Processing 17-year-old Tasmanian blue gum sawlogs grown at wide spacing

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Summary

Large areas of Tasmanian blue gum (*Eucalyptus globulus* Labill. subsp. *globulus*) have been planted in the south-west of Western Australia. This resource is principally planted on farmland for pulp and paper manufacture, but a small proportion has been managed for sawlogs. In this study a sample of logs from a 17-y-old Tasmanian blue gum stand grown on an ex-bush site, and thinned and pruned at an early age, was processed into sawn timber. Mean sawlog small-end-diameter-under-bark was 39.3–45.6 cm. The recovery of appearance-grade boards, based on log volume, was 30%, and another 2.4% could be used as filler laminates in panels or panel products. Mean air-dry density was estimated to be 680 kg m^{-3}, similar to the density found in other studies, but lower than the density of mature trees. Recovery and wood quality are compared with those obtained in other studies conducted in Western Australia and the eastern States. The development of a new eucalypt sawlog industry on cleared private land is discussed.

Keywords: forest plantations; silviculture; fertilizers; sawmilling; drying; recovery; outturn; wood utilization; wood properties; wood density; quality; wood defects; *Eucalyptus globulus*

Introduction

The timber of Tasmanian blue gum (*Eucalyptus globulus* Labill. subsp. *globulus*) has been used for general construction, pulp and paper, rayon, flooring and furniture. If preservative-treated it can be used for posts, poles, sleepers and fence posts. The species has generally been used as a green structural timber because of the timber's susceptibility to surface checking, collapse and warping, particularly when backsawn (Boland *et al*. 1984).

Currently there are about 200 000 ha of Tasmanian blue gum plantations in the south-west of Western Australia on ex-pasture land, established mainly as a source of woodchips for pulp and paper manufacture. Almost 60% of the total resource has been planted since 1995 (Department of Fisheries, Agriculture and Forestry — Australia 2001). Some of this resource could be allocated to other end uses, for example sawn timber, medium-density fibreboard or veneer.

There are an estimated 1080 ha of eucalypts planted and managed for sawlogs on privately-owned land in Western Australia, of which 640 ha or 60% is Tasmanian blue gum. A further estimated area of 100 ha or 9% of the privately-grown eucalypts that are managed for sawlogs consists of Sydney blue gum (*Eucalyptus saligna* Sm.) (Hingston 2000). The areas available for sawlog production could be increased by managing already established stands for sawlogs, using appropriate pruning and thinning schedules, thereby increasing the area of trees potentially yielding a sawlog crop (Hingston 2002).

Farm forestry research in Western Australia started in the mid-1970s, and investigated the growing of pine sawlogs at wide spacing. Similar trials with eucalypts began in the early 1980s. Many of the trees in these trials have reached a size suitable for milling and assessment of their utilisation potential. These studies contribute to the development of commercial tree crops that can be used by farmers to provide a range of benefits, such as land protection, salinity control, shade and shelter, and income from timber.

In 1994 a sawmilling study was conducted at the CALM Centre for Timber Technology (CTT) and a veneering trial at Wesfi's Victoria Park plant, using 13-y-old Tasmanian blue gum (Moore *et al*. 1996).

This paper reports a further sawmilling study begun in October 1998, using trees from an adjoining stand. On-farm milling equipment was used to break down the logs in the field, followed by re-sawing resultant flitches with a conventional bandsaw. The purpose of the study was to assess graded recovery of 17-y-old Tasmanian blue gum timber milled from pruned trees grown at wide spacing on ex-pasture land.

As density is the best single predictor of strength and hardness, and these properties have not been assessed for blue gum grown in Western Australian plantations, we also took the opportunity to evaluate density.

Materials and methods

Stand management history and study aims

The five Tasmanian blue gum trees used in this study came from a study site in Vasse Plantation, about 20 km south-west of Busselton. The trial had been established on an ex-bush site in 1981. At the same time, pasture was established to build up soil fertility and to graze cattle. Six different eucalypt species were planted in 7-row belts at 3 m x 2 m spacing (1666 trees ha^{-1} within the tree belt). The slower-growing, forked and crooked trees were

Table 1. History of the Tasmanian blue gums growing at Vasse, Western Australia

Year	Operation	Fertiliser application
0	Trees planted at 3 m x 2 m spacing in belts of 7 rows (1666 trees ha^{-1})*	Aerial application of 416 kg ha^{-1} Super Copper Zinc Molybdenum No. 1 applied with pasture establishment; 100 g Agras No. 1 (18% N, 7.6% P, 17% S, 0.06% Zn) applied to each tree at planting
1		480 kg ha^{-1} of Super Copper Zinc Molybdenum applied to increase pasture and tree growth
3	Culled to 675 trees ha^{-1}*. Crop trees pruned to 50% of tree height (about 2.5 m).	200 kg ha^{-1} of superphosphate applied annually in years 3 to 10
5	Culled to 220 trees ha^{-1}*. Crop trees pruned to 50% of tree height (about 6.0 m).	See above for year 3
8	Crop trees pruned to 50% of tree height (about 10.0 m)	See above for year 3
11		240 kg ha^{-1} of superphosphate (9% P) applied
13	55 trees harvested for milling and veneer study (Moore et al. 1996)	150 kg ha^{-1} of superphosphate (9% P) applied
15 and 16		200 kg ha^{-1} of super potash (3:1) applied to the pasture strips only
17	5 trees harvested for this milling study	

The annual applications of fertiliser were to increase pasture growth, but would have also benefited the trees.
* tree density within the tree belt.

culled at 3, 5 and 8 y of age to allow the remaining widely-spaced crop trees to grow with less competition. The final stocking was 220 trees ha^{-1}. The trees were pruned at age 3 y to 2.5 m, then at age 5 y and 8 y to about 6 m and 10 m respectively. Cattle were introduced at year 3 to graze the pasture. The history of silvicultural treatment and fertiliser application is given in Table 1.

The stand parameters for the five trees prior to felling the trees in October 1998 were:

- Stand density: 220 stems ha^{-1} (within the tree belt)
- Stand mean height: 24.4 m
- Stand mean dbhob: 45.9 cm
- Stand basal area (over bark): 37.6 m^2 ha^{-1} (within the tree belt)
- Total tree volume: 306 m^3 ha^{-1} (within the tree belt)
- Mean annual increment (volume over bark): 17.8 m^3 ha^{-1} (within the tree belt)

For the five sample trees:

- Total merchantable volume (to 10 cm dbhob): 10.5 m^3
- Sawlog volume to 7.5 m: 6.35 m^3
- Pulpwood volume: 4.20 m^3.

Logging

Five dominant trees were randomly selected for this study. After felling, each tree was docked into logs 2.5 m long; the logs were marked with a branding hammer to identify tree number and butt, mid and crown logs, then end-sealed with 'Mobilcer' log end sealer. The logs were taken only from the pruned section of the trees. Although the crown section was not used for sawlogs, it was assumed to be pulpwood and the volume was calculated.

Log measurement and yield

After felling, tree height and merchantable height (to 7.5 m) were measured, together with log lengths, and small and large-end diameters under bark. Any major log defects, for example large knots, branches or sweep, were recorded. Log volumes were determined using Smalian's formula (Carron 1968).

Milling — log breakdown

The logs were milled on site in October 1998, using a 'Woodmizer' portable bandsaw with a thin (2.5–3 mm) kerf. Logs were broken down into flitches using a back-sawing pattern, which involved cutting on one side of the log, then on the opposite side (at 180° to the first cut), then backsawing the remainder of the log. Dimensioned flitches were cut to about a quarter of the log diameter or until log degrade was encountered, then logs were turned 180° and further flitches were cut on the opposite side of the log. The effect of growth stresses (bow and spring) was monitored during log breakdown. This cutting pattern is similar to one used by CSIRO for fast-grown eucalypt sawlogs >45 cm mid-diameter (Waugh 1998), although Waugh recommended turning the logs 90°, not 180°.

This pattern, combined with cutting the logs to short lengths (2.5 m), helped to minimise the effects of any growth stresses in the logs. The resultant flitches had minimal bow and spring following milling. Each flitch was cut parallel to the bark, that is 'taper sawn'. This allowed the shorter-length products and residue to come from the lower-quality knotty core region of the log, rather than from the more valuable clear wood on the outer parts of the log.

The logs were cut into flitches 25 mm, 38 mm and 50 mm thick which were identified with a log number, block stacked by log, strapped and taken to the Centre for Timber Technology (CTT) in Harvey for re-sawing. During transport the flitches were covered with a tarpaulin to reduce drying.

Milling — re-sawing and docking

At CTT, flitches were stored in a shed with open ends for about two weeks before re-sawing into backsawn boards with a 'Jonsereds' band re-saw. The following widths were cut from each

Table 2. Drying schedule for Tasmanian blue gum boards 25 mm or 38 mm thick, and 50 mm thick

Drying	MC at change (%)		DBT (°C)		WBD (°C)		RH (%)		EMC (%)		Air velocity (m sec^{-1})	
stage	25/38 mm	50 mm	25/38 mm	50 mm	25/38 mm	50 mm	25/38 mm	50 mm	25/38 mm	50 mm	25/38 mm	50 mm
1	Green		30	20	1.5	1.0	89	91	19.6	20.9	0.5	0.5
2	60	60	30	25	2.0	1.5	86	88	18.0	19.3	0.5	0.5
3	45	45	40	30	3.0	2.0	82	86	16.0	18.0	0.5	0.5
4	35	35	45	40	4.5	3.0	78	82	14.2	16.0	0.5	0.5
5	30	30	50	45	5.0	4.5	75	78	12.8	14.2	0.5	0.5
6	25	25	50	50	8.0	5.0	62	75	9.9	12.8	0.5	0.5
7	20	20	55	50	10.0	8.0	57	62	8.6	9.9	0.5	0.5
8	15	15	60	60	15.0	15.0	43	43	6.4	6.4	0.5	0.5
9	12	12	60	60	5.0	5.0	77	77	12.7	12.7	0.5	0.5

MC = moisture content; DBT = dry bulb temperature; WBD = wet bulb depression, i.e. the difference between the dry bulb and wet bulb readings; RH = relative humidity; EMC = equilibrium moisture content.

of the different flitch thicknesses: 50 mm, 75 mm, 100 mm, 125 mm or 140 mm. Priority was given to boards 100 mm, 125 mm or 140 mm wide, as these sizes are commonly used by Western Australian furniture manufacturers. At the docking saw, boards were trimmed to 1.2 m, 1.5 m, 1.8 m, 2.1 m or 2.4 m. The aim of docking was to produce the longest possible lengths free of faults, for example brittle heart, decay, excessive knots, kino, wane and end splits. Boards from each log were identified and individually tallied, which allowed recovery from individual logs to be calculated.

Boards were then treated with log end-sealer to reduce end splitting, and block stacked ready for dipping.

Dipping for *Lyctus* borer attack

The sapwood of Tasmanian blue gum is susceptible to *Lyctus* borer attack (Bootle 1983). To prevent attack, the timber was dipped in a 4.5% borax solution immediately after block stacking. After draining the excess liquid, the timber was covered completely with a plastic tarpaulin to prevent drying and to facilitate diffusion of the preservative throughout the sapwood. The timber remained block stacked for several months in a controlled high-humidity environment, before strip stacking and drying by solar kiln. The recommended diffusion time is 28 days, but the timber remained blocked stacked for several months until kiln space was available.

Strip stacking and kiln drying

The timber was strip stacked into stacks 2.4 m long for drying, using standard 19 mm pine strippers. Standard 800 kg weights (400 kg m^{-2}) were placed on top of each stack to minimise cupping or twisting during drying. Sample boards located throughout the stacks were used to monitor moisture content.

Timber of all sizes was dried using the commercial drying schedules for marri (*Corymbia calophylla* (Lindl.) K.D.Hill and L.A.S.Johnson). These schedules (Glossop and Bishop 1996) recommend increasingly severe drying conditions as moisture content of the timber decreases. Table 2 gives the drying schedules for 25 mm or 38 mm boards, and 50 mm boards.

Collapse recovery steaming

After kiln drying, cell collapse was observed in some 50 mm boards. To recover cell collapse, a steam re-conditioning treatment with the wet and dry bulb temperatures set at 97°C was applied for 8 h. To restrain the timbers from twisting, concrete weights of 3.7 t were placed on top of the bundles. A visual assessment of the timber after steaming indicated that the boards had recovered from the cell collapse.

Table 3. Tree dimensions and sawlog and pulpwood yield for the five 17-y-old Tasmanian blue gum trees assessed

Tree	Dbhob	Total	Pruned	Sawlog, pulpwood and merchantable volume (m^3)					
no.	(cm)	height (m)	height (m)	Butt log	Mid log	Crown log	Total sawlog	Pulpwood	Total merchantable
1	60.6	26.5	10.5	0.65	0.51	0.43	1.59	0.92	2.51
2	55.6	25.5	10.0	0.57	0.41	0.37	1.35	0.88	2.23
3	56.4	23.6	9.1	0.46	0.30	0.24	1.00	1.04	2.04
4	52.2	24.0	10.2	0.61	0.34	0.29	1.25	0.62	1.87
5	52.0	22.3	9.5	0.48	0.36	0.32	1.16	0.74	1.90
Mean	55.4	24.4	9.9	0.55 (43.6)[a]	0.38 (30.3)[a]	0.33 (26.1)[a]	1.27 (60.2)[b]	0.84 (39.8)[b]	2.11

[a] mean volume in each sawlog category as a percentage of mean total sawlog volume, and

[b] mean volume of (total) sawlog and pulpwood as a percentage of mean (total) merchantable volume for all trees

Dressing and grading

After kiln drying and reconditioning, boards were pre-dressed and graded into appearance- or core-grade timber. Appearance grades were based on the WA Industry Standard (FIFWA 1992) and core grade or laminated panel core grade (CALM 1989). The core-grade boards are structurally sound and suitable for filler laminates in panels or panel products to be used without further manufacture. Boards were graded and docked to lengths ranging from 0.9 m to 2.4 m (in increments of 0.3 m), with some 2.5 m lengths, aiming at producing longer lengths in a lower grade rather than shorter lengths of a higher grade. Reasons for downgrade, rejection or docking were recorded.

Lengths as short as 0.9 m were permitted because a survey of ten furniture manufacturers in Western Australia found that while the maximum length of solid jarrah (*E. marginata* Donn ex Sm.) timber required was 2.2 m, 84% of lengths were less than 1.0 m (Challis 1989).

Harris Wood Machining of Busselton dressed a 1 m^3 sample of timber into floor boards 12 mm and 19 mm thick. Wood quality and machining properties were noted. Another sample was given to 12 woodworking students at the South-West Regional College of TAFE to assess the quality of the timber.

Air-dry density

After kiln drying to 12% moisture content, 23 Tasmanian blue gum boards were randomly selected for assessment of air-dry density. The air-dry volume was calculated after measuring the width and thickness of each board with Vernier calipers, and the length with a lineal tape measure. Mass was determined using digital scales to an accuracy of 0.01 g.

Results and discussion

Log yields and stand management

Table 3 gives the tree dimensions, and sawlog and pulpwood yields, for the five trees assessed in this study. The mean sawlog and pulpwood yields were 1.27 m^3 per tree and 0.84 m^3 per tree respectively, with sawlogs making 60.2% and pulpwood 39.8% of the merchantable tree volume to a 7.5 cm diameter limit. Four trees produced a higher proportion of sawlogs than pulpwood; tree 3 had 49% of its volume as sawlogs and 51% as pulpwood.

Moore *et al*. (1996) estimated a mean sawlog and pulpwood yield of 0.96 m^3 per tree and 0.36 m^3 per tree, respectively, at 13 y, giving a total merchantable volume of 1.32 m^3 per tree. The sawlog component was 73% and pulpwood 27% of merchantable volume. As would be expected, the sawlog and pulpwood yields were greater at age 17 y than those reported for 13 y. Any further comparison is unwarranted as the trees in the earlier study were grown in a different stand and at a mean stocking of 135 stems ha^{-1}, whereas stocking in this study was 220 stems ha^{-1}.

Knots and other branch defects

The reasons for downgrading the finished boards, and percentage (based on board volume) downgraded for each log class, are shown in Figure 1 for 25 mm and 38 mm boards, and in Figure 2 for 50 mm boards. In the mid and crown logs, knots and the combination of knot and checks were the major reason for downgrading boards. For example, in the 25 mm and 38 mm boards the fraction downgraded from Prime Grade to Standard Grade was 3% for mid logs and 5.1% for crown logs. The fraction downgraded from appearance grade to Core Grade or below was 8.4% for mid logs and 14.9% for crown logs. For the 50 mm boards, knots did not result in any mid-log boards being downgraded from Prime Grade

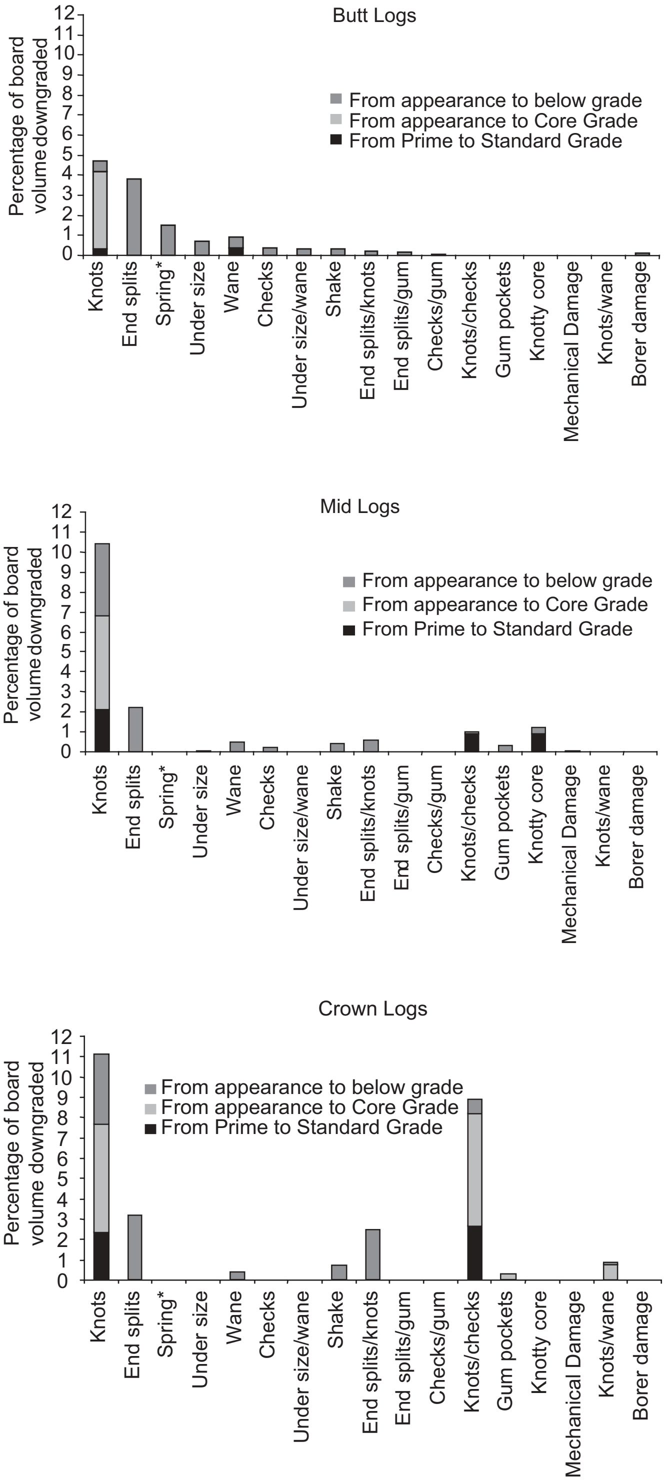

Figure 1. Reasons for downgrading 25 mm and 38 mm Tasmanian blue gum boards and percentages (based on board volume) downgraded for each log class

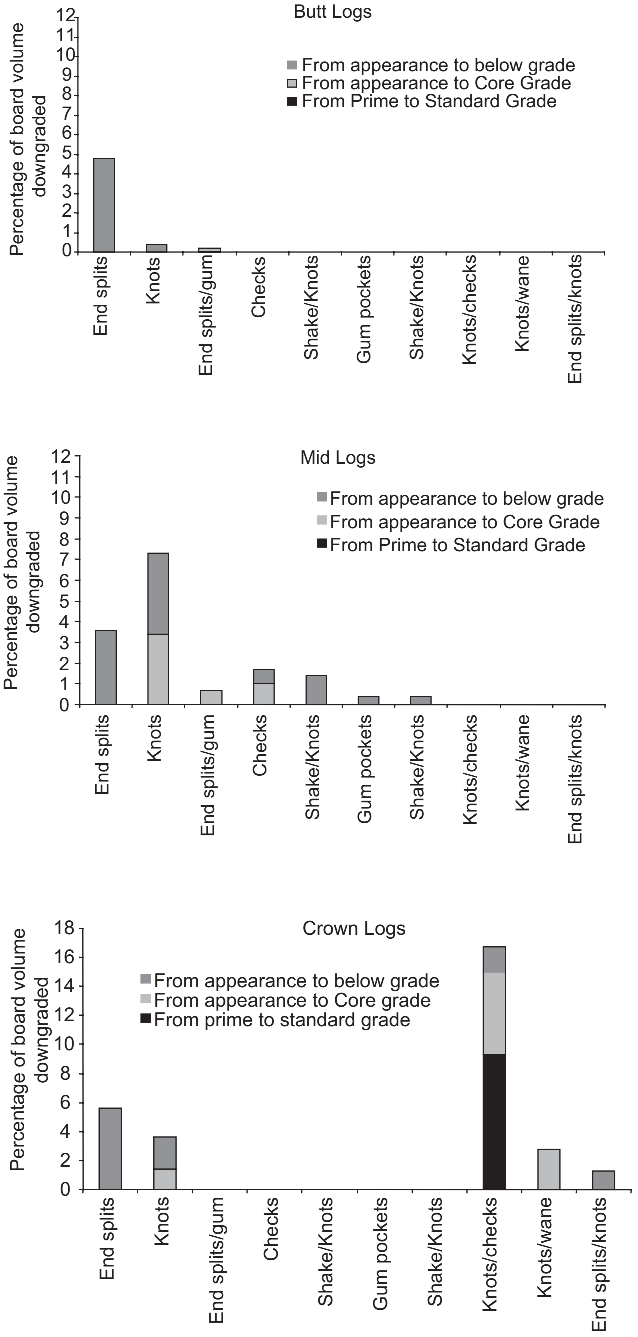

Figure 2. Reasons for downgrading 50 mm Tasmanian blue gum boards and percentages (based on board volume) downgraded for each log class

to Standard Grade, but knots caused 9.3% of the board volume cut from crown logs to be downgraded. For all timber thicknesses, the overall fraction downgraded from appearance grade to Core Grade or below was 7.7% for mid-logs and 11.0% for crown logs. This indicates that some boards from the mid and crown logs were cut from the knotty core section of the tree.

Wide-spaced trees produce large branches, which result in large knots that downgrade sawn timber products. Pruning at an early age, as occurred in this trial, is essential where the aim is to produce appearance-grade products, as it reduces the size of the knotty core and knot size in sawn timber, and restricts the development of loose knots which can result from encased dead branches. If pruning is timed to coincide with the period of most rapid diameter growth, branch stubs will be rapidly occluded, minimising the likelihood of infection by decay-causing pathogens.

Mechanical pruning[1] was in three lifts: at age 3 y to 2.5 m, then at ages 5 y and 8 y to about 6 m and 10 m respectively. The higher proportion of knots in the mid and crown logs would have resulted from pruning at either age 5 or 8 y. Pruning to 6 m or 10 m at an earlier age may result in fewer knots in the mid and crown logs, but the loss of overall leaf area and its effect on tree growth must also be considered. Pinkard and Beadle (1998) found that removing 50% of the lower green crown in *E. nitens* ((Deane and Maiden) Maiden) had no impact on height or diameter increment in the two years following treatment, but removal of 70% of the length of the lower crown resulted in significant decreases in both height and diameter increment.

In comparison, a milling study using 15-y-old unpruned *E. globulus* also found that knots were the major factor causing boards to be downgraded from select-grade products (Washusen *et al*. 2000b). In those unmanaged trees, decay and kino appeared to be associated with branches and were a serious problem, but those defects can be reduced with mechanical pruning. In our study knots were a common cause of downgrade in the mid and crown logs, but not to the same extent as reported in the unpruned trees. We found no decay associated with knots, and kino caused only a very small proportion of the boards to be downgraded from appearance grade to below grade (Figs 1 and 2), indicating rapid branch occlusion.

This study has shown that mechanical pruning will improve wood quality. Good silvicultural practice — early thinning and mechanical pruning as in this example — produces a healthy stand, reduces branch and knot size and results in rapid branch occlusion, which reduces the chance of fungal and insect attack. Efficient stand management improves overall wood quality.

Milling, drying and processing

In this trial minimal splitting of log ends was observed when the logs were cut to length. Applying a water-resistant log end sealer immediately after felling and docking reduced the amount of drying from the log ends and helped reduce end splitting. Bow and spring of flitches and board was not a problem during milling and drying. Cutting logs into short lengths and using a backsawing cutting pattern assisted in reducing the amount of bow and spring. Storing logs under water spray for up to six months before milling can also assist in relieving growth stresses in fast-grown eucalypts (Brennan *et al*. 1990).

The 17-y-old Tasmanian blue gum boards were dried under mild conditions in a solar kiln, using commercial drying schedules developed for marri. These schedules recommend increasingly severe drying conditions as the moisture content of the timber decreases. The drying rates for the 25 mm and 38 mm boards could have been increased, as minimal drying degrade occurred on these boards. Some cell collapse occurred in the 50 mm boards

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[1] The removal of unwanted shoots or branches from a tree to improve its form and wood quality using mechanical equipment, for example small hand shears and saws, long-handled shears or light-weight chainsaws.

Table 5. Mean diameter and mean recovery of green sawn, appearance grade and laminated panel core grade wood from 17-y-old Tasmanian blue gum (based on volume of log and dry dressed boards), by log position. (LPCG = laminated panel core grade)

Log position	Sedub of logs (cm)	Fraction of log volume recovered as green sawn wood (%)	Fraction of volume of log recovered in appearance grades (%)			Fraction of volume of dry dressed boards recovered in appearance grades (%)			Fraction of volume of log recovered in LPCG (%)	Fraction of volume of dry dressed boards recovered in LPCG (%)
			Prime grade	Standard grade	Total	Prime grade	Standard grade	Total		
Butt	45.6	46.8	30.7	0.3	31.0	86.3	0.7	87.0	1.6	4.5
Mid	42.4	50.6	31.2	1.1	32.3	82.5	3.0	85.5	2	5.1
Crown	39.3	49.9	25.4	1.3	26.7	74.4	4.6	79.0	3.6	10.8
Overall[1]	42.4	48.8	29.2	0.9	30.1	82.6	2.4	85.0	2.2	6.3

[1] Overall mean recoveries are based on total volume

when dried under these mild conditions, but this was recovered in a steam re-conditioning treatment. Further research is required to develop efficient drying schedules for the three board thicknesses studied.

The local wood machining company which dressed the 1 m^3 sample of timber into floor boards compared the sample to standard timbers they process. No collapse or surface checking was observed when the timber was dressed, while end splits were minimal and did not significantly affect recovery. Any knots were generally tight and did not cause problems when dressing the timber. Planing and sanding the boards did not result in any lifting grain. The timber colour was a consistent light yellowish-brown, similar to Victorian ash and Tasmanian oak (P. Harris, Harris Wood Machining, Busselton, *pers. comm.*).

Woodworking students at the South-West Regional College of TAFE provided a positive assessment of the quality of the timber, most finding it very easy to machine and work, and sanding and polishing to a smooth finish. A sample of flooring has been placed in service, and stability and performance will be monitored.

Recovery of appearance-grade and laminated-panel-core-grade products

The recovery of appearance-grade and laminated-panel-core-grade products, based on log volume and dry dressed board volume, is given in Table 5. Thirty percent of the log was recovered into appearance-grade products, with a further 2.2% suitable for filler laminates in panels or panel products. Of the total volume of the dried and dressed boards, 85% of the volume was recovered in appearance-grade timber, and a further 6.3% could be used for filler laminates (Table 5). Moore *et al.* (1996) also reported high recoveries as appearance-grade products for 13-y-old Tasmanian blue gum.

The major reasons for downgrading boards from Prime Grade to Standard Grade, and from appearance grade to laminated panel core grade, were knots and the combination of knots and surface checks (Fig. 3). The major reasons for downgrading to a category below these grades were end splits and knots. End splits were generally less than 100 mm long and did not significantly affect recovery. In this trial, boards were end-sealed, which restricted end splitting during drying.

The figures for recovery of appearance-grade products from butt and mid logs were similar, and higher than those for crown logs. Crown logs produced a greater volume of laminated panel core grade than did butt and mid logs, as some of the boards from crown logs did not meet the specifications of an appearance product but were structurally sound and suitable for laminated panel cores.

The results in this study are considerably better than those reported by Washusen *et al*. (2000a,b), who found low recoveries of select grade or better from logs from an unpruned 15-y-old Tasmanian blue gum stand from a medium-rainfall area in the southern Murray-Darling Basin. The low recoveries in the latter studies were largely due to knots, decay, kino and drying degrade, which is partly caused by the presence of tension wood cells. The present study had substantially less of these inherent characteristics, resulting in a recovery of 30% of log volume into appearance-grade products and a better overall wood quality.

Air-dry density

Air-dry density was assessed when the timber dried below 12% MC. The mean air-dry density was 680 kg m^{-3}, with standard deviation

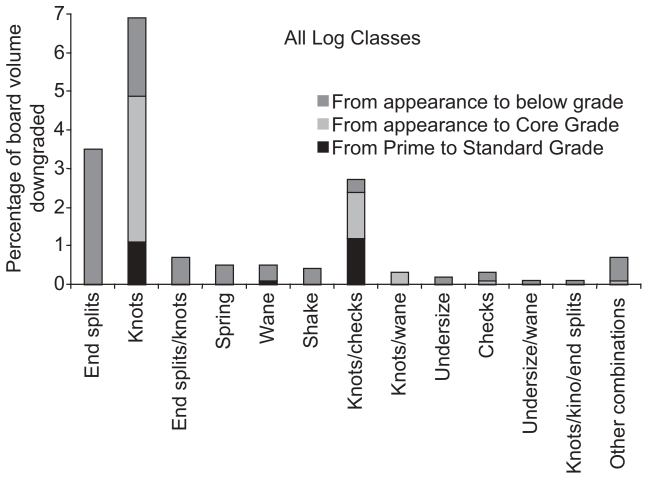

Figure 3. Reasons for downgrading 25 mm, 38 mm and 50 mm Tasmanian blue gum boards and percentages (based on board volume) downgraded for all log classes

±65 kg m^{-3} and range 525–780 kg m^{-3}. Kingston and Risdon (1961) quoted a mean air-dry density of 790 kg m^{-3} (before re-conditioning) and 727 kg m^{-3} (after re-conditioning) for 17–23-y-old Tasmanian blue gum. In comparison, Bootle (1983) quoted a mean air-dry density of mature Tasmanian blue gum of 900 kg m^{-3}. As expected the 17-y-old material had a lower density than wood from mature trees, because wood density increases with tree age; it can also be influenced by the combination of environmental and genetic factors and in some cases growth rate.

Brennan *et al*. (1992) assessed density of Tasmanian blue gum from the Manjimup area. The mean basic density of 8-y-old ex-pasture grown trees was 525 kg m^{-3}, and of 10-y-old ex-bush grown trees, 470 kg m^{-3}. Bishop and Siemon (1995) assessed the air-dry density of 13-y-old Tasmanian blue gum from the same trial as the 17-y-old trees assessed in this trial, and reported a mean value of 640 kg m^{-3}. Northway and Blakemore (1996) estimated the basic density of 24-y-old Tasmanian blue gum growing in south-eastern Gippsland in Victoria as 590 kg m^{-3}.

Future developments

There is now a project in Western Australia to grow eucalypts for sawlogs. In 2001 and 2002 about 650 ha were planted on cleared farmlands in water recovery catchments[2] to produce high-grade timber and to improve water quality (Moore and Buckton 2002). The long-term aim is to develop a new industry — using cleared private land in the 450–650 mm annual rainfall zone — delivering multiple benefits for landcare and regional development. The planting will also assist the protection and recovery of biodiversity and water resources threatened by salinity. The species planted are Tasmanian blue gum and Sydney blue gum on the better soils and in the wetter end of the rainfall range, and spotted gum (*E. maculata* Hook.) and sugar gum (*E. cladocalyx* F.Muell.) on the poorer soils at the drier end of the range.

Further studies are required of the milling and drying of the remaining trees at the Vasse trial and of trees from other trials. Results of the present and future studies will provide basic information for growers and timber processors involved with the new eucalypt sawlog industry, so they can have more confidence in using Tasmanian blue gum timber from trees grown at wide spacing.

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[2] Catchments recognised by the WA Government as being of high priority for protection and rehabilitation by revegetation with trees and other woody perennials. This will improve the quality of water from the catchments and protect biodiversity.