Sawn Recoveries from Crown Logs of Radiata Pine

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Wood Utilisation Research Centre
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SUMMARY

Sawn graded recoveries from logs in the green crown of radiata pine (*Pinus radiata* D.Don) were compared with those from second logs (i.e. the adjacent logs), milled into either structural or appearance grade timber. Logs were classified as either specification second grade sawlogs, or non-specification.

The results indicated no significant differences in sawn graded recoveries between crown and adjacent logs, or between specification and non-specification logs within each of the former treatments. Combining recovery data from specification and non-specification logs did give a significantly lower recovery from crown than from second logs. Overall, the results indicated that crown logs could be milled into either structural or appearance grades with recoveries that were satisfactory but less than those from second logs. Therefore the economics of a sawmilling operation would be adversely affected as the proportion of crown logs increased.

INTRODUCTION

Radiata pine (*Pinus radiata* D.Don) has been extensively planted in the south-west of Western Australia. Approximately 35 000 ha have been established in State plantations, representing a major timber
resource to complement the native hardwood forests. An extensive industry is based upon these radiata pine plantations.

As a grower of radiata pine, the Department of Conservation and Land Management (incorporating the former Forests Department) has periodically undertaken studies to assess the product offered for sale. Previous research has included a study of recoveries and quality of radiata timber produced from fast-grown trees in fuel-reduced buffers and agroforestry (Siemon *et al.* 1989).

The present trial compared the recoveries and quality of structural and appearance grade timber produced from small diameter logs from the green crown, with timber from second logs of radiata pine crop trees. It also compared recoveries from logs meeting Departmental specifications for second class pine sawlogs with those from logs not meeting specification because of excessive sweep or knot size.

METHODS

Logs from 29-year-old radiata pine were harvested from Compartment 30 in Millward Plantation, Nannup District. The compartment had been low pruned at age four, high pruned to 6.0 m at age seven, and thinned at age 21 years. Logs were harvested full length by skyline system during clear felling, and docked to 3.6 m on the skyline landing. Four treatments were separated out on the landing:

crown logs
- specification
- non-specification

second logs
- specification
- non-specification.

A crown log was defined as the uppermost 3.6 m sawlog found in the tree, to a minimum small end diameter under bark (s.e.d.u.b.) of 20 cm, and a second log as the 3.6 m sawlog immediately below the crown log. Some of these second logs contained green branches.

A specification log met the requirements of a second class pine sawlog, which was defined as having no abrupt changes in diameter, no massive knot whorls, no individual dead knots greater than 6 cm diameter on the greatest axis, and sweep not exceeding 20 per cent of the s.e.d.u.b. in any 3.0 m length. A non-specification log had defects exceeding those requirements, but the actual size of defects was not quantified.

Logs were transported to the Wood Utilisation Research Centre at Harvey for processing. Prior to milling, logs were measured,and length, s.e.d.u.b., large end diameter under bark (l.e.d.u.b.), and defects recorded.

Logs were sawn to produce either:

(i) 90 x 35 mm structural timber, with 70 x 35 mm and 19 mm thick boards as recovery items, or

(ii) appearance grade 19 mm thick boards as wide as possible, with narrow or 19 mm thick boards as recovery items.

Ten logs in each of the eight treatments (two log x two specification x two sawing treatments) were processed, and individual recoveries recorded.

Logs were broken down in the sawmill by passing twice across a twin edger with overhead beam feed, producing a centre cant with four flat sides and two wing flitches for further resawing. The two roundback wings produced by the first skimming cut across the twin edger were too small to resaw and were chipped to waste. Resawing was done on a 3 mm kerf vertical bandsaw, and timber produced was docked to commercial lengths in multiples of 0.3 m.

The sawn timber was high temperature dried in accordance with R.P.A.A. Industry Standard No 100-1979 (Radiata Pine Association of Australia 1979). Two kiln charges were dried, one of structural timber, and the other of 19 mm thick boards. The seasoned timber was then dressed on a four-sider plane. Structural grade timber (i.e. 90 x 35 mm and 70 x 35 mm) to Australian Standard AS2858-1986 (Standards Association of Australia 1986). All pieces meeting at least Structural Grade No 5 of the Standard were graded as F5, and those not meeting this specification as Merchantable grade. Appearance grade boards were graded in full length to Australian Standard AS1489-1973 (Standards Association of Australia 1973), and material not meeting Clear, Joinery, Select or Standard grades of the Standard was classified as Commons.

Data were compiled on a personal computer spreadsheet and analysed using analysis of variance.

RESULTS AND DISCUSSION

Log dimensions and quality

The mean s.e.d.u.b. for all crown logs was 23 cm, and for second logs 26 cm (Table 1). The logs in the crown/non-specification/structural treatment had a mean s.e.d.u.b. of 21 cm, which could be expected to result in lower sawn recoveries because of the strong correlation between log size and recoveries.

Table 1
Dimensions of radiata pine logs

Treatment		Length (m)	s.e.d.u.b. (cm)	l.e.d.u.b. (cm)
Crown/specification/ structural	Mean	3.6	23	26
	S.D.		1.7	2.4
Crown/specification/ appearance	Mean	3.6	24	27
	S.D.		1.8	2.0
Crown/non-specification/ structural	Mean	3.6	21	25
	S.D.		2.5	2.9
Crown/non-specification/ appearance	Mean	3.6	24	27
	S.D.		2.3	2.0
Second/specification/ structural	Mean	3.6	27	30
	S.D.		2.2	1.5
Second/specification/ appearance	Mean	3.6	26	30
	S.D.		3.0	3.7
Second/non-specification/ structural	Mean	3.6	25	28
	S.D.		3.7	3.3
Second/non-/specification/ appearance	Mean	3.6	26	28
	S.D		2.7	2.9

The main reason that logs failed to meet the specifications for a second class pine sawlog was excessive sweep (Table 2). Logs with dead knots greater then 6 cm diameter were more common than those with massive knot whorls, but there were no logs with abrupt changes in diameter. Twelve of the non-specification logs had a combination of defects.

Table 2
Number of logs and classification in each treatment

Treatment	Crown				Second			
	Spec		Non Spec		Spec		Non Spec	
Defect	Str	App	Str	App	Str	App	Str	App
Knots 6 cm	-	-	6	5	-	-	4	4
Massive knot whorls	-	-	1	-	-	-	2	-
Abrupt diameter change	-	-	-	-	-	-	-	-
Excessive sweep (exceeding specification)	-	-	9	8	-	-	6	8
Sweep within specification	6	5	-	-	5	3	-	-

Spec = Specification
Str = Structural
App = Appearance

Total recoveries

Mean recovery from all treatments was 30.9 per cent (Table 3). Crown and second logs meeting specification produced 32.5 per cent and 32.0 per cent recovery, and non-specification logs 29.0 per cent and 29.7 per cent recovery respectively. Statistical analysis (ANOVA) showed no significant differences ($p<0.1$) between individual treatments. However, when the data for specification and non-specification logs were grouped, the 30.5 per cent mean recovery from crown logs was significantly less than the 31.4 per cent recovery from second logs. This could be attributed to the comparatively lower recoveries from the crown/non-specification/structural treatment which contained logs with generally smaller s.e.d.u.b. than logs of other treatments (Table 1).

Table 3
Summary of structural, appearance, and combined recoveries, from each treatment (% of log volume)

	Structural logs		Appearance logs	
	Crown	Second	Crown	Second
Structural timbe				
Specification	27.7	28.6	-	-
Non-specification	25.7	24.9	-	-
Appearance timber				
Specification	4.8	3.4	31.5	33.1
Non-specification	3.3	4.8	29.1	30.6
Combined recovery				
Specification	32.5	32.0	31.5	33.1
Non-specification	29.0	29.7	29.1	30.6

Recoveries of structural timber

The recoveries of structural sized timber from crown and second logs were 27.7 per cent and 28.6 per cent respectively for specification logs, and 25.7 per cent and 24.9 per cent respectively for non-specification logs. Analysis indicated that there were no significant differences between treatments.

Recovery of F5 grade material varied from 17.1 to 22.0 per cent (Table 4), and Merchantable material from 6.6 to 10.1 per cent. The proportion of pieces of timber making F5 structural grade were:

	Crown	Second
Specification	68.8 per cent	76.9 per cent
Non-specification	66.4 per cent	79.3 per cent

The majority of timber produced by the structural sawing strategy was 90 x 35 mm and some 70 x 35 mm, with 90 x 19 mm boards cut as recovery items (Table 5).

Table 4
Recoveries of sawn timber from each treatment

	Crown				Second			
	Spec		Non Spec		Spec		Non Spec	
	Str	App	Str	App	Str	App	Str	App
Grade								
(Structural)								
F5	19.1	-	17.1	-	22.0	-	19.7	-
Merchantable	8.6	-	8.6	-	6.6	-	5.2	-
(Appearance)								
Clear	-	-	-	-	0.3	-	-	
Joinery	-	0.6	-	0.9	-	0.2	-	-
Select	-	9.1	-	8.9	-	10.4	-	6.0
Standard	-	4.3	-	5.5	-	7.2	-	8.5
Common	4.8	17.5	3.3	13.8	3.4	15.0	4.8	16.1

Spec = Specification
Str = Structural
App = Appearance

Table 5
Proportions of sizes produced from each treatment (%)

Treatment	Crown				Second			
	Spec		Non Spec		Spec		Non Spec	
	Str	App	Str	App	Str	App	Str	App
70 x 19	17	13	10	10	9	7	18	11
90 x 19	12	23	14	30	11	15	3	15
120 x 19	-	14	-	25	-	22	-	6
140 x 19	-	37	-	20	-	42	-	30
170 x 19	-	13	-	15	-	13	-	38
70 x 35	13	-	8	-	20	-	16	-
90 x 35	58	-	68	-	60	-	63	-

Spec = Specification
Str = Structural
App = Appearance

The imperfections which caused structural timber to be downgraded from F5 to Merchantable are listed in Table 6. Knots and material containing heart were the most frequent imperfections with group knots causing more downgrading than single knots, suggesting that whorls with numerous branches were present on the tree rather than whorls with fewer large branches. Ten out of the twenty non-specification logs had individual knots larger than specification tolerance, while only three logs were rejected because of massive knot whorls. The fact that individual knot size was not a major source of degrade suggested that the current log specification is satisfactory in the limit of dead knot size allowed (i.e. a maximum of 6 cm diameter), because these defects are docked out in the sawmill. While 18 pieces were rejected because they contained heart and wide growth rings, another 20 which also contained heart were graded as F5 to the requirements of AS2858-1986 (S.A.A. 1986) because growth rings were narrower. The 18 reject pieces could have been regraded to F5 'Heart-in' stud grade.

Table 6
Imperfections downgrading structural timber from F5 grade (AS2858-1986)

IMPERFECTION	TREATMENT			
	Crown/ specification	Crown/non-specification	Second/ specification	Second non-specification
Face knot	-	-	-	1
Group face knot	3	3	4	3
Edge knot	-	-	-	1
Other knot	1	1	1	1
Combination knot	-	2	-	2
Growth rings (pith)	7	3	3	5
Wane	-	-	-	-
Surface checks	-	-	-	-
Holes	-	-	-	-
Bark pockets	1	2	5	1
Resin pocket	-	-	-	-
Sloping grain	-	1	1	1
Shake	-	1	3	3
Bow	1	-	-	-
Spring	-	-	-	-
Twist	-	-	-	-

Recoveries of appearance timber

Recoveries from the four appearance treatments varied between 29.1 and 33.1 per cent (Table 3), but statistically there was no significant difference between treatments. Presumably this was because of the small sample size of 10 logs/treatment. The overall recovery of boards was higher than that from milling structural timber. The recoveries of boards meeting the requirements of AS1489-1973 (S.A.A. 1973) varied from 13.0 to 18.2 per cent (Table 4). The majority of boards meeting the grading standard were either Standard or Select grade. Three of the four treatments (the exception was second/non-specification) produced only a small recovery of Joinery grade boards and only one treatment (second/ specification) produced Clear grade boards.

The production of higher grade boards eg. select and better or standard and better, resulted in some anomalies (Table 4) for which there is no apparent explanation. For example, non-specification logs in the crown produced higher proportions of these boards than did specification logs. Log size and sweep should not affect grade, but pith and cone holes generally are more prevalent in crown logs.

For statistical analysis, data from Standard and Select grade boards were grouped because there was little difference between the two grades with respect to the size of certain permitted imperfections e.g. sound knots. Similarly Joinery and Clear grades were grouped together. Analysis indicated that there was no significant difference between treatments in the recovery of the grouped grades.

The most common width cut in producing appearance grades was 140 mm, with 170, 120 and 90 mm wide boards having approximately equal quantities cut, and 70 mm width boards as a recovery item (Table 5). The proportion of 120 mm or wider boards was considerably greater in the second/specification log category:

	Crown	**Second**
Specification	64.0 per cent	81.0 per cent
Non-specification	60.0 per cent	74.0 per cent

This is a function of log size, as shown by comparing the s.e.d.u.b.'s of crown and second logs (Table 1), and log degrade making it necessary to dock defects.

The proportion of full length boards in crown logs decreased from 74 per cent in specification to 68 per cent in non-specification, and in second logs from 78 per cent in specification to 71 per cent in non-specification.

Knots were the most frequent imperfection in boards (Table 7). Encased knots were the worst imperfection, and these are usually associated with poor pruning practices or poor branch shedding i.e. self pruning. Because these logs were from the upper part of mature trees, above the height of 6.0 m to which pruning is generally carried out, poor self pruning was the likely cause of the defects. Non-specification logs require more docking than specification logs, and hence have reduced proportions of full length boards.

Individual tight knots resulted in boards being graded as Select rather than Joinery situation with structural timber and suggests that whorls with numerous branches rather than massive branching were present in the tree. Holes also caused downgrade, resulting from either cone holes or from loose knots falling out.

Table 7
Imperfections resulting in specific grades in boards cut from appearance logs (AS1489-1973)

IMPERFECTION	TREATMENT														
	Crown/ specification				Crown/non-specification				Second/ specification				Second non-specification		
	Rej	Std	Sel	Join	Rej	Std	Sel	Join	Rej	Std	Sel	Join	Rej	Std	Sel
Group knots	6	-	-	-	8	-	-	-	4	-	-	-	19	-	-
Tight knots	3	-	20	2	1	-	16	4	-	-	15	1	1	-	13
Encased knots	15	7	6	1	15	4	5	-	31	31	7	-	14	4	4
Holes	11	-	3	-	10	-	7	-	8	-	5	-	4	-	4
Resin pockets	3	7	-	-	-	-	-	-	-	2	-	-	-	-	-
Bark pockets	-	1	-	-	2	1	3	-	-	3	2	-	3	2	2
Surface checks	-	-	-	-	-	-	-	-	-	-	3	-	-	2	-
Needle trace	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pith	-	4	-	-	1	1	1	-	-	-	-	-	2	1	-
Bow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sloping grain	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Rej = Reject
Std = Standard
Sel = Select
Join = Joinery

In summary, the results of this trial indicated that crown logs produced lower recoveries than the adjacent second logs, and specification logs had higher recoveries than non-specification logs. The sample size was small, because of the need to identify the recovery from each log for statistical analysis. Although the statistical analysis indicated few differences, the commercial implications must be considered. A small increase in percentage recovery has a major effect on the commercial viability and profitability of a sawmilling operation. The trial indicated that there were advantages in milling crown logs into boards rather than into structural timber, because of the higher recoveries of the former product. However, the market demand for appearance grade timber is comparatively limited, and would need to increase to justify milling all crown logs into boards.

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