SESSION 2
PAPER (c)

SILVICULTURAL INFLUENCES IN SMALLWOOD HARVESTING

or "WHO WAGS WHAT?"

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Introduction

The main influence of silviculture on smallwood harvesting is in relation to production thinning operations. The object of this paper is to emphasize that production thinning, in addition to being the first of the logging operations in the crop's life, is also the last of the silvicultural operations - that is, it is a tending operation, the main objective of which is to improve the quality of the crop, and maintain forest health.

Silvicultural Characteristics of *P.radiata*

P.radiata is the major species involved in current production thinning operations. Radiata grown on the pumice plateau has a number of characteristics which have a strong influence on the regimes and thinning systems practiced. Outside of the pumice-lands, some of these characteristics become less important but in general they still apply.

1. Growth rate

   P.radiata is a very vigorous species with growth rates as high as any softwood species in the world. Peak annual growth rates occur relatively early in the stand's life. (fig. 1)

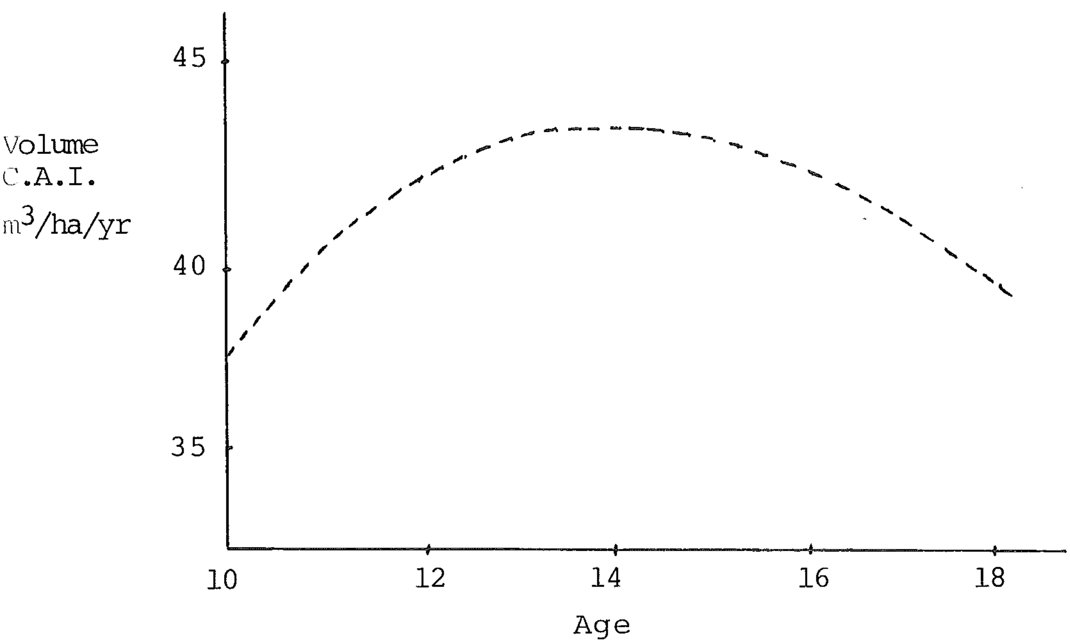

Fig. 1

Volume Current Annual Increment

With higher quality sites and with higher stocking levels the peak will be earlier and higher than for lower quality sites or lower stockings, but the general curve still pertains. Peak basal area growth occurs before peak volume growth.

2. Light demanding character

Radiata is a strong light demanding species. In stands planted at the common stocking levels of 1500-2000 s/ha, crown closure will occur after 5 to 8 years, after which time interstem competition increases rapidly. The result is an early establishment of distinct dominance classes within the stand with the stronger trees suppressing out the less vigorous neighbours. The degree of intertree competition is dependent on site quality and is greatest on the higher site areas. The origin of the stand will also influence the degree of variation in the diameter distribution, and is usually greater in naturally regenerated stands than in planted areas.

3. Malformation

Radiata is characterised by a high level of malformation and again this varies with site quality. In general the higher the site quality, the greater the degree of malformation. In stands grown from non-selected seed less than 15% of the crop may be straight and defect free. Increased use of seed orchard stock will result in decreased levels of malformation and a more uniform crop but in many of the stands to be thinned in the next decade we can still expect a high proportion of trees with kinks, heavy laterals, double leaders, or gross branching habit.

Silvicultural Implications

These characteristics of *P.radiata* have a number of implications in the management of the species.

1. Thinning is required to maintain forest health. If a high quality stand is left unthinned then mortality will begin by about age 10 and will continue for the next 20-25 years until stocking stabilises at between 300 and 400 s/ha. During this period nett basal area growth is often zero with live basal area plateauing at about 55-60 m^2/ha.

2. Thinning is required to achieve maximum volume production from the stand. Table 1 shows the volume production predicted by one growth model for two production thinning regimes compared to an unthinned regime.

Table 1

Regime	Age 25 Clearfall	Age 30 Clearfall	Age 35 Clearfall
	Total Volume Production as a Percentage o: Volume Production of an Unthinned Regime		
(a) Unthinned	100	100	100
(b) One thinning 1700/350 s/ha Age 11	104	118	130
(c) Two thinning 1700/600 s/ha Age 12 and /350 s/ha Age 18	108	121	130

3. *P.radiata* will respond rapidly to thinning.

   (a) Response will be greatest when the thinning is carried out early in the stand's life (near the peak Current Annual Increment - C.A.I.)

   (b) Individual tree response is less once the tree has become suppressed. Intermediate and codominant trees will take far longer to respond to a thinning than dominant trees, and hence the emphasis in thinning should be to minimise both the removal of dominants and the retention of trees already suffering from competition.

   (c) Thinning must therefore be "on time" in order to maximise the response. The higher the site quality and the denser the standing stocking, the earlier the thinning should be carried out.

4. The timing and intensity of thinning will also depend on the objectives of management. Heavy early thinning will result in some loss in total production compared to lighter more frequent thinnings, but will also result in an increased growth on the residual trees. The more intensive thinning regimes are usually practised on pruned stands in order to maximise the production of clear wood on the final crop. In selectively pruned stands, thinning must also be early in order to decrease the competition between the pruned and unpruned element of the crop.

5. Heavy early thinning will result in increased branch growth. Without pruning, branch growth can be controlled by decreasing the intensity and increasing the age of the thinning operations, but at a cost in diameter growth.

6. Damage to the residual crop should be avoided at thinning. Although *P.radiata* has a high ability to produce resin to protect damaged areas, and to occlude over damage scars, removal of bark can only result in a degrade in the product from the residual trees. It is especially important in

pruned areas and where veneer is being produced.

7. Wind damage following production thinning will be increased by:

   (a) Delaying the age of thinning

   (b) Increasing the intensity of thinning

   (c) Non removal of malforms. Although not all malforms are lost if retained at thinning the chances of windthrow are 3-4 times greater than with dominant well formed stems.

Implications for Logging

Production thinning will inevitably result in some conflict between the silvicultural and logging objectives. Some of the stand factors which will affect logging production levels, and therefore the cost of the logging operation are:

- The volume per hectare to be removed
- The stems per hectare to be removed
- The residual stocking remaining
- The piece size of the thinnings
- The topography of the stand.

The relative importance of these factors will vary depending on the type of logging operation

(a) Tree length extraction. Productivity is directly proportional to piece size being extracted. Productivity is similar over a wide range of volumes per hectare and stems per hectare extracted, but residual stocking will affect productivity where extraction speeds are reduced to prevent damage to the residuals. Topography has an effect but tree length extraction will be possible over a wider range of topography than with other systems.

(b) Log length extraction (e.g. using forwarders) is not used in New Zealand but is common overseas. Piece size becomes relatively less important, with the number of pieces and volume per hectare, the topography, and the stand access becoming more important. Forwarder systems require a higher degree of neutral thinning.

(c) Productivity of shortwood extraction systems is dependent much more on:

   - The volume per hectare and number of trees to be removed, which will have a strong influence on the productivity of the individual cutters.
   - Piece size is important but to a lesser extent than with tree length extraction, and piece size can even

be unacceptably large for manual moving of the smallwood billets.

- Shortwood extraction can be carried out in stands thinned to a much higher residual stocking than with other systems, especially in operations where neutral thinning (e.g. with outrows) is not practised.
- Topography will influence smallwood extraction more than long length systems.

The Compromise between the Silvicultural and Logging Objectives

The conflict between the logging and silvicultural objectives of production thinning will usually result in some form of compromise, with varying movements towards either the logging or silvicultural points of view - hence the subtitle of my paper - "who wags what?" There are varying ways that this compromise has been achieved.

(a) Alteration in the timing of the operation. Delaying in thinning age will have a large effect on productivity of the logging operation, especially for early thinning operations near the peak of the C.A.I. when the percentage increase in standing volume in one year's growth is very high. However, this is also the period when the silvicultural objective is to maximise growth on the crop trees, and the emphasis must therefore be for thinning on time. This is especially true for highly stocked stands.

(b) Altering the intensity of thinning. For thinning at a given age, altering the intensity of thinning will again mainly affect the productivity of the early thinning operations, especially shortwood systems where volume per hectare is an important variable. However, the selected intensity is again a compromise between the logging cost and the requirement for optimum growth. Over thinning will result in the site being underutilised with consequent reduction in volume production over the rotation.

(c) Adoption of more neutral thinning systems. Neutral thinning involves the automatic removal of some portion of the crop, either without any selection (line thinning) or with selection in the remaining crop (outrow thinning plus selection). Neutral thinning allows easier access to the stand and results in some increases in the logging productivity through increased volume available and a greater piece size extracted. It is strongly advocated in Australia, especially where mechanised thinning systems are practised. There have been many studies on the effect of neutral thinning on the residual stand, but the real effects are still unclear. In general:

(i) Neutral thinning will result in some drop in total production from the stand. The degree of loss of production will depend on:

- the proportion of the stand removed neutrally. Increased intensity of outrows will result in greater production losses. In Australia the tendency has been to accept the decreased production and to narrow the distance between outrows in order to facilitate more mechanised operations. In Sweden, however, where there is a need to maximise production from the stands currently being thinned, the trend is to reduce the amounts of neutral thinning by increasing outrow distance.
- the age of the thinning. At older ages the codominants remaining have less ability to respond. The loss can be minimised by thinning as close to the peak C.A.I. as possible.
- the site index. Earlier establishment of distinct dominance classes on better sites again results in a reduction of the ability of residual codominants to respond.

(ii) Damage to the residual stand is generally lower with neutral thinning.

(iii) Windthrow risk can be increased through neutral thinning.

(iv) Neutral thinning is generally only applicable on very easy topography, unless the stand has been planted at right angles to the contour. If not, neutral thinning will involve removal of corridors with greater potential for over removal of dominant crop trees.

(v) Neutral thinning is less applicable in regenerated stands because the crop is generally more variable both in spacial distribution and in size.

(vi) Neutral thinning of pruned stands is unacceptable because of the loss of pruning investment.

In summary, neutral thinning is only applicable in New Zealand conditions in unpruned stands with a highly stocked even crop (preferably planted with seed orchard stock). The thinning must be early and on time.

(d) Early manipulation of the crop to improve Logging production. Because of the ability of *P.radiata* to respond to a wide range of silvicultural practices, there is opportunity for some early manipulation of the crop for later gains in logging productivity with little loss in production or growth of crop trees. The main opportunities are at planting, and in young crops well before production thinning.

(i) At planting.

1. Increase in planting spacing can result in increased piece sizes at time of thinning, with little drop in total production. However, branch sizes will inevitably be larger and decreased stockings at planting could only be possible through use of seed orchard stock. Especially on the more malformation prone higher site areas, the need for sufficient trees to select a dominant, non-malformed final crop will still be present.

2. Alteration of the planting spacing to suit future logging has been advocated, but the history of success is not good, mainly because the manager is trying to predict the extraction system which will be used in 10-15 years.

(ii) In young stands.

Probably the greatest potential for increased logging productivity is by manipulation of the stand after planting, i.e. regimes combining waste thinning and production thinning. The opportunity is greatest for tree length operations where piece size is a very important variable. Waste thinning allows the removal of the slower growing and malformed trees, which lower logging production if present at the time of thinning. Additional gains can be made if waste thinning allows delayed production thinning operations because of decreased inter-tree competition. The intensity of the waste thinning is critical: if too great then the volumes available for production thinning will be below acceptable levels (especially with shortwood systems); if too low then the objective of removing the smaller suppressed trees and concentrating growth on the dominants and codominants will not be met.

Conclusions

Production thinning of *Pinus radiata* is a silvicultural operation required to maintain forest growth and forest health, and is a means of obtaining utilisable volume early in the crop's life. This paper assumes the perfect world where a market for smallwood and the manpower required for the job are available, and in such a situation production thinning at the right age and right intensity to meet silvicultural objectives is desirable. Some compromise is required, and because of the growth characteristics of *P.radiata*, opportunity exists for manipulation of young stands in order to improve productivity in logging operations. However, because of the rapid growth rate and high malformation levels in high site quality *P.radiata* stands, the requirement is for selection thinning, on time, with retention of the dominant crop trees, in order to best meet the silvicultural objectives of managing these stands in New Zealand.

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