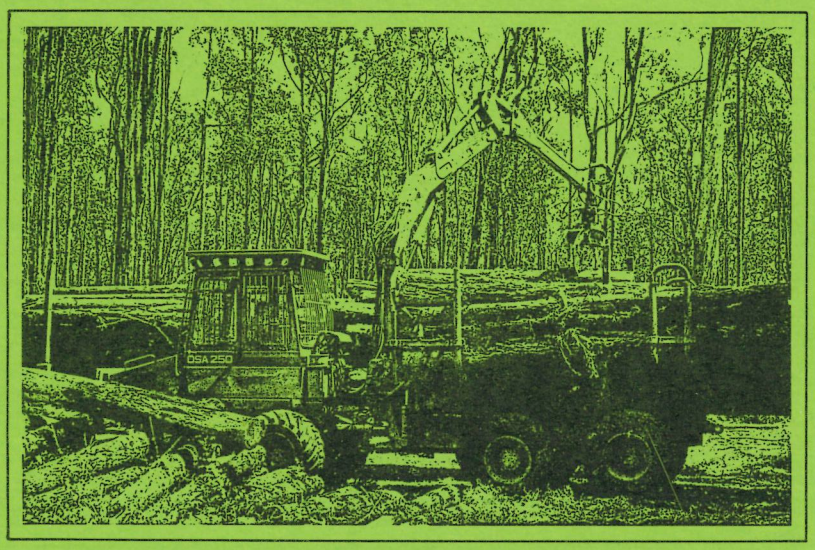
Small Jarrah Sawlog and Residue Log Harvesting Trials Near Harvey, W.A.

by J.D. Clark and G.K. Brennan



Report No. 4
July 1988

Wood Utilisation Research Centre
Department of Conservation and Land Management

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SUMMARY

Small sawlogs and residue logs of jarrah (*Eucalyptus marginata* Donn ex Sm.) were harvested in trials conducted near Harvey, 140 km south of Perth. The Department of Conservation and Land Management co-operated with timber industry representatives.

The trials indicated that conventional hardwood logging equipment, currently used in W.A., can effectively harvest small jarrah sawlogs without excessive crop tree damage. Current pine harvesting equipment (OSA forwarder and Case buncher) is also effective, but costs may be higher until operators gain experience with hardwood.

Whole tree logging was most efficient. Volume of small sawlogs varied considerably, averaging 9 m^3/ha to 15 cm s.e.d limit in this specific area near Harvey. There were 27m^3/ha of general purpose sawlogs and 2 poles/ha previously extracted.

The volume of jarrah residue logs (suitable for charcoal production) averaged 46 m^3/ha in the area. This residue log extraction could result in unacceptable levels of damage to the crop trees in predominantly regrowth forest. However, in cut over forest affected by dieback, and in mainly mature jarrah forest, the harvesting is efficient.

INTRODUCTION

Past cutting of the jarrah (*Eucalyptus marginata* Donn ex Sm.) forest has resulted in the formation of differing stand structures. These structures can be divided into three categories (Bradshaw 1983):

(a) regrowth forests - resulting from the uncontrolled cutting prior to the 1920s, and forest treatment in the 1930s.

(b) grouped (or two tiered) forests - resulting from the group selection cut, and cull treatment. These forests consist of groups of old growth and groups of second growth in patches of 0.1 ha or larger.

(c) mature forests - these stands are virgin, or lightly cut forests on a uniform (rather than a grouped) basis.

It is Departmental policy to treat silviculturally selected areas of cut over jarrah forest to promote growth of retained crop trees. The areas of forest selected for treatment correspond in most cases to category (a) above, the regrowth forests. To date the silvicultural treatments used have largely involved the culling of unwanted stems, including jarrah, by felling and/or poisoning.

These trials investigated the potential for the removal of currently non-commercial jarrah stems in a Harvey logging area, while supplying a volume of small jarrah sawlog material for research purposes. In addition, the trials incorporated measurement of yield of jarrah log residues for charcoal production.

A joint industry/Departmental working group was responsible for preparing the research working plan and deciding on the parameters for the trial and the equipment to be tested. The technical group members were:

Mr Hiski Kippo of Whittakers Ltd
Mr Ron Adams of Bunning Bros Pty Ltd
Mr Peter Colli of Colli and Sons
Mr Des Donnelly of CALM.

The specific objectives of the trials were:

(a) to determine the volume of small jarrah sawlogs available in a forest stand consisting of areas of regrowth and mature forest.

(b) to assess the cost-effectiveness of (i) pine logging equipment and (ii) conventional hardwood logging equipment in harvesting small jarrah sawlogs.

(c) to assess the ability of (i) pine logging equipment and (ii) conventional hardwood logging equipment to harvest small jarrah sawlogs without damaging retained crop trees.

(d) to determine the volume of jarrah residue in a Harvey forest stand suitable for manufacturing charcoal, available in three different forest types: (i) cut over dieback forest (ii) regrowth forest and (iii) mature forest

(e) to assess the damage to retained crop trees after extracting jarrah residue material.

METHODS

An area of cut over jarrah forest, consisting of a mixture of mature and regrowth forest, was selected 15 km east of Harvey in Kent Block, Harvey District. This area was cut over for general purpose sawlogs in the 1940s and 1950s. Some pole cutting was carried out in this area in 1983. The area was considered typical of the bulk of the area of forest available for future wood production in the Harvey District.

Small Jarrah Sawlog Harvesting Trials

The area was divided into seven plots, totalling 45 ha. Plots 1 to 6 were 5 ha each and plot 7 was 15 ha. Plot 6 was used as a practice plot by the machine operators; plot 7 was harvested to meet the target volume of sawlogs required by the Wood Utilisation Research Centre (WURC) and Bunning Bros Pty Ltd for subsequent sawmilling trials.

All tree marking was carried out according to the Bradshaw prescription; that is, crop trees selected for retention prior to logging, with a minimum of 10 m^2/ha basal area retained wherever possible.

Plots 1 to 5 were treated as follows:

Plot 1. Conventional logging of small and general purpose (GP) sawlogs with a John Deere 740 skidder and Cat 950 loader.

Plot 2. Conventional logging of GP sawlogs with John Deere 740 skidder and Cat 950 loader, then logging of small sawlogs with an OSA 250 forwarder.

Plot 3. Conventional logging of GP sawlogs with John Deere 740 skidder and Cat 950 loader, then logging of small sawlogs with a Case log buncher and OSA forwarder.

Plot 4. Logging of small sawlogs with an OSA forwarder then logging of GP sawlogs with a John Deere 740 skidder and Cat 950 loader.

Plot 5. Logging of small sawlogs with Case buncher and OSA forwarder, then logging of GP logs with John Deere 740 skidder and Cat 950 loader.

In all plots, trees were felled and docked with a manually operated chainsaw to the specifications detailed in Appendix 1. Volumes of timber extracted were measured at the various mill destinations. The time taken to unload the small jarrah sawlogs at the WURC was also recorded.

Jarrah Residue Logging Trials

Forest consultants McArthur and Associates were funded by Cliffs Robe River Pty Ltd to assess the available volume of jarrah residues suitable for manufacturing charcoal, in a regrowth stand, a mature stand and a graveyard dieback area. These trials were carried out in Plot 2 (a regrowth stand) and Plot 3 (a mature stand) after the GP

sawlogs, poles and small sawlogs were removed. Manual felling and snigging with the John Deere skidder were used to extract this material to landings.

A dieback site about 1 km east of these plots was logged for jarrah residues to compare volumes with Plots 2 and 3. The trees in this plot had been dead for many years, and had little or no bark. This plot was also logged with conventional hardwood logging equipment. The specification used in this trial for logs suitable for manufacturing charcoal is detailed in Appendix 2.

Stem Damage Assessment of Retained Crop Trees

Assessment of crop tree damage was carried out after each of the following logging phases: (i) small sawlog removal (ii) GP sawlog and pole removal and (iii) residue extraction. Damage measured was attributed to either the felling operation or the extraction operation, and was recorded as follows:

(i) slight damage - less than 0.01 m^2 of cambium exposed.

(ii) moderate damage - 0.01 to 0.06 m^2 of cambium exposed.

(iii) severe damage - greater than 0.6 m^2 of cambium exposed.

Log Volumes

(i) GP Sawlogs and Poles

The GP sawlogs and poles were measured at Bunning's Collie mill and Worsley Pole Dump respectively. This was done by measuring log mid-diameter and length, then using the GP sawlog volume table to estimate volume.

(ii) Small Jarrah Sawlogs

The small sawlogs were measured at the WURC and at Bunning's Yarloop mill. The diameter under bark at both ends and log length were measured with a diameter tape and lineal tape respectively. Log volume was estimated from a volume table specifically for regrowth jarrah sawlogs.

(iii) Jarrah Residues

The volume of jarrah residue material was estimated in the field. This was done by measuring the large and small end diameters and log length, and calculating volume from these measurements. A visual estimation was made of any decay or voids and this was subtracted from total volume.

RESULTS AND DISCUSSION

All quantitative results are summarized in tabular form. No attempt, however, has been made to statistically analyse the data because of lack of replications.

Small Jarrah Sawlog Harvesting Trial

Results of this trial are summarized in Table 1, which shows:

(i) the most efficient harvesting system for extraction of small jarrah sawlog was that involving conventional hardwood logging equipment, extracting logs in long lengths.

(ii) a high unit cost in Plot 3 reflected the low volume of small jarrah sawlogs in this plot. In normal circumstances, harvesting of small jarrah sawlogs in a mature forest type such as in Plot 3 would not be considered.

(iii) the lowest unit cost involving the pine logging equipment was in Plot 2, where GP sawlogs were removed first. It was expected that the extra ground debris created by prior logging of GP sawlogs would reduce the efficiency of the forwarder. This in fact did occur, and consequently, it was decided to use the Case buncher to bunch small jarrah sawlogs prior to extraction by the forwarder in all plots. The Case buncher proved very effective in this role, enabling the forwarder to operate efficiently in all plots. If the results for Plot 3 are ignored, it appears that it is of little consequence whether GP sawlogs are removed before or after small sawlog extraction. In normal circumstances it would seem logical to remove the small sawlogs first, however, in areas consisting mostly of regrowth with few mature trees, the prior felling and extraction of the scattered mature trees had little effect on the small jarrah sawlog extraction operation.

(iv) the variation in the small jarrah sawlog resource is quite significant, from a low of 1 m^3/ha in the mature forest plot to a high of 17 m^3/ha in the thickest of the regrowth plots. The average figure, it must be remembered, relates to the small jarrah sawlogs specification used during the trials (Appendix 1). It is possible that the subsequent milling of this small jarrah sawlog may indicate that it is uneconomic to harvest and cut logs of less than 20 cm crown diameter. This would reduce the resource by approximately 40 per cent, as indicated by Table 2 which summarises the diameter distribution of all small logs harvested during the trials.

Log Lengths

The question of log length was debated regularly during the trials. Initially, it was decided to cut the small jarrah sawlogs to any length, prior to extraction by forwarder. This led to a number of problems during the stacking and truck loading operations at the bush landing. It was decided during the trials to switch to a set length log specification. This improved the efficiency of the whole harvesting operation involving pine logging equipment.

Table 1
Summary of small jarrah sawlog harvesting trials

Plot No.	Area (ha)	Treatment	Vol of small sawlogs (m^3)	Vol/ha (m^3)	% crop tree damage *	Remarks.
1	5	Log completely using conventional equipment (ie. GP sawlogs, poles and small sawlogs in an integrated operation)	37.7	7.54	2.6	Regrowth forest
2	5	Log GP sawlogs & poles first, then harvest small sawlogs using manual fallers, buncher & forwarder **	63.9	12.80	4.0	Regrowth forest
3	5	Log GP sawlogs & poles first, then harvest small sawlogs using manual fallers, buncher & forwarder	5.0	1.00	8.3	Mature forest, little regrowth
4	5	Harvest small sawlogs using manual fallers & forwarder * then log GP sawlogs conventionally	85.4	17.08	3.6	Thick regrowth forest
5	5	Harvest small sawlogs using manual fallers, buncher & forwarder then log GP sawlogs conventionally	35.1	7.02	7.7	Part regrowth forest, part mature
Av.	5	-	45.42	9.1	5.2	-

GP sawlogs removed were 5.5m^3/ha. SEC poles removed were 2/ha.

* Includes moderate and severe damage, assessed after sawlogs removed
Full details are in Table 4.

** Case buncher was used to assist forwarder when the latter could not operate effectively without prior bunching.

Table 2
Small jarrah sawlog diameter distribution

Diameter Class (cm)	Volume (m^3)	(%)	No. of Logs	(%)
10-14	19.1	5.0	226	9.0
15-19	132.0	34.3	1105	43.9
20-24	132.4	34.3	781	31.0
25-29	71.1	18.4	304	12.1
30-34	26.5	6.9	88	3.5
35-39	4.3	1.1	12	0.5
TOTAL	**385.3**		**2516**	

Table 3
Summary of jarrah residue (charcoal log) extraction trial

Plot No.	Forest Type	Area (ha)	Volumes Extracted (m^3)				Yield (m^3/ha)		
			Residue on ground		Standing Residue				
			Dry	Green	Dry	Green	Dry	Green	Total
3	Mature Stand	5	79.5	119.9	16.9	66.8	19.3	37.3	56.6
2	Regrowth Forest	5	69.2	50.0	32.9	78.9	20.4	25.8	46.2
-	Cut over Dieback	5	118.9	NIL	36.2	15.8	31.0	3.2	34.2
Mean	(m^3/5ha)		89.2	56.6	28.7	53.8			
Mean	(m^3/ha)		17.8	11.3	5.8	10.8	23.6	22.1	45.7

However, the extraction of small jarrah sawlogs in whole tree lengths (as was done in Plot 1 involving conventional hardwood logging equipment) proved to be the most efficient method. These logs were carted in long lengths to the WURC where they were cut to length, measured and stacked. This system has the advantage of enabling the mill (the customer) to dock to required lengths immediately, or to stack the logs and leave the decision regarding lengths to some future date.

The time and cost to cut logs to preferred lengths at the WURC was not great. More time in fact was spent on log measurement.

Jarrah Residue (charcoal log) Harvesting Trials.

Results of this trial are shown in Table 3.

The volume of jarrah residue material extracted that was suitable for charcoal production varied from 34.2 m^3/ha in the cut over dieback plot to 56.6 m^3/ha in the mature stand plot. The average volume extracted was 45.7 m^3/ha.

The separation of the volumes into green material and dry material is of interest. In the dieback plot, 91 per cent of the material extracted was dry, whereas in the mature forest plot and the regrowth forest plot the percentages of dry material were 34 per cent and 44 per cent respectively.

It is interesting to note that of all the material extracted, the majority (64 per cent) was from ground residue.

Of the green material extracted, a certain percentage must in normal circumstances be considered as salvage sawlog material. In these trials, an attempt was made to estimate the volume of salvage quality material. This proved difficult because of the different interpretations of a salvage log. It is estimated that approximately 4 m^3/ha would be acceptable as salvage sawlogs, therefore the volume of charcoal log material available should be reduced by that amount

The extraction of the jarrah residue with conventional hardwood logging equipment was relatively efficient.

The technique used for extracting this material was the same as that used in conventional hardwood logging operations, that is, all material was felled, docked and/or dressed first, followed by systematic extraction using a JD 740 skidder. Some discussion with the contractor was held regarding the desirability of dressing and extracting ground residues prior to felling and extracting standing residues. This would have required two passes by the skidder over the same area and was not favoured by the contractor.

Crop Tree Damage Assessments

Table 4 details the crop tree damage assessments.
Relevant facts are as follows:

(i) crop tree damage resulting from small sawlog extraction was nil in plots involving the Case buncher and OSA forwarder. In Plot 1, in which small sawlogs were extracted in long lengths using the JD 740 skidder, only two stems (0.6 per cent of crop trees) were found to be in the moderate or severe categories.

(ii) crop tree damage resulting from GP sawlogging operations averaged 4.3 per cent in all plots (again, excluding the slight damage category). When added to the two stems damaged during the small sawlog extraction operation, a total of only 4.4 per cent of all crop trees were damaged during the sawlog extraction part of the trials. This result, although not perfect, is regarded as satisfactory.

(iii) most damage during the sawlogging trials (3.2 per cent) was incurred when felling the GP sawlog trees. In most situations the direction of fall of these trees was pre-determined by their lean. If damage to the residual crop trees was to be avoided, the only option would have been to not fell the trees.

(iv) crop tree damage resulting from the jarrah residue extraction operation was unacceptable in Plot 2. In this plot 34 trees (12.5 per cent) were damaged during the charcoal log harvesting operation. This reflects firstly the large volume of charcoal log material that is available in the forest, and the consequent intense level of machine movement necessary to extract the material, and secondly the difficulties encountered in felling large, spreading trees without damaging smaller crop trees.

In Plot 3 (the mature forest plot) the amount of damage resulting from the charcoal log harvesting operation is almost negligible in comparison with Plot 2. This is due to the relatively small number of crop trees in Plot 3, enabling the feller and the skidder operator to work with much greater freedom.

Table 4
Crop tree damage assessments (No. of trees)

Plot	No. Crop Trees in 5ha	G.P. Sawlog Extraction						Small Sawlog Extraction			Sub Total			Jarrah Residue Extraction			Total		
		Falling			Skidding														
		Sl	M	S	Sl	M	S	Sl	M	S	Sl	M	S	Sl	M	S	Sl	M	S
1	348	4	2	2	2	1	2	2	1	1	8	4	5	NA	NA	NA	NA	NA	NA
2	273	2	3	4	2	3	1	-	-	-	4	6	5	15	9	25	19	15	30
3	109	1	1	4	4	3	1	-	-	-	5	4	5	2	2	1	7	6	6
4	333	3	3	7	-	2	-	-	-	-	3	5	7	NA	NA	NA	NA	NA	NA
5	195	1	3	11	2	1	-	-	-	-	3	4	11	NA	NA	NA	NA	NA	NA
Total	1258	11	12	28	10	10	4	2	1	1	23	23	33	17	11	26	26	21	36
		0.9%	1.0%	2.2%	0.8%	0.9%	0.3%	0.2%	0.1%	0.1%	1.1%	1.8%	2.6%	4.4%	2.9%	6.8%	6.8%	5.5%	9.4%

Sl = Slight damage ($< 0.01m^2$ cambium exposed)
M = Moderate damage (0.01 to $0.06m^2$ cambium exposed)
S = Severe damage ($> 0.06m^2$ cambium exposed)
NA = Not applicable

Remarks
Plot 1 - Small sawlog extracted first in long lengths using JD 740 skidder.
Plot 3 - Only $5m^3$ of small sawlog extracted from this plot. Few crop trees.

GENERAL DISCUSSION

The trials indicated that conventional hardwood logging equipment, used extensively in the forests of Western Australia, can effectively extract small jarrah sawlog material without excessive crop tree damage. They also showed that the pine logging equipment (an OSA forwarder and a Case buncher) can be used effectively. The comparative inexperience of pine operators in the different forest environment would have contributed to the comparatively higher costs.

Extraction and haulage of small sawlogs in whole tree lengths using a skidder is probably the most efficient method. This method has the advantage of allowing the customer greater flexibility.

The volume of small sawlogs available in this 25 ha piece of mostly cut over forest in Harvey District was approximately 9 m^3/ha. The trials have shown, however, that there is significant variation in resource volume over a small area, reflecting the significant variation in stand structure that exists in our forests.

The figure of 9 m^3/ha of small sawlog was based on a minimum crown diameter of 15 cm. This minimum diameter may be too small, depending on the outcome of milling studies. The average of 9 m^3/ha of small sawlogs extracted from the 25 ha of plots represents a practical significant increase in the possible total volume of material extracted, as 27 m^3/ha of GP sawlog and 2 poles/ha were extracted from the same 25 ha.

The volume of jarrah residues suitable for charcoal production averaged approximately 46 m^3/ha, including an estimated 4 m^3/ha of what normally would be considered salvage sawlog material. The trials have shown that extraction of jarrah residue from a predominantly regrowth forest could lead to unacceptable levels of crop tree damage. However, in cut over dieback forest, and in predominantly mature jarrah forest, the harvesting of charcoal log material is a relatively straightforward and cheap operation.

Excluding the dieback plot, the per hectare volumes of material extracted were:

GP sawlog	27 m^3/ha
Poles	2/ha
Small Sawlog	9 m^3/ha
Charcoal log material	51 m^3/ha (including salvage sawlogs)
TOTAL:	87 m^3/ha + 2 poles/ha

As stated previously, these results indicated the potential of the comparatively high quality jarrah forest near Harvey, and are not representative of the total jarrah forest.

REFERENCE

BRADSHAW, J. (1983). Silvicultural treatment of jarrah forest for wood production. Forests Department of W.A. Internal report.

APPENDIX 1

SMAll JARRAH SAWLOG SPECIFICATION

1. Small End diameter

   Min. 150 mm under bark
   Max. 350 mm under bark

2. Large end diameter

   Min. 150 mm under bark
   Max. 400 mm under bark

3. Lengths

   Any of the following, aiming for long lengths. : 1.5, 2.4, 3.0, 3.6, 4.2, 4.8 and 5.4 m.

4. Quality

   * sweep - maximum allowed is 30 mm in any 2.1 m length
   * ends of logs must be greater than or equal to 50 per cent solid wood
   * both ends of logs to be cut square
   * no deformities such as dry sides, bumps or protrusions.

N.B. This specification changed slightly during the course of the trials. Initially, any length of log above 1.5 m was acceptable. However, this created stacking, loading and haulage problems In addition, feedback from milling personnel indicated that log quality in terms of decay, gum rings and shakes needed to be better than indicated in the above specification. It was probable that a small percentage of logs extracted would be below standard. Milling studies will play a major role in determining future small jarrah sawlog specifications.

APPENDIX 2

JARRAH RESIDUE (CHARCOAL LOG) SPECIFICATION

Dimensions

Diameter - minimum small end under bark 25 cm
- maximum large end under bark 120 cm
- minimum length 2.0 m
- maximum length 6.0 m

Log Preparation

Flush-cut at one end
Projections not to exceed 15 cm.

Acceptable defects

Decay - provided no more than 25 per cent volume is affected
Voids - provided log volume has at least 75 per cent solid wood
Central pipes - not to exceed 25 per cent volume
Charcoal - provided log is sound
Bends - not to exceed 15 cm in 3 m
Pin-hole borers, shakes, gum pockets and dry sides.

Un-acceptable defects

Evidence of termite activities in heartwood
Hollow butts
Shattered logs
Structurally unsound and rotten logs
Forks and branches.

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