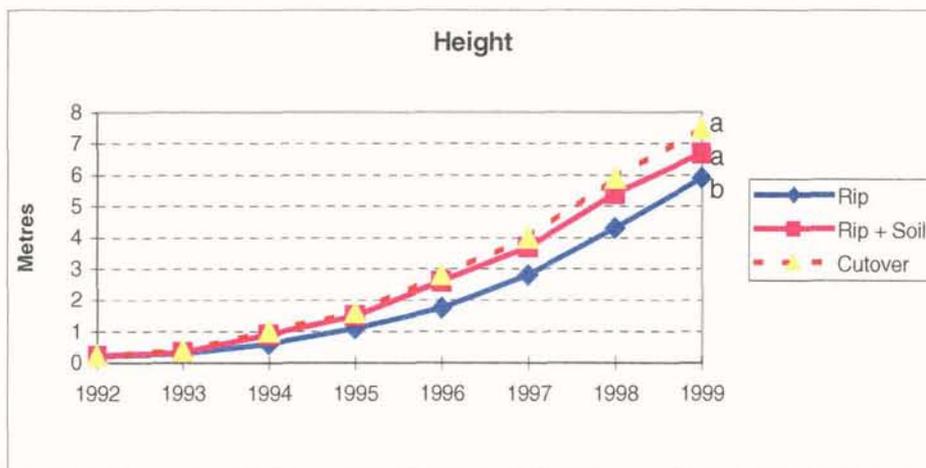


Figure 4 - Height by treatment, Kaingaroo

## Survival

The cutover had the lowest survival, significantly lower than both RS and R treatments, which were not significantly different to each other (Figure 5).

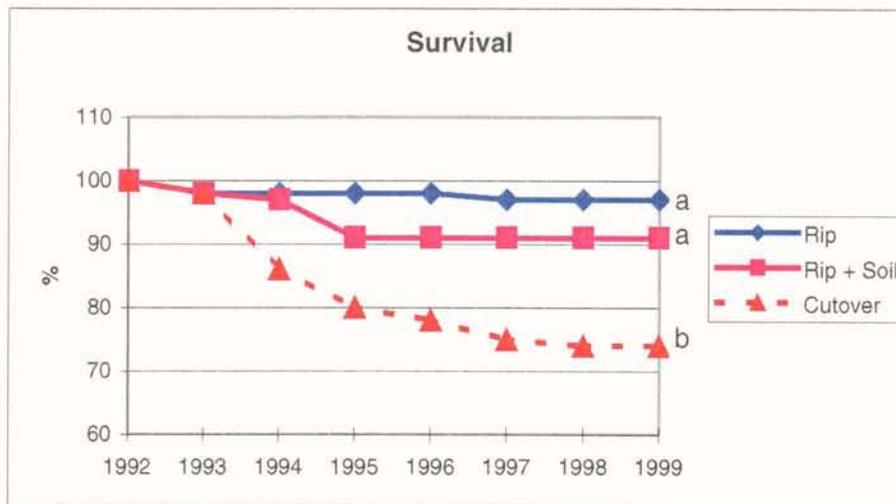


Figure 5 - Percent survival by treatment, Kaingaroa

## Basal area

The rip treatment had a substantially lower basal area than the rip and return soil and cutover treatments (Figure 6). The CO and RS had very similar basal areas. The cutover had larger individual DBHs but lower survivals. This was due to some re-establishment problems related to frosts. If the cutover survivals had been higher, 90% for example (typical of cutover re-establishment) the cutover would have had a higher basal area (+5%) than the RS treatment.

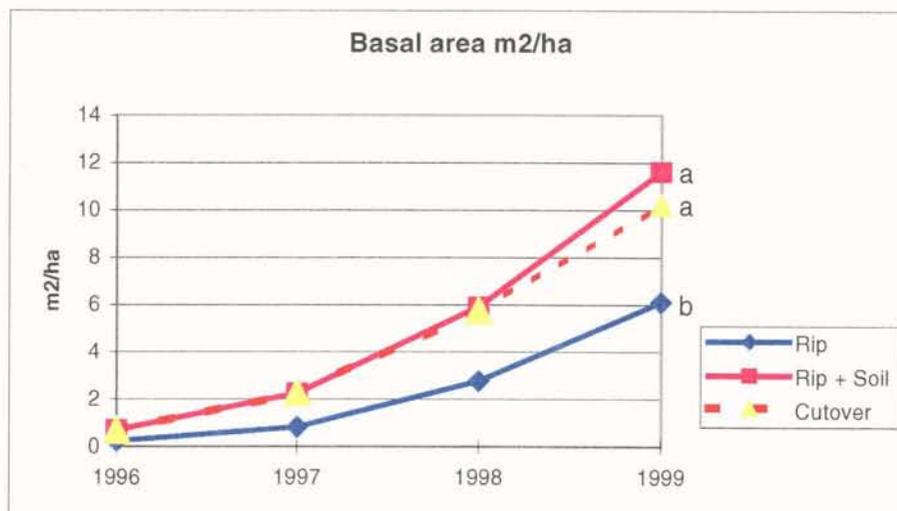


Figure 6 - Basal area (m<sup>2</sup>/ha) by treatment, Kaingaroa

## Golden Downs, trial at age 5

### Diameter and Diameter Increment

There were significant differences in both DBH and DBH increment between treatments. The cutover plots were performing better than any of the four rehabilitation treatments (with a DBH 30% larger than the best rehabilitation treatment DBH). The rip only (R) treatment was significantly worse than any other treatment. Rip and fertilise and slash (RFS) and Rip and fertilise (RF) were performing better than the R treatment. The RFS was significantly better than rip and slash (RS) but RF was not. The slash appeared to be having an effect on tree growth, as was the fertilisation (Figure 7).

There were also significant differences in DBH increment, with the cutover better than all treatments except RFS. The RFS treatments out-performed R and RS but not RF.

The trends suggest that the cutover will continue to out-perform the rehabilitation treatments. Substantial fertiliser application was required in the RF and RFS treatments to get growth responses on the skid sites. The fertilised treatments are likely to be divergent from the R and RS treatments over time.

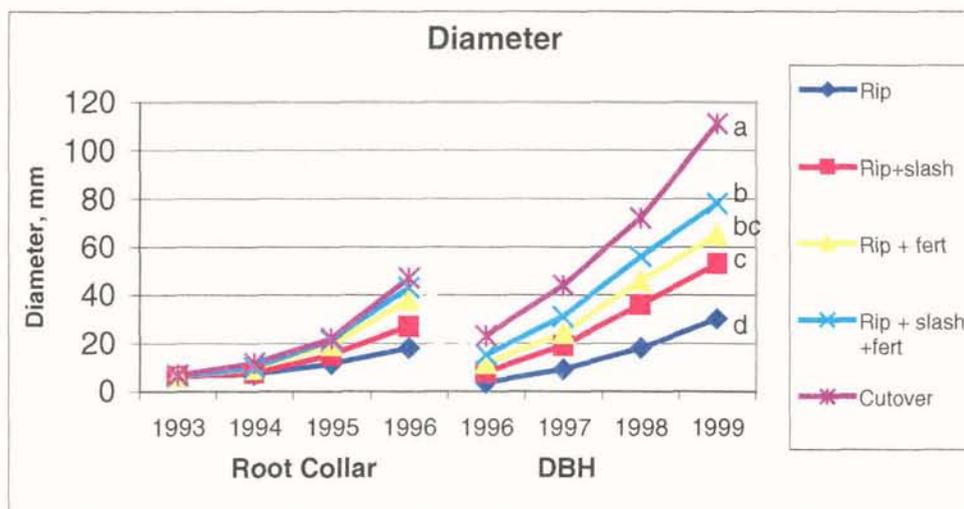


Figure 7 - Diameter by treatment, Golden Downs

### Height and Height Increment

The cutover plots had significantly greater height and height increment than the rehabilitation treatments (Figure 8).

Tress from the RSF and RF treatments were taller than the R and RS treatments, and were not different to each other. The height increments of the RF, RS and RFS treatments were not significantly different to each other but they were all significantly less than the cutover and greater than the R.

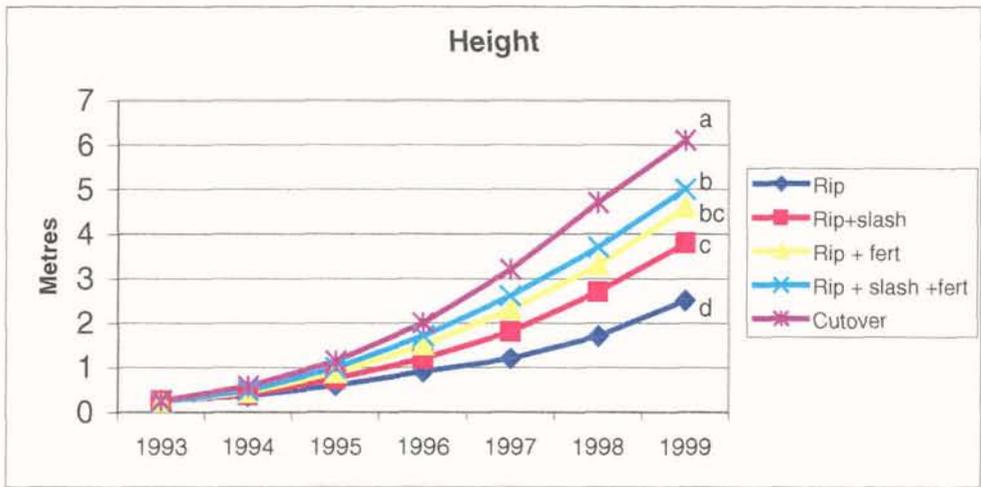


Figure 8 - Height by treatment, Golden Downs

### Survival

There were no significant differences in survival with all survivals being between 86% and 93%. Despite the trees in the R treatment showing very poor health, and having very poor growth, they continued to survive. This may be partly attributable to the very low level of weed competition on the skids. Weed germination on the skids has been minimal.

### Basal Area

The CO plots had the greatest basal area, and were significantly larger than any other treatment. The RSF treatment had the next best result, being significantly greater than RF, RS and R. The RF treatment gave a significant improvement in basal area compared to R (Figure 9).

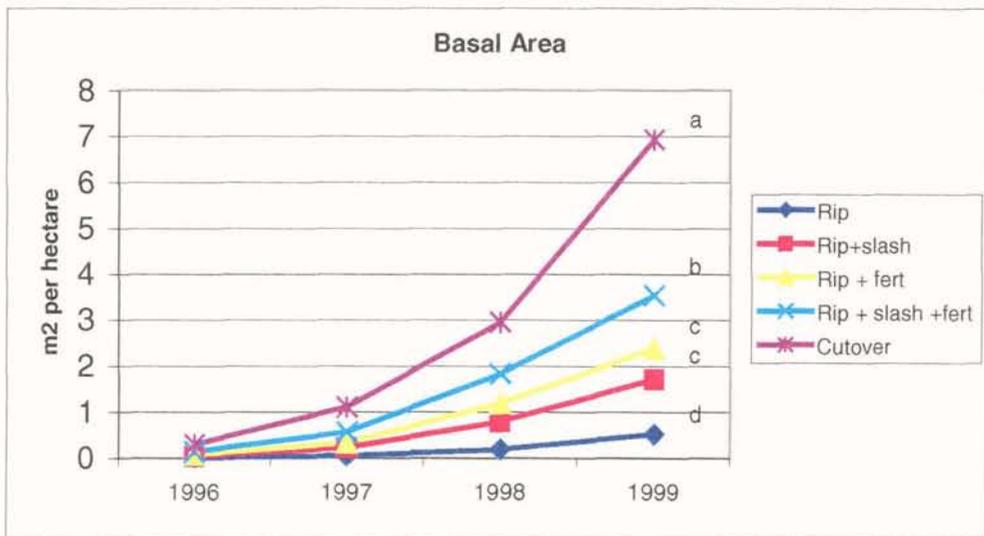


Figure 9 - Basal area by treatment, Golden Downs

## Berwick, trial at age 5

### DBH and DBH increment

When analysed by skid treatment significant differences were found for DBH, with all treatments significantly different. For DBH increment, Cutover and Rip + soil and debris were outperforming the rip treatment.

When DBH was analysed by planting stock type, 1.5/0 stock (1.5 year old seedlings) was significantly ahead of 1.0/0 stock (1 year old seedlings).

When analysed by stock type and treatment together all combinations were significantly different to each other for DBH (Figure 10).

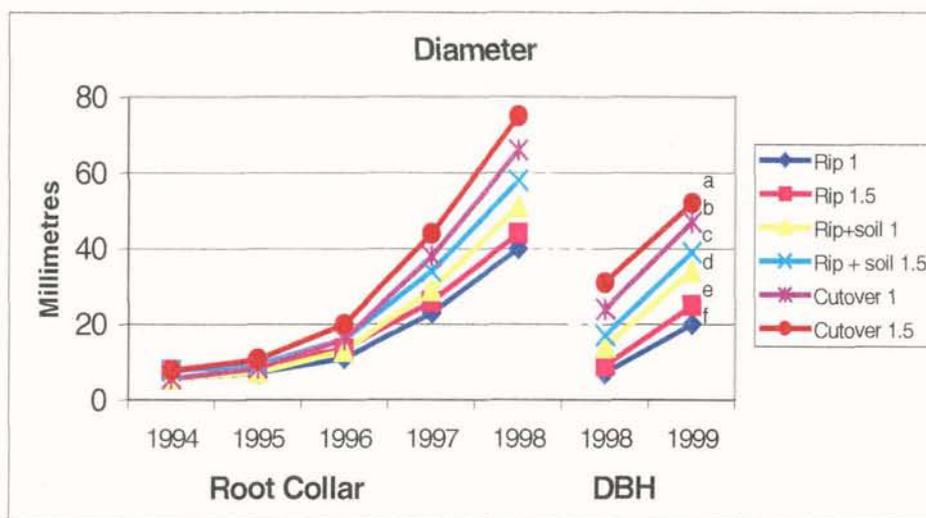


Figure 10 - Diameter by treatment, Berwick

### Height and Height increment

For height, all treatments were significantly different (Figure 11). When analysed by stock type, heights were significantly different, but height increment only varied significantly between Rip and the other two treatments.

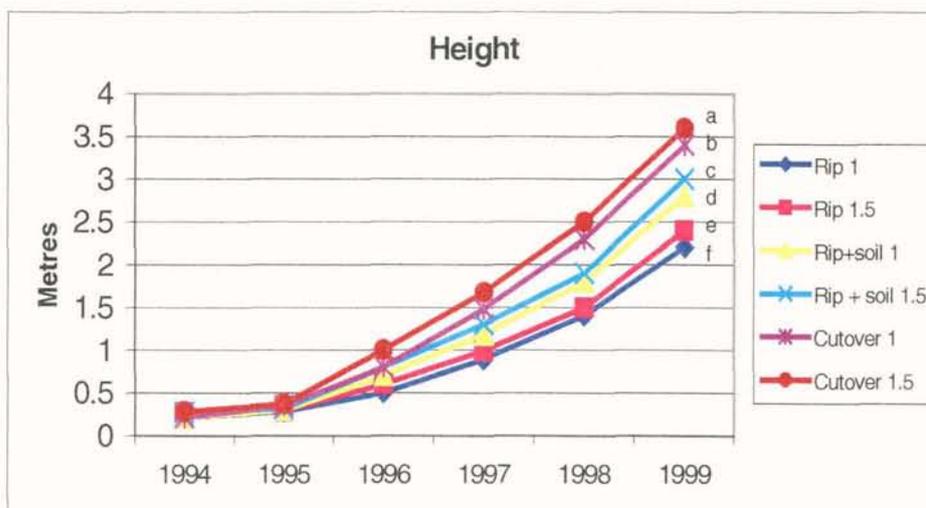


Figure 11 - Height by treatment, Berwick

## Survival

Survivals by rehabilitation treatments were the same. The 1.5/0 stock type had significantly higher survival (Table 1).

Table 1 – Survivals by treatment and stock type (Berwick)

Treatment	1/0 stock type	1.5/0 stock type
Rip	90 a	95 a
Rip + soil & debris	92 a	95 a
Cutover	90 a	97 a

## Basal Area

The cutover 1.5/0 treatment was giving the best growth. The two rip only treatments were giving the poorest growth. The rip 1/0 and rip 1.5/0 treatments were not significantly different (Figure 12).

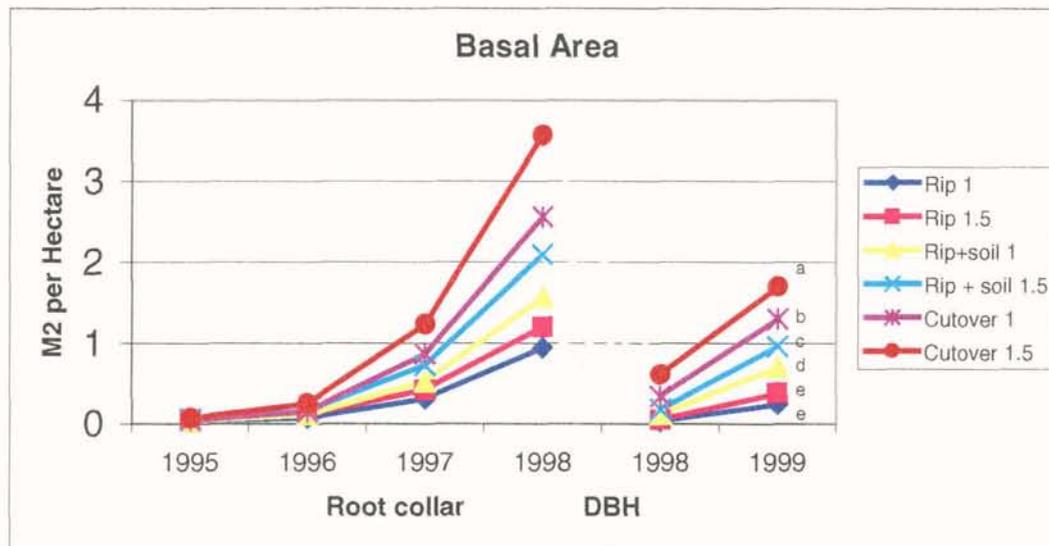


Figure 12 - Basal area by treatment, Berwick

## DISCUSSION

Whether the cost (\$800 to \$1100 per hectare or \$270 to \$370 per skid) of the rehabilitation treatments is justified by the growth of the trees on the rehabilitated skids is not yet clear. Currently most of the growth trends are divergent.

The best results in comparison to the cutover was in the Kaingaroa trial. The second best was in Berwick. Although the growth performance of the best rehabilitation treatments in Berwick and Golden Downs were similar in percentage terms the cost of the treatments in Berwick was substantially less.

The rehabilitation treatments at Golden Downs have proved to be less successful than hoped but the data is giving indications that rehabilitation treatments will give improved growth. To give a viable crop, the treatments would have to be more intensive than those applied in the trial plots. That is, more soil and residue closer to

the trees and a heavier fertiliser application. It was also apparent that ripping by itself is an inadequate treatment

Perhaps the most important result from the Berwick trial was the significantly superior performance of the 1.5/0 stock for diameter and height growth, across treatments.

Based on the current results, the rehabilitation of skid sites is a viable option in Kaingaroa, but not in Golden Downs and Berwick. However, the reason that the Kaingaroa skids are performing better in terms of basal area is due to poor survivals on the cutover. The trial was established in an area prone to heavy frosts and some of the mortality on the cutover is due to this. The skid sites remained largely free of weeds for the first two years of the trial, whilst the cutover had heavy grass growth. The cutover had spot weed control to release the trees from the grass. If the cutover had not had the heavy mortality, and had a survival similar to the rehabilitation treatments (90%), then it would have had a larger basal area than the rip and return soil and debris sites (+5%).

## CONCLUSIONS

In the Kaingaroa trial the rehabilitation treatment (Rip and return soil) has given growth similar to that of the surrounding cutover (Diameter -3%, Height -8%, Basal Area +13%). The rip only treatment has given substantially less growth (Diameter -32%, Height -24%, Basal Area -40%).

At Golden Downs, the most intensive (and expensive) treatment has given the best growth on the skid sites, but it was still significantly less than the cutover growth (Diameter -30%, Height -18%, Basal Area -48%). The rip only treatment was performing very poorly by comparison (Diameter -73%, Height -62%, Basal Area -92%).

In the Berwick trial, there were significant differences in rehabilitation treatment responses and in planting stock type. The 1.5 year old planting stock has given better height and diameter growth regardless of treatment. The rip and return soil skid site rehabilitation treatment was giving significantly better growth than the rip only treatment but significantly less than the cutover (Diameter -26%, Height -18%, Basal Area -43%). The rip only treatment was giving very poor growth (Diameter -55%, Height -34% and Basal Area -79%).

## REFERENCES

Hall P. (1995): Rehabilitation of skid sites and major extraction tracks - preliminary growth trial results. In; Harvest Planning, Proceedings of a Conference. LIRO Annual Conference, Nelson, New Zealand, November 1995.

Hall P (1993): Skid site rehabilitation. LIRO Report, Vol. 18, No. 8.