Rehabilitation of Skid Sites and major Extraction Tracks - Preliminary growth trial results

Peter Hall [1] & Mark Kimberly [2]
1. Researcher, Logging Industry Research Organisation.
2. Scientist, Biometrics, NZ Forest Research Institute Ltd.

ABSTRACT

Early results of six trials, three on skid sites and three on extraction tracks, testing the effects of site rehabilitation treatments on tree growth, are reported. The areas of land occupied by skid sites and tracks and the costs of the rehabilitation treatments are presented. They are then used to calculate the costs and benefits of rehabilitating land affected by logging operations. A net present value analysis of the results is used to indicate the point at which it is more economic to rehabilitate rather than buy new land.

INTRODUCTION

The area of potentially productive land affected by logging operations can be substantial. In the case of skid sites it can be 5-8% (Larsen 1986, unpublished, Hall 1995). For extraction tracks, especially on rolling terrain where benched contour tracks have been formed, it can be even higher, with 7-10% of sites covered in major extraction tracks. Levels higher than these have been recorded (Brownlie and Terlesk 1995). Together these areas can account for 12-18% of the productive land in a setting logged by ground based systems using formed tracks. This is a significant area and will obviously affect the overall production of subsequent rotations. The number of skid sites and the amount of tracking used depends on a number of factors, including slope, evenness of contour and roading access density (Krag 1984). Trees planted on extraction tracks (Murphy 1984) and skid sites (Hall 1995) typically do not perform as well as those planted on surrounding cutover. This is due to the highly compacted soils, which inhibit root growth and water permeation, and the low levels of nitrogen and organic matter. Given this high area of land loss, rehabilitation of these sites to a level of production similar to the surrounding cutover is desirable (Shuster, 1979).

LIRO has established 6 site rehabilitation tree growth trials since 1992, on a range of sites with treatments that are aimed at ameliorating the compaction and nutrition problems on skids and tracks.

ACKNOWLEDGMENTS

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METHODS

Each skid or track was divided into two or more plots and, together with an adjacent plot in the cutover, formed a block. The treatments were applied, one block to each skid or a series of blocks along a track, forming a randomised complete block design. Plot sizes vary depending on the size of the skid, but are a minimum of 30 trees. Track plots are 30 trees.

A. Skid Site Rehabilitation Trials have been established at three locations, with a varying number of skids, they are;

1. Kaingaroa, 1992, 10 skids, pumice soil, treatments; cutover, rip skid, rip skid and return surrounding soil and debris.
2. Golden Downs, 1993, 9 skids - now 7 due to outside influences, Moutere gravel soil, treatments; cutover, rip skid, rip skid and fertilise, rip skid and return slash and debris, rip skid and fertilise and return slash and debris.
3. Berwick, 1994, 8 skids, clay loam soil, treatments; cutover, rip skid, rip skid and return surrounding soil and debris.

B. Track Rehabilitation Trials have been established at three locations;

1. Omataroa, 1993, scoria soil, 9 replications, treatments; cutover with weed control, cutover without weed control, untreated track, rip track, rip track and fertilise, rip track and return side cast soil and debris.
2. Golden Downs 1993, Moutere gravel soil, 9 replications, treatments; cutover with weed control, untreated track, rip track, rip track and fertilise, rip track and return side cast soil and debris.
3. Berwick, 1994, clay loam soil, 10 replications, treatments; cutover with weed control, untreated track, rip track, rip track and fertilise, rip track and return side cast soil and debris.

The time taken by the machinery to complete the treatments and their rates of production were measured during the establishment of the trials. The costs of the treatments were derived using the methods shown in Riddle 1994. These costs were then extrapolated to a per hectare cost.

The trials have had regular visits for maintenance and weed control when required, as well as being measured annually. Measurements are carried out during winter at 12 month intervals. Trees are measured for diameter (root collar until large enough to have a DBH) and height. Survivals are calculated by comparing live trees to the initial stocking. A subjective assessment of health and form is made for each tree, on a scale of one to five, with one being very healthy - five being dead, and for form one being a single straight leader and five being toppled or severely butt swept.

The analysis of the growth data for treatment differences was by using a randomised complete block analysis of variance, followed by a least significant difference test. Foliar nutrient analysis has been completed on the Kaingaroa skid site trial and the Omataroa track trial.

RESULTS

A. SKID SITE REHABILITATION TRIALS.

1. Kaingaroa

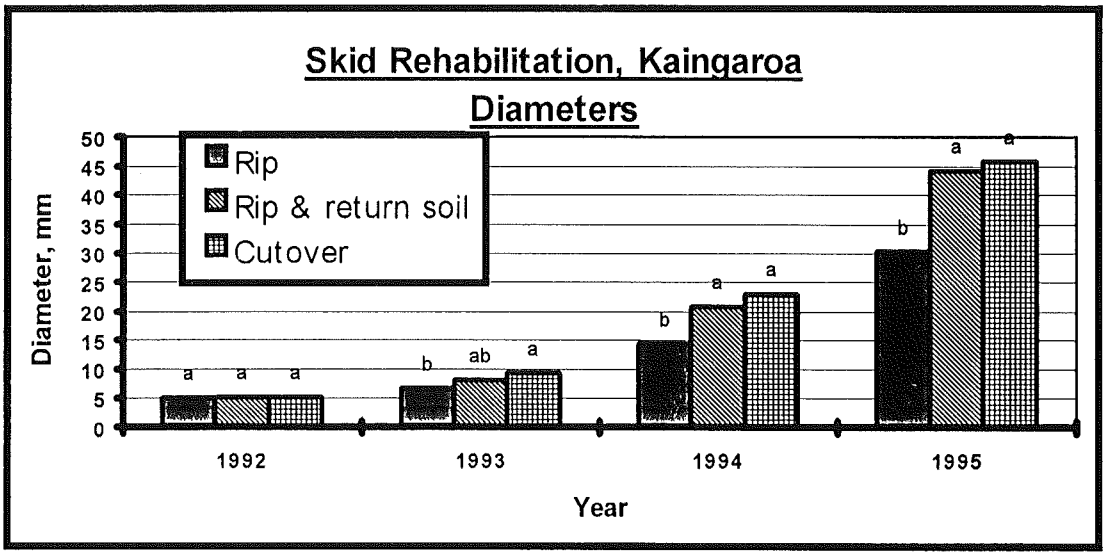
The rip only treatment is performing poorly, with high survivals (Table 1), but poor growth, at around 66% of the cutover's height and diameter growth (Figures 1 & 2) and 50% of the cutovers basal area (BA) and volume. The rip and return soil is doing well in terms of height and diameter at 95% of the cutover. It also has slightly greater basal area and volume per hectare than the cutover because of the better survival of the trees on the skid. The cutover trees have suffered from frost and Dothistroma leading to slower than optimum growth and a survival of only 80%. These results show that the rip & return soil treatment is likely to perform nearly as well as the cutover in the early years. Once the cutover trees recover from their poor start there may be a change in the relative growth rates.

Table 1. Kaingaroa growth results, at age 3

	Diameter mm	Height m	Health Score*	Form Score*	Survival %	Basal area (m^2/ha)	Volume (m^3/ha)
Rip	30.4 b	1.1 b	1.9 a	1.7 a	99 a	0.6	1.77
Rip & return soil	44.2 a	1.5 a	1.8 a	1.7 a	91 a	1.2	3.51
Cutover	45.8 a	1.6 a	2.0 a	1.7 a	80 b	1.1	3.44

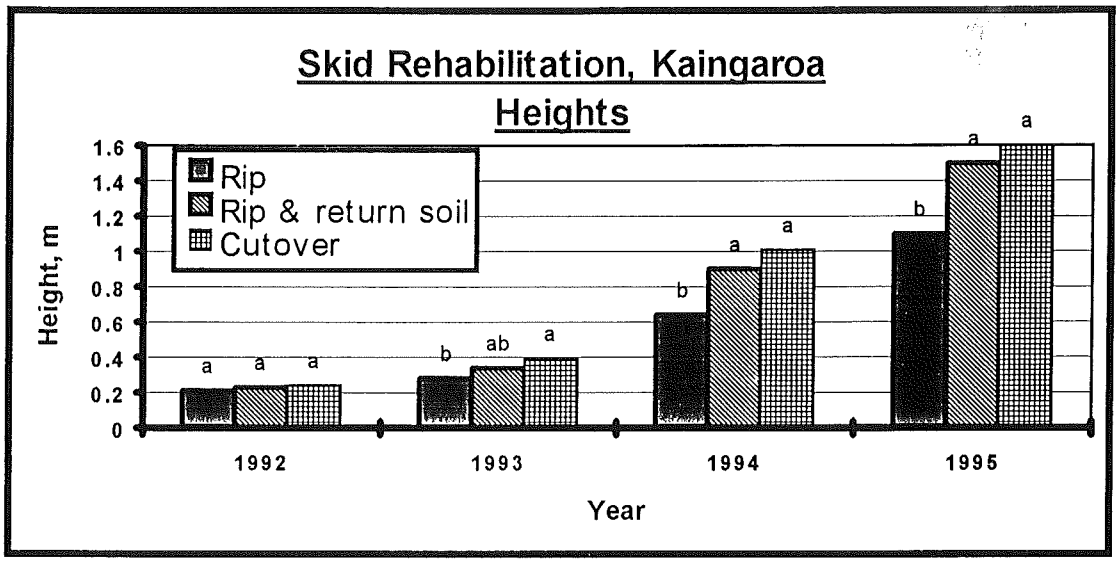
* A lower score represents a better health and form result.

Figure 1.



Note: Data in a table column followed by a different letter are significantly different (P = 0.05). For the graphs, data in an annual series marked with a different letter are significantly different (P = 0.05). The data for basal area and volume are derived from diameter height and survival values and have not been analysed statistically.

Figure 2



2. Golden Downs

The cutover trees are, as expected, performing the best for both height and diameter (Figures 3 & 4). The rip + fertilise + slash, and rip + fertilise treatments are not doing as well, but the differences are not statistically significant. The rip + fertilise + slash (RFS) treatment is about 90% of the cutover for height and diameter. The rip + fertilise treatment is about 80 % of the cutover for both height and diameter growth. For basal area and volume the differences are magnified with the RFS clearly affecting the performance of the trees on the skid (Table 2).

The unfertilised treatments are significantly smaller than the cutover trees and will probably suffer more in the long term due to the very impoverished nature of the site. Differences are likely to increase as a result of fertilised plots receiving a further application of fertiliser in 1995. Survivals in all treatments are good, at over 90% with no treatment differences. The cutover has the healthiest trees, with the fertilised trees next and the unfertilised trees doing poorly (Table 2). The growth trends here are indicative only and are not yet conclusive enough to justify the expense of the treatments. Whether the growth on the rehabilitated skids continues to match the cutover may depend on continued fertiliser applications. However the results are consistent with the Kaingaroa trial where trees on rehabilitated skids one year older are performing at around 90% of the trees on the cutover.

Table 2. Golden Downs, Growth results, age 2.

	Diameter mm	Height m	Health score	Form score	Survival %	Basal area (m^2/ha)	Volume (m^3/ha)
Rip	11.3 c	0.59 c	2.6 a	1.5 a	93 a	0.08	0.11
Rip & return slash	15.0 bc	0.75 bc	2.2 ab	1.6 a	96 a	0.14	0.36
Rip & fertilise	19.2 ab	0.89 ab	1.8 b	1.6 a	93 a	0.22	0.68
Rip & slash & fert	21.3 a	0.99 ab	1.7 b	1.5 a	92 a	0.27	0.89
Cutover	21.9 a	1.14 a	1.3 c	1.5 a	90 a	0.28	1.06

Figure 3.

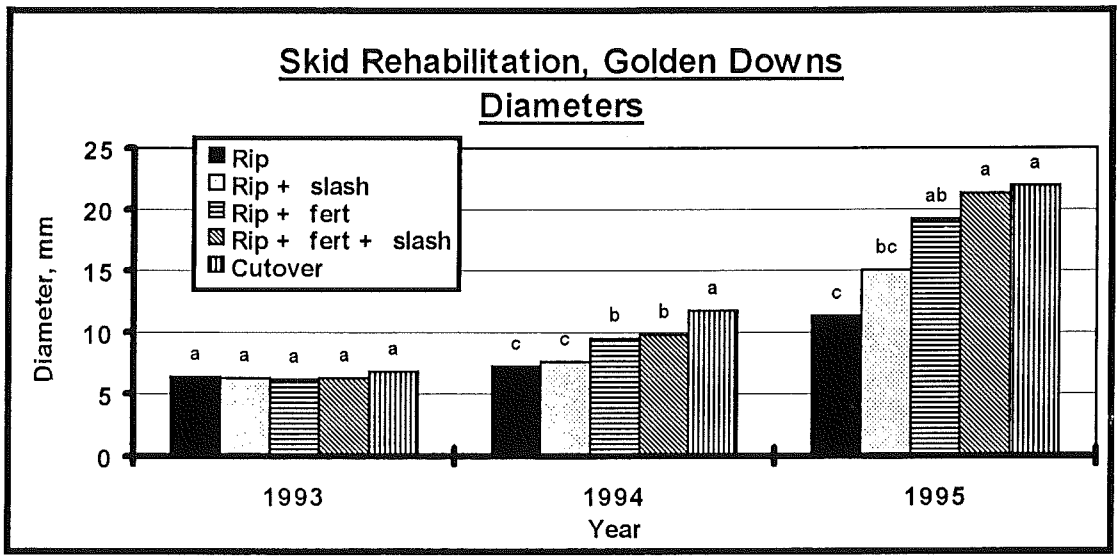
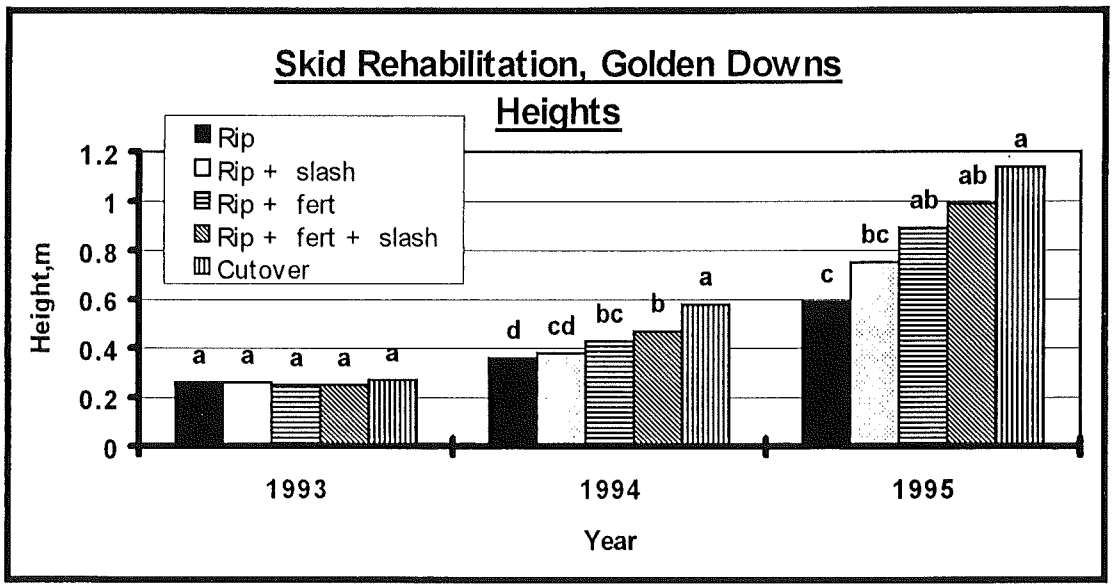


Figure 4.



3. Berwick

The data from this trial is still of a preliminary nature as the trees are only one year old. However, there are some statistically significant results (Table 3). This trial was planted with two stock types, 1 year old (1/0) and one and a half year old (1.5/0). It can be seen quite clearly that the 1.5/0 trees have not gained much in height or diameter in the first year, with the 1/0 stock having a much better annual increment.

The trees on the cutover are performing significantly better for diameter and height growth (Figures 5 & 6) than those on the skids (both stock types). There are no statistical differences between the two skid treatments for diameter. For height growth the 1.5/0 trees on the rip+soil treatment are better than the 1.5/0 on the rip

only. There has been a small amount of animal browsing in all the treatments that has slightly reduced the height of some of the trees but it is not statistically significant between treatments.

Survivals are quite high, except for the 1/0 stock on the cutover and the rip only, where there is a significant difference, with more mortality in the 1/0 stock. The difference in basal area between the treatments is due to the combination of the better survivals and greater diameters for the 1.5/0 stock.

This trial is also showing results that support those coming from the oldest skid rehabilitation trial (Kaingaroa), with the rip + return soil performing at 85% of the cutover for height and diameter growth.

Table 3. Berwick, growth results, age 1.

	Diameter mm	Height cm	Healt h Score	Form Score	Survival %	Basal area (m^2/ha)
Rip 1/0	7.1 c	28.1 c	2.6 a	1.6 c	92 ab	0.03
Rip 1.5/0	9.1 bc	28.9 c	2.4 ab	1.8 ab	97 a	0.05
Rip & return soil 1/0	7.3 c	29.6 bc	2.2 b	1.8 bc	97 a	0.03
Rip & return soil 1.5/0	9.3 bc	31.5 b	2.1 bc	1.9 a	98 a	0.05
Cutover 1/0	8.5 ab	34.9 a	1.9 c	1.7 bc	91 b	0.04
Cutover 1.5/0	10.8 a	37.0 a	1.7 c	1.8 ab	97 a	0.07

Figure 5.

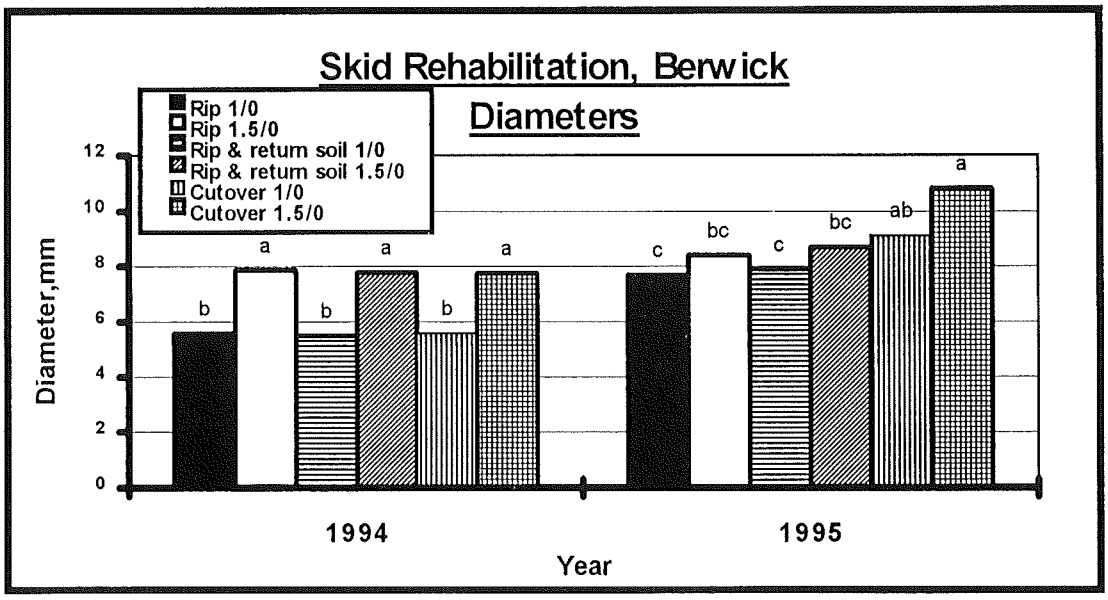
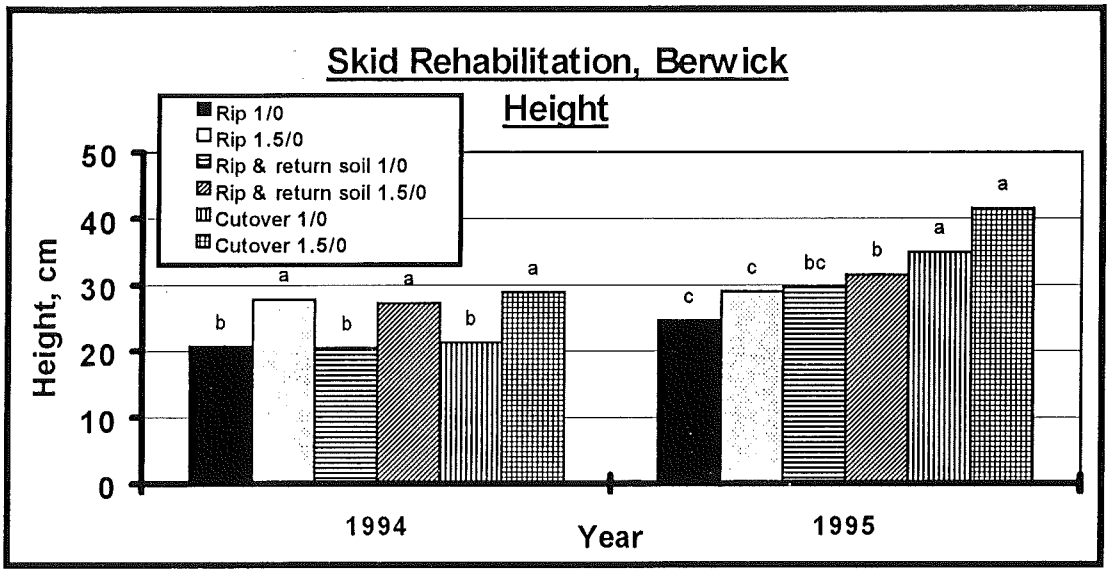


Figure 6



B. TRACK REHABILITATION TRIALS.

1. Omataroa

This trial was planted in 1992. There are some small differences between diameters (Figure 7). Some of the cutover trees are performing slightly better, and the rip + fertilise are doing the worst. For height there is a significant difference, with the cutover doing much better than any of the track treatments (Figure 8). There are no differences between the different track treatments. There are no major differences in health or form although again the rip and fertilise treatment is doing quite poorly, as is the untreated track (Table 4). However there are some major differences (not tested for statistical significance) in basal area and volume per hectare. This is due to the very poor survivals of the cutover treatments, which are about 60 %, for which there is obvious explanation. The minor advantages in diameter and height are outweighed by the low number of trees per hectare.

Table 4. Omataroa, growth results, age 3.

	Diameter mm	Height cm	Health score	Form score	Survival %	Basal area m^2/ha	Volume m^3/ha
Untreated track	35.3 ab	151.9 b	1.2 ab	1.5 ab	80	0.70	2.96
Rip only	36.2 ab	160.9 b	1.2 a	1.5 a	84	0.97	3.58
Rip + Fert	33.4 b	155.1 b	1.3 b	1.6 b	74	0.78	4.36
Rip + return soil	35.2 ab	160.6 b	1.2 a	1.6 ab	91	0.98	4.53
Cutover - weed control	35.1 ab	188.6 a	1.1 a	1.5 ab	60	0.86	2.66
Cutover - no weed control	38.8 a	195.5 a	1.1 a	1.6 ab	66	0.62	2.65

Figure 7

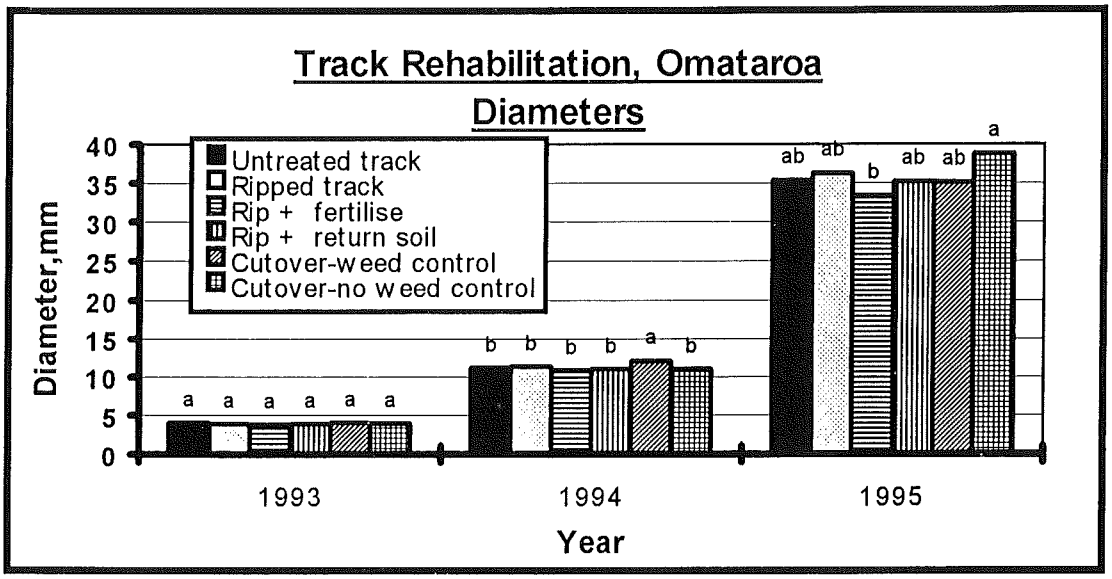
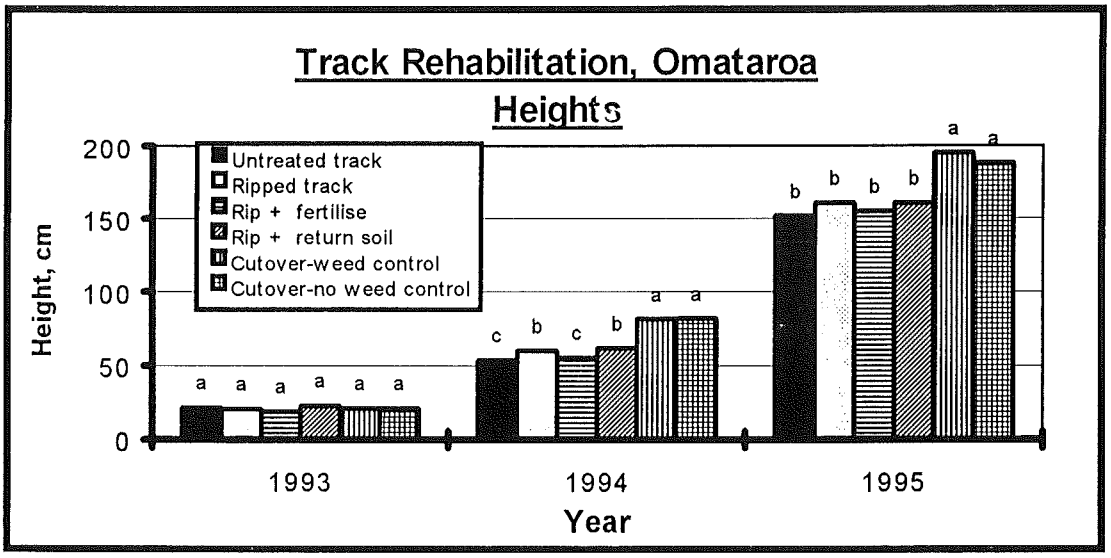


Figure 8

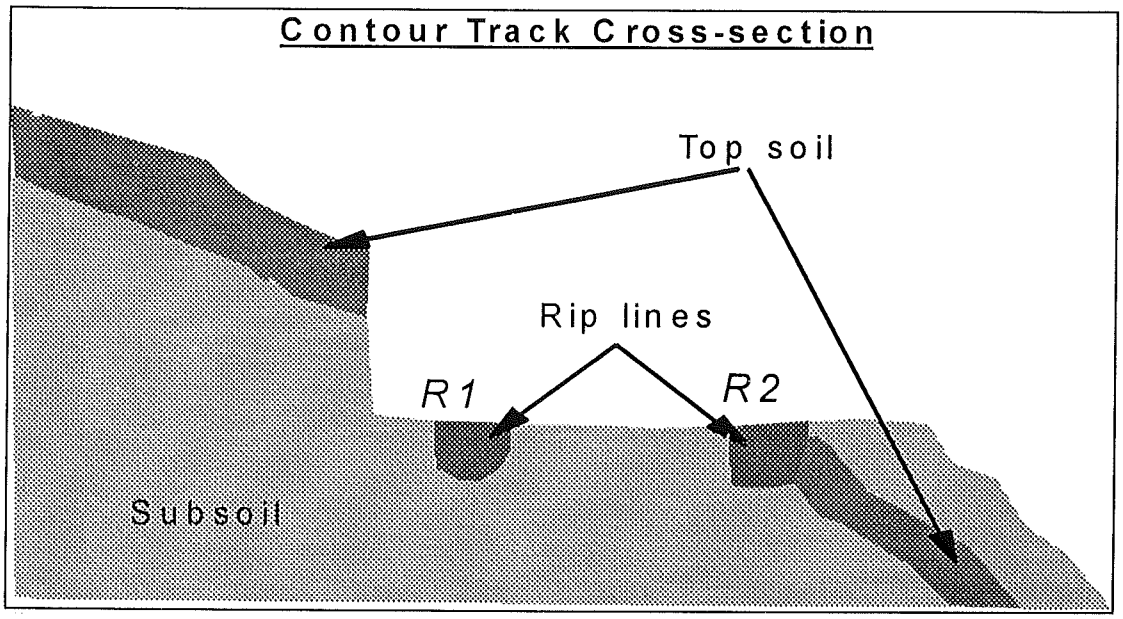


2. Golden Downs

The strongest result here is that the row on the outside of the track, nearest the fill slope produces much better growth than the inside row next to the cut bank (Table 5). This is consistent with results from contour skid roads in Canada (Smith and Wass 1985).

There are two main causes for this, the trees near the cut bank receive excess water running from the face of the cut bank, and may be more shaded. The trees on the outer edge of the track are able, with the aid of the ripping, to reach roots down to the topsoil buried under the fill (Figure 9).

Figure 9. Diagram of contour track soil profile.



If the data from the inside (1) and outside (2) rows are separated and analysed by treatment, see attached graphs, the relative growth rates can be seen.
For height (Figure 11);

- rows 1, untreated and ripped tracks show significantly less growth than rip + fertilise, which has less growth than rip and return soil. Cutover falls between rip + fertilise and rip & return soil.

- for rows 2, there is a much smaller range of differences, with rip + fertilise performing the best, but not significantly better than the cutover or rip only. Rip & return soil and untreated are significantly worse.

Diameter (Figure 10) shows the same trends as for height.

When the height, diameter and survival figures are converted into volume per hectare, there are some large differences with the rehabilitated track performing well (Table 5). The cutover figures are down slightly due to a lower survival, which should not be significant after thinning.

Overall, the rehabilitation treatment likely to give the best result is a rip + fertilise treatment of a single row of trees established towards the outer edge of the track.

Table 5. Golden Downs, growth results, age 2.

	Diameter mm	Height m	Health score	Form score	Survival %	Basal area m^2/ha	Volume m^3/ha
Untreated 1	19.2 c	0.95 c	1.6	1.4	89	0.279	0.916
Rip 1	16.7 c	0.84 c	1.6	1.5	88	0.196	0.575
Rip + fertilise 1	25.0 b	1.19 b	1.2	1.3	76	0.414	1.516
Rip, return soil 1	28.7 ab	1.41 a	1.1	1.5	90	0.641	2.574
Cutover, no weed control	28.3 ab/*bc*	1.36 a/*ab*	1.2	1.4	90	0.659	2.503
Cutover, weed control	29.8 a/*c*	1.35 ab/*ab*	1.2	1.5	75	0.549	2.086
Untreated 2	34.9 *ab*	1.26 *b*	1.3	1.5	78	0.786	2.416
Rip 2	34.6 *ab*	1.31 *ab*	1.2	1.4	93	0.937	3.058
Rip + fertilise 2	38.3 *a*	1.46 *a*	1.2	1.5	89	1.120	3.746
Rip, return soil 2	33.9 *abc*	1.29 *b*	1.1	1.4	89	0.840	2.776

NB; this trial is established on benched contour tracks. The inside row of trees on the track, closest to the cut bank on the uphill side are coded 1. The row on the outside of the track nearest the side cast on the downhill side are coded 2. There were significant differences between the inside and outside rows in most cases. As there was such a strong difference between the rows, they were separated and then analysed.

Figure 10

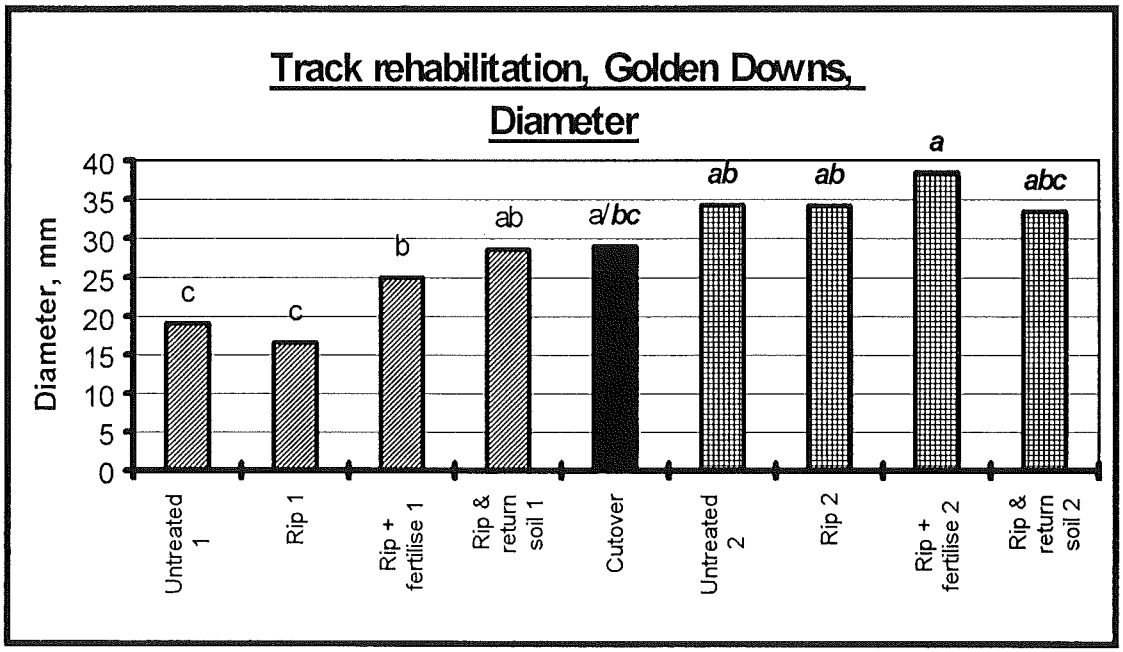
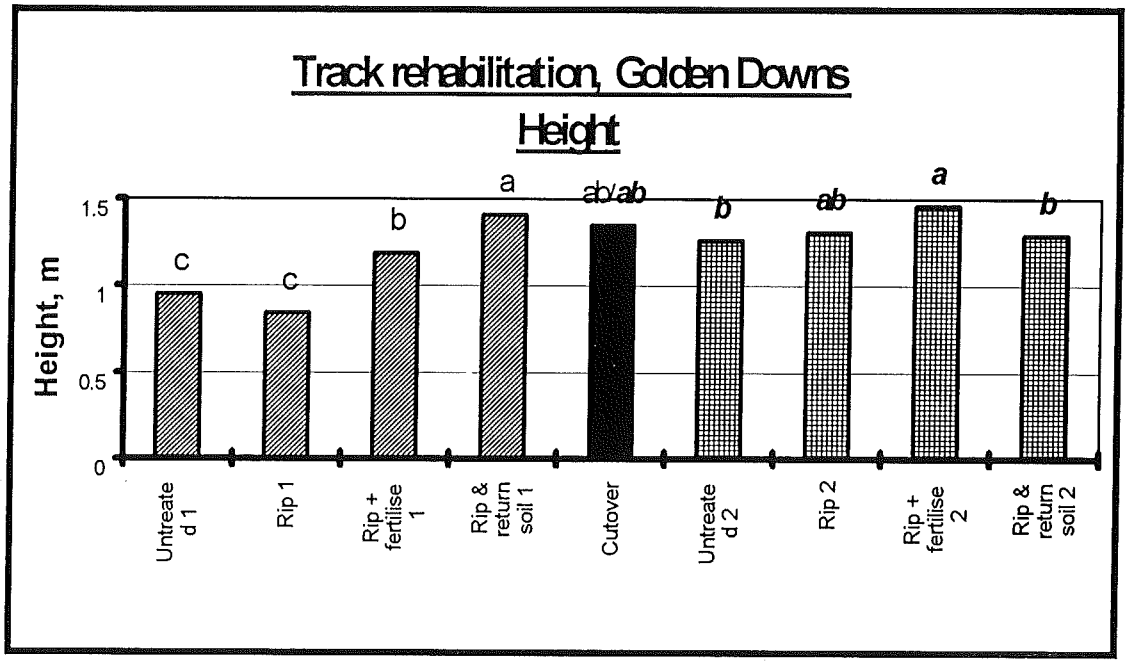


Figure 11



3. Berwick.

The major result from the early analysis of this trial is that the rip and fertilise treatment is giving the best height and diameter growth (Figures 12 & 13). The diameter advantage is sufficiently large that even though the survival is lower than any of the others it still has an advantage in basal area per hectare. The fertilising has also affected tree health (Table 6). The rip only treatment is having no effect on growth at this stage, in comparison to the untreated track. The cutover is performing slightly, but not significantly, less than the rip + fertiliser treatment and slightly, but not significantly, better than the rip + return soil. Rip + fertilise is significantly better than rip + return soil for both height and diameter. It would appear that the fertilising is having a substantial effect on growth. This treatment would be cheaper than the rip + return soil, but as the results are for trees only one year old it is not possible to say how long this effect will last.

Table 6. Berwick, growth results, age 1.

	Diameter mm	Height cm	Health score	Form score	Survival %	Basal area m^2/ha
Untreated track	8.3 cd	29.6 c	2.6 c	1.6 ab	89	0.053
Rip only	8.0 d	29.7 c	2.6 c	1.5 b	94	0.054
Rip + fertilise	11.0 a	38.7 a	1.8 a	1.7 a	87	0.092
Rip + return soil	9.0 bc	33.4 b	2.1 b	1.7 a	93	0.067
Cutover	9.6 b	35.9 ab	2.0 a	1.7 a	94	0.075

Figure 12

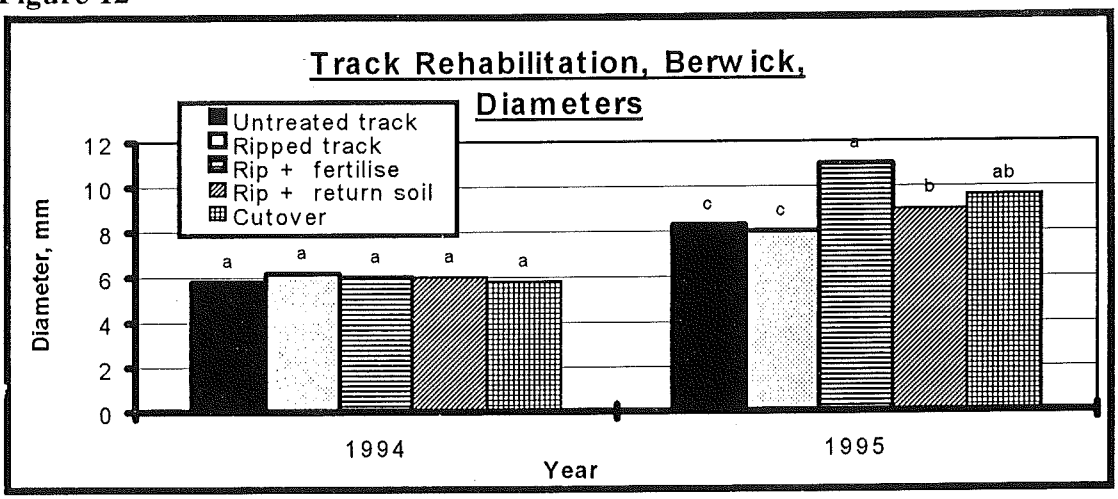
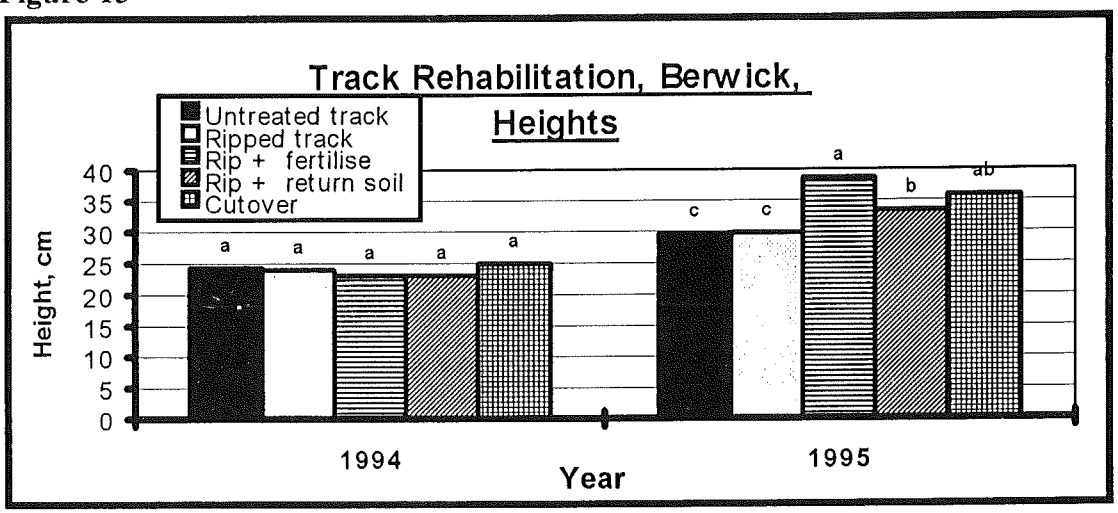


Figure 13



Foliar nutrient analysis.

The two older trials, Kaingaroa - skid site and Omataroa - track (both three years old), had foliage nutrient analysis completed in 1995. Table 7, below, is included so the results of the analysis can be compared to values that have been found to be critical for *Pinus radiata* (Will 1995).

Table 7. A guide to Foliage analysis values for *Pinus radiata.*,(From Will, 1985)

	Nutrient	Low, <	Marginal	Satisfactory, >
%	N	1.2	1.2 - 1.5	1.5
%	P	0.12	0.12 - 0.14	0.14
%	K	0.30	0.30 - 0.50	0.50
%	Ca	0.10	0.10	0.10
%	Mg	0.07	0.07 - 0.10	0.10
ppm	B	8	8 - 12	12
ppm	Cu	2	2 - 4	4
ppm	Zn	10	10 - 20	20
ppm	Mn	10	10 - 20 ?	20?

In the Kaingaroa skid site trial there were adequate levels of K, Ca, Mn, Zn and Cu in all three treatments (Table 8). There was a low level of B for the rip treatment, which was significantly (P = 0.05) lower than the rip and return soil and cutover plots, which both had satisfactory levels. For P there were significant differences, the rip sites had marginal levels whereas the rip & soil and cutover sites had satisfactory levels. The levels of N were marginal for all sites, with no significant differences, but the rip treatment had the lowest level and the cutover the highest. Mg was marginal for all sites, with no difference between sites.

Table 8. Kaingaroa Skid Site Rehabilitation Trial, Foliage sampling data, 1995.

	Results in %					Results in ppm			
	N	**P**	**K**	**Mg**	**Ca**	**B**	**Mn**	**Zn**	**Cu**
Rip	1.42 a	0.14 b	0.92 a	0.070 a	0.27 a	10.9 b	231 a	74 a	4.40 a
Rip & return soil	1.45 a	0.15 b	0.91 a	0.170 a	0.21 b	13.8 a	240 a	76 a	4.46 a
Cutover	1.48 a	0.16 a	0.89 a	0.070 a	0.24 b	12.8 a	303 a	70 a	4.96 a

In the Omataroa track rehabilitation trial there were adequate levels of K, Mg, Ca, B, Mn, Zn and Cu in all treatments (Table 9). There were significant differences in the levels of K, with the cutover higher than the other treatments and the untreated track had the lowest level. For P the results for all treatments showed a level that was low except for the cutover with no weed control (Cnwc) which was marginal to satisfactory. The cutover with weed control (Cwc) was marginal but not significantly different to Cnwc. The Cnwc was significantly better (P = 0.05) than untreated (U), rip (R), Rip and fertilise (RF) and rip and return soil (RS). For N the results showed that only the rip treatment was consistently marginal, all other treatments were marginal or satisfactory, with no significant differences. The fertiliser application at planting (50 g of MagAmp per tree) has influenced the levels of N but not P in the rip and fertilise treatment.

Table 9. Omataroa Track Rehabilitation Trial, Foliage sampling data, 1995.

	Results in %					Results in ppm			
	N	**P**	**K**	**Mg**	**Ca**	**B**	**Mn**	**Zn**	**Cu**
Cutover, wc	1.48 a	0.13 a	1.05 b	0.12 a	0.29 a	16.0 a	135 a	67 a	4.74 a
Untreated	1.49 a	0.11 b	0.94 d	0.13 a	0.23 b	15.4 a	143 a	64 a	4.81 a
Ripped	1.40 a	0.11 b	1.01 cd	0.12 a	0.22 b	14.9 a	116 a	64 a	4.94 a
Rip & fertilise	1.58 a	0.11 b	1.03 bc	0.11 a	0.22 b	15.3 a	129 a	61 a	5.08 a
Rip & return soil	1.45 a	0.11 b	1.03 c	0.13 a	0.25 ab	15.9 a	134 a	69 a	4.84 a
Cutover, nwc	1.53 a	0.14 b	1.12 a	0.12 a	0.28 a	17.2 a	126 a	70 a	4.74 a

Cost of rehabilitation.

The average cost of rehabilitating skid sites (rip and return soil) was $950 per hectare, or $1010 including fertilising (Table 10).

Table 10. Skid Sites, 0.3 - 0.4 hectares per skid.

Forest	Treatment	Cost per hectare
Kaingaroa	Rip - (B)	$125
	Rip + return soil (B)	$880
Golden Downs	Rip (B)	$185
	Rip (B) + fertilise	$245
	Rip (B) + fert + return slash (E)	$985
Berwick	Rip (B)	$165
	Rip (B) + return soil (E)	$1050

Note; B = Bulldozer, E = Excavator, Denotes what type of machine was used to complete the treatment.

The average cost of rehabilitating extraction tracks was $540 per hectare for rip and fertilise and $1940 per hectare for rip and return soil (Table 11).

Table 11. Extraction Tracks, average of 185 m of track per hectare.

Forest	Treatment	Cost per hectare
Omataroa	Rip (B)	$ 400
	Rip (B) + fertilise	$ 460
	Rip (B) + return soil (E)	$1650
Golden Downs	Rip (B)	$ 600
	Rip (B) + fertilise	$ 660
	Rip (B) + return soil (E)	$2570
Berwick	Rip (B)	$ 475
	Rip (B) + fertilise	$ 540
	Rip (B) + return soil (E)	$1940

DISCUSSION

The trial results to date show quite clearly that trees planted on either skid sites or major tracks where there has been no rehabilitation treatments do not perform particularly well. Typically these trees are producing growth rates that are 60 - 70% of the diameter and height of the trees on the cutover.

Without exception the skid and track surfaces are nutrient deficient (Hall 1993), having been stripped of topsoil during construction. The logging operations have then compacted the soils beyond the point (soil shear strength 3 MPa) where root growth is inhibited (Mason & Cullen, 1986).

Rehabilitation treatments that return the topsoil or provide nutrients from fertiliser along with cultivation to break up the compaction can produce significant improvements in tree growth rates on skids and tracks. They can produce results up to 90 % or better of the diameter and height of the trees on the cutover, depending on the treatment and soil type.

The area of land occupied by tracks and landings can be substantial. On average in the study areas the proportions of seriously affected land was 5% under skid sites and 8.4% under tracks (Tables 12 & 13).

How much of the site is affected will depend on the logging system but based on these figures it would approximate the following; ground based logging 8-12%, ground based logging with contour tracks 12-15%, hauler logging 5-7% and two staging 7-10%.

These figures do not include any area for roads (another 1-2% depending on terrain) and for hauler logging they do not include any allowance for the heavily disturbed area near the skids where the haul lines converge and trees are dragging on the ground.

Table 12. Area of land occupied by skid sites.

	Percent of land occupied by skid sites	No. of skids	Area Logged, hectares	Area occupied by skids (ha).
Kaingaroa	5.9 %	17	162.5	9.6
Golden Downs	5.3 %	8	45.1	2.4
Berwick	3.8 %	8	65.5	2.5

Table 13. Area of land occupied by extraction tracks.

	Percent of land occupied by tracks	Length of track, km	Area Logged, hectares	Area occupied by tracks (ha).
Kaingaroa	7.2 %	2.0	13.5	1.0
Golden Downs	9.7 %	3.5	16.4	1.6
Berwick	8.3 %	12.2	65.5	5.4

The loss of productive land area shown in the above tables is significant for two reasons, firstly it affects the overall productivity of the forest and secondly if a certain level of wood supply is required then additional land will have to be bought to make up the loss of land and production.

The decision to rehabilitate or buy new land is an economic one; at what point is it better to go to the expense of rehabilitation rather than simply buy new land? This is a complex issue and the decision to purchase or rehabilitate will obviously vary according to local land prices.

A simple approach using the net present value (NPV) of the two options (rehabilitate or buy new land) can indicate where the cut off point is for a number of rehabilitation treatments and growth rates, using standardised establishment costs and log revenues (Table 14). The cost in year 0 is the cost of purchasing new land, this value is 0 for rehabilitated land, and the values for the purchase new of land were derived by repeating the calculation until the values for the NPV were similar.

All the silvicultural costs are kept the same, except the establishment cost, where the rehabilitation treatments are included, making the cost in year 1 higher than for newly purchased land.

NB: These figures are based on growth data from trees that are three years old or less and are used to give an indication of the costs and benefits assuming the current growth trends continue. They are **not** definitive as the growth trends may be divergent.

Skid site rehabilitation

On the basis of the results of the Kaingaroa trial, and assuming that the rip + return soil treatment will continue to return growth rates that are 90% of the cutover, and assuming a series of standardised silvicultural costs, the point at which it is better to rehabilitate than purchase new land is when the price of the new land is $1700-$1800 per hectare. This is a purely economic decision and not necessarily the best one when all things, including public image, are taken into consideration.

Extraction track rehabilitation

Based on the results of the Omataroa and Golden Downs trials, and assuming that the rip and return soil and rip and fertilise treatments will continue to return growth rates similar to those currently observed, and assuming a set of standardised silvicultural costs the points at which it would be better to rehabilitate than to purchase new land would be;

$2800 - $2900 per hectare for rip and return soil.

$1500 - $1600 per hectare for rip and fertilise.

Given that the rip and fertilise treatment is currently giving very promising results, ripping and fertilising for the rehabilitation of tracks, with the rip line close to the outside edge of the benched track would appear to be the best option.

Table 14. Net present value, series of annual costs.

Year	Cost/ Revenue	Skid New land	Skid Rehab Rip+soil	Track New land	Track Rehab Rip+soil	Track New land	Track Rehab Rip+fert
0	Land	*-$1,800*	*0*	*-$2,800*	*0*	*-$1,500*	*0*
1	Establish	-$700	-$1,700	-$700	-$2,700	-$700	-$1,250
2	Release	-$100	-$100	-$100	-$100	-$100	-$100
3	-	0	0	0	0	0	0
4	Prune	-$300	-$300	-$300	-$300	-$300	-$300
5	Thin	-$250	-$250	-$250	-$250	-$250	-$250
6	Prune	-$300	-$300	-$300	-$300	-$300	-$300
7	-	0	0	0	0	0	0
8	-	0	0	0	0	0	0
9	-	0	0	0	0	0	0
10	Prune	-$300	-$300	-$300	-$300	-$300	-$300
11	-	0	0	0	0	0	0
12	Prod thin	$1,800	$1,620	$1,800	$1,620	$1,800	$1,620
13 >26	-	0	0	0	0	0	0
27	Harvest	$114,000	$102,600	$114,000	$102,600	$114,000	$102,600
	NPV	**$5,550**	**$5,517**	**$4,640**	**$4,690**	**$5,822**	**$5,889**

There are other considerations that would affect any decision making regarding the rehabilitation of tracks other than the simple economic one presented here. They would be;

- availability of land,
- public resistance to expanding forests,

- the need to spend money on water control for skid and tracks anyway (if a machine is on site rehabilitation is the next logical step from cut-offs),

- shareholder and community pressure to be "sustainable"

- concerns over long term productivity of the land base.

Given the problems of sedimentation from skids and tracks, the costs of forming them, the loss of productive land, the loss of tree growth the costs of rehabilitation and increasing public scrutiny of private forest operations careful planning and management of logging operations to minimise the area of land under skids and tracks is well worth the effort.

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