Growth responses to thinning in eucalypt regrowth forests

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Abstract

A series of trials was established and monitored to evaluate the effect of thinning on regrowth eucalypts. The relationship between growth response and thinning intensity (up to 75% reduction) was found to be positive and linear over the range of basal areas examined. The size of the response was positively correlated with initial stem diameter, dominance class and crown development. Younger regrowth stands respond strongly to thinning while the response tends to be less dramatic but more protracted in older stands. Removal of up to 50% of stand basal area does not reduce the overall increment in stand basal area and has been shown to lead to an extra 25% of sawlog volume after 25 years. A potential reduction in rotation time of between five and 20 years may be reasonably anticipated in stands where thinning is appropriate.

A positive relationship between clear bole length and stocking density has been demonstrated in Eucalyptus obliqua. *Data from thinned stands indicate that little additional increment in clear bole length occurs after thinning. The presence of a dense understorey encourages clear bole extension and its removal reduces the rate of clear bole extension. The results obtained are discussed in relation to future sawlog needs and thinning strategies.*

Introduction

Thinning of regrowth forests has been practised by foresters since the time of Henry VIII. It does not increase the rate of gross stand basal-area increment but allows for the salvage of wood that would otherwise be lost through death. It concentrates the volume produced onto the most valuable stems, the sawlogs, thereby producing larger, higher value trees at an earlier age.

In recent years, there has been an emphasis on increasing productivity associated with the move from logging mainly oldgrowth eucalypt forest to logging mainly regrowth forests. One of the main techniques to increase sawlog productivity in the native regrowth forests is thinning. The 1984 Intensification of Native Forest Management Report (INFM 1984), the Groome Poyry Report (1989), and Kerruish and Rawlins (1991) all recommended that large areas of native eucalypt regrowth forest be thinned (between 400 and 1800 ha/year). However, at the time of these reports, little information was available on the effects of thinning on growth responses in regrowth forests, even though thinning had been used in Tasmania both operationally and on a research scale for many years. Thus, planning was limited by a lack of resource data and little understanding of the characteristics which indicated that a stand was suitable for thinning.

The Forests and Forest Industry Strategy (FFIC 1990) for Tasmania included the development of economically feasible techniques and management prescriptions for commercial and non-commercial thinning of regeneration to increase the growth of sawlogs in thinned stands. This process was divided into a number of tasks:

- Development of procedures for identifying forests suitable for thinning;
- Identification of Crown Forest areas suitable for thinning;
- Establishment and evaluation of thinning trials, both commercial and non-commercial;

- Development of management prescriptions for commercial and non-commercial thinning; and
- Training of operators in the chosen thinning systems.

The five-year research programme reported here aimed to establish and evaluate thinning trials and to develop management prescriptions for commercial and non-commercial thinning. This paper presents results obtained from these trials as well as from older, pre-existing trials, and examines the relationship between stand characteristics, thinning treatment and growth response to thinning.

Methods

Location of trials and details of the plots used in the study are shown in Table 1.

BACI sampling

To demonstrate the effects of thinning on growth, it is necessary to compare the growth of trees in thinned stands to that of equivalent trees in unthinned stands. However, one of the major difficulties encountered in forest mensuration is the high degree of variability within the forest (Arp 1984; Arp and Krause 1984), resulting in considerable inter- and intra-plot variability. This is a common problem in large-scale forestry research trials where the non-uniform nature of the forest causes difficulties in finding suitable areas to act as replicates of each treatment. Before/after/impact/control (BACI) sampling has been used in an attempt to overcome this problem (Underwood 1991, 1993) and offers an easy method for comparing the growth of trees on treatment plots with those on control plots as well as on the treatment plot prior to thinning.

The BACI technique involves the comparison of a population before and after a perturbation (in this case, thinning) as well as comparison of the treated population with an untreated control population. In the case of thinned stands, the diameter increment of trees selected and retained in the thinned stand are compared with those of similar size in the same stand removed during the thinning operation. Data from this comparison are used in conjunction with the usual comparison of diameter increment between thinned and unthinned control stands.

Results and discussion

A. DIAMETER/BASAL AREA GROWTH RESPONSES

The diameter increments of trees in 5 cm diameter classes growing in three thinning treatments (125, 250, 500 stems retained per hectare) at Southport (SO22) are shown in Figure 1. Each graph shows diameter increment before thinning, after thinning, and on the control plots measured after the other plots were thinned.

It can be seen from these graphs that, in the thinned stands, retained trees were increasing in diameter at a faster rate than equivalent trees on the control plots. They were also growing faster than equivalent trees growing on the same plots prior to the thinning. Trees on the control plot and those on the thinned plots before any trees had been removed were both growing very slowly. The results indicate that retained trees on the thinned plots have increased growth caused by the treatment imposed upon them (i.e. thinning) and, from this, it is possible to conclude that the trees have responded to thinning by producing extra diameter increment.

1. Thinning intensity

The size of the thinning response on individual trees is related to thinning intensity and a number of factors relating to tree and stand characteristics.

Thinning intensity is a measure of the degree of release from competition that occurs within the stand, and is usually expressed as the percentage reduction in basal area. At its most basic, the relationship between thinning intensity and diameter increment is a simple linear one, as seen in Figure 2.

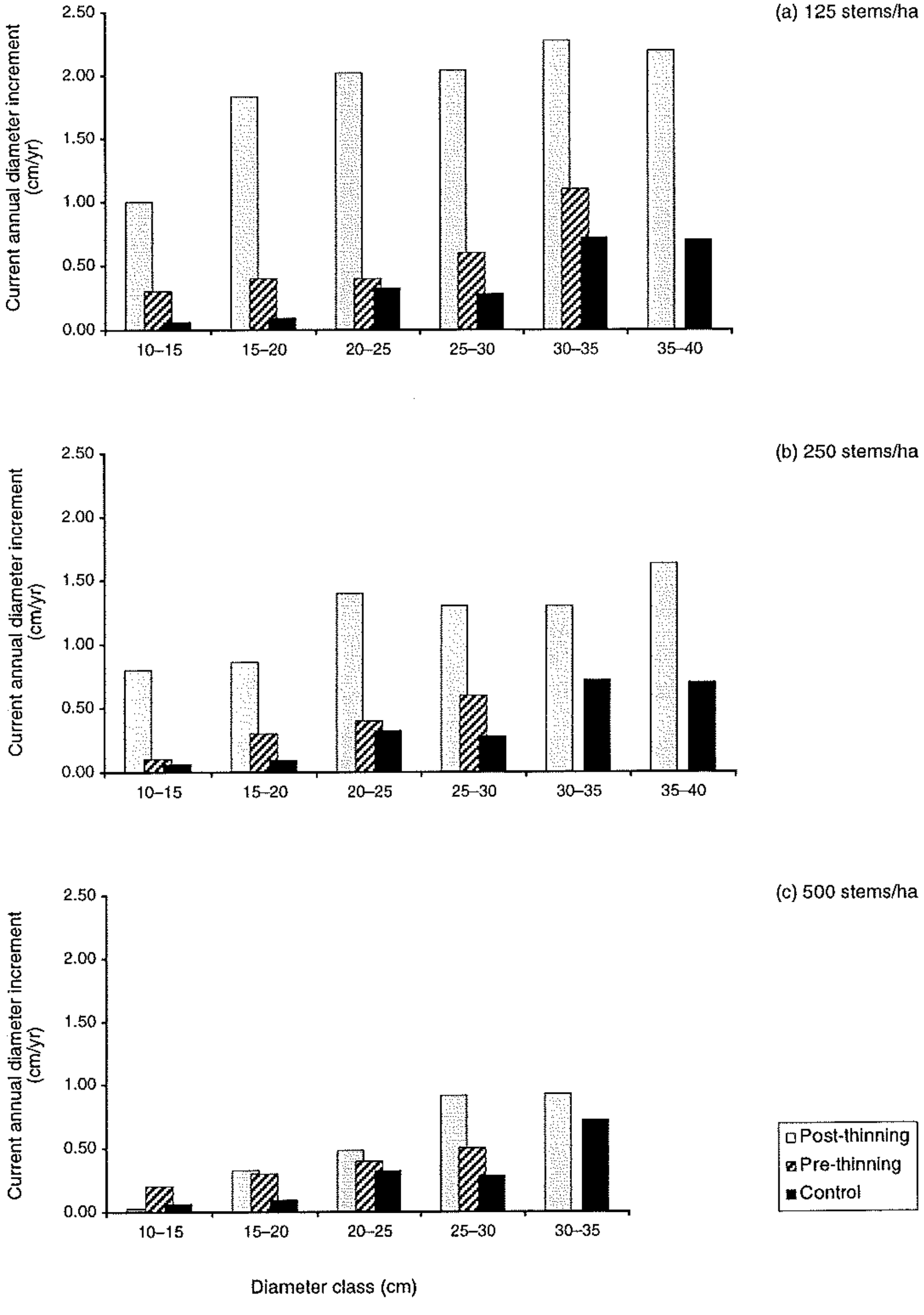

Figure 1. Current annual diameter increment over a range of thinning intensities for treated plots after thinning, treated plots before thinning, and untreated plots after thinning. Data were collected in 27-year-old Eucalyptus obliqua *regrowth at Southport thinned at age 24 years. Thinning treatments are (a) 125 stems/ha, (b) 250 stems/ha and (c) 500 stems retained per hectare. Pre-thinning measurements were estimated using stem analysis.*

Table 1. Thinning trials established or re-measured in the IFM thinning research trial. (sph = stems/ha; BA = basal area; IFM = Intensive Forest Management Program; FT = Forestry Tasmania)

Trial name	Location	Grid reference	Species	Stand age(yrs) at thinning	Monitoring period (yrs)	Retention rate (sph)	BA reduction (%)	Established by	Comments
SO22	Southport	496400 194750	*E. obliqua,* *E. regnans*	24	6	500 250 125	48 68 78	IFM, FT	Permanent trial, well laid out and robust.
AR008	Arve Valley	482350 218350	*E. delegatensis*	24	6	500 250 125	38 78 82	IFM, FT	Permanent trial, well laid out and robust.
MI028	Florentine Valley	459800 295700	*E. regnans*	24	6	250 125	56 69	IFM, FT	Permanent trial, well laid out and robust.
			E. delegatensis	24	6	250	69		Single control plot.
RP003 (JU003)	Florentine Valley	460500 297200	*E. regnans*	29	5	150 273	50 50	IFM, FT	Permanent trial, well laid out and robust.
FT008D	Forestier Peninsula	573400 244100	*E. obliqua*	60	3	90	45	IFM, FT	No control plots, competition indices. Trial discontinued.
CL314T	Liffey Falls	478300 384600	*E. delegatensis*	60	7	100	80	IFM, FT	Thinning from above mixed-age stand.
Chesterman's	Plenty Valley	489900 258200	*E. regnans*	24	27	340 220 125	37 54 69	ANM	Very important long-term trial.
ETYPs	Geeveston	492200 214750	*E. obliqua*	50	38	180 140 100 60	35 50 65 75	FT	Very important long-term trial.
WR004	Geeveston	477700 231300	*E. obliqua*	8	6	800 1500	unknown unknown	FT	Trial abandoned: design flaws.
WR003	Geeveston	478200 231400	*E. obliqua*	3	NA	1000	unknown	IFM, FT	Temporary plots.
AR046	Geeveston	488500 224000	*E. obliqua*	5,6	NA	1300	unknown	IFM, FT	Temporary plots.

The response to thinning seen in Figure 2 has been very strong as the stand is young and growing vigorously. Thus, the more intense the thinning the greater the amount of extra growth that occurs. The slope of the relationship varies depending on site factors but, in all cases, a positive linear (over the range observed) relationship has been found to exist between thinning intensity and increase in diameter increment.

2. *Stand age*

The degree of response to thinning varies with stand age. In older stands, the response is not as dramatic as in younger stands but follows the same general trend. For example, in a stand of *Eucalyptus obliqua* thinned at 50 years of age, both the short-term (2 years) and longer term (25 years) thinning response were directly proportional to the thinning intensity (Figure 3).

This relationship holds until the continued removal of stems will not reduce competition further. This occurs at around 75 to 80% reduction in stand basal area (Goodwin 1990) which is above the highest level of reduction in all of the trials examined during the study.

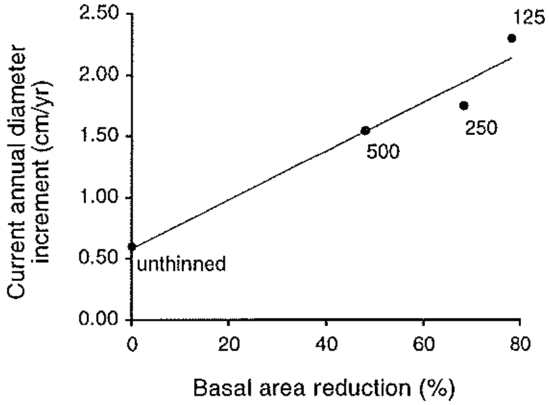

Figure 2. Current annual increment in diameter of the largest 75 stems/ha of Eucalyptus obliqua *thinned to residual stockings of 500, 250 and 125 stems/ha at Southport (SO22). Data were collected three years after 24-year-old regrowth was thinned.*

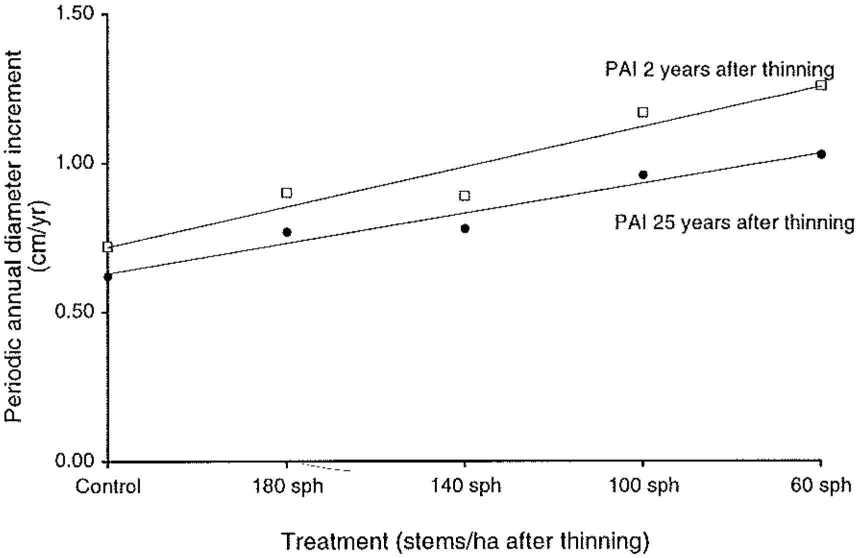

Figure 3. Periodic annual increment (PAI) for two years after thinning and for 25 years after thinning of the largest 75 stems/ha in 50-year-old Eucalyptus obliqua *thinned to a range of final stockings. (sph = stems/ha; 180 sph = 35% basal area (BA) reduction; 140 sph = 50% BA reduction; 100 sph = 65% BA reduction; 60 sph = 75% BA reduction)*

Generally, it appears that older stands respond more slowly to thinning than young stands; the response takes longer to appear and is less intense. However, the response period may be longer. Given sufficient time, an older, thinned stand may behave in a similar way to a younger one and produce sufficient extra volume on the retained trees, providing that no more than 50% of stand basal area is removed initially (Webb and Incoll 1969).

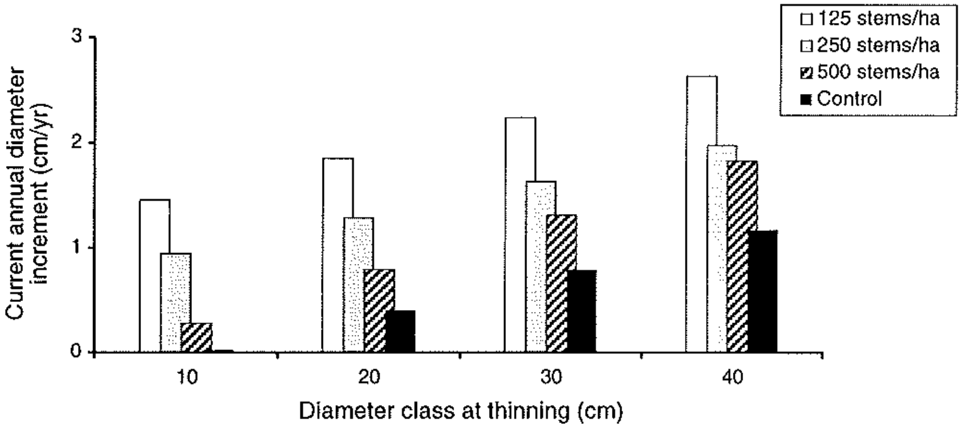

Figure 4. The relationship between diameter and growth response expressed as current annual diameter increment for three thinning treatments and an unthinned control at Southport. Data were collected in 27-year-old Eucalyptus obliqua *regrowth thinned at age 24 years.*

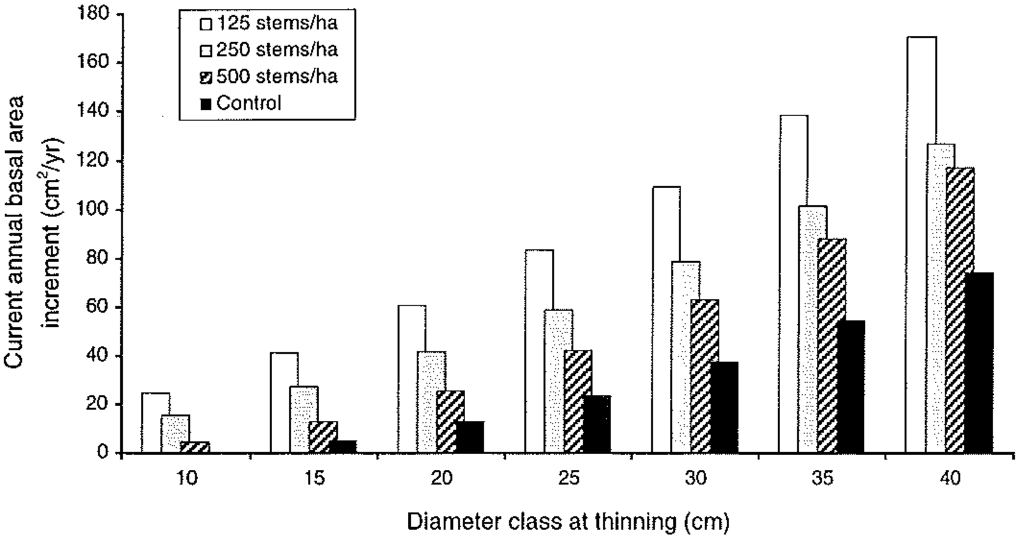

Figure 5. The relationship between diameter and growth response expressed as current annual basal area increment for three thinning treatments and a control at Southport. Data were collected in 27-year-old Eucalyptus obliqua *regrowth thinned at age 24 years.*

Goodwin (1990) states that larger trees tend to respond more slowly to thinning although the response is of a longer duration. The extended length of response is a result of the larger size of gaps in older stands and the greater time required to fill them. The rate of crown and root expansion of retained trees may decline as they age (Jensen and Long 1983) and this may account, in part, for the reduction in response of older trees.

As a stand ages and dominant trees establish themselves, the level of thinning required to produce a response may increase. Webb (1966) stated that trees in the dominant crown class will not begin to respond until 30% of basal area is removed. In a younger, less stratified stand, the removal of even a small number of co-dominant trees will affect those around them.

3. *Diameter class of retained trees*

The relationship between stocking, tree diameter at thinning and annual diameter increment in an even-aged stand at Southport (SO22) is shown in Figure 4.

Stems in thinned stands increased in diameter faster than equivalent stems in unthinned stands. Within each particular treatment, the magnitude of the diameter increase compared to the controls is generally similar across the diameter classes, indicating that the advantage conferred by the thinning is relatively constant over the range of diameters measured. The stems growing in the most heavily thinned treatment (125 stems/ha) produced an extra 1.5 cm diameter growth annually compared to the controls while those in the 250 stems/ha class produced approximately 0.8 cm extra diameter increment (Figure 4).

It cannot be assumed that the size of the growth response would remain similar across the diameter classes if the range of classes was increased. For example, in older and larger trees, the size of the diameter increment will be less than those shown for this relatively young stand (see previous section dealing with stand age).

The use of diameter increment when comparing trees of different diameter classes is somewhat misleading. Because the annulus of timber is larger in a larger stem, the effect of a 1 cm increase in diameter on basal area is much greater in a larger stem than in a smaller one. The data cited in Figure 4 may be expressed as a change in tree basal area rather than diameter and a somewhat different picture emerges.

Examination of Figure 5, which expresses the diameter data used in Figure 4 as basal area, reveals that larger stems produce more wood than smaller stems following thinning. Despite a proportionally large increase in diameter increment associated with thinning, the actual extra wood produced is quite small in smaller stems, particularly in the younger stands where the smallest stems are below 15 cm in diameter.

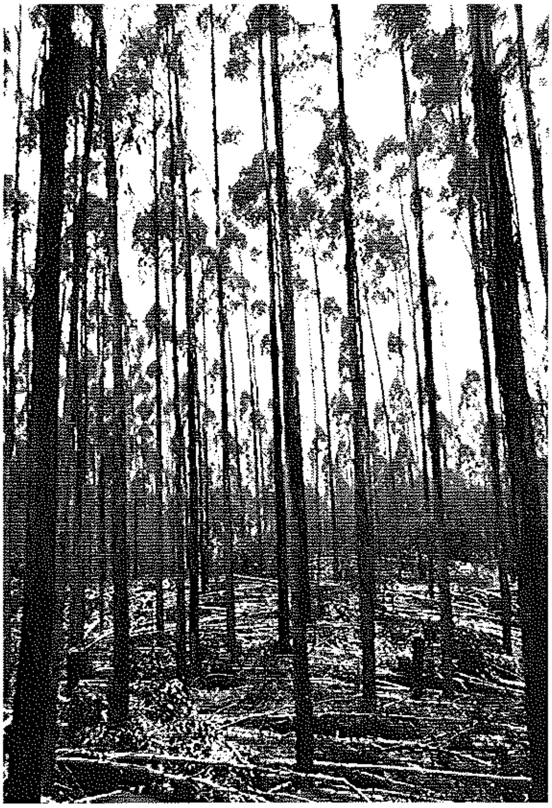

Photo 1. A stand of eucalypts at Southport (SO22) thinned at age 24 years to 250 stems/ha.

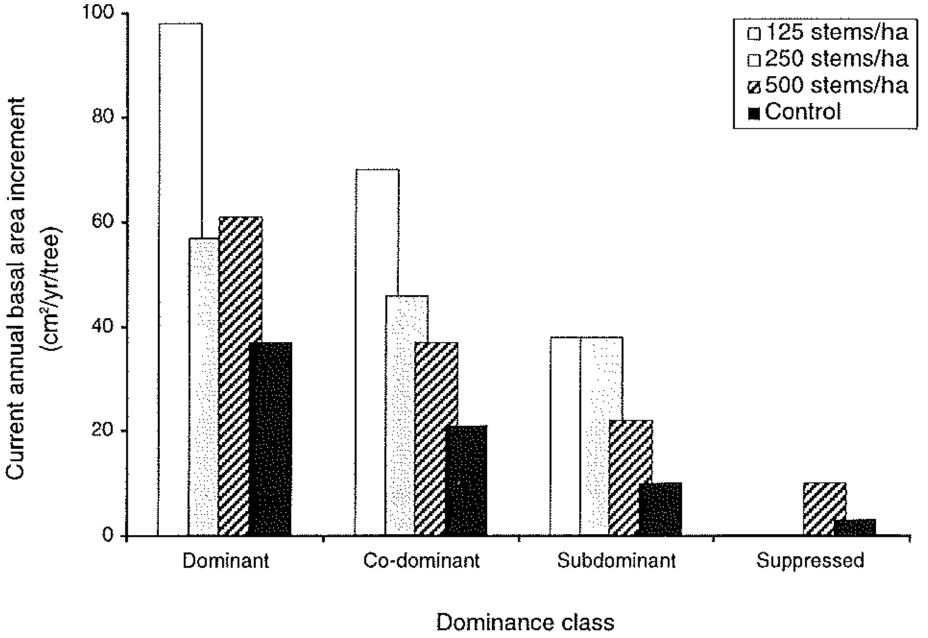

Figure 6. The relationship between dominance class and current annual basal area increment. Data are for a 27-year-old stand of Eucalyptus delegatensis *in the Arve Valley (AR008), thinned at age 24 years to three final stockings, plus an unthinned control.*

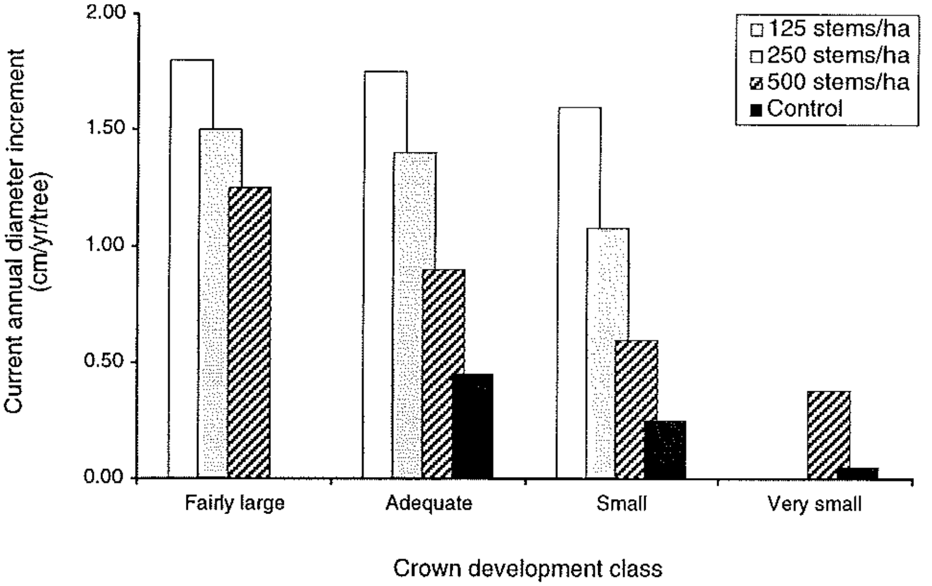

Figure 7. The relationship between crown development class and periodic annual diameter increment. Data are for a 27-year-old stand of Eucalyptus delegatensis *in the Arve Valley (AR008), thinned at age 24 years to three final stockings, plus an unthinned control. Crown development classes are standard Continuous Forest Inventory (CFI) gradings.*

4. *Dominance class of retained trees*

It has been proposed that dominant trees, being relatively free from competition because of their position in the structure of the forest, will not respond to release from competition strongly until other dominant trees are removed from the stand (Webb 1966). Results from trials in this study have not supported this contention. In all trials where a positive growth response to thinning has occurred, the magnitude of the response has been proportional to the dominance class of the tree. Dominant trees tend to have a relatively large diameter, and therefore results presented in Figure 4 showing the relationship between diameter class and growth response support the finding that dominant trees respond to thinning.

It is very difficult to separate the effects of dominance class from those of tree diameter and crown development class, as dominance is closely associated with these two (as well as other) factors. In all treatments, dominant trees grew at a faster rate than co-dominant or subdominant trees (Figure 6). One possible reason for this strong response is that, in the young stands examined by this project, true dominance may not have been fully established.

5. *Crown size of retained trees*

The relationship between crown development class and thinning growth response is very similar to that of dominance class. This is not surprising as dominance class and crown development class are very closely related. Growth response in all treatments shown in Figure 7 was positively correlated with development class. This response is to be expected because a healthy, well-developed crown is necessary for a tree to utilise the increased availability of limiting resources after a stand has been thinned. Trees with poorly developed crowns have less capacity to produce extra levels of carbohydrate to convert to extra wood (and hence extra basal area). Therefore, selection for retention has favoured trees with well-developed crowns.

6. *Maintenance of growth response*

The duration of the growth response to thinning is determined by the intensity of the thinning (expressed as the percentage of basal area removed), and the speed with which the removed basal area is replaced (the improvement in nett basal area production resulting from thinning).

Figure 8 shows the change in periodic annual diameter increment (PAI) over time of the 75 largest stems/ha grown for 25 years under four thinning treatments and an unthinned control treatment on the Eucalypt Thinning Yield Plots (ETYPs) trial plots.

A diameter growth response to thinning in this stand is still apparent after 25 years. However, there has been a steady diminution of this advantage during the period of measurement to a point where only 3 mm in diameter increment separates the most heavily thinned (60 stems/ha or 80% basal area reduction) from the unthinned diameter increment.

If the data are expressed as change in mean stem basal area for the same trees, a different interpretation can be placed on these results. Figure 9 indicates that the basal area growth advantage is reduced more slowly throughout the period of measurement than diameter increment advantage.

B. CLEAR BOLE LENGTH

Trials established during the course of this Program have not been measured for long enough to determine the relationship between clear bole extension and thinning intensity. Information that is available from short-term, retrospective studies tends to contradict results obtained from older work. Data from a series of retrospective evaluations of growth response to thinning operations in very young stands are presented in Figure 10 and summarised in Figure 11.

Webb (1966) found that clear bole lengths did not increase appreciably after heavily

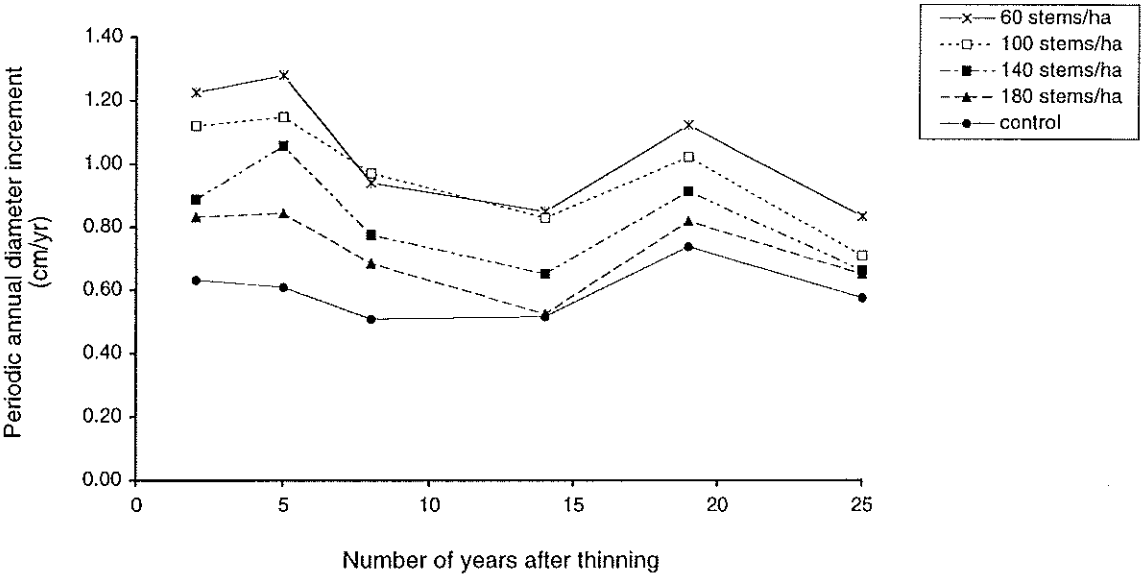

Figure 8. Periodic annual diameter increment of the 75 largest stems/ha of Eucalyptus obliqua *thinned at age 50 years to four final stockings, and an unthinned control.*

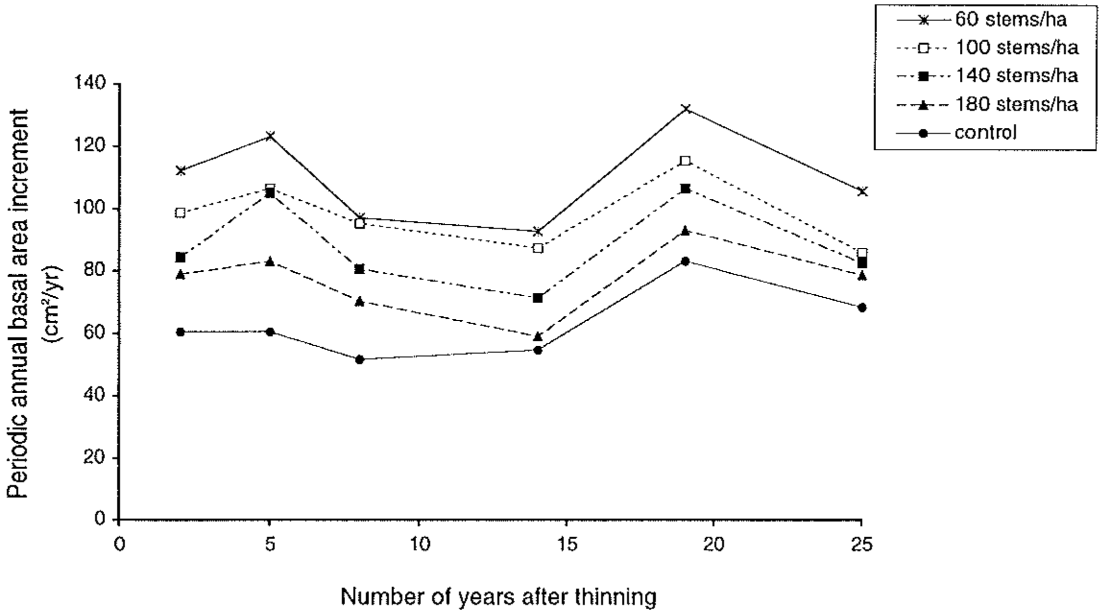

Figure 9. Periodic annual basal area increment of the 75 largest stems/ha of Eucalyptus obliqua *thinned at age 50 years to four final stockings, and an unthinned control.*

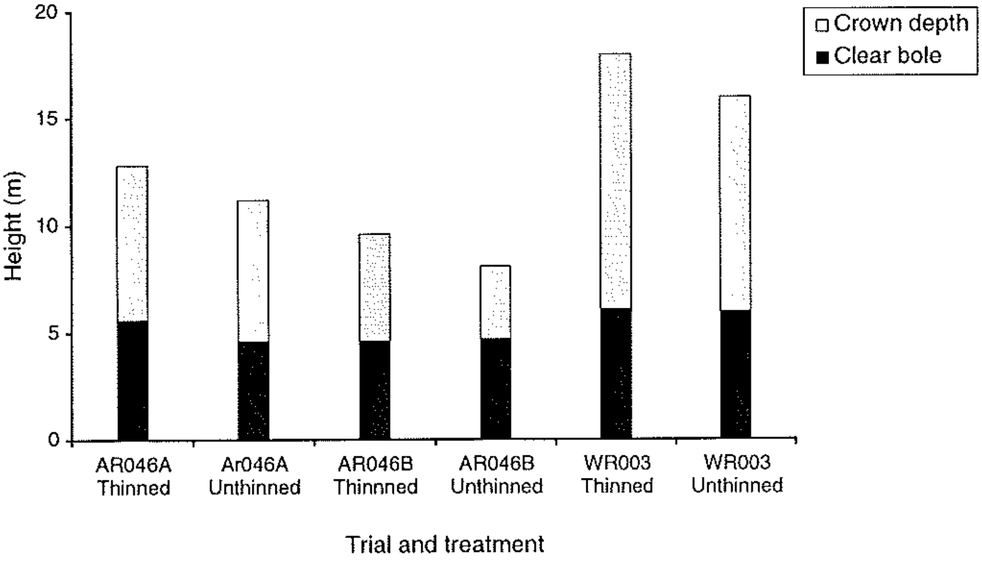

Figure 10. Clear bole lengths and crown depths for trees measured in three young-aged thinning trials in Eucalyptus obliqua, *thinned at 5 (AR046A), 6 (AR046B) and 3 (WR003) years of age to a range of stockings. Data were collected at 8, 9 and 9 years respectively after thinning.*

thinning 20-year-old *E. regnans*. He also found that the reduced rate of stem extension was related to an increase in crown depth in trees on thinned stands. Data from thinning trials in 10-year-old *E. obliqua* indicate that little additional increment in clear bole length occurred in a thinned stand during the ten years following thinning (Goodwin 1990). Data from 75-year-old *E. obliqua* thinned at age 50 years also support the notion that length of clear bole does not increase appreciably after thinning. Therefore, it has been recommended that thinning should not be contemplated until a satisfactory length of clear bole is achieved (Goodwin 1990).

Data generated by trials in very young stands indicate that thinning will cause a loss of clear bole increment only for a few years until the site is once again approaching full occupancy. It appears that, if the thinning is light enough, very young stands may quickly re-establish canopy closure on the site after thinning, and clear bole length may continue to increase.

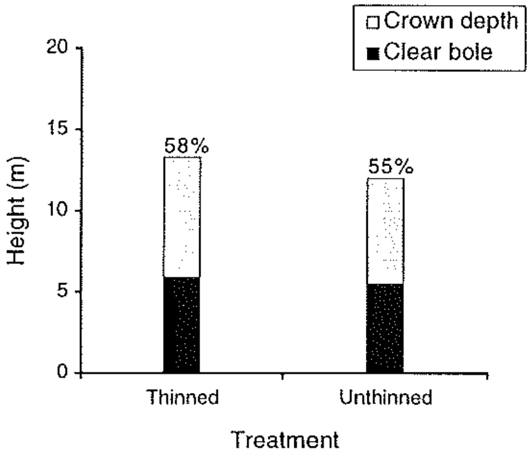

Figure 11. A summary of data presented in Figure 10. Percentage values represent the percentage of total height occupied by clear bole.

These data indicate that thinning at an early age does not cause any major reduction in clear bole length of a stand. There are only very minor differences between the length of clear bole of the trees in each of the three trials above (see Figure 10). The ability of a young stand to quickly re-establish canopy closure on an area after thinning is probably the main reason for the apparent lack of difference in clear bole length between thinned and unthinned stands. Continual monitoring of thinning trials will determine if older stands also behave in this manner.

Understorey density

The density of undergrowth retained after thinning affects the final clear bole length (Brown 1992). It is probable that dense undergrowth in a thinned stand will increase the clear bole length of retained stems through competition for light. Thinning and undergrowth removal in *E. obliqua* at age three resulted in clear bole length at age 30 being shorter than that in a stand of the same age with the understorey retained. While total height and depth of crown were greater in trees grown in the complete absence of an understorey, the clear bole length was reduced by 4 m or 24% in this treatment (Figure 12a) compared to the stand with an untreated understorey. However, if the largest 50 stems/ha only are considered, this difference is reduced considerably to only 1.4 m, or less than 10% (see Figure 12b), indicating that clear bole extension of dominant trees is less affected by the presence of undergrowth than co-dominant or subdominant trees.

Data from branching studies in 20–30-year-old mixed *E. regnans/E. delegatensis* regrowth indicate that a robust, positive relationship existed between present plot basal area and clear bole length in metres (see Figure 13) and as a percentage of total height.

For the stands investigated, the slope of the linear relationship was positive, indicating that an increase in clear bole length occurred with an increase in basal area.

C. STAND BA/VOLUME INCREMENT

A stand's nett volume production will not be reduced until more than 50% of its basal area has been removed (Goodwin 1990). As mortality reduces the nett volume increment in unthinned stands, basal area (and volume) production in thinned stands will increase relative to the

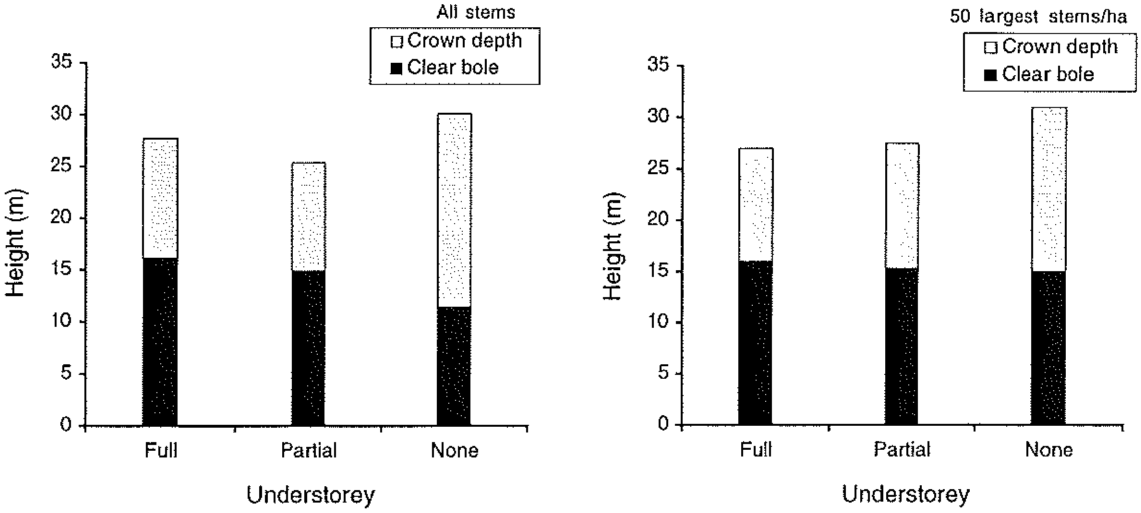

Figure 12. The clear bole and crown lengths of 30-year-old Eucalyptus obliqua *grown at the same stocking under different levels of understorey removal. Data are shown for (a) all stems on the plot (equivalent to approximately 1200 stems/ha) and (b) for the 50 largest stems/ha. Data are from RP115 plots at Togari.*

unthinned stand. The nett stand volume of the thinned stand will continue to increase and approach that of the unthinned stand until self-thinning affects its nett volume increment.

Thinning does not increase the rate of gross stand basal-area increment. It merely salvages wood that would be lost through death, and directs and concentrates the volume produced onto the most valuable stems, the potential sawlogs.

In Figure 14, the change in stand basal area over time of an unthinned control and three thinned treatments is shown from time of thinning to 1995, a period of 25 years. The two relatively lightly thinned stands (28 m^2/ha or 37% basal area reduction and 21 m^2/ha or 54% basal area reduction) have both returned to basal area levels similar to those of the unthinned control plots after 25 years. As the basal area of the thinned plots approaches that of the unthinned stand, the rate of increase will decline and the basal area of the thinned stands should not exceed that of the unthinned stand. However, in this case where the control plot had the smallest basal area before thinning, it is possible that the basal area of the thinned stands will eventually exceed that of the unthinned stand.

Basal area values for the heavily thinned stand (14 m^2/ha retained or 66% basal area reduction) have not met those of the control plots. The slope of the line, while still greater than the control, is decreasing. This result agrees with the work of Webb and Incoll (1969) who found that in stands greater than 30 years of age, gross basal area increment was not reduced by more than 10% until the basal area removed by thinning exceeded 50%.

D. Increasing the sawlog component

A variable percentage of the retained trees will be potential sawlogs, the amount depending on stand characteristics, the skill of the fallers, the retention rates chosen and the response of the retained trees following thinning. Ideally, 100% of retained trees should be potential sawlogs and, as a minimum standard, areas should not

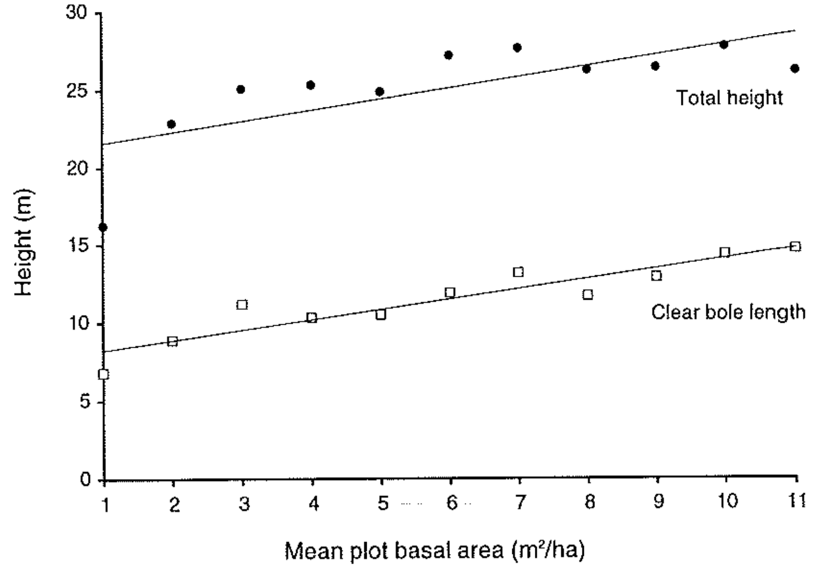

Figure 13. Relationship between plot basal area and mean total height and clear bole length of trees on that plot. Data are presented for a mixture of Eucalyptus regnans *and* E. delegatensis *in the same stands.*

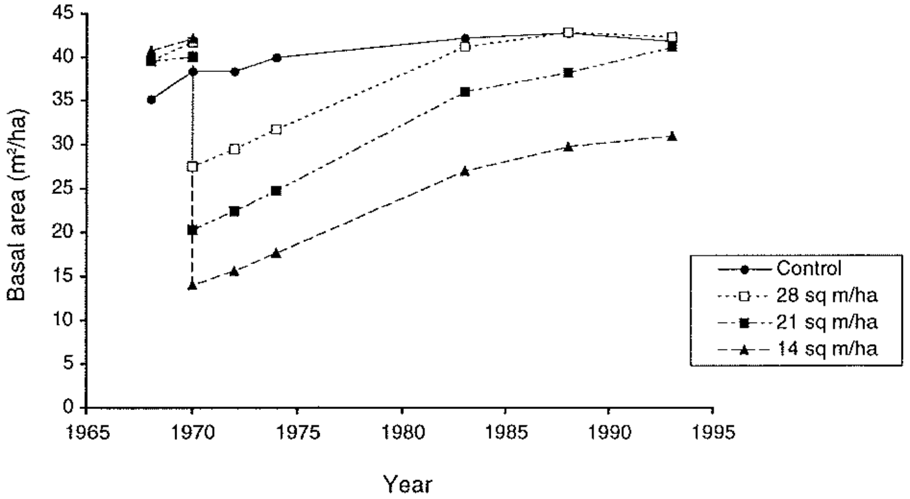

Figure 14. Change in the nett basal area of thinned and unthinned plots in Eucalyptus regnans *thinned in 1970 at age 24 years (Chesterman's Plots). Data are presented for the period of 1970 until 1995.*

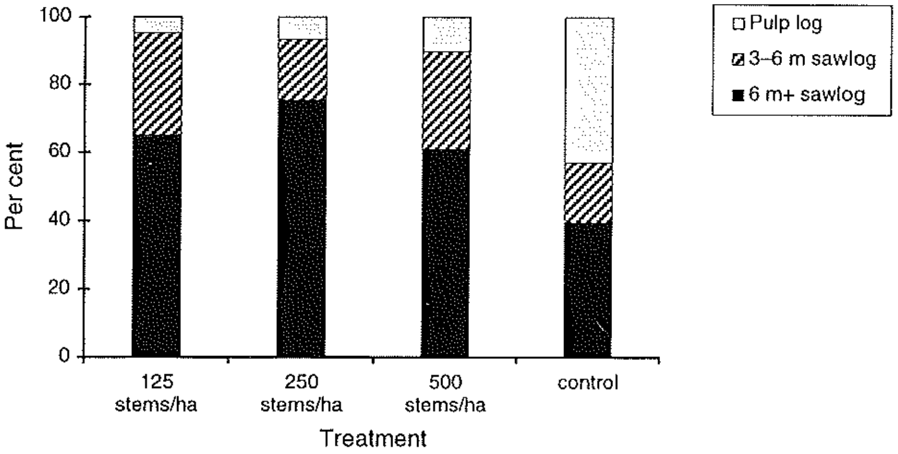

Figure 15. The percentage of potential sawlogs and pulp logs in E. delegatensis *thinned to a range of stockings at 24 years.*

be thinned unless at least 80% of retained trees are potential sawlogs. Non-commercial thinning operations in the Southern Forests have exceeded this figure, with an average of 95% of the retained logs being potential sawlogs, while in a commercial cable operation, Cunningham (1994) reported that 83% of retained trees were potential sawlogs.

The lower the final stocking, the greater the ratio of potential sawlogs to pulp logs which can be expected. Figure 15 shows the final sawlog to pulp log ratio for a non-commercially thinned stand of 24-year-old *E. delegatensis*, with the potential sawlog component separated into logs greater than 6 m and those between 3 m and 6 m.

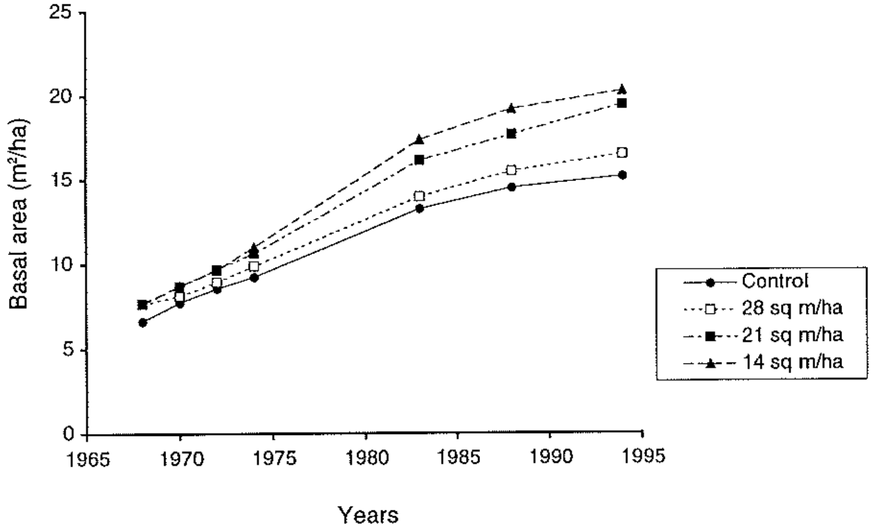

Figure 16. The change in basal area over time of the 100 largest stems/ha in each of the treatments of the Chesterman's Thinning Plots.

The effect of almost doubling the percentage of potential sawlogs by thinning these stands has not been evaluated. However, it is probably as significant as growth response in improving final sawlog yield.

No data relating to the effects of thinning on final sawlog production will be available for many years from trials established during this Program. However, it is possible to use results from other long-term trials to examine the effects of thinning on the final basal area of the largest stems.

Figure 16 shows the change in basal area over time of the 100 largest stems/ha in each thinning treatment of the Chesterman's Thinning Plots, a stand of *E. regnans* thinned at age 24 years and monitored for 25 years.

The largest 100 stems/ha for the medium and heavily thinned treatments continued to maintain a growth advantage over trees on the unthinned plots for at least 25 years. The mean present basal area of the stems is presented in Figure 17.

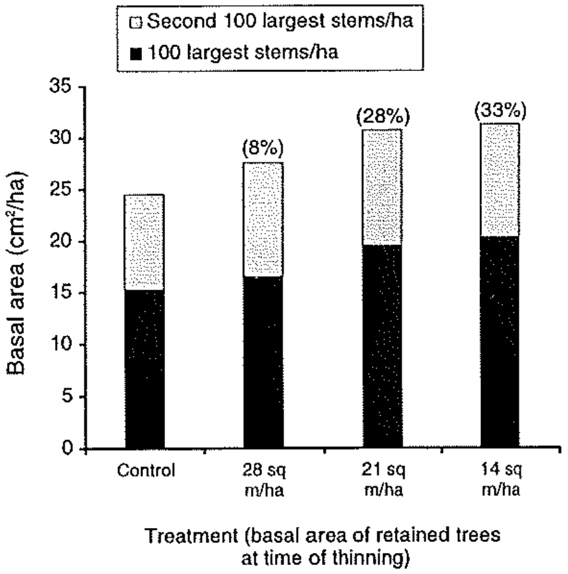

Figure 17. The final basal area values of the largest stems on the Chesterman's Thinning Plots 25 years after thinning. Values in brackets are the percentage increase in basal area of the 100 largest stems/ha. This trial consists of Eucalyptus regnans *thinned at age 24 years and monitored for 25 years after thinning.*

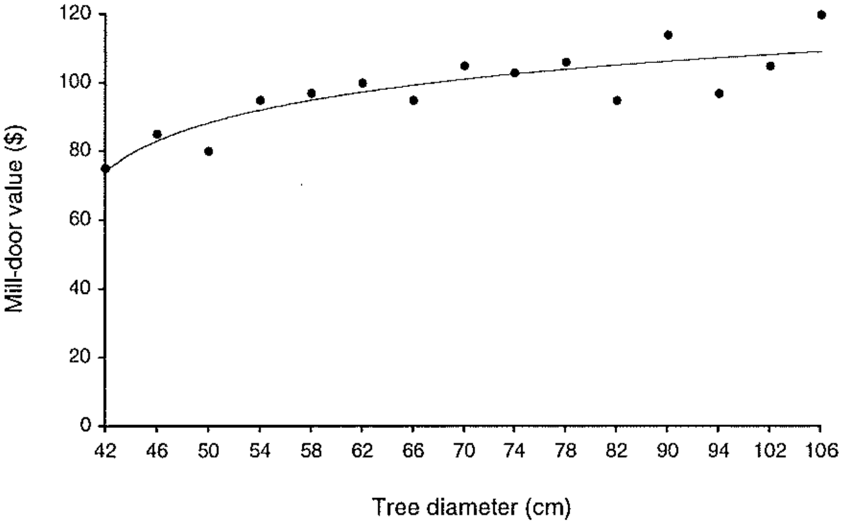

Figure 18. The relationship between tree diameter and mill-door value. The data are for engineering and structural products (Waugh and Rozsa 1991).

A 33% increase in basal area of the 100 largest stems was recorded in the most heavily thinned plots where initial basal area reduction of 66% occurred (14 m^2/ha, see Figure 14). This was accomplished at the cost of overall stand productivity (to the present). In practice, a more likely treatment is the reduction in basal area to 21 m^2/ha (a 54% reduction from initial stand basal area). This led to an increase of 28% in basal area production of the largest 100 stems/ha, with no loss of overall stand growth (see Figure 14).

One of the advantages of thinning is that it produces larger diameter trees for a given rotation lenth. Sawlog utilisation studies have shown that product recovery of sawn timber is maximised for log diameters of between 50 and 70 cm (Waugh and Rozsa 1991). Increasing log small-end diameter from 25 cm to 80 cm was found to reduce mean costs of sawn timber production by 14% to 18% (Grant 1977). However, log small-end diameter was found to be a poor indicator of the cost of sawn timber from a specific log. Waugh (1980) found that while log diameters were not necessarily a good predictor of product recovery, they did account for a high proportion of the variation in sawmill productivity. The choice of sawing pattern also becomes less critical as logs increase in diameter over 35 cm (Waugh and Yang 1992).

Waugh and Rozsa (1991) examined the relationship between mill-door log value per cubic metre and tree diameter (Figure 18). The relationship was a positive power curve, the slope and intercept values of which were dependent upon sawing method used and product. They found that, by the selection of appropriate sawing techniques, returns could be increased by values of up to \$30/m^3.

An increase in diameter of 10 cm from 70 cm to 80 cm results in an increase in value of approximately \$3/m^3. The value differential is far higher for appearance grade material, being about \$10/m^3.

Discussion

Thinning regrowth eucalypt forests produces two main effects: the growth rate of individual trees increases, and there is an increase in total number of sawlogs over the thinned area. Each of these effects has a number of implications for the sawlog industry.

The ability to cause selected trees of good form and vigour to grow more rapidly means that a thinned stand can have a number of stems above a pre-determined diameter class sooner than an unthinned stand. This will allow that stand to be harvested at a younger age than if left unthinned. This extra increment could reduce projected rotation lengths by between five and 20 years. An alternative treatment for that stand would be to allow it to grow on for a longer rotation length, and reap the benefit of larger (and more valuable) sawlogs.

Achieving the balance between maximising piece size and minimising rotation length is an economic and political issue which is beyond the scope of this discussion. However, thinning, with its enhanced growth rates of selected stems, should provide a degree of flexibility in this decision-making process.

The increase in the number of sawlogs per given area will mean that more sawlogs will be available, or that smaller areas will need to be processed to produce the same volumes of sawlog over the same time period.

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