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Department of Conservation
and Land Management

Wood Utilisation Research Centre

SAWING REGROWTH JARRAH GROWN UNDER DIFFERENT SILVICULTURAL PRESCRIPTIONS

G.K. Brennan and J.A. Pitcher

October 1992
W.U.R.C. Technical Report No. 32

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SUMMARY

A jarrah (*Eucalyptus marginata* Donn ex Sm.) stand was regenerated following harvesting and a fire in 1922 in Inglehope Block near Dwellingup, and plots were established in 1964 by thinning to a range of stand densities. Small sawlogs obtained from a second thinning in 1986 were used in a stockpiling and sawmilling study. Yields of sawlogs and poles were determined for each plot, and sawmilling properties were related to tree growth and stand density.

Growth rate had no effect on bow and spring of sawn boards but faster growing trees tended to produce higher recoveries. A mean sawn recovery of 22.4 per cent was recorded, with small end diameter having the greatest influence on sawn recovery while log length had no effect. Drying and grading resulted in 12 per cent of boards making Clear grade, which is a similar result to that for regrowth jarrah grown in other areas.

INTRODUCTION

Western Australia's jarrah (*Eucalyptus marginata* Donn ex Sm.) forests have been used for timber production since European settlement in 1829, and an estimated 50 million cubic metres of jarrah have been extracted from Crown land since then. The forest currently yields 550 000 m^3 of sawlogs per annum and has the potential to sustain indefinitely a viable and profitable timber industry (Department of Conservation and Land Management 1987).

There are approximately 140 000 ha of relatively even-aged regrowth jarrah forests, which have regenerated after heavy cutting (almost clearfelling) of the original forest (Department of Conservation and Land Management 1987). The regrowth forests can occur as extensive blocks, but are often in areas as small as 10 to 15 ha. They vary in age from 10 to 80 years, and some have been thinned.

The most productive regrowth is usually located on fertile sites, and these areas are important future sources of timber on a sustained yield basis. The major factor which limits their potential for sawlog production is the absence of a market for the small trees removed in thinning operations.

Sawlogs can be produced from thinning these high quality jarrah stands after 40 to 60 years, and the final crop could be cut for sawlogs after about 60 to 80 years. It is intended, however, that stands are grown to at least 100 years before the next felling cycle is introduced (Department of Conservation and Land Management 1987).

Shea *et al.* (1975) suggested that thinning be used to increase wood production. Stoneman and Schofield (1989) have shown that thinning of jarrah grown on water catchments could also result in substantial increases in the production of water. Abbott and Loneragan (1986) drew attention to the lack of information available on the wood properties of jarrah grown at different growth rates.

This study provides data on wood properties and sawing characteristics of regrowth jarrah from Inglehope Block, Dwellingup District, which were grown at different stand densities and hence different growth rates. The recoveries of regrowth jarrah timber from stands of different cutting histories, site type and growth rate, and stockpiled under different watering schedules, are summarised.

MATERIALS AND METHODS

A jarrah stand in Inglehope Block, Dwellingup District, was regenerated following harvesting and a fire in 1922, and 27 study plots were established in 1964 by thinning to a range of densities. The plots are 0.16 ha (40 m x 40 m) with an 8 m surround, with six replicates of four different intensities of thinning and three control plots. Measurements of basal areas and tree diameter in 1965 and 1984 gave growth rates of each tree over a 19-year period.

In 1965 the nominal stand basal area under bark of each group of groups was 7.0, 11.0, 15.4, 18.3 and 22.0 m^2 ha^{-1} respectively (referred to as thinning treatments T1, T2, T3, T4, and T5). Logs for a sawmilling study were extracted from the T1, T2 and T3 groups.

By 1984 the average stand basal areas under bark (b.a.u.b.) of plots T1, T2 and T3 were 12.8, 17.7 and 21.8 m^2 ha^{-1}, and following the second thinning in 1984 the stand b.a.u.b.s were 4.6, 9.8 and 15.8 m^2 ha^{-1} respectively.

Stoneman *et al.* (1989) have reported on the growth of trees and stands in this experiment over this 19-year period.

Trees removed in a second thinning in 1986 were used for stockpiling and sawmilling studies, in which growth stress and sawn recovery data were related to growth rate and stockpiling treatment.

Log specification

The specification for small sawlogs used in this trial is given in Appendix 1. The logs were transported to the Wood Utilisation Research Centre (W.U.R.C.) at Harvey, where half were sawn fresh from the forest (within two weeks of felling), and the other half were stockpiled under continuous water spray for 3 months before sawing.

Log and pole yield

Yields of small sawlog and State Energy Commission (S.E.C.) poles were determined. Only felled trees were assessed for S.E.C. poles, and recorded as 9.5, 11.0, 12.5, 14.0 or 15.0 m lengths using the S.E.C. pole specifications.

Milling

Log taper was estimated from the differences in mean log diameter at each end and log length (recorded as mm/m), and subsequently correlated with b.a.u.b.

Logs were sawn into 28 mm boards using the Waugh (1980) sawing pattern. The logs were broken down by two passes through a twin edger, producing a centre cant. The cant and wings (if sawn timber could be recovered from the latter) were re-sawn using a vertical bandsaw or a two-person circular saw, and bow and spring were measured before resawing.

The cant was cut through the middle with the bandsaw to produce two flitches which were then backsawn, commencing from the sapwood, to produce 28 mm thick boards with widths of 50, 75, 100, 125 or 150 mm. Any brittle heart was discarded. The wings were sawn on a two-person circular saw bench if it was unsafe to feed them through the bandsaw. Bow or spring were measured on the centre flitch and the flitch halves after cutting through the middle.

At the docking saw, boards were trimmed to lengths of 1.2, 1.5, 1.8, 2.1 or 2.2 m (the last specifically for timber to be dried in tunnel kilns). Faults such as brittle heart, rot, excessive knots, gum and wane were removed in the docking process. Bow or spring and board length were measured on all boards.

Drying and grading

Green bundles of timber were placed into the tunnel kiln under either summer conditions (sawn fresh boards) or mild winter conditions. Drying conditions and method of kiln operation are described by Brennan (1990). Timber was dried in the tunnel kiln to below fibre saturation point (f.s.p.), then placed in an experimental high temperature kiln and dried to 10 per cent moisture content. Boards were pre-dressed to 22 mm and graded into Clear, Feature, Processing and Merchantable grades, using the W.U.R.C. grading rules for boards milled from regrowth eucalypts (Brennan *et al.* 1990a). Defects resulting in downgrading of the boards were recorded.

Evaluation of log degradation

Log end splits were rated from 0 to 5 using a photographic key. Code 0 is no splitting, 1 and 2 minor splits (fissures not extending to the log perimeter), 3 moderate (one or two fissures extending to the log perimeter) and 4 and 5 severe splits (most fissures extending to the log perimeter with splits occurring along the log).

RESULTS AND DISCUSSION

Yield of small sawlogs and poles

Thinning treatment T1 (thinned from 12.8 m^2 ha^{-1} to 4.6 m^2 ha^{-1}) produced the highest volume and number of sawlogs (30.8 m^3 ha^{-1} and 151 sawlogs/ha) and thinning treatment T3 (thinned from 21.8 m^2 ha^{-1} to 15.8 m^2 ha^{-1}) produced the lowest volume and number of sawlogs (12.8 m^3 ha^{-1} and 70 sawlogs/ha) (Table 1). Growing jarrah trees at a lower stand density, as occurred in T1 (12.8 m^2 ha^{-1}) compared with T3 (21.8 m^2 ha^{-1}), and reducing the basal area by similar amounts yields 2.5 times the volume and twice the number of small sawlogs. The comparison between T1 and T2 (density before thinning 17.7 m^2 ha^{-1}) shows T1 yielded 1.3 times the volume and 1.3 times the number of sawlogs. The majority of poles produced from all plots were 9.5 m long, with T1 and T2 plots producing approximately 10 poles per treatment, or 12 poles/ha. Future thinning operations will produce additional poles, and in greater lengths if required.

Figure 1 shows the yield of small sawlogs by diameter class for each tree thinning treatment. Yields from the three thinning treatments were 29.1, 15.5 and 10.2 m^3/ha. Sawlog yields were directly related to the basal area before thinning, i.e. plots thinned to a low basal area had high yields and plots thinned to a high basal area had low yields. This is because the former plots had increased growth rates and trees were larger by 1986 than those on high basal area plots which grew more slowly.

Sawn recovery

The recoveries of regrowth jarrah for the sawn fresh, stockpiled for three months and combined treatments are given in Table 2. The mean s.e.d.u.b. for all plots was 21.4 cm, similar to the mean s.e.d.u.b. of 20.9 cm reported by Brennan and Ward (1990) for regrowth jarrah samples from four different areas within the Northern Jarrah Forest.

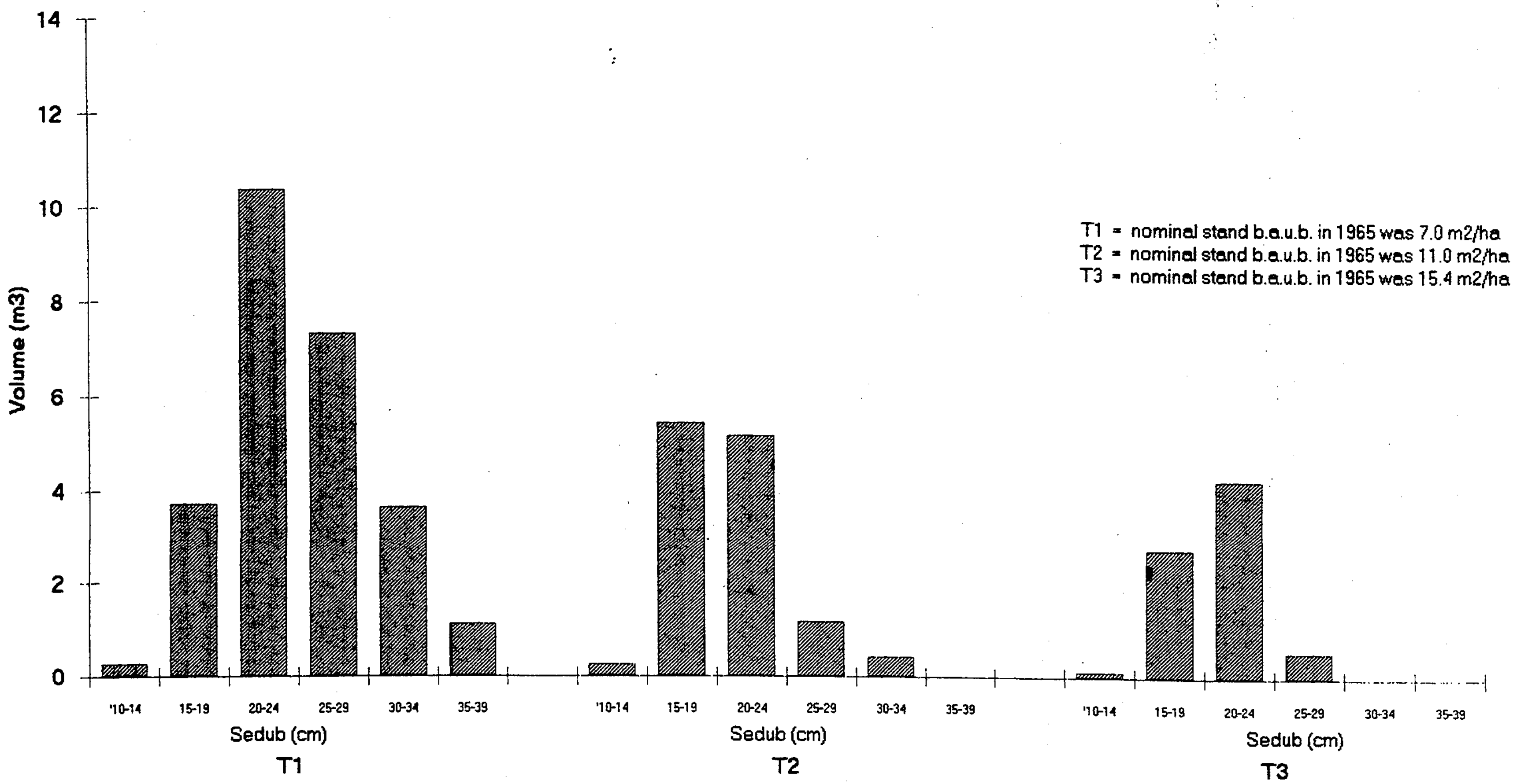

Figure 1
Yield of small sawlogs for different thinning treatments

The mean sawn recovery was 22.4 per cent and ranged from 20.7 per cent (stockpiled for three months) to 24.7 per cent (sawn fresh). The maximum and minimum recoveries were significantly different ($p<0.05$). Brennan and Ward (1990) found a green sawn recovery of 23.2 per cent, which ranged from 21.4 to 26.4 per cent. The sawn fresh logs were significantly larger, which would have contributed to higher recoveries.

Table 1

Summary of yield of small sawlogs and poles thinned from the Inglehope Plots

Thinning Treatments	Basal area reduction (m^2/ha)	Yield of small sawlogs (m^3) (per treatment)	(per ha)	No. of small sawlogs (per treatment)	(per ha)	No. of poles per treatment 9.5 m	11.0 m	12.5 m
T1	8.2	29.1	30.3	145	151	4	6	1
T2	7.9	15.5	19.4	92	115	5	4	1
T3	6.0	10.2	12.8	56	70	3	-	-
Total		54.8	21.4					

T1 = Nominal stand b.a.u.b. in 1965 was 7.0 m^2/ ha

T2 = Nominal stand b.a.u.b. in 1965 was 11.0 m^2/ ha

T3 = Nominal stand b.a.u.b. in 1965 was 15.4 m^2/ ha

Table 2

Log dimensions and sawn recovery of regrowth jarrah milled in this trial

	S.e.d.u.b. (cm)			Length (m)			Recovery (%)		
Treatment	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
Sawn fresh	22.6	5.2	14.0-37.0	3.7	1.2	1.6-6.0	24.7	10.9	0.0-50.7
Sawn after Stockpiling	20.2	3.4	13.0-35.0	3.6	1.1	2.3-6.2	20.4	9.7	1.2-55.1
Combined	21.4	4.5	13.0-37.0	3.7	1.1	1.6-6.2	22.4	10.4	0.0-55.1

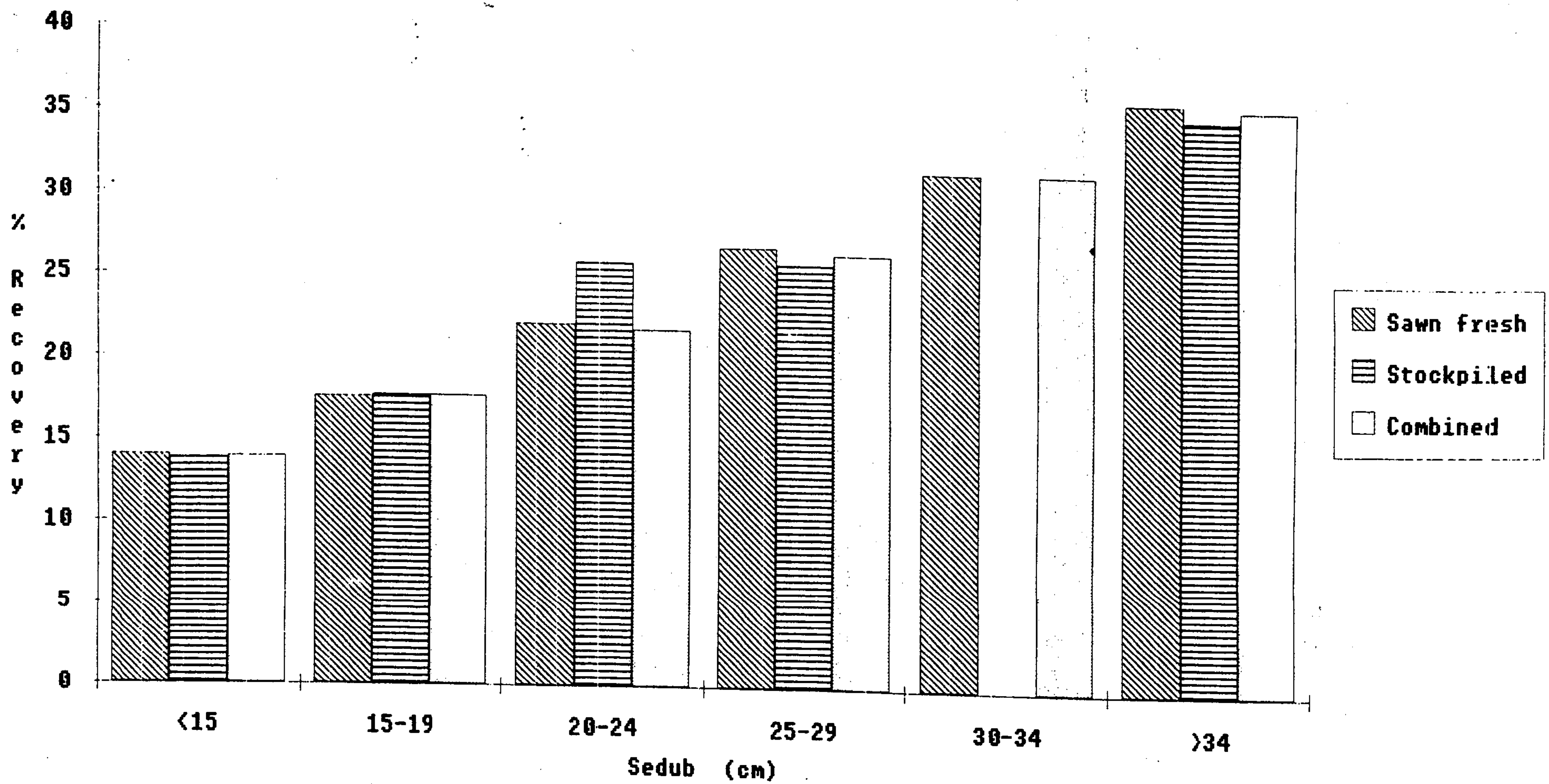

Figure 2
Effect of stockpiling treatment and log diameter class (s.e.d.u.b.) on sawn recoveries of regrowth jarrah logs

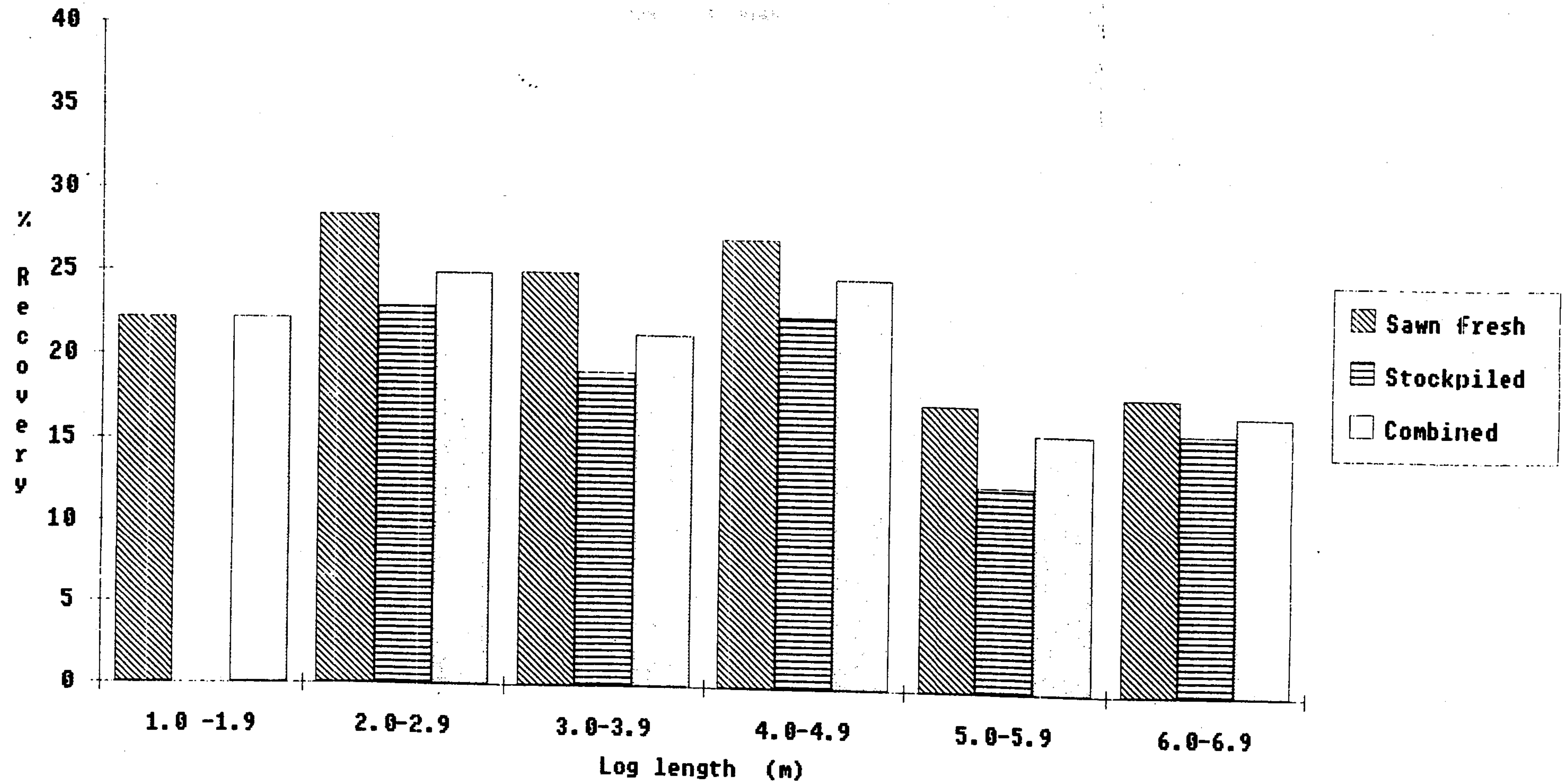

Figure 3
Effect of stockpiling treatment and log length class on sawn recoveries of regrowth jarrah logs

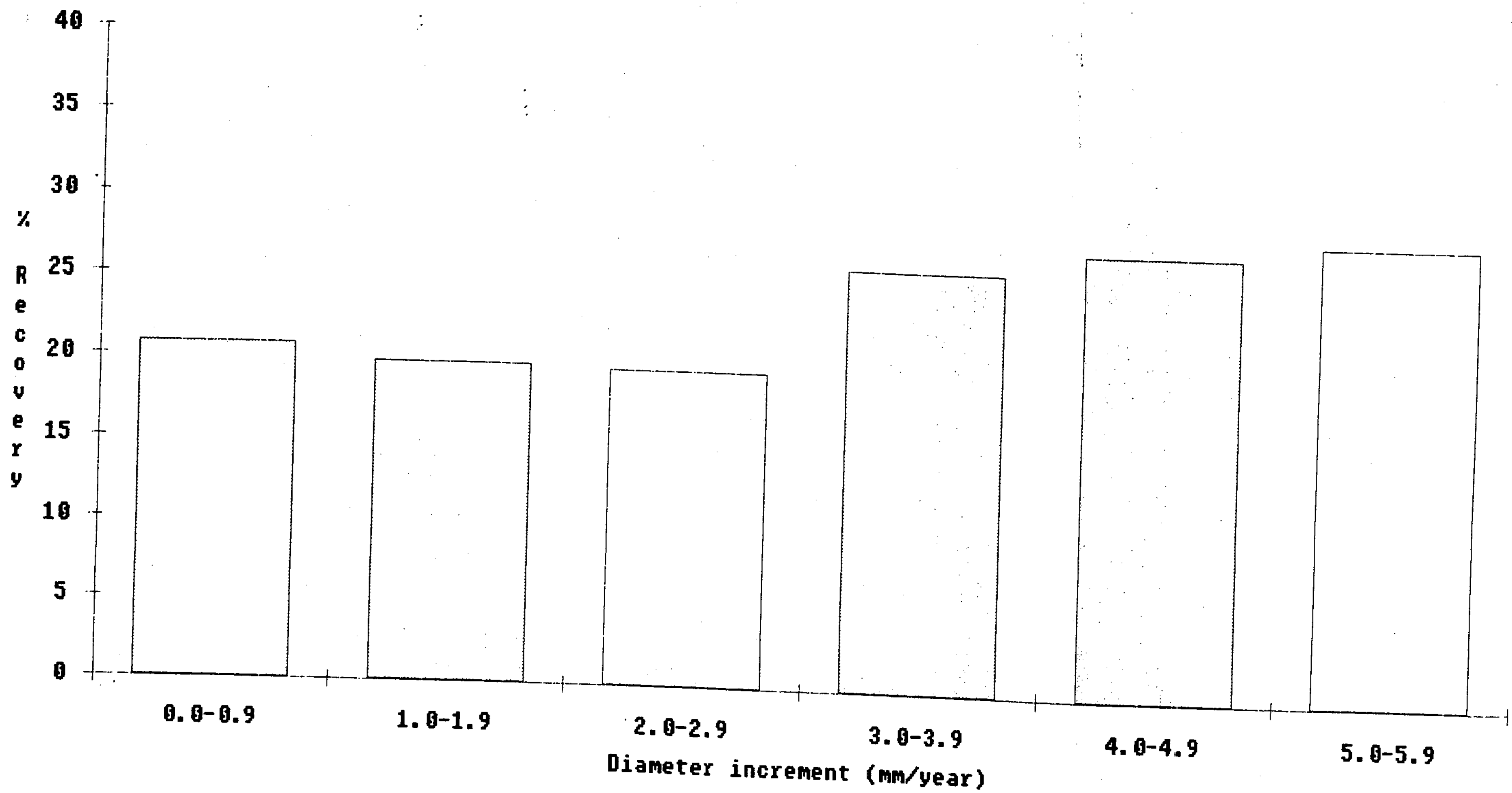

Figure 4
Effect of diameter increment on sawn recoveries of regrowth jarrah logs

Mean log length was 3.7 m, and ranged from 1.6 to 6.2 m. To reduce the risk of butt damage to retained trees during harvesting, no logs greater than 6.2 m were extracted. Recovery increased as s.e.d.u.b. increased (Fig. 2), but length did not influence recovery (Fig. 3). Previous regrowth jarrah sawmilling trials have found similar results (Brennan and Ward 1990; White 1989). Figure 4 shows the effect of diameter increment on green sawn recovery. The trees with the greater diameter increment produced higher recoveries.

End splitting

For the combined treatments, the majority of end splits were minor or moderate and only 2 to 3 per cent of logs had severe splitting (Table 3). Stockpiling for three months resulted in fewer instances of moderate splitting compared with logs sawn fresh, indicating that end splits present at the time of stockpiling may close during storage.

Table 3
Percentage of end split codes for logs sawn fresh, stockpiled for 3 months, and combined.

Severity Code	Sawn fresh (%)	Stockpiled for 3 months (%)	Combined (%)
Minor	42.0	69.6	56.1
Moderate	56.4	27.1	41.5
Severe	1.5	3.2	2.4

Effect of growth rate on bow and spring of sawn flitches and boards

Few data are available on the effect of silvicultural techniques on the level of growth stress. In plantations, the more uniform conditions and even spacing of trees should reduce mean stress levels and within-stem variations, in comparison with those trees growing under natural conditions (Hillis 1978). Waugh (cited by Hillis 1978) commented that there is no quantitative evidence that rapid growth results in higher growth stresses. He found no correlation between diameter increment and stress level in trees of either a fully stocked plantation or of a natural stand of mountain ash (*Eucalyptus regnans* F. Muell.).

Table 4
Effect of diameter increment (mm/yr) on bow and spring in boards, centre flitch and flitch halves from regrowth jarrah logs either sawn fresh or stockpiled under water spray for 3 months

Diameter increment (mm/yr)	Fresh sawn No of samples	Fresh sawn Mean (mm/m)	Fresh sawn SD (mm/m)	Sawn after stockpiling No of samples	Sawn after stockpiling Mean (mm/m)	Sawn after stockpiling SD (mm/m)
Board Bow						
0-0.9	63	4.6	2.6	58	4.5	2.7
1-1.9	145	4.2	2.0	126	5.0	2.5
2-2.9	103	4.9	3.7	216	4.1	2.1
3-3.9	119	4.1	2.2	240	4.2	2.2
4-4.9	69	4.1	2.4	62	3.7	1.9
5-5.9	11	2.0	1.5	21	4.0	1.5
TOTAL		4.0			4.2	
Board Spring						
0-0.9	63	0.7	0.7	58	1.0	0.9
1-1.9	147	1.0	1.1	126	0.9	0.8
2-2.9	104	0.9	0.9	216	1.2	1.3
3-3.9	120	1.0	0.8	238	1.1	1.0
4-4.9	70	0.8	0.9	62	0.9	0.8
5-5.9	11	0.7	0.6	21	1.0	0.6
TOTAL		0.8			1.0	
Centre Flitch Bow						
0-0.9	13	1.6	0.8	16	2.0	1.3
1-1.9	37	2.1	1.6	35	2.0	1.4
2-2.9	30	1.3	1.0	45	1.9	1.3
3-3.9	24	1.8	0.9	35	1.8	1.3
4-4.9	19	1.3	0.6	13	2.0	0.8
5-5.9	2	2.4	0.9	5	1.1	0.5
TOTAL		1.8			1.8	
Centre Flitch Spring						
0-0.9	15	1.2	1.0	16	1.1	0.4
1-1.9	36	1.3	1.5	35	1.2	0.9
2-2.9	30	1.4	1.7	45	1.1	1.4
3-3.9	24	1.2	1.6	35	0.8	0.6
4-4.9	20	0.8	1.1	13	1.1	0.5
5-5.9	2	1.5	0.3	5	0.8	0.4
TOTAL		1.2			1.0	
Flitch half bow						
0-1.9	30	6.0	4.7	32	5.2	2.0
1-1.9	71	6.0	3.4	70	6.0	2.9
2-2.9	53	6.6	3.9	89	5.4	2.4
3-3.9	42	5.6	3.6	70	6.0	2.9
4-4.9	37	5.6	3.1	24	6.6	2.8
5-5.9	4	3.6	0.4	10	3.1	1.7
TOTAL		5.6			5.4	
Flitch half spring						
0-0.9	29	1.8	1.4	32	1.6	1.2
1-1.9	69	2.1	1.7	70	1.6	1.2
2-2.9	31	2.3	3.0	90	1.6	1.6
3-3.9	39	2.7	3.5	70	1.6	1.6
4-4.9	37	1.2	0.8	24	1.8	0.8
5-5.9	4	1.2	1.0	10	1.1	0.4
TOTAL		1.9			1.6	

Large diameter logs produce a proportionally greater volume of sawn timber with less distortion than would be possible from a smaller diameter log with the same peripheral growth stress but steeper internal stress gradients (Hillis 1978). Where existing trees have high levels of stress, extending the rotation age reduces the effects. Another approach has been to stop or slow down tree growth for a period before felling to enable relaxation of the stresses. Work carried out by the CSIRO has shown that using watersprays on stockpiled ash-type eucalypt logs over a six-month period, can reduce overall stress levels by as much as 20 per cent. Most of this reduction takes place in the highly stressed logs, in which the stress intensity can be halved (Waugh 1986). Bow and spring of sawn flitches and boards are measures of the effects of growth stress.

In this study, diameter increment had little influence on bow and spring for flitches and boards whether sawn fresh or stockpiled under waterspray for three months (Table 4). Mean bow for boards sawn fresh or sawn after three months stockpiling was 4.0 mm/m and 4.2 mm/m respectively and board spring 0.8 mm/m and 1.0 mm/m respectively. These bow and spring measurements for flitch halves were similar and were combined in Table 4. The mean bow of 5.6 mm/m for fresh sawn and 5.4 mm/m for sawn after stockpiling, were understandable because cutting the centre cant into two pieces releases a large amount of growth stresses, resulting in considerable deflection. The amount of spring in boards measured in this study is allowable in specifications given in AS 2082 (Standards Association of Australia 1979).

The results of the bow and spring measurements in this study were similar to those from a regrowth jarrah stockpiling study by Brennan *et al* (1990b), where the bow and spring of boards milled from logs stored under reduced watering schedules were similar to those from logs stored under continuous spraying. Subsequent drying substantially reduces bow in regrowth jarrah boards (Brennan 1990).

Log taper

The amount of taper can vary considerably but a rough guide for mature trees would be about 10 mm of diameter change per metre length of trunk (Bootle 1983). In this trial a mean taper of 12.4 mm/m (S.D. 7.5 mm/m) was found for regrowth jarrah (Table 5), which is similar to the figure for mature trees. Taper had a poor correlation with sawn recovery.

Table 5

Effect of stand density (b.a.u.b.) on log taper before second thinning in 1986
(Standard deviations are given in brackets)

	b.a.u.b. class (m^2/ha)	Log taper (mm/m)	
T1	10-15	13.0	(8.6)
T2	151-20	12.6	(6.0)
T3	201-26	11.6	(6.4)
Mean		12.4	(7.5)

T1 = Nominal stand b.a.u.b. in 1965 was 7.0 m^2/ha
T2 = Nominal stand b.a.u.b. in 1965 was 11.0 m^2/ha
T3 = Nominal stand b.a.u.b. in 1965 was 15.4 m^2/ha

Grading results

Tables 6 and 7 show the grading results and defects causing the downgrading of boards from the higher grades. A recovery of Clear grade of 12 per cent was achieved and 20 per cent made full length (2.2 m) and 54 per cent was 1.5 m or longer. Feature and Processing grades contributed 49 per cent of the graded recovery. Similar recoveries were found when grading 30 mm and 40 mm regrowth jarrah dried in a batch kiln (Brennan *et al.* 1990a), however a higher proportion of both 30 mm and 40 mm boards made Feature and Processing grades.

The major defects downgrading boards from Clear to Feature grade were epicormic buds (birds eyes) with 63.2 per cent of boards affected, then surface checks (8.3 per cent) and skip (7.5 per cent). The principal defects downgrading boards to Processing and Merchantable grades were gum veins, knots, knot holes, surface checks and skip.

Table 6

Grading results for regrowth jarrah from the Inglehope Plots

Grade	Graded recovery (%)	Lengths (m) distribution by grade (%)										
		2.2	1.8	1.5	1.3	1.2	1.0	0.9	0.7	0.6	0.4	0.3
Clear	12.1	20	11	21	1	21	0	22	0	1	0	0
Feature	32.2	66	40	37	1	50	2	33	1	1	0	0
Process	16.6	45	15	30	1	19	4	9	2	3	0	1
Merch	37.7	96	22	44	12	52	17	22	19	15	2	0
Reject	1.5	0	0	0	0	0	1	0	2	0	23	21

Table 7
Occurrence of defects in each grade (percentage of boards affected)

Defect	Grade			
	Clear	Feature	Processing	Merchantable
Skip		7.5	22.5	22.5
Surface checks		8.4	17.8	37.4
End splits			2.3	10.9
Twist				0.7
Spring				1.0
Cupping			0.8	3.3
Bow			0.8	0.7
Wane		2.1	6.2	5.3
Brittle heart		0.8	0.8	7.9
Knots		6.7	20.9	28.8
Insect damage		7.1	9.3	8.9
Pin holes				0.7
Epicormics		63.2	19.4	5.3
Gum veins		6.7	14.0	25.8
Gum pockets		0.4	5.4	14.9
Decay				1.3
Shake				0.7
Shatter			0.8	4.3
Knot holes		3.8	16.3	30.1

In summary, this trial based on the Inglehope plots confirmed that plots thinned to a low basal area yielded higher volumes of sawlogs than plots thinned to high basal areas. The plots thinned to low basal areas had high tree growth rates and were larger by 1986 than those on high basal area plots, hence had higher yields. A mean sawn recovery of 22.4 per cent was achieved for logs sawn fresh or stockpiled for three months. Recoveries varied with s.e.d.u.b. After drying and grading, 12 per cent of boards made Clear grade, which is suitable for interior furniture.

Silviculturalists can use the data in designing thinning prescriptions for efficient management of timber resources, and sawmillers can use them in comparing sawn recoveries and assessing the effects of growth stresses on log processing.

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APPENDIX 1

Specification for small sawlogs used in the trial

1. Small end diameter under bark (s.e.d.u.b.)
   Minimum 150 mm
   Maximum 350 mm

2. Large end diameter under bark (l.e.d.u.b.)
   Minimum 175 mm
   Maximum 400 mm

3. Length
   Any of the following, aiming for long lengths:-
   2.4, 3.6, 4.8, or 6.0 m

4. Quality
   Straightness - maximum 30 mm sweep in any 2.1 m length
   log ends at least 50 per cent solid wood
   both log ends cut square
   no deformities such as dry sides, bumps or protrusions

Note: (1) Some logs had dimensions outside this specification, however they were still included in the sawmilling and stockpiling trials.

(2) Logs were docked to shorter length if sweep was excessive or short lengths were required.