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Department of Conservation
and Land Management

Wood Utilisation Research Centre

RELATIONSHIPS BETWEEN VISIBLE EXTERNAL LOG CHARACTERISTICS AND PRODUCT RECOVERY IN JARRAH

M.E. Tucek

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W.U.R.C. Technical Report No. 37

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SUMMARY

Log dimensions and externally visible defects of 23 regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) logs were measured in an attempt to relate dimensions and defects to dried dressed recovery of 10 mm thick boards.

A significant multiple linear regression model predicting recovery from log length and small-end diameters was found (adjusted $R^2 = 0.69$). However, no significant relationship was found between log defects (e.g. lump area, sweep, branch area and dryside area) and recovery. This relationship did not hold for sawn structural products (scantling). The regression of small-end diameter against recovery accounted for 59 per cent of the variation in recovery.

INTRODUCTION

Natural regrowth and plantation-grown eucalypts with a small-end diameter under bark (s.e.d.u.b.) of down to 250 mm, are an increasing proportion of the sawlogs available to the sawmilling industry in Australia (Waugh 1980). Assessing the value of eucalypt logs by applying grading criteria based on their external appearance and apparent defects is generally difficult, but provide a convenient basis for sale.

Defects are defined as any feature of a log or tree which reduces its utilization potential. Traditionally, features such as sweep, dryside, pins, rot, branch knots, gum pockets and termite damage are classified as defects (Clarke 1989). In terms of the broader definition, however, defects also include excessive log taper and growth stresses.

Unpublished research carried out in the Department of Conservation and Land Management's Small Eucalypt Processing Study attempted to assess the influence of defects on the utilization of regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) logs. Specifically, it attempted to construct a stochastic model describing the occurrence of internal defects relative to visible external log features of measurable dimensions. Digitized video images were used to collect defect data from sap-to-sap sawn boards and external features from logs, and computer modelling was employed to quantify the three-dimensional spatial incidence and distribution of defects with external log features. However, problems with poor image resolution and excessively long computer processing time led to this work being discontinued.

This trial was to relate the quantifiable external characteristics of jarrah logs to the recovery of graded sawn timber, and continued on from the previous research. Manual techniques were used for data collection, and simple statistical models were developed to predict the quality and quantity of sawn timber recovered, based on the externally quantifiable characteristics of the logs in standing trees.

This work was a preliminary investigation to assess improved methods of describing tree defects for forest inventory (particularly in relation to the jarrah inventory undertaken by the Department of Conservation of Land Management), increase the objectivity of assessment of the available timber resource of W.A.'s jarrah forest, and assist in a more accurate and consistent grading of logs from their external appearance.

METHODS

Twenty-three regrowth jarrah logs with s.e.d.u.b. ranging from 150 to 400 mm, and amounting to 5.2 m^3, came from Urbrae Block near Jarrahdale in the south-west of Western Australia. Logs of poor quality, with multiple down-grading features such as drysides, sweep, green and dead branches were used, because it was considered that such logs would provide extra data for a multiple linear regression model to integrate the combined effect of all down-grading log features of jarrah on the graded sawn recovery.

Log external characteristics

Owing to difficulties experienced in quantifying log characteristics using digitized video images in previous approaches to this work, manual techniques were employed. Because this was a preliminary trial, the external log features quantified (and the units of measurement) were limited to green and encased branch stubs (surface area), drysides (surface area), lumps (area), sweep (amount of deviation from a straight edge as a percentage of the specified length), bend (angle), as well as length, small-end and large-end diameters.

Milling

After external characteristics were recorded, logs were sawn through-and-through into 15 mm thick boards with a 'Forestor 150' horizontal bandsaw. Bottom wings were sawn on a 'Jonsered' vertical band re-saw to maximize recovery.

Seasoning/Grading

Green boards were strip-stacked and air-dried under weight restraint for approximately eight weeks before being kiln dried to 8 per cent moisture content. Boards were then skip-dressed to a nominal thickness of 11.5 mm and re-sawn, as required, to remove defects such as end splits. Minimum dimensions allowed for final dressed dimensions of 10 mm thickness, 40 mm width and 600 mm length.

Total and percentage recoveries were determined for each log from the respective recoveries. Stepwise multiple linear regression was used to relate gross log dimension measurements and derived parameters i.e. log length, small- and large-end diameters and circumferences, log volume and taper to the ungraded volume recovery. Percentage recovery was then related to these variables.

RESULTS AND DISCUSSION

Influence of log dimensions on volume recovery

Table 1 gives the sample size for the major log features measured, their mean values and standard deviations. Large variances were associated with lump area, branch area and dryside area, but it is unlikely that the relationships discussed above would improve if larger sample sizes were obtained.

Table 1

Sample sizes, values and variation of external log characteristics.

Log characteristic	Units	Sample size	Mean	S.D.
lump area	cm^2	16	1785	2519
sweep	% of length	17	2.1	0.7
branch area	cm^2	11	70	95
dryside area	cm^2	5	1848	2368
length	cm	23	332.7	61.7
large end diameter	cm	23	31.7	8.0
small end diameter	cm	23	25.6	6.1
sweep	% mm/mm length	23	1.9	1.2

Highly significant ($p < 0.01$) models incorporating combinations of length, large-end diameter, and small end diameter were produced, and the model accounting for the most variation (69 per cent) in recovery volume was:

$$rec = 0.0001586 \times len + 0.001 \times l.e.d. + 0.004 \times s.e.d. - 0.126$$

where rec = ungraded dried dressed recovery of VALWOOD® feedstock (m^3)
len = log length (cm)
l.e.d. = large end diameter (cm)
s.e.d. = small end diameter (cm)

Deletion of log length from the above equation revealed that this variable contributed relatively little to its predictive performance. This is understandable because of the small range of log lengths used in this study (Table 1). The regression of s.e.d. and l.e.d. against recovery volume was also highly significant ($p < 0.01$) and had an associated adjusted r^2 of 0.59. Coefficients of this model were as follows:

$$\text{rec} = 0.002 \times \text{l.e.d.} + 0.002 \times \text{s.e.d.} - 0.051.$$

The anticipated high correlation for the regression of s.e.d. with l.e.d., resulted in the adjusted coefficient of determination calculated from the regression of each of these variables against recovery being similar to the coefficient when they were both included in the regression analysis. The same adjusted r^2 of 0.59 was associated with l.e.d. as follows:

$$\text{rec} = 0.00478 \times \text{l.e.d.} - 0.0969.$$

In comparison with the relationship between actual volume recovery and the log length and diameter, the relationship between percentage recovery and log dimensions was considerably poorer. The best equation related percentage recovery and log S.E.D., but r^2 was only 0.15.

Influence of log defects on volume and percentage recovery

The sawn recovery from logs would be expected to be reduced by defects.

Initial graphical analysis of the quantified external log characteristics had indicated that while measurements of log dimensions were related linearly to sawn recovery volume, the relationship with other characteristics i.e. lump area, sweep, branch area, and dryside area was less evident. Sample sizes were small, and none of the adjusted coefficients of determination of the latter relationships was greater than 0.10. Transformation of the data improved some relationships, and consequently these characteristics were incorporated into a linear regression model.

The equation giving the best fit when predicting percentage recovery from log dimensions and defects was:

$$\%\ \text{rec} = 34.9 + 0.0645 \sqrt{\text{lump area}} - 0.101 \sqrt{\text{dryside area}} - 293 \frac{1}{\text{S.E.D}}$$

The inverse term involving the S.E.D. values ($r^2 = 0.25$) is justifiable because of the negative sign, because percentage recovery would be expected to increase with increasing S.E.D. However, a larger lump area and dryside area would be expected to decrease recovery. Overall, the equation indicates a poor relationship.

The poor relationship between total exposed branch area and recovery was unexpected because many studies on mountain ash (*E. regnans* F. Muell.) have indicated that knots contribute to the downgrading of sawn timber more than any other defect in appearance grade products (Waugh 1980). Knots were also the defect which accounted for the greatest frequency of rejected boards in karri (*E. diversicolor* F. Muell.) ([1]Brennan, personal communication). Similarly, lumps on the bole are indicators of occluded limb stubs and associated pockets of decayed wood (Clarke 1989) and it was expected that these log characteristics would relate to recovery. The influences of branches and occluded branch stubs on recovery should be particularly evident in small diameter logs such as those used in this study, which generally have only a thin annulus of clear wood over the knotty core (Jacobs 1955).

Decayed wood was associated with the five logs with dryside scars, particularly the larger examples, and milling showed recovery (percentage of log volume) was significantly ($p<0.05$) lower in logs with drysides (14.7 per cent) than in those without drysides (24.5 per cent).

Two trees, with 1080 cm^2 and 5100 cm^2 of dryside respectively, were rotten throughout and had disintegrated when sawn, yielding no sawn timber. However, two other logs with drysides of 1470 cm^2 and 6000 cm^2 yielded recoveries of 24.6 per cent (greater than the overall recovery of 21.5 per cent) and 16.2 per cent respectively. In an extensive study, McCaw (1983) found that the fire scar wounds in jarrah greater than 1100 cm^2 in area had associated decay or discoloration, indicating incipient rot. While discoloration was linked to drysides in the present study, this did not affect recovery because such discoloured wood (providing it was sound) was acceptable. McCaw (1983) had demonstrated a significant positive correlation between the amount of degraded timber associated with drysides and dryside area in regrowth jarrah. However, he used the dimensions of the original wound, which were determined from the extent of callus tissue after longitudinal dissection of the dryside. This approach was not possible in the current study because sawn recoveries were being evaluated. The confounding influence of other log defects may also have masked any relationship between dryside area and recovery in the present study in which only five drysides were included.

Brown and Miller (1975) found that the effect of sweep on recovery was second only to that of small-end diameter in radiata pine (*Pinus radiata* D. Don.) logs, accounting for 37 per cent of variation in recovery. In comparison, sweep accounted for only 1 per cent of variation in the present study. The major difference in definition was that Brown and Miller determined sweep in proportion to log diameter (rather than length). In the present study, acceptance of boards as short as 600 mm allowed for many defects to be docked out and improved recovery from logs with sweep, and the narrow minimum width boards (40 mm) allowed for increased recovery of higher quality timber by ripping boards to remove defect.

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[1] Mr G.K. Brennan, Department of Conservation and Land Management, Harvey.

In summary, the study showed a significant relationship between log dimensions and dried dressed recovery, but a poorer relationship between log dimensions and percentage recovery. External characteristics such as lump area and dryside area were not related as predicted to recoveries. Although these results were inconclusive, the use of external characteristics to predict recoveries would have great commercial benefit, and further research is recommended.

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