THE EFFECT OF THE PULP AND PAPER INDUSTRY ON FOREST MANAGEMENT

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SYNOPSIS

The pulp and paper industry as at present established in New Zealand draws its raw material from large exotic forests on the central North Island plateau. Their establishment and subsequent general history are well known to all. This paper is confined to this region because as yet it is only here that the pulp and paper industry has had a large-scale influence.

This paper seeks to show the impact these large integrated industries are having on such an even-aged, unmanaged estate, their only available source of supply. It outlines the problems thus created and the measures to be taken in future to provide an ever-increasing supply of high quality produce from these forests.

MANAGEMENT OF FIRST ROTATION

That we will need to provide even greater volumes of wood from our exotic forests has been the continuing theme of all forecasts undertaken since the first prognostications were made in the 1920's. The following factors have been common to all predictions:

(1) Our dwindling indigenous resource.

(2) The date at which the Pacific-Asia area is going to be short of wood has in each case been brought closer to the present, and New Zealand is part of this area.

(3) The amounts required in any given year have been increased with each analysis of the market potential.

The current mature stands of *Pinus radiata*, D. Don, are untended, of poor quality and contain a large number of dead stems. These are the stands which were heavily attacked by *Sirex noctilio* 12-14 years ago and opinions have already been expressed that this first rotation may once again be approaching the stage where, because of competition both above and below ground, it will be again dangerously susceptible to increased mortality. Nevertheless this is the wood on which the pulp and paper industry must depend for at least the next twenty years.

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Although there exists a current annual surplus of some 47 million cu.ft in our exotic forest increment it must be recognized that this is merely temporary; "finally a study of both population and per-capita consumption trends for the various classes of forest products shows that the surplus could possibly disappear by 1975 and that even under the most likely or least favourable market conditions it will completely disappear by 1985 at the very latest" (Entrican, 1960). While it is recognized that the present crop is such that it must yield only an insignificant quantity of high quality, knot-free logs yet it must be conserved until the regenerated second crop, new plantings, and extensions of farm forestry have reached an age where their produce can provide an appreciable proportion of volume and quality requirements.

The only way in which the forest can tide the industry over this waiting period is by thinning the first crop stands wherever possible. By doing this there will be effected a reduction in the risk of insect and disease attack and a diminished rate of loss to natural mortality through competition within the stands. Use can thus be made of timber already grown to sawlog size, some of which would in all probability be lost within the ensuing 15-20 year period. Our forests should be capable of putting on a volume at least equal to that removed in the thinning. Because of the above factors we cannot expect to hold in reserve any area unless it is healthy and windfirm. What are the consequences that face us if we do not thin these available first rotation stands? We can be sure they will rapidly approach a state of stagnation; there will be a loss of growing stock and the survival of an unthrifty unhealthy stand, with risk of repeating the devastated windblown waste that occurred north-east of Taupo in May 1958.

It must be borne in mind that this dead wood, unless used very quickly, is of little value to the pulp and paper industry. In Kraft pulping of *P. radiata*, a reduction of up to 10% in burst and tear properties takes place after three months. At the end of twelve months this loss in desirable properties is as much as 40%. For groundwood pulping after age six months, yield and brightness both show a significant decrease. Wood older than twelve months shows a serious drop in burst and brightness, a considerable fall in yield, with a concomitant increase in fines and in power consumption.

Naturally the pulp and paper industry is interested in the additional costs of first rotation thinnings. Here the manufacturer who is also the forest owner is at an advantage. Recent experience of a major American forest-owning company shows that while a cost increase of 10% to 12% accrues in thinning operations when compared with clear-felling, this extra cost and some 12% to 15% more is recovered in the subsequent clear-cutting. Malformed and dead trees are removed, access both for men and machines is improved and there is less damage in logging, loading and transporting the smaller trees.

A stand containing larger diameter, and more uniform stems then remains. Costs of utilisation operations are thus reduced at all stages.

MANAGEMENT OF THE SECOND ROTATION

The major part of the wood supply is drawn from clear-felling of *P. radiata* which is proceeding at a rate of some 6,500-7,000 acres per year in this region.

These large clear-felled areas, which are being regenerated or replanted to second crop, pose the major problem for the forester. Logging practice must be supervised to ensure good logging hygiene. Even with adequate supervision and efficient logging, a normal clear-felling is characterized by an accumulation of logging debris, a pattern of logging roads at close intervals and compacted, sterile logging landings. This area must be re-established as quickly as possible and brought to maximum production. Until recently, natural regeneration has been considered to provide an adequate re-stocking. The altered environment for birds and animals has brought with it an alarming increase in their population and, concurrently with this, a reduction in the reliance which can be placed on this method. At present the common practice is to plant all winter-logged areas, skid-sites and unwanted tracks. Summer-logged areas are still considered to be adequately stocked.

However, a number of problems are being currently investigated. Experimental techniques which are being utilised are:

(1) The sowing of treated and coloured seed from the air.

(2) The broadcasting of seed prior to logging so that subsequent operations will bury these, provide better germination and reduce the effect of seed-eating birds.

(3) The scarifying of the soil by mechanical means after logging, either to knock the seed from the opened cones and bury it out of reach, or to bury seed broadcast immediately prior to scarification.

(4) The reservation of a small number of stems per acre during logging operations, to ameliorate the winter frost regime which has had an adverse effect on natural regeneration.

(5) Felling in strips to provide marginal shelter from frosts for regeneration.

(6) Ripping compacted landings so that plants or seeds may have some chance to grow into a second crop.

Much work yet remains, to determine just how and when any or all of the above methods should be used in order to guarantee a fully-stocked second crop. Exposure of the second rotation stands to grave risk of insect attack and disease cannot be afforded. It is perilous to ignore such authoritative comment as that expressed by de Gryse (1955): "These forests are extensive monocultures; the susceptibility and vulnerability of monocultures to insects and disease has become axiomatic. . . . The fact that until now no widespread damage has occurred is nothing short of a miracle and should not inspire too much reliance on continued good fortune."

SILVICULTURAL TECHNIQUES

The forester must undertake a silvicultural cycle that will keep these forests healthy and vigorous and at the same time create products that will command premium prices in the future. "Even by the middle of the next century the saw-log should still account for some 70% of the wood extracted for final consumption in New Zealand and this must compare with the present indigenous cut for quality." (Grainger, 1961)

To assure this, the forester needs to undertake intensive management of the forests. Experience has shown that silvicultural schedules which aim at producing logs with an average knotty core of 6in., and which will provide the maximum of high quality wood production from any site, are eminently practicable. Variations in early treatment are necessitated by differences of soil type and altitudinal location, but later in stand development a relatively uniform schedule can be adopted.

Sites below 1000-1200 ft altitude, on the medium fertility soils developed from Tirau ash and also on the low and very low fertility soils such as Tokoroa and Taupo sandy silts, allow for a relatively sharp drop in initial stocking without prejudice to later selection. However above 1500 ft altitude, on the low to very low fertility soils developed from the Taupo ash, the Kaharoa ash and the Tarawera ash of the Kaingaroa plains, early stocking must be maintained to preserve tree form and ensure adequate scope for selection.

Thus in the former case treatments to age 6 will be as follows:

At age 2 the whole area (either naturally regenerated or planted) is covered, cutting back competing weed and scrub growth and thinning to approximately 700 stems per acre.

At age 4 the area is again traversed to slash back regrowth, to eliminate malforms and to leave a stocking of about 500 stems per acre. At the same time the trees are pruned to a height of 6 ft. At age 6 at least 250 of these are pruned to 12 ft.

However, in the latter case, at Kaingaroa, weed growth is as yet not considered a major problem. Moreover the high incidence of malformation, and a tendency for differential crown development in the young stand, necessitate that high stockings be retained until age 5 to 7.

When stand height reaches 25 to 30 ft the first thinning to 350/400 s.p.a. is executed, together with pruning of all remaining stems to 8 ft.

At age 8 to 10 this is followed by medium pruning of 150 to 200 stems up to 18 or 20 ft. High pruning treatment carries the pruned level up to 32 ft at the time of the first commercial thinning at age 12 to 15. Approximately 100 stems per acre are treated.

This extraction thinning at age 12 to 15 reduces stocking to 180 to 200 and is the first of a cycle of commercial thinnings which should be light and frequent. Henry and Rawlings have both noted the mortality which may occur in *P. radiata* stands with basal areas greatly in excess of 220 sq ft. Examples such as Compt. 1123 at Kaingaroa, where a 47-year-old stand has a basal area of 395 sq. ft, may be quoted as a reason for allowing less rigorous thinning regimes to be practised. However, we have had one devastating demonstration of the inadvisability of holding a high basal area at the expense of stand health and vigour. If we are to obtain the maximum yield from the forest and avoid the chance of a damaging mortality, a cycle of thinnings at approximately six year intervals is indicated. Most *P. radiata* sites in the Central North Island can be expected to give an annual increment of 8 to 10 sq. ft of basal area once the stand fully occupies the site. Thus regulation of stand basal area between the limits of 180 to 240 sq. ft/acre, which will ensure an adequate stocking yet minimise mortality losses, is feasible on a six year thinning cycle. Such a regime taken to a rotation age of 50 years is expected on good sites to give yields of 12,450 cu. ft per acre from thinnings. Sample plot data indicate that under this regime M. A. I. over the rotation will be of the order of 450 cu. ft per annum. With continuing rapid increment on each stem a further lift of pruning height to 50 ft can be justified for 40 to 60 stems per acre; this to be carried out at 15 to 18 years. If this regime is adopted, the ideal whereby the green crown extends down to the pruned level will be approached.

ECONOMICS OF SILVICULTURE

Now, while no doubt the silviculturist will view the preceding dissertation with some satisfaction, the wood consumer and the forest owner will be extremely interested in the economics of these operations. The thinning schedules may accordingly be examined first.

The major effect on forest utilization that the introduction of the pulp and paper industry has had in New Zealand has been in the ability to use material either too small or too poor in quality for conventional sawmill use. As a graphic example of the effect that the availability of a pulp-market has had on net yield, experience with clear-felling on Kaingaroa may be cited. Change of type of log-production from entirely sawlogs to an operation including pulp-logs results in a reduction of waste per acre from 2,000 cu. ft to only 400 cu. ft (to a 4 in. small-end diameter). If sufficient volume is available, thinning yields in the form of small diameter short logs are now feasible whereas previously a yield of longer logs of reasonable form was required before extraction could be considered. However, the point of view which is often expressed, that the pulping industry can take any shape of log so long as it is cellulose, is blind to the technical and mechanical limitations of the industry.

In the case of *P. radiata* thinnings at age 12 to 15 a high proportion of the wood is short fibred. The following table illustrates the range of fibre lengths which may be expected.

At age	8	12	32	years
Mean fibre length is	2.04	2.20	2.65	m.m.

The effect this has on the quality of pure Kraft pulp may be expressed in terms of standard tear values (i.e. related to imported Scandinavian pulp as 100 per cent.) :

Yield-source	*Age (years)*	*Standard Tear Value*
Thinnings	6	75%
Thinnings	10	90%
Thinnings	20	100%
Clear-felling	30	115-200%

However, the picture is not quite as gloomy as the above data suggest. Recent tests show that a Kraft pulp entirely of 12 to 14 year old *P. radiata* thinnings, when compared with pulp of mature *P. radiata,* is more easily beaten and gives a paper of higher tensile strength and greater density although possessing a lower tear strength. It has been found that when 10% of total pulp input comes from this young material, the alteration in the Kraft pulp quality cannot be detected either in mill or laboratory tests. The effect of this material on groundwood furnish quality has as yet not been ascertained, although tests are planned.

As this 12 to 14 year old material is acceptable for pulping, how do the costs of extraction compare? From studies already undertaken, it appears that, linked with the preceding silvicultural schedules, the increase in direct costs of extraction would approximate 2.16 pence per cubic foot. Even if this estimate of cost rise for such a grade of thinning is on the low side, the pulp and paper manufacturer can expect little rise in his overall cost through introduction of this material to his log supply. It is probable that due to the increased wood yield per acre over the rotation, which can be equated to lower unit access cost per cubic foot, there will be, under this regime of intensive thinning, an eventual reduction in unit cost of wood.

The forest owner may now want to examine the economics of pruning; especially the expensive pruning to a suggested height of 50 feet. A good deal has been spoken and written on value increment due to pruning but it may not have been brought home just what volume of wood accrues over the 6 in. knotty core when pruning is linked with intensive thinning. The extreme case of pruning to 50 feet is also the most expensive. It is estimated that the lift from 32 feet to 50 feet would cost 5*s*. 6*d* per tree. This estimate is supported by N.Z. Forest Service studies at Kaingaroa. If this cost, along with other pruning costs, is compounded to the end of the rotation and the volume of clear wood is assumed to lift sawn produce from box to framing grade, then the increased value at 50 years is £7 8*s*. 9*d*. per tree (Henry, 1960). Similar intermediate results can be obtained. For instance, at age 24 a tree pruned to 20 feet has an increased value of 10*s*. 10*d*. Thus what may appear to be heavy pruning costs can be justified if the forest owner can reap the dividend from his investment. It is pertinent that one of the private pulp and paper companies is accepting a cost of £47 10*s*. 0*d*. per acre, covering all operations including re-establishment up to the pruning to 32 feet, in full expectation of obtaining a greater return in the future. Wood consumers without their own wood supply would be wise to include incentives for good wood quality in their wood purchase price, in order to ensure higher quality log supplies in the future. As New Zealand's overall timber grades improve in the future, production from poor quality logs will meet an ever-diminishing market.

The above argument reiterates the case for improved sawlog quality. The case for improved pulp-log quality is much more complex and less clear. Log supplies from the present, poor quality, untended stands often contain a high proportion of material which by virtue of size and shape can be a costly item to handle and convert to chips and is too difficult to put to ground-wood. However, the cost of this log-handling problem at the mill is difficult to assess. In the good quality, well-tended stands of the future this material will not be a significant feature. This will improve log flow in the plants and will ease some of the burden of log selection in integrated units. For groundwood, supply factors affecting billet handling and pulping are assessed in terms of log form and quality, but tests to determine the scale of the effects of individual factors are difficult to devise. Thus although very rough billets may be excluded, due to suspected effects on pocket efficiency and general degrade of groundwood furnish, to assess the effect of this single factor would require extensive (and expensive) trials. However, there are sufficient grounds for assuming that knot-free billets of clean profile are a better quality raw material and this justifies continuation of trials, despite inconclusive results in previous tests. In Kraft pulping, tests are planned on the cooking times required for knotty chips, but as yet no results have been obtained.

In attempting to assess the increment in value for pruning of pulpwood the forester is trying to justify an increase in pruning intensities. On hard sites and poor soils, *P. radiata* is a species which shows high incidence of malformation, at least up to age 12 to 15. In the past selective pruning procedures have tended to cause the mortality of a number of pruned stems. Often a not-so-vigorous co-dominant had such a proportion of green crown removed that a vigorous, dominant, unpruned neighbour soon suppressed the selected crop tree. Thus the quality of the stand could be improved if all stems remaining after a thinning had been pruned. Then the selection for the next stage would encompass all stems remaining. However, before this blanket pruning specification can be justified, a return for increased pulp-log quality must be forthcoming.

For forests owned by the wood consumer, the position is not quite so difficult. The branches must be removed at some stage in the tree's life, whether by pruning or by trimming after felling. For clear-fellings this trimming cost has been assessed by work study units and applied to trimming costs at the time of thinning. These data indicate that from ground-level to eight feet pruning costs and trimming costs at the time of thinning at age 12-15 are comparable, while for 8 to 20 feet trimming costs are reduced by 0.45 pence per cubic foot, bringing overall net cost to 1.09 pence per cu. ft. It is this net cost margin which must be justified. However, no data have been examined on the effects of improved access and increased speed of the thinning operation which should result from having pruned all stems to 20 ft. Only a small decrease in thinning cost would be required to make a blanket pruning proposal economic.

SPECIES OTHER THAN *P. RADIATA*

Until now the discussion has encompassed only *P. radiata*. This species is such a prince of pulping timbers that others suffer invariably in comparison. However, there is a large area of central North Island planted in other species, which must be drawn into a pulp supply if their management is to be an economic proposition.

Douglas fir. This species enjoys as sawn timber a reputation which generally obscures a number of deficiencies as a pulping species. However, these deficiencies do not completely preclude its use as a source of raw material either for groundwood or Kraft pulping. Major American companies are using it for groundwood, provided it is under twenty years of age, and have accepted its use in the Kraft pulping process. Fibre length is generally satisfactory.

Corsican pine. Although having a shorter fibre length than *P. radiata*, this species gives a good Kraft pulp. It may not be used in a groundwood supply where it is a minority species, since it possesses 2.8% of resin content by weight as compared with 1.6% for *P. radiata*. However, when required in sufficient quantity, it can be ground as a pure Corsican stock on a specially sharpened stone.

Ponderosa pine. The poor name which is associated with Ponderosa pine as a sawn timber is the antithesis of its performance as pulpwood. It can be treated in Kraft cooking as Radiata pine, despite slightly shorter fibre. It is a good groundwood species, giving pulp with similar brightness and opacity to *P. radiata*. However bursting strength is lower and power consumption slightly higher, so that it is generally used only as a minor admixture. Poor barking characteristics can cause the non-use of this species in some seasons.

Muricata pine. This close relative of *P. radiata* has not given results closely resembling it, either as a sawn or pulp log. If used in the form of chips it gives satisfactory Kraft pulp. However, as groundwood it has not proved highly satisfactory, due in part to high resin content and poor billet shape allied with heavy dry knots.

Strobus pine. This again is a satisfactory Kraft pulp. Grinding trials gave inconclusive results. At best it is the equal of *P. radiata* with a slightly lower bursting strength. At worst it gives most unsatisfactory results. It shows sufficient promise to justify further trials if it is to be supplied in major quantities.

Murrayana pine. Once more, this material can be chipped and cooked as a minor admixture in Kraft pulp. As a grinding species only the yellow strain has been tested locally, with unsatisfactory results. Bursting strength was seriously depressed, although colour characteristics were quite good. Trials of the green strain should give better results as overseas tests have given it quite a good name as a grinding proposition (F.A.O., 1953).

In assessing the worth of a species which is numerous and well established one tends to recall Hepting's remarks which in essence suggested that if a species was the only one which would grow in a particular locality, the pulp technicians would eventually master the technology required to utilise it. In New Zealand, however, *P. radiata* has proven such a good pulping species that New Zealand's paper products have commanded a market wherever strength is of prime importance. The other species present in any volume have invariably been of poorer pulping quality and given lower-strength papers. Also there has now developed an extensive technology of pulping for *P. radiata*, whilst for other species this technology is minimal. These other species are only tolerated because they must be used, and this use is limited to a percentage which will not seriously affect the overall pulp and paper quality.

As a general premise, plant policy in the area tends to the view that mechanical pulping will be limited to those species which are fully trusted, i.e. *P. radiata* and *P. ponderosa*. All other available species can be chipped and cooked in the Kraft process if quantities are kept within minor proportions. This has an obvious implication for the forester. He should have the largest possible proportion of his growing stock in Radiata pine. Next in importance come Douglas fir and Corsican and Ponderosa pines. Minor quantities of *P. strobus* or *P. monticola* can be justified. *P. murrayana* should only be used as a nurse species or on extremely hard sites. Unsatisfactory species such as *P. muricata* should be removed as fast as they can be used and the site converted to good quality fast-growing species.

CONCLUSION

The interaction of effects of the forest on the pulp and paper industry demonstrates how much of the forester's success with forest management depends on the pulp and paper industry's ability to absorb material which would otherwise be rejected by the sawmill industry. In the central North Island the three major plants have all integrated the pulpmill with a sawmill. Pruning techniques have been aimed accordingly at the improved sawlog. A case is put forward for consideration of pruning for pulpwood. However, the point which must be given due weight is that intensive silviculture requires man-power. With continuing full utilisation of available labour, the forests will continue to be under-managed unless we adopt progressive policies in the provision of good housing and community amenities, plus payment of wages which will ensure that we can compete with the attractions of the larger urban areas.

Naturally mechanisation should be attempted in all phases of the pruning programme, and some investigation of this aspect has been made at Kaingaroa. Investigation of the best techniques of thinning has also been initiated, but only experience will demonstrate the economics of long term intensive management. The desirability of such techniques has been demonstrated silviculturally, and a preliminary analysis of effects for the wood consumer has been made. The industry can rest assured that the forester will continue to strive towards making this desirable intensive management more and more attractive economically to pulp and paper manufacturers.

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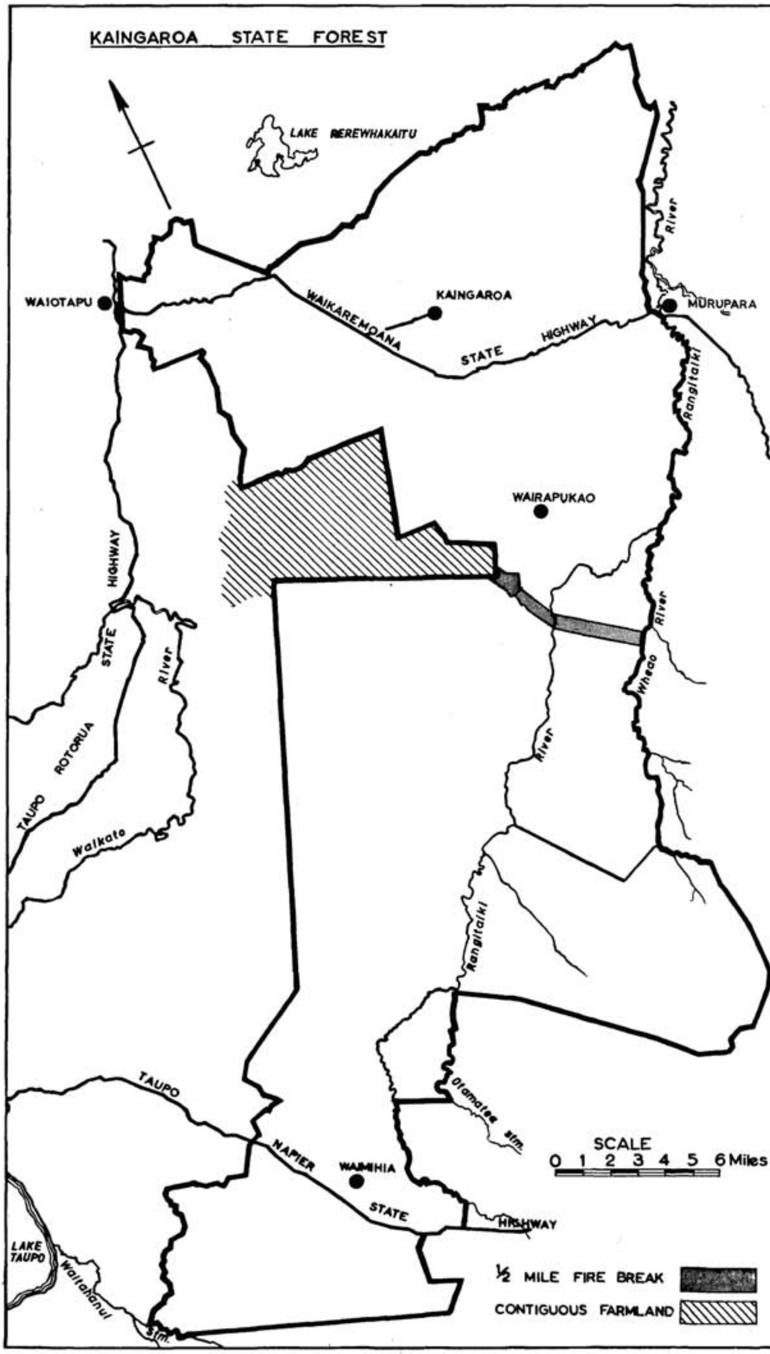
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