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Determining the economics of processing plantation eucalypts for solid timber products

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Prepared for

Forest and Wood Products Australia

by

T. Innes, B. Greaves, R. Washusen and G. Nolan

Contents

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- Integrated Tree Cropping Ltd (ITC). At the beginning of this study, this company was known as Neville Smith Timber Industries (NSTI) in Victoria and Neville Smith Tasmania (NST) in Tasmania. They are still referred to as this in Appendix 7;
- Gunns Ltd's timber and plantation divisions;
- Sustainable Forest Management; and
- SmartFibre.

Other companies and organisations who contributed to the project including Forestry Tasmania, Grand Ridge Plantations, Frank Hirst, and Robin.

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- Morrow and M. Bojadzic from Ensis.

Executive Summary

This project sought to assess the economics of processing plantation eucalypts of known origin using current industry-standard equipment and procedures and identify the factors most directly affecting the value of dry output given current market conditions.

When the project began, it was believed that *E. nitens* and *E. globulus* stands of harvestable age would be available in Victoria and Tasmania. This proved incorrect. The logs for this project were selected from only a short list of suitable trial coupes. Still, the silviculture and age of the stands sampled was not optimal.

As detailed in Table E1, two species, *E. nitens* and *E. globulus,* harvested from four sites in two States were milled across three operational hardwood mills, ITC's small regrowth log mill at Newood in Tasmania and two conventional logs mills, ITC Heyfield in Victoria and Gunns Lindsay Street in Tasmania. A total of 12,778 sawn boards were produced. The resultant material was dried in either conventional drying yards (ITC Heyfield and ITC Mowbray) or recently commissioned predryers (Gunns Lindsay Street). A proportion of boards were milled into final products and all boards were graded and tallied. Value reducing defects were assessed. Market values were estimated and applied to the recovered material.

Table E1: The seven log classes evaluated from four sites across two states

species	*E. globulus*	*E. globulus*	*E. nitens*	*E. nitens*			*E. globulus*
age (years)	47	13		26			19
silviculture	fibre	wide spaced, pruned		thinned, pruned		fibre	thinned, pruned
location	Gippsland	Gippsland		Ridgley			Ulverstone
forest owner	GRP	Frank Hirst		Gunns			Robyn May
log description	run-of-bush	pruned butt		pruned butt	unpruned upper	run-of-bush	pruned butt
sawn at	ITC Heyfield, Victoria			Gunns Lindsay Street, Launceston, Tasmania and ITC Newood, Geeveston, Tasmania			

The major findings of the study are that:

- sawn recovery is dependant on the milling equipment available. Predictably, total dry recovery from the newer ITC Newood mill was significantly higher from the same resource than the conventional mills. Production was also quicker. ITC Newood achieved a dry recovery of 40% from 26-year-old thinned-pruned *E. nitens* butt logs milling them at a rate of 15.4 m^3/hour. Gunns Lindsay Street recovered 34% at a rate of 12.5 m^3/hour. For *E. globulus* butt logs, recoveries of 37% and 29% respectively. See Figures E1 and E2;
- the value of solid products recovered from the thinned and pruned *E. globulus* logs and probably logs salvaged from the fibre-managed *E. nitens* stands, is likely to be sufficient for the both the grower and processor to make a suitable return. This assumes a mill door value for delivered logs would need to be around $100 for unpruned to $140 per cubic metre for pruned sawlogs. See Figure E3 and Table E2;
- Growing and processing the thinned and pruned *E. nitens* was marginal or uneconomic, mainly due to the loss of value from internal checking, especially of the butt log. See Figure E3 and E4; and
- Significant loss in the value of dry output resulted from internal check, especially in *E. nitens,* and board distortion, especially in *E. globulus* See Figure E4.

There are several major conditions on these results, namely:

- The value of sawn and milled boards from the plantation species is assumed to be the same as current native regrowth boards;
- The value of by-products, such as solid woodchips, is generally excluded;
- The impact of future production processes or end-products is excluded; and
- The cost of harvesting, handling and sorting plantation material for different product groups in a mature industry is unclear. Efficiency improvements are likely.

Finally, today's market situation will be different in the future and the effect of this change may influence the results of this study. It can be expected that long straight lengths of select native forest hardwood will be increasingly difficult to obtain and attract an increased premium. Higher levels of feature and possibly distortion will become more common and may be more widely accepted. Market perceptions and relevant performance Standards may change to reflect this.

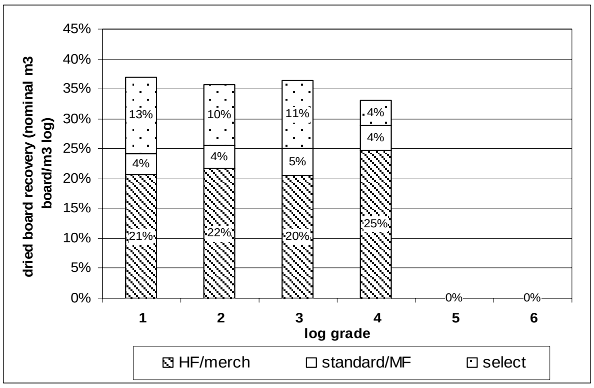

Figure E1: 26-year-old *E. nitens* thinned-pruned butt recovery- ITC

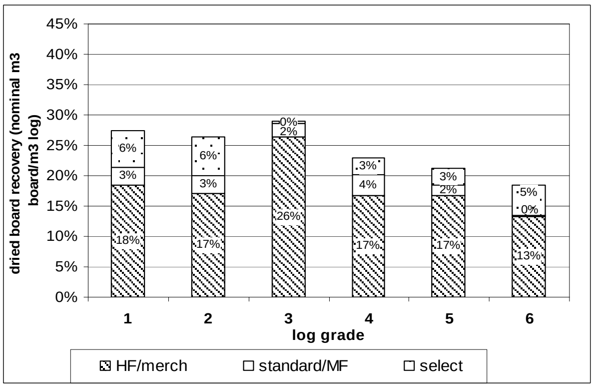

Figure E2: 26-year-old *E. nitens* thinned-pruned butt recovery - Gunns

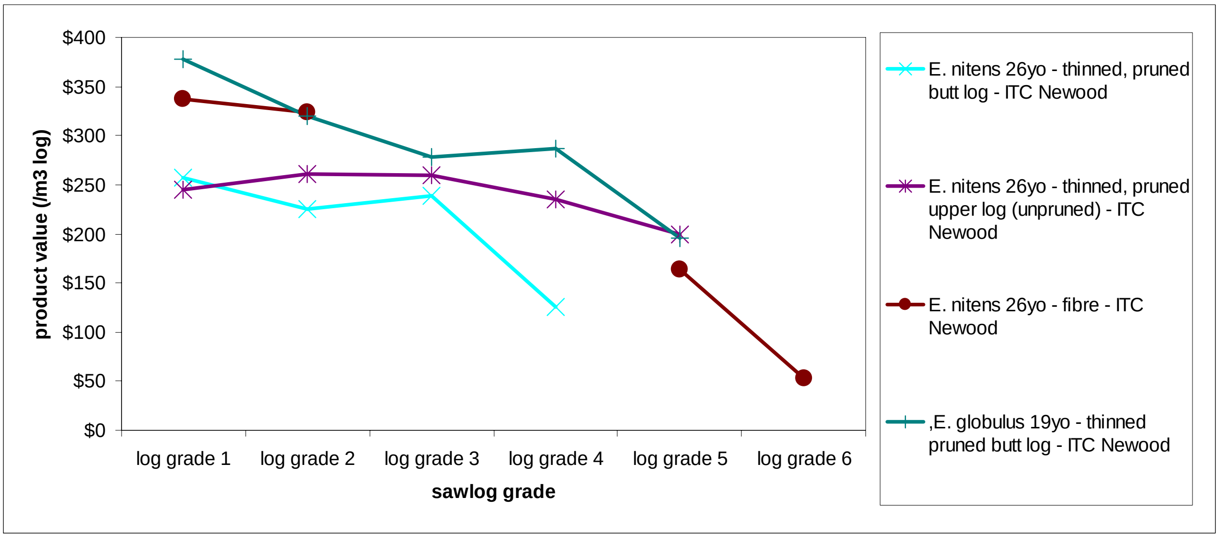

Figure E3: Total product value per cubic metre of sawlog at ITC Newood

Internal Check

There was a high level of internal check, a serious unrecoverable drying defect, in the Tasmanian *E. nitens* butt logs harvested from both the fibre-managed and thinned and pruned stands. 25-31% displayed minimal check while between 6-17% showed moderate/heavy check. The check classed as minimal was still sufficient to be a serious defect and be grade limiting.

Table E2: Estimated delivered mill-door value of a cubic metre of sawlog.

The mill-door values represent the total value of sawn product from a cubic metre of log (excluding sold woodchips in this case) less the cost of sawing including an element of profit. Assumptions underlying the estimated mill-door values are detailed in Appendix 6.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
2	age			47	13	13	26	26	26	26	26	26	19	19
3	silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
4	location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
5	sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
6		log grade 1					$91	$104	$192				$191	
7		log grade 2					$67	$107					$150	
8	40,000 m3 log intake, 2	log grade 3					$82	$113					$126	
9	shifts - 20% IRR	log grade 4					$7	$94					$189	
10		log grade 5						$59					$29	
11		log grade 6												
12		log grade 1					$74	$86	$171				$170	
13		log grade 2					$51	$89					$131	
14	40,000 m3 log intake, 2	log grade 3					$65	$95					$108	
15	shifts - 25% IRR	log grade 4						$77					$168	
16		log grade 5						$43					$14	
17		log grade 6												
18		log grade 1					$56	$69	$157				$156	
19		log grade 2					$32	$72					$115	
20	30,500 m3 log intake, 2	log grade 3					$47	$78					$91	
21	shifts - 20% IRR	log grade 4						$59					$154	
22		log grade 5						$24						
23		log grade 6												
24		log grade 1					$37	$49	$134				$133	
25		log grade 2					$14	$52					$94	
26	30,500 m3 log intake, 2	log grade 3					$28	$58					$71	
27	shifts - 25% IRR	log grade 4						$39					$131	
28		log grade 5						$6						
29		log grade 6												

The rate of checking was consistent for air-dried and predried material. Internal check in the *E. nitens* top logs and the *E. globulus* was significantly less.

The high level of internal check observed is of serious concern as the studied logs were from an expensive silvicultural regime, similar to the regime adopted by major growers managing *E. nitens* plantations for clearwood log production. The results indicate that between 15 and 40% of boards from similar thinned and pruned full-rotation *E. nitens* can be expected to contain significant levels of internal check if dried with current industry technology.

The situation could be even worse in full-scale production if 5.4 m logs were milled into long length boards. If the rate of internal check in the *E. nitens* butt log could be constrained to the rate found in the *E. globulus*, it is likely that the *E. nitens* could be processed economically, as higher recoveries of select material could be expected from pruned logs.

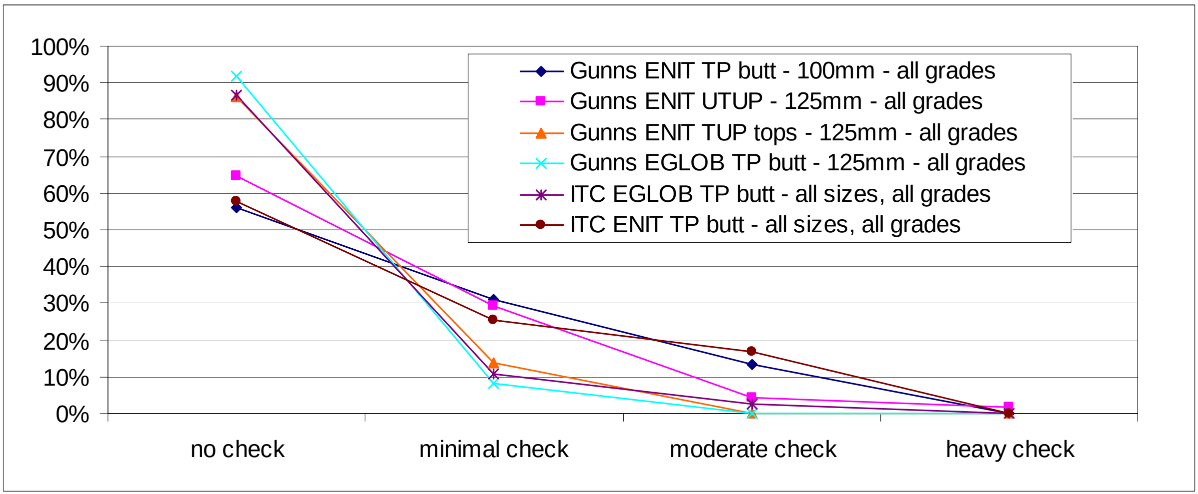

Figure E4: Levels of internal check by log type.

Board distortion

Board distortion affects satisfactory milling into the required profile and the spring or bow in boards. In this study, there was an unexpected high loss in recovery when skim-dressed boards were milled into final products, especially of *E. globulus*. 12% of sawn volume from the thinned-pruned *E. nitens* butt logs was rejected and 30% of sawn volume from the thinned-pruned *E. globulus* butt logs was rejected. The high level of reject was due to formed tongue-and-groove boards having pieces of the tongue or groove missing making the boards unacceptable at any grade under the relevant Australian standard. Quartersawn boards of both species cut at normal full length (5.4 – 6.0 m) can be also expected to incur significant downgrade from spring distortion.

This result casts doubt on assumptions of board and value recovery based on the assessment of skim-dressed material only.

Conclusions

The results of the study indicate that future, economically-viable production of high value traditionally sawn products from these types of plantations will require:

- different processing techniques to provide better control over value-limiting factors such as distortion, collapse and internal checking; and
- sawing equipment optimised to handle this resource.

If these technical issues can be overcome, some optimism can be held for the future of an industry based on production of both new and existing sawn products from a suitably managed plantation resource.

Further research is needed to:

- address value-limiting factors of internal check, collapse and distortion while growing the resource and after milling;
- better quantify whole-of-process product values; and
- clarify recovery of sawn appearance material from full rotation, high stand density unpruned *E. nitens* and *E. globulus*.

Research that involves processing a plantation resource through facilities clearly unable to optimally handle or process the raw material is unlikely to yield encouraging results.

1.0 Introduction

Eucalypt plantation forestry in southern Australia has developed rapidly in recent years. Much of the existing resource comprises *E. globulus* (mainly in Western Australia and Victoria) and *E. nitens* (mainly in Tasmania). While most of this resource is managed primarily to provide fibre logs for the pulp and paper industry, there is potential for these and future plantations to provide logs for sawn timber production, potentially supplementing or ultimately replacing supplies from native forests. Recent published trials using both pruned and unpruned sawlogs in conventional hardwood mills have produced encouraging results (Washusen and McCormick 2002, Washusen *et al.* 2004, Washusen 2006), although doubts still exist as to the processing behaviour of the wider plantation resource. There is little economic data available to verify if plantation-grown resources can be processed profitably using the existing sawing and wood drying systems available to native forest sawmillers, while still providing a viable return to growers. This information is needed to improve the decision-making capacity of forest managers and the existing hardwood industry about utilization of young plantation-grown eucalypts.

The trials described in this report were a first step in determining the economics of processing plantation-grown eucalypts in existing hardwood mills. The trees selected for this study were selected from a limited available range of sawlog-managed plantations, plus a control unthinned and unpruned pulp-managed stand.

In summary:

- Four plantation sites were sampled across two states, Tasmania and Victoria;
    - Gippsland, Victoria (2 sites)
    - Ulverstone, Tasmania
    - Ridgley, Tasmania
- The sampled stands represented three distinct silvicultural management regimes;
    - Fibre management (no thinning or pruning)
    - High establishment stocking thinned to 200 sph and pruned
    - Open spaced at establishment (100 sph) and pruned
- Two species were sampled;
    - *Eucalyptus globulus*
    - *Eucalyptus nitens*
- Three age classes were represented;
    - 13 years
    - 18-26 years
    - 47 years
- A total of 696 short (2.7m) sawlogs were sawn across three sawmills;
    - ITC Heyfield, Victoria
    - Gunns Lindsay Street, Launceston, Tasmania
    - ITC Newood, Geeveston, Tasmania
- A total of 12,778 sawn boards were produced and dried using conventional air drying at ITC Heyfield, Victoria, and ITC Mowbray (for the Newood sawn material) and in recently commissioned predryers at Gunns Lindsay Street.

2.0 Methodology and materials

2.1 Forests sampled and log types evaluated

Plantation-grown eucalypts were selected for trial processing from four sites - two in Tasmania and two in Victoria (Table 2). These sites represented three distinct silvicultural management regimes and two species. In Victoria the first site was an over-mature 47-year-old stand of *E. globulus* that had been grown under fibre-management conditions without thinning or pruning, but which had produced some relatively large trees. The second Victorian site was established at a relatively low stocking of 100 trees per hectare with the trees pruned and grown without competition for most of their life - 13-year-old *E. globulus* and *E. nitens* from this site were evaluated.

The first site in Tasmania was a 26-year-old forest of *E. nitens* containing a stand of thinned and pruned trees and a stand of trees which had received no thinning or pruning treatments. The second Tasmanian site contained 19-year-old *E. globulus* which had been thinned and pruned. The sampled stands are described in detail in Appendix 1.

Table 2: The seven log classes evaluated from four sites across two states

<table>
<tr><td>species</td><td>E. globulus</td><td>E. globulus</td><td>E. nitens</td><td colspan="3">E. nitens</td><td>E. globulus</td></tr>
<tr><td>age (years)</td><td>47</td><td colspan="2">13</td><td colspan="3">26</td><td>19</td></tr>
<tr><td>silviculture</td><td>fibre</td><td colspan="2">wide spaced, pruned</td><td colspan="2">thinned, pruned</td><td>fibre</td><td>thinned, pruned</td></tr>
<tr><td>location</td><td>Gippsland</td><td colspan="2">Gippsland</td><td colspan="3">Ridgley</td><td>Ulverstone</td></tr>
<tr><td>forest owner</td><td>GRP</td><td colspan="2">Frank Hirst</td><td colspan="3">Gunns</td><td>Robyn May</td></tr>
<tr><td>log description</td><td>run-of-bush</td><td colspan="2">pruned butt</td><td>pruned butt</td><td>unpruned upper</td><td>run-of-bush</td><td>pruned butt</td></tr>
<tr><td>sawn at</td><td colspan="3">ITC Heyfield, Victoria</td><td colspan="4">Gunns Lindsay Street, Launceston, Tasmania
and
ITC Newood, Geeveston, Tasmania</td></tr>
</table>

2.2 Sawlog grading

The logs were graded using the Victorian log-grading system.

Many of the 13-year-old *E. globulus* and *E. nitens* processed at ITC-Heyfield were below minimum sawlog specification, due to their small diameter and/or the presence of swellings associated with kino pockets that are counted as defective quarters in Victorian grading rules. To accommodate this, two additional grades were developed and added to the grading table, making 6 grades in all. The log quality specifications for the 6 grades are summarised in Table 3. End defects such as decay, pipe and insect defect were not evident in any log and are not included in the table. Grades 1, 2, 3 and 4 are equivalent to Victorian A, B, C and D grades.

Table 3: Log grading chart

	GRADE					
	1	**2**	**3**	**4**	**5**	**6**
25-30 SED				0		1+
>30-35 SED			0	1	2+	
>35-40 SED		0	1	2	3+	
>40-45 SED	0	1	2	3	4	
>45-50 SED	0	1	2	3	4	
>50-55 SED	0	1	2	3	4	
>55-60 SED	0	1	2	3	4	
>60-65 SED	0	1	2	3	4	
>65-70 SED	0	1	2	3	4	
>70-75 SED	0	1	2	3	4	
>75-80 SED	0	1	2	3	4	
>80-85 SED	0	1	2	3	4	
>85-90 SED	0	1	2	3	4	
>90-95 SED	0	1	2	3	4	
>95-100 SED	0	1	2	3	4	
Sweep	<20% of diameter over 2.4 m length					
Grain	<1:10		<1:8			
tight kino <3mm width : length % of diameter	25	200	ul			
tight kino >3mm width : length% of diameter	25	100	ul			
loose kino/kino pockets/shakes : length % of diameter	25		100	200		
stain	light		dark			

allowable defective quarters

2.3 Log processing

2.3.1 Log processing

Each sawlog was measured for length and diameter each end. End splits were measured on each end of the bush logs as total length of end split measured across the end of the log and width of the widest end split. The barrel of each log was assessed for number of defective quarters. Openings in the bark such as branch stubs or holes weeping kino were assessed as defects. Continuous imperfections such as epicormics or smooth bumps as seen in Plate 23 (Appendix 1) were not. The logs were graded against the specification shown in Table 3 and then colour coded by grade (Plate 1).

2.3.2 Sawing

Sawing - ITC Heyfield, Victoria

Sawing in Victoria was conducted in the Integrated Tree Cropping Ltd mill at Heyfield, Victoria. For the sawing, the logs were grouped by species, plantation, log grade and diameter. Each log group was tracked through the mill by allocating a colour code to both log-ends using a sequence of 8 colours. In the case of Grade 3 and 4 logs from the 13-year-old stands, the small numbers of logs in one or both of the grades was overcome by combining the logs to simplify tracking of boards.

Logs smaller than 30 cm small end diameter (SED) were backsawn. The larger logs were quartersawn. In both cases, a slab sawing strategy was applied to produce a green slab thickness of 32 mm to allow for sawing thickness variation and shrinkage and to produce a nominal 25 mm thick board after drying and skip dressing. Small-dimensioned slabs and poor quality wood were re-sawn to produce nominal 50 x 25 mm tile battens. The remaining slabs were identified with a code relevant to each log group, racked and covered with Hessian for drying in July 2005. Recoveries of green tile battens were tallied at completion of sawing.

Sawing - ITC Newood

The *E. nitens* logs from Ridgley were sawn at ITC Newood on 4th November 2005, and the *E. globulus* logs from Ulverstone were sawn on 7th December.

The breaking down saw was a single bandsaw followed by two twin bandsaw resaws and an optimising multi-rip edger. Saw kerf was 3 mm. Logs smaller than approximately 40 cm SED were cut in half on the headrig, with each roundback then boarded off by multiple passes through one of two resaws (Figure 1). Logs greater than about 40 cm SED but less than approximately 45 cm SED were sawn to the pattern shown in Figure 2, while larger logs were sawn to the pattern shown in Figure 3. All boards then passed through the optimiser. All boards were cut to 25 mm nominal dry thickness. Boards were block-stacked, tallied and then transported to ITC's Mowbray (Launceston) mill by covered truck.

Boards were cut to six width sizes at the discretion of the sawmill: 200, 150, 125, 100, 75 and 50 mm nominal dry width.

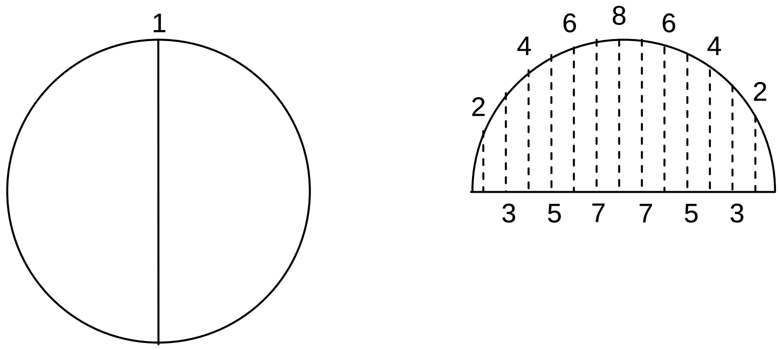

Figure 1: ITC cutting pattern for logs less than approximately 40 cm SED. Cut 1 on headrig, cuts 2-8 on twin resaw (both roundbacks separately). All boards then edged.

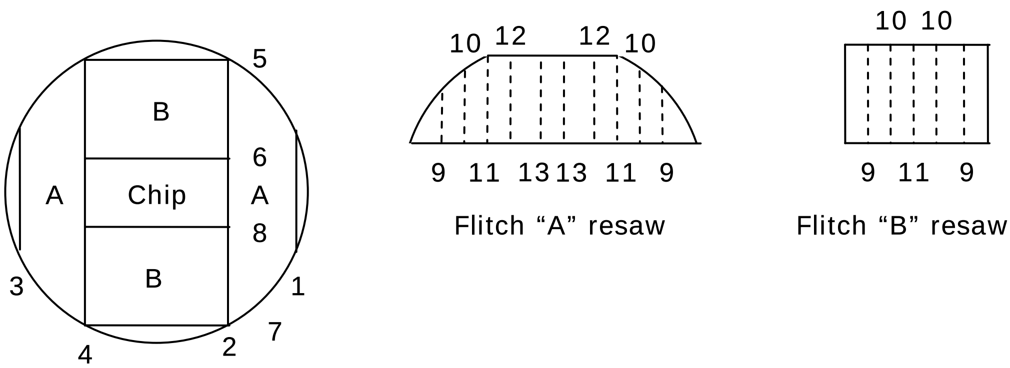

Figure 2: ITC sawing pattern for logs greater than 40 cm SED and less than approximately 45 cm SED. Cuts 1-8 on headrig, four flitches resawn as shown. Boards from cuts 9-11 on flitches "A" then edged.

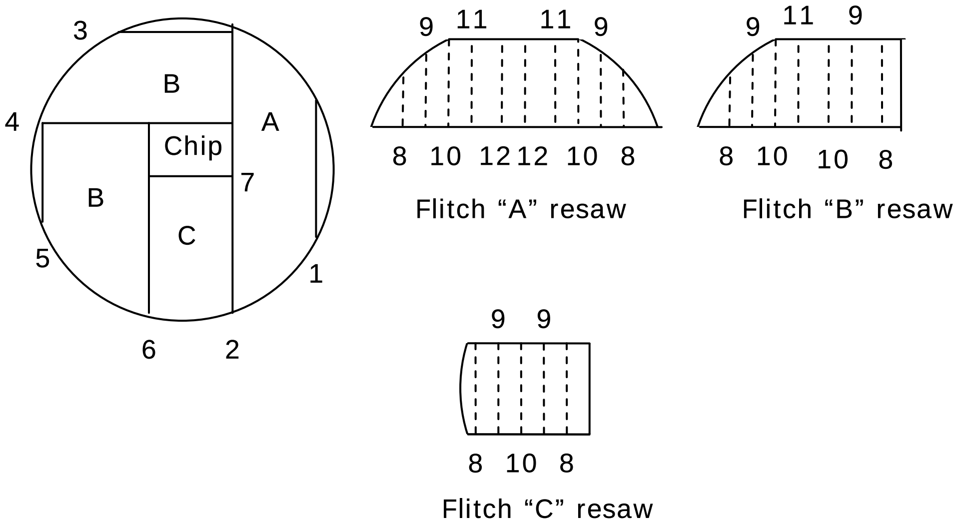

Figure 3: ITC sawing pattern for logs greater than approximately 45 cm SED. Cuts 1-7 on headrig, four flitches resawn as shown. Boards from cuts 8-10 on flitches "A" and "B" then edged.

The multi-rip edger was unable to keep up with the head-rig and re-saws; its throughput governed the mill's throughput. Unpruned *E. nitens* top logs were sawn in 2 hours and 40 minutes (2:40) (14.0 m^3/hour), pruned *E. nitens* butt logs in 1:40 (15.4 m^3/hour) and unthinned/unpruned *E. nitens* logs in 0:40 (11.1 m^3/hour). The mill was substantially slower than when processing its normal stock of regrowth native forest logs (approximately 26 m^3/hour). This is due to the smaller size of logs, and also because a higher proportion of the boards from smaller logs need to be edged, as there is a lower proportion of squared flitch produced by the head-rig.

Plate 1: Colour coding logs ITC Newood.

Plate 2: Twin-saw re-saw at ITC Newood.

Sawing - Gunns Lindsay Street

The *E. nitens* logs from Ridgley were sawn at Gunns on 21st and 24th October, and the *E. globulus* logs from Ulverstone were sawn on 1st December. Logs were stored under water spray until sawn.

The breaking-down saw was a single bandsaw pony carriage, followed by two single band resaws on a roundabout, and then two edgers. Sawing kerf on the breakdown and resaws was 5.5 mm. Small logs (less than 30 cm SED) were sawn through-and-through with slabs sent to the edgers and residual material sawn on a resaw and then edged (Figure 4). Other logs were cut in half and the two roundbacks boarded off each side on the resaws (Figure 5). Boards were cut to 25 mm nominal dry thickness. Boards were manually racked immediately following sawing.

Boards were cut to five width sizes at the discretion of the sawmill: 150, 125, 100, 75 and 50 mm nominal dry width.

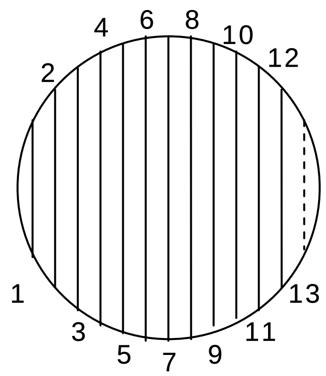

Figure 4: Gunns cutting pattern for logs less than 30 cm SED. Cuts 1 – 12 on headrig, 13 on resaw. All boards then edged.

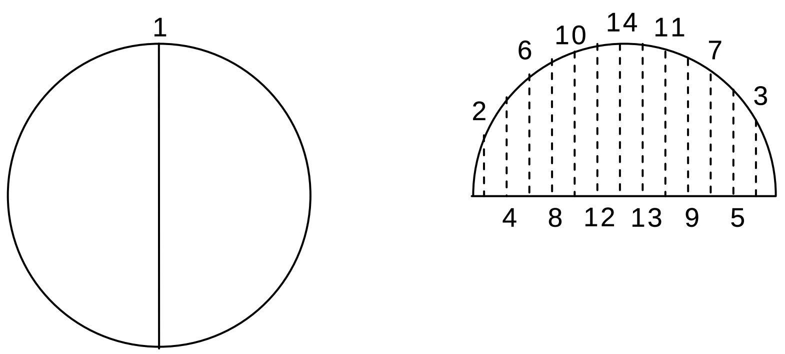

Figure 5: Gunns cutting pattern for logs greater than 30 cm SED. Cut 1 on headrig, 2-14 on resaw (both roundbacks separately). All boards then edged.

Sawing of the unthinned and unpruned logs took 4 hours and 40 minutes, pruned butt logs took 2:15 and the top logs took 0:25; logs were sawn in this order. Volume throughput of the unthinned and unpruned logs was slower (8.8 m^3/hour) than the other two batches (12.5 m^3/hour and 9.4 m^3/hour respectively) as the logs were smaller and this was the first batch sawn; the mill's speed improved as operators adapted to the logs. Average time taken to saw each log was approximately 2 minutes for each batch.

Time was lost compared to their normal stock due to the short log length: this resulted in flitches dropped from the chains and also off the carriage. Roundbacks had to be manually turned over following cut 1 of Figure 5 as the mechanical arms normally used for this purpose could not grip the logs. Rain on the first day of sawing exacerbated this problem, making the logs more slippery.

2.3.3 Drying

Drying - ITC Heyfield

Sawn slabs were air-dried by ITC Heyfield, using the current production methods for ash timber. In April 2006, when the slabs were below fibre saturation point they were kiln-dried to final moisture content using standard drying schedules for ash eucalypts.

Drying - Gunns Lindsay Street

Racks of Gunns' sawn Ridgley *E. nitens* were placed in a pre-drier on 24th October (Plate 3). Pre-drying continued until 22nd December, at which point the pre-driers were turned off with vents closed for the Christmas break. Pre-drying restarted on 23rd January and was complete on 22nd February, following the schedule shown in Table 4. Timber was then removed from the pre-drier for reconditioning and final kiln drying. Total pre-drying time was 115 days with the pre-drier running for 74 of those days. Time was lost due to the Christmas shutdown (28 days) and no steam at weekends (12 days). Reconditioning took 6.5 hours and final drying 36 hours.

Racks of Gunns' sawn Ulverstone *E. globulus* were placed in a pre-drier on 12th December.

Table 4: The drying schedule used in Gunns' pre-drier.

Phase	Time (days)	Temperature (°C)	Wet bulb temperature (°C)	Ramp (days)	Air speed (m/s)
Heating	7	20	19	2	0.5
Predry	5	21	19.7	0.5	0.5
Predry	5	22	20.3	0.5	0.7
Predry	7	23	20.7	0.5	0.7
Predry	7	25	22	0.5	0.7
Predry	7	27	23	1	0.9
Predry	7	29	24	1	0.9
Predry	4	32	24	1	1.1
Equalise	4	32	30	0	1.1
Predry	7	32	24	0	1.1
Predry	10	35	25.5	1	1.1
Equalise	4	36	34	0	2.5

Reconditioning was carried out in a saturated atmosphere at close to 100°C for six hours, following a thirty minute heat-up. Final drying followed the schedule in Table 5, with air velocity of 1.5 m/s and fans reversed every four hours.

Table 5: Final drying schedule used at Gunns.

Time (hours)	Temperature (°C)	Wet bulb temperature (°C)
8	65	57
20	75	60
8	75	55

Drying - ITC Newood.

Racks of ITC Newood sawn Ridgley *E. nitens* were placed in the ITC's yard in Mowbray, Launceston for air-drying on 19th November (Plate 4). Air-drying to fibre saturation point was complete in late March, taking approximately four months. They were reconditioned at close to 100°C for six hours and then final drying took about 36 hours.

ITC Newood sawn Ulverstone *E. globulus* was stored block-packed over the Christmas break. It was racked for air-drying on January 20th.

Plate 3: Racks of *E. nitens* in Gunns pre-drier (2.7m long packs on the top).

Plate 4: Racks drying at ITC Mowbray.

2.3.4 Dry milling

Dressing and product grading - ITC Heyfield

After drying, the boards were planed, edged, docked and graded by ITC staff, then tallied by Ensis-Wood Quality staff.

Dressing and product grading - Gunns

After final drying racks were pulled-down into packs of similarly sized boards on 30th March 2006.

All boards of 150, 125 and 100 mm nominal width were machined into 135x19, 108x19 and 85×19 mm tongue and groove flooring respectively by edging through a twin saw and then machining through a Weinig Hydromat 22BL running at 47 m/minute.

Finished boards were then transported to the University of Tasmania, Launceston, where they were tallied. A sample of boards was graded by a senior grader, Nigel Lee-Jones of Gunns, into Select, Medium Feature, High Feature and reject grades.

Dressing and product grading - ITC Newood

ITC rack all timber into single-size racks and de-rack directly into their planer. For this reason, all boards from the experimental mixed-size racks were machined together by skimming both wide faces and not machining edges.

Racks were machined over three sessions, except for nominal 75 mm width material, which was separated out. All other timber was machined to 19 mm thickness by removing approximately 3 mm from one surface and the rest from the other on a Weinig two-head moulder running at about 20 m/min. Edges were not dressed and no docking occurred.

Boards of 75 mm nominal width were machined into "Colonial" architrave, a deep-moulded profile. This was expected to uncover any internal checking.

2.4 Grading sawn boards

Unfortunately there where significant differences between the ways that sawn boards were graded at the three sawmills

2.4.1 Grading - ITC Heyfield

At ITC Heyfield, boards were graded by ITC staff according to the appearance grading criteria specified in Appendix 2 into Select, Medium Feature (standard), and High Feature (utility) grades.

2.4.2 Grading - ITC Newood

Timber was graded on the best face only into two grades by ITC personnel Select and sub-Select - according to ITC company grading rules which use Australian Standard 2796 (Standards Australia 1999) as a minimum. All boards where graded. Up to 500 mm length of each board was disregarded for the purposes of grading if it was affected by end-splits or other grade limiting defect. Similarly, defect near the edges of boards that didn't affect the board's nominal width were disregarded.

A sample of boards graded as Select and Sub-Select were regraded by Nigel Lee-Jones to estimate the fraction of each that could be graded into the three grades: Select, Medium Feature (standard), and High Feature (utility). The fractions were then applied to the ITC grade recoveries to estimate overall product grade recoveries in the three grades. There was no reject grade.

2.4.3 Grading - Gunns Lindsay Street

Only a sample of boards was graded. Grading was undertaken by Nigel Lee-Jones of Gunns. Boards were graded into Select, Medium Feature (standard), High Feature (utility) and reject grades.

Minimum allowable board length was 1.8 metres and grading assumed boards could be docked to waste to achieve a higher grade providing that the remaining board length was greater than 1.8 metres.

2.5 Calculations

Board volume by board-width was estimated after:

$$vol = \frac{width \times length \times numberofboards \times thickness}{1{,}000{,}000{,}000}$$

where: *width* is nominal board width in mm (200, 150, 125, 100, 75 or 50); *length* is the average log length of sawn logs; *numberofboards* is the tallied number of boards by log grade; *thickness* is the nominal dry board thickness (Gunns: 25 mm for 28mm green boards and 35mm for 38mm green boards); and 1,000,000,000 is to convert cubic mm to cubic metres.

Total board volume by board grade and log grade was calculated as the sum of all board volumes by board-width:

$$vol_{total} = vol_{200} + vol_{150} + vol_{125} + vol_{100} + vol_{75} + vol_{50}$$

Total recovery (by grade: Select and High-feature) by log was estimated as the total board volume:

$$recovery = \frac{vol_{total}}{logvol_{total}}$$

where $logvol_{total}$ is the estimated total log volume by log grade, where individual log volumes (*logvol*) where estimated after:

$$logvol = \frac{\pi}{2}\left(\left(\frac{SED}{2000}\right)^2 + \left(\frac{LED}{2000}\right)^2\right)\frac{l}{1{,}000}$$

where *SED* and *LED* are sawlog small-end and large-end diameters under-bark respectively (in mm) and *l* is sawlog length in mm.

Total product value per cubic metre of sawlog (*value*) was estimated by log grade after:

$$value = \frac{\sum\left(vol_{size-grade}value_{size-grade}\right)}{logvol_{total}}$$

where $vol_{size-grade}$ is the total sawn-board volume by board-width and board-grade and $value_{size-grade}$ is the per-cubic-metre value of sawn product by board width and grade (Table 6).

Total product value per cubic metre of sawlog by log grade with allowance for observed levels of length lost due to board end-split and internal check was estimated by assuming that the observed fraction of Select and Medium-feature sawn-boards with moderate or heavy internal check were downgraded to high-feature and that one third of observed fraction of Select and Medium-feature sawn-boards with minimal internal check were down-graded to high-feature. Total value was then recalculated with allowance for length lost due to end-split as described above.

All value calculations were based upon nominal dry dimensions, that is, 25mm board thickness.

2.6 Assumed product values

Product values were required to estimate the value of sawn product per cubic metre of sawlog and per hectare of harvested plantation. At the time of writing the only available product values were as deemed appropriate for the timber produced at ITC Heyfield mill (Table 6) for skip-dressed boards. In the absence of better available information the same product values have been applied to timber produced in the Tasmanian mills.

Table 6: Assumed product values for boards sawn at ITC Heyfield (after Washusen et al. 2006)

prices used to value wood sawn at Heyfield (R. Washusen)				value per nominal cubic metre		
product	nominal dimensions			grade		
	width	thickness	length	select	MF	HF
skip dressed	200mm	25mm	<3m	$1,611	$1,382	$315
skip dressed	150mm	25mm	<3m	$1,359	$1,071	$315
skip dressed	125mm	25mm	<3m	$1,314	$1,049	$315
skip dressed	100mm	25mm	<3m	$1,310	$1,008	$315
skip dressed	75mm	25mm	<3m	$1,224	$905	$315
skip dressed	50mm	25mm	<3m	$1,094	$873	$315

A 44% discount was applied to Select and Medium-feature boards shorter than 1.8 metres in length cut at ITC Heyfield.

Table 7: Assumed product values for products produced by ITC (Newood, Geeveston and Mowbray, Launceston) - based on the product values applied to the products produced in Victoria by ITC-Heyfield (Table 6)

wood sawn at ITC Southwood, Geeveston, Tasmania				value per nominal cubic metre		
product	nominal dimensions			grade		
	width	thickness	length	select	MF	HF
skim-dressed	200mm	25mm	<3m	$1,611	$1,382	$315
skim-dressed	150mm	25mm	<3m	$1,359	$1,071	$315
skim-dressed	125mm	25mm	<3m	$1,314	$1,049	$315
skim-dressed	100mm	25mm	<3m	$1,310	$1,008	$315
65x19 colonial arch	75mm	25mm	<3m	$1,224	$0	$0
skim-dressed	50mm	25mm	<3m	$1,094	$873	$315

Table 8: Assumed product values for products produced by Gunns Lindsay Street, Launceston - based on the product values applied to the products produced in Victoria by ITC-Heyfield (Table 6) plus a milling and product upgrade allowance.

wood sawn at Gunns, Lindsay Street, Launceston, Tasmania				value per nominal cubic metre		
product	nominal dimensions			grade		
	width	thickness	length	select	MF	HF
	200mm	25mm	<3m	$1,731	$1,484	$549
135x19 reveal	150mm	25mm	<3m	$1,435	$1,131	$586
108x19 flooring	125mm	25mm	<3m	$1,366	$1,090	$504
85x19 flooring	100mm	25mm	<3m	$1,477	$1,137	$557
65x19 colonial arch	75mm	25mm	<3m	$1,315	$0	$0
45x19 DAR	50mm	25mm	<3m	$1,175	$938	$549

Reject boards were assumed to have no value.

2.7 Disk measurements

A disk approximately 50 mm thick was cut from the mid-length of each bush log from the thinned and pruned butt log group from the Ridgley *E. nitens* - orientation of the disk (relative to the cores cut from the south-west side) was marked. Each disk was cut in half, with half the disk used for measurement of moisture content, and green and basic density. Three shrinkage blocks were cut out of the other half disk, centred at 30%, 60% and 90% of the radius aligning with the cores cut from the south-west side of the tree; see Figure 6.

Each block was approximately 25 mm × 25 mm × 50 mm longitudinally. Shrinkage blocks were weighed and measured in the three directions when green. Following air-drying in the laboratory, the three dimensions were again measured along with weight. After reconditioning and re-drying in air, the samples were measured twice; once at a moisture content higher than the initial equilibrium and then again at a moisture content lower than the initial equilibrium; results were then interpolated to give shrinkage for each sample at the same moisture content as prior to reconditioning. This was necessary as the TRU laboratory is not equipped with a constant climate chamber for equilibration. Samples were then oven-dried and re-weighed.

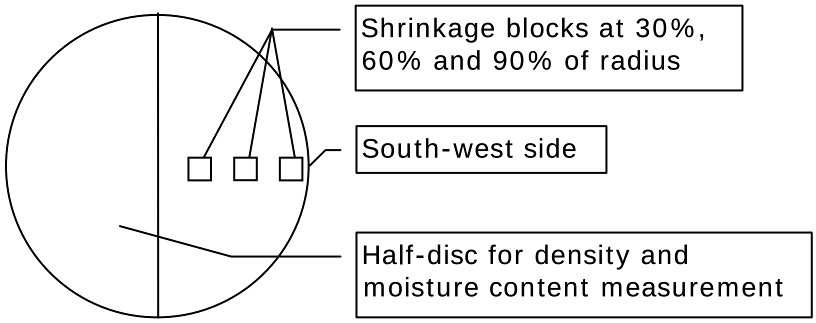

Figure 6: Disk processing.

3.0 Results

3.1 About forests

3.1.1 Harvested area

Table 9 depicts the estimated harvested area for each sampled plantation type, including brief descriptions of the source of each area estimate. Whilst harvested areas are not well estimated, they none-the-less provide a good enough basis to derive per-hectare sawlog and total product value yields.

Table 9: Estimated area of harvested forest required to derive per-hectare productivity estimates

samples plantation	area (ha)	notes on estimated area
VIC 47yo *E. globulus* fibre	0.50	estimate from Simon Gatt, Grand Ridge Plantations
VIC 13yo wide-spaced P *E. globulus*	0.44	estimated assuming 90 sph
VIC 13yo wide-spaced P *E. nitens*	0.35	estimated assuming 80 sph
TAS 26yo TP *E. nitens*	0.33	estimated after harvesting without clear deliniation between the thinned-pruned sectiopn and the fibre-managed section - areas are indicative only
TAS 26yo *E. nitens* fibre	0.16	
TAS 19yo TP *E. globulus*	0.88	estimated assuming 250 stems per hectare at harvest, and 50% of stems being suitable for sawing

3.1.2 Sawlog yield

Table 10 presents the number of sawlogs recovered from each plantation type sampled (rows 9-17) by the sawlog grades specified in Table 3. The quantity of recovered fibre (pulp logs) was not recorded for any of the sampled plantations (Table 10 - row 18) except the wide-spaced pruned *E. globulus* and *E nitens* from Gippsland which yielded no fibre. No logs from any sources were rejected because of sweep.

Fractional sawlog grade recovery is tabulated in Table 10 (rows 19-25) and presented graphically in Figure 7. Aspects of sawlog recovery that are of interest include:

- The 26-year-old thinned-pruned *E. nitens* butt logs have the highest sawlog grade distribution - the greatest fraction of higher grade logs. (Table 10 - col. F, rows 19-21);
- The 26-year-old fibre-managed *E. nitens* and the unpruned top-logs from the thinned/pruned *E. nitens* stand showed the lowest sawlog grade distribution (Table 10 - col. H, rows 22-24, and col. G, rows 22-24 respectively);
- The 47-year-old fibre-managed *E. globulus* and the 19-year-old thinned-pruned *E. globulus* have similar and relatively high sawlog grade outturn distributions (Table 10 - col. C, rows 22-24, and col. I, rows 22-24 respectively). However in both cases the logs to be sawn were relatively carefully selected during the harvest operation were thus expected to be relatively good quality. The 47-year-old fibre-managed *E. globulus* did produce some grade 4 sawlogs but these were combined with the grade 3 logs during processing due to the low numbers of logs in each grade;

- The 13-year-old wide-spaced *E. globulus* and *E. nitens* both showed moderate sawlog grade distributions (Table 10 - col. D-E, rows 22-24) with no grade 1 sawlogs. The trees were relatively young and too small for grade 1. The *E. nitens* did produce some grade 3 sawlogs but these were combined with the grade 4 logs during processing due to the low numbers of logs in each grade.

Table 10: Summary of stands sampled - by sawlog grade: volume of sawlogs; fractional sawlog grade recovery; estimated sawlog yield per hectare at harvest; and estimated sawlog productivity (as Mean Annual Increment in cubic metres per hectare per year).

REF	A	B	C	D	E	F	G	H	I
1	species		*E. globulus*	*E. globulus*	*E. nitens*	*E. nitens*			*E. globulus*
2	age (years)		47	13		26			19
3	silviculture		fibre	wide spaced, pruned		thinned, pruned		fibre	thinned, pruned
4	location		Gippsland	Gippsland		Ridgley			Ulverstone
5	forest owner		GRP	Frank Hirst		Gunns			Robyn May
6	log description		run-of-bush	pruned butt		pruned butt	unpruned upper	run-of-bush	pruned butt
7	sawn at		ITC Heyfield, Victoria			Gunns Lindsay Street, Launceston, Tasmania and ITC Newood, Geeveston, Tasmania			
8	harvest area (ha)		0.50	0.44	0.35	0.33	0.33	0.16	0.88
9	number of logs		58	80	56	124	110	158	110
10	total sawlog volume by sawlog grade (m3)*	grade 1	8.3	0	0	33.9	0.3	3.1	14.2
11		grade 2	16.4	4.2	4.8	13.4	1.5	7.2	22.9
12		grade 3	3	6.4	0	2.3	7.1	5.6	8.4
13		grade 4	0	6.2	6.3	2.5	8.0	7.5	3.8
14		grade 5	0	3	5.8	0.3	24.2	19.8	0.6
15		grade 6	0	5.7	2.9	0.3	0.0	5.2	0.0
16		**grades 1-3**	**27.7**	**10.6**	**4.8**	**49.6**	**8.9**	**15.8**	**45.5**
17		**all grades**	**27.7**	**25.5**	**19.8**	**52.7**	**41.0**	**48.4**	**49.9**
18	total fibre			0.0	0.0				
19	total sawlog fractional grade recovery recovered from forest	grade 1	30%	0%	0%	64%	1%	6%	28%
20		grade 2	59%	16%	24%	25%	4%	15%	46%
21		grade 3	11%	25%	0%	4%	17%	11%	17%
22		grade 4	0%	24%	32%	5%	20%	16%	8%
23		grade 5	0%	12%	29%	1%	59%	41%	1%
24		grade 6	0%	22%	15%	1%	0%	11%	0%
25		**grades 1-3**	**100%**	**42%**	**24%**	**94%**	**22%**	**33%**	**91%**
26	total sawlog volume per hectare (m3)	grade 1	17	0	0	102	1	19	16
27		grade 2	33	9	14	40	4	45	26
28		grade 3	6	14	0	7	21	35	10
29		grade 4	0	14	18	7	24	47	4
30		grade 5	0	7	17	1	73	124	1
31		grade 6	0	13	8	1	0	33	0
32		**grades 1-3**	**55**	**24**	**14**	**149**	**27**	**99**	**52**
33		**all grades**	**55**	**57**	**57**	**158**	**123**	**304**	**57**
34		**grades 1-3**				**176**			
35		**all grades**				**281**			
36	sawlog productivity per hectare per year (m3)	grade 1	0.35	0.00	0.00	3.92	0.04	0.74	0.62
37		grade 2	0.70	0.73	1.05	1.54	0.17	1.74	1.00
38		grade 3	0.13	1.11	0.00	0.27	0.82	1.34	0.37
39		grade 4	0.00	1.07	1.38	0.29	0.93	1.81	0.17
40		grade 5	0.00	0.52	1.27	0.03	2.79	4.78	0.03
41		grade 6	0.00	0.99	0.64	0.04	0.00	1.26	0.00
42		**grades 1-3**	**1.2**	**1.8**	**1.1**	**5.7**	**1.0**	**3.8**	**2.0**
43		**all grades**	**1.2**	**4.4**	**4.4**	**6.1**	**4.7**	**11.7**	**2.2**
44		**grades 1-3**				**6.8**			
45		**all grades**				**10.8**			

Estimated sawlog yield per hectare by grade is tabulated in Table 10 (rows 26-35) and graphically in Figure 8. This shows that:

- Whilst the 47-year-old fibre-managed *E. globulus* showed a relatively good sawlog grade outturn distribution (Figure 7), the volume of logs came from a relatively large harvest area and thus the yield per hectare grade distribution less impressive (Figure 8), and much less impressive when the stand age is taken into account to derive the annual sawlog productivity (Figure 9, and Table 10 - col. C, rows 34-41);

- The 26-year-old fibre-managed *E. nitens* showed the highest estimated total sawlog yield (304 m^3/ha - Table 10 - ref. H33); and
- The 26-year-old thinned-pruned *E. nitens* showed the highest estimated yield of grade 1-3 sawlogs (176 m^3/ha - Table 10 - ref. F34). Note that rows 34-35 show the estimates for the thinned-pruned stand being the sum of the pruned butt and unpruned upper logs.

Estimated sawlog productivity (as Mean Annual Increment in cubic metres per hectare per year) is depicted in Figure 9, and tabulated in Table 10 (rows 36-45). This shows that the 26-year-old thinned-pruned *E. nitens* had the highest estimated productivity of grade 1-3 sawlogs (6.8 m^3/ha/year - Table 10 - ref. F45)

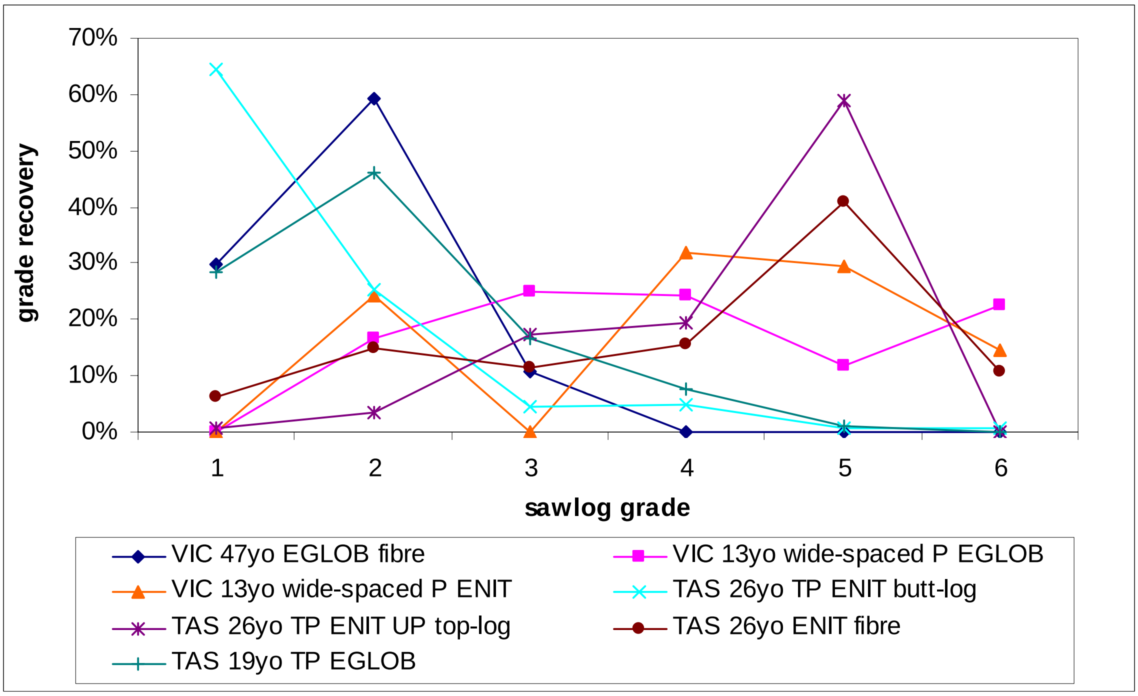

Figure 7: Sawlog grade recovery by sawlog type - grade recoveries depicted represent volume fractions of total log volume by sawlog type.

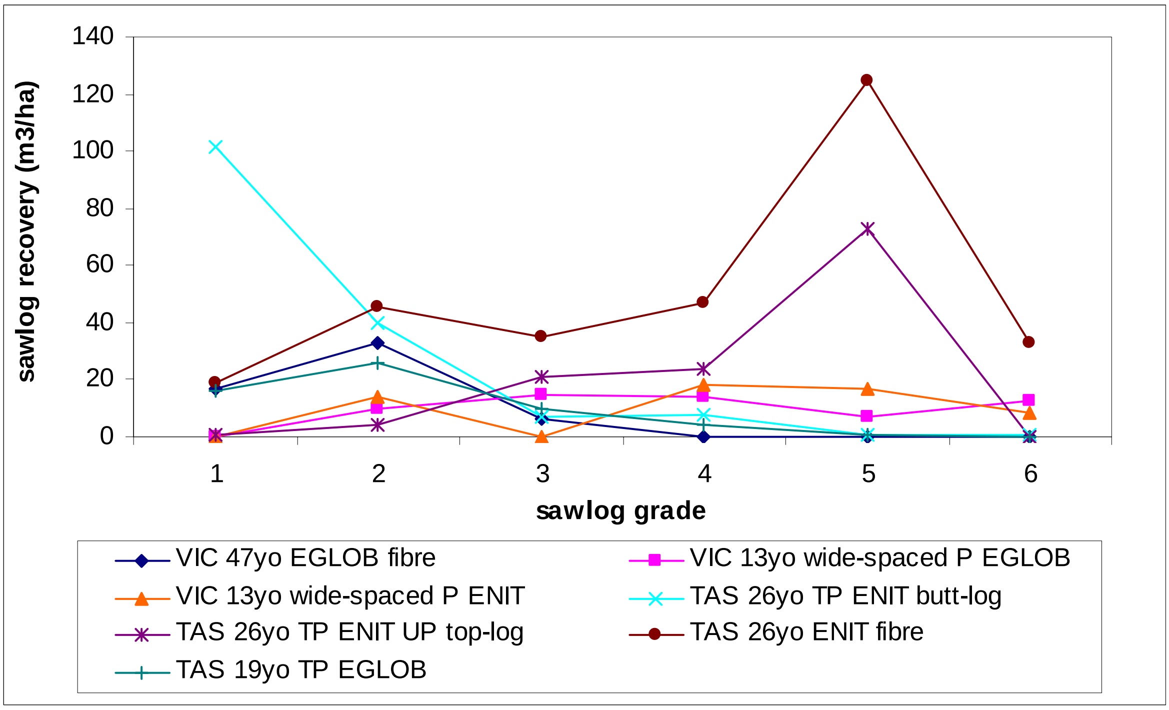

Figure 8: Sawlog grade recovery per hectare at harvest by sawlog type.

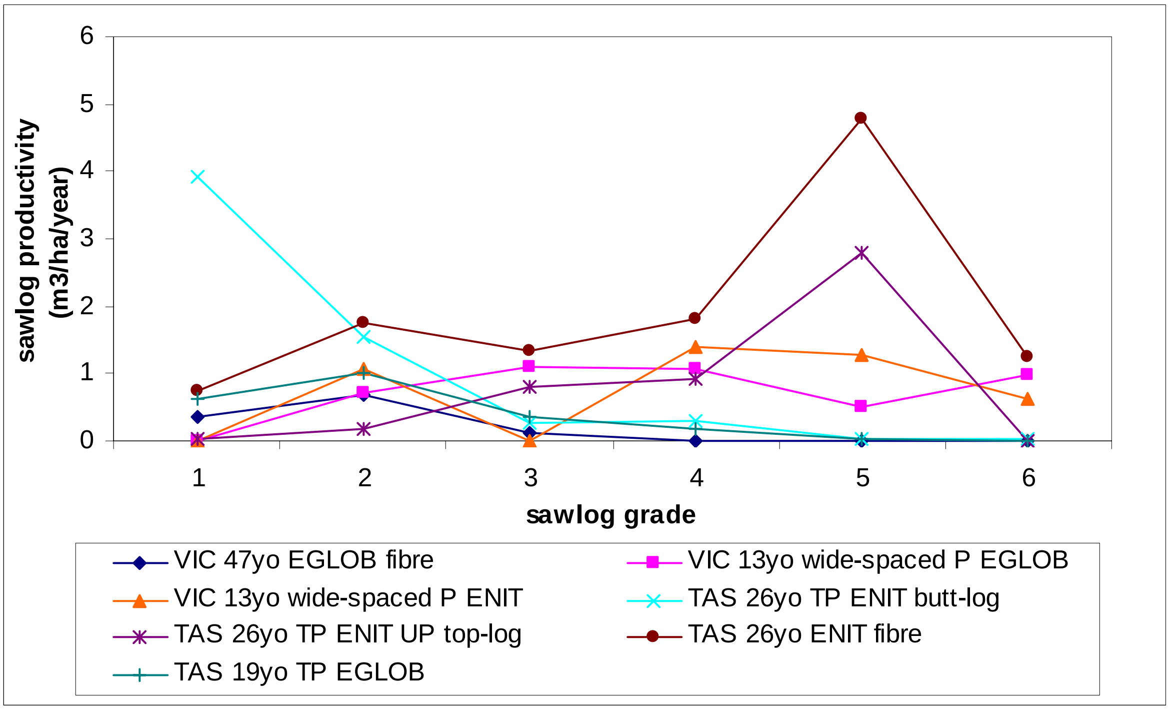

Figure 9: Mean annual increment of sawlog productivity by sawlog grade at the time of harvest.

3.2 Log Characteristics

Table 11 presents the number and volume of sawlogs by grade by log type.

Table 11: Log characteristics summary

- total log volume (row 6)
- number of logs (row 7)
- mean log diameters (rows 8-10)
- number of logs by log grade (rows 11-16) and
- log volume by log grade (rows 17-24)

Grey shading indicates data not available - either because there were no logs of the given type-grade, or because the result was not recorded (Ref. D9-F10).

REF	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	species			*E. globulus*	*E. globulus*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. globulus*	*E. globulus*
2	age (years)			47	13	13	26	26	26	26	26	26	19	19
3	silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
4	location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
5	sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
6	total log volume (m3)			27.7	25.4	19.8	25.7	37.4	7.3	27.0	3.6	41.1	25.8	24.1
7	number of logs			58	80	56	60	100	20	64	10	138	54	56
8	mean log diameter (cm)			46	34.5	36.3	44.2	41.2	40.7	44.7	41	36.4	46.4	43.9
9	mean log SED (cm)						42.3	40.3	39.4	42.9	40.3	34.8	44.4	41.4
10	mean log LED (cm)						46.1	42.1	41.4	46.4	41.6	37.6	48.4	46.5
11	number of logs	log grade 1		10			32	1	5	36		1	17	10
12		log grade 2		39	9	10	18	2	2	15	1	12	23	28
13		log grade 3		7	18	7	5	13		2	4	16	9	12
14		log grade 4		2	20	11	5	16		5	4	24	4	5
15		log grade 5			8	16		68	11	1	1	59	1	1
16		log grade 6			25	12			2	2		26		
17	log volume (m3)	log grade 1		8.3			15.5	0.3	2.5	18.4		0.5	9.1	5.1
18		log grade 2		16.4	4.2	4.8	7.3	1.0	1.1	6.1	0.5	6.2	11.0	11.9
19		log grade 3		3	6.4		1.7	5.7		0.6	1.4	5.6	3.5	4.8
20		log grade 4			6.2	6.3	1.1	6.6		1.3	1.4	7.5	1.9	2.0
21		log grade 5			3	5.8		23.8	3.3	0.3	0.4	16.5	0.3	0.3
22		log grade 6			5.7	2.9			0.4	0.3		4.8		
23		**log grades 1-3**		**27.7**	**10.6**	**4.8**	**24.6**	**7.0**	**3.6**	**25.0**	**1.8**	**12.2**	**23.6**	**21.8**
24		**all log grades**		**27.7**	**25.5**	**19.8**	**25.7**	**37.4**	**7.3**	**27.0**	**3.6**	**41.1**	**25.8**	**24.1**
25	log grade notes			grades 3 and 4 combined		grades 3 and 4 combined								

3.3 Sawn timber grade recovery

Table 13 presents the observed sawn-board grade recoveries by log grade and log type. Sawn board recovery by board grade, nominal board width and log grade are recorded in Appendix 3.

Sawing of thinned and pruned butt logs at Newood also produced approximately 30 tonnes of woodchip; a similar amount was also produced at Gunns. The other log resources sampled would have produced a similar proportion of woodchip.

3.3.1 Total dry recovery

Total dry recovery (including dried rejects) calculated as the total nominal dry volume as a fraction of the total log volume is depicted in Table 13 by log grade (rows 6-12), total for log grades 1-3 (row 12) and total for all logs processed in the log-type (row 13). This shows that:

- Total dry recovery for log-grades 1-3 ranged from 24% (ref. F12) for the 13-year-old wide-spaced *E. nitens* processed by ITC Heyfield, to 42% (ref. H12) for the upper-unpruned-log of the thinned-pruned *E. nitens* processed by ITC Newood.
- The difference in sawmill technologies is highlighted by comparing the recoveries from:
    - 26-year-old thinned-pruned *E. nitens* butt logs processed by ITC Newood (40% - ref. G12) and Gunns Lindsay Street (34% - ref. J12);
    - 19-year-old thinned-pruned *E. globulus* butt logs processed by ITC Newood (37% - ref. M12) and Gunns Lindsay Street (29% - ref. N12); and
    - 47-year-old fibre-managed *E. globulus* processed by ITC Heyfield (29% - ref. D12) and 19-year-old thinned-pruned *E. globulus* butt logs processed by Gunns Lindsay Street (29% - ref. N12).
- The difference in recovery (sawlog grades 1-3) between the thinned-pruned butt logs of the 26-year-old *E. nitens* and the 19 year-old *E. globulus* is consistent between Tasmanian mills:
    - 34% for 26-year-old *E. nitens* (ref. J12) versus 29% for 19 year-old *E. globulus* (ref. N12) at Gunns Lindsay Street Launceston;
    - 40% for 26-year-old *E. nitens* (ref. G12) versus 37% for 19 year-old *E. globulus* (ref. M12) at ITC Newood, Geeveston; and
    - Recovery differences appear to hold across log grade at the two mills (Figure 10).

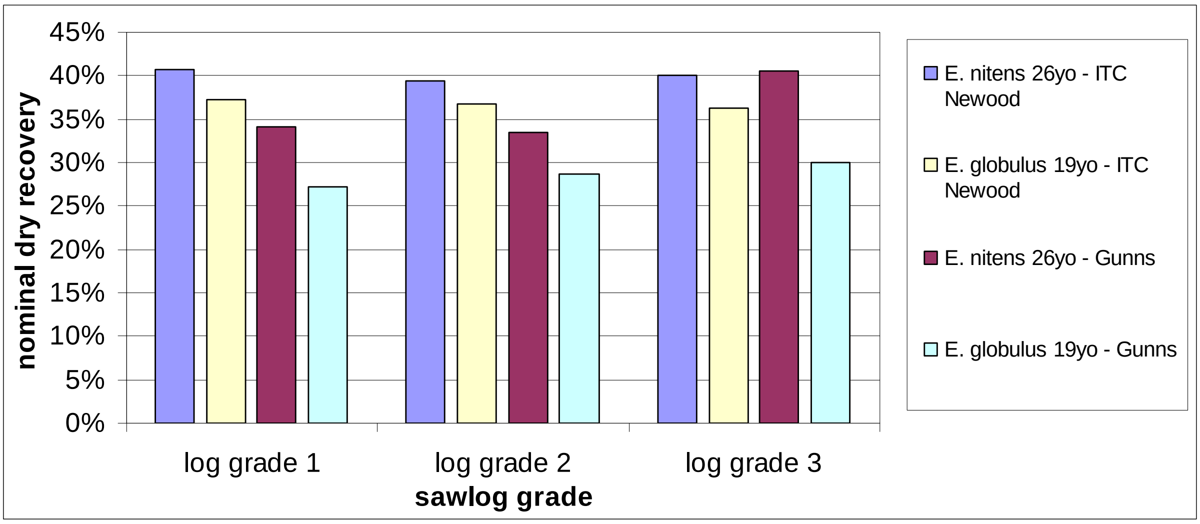

Figure 10: Nominal dry recovery by sawlog grade - thinned-pruned butt logs of 26-year-old *E. nitens* and 19-year-old *E. globulus* processed by ITC Newood and Gunns Lindsay Street. Rejects included.

3.3.2 Final sawn-board grade recovery

Sawn grade recovery after allowance for end-docking and internal check, calculated as the total nominal dry volume as a fraction of the total log volume is depicted by sawn-board grade (Select, Medium Feature, High Feature) by log grade in Table 13 (rows 14-37) and in Figure 11 to Figure 16. Note however that Tasmanian *E. nitens* and *E. globulus* boards at Gunns were straightened and machined into final products, whereas at ITC boards were only skimmed on wide faces and distortion was not considered in grading. Hence volume recovery of machined boards at Gunns was artificially lowered in comparison to ITC Newood. The samples of boards processed by Gunns Lindsay Street, Launceston, that were graded, and the resulting grade distributions, are presented in Table 12. Issues to note are that:

- Results were not explicitly calculated by sawn-board grade for logs sawn at ITC Heyfield (Table 13 - ref. D14 to F37);
- There were insufficient logs to get indicative numbers for unpruned top-logs from the thinned/pruned *E. nitens* stand processed by Gunns Lindsey Street (Table 13 - col. K).
- Confusion with colour coding of sawn boards resulted in it being impossible to estimate recovery values for *E. nitens* fibre logs processed by Gunns (Table 13 - col. L). This was unfortunate given the high yield of Select grade boards from this material at ITC (Figure 13).
- Grade and overall recovery from thinned and pruned butt logs of 26 year old *E. nitens* was no better than the unpruned top logs from the same trees (Figure 11, Figure 14)
- Grade recovery from *E. globulus* was much lower at Gunns than the same material at ITC; this is most likely due to distortion that was not graded at ITC (Figure 15, Figure 16).
- Yield of high-value Select grade boards was much lower than these mills usually obtain from their day-to-day resource.

Table 12: Samples of boards processed by Gunns Lindsay Street, Launceston, that were graded: number of boards, fraction of boards by grade, and fraction of board volume by grade allowing for docking to upgrade board (minimum board length 1.8m).

log source, board type	number of boards assessed	fraction of boards				fraction of volume >1.8m length			
		select	MF	HF	reject	select	MF	HF	reject
EGOLB TP butt - 108x19 flooring	72	17%	25%	24%	35%	15%	23%	23%	38%
ENIT fibre - 108x19 flooring	173	9%	10%	25%	56%	7%	9%	24%	59%
ENIT TP butt - 108x19 flooring	340	24%	16%	51%	10%	22%	15%	52%	11%
ENIT TUP top - 108x19 flooring	53	38%	19%	15%	28%	35%	19%	15%	31%
EGOLB TP butt - 135x19 reveal	200	19%	19%	59%	4%	17%	17%	62%	4%
ENIT fibre - 135x19 reveal	131	2%	8%	85%	5%	2%	7%	86%	5%
ENIT TP butt - 135x19 reveal	252	15%	16%	67%	2%	12%	14%	71%	2%
ENIT fibre - 45x19 DAR	74	26%	0%	0%	74%	22%	0%	0%	78%
ENIT TP butt - 45x19 DAR	37	19%	3%	0%	78%	16%	2%	0%	82%
EGOLB TP butt - 85x19 flooring	172	35%	10%	14%	41%	33%	9%	14%	44%
EGOLB TP butt - 65x19 colonial arch	33	42%	0%	0%	58%	39%	0%	0%	61%
ENIT TP butt - 65x19 colonial arch	51	61%	0%	0%	39%	59%	0%	0%	41%

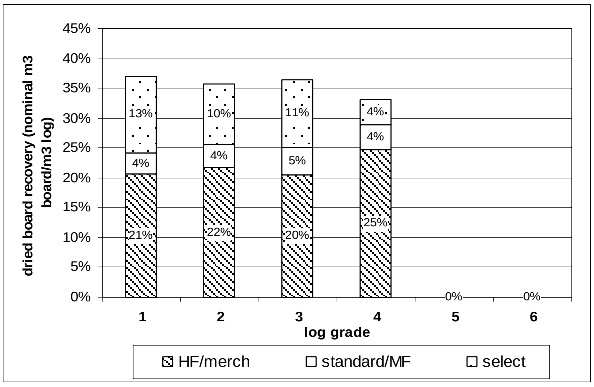

Figure 11: 26-year-old *E. nitens* thinned-pruned butt - ITC

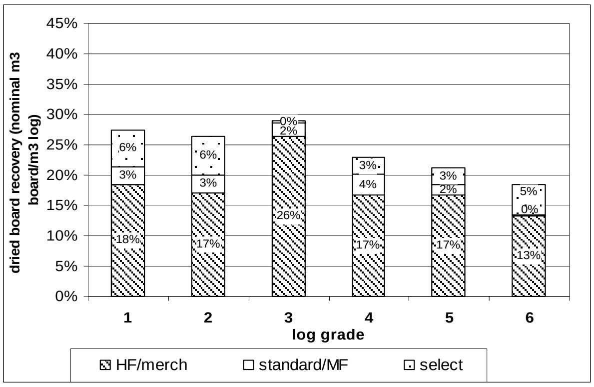

Figure 12: 26-year-old *E. nitens* thinned-pruned butt - Gunns

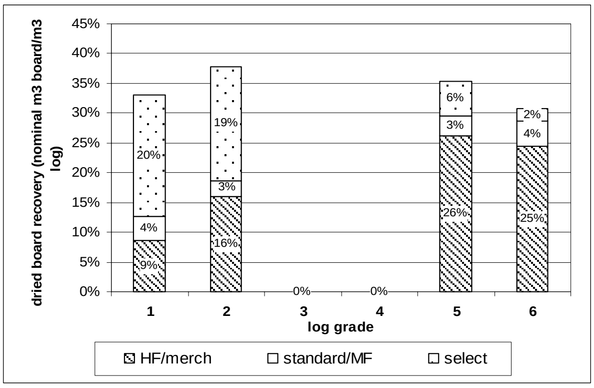

Figure 13: 26-year-old *E. nitens* unthinned-unpruned - ITC

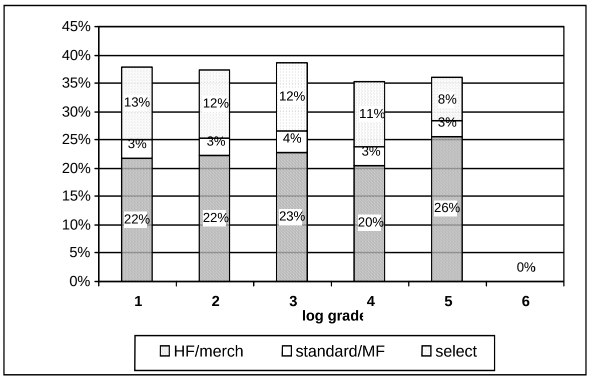

Figure 14: 26-year-old *E. nitens* thinned-unpruned top - ITC

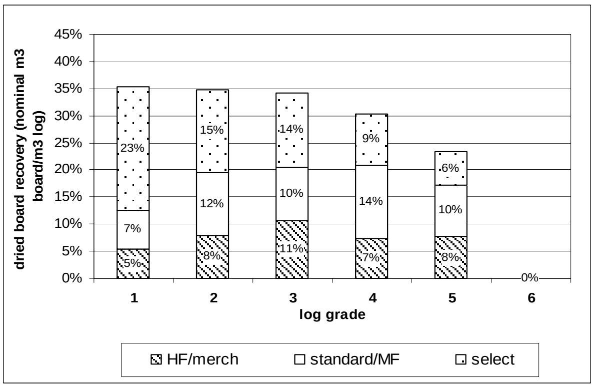

Figure 15: 19-year-old *E. globulus* thinned-pruned butt - ITC

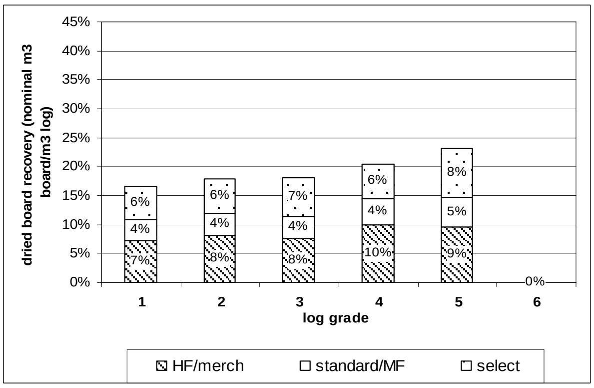

Figure 16: 19-year-old *E. globulus* thinned-pruned butt - Gunns

Table 13: Sawn-timber grade recovery summary (see text above)

REF	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
2	age			47	13	13	26	26	26	26	26	26	19	19
3	silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
4	location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
5	sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
6		log grade 1		33.1%			40.7%	41.6%	36.5%	34.1%			37.3%	27.2%
7	total board recovery after	log grade 2		28.3%	32.7%	24.3%	39.4%	41.2%	41.6%	33.4%			36.7%	28.6%
8	drying (nominal dry width x	log grade 3		23.4%	25.9%		40.1%	42.6%		40.6%			36.2%	30.0%
9	25mm thick x average	log grade 4			23.0%	27.6%	36.4%	38.8%		30.6%			32.0%	31.2%
10	group length) including	log grade 5			22.1%	26.2%		39.8%	39.0%	28.6%			24.8%	38.9%
11	reject	log grade 6			22.2%	18.7%			34.0%	29.1%				
12		**log grades 1-3**		**29%**	**29%**	**24%**	**40%**	**42%**	**38%**	**34%**			**37%**	**29%**
13		**all log grades**			**25%**	**25%**	**40%**	**40%**	**36%**	**34%**			**36%**	**29%**
14		log grade 1					12.7%	12.8%	20.4%	5.9%			22.8%	5.8%
15		log grade 2					10.2%	12.0%	19.1%	6.3%			15.3%	5.9%
16	total recovery select - after	log grade 3					11.3%	12.0%		0.3%			13.8%	6.6%
17	allowance for board end-	log grade 4					4.1%	11.5%		2.8%			9.4%	6.0%
18	split or end-dock, and	log grade 5						7.7%	5.8%	2.8%			6.2%	8.5%
19	internal check	log grade 6							2.1%	5.0%				
20		**log grades 1-3**					**12%**	**12%**	**20%**	**6%**			**18%**	**6%**
21		**all log grades**					**12%**	**9%**	**18%**	**6%**			**17%**	**6%**
22		log grade 1					3.6%	3.2%	4.1%	3.1%			7.1%	3.6%
23	total recovery medium	log grade 2					3.9%	3.0%	2.6%	2.8%			11.5%	3.9%
24	feature (standard) - after	log grade 3					4.7%	3.8%		2.4%			9.9%	3.7%
25	allowance for board end-	log grade 4					4.3%	3.3%		3.6%			13.5%	4.5%
26	split or end-dock, and	log grade 5						2.8%	3.5%	1.7%			9.6%	5.1%
27	internal check	log grade 6							4.2%	0.2%				
28		**log grades 1-3**					**4%**	**4%**	**4%**	**3%**			**10%**	**4%**
29		**all log grades**					**4%**	**3%**	**4%**	**3%**			**10%**	**4%**
30		log grade 1					20.6%	21.8%	8.6%	18.4%			5.4%	7.2%
31		log grade 2					21.7%	22.3%	16.0%	17.1%			7.9%	8.1%
32	total recovery high feature -	log grade 3					20.4%	22.9%		26.3%			10.5%	7.7%
33	after allowance for board	log grade 4					24.7%	20.4%		16.7%			7.3%	9.9%
34	end-split or end-dock, and	log grade 5						25.6%	26.1%	16.7%			7.7%	9.5%
35	internal check	log grade 6							24.5%	13.2%				0.0%
36		**log grades 1-3**					**21%**	**23%**	**11%**	**18%**			**7%**	**8%**
37		**all log grades**					**21%**	**24%**	**11%**	**18%**			**7%**	**8%**
38		log grade 1		19.6%			16.3%	16.0%	24.5%	9.0%			29.9%	9.3%
39	total recovery select and	log grade 2		9.7%	20.9%	13.2%	14.1%	15.1%	21.7%	9.2%			26.8%	9.8%
40	medium feature - after	log grade 3		6.7%	9.2%		15.9%	15.8%		2.7%			23.7%	10.4%
41	allowance for board end-	log grade 4			5.1%	10.3%	8.3%	14.8%		6.3%			22.9%	10.4%
42	split or end-dock, and	log grade 5			6.3%	8.0%		10.5%	9.3%	4.6%			15.8%	13.6%
43	internal check	log grade 6			1.4%	1.6%			6.3%	5.2%				
44		**log grades 1-3**		**12%**	**14%**	**13%**	**16%**	**16%**	**24%**	**9%**			**28%**	**10%**
45		**all log grades**			**8%**	**9%**	**15%**	**12%**	**22%**	**9%**			**27%**	**10%**
46	total recovery all grades	**log grades 1-3**					**37%**	**38%**	**34%**	**27%**			**35%**	**18%**
47	(not rejects)	**all log grades**					**36%**	**36%**	**33%**	**27%**			**34%**	**18%**
48	total reject									**4%**				**9%**

3.4 Defects in sawn boards

3.4.1 Reason for board downgrade

Figure 17 shows the primary reason for 108x19mm flooring boards milled from the experimental material to be downgraded from Select grade. The results reported in Figure 17 cannot be viewed in strict quantitative terms as only the first and most apparent defect feature was recorded for each board. Some of the boards downgraded due to the presence of knots might also have had internal check for example. The results indicate however that:

- The presence of knots, both tight and loose knots (e.g. Plate 7), were the predominant primary reason for down-grade in boards cut from all log types, ranging from 30% of boards in *E. globulus* thinned-pruned butt logs (*EGOLB TP butt*) to 50% in fibre managed *E. nitens* (*ENIT fibre*).
- Boards cut from *E. nitens* butt logs, both thinned-pruned (*ENIT TP butt* **-** Figure 17) and fibre managed (*ENIT fibre*, being predominantly butt logs) show higher levels check (surface check) as the primary reason for downgrade (25-30%) than do boards cut from *E. globulus* thinned-pruned butt logs (*EGOLB TP butt*) or unpruned *E. nitens* top logs from the thinned-pruned stand (*ENIT TUP top*) from the thinned-pruned stand (8-10%). This may be due to (anecdotally) observed higher levels of internal check in boards from butt logs, particularly in the butt ends of those boards. If exposed by machining, internal check is manifested as surface check.
- Boards cut from *E. globulus* thinned-pruned butt logs (*EGOLB TP butt*) show higher level of "dimensions" as the primary reason for downgrade (22%) than do boards cut from *E. nitens* (3-5%). "Dimensions" as a down grade feature means that the board has not met its minimum dimensions in some respect. This may be expressed as skip for example (Plate 9).

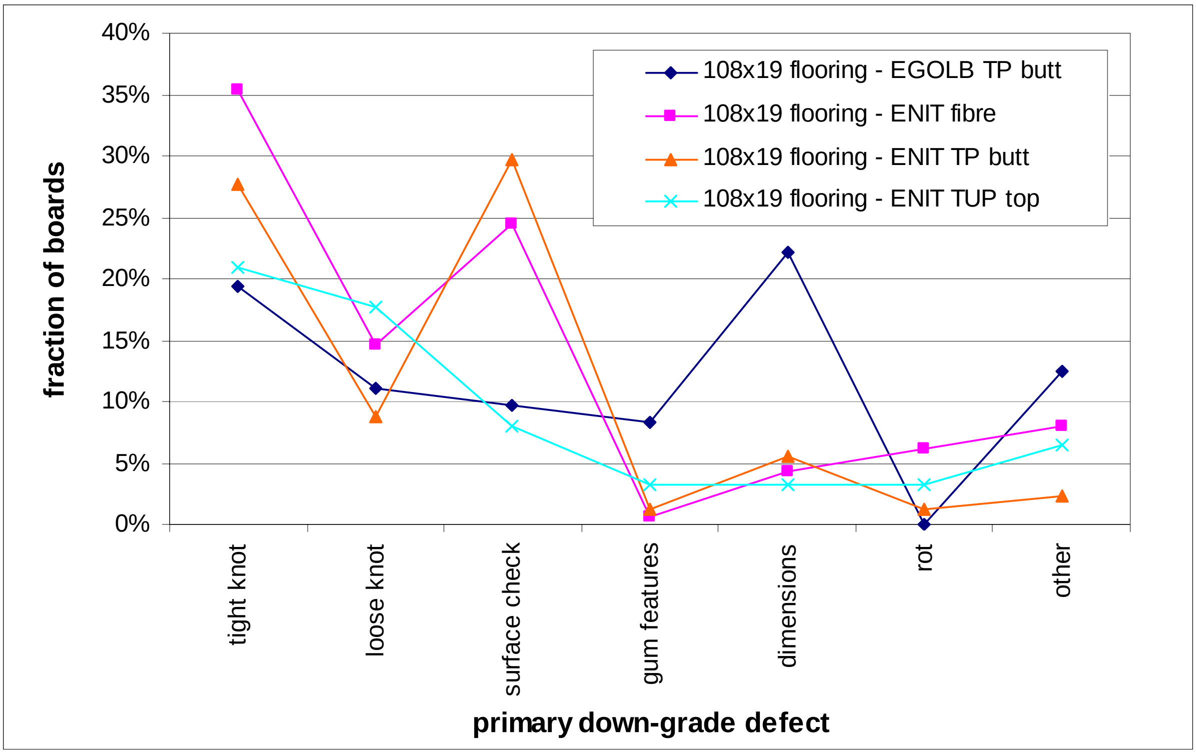

Figure 17: Primary reason for down-grade of 108x19mm flooring by log type - boards manufactured by Gunns.

- No 108x19 flooring boards cut from *E. globulus* thinned-pruned butt logs were down-graded primarily due to the presence of rot.
- A higher proportion of boards cut from *E. globulus* thinned-pruned butt logs (*EGOLB TP butt*) have “gum features” as the primary reason for downgrade (e.g. Plate 12) than boards cut from any of the *E. nitens* log types.

Figure 17 represents only a subset of products for which the primary reason for down-grade was recorded - a figure depicting all primary-downgrade-defect results is recorded in Appendix 5.

3.4.2 Observed defects in sawn boards

Boards sawn from the Ulverstone thinned-pruned *E. globulus* showed significant colour variation (Plate 10), particularly between heartwood and sapwood (Plate 11).

Decay was apparent but not significant in the Ridgley thinned-pruned *E. nitens* and largely confined to the knotty core. Plate 5 shows discolouration of the knotty core due in part to the presence of decay. Plate 6 shows a pruned branch stub that has clear evidence of decay within the stub, but no decay in the surrounding wood.

There is evidence that traces of some pruned branches present as discolouration ranging from slight to significant in clearwood outside the knotty core in the butt logs of the Ridgley thinned-pruned *E. nitens* (Plate 8).

At the Tasmanian sawmills *E. globulus* boards appeared to suffer more distortion through the drying process than *E. nitens* boards. This is highlighted in the high incidence of downgrade of *E. globulus* boards due to boards not meeting dimensional requirements (Figure 17, Plate 9). Quartersawn boards of both species cut at normal full length (5.4 – 6.0 m) can be expected to incur significant downgrade from spring distortion when graded to current Australian Standards (2796) for high quality machined products.

Significant downgrade was observed at the upper end of boards from some pruned stems, indicating that pruned height was insufficient. Trees were said to be pruned to 6.0 m, allowing only 600 mm to be trimmed from the butt to produce two 2.7 m sawlogs. This problem was also expressed as butt logs with flared butts where the harvester operator had to trim logs closer to the ground than desirable due to large branches above the second 2.7 m sawlog.

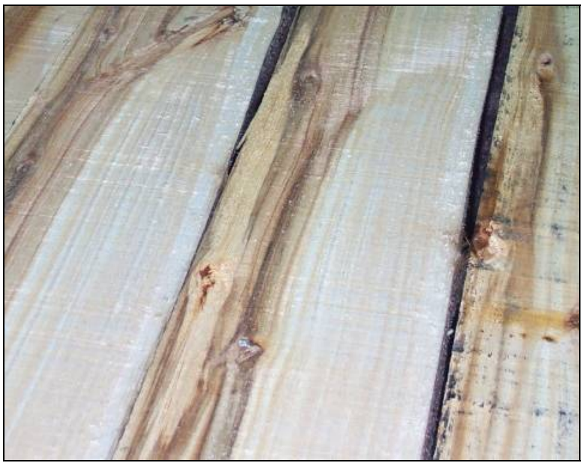

Plate 5: Knotty core exhibiting stain and obvious decay, pale heartwood and sapwood in slabs cut from thinned-pruned butt log of *E. nitens* from Ridgley, Tasmania.

Plate 6: Pruned branch stub in board cut from butt log of 26-year-old thinned-pruned *E. nitens* from Ridgley, Tasmania.

Plate 7: Loose knot in board cut from thinned-pruned butt log of *E. nitens* from Ridgley, Tasmania.

Plate 8: Traces from pruning extending beyond the knotty core in boards cut from thinned-pruned butt log of *E. nitens* from Ridgley, Tasmania.

Plate 9: Skip defect boards cut from the butt log of 19-year-old thinned-pruned *E. globulus* (a “dimension” defect - Figure 17).

Plate 10: Colour variation in sawn boards of 18-year-old thinned and pruned *E. globulus* grown at Ulverstone, Tasmania.

Plate 11: Colour variation between sapwood and heartwood in 19-year-old thinned-pruned *E. globulus* from Ulverstone, Tasmania.

Plate 12: Kino pocket from overgrowth of injury in 19-year-old thinned-pruned *E. globulus* from Ulverstone, Tasmania.

3.5 Internal check

Internal check is a serious value-reducing drying-related defect in collapse-prone eucalypts. It presents as radial splits along the fibres inside the piece, normally stating at the junction of the earlywood and latewood band. Internal check is very hard to detect operationally and in the worse cases, may only become apparent during final processing.

Internal check was assessed on samples of boards by cross-cutting approximately 40cm from the end of individual boards and subjectively allocating a 0-3 score for internal check: 0 for no check, 1 for minimal check, 2 for moderate check, and 3 for heavy check (see Plate 13).

The observed levels of internal check are shown in Figure 18. While only a sample of boards was assessed (see Table 14), the internal check assessments indicate:

- *E. nitens* butt logs show relatively high levels of internal check. As shown in Table 14, these were:
    - 56-65% no check
    - 25-31% minimal check
    - 6-17% moderate/heavy check;
- The level of internal check in the *E. nitens* butt logs is seemingly independent of:
    - silviculture (thinned-pruned versus UTUP fibre management which were predominantly butt logs); and
    - drying method. The *ITC ENIT TP butt* were air-dried and showed the same internal check levels as *Gunns ENIT TP butt* which were kiln-dried.
- *E. globulus* butt logs show lower levels of internal check than *E. nitens* butt logs. As shown in Table 14, these were:
    - 87-92% no check
    - 8-11% minimal check
    - 0-3% moderate/heavy check;
- T internal check levels in *E. globulus* butt logs is seemingly independent of drying method. *ITC EGLOB TP butt* were air-dried and show the same internal check levels as *Gunns EGLOB TP butt* which were kiln-dried;
- *E. nitens* unpruned upper logs (from above 5.5m) show lower levels of internal check than *E. nitens* butt logs, and similar levels to *E. globulus* butt logs (Table 14);
- Internal check seemed (anecdotally) to be reasonably heritable, with most boards cut from a particular log (of *ENIT TP butt*) exhibiting similar levels of internal check;
- Internal check was observed to behave similarly in these resources to that commonly observed in native forest material, particularly regrowth Victorian Ash, being normally seen in discrete earlywood growth-rings that tended to be wider than adjacent growth-rings.

Note that internal check was neglected during external grading of boards, except where it was exposed during machining, in which case it was graded as surface checking.

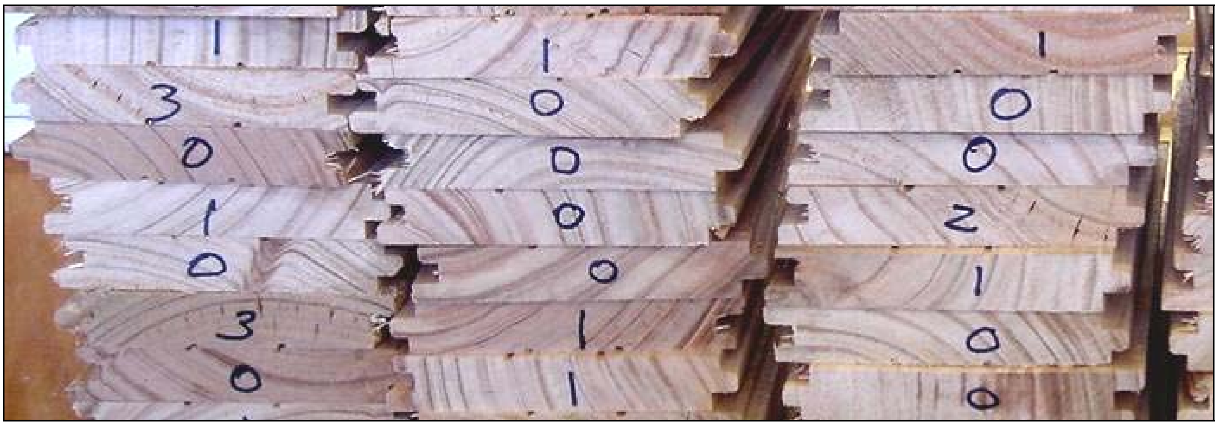

Plate 13: Internal check scores in un-thinned un-pruned 26-year-old *E. nitens* from Ridgley, Tasmania - 0 is no check, 1 is minimal check, 2 is moderate check, and 3 is heavy check.

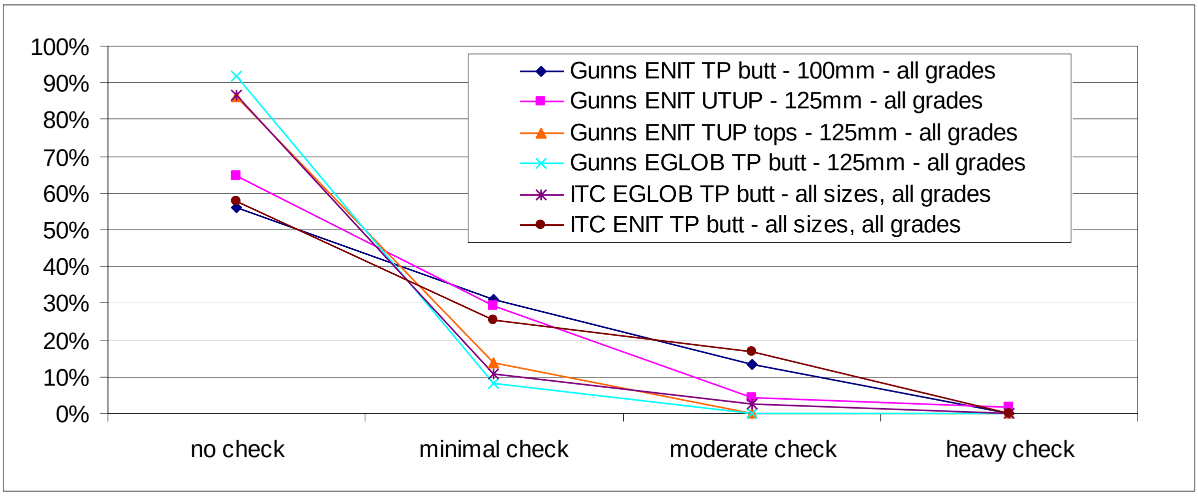

Figure 18: Levels of internal check by log type.

Table 14: Internal check samples - board type, number of boards assessed, and internal check levels.

board	total boards assessed	no check	minimal check	moderate check	heavy check
Gunns ENIT TP butt - 100mm - all grades	347	56%	31%	13%	0%
Gunns ENIT UTUP - 125mm - all grades	164	65%	29%	4%	2%
Gunns ENIT TUP tops - 125mm - all grades	51	86%	14%	0%	0%
Gunns EGLOB TP butt - 125mm - all grades	75	92%	8%	0%	0%
ITC EGLOB TP butt - all sizes, all grades	302	87%	11%	3%	0%
ITC ENIT TP butt - all sizes, all grades	1178	58%	25%	17%	0%

3.6 Total product value

3.6.1 Total product value per cubic metre of sawlog

Table 15 presents the calculated total-sawn-product-value estimates by log type and log grade.

The values estimated for the logs sawn at ITC Heyfield (Table 15 - ref. D6 to F11) were calculated without allowance for internal check (which was not assessed on the boards produced in Victoria), and allowing for board length shorter than 1.8 metres (at a discounted value). As such the Victorian values are not directly comparable to the values for the Tasmanian sawn logs.

The values estimated for the logs sawn by Tasmanian sawmills were calculated in three steps: firstly calculated without allowance for volume lost due to board end-docking or internal check (Table 15 - rows 14-19); secondly, calculated ***with*** allowance for volume lost due to board end-docking (rows 20-25); and finally calculated ***with*** allowance for volume lost due to board end-docking and downgrade due to internal check (rows 26-33).

Total product values for processed logs cannot be directly compared between the two Tasmanian mills because different products were manufactured at each mill: ITC Newood processed sawn boards to skim-dressed rejecting no boards and only downgrading to High feature grade. Gunns Lindsay Street, on the other hand, processed sawn boards to tongue-and-groove flooring, resulting in high levels of reject boards. For example, 12% of sawn volume from the thinned-pruned *E. nitens* butt logs was rejected and 30% of sawn volume from the thinned-pruned *E. globulus* butt logs was rejected. The high level of reject was due to formed tongue-and-groove boards having pieces of the tongue or groove missing making the boards unacceptable at any grade under the relevant Australian standard. This was more prevalent in the *E. globulus* which clearly had more distortion than the *E. nitens* following the drying process.

Total product value per cubic metre of sawlog, by log-grade and log type for all log types is presented graphically in Figure 19. Due to the uncertainties surrounding the direct comparison of total product value results between sawmills, Figure 20 presents only the product-value versus log-grade curves for logs processed by ITC Heyfield, Figure 21 for logs processed by ITC Newood, and Figure 22 for logs processed by Gunns Lindsay Street. These results indicate that:

- The value yield per cubic metre of log from thinned and pruned butt logs of *E. nitens* was found to be lower than that from the unpruned top logs from the same trees (Figure 21, Table 15 cells H26 and G26). This difference is primarily due to the higher levels of internal checking observed in butt logs of *E. nitens* compared to upper logs (Figure 18).
- There are considerable differences in value for the same logs types sawn through the two Tasmanian sawmills. The differences are attributable to differences in total dry recovery (Figure 10) and differences in sawn-board grade recovery (Figure 11 and Figure 12 for Ridgley thinned-pruned *E. nitens* butt logs, and Figure 15 and Figure 16 for Ulverstone thinned-pruned *E. globulus*). Specifically,
    - Ulverstone thinned-pruned *E. globulus* butt logs sawn through ITC Newood showed much higher product value per cubic metre of sawlog (Table 15, cells M24-28) than logs from the same forest sawn through the Gunns Lindsay Street mill (Table 15, cells N26-30);
    - Ridgley thinned-pruned *E. nitens* butt logs sawn through ITC Newood showed much higher product value per cubic metre of sawlog (Table 15, cells G26-30) than logs from the same forest sawn through the Gunns Lindsay Street mill (Table 15, cells J26-30).

The fibre-managed *E. nitens* logs from Ridgley sawn by ITC Newood showed the highest product value per cubic metre of sawlog (Table 15, cell I26 for grade 1 sawlogs). This is primarily attributable to the very high recovery of Select boards recorded for this log type (20.4% of log volume, Table 13, cell I14). This results needs to be treated with caution as this estimate is based upon sawing only five logs totalling 2.5 m^3 (Table 11, cells I11 and I17).

Table 15: Total product value per cubic metre of sawlog, by log-grade.

REF	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
2	age			47	13	13	26	26	26	26	26	26	19	19
3	silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
4	location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
5	sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
6		log grade 1		$226										
7		log grade 2		$158	$259	$184								
8	product value per cubic	log grade 3		$118	$152									
9	metre of log by log grade,	log grade 4			$120	$167								
10	no allowance for internal	log grade 5			$119	$144								
11	check	log grade 6			$86	$75								
12		**log grades 1-3**		**$174**	**$194**	**$184**								
13		**all log grades**			**$143**	**$151**								
14	product value per cubic	log grade 1					$340	$278	$422	$294			$418	$208
15	metre of log by log grade,	log grade 2					$294	$295	$401	$297			$353	$221
16	no allowance for loss to	log grade 3					$313	$295		$214			$307	$227
17	board end-split or end-dock,	log grade 4					$158	$267		$219			$317	$244
18	or internal check	log grade 5						$226	$197	$182			$215	$298
19		log grade 6							$63	$178				
20	product value per cubic	log grade 1					$308	$252	$382	$260			$395	$184
21	metre of log by log grade	log grade 2					$266	$268	$364	$262			$334	$195
22	allowing for volume lost to	log grade 3					$284	$267		$190			$291	$201
23	board end-split or end-dock,	log grade 4					$144	$242		$193			$300	$215
24	no allowance for internal	log grade 5						$205	$179	$161			$203	$263
25	check	log grade 6							$57	$157				
26		log grade 1					$257	$245	$337	$232			$377	$181
27	product value per cubic	log grade 2					$225	$261	$323	$231			$319	$193
28	metre of log by log grade	log grade 3					$238	$260		$182			$278	$198
29	allowing for volume lost to	log grade 4					$125	$236		$176			$287	$213
30	board end-split or end-dock,	log grade 5						$200	$164	$147			$195	$260
31	and down-grade due to	log grade 6							$54	$140				
32	internal check	**log grades 1-3**					**$246**	**$260**	**$333**	**$231**			**$336**	**$191**
33		**all log grades**					**$241**	**$217**	**$242**	**$226**			**$330**	**$194**

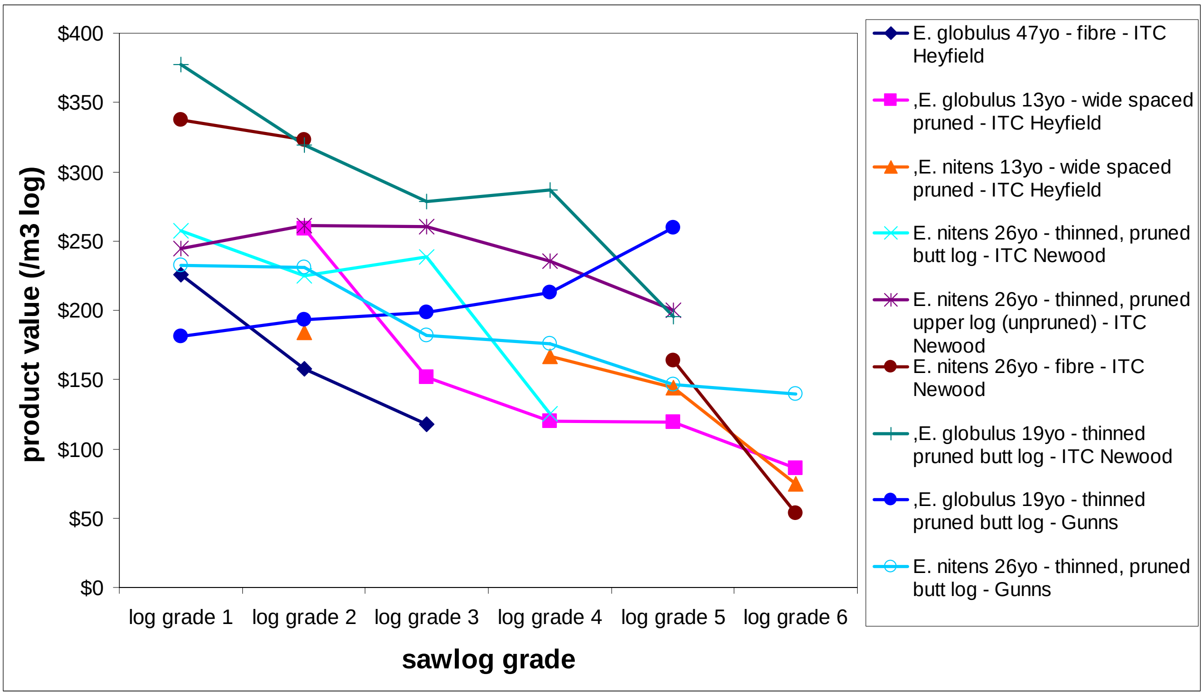

Figure 19: Total product value per cubic metre of sawlog, by log-grade and log type. Data reported in Table 15: ITC Heyfield ref. D6 to F11; ITC Newood and Gunns Lindsay Street ref. G24 to N29.

Total product value per cubic metre of sawlog, by log-grade and log type

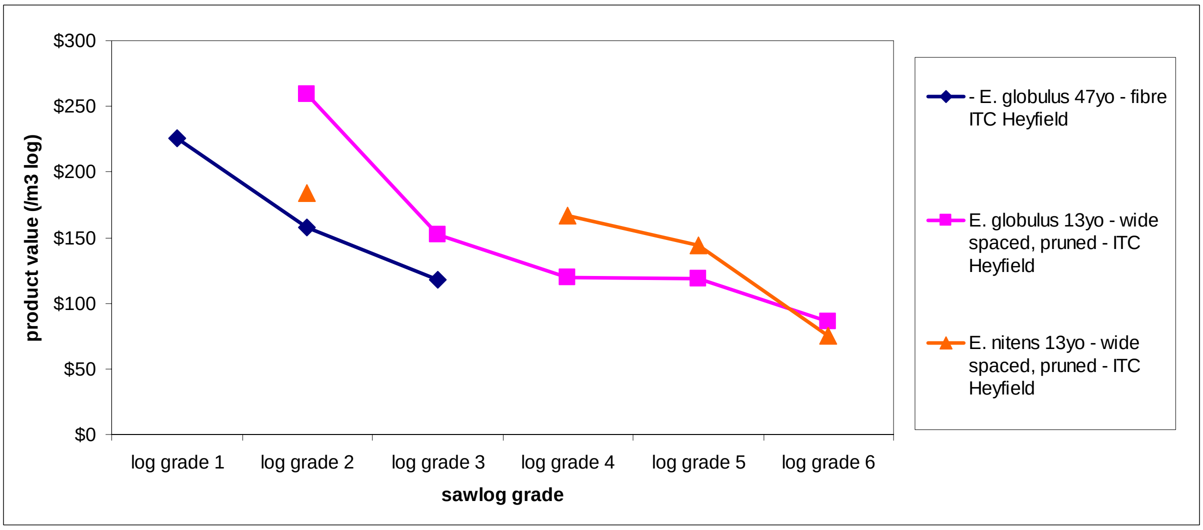

Figure 20: Total product value per cubic metre of sawlog, by log-grade and log type - logs processed by ITC Heyfield. Data reported in Table 15: ref. D6 to F11.

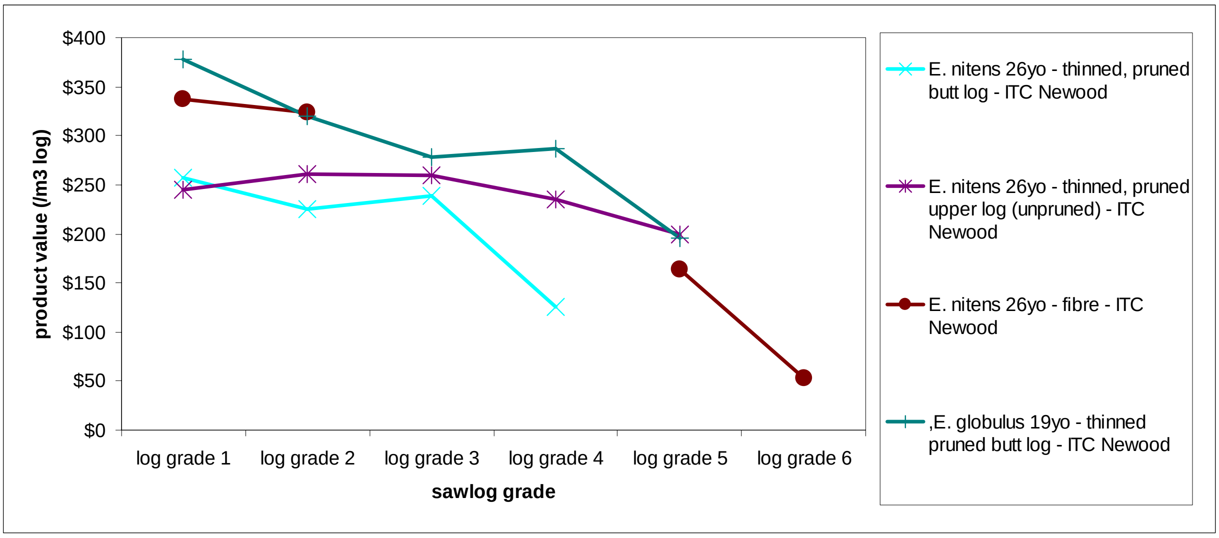

Figure 21: Total product value per cubic metre of sawlog, by log-grade and log type - logs processed by ITC Newood. Data reported in Table 15, rows 24-29.

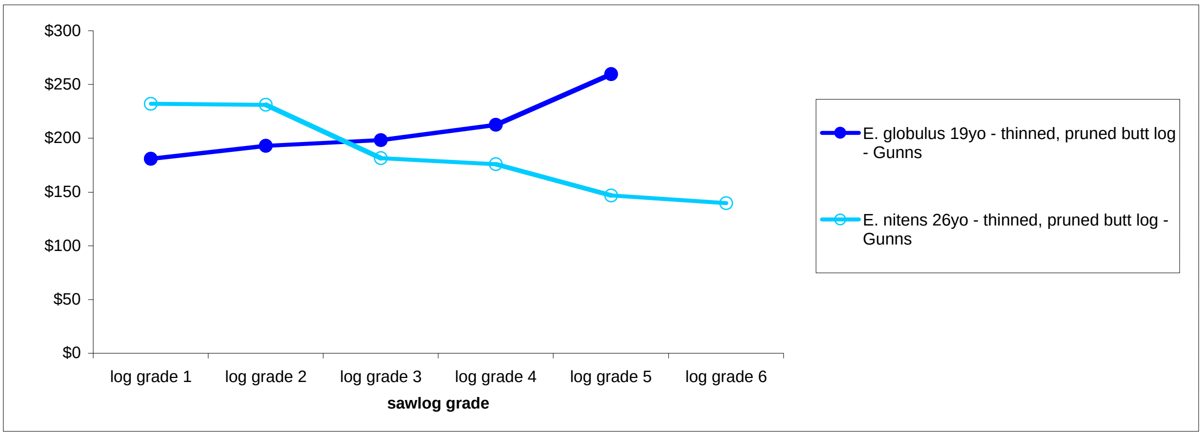

Figure 22: Total product value per cubic metre of sawlog, by log-grade and log type - logs processed by Gunns Lindsay Street, Launceston. Data reported in Table 15, rows 24-29.

3.7 Total product value per hectare

Estimates of total product value per hectare and Mean Annual Increment of total value per hectare are reported by log type in Table 16 (rows 6-7). The estimates of harvested area used in the calculation of per-hectare value (Table 9) are not considered to be overly accurate and thus the reported per-hectare total-product-values and per-hectare Mean Annual Increments of value (Table 16 - rows 6-7) must be considered as indicative only. Further, the per-hectare values reported do not take account of the value of pulpwood produced on each site. This is unfortunately a significant shortfall in the study as pulpwood value, even from a silviculturally expensive pruned site, can be expected to be significant. Note also that this study does not take into account the cost side of growing the trees, the economic affect of thinning, or the cost of pruning.

Table 16: Total sawn-product value per hectare (not including pulpwood), and mean-annual-increment of total sawn-product value per hectare.

Note that the butt logs and the unpruned top logs came from the same stand and thus there is a single combined per-hectare estimate for these log types (cells G-H: 8-9).

REF	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
2	age			47	13	13	26	26	26	26	26	26	19	19
3	silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
4	location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
5	sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
6	**sawn product value per ha**			**$9,642**	**$8,217**	**$8,537**	**$37,812**	**$27,108**	**$41,515**	**$35,732**			**$18,415**	**$10,916**
7	**MAI sawn value per hectare**			**$205**	**$632**	**$657**	**$1,454**	**$1,043**	**$1,597**	**$1,374**			**$969**	**$575**
8	**sawn product value per ha**							**$106,434**						
9	**MAI sawn value per hectare**							**$4,094**						

3.8 Estimated mill-door log value

Table 17 presents the estimated delivered mill-door value of a cubic metre of sawlog. The mill-door values represent the total value of sawn product from a cubic metre of log (excluding sold woodchips in this case) less the cost of sawing including an element of profit.

The mill door prices have been calculated using CSIROMILL with a module representing a hypothetical hardwood sawmill located in south-eastern Australia. This module was developed after widespread consultation with the hardwood processing industry in Australia and represents a modern processing system incorporating many of the characteristics of the ITC mill at Newood, Geeveston, Tasmania.

CSIROMILL is a financial analysis system that simultaneously calculates Net Present Value, Internal Rates of Return and Mill Door log values, in a time series analysis over 16 years using real Australian dollars. Some details of the data used for calculations are given in the Appendix 6. The sixteen year period represents an investment cycle at the end of which the mill is either sold off or re-investment is undertaken to upgrade the mill for further production. Depreciation rates for the various components of the mill are given in the Appendix 6.

It is assumed for this analysis that there is 100% equity in the mill and that a taxation rate of 30% is applied to any profit.

The product values per cubic metre of log input obtained from the trials were used to generate the returns. For this analysis wood chip values have not been included and sawdust is assumed to be used for fuel at the mill.

The analysis produced by the CSIROMILL system requires that the Internal Rate of Return be around 20-25% considering the use of real capital and the risks associated with a new plantation-based resource.

Assumptions underlying the estimated mill-door values are detailed in Appendix 6.

Assuming stumpage of around $90 per cubic metre of pruned sawlog and $50 per cubic metre of unpruned sawlog (after Volker et al. 2005) and harvesting and transport of around $50 per cubic metre (unconfirmed industry estimate), mill door value (Table 17) would need to be around $100 to $140 per cubic metre. The analysis indicates:

- Logs from the thinned-pruned *E. globulus* at Ulverstone are worth processing in a Newood-style sawmill, down to and including log grade 4. The mill-door log values shown in Table 17 (reference M6:9 and M12:15) are greater than $100 to $140 per cubic metre for these grades. This is providing the mill scale is 40,000 m^3 per year log intake. At the lower log volume intake modelled (30,500 m^3/year) unit sawing costs are higher (not tabulated) and mill-door log values are reduced (Table 17, reference M18:21 and M24:27);
- That the butt logs of the Ridgley thinned-pruned *E. nitens* are not worth processing in a Newood-style sawmill, as none of the log grades were predicted to have value greater than the $100 per m3 threshold (Table 17, column G); and
- The unpruned top logs from the Ridgley thinned-pruned *E. nitens* appear to be marginally better than the butt logs.

Table 17: Estimated delivered mill-door value of a cubic metre of sawlog.

The mill-door values represent the total value of sawn product from a cubic metre of log (excluding sold woodchips in this case) less the cost of sawing including an element of profit. Assumptions underlying the estimated mill-door values are detailed in Appendix 6.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
2	age			47	13	13	26	26	26	26	26	26	19	19
3	silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
4	location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
5	sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
6	40,000 m3 log intake, 2 shifts - 20% IRR	log grade 1					$91	$104	$192				$191	
7		log grade 2					$67	$107					$150	
8		log grade 3					$82	$113					$126	
9		log grade 4					$7	$94					$189	
10		log grade 5						$59					$29	
11		log grade 6												
12	40,000 m3 log intake, 2 shifts - 25% IRR	log grade 1					$74	$86	$171				$170	
13		log grade 2					$51	$89					$131	
14		log grade 3					$65	$95					$108	
15		log grade 4						$77					$168	
16		log grade 5						$43					$14	
17		log grade 6												
18	30,500 m3 log intake, 2 shifts - 20% IRR	log grade 1					$56	$69	$157				$156	
19		log grade 2					$32	$72					$115	
20		log grade 3					$47	$78					$91	
21		log grade 4						$59					$154	
22		log grade 5						$24						
23		log grade 6												
24	30,500 m3 log intake, 2 shifts - 25% IRR	log grade 1					$37	$49	$134				$133	
25		log grade 2					$14	$52					$94	
26		log grade 3					$28	$58					$71	
27		log grade 4						$39					$131	
28		log grade 5						$6						
29		log grade 6												

3.9 Disk measurements from Ridgley thinned-pruned *E. nitens* butt logs

Summary measurements of green density, basic density and initial moisture content from disks cut from 3m height (between short sawlogs) from the thinned-pruned *E. nitens* butt logs (from Ridgley, Tasmania) are shown in Table 18. There was a strong relationship between basic density and initial moisture content (Initial MC = -0.3477×Basic density + 282.31, R^2 = 0.7926) and a weaker one between green and basic densities (Basic density = 0.5858×Green density - 131.97, R^2 = 0.3489). The relationship between green density and initial moisture content was not significant. There was no significant correlation between the tree breast height diameter over bark and green density, basic density, or green moisture content.

Relationship of radial and tangential shrinkage with position in tree radius from the shrinkage blocks before and after reconditioning is shown in Figure 23 and Figure 24.

Table 18: Density and initial moisture content from disks.

	Green density (kg/m^3)	Basic density (kg/m^3)	Initial MC (%)
Mean	1024	468	120
Minimum	962	387	97
Maximum	1106	545	149
Standard Deviation	32	32	13

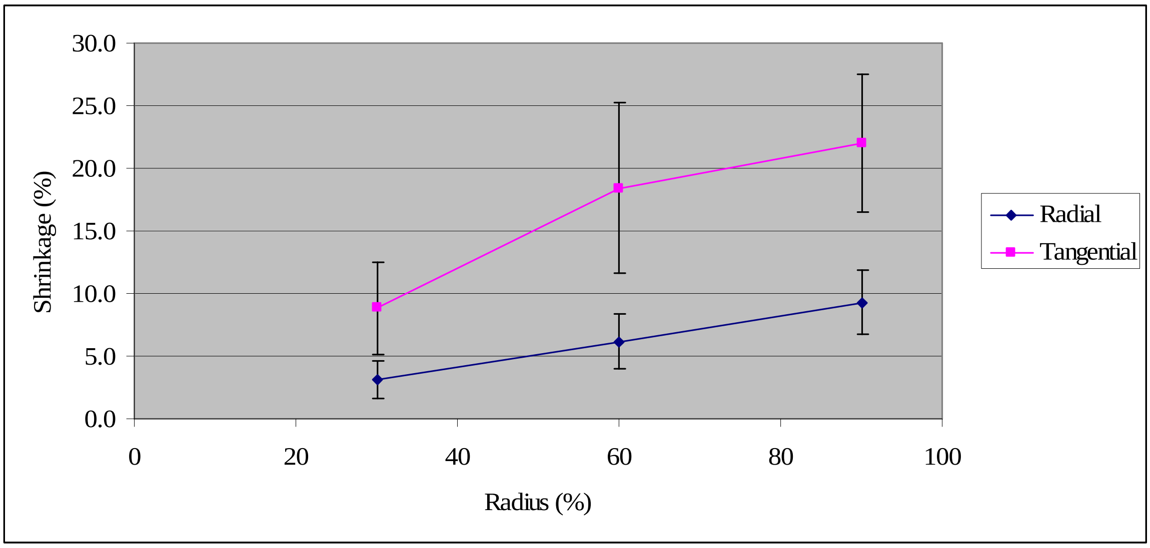

Figure 23: Air-dry shrinkage prior to reconditioning of shrinkage blocks cut from 30%, 60% and 90% of radius on South-west side of tree; error bars show ±one standard deviation. Mean moisture content 10.7%, standard deviation 0.4.

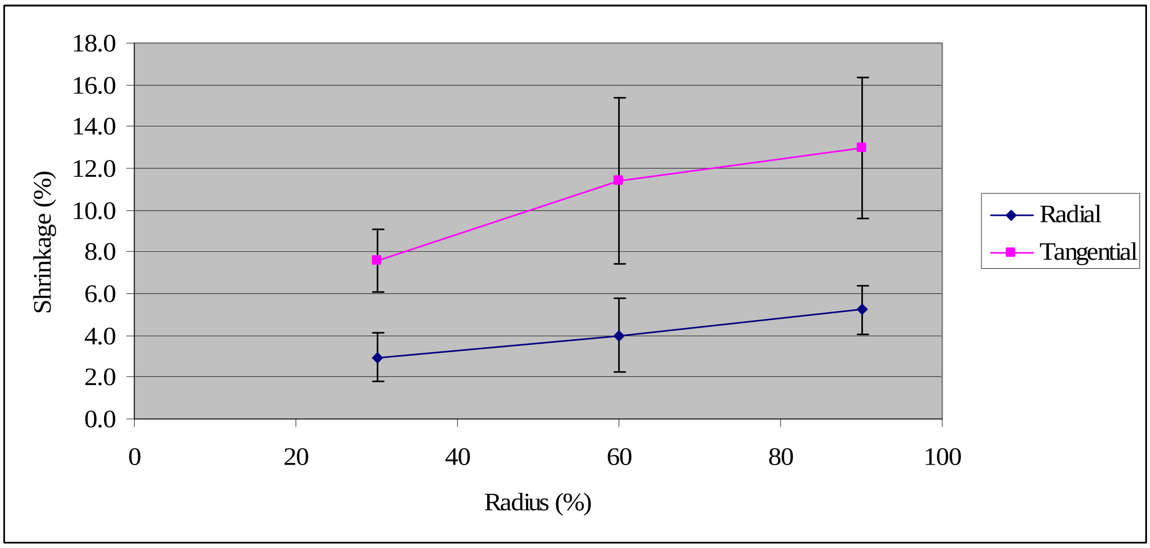

Figure 24: Air-dry shrinkage after reconditioning and re-drying of shrinkage blocks cut from 30%, 60% and 90% of radius on South-west side of tree; error bars show ±one standard deviation. Mean moisture content 10.7%, standard deviation 0.4.

4.0 Discussions and conclusions

The objectives of this project were to assess the economics of processing plantation eucalypts of known origin using current industry-standard equipment and procedures and identify the factors most directly affecting the value of dry output given current market conditions.

Eucalypt plantation forestry has developed rapidly in Australia in recent years. In 2005, the nation's hardwood plantation estate was estimated at 715,531 hectares (National Forest Inventory 2005). Much of the existing resource in southern Australia is made up of two species *E. globulus* (mainly in Western Australia and Victoria) and the more frost-resistant *E. nitens* (mainly in Tasmania). While most of this resource is managed to provide logs for the pulp and paper industry, approximately 17.5% is managed for sawlogs (Nolan et al. 2005). Also, there is potential for fibre managed and future plantations to provide logs for the production of sawn timber.

When the project began, it was believed that stands of trees of harvestable age (between 20 and 35 years old) of the major plantation species, *E. nitens* and *E. globulus,* would be available in Victoria and Tasmania. This proved incorrect. A survey of forest owners in each state showed that hardwood plantations grown on a sawlog silvicultural regime (thinned and pruned) of a harvestable age are very rare. As a consequence, the plantation resources studied in this project were selected from only a short list of suitable trial coupes. Still, the silviculture and age of the stands sampled was not what is currently regarded as optimal. For example, the Ridgley plantation was pruned too late, hence more defect was pushed into the clearwood from the knotty core than would otherwise be expected from early pruned stems.

Study of the overall economics of producing sawn wood from plantation eucalypts is very open-ended due to the number of variables that occur at each stage of the growth and production process. This study sought to control these variables by focusing on the two main eucalypt plantation species in southern Australia, *E. nitens* and *E. globulus*, milling the recovered logs into appearance products at industry-standard hardwood production facilities: a mill specifically designed for a smaller regrowth log resource (ITC Newood) and two conventional large logs mills (ITC Heyfield and Gunns Lindsay Street), and drying the material in both conventional drying yards (ITC Heyfield and ITC Mowbray) and in recently commissioned predryers (Gunns Lindsay Street).

Considerable detail on the material processed, recoveries achieved and the factors most directly affecting the value of dry output is included in Section 3 and the attached appendices. In summarising this data, the major findings of the study are that:

- the sawn recovery is dependant on the milling equipment available. Predictably, total dry recovery from the newer ITC Newood mill was significantly higher from the same resource than the conventional mills. Production was also quicker. ITC Newood achieved a dry recovery of 40% from 26-year-old thinned-pruned *E. nitens* butt logs milling them at a rate of 15.4 m^3/hour. Gunns Lindsay Street recovered 34% at a rate of 12.5 m^3/hour. The comparisons are similar for the *E. globulus* butt logs with recoveries of 37% and 29% respectively. Mill details are in Section 2.3.
- the value of solid products recovered from the thinned and pruned *E. globulus* logs and probably logs salvaged from the fibre-managed *E. nitens* stands, is likely to be sufficient for the both the grower and processor to make a suitable return. That is, the value of recovered products less the costs of sawmilling (including profit), is higher than the estimated delivered mill-door cost of the sawlogs;
- Growing and processing the thinned and pruned *E. nitens* was marginal or uneconomic, mainly due to the loss of value from internal checking, especially of the butt log.

- Significant loss in the value of dry output resulted from internal check, especially in *E. nitens,* and board distortion, especially in *E. globulus*. These are discussed in greater detail below.

There are several major conditions on these results, namely:

- The value of sawn and milled boards from the plantation species is assumed in this study to be the same as current native regrowth boards. Industry members involved in the study strongly suggested that as *E. nitens or E. globulus* are not currently major commercial species, this may not be the case. They believe that factors such as the colour, grain and hardness may limit market acceptance and affect value. They believe that the material's performance and acceptance in use needs to be confirmed;
- The value of by-products, such as solid woodchips, is generally excluded. Closer attention to residue and by-product values is necessary as modelling the overall economic performance of a long term crop like trees requires significant assumptions regarding general economic conditions over a timeframe of up to a quarter of a century.
- The impact of future production processes or end-products is very hard to determine. It is difficult to gauge the possible commercial implications of new or very different products that may contribute to whole-of-forest value, whether they be the focus of production, such as sawn appearance or structural material, or by-products, such as fibreboards, fibre, energy, or carbon storage;
- The cost of harvesting, handling and sorting plantation material for different product groups in a mature industry is unclear. Current plantation harvesting methods focus on handling large numbers of smaller pulp logs and experience with harvesting a larger diameter, even age resource is rare. Efficiency improvements in mechanically harvesting both pulp and sawlogs are likely.

Finally, today's market situation will be different in the future and the effect of this change may influence the results of this study. It is known that log supply will be different (Nolan et al. 2005). Supply of full rotation age plantation hardwood saw logs is projected to grow only slowly till beyond 2015 while the supply of native forest material is projected to fall. The market for hardwood products is changing and is likely to change further. It can be expected that long straight lengths of select native forest hardwood will be increasingly difficult to obtain and attract an increased premium. Higher levels of feature and possibly distortion will become more common and may be more widely accepted. Market perceptions and relevant performance Standards may change to reflect this.

4.1 Loss of value

4.1.1 Internal Check

Internal checking is a serious and unrecoverable drying defect in high-value appearance timber. Occurring inside the board, it is often only found when boards are fully dried and machined and much of the cost of production has been borne.

There was a high level of internal check in the Tasmanian *E. nitens* butt logs harvested from both the fibre-managed and thinned and pruned stands. 25-31% displayed minimal check while between 6-17% showed moderate/heavy check. The check classed as minimal was still sufficient to be a serious defect and be grade limiting. The rate was consistent for air-dried and predried material. Internal check in the *E. nitens* top logs and the *E. globulus* was significantly less.

The internal check observed was similar to that commonly seen in native forest material, particularly regrowth Victorian Ash, where it is normally found in discrete earlywood growth-rings that tended to be wider than adjacent growth-rings.

The high level of internal check observed is of serious concern as:

- the trees from which the boards were cut were the product of an expensive silvicultural regimes, including pruning, designed for the express purpose of clearwood production; and
- this regime is similar to the regime adopted by major growers in managing *E. nitens* plantations for clearwood log production.

This trial indicates that between 15 and 40% of boards from similar thinned and pruned full-rotation *E. nitens* can be expected to contain significant levels of internal check if dried with current industry technology. If this is the case, it may be marginal or uneconomic to mill these logs into the high value appearance products for which they were grown.

The situation could be even worse in full-scale production. The results of this trial were obtained from 2.7 m long logs. This study and other anecdotal evidence suggest that internal check is more prevalent in the butt end of trees. So, if 5.4 m logs were milled into long length boards, potentially up to twice as much of the board volume (if graded at full length) could be affected by internal check.

Internal check may potentially be reduced in the short to medium term by tuning processing regimes, particularly drying, and perhaps by using novel technologies to sort or treat material before it is dried. In the long term, breeding programmes may also reduce occurrence of this defect as there is some evidence that it is a heritable characteristic.

If the rate of internal check in the *E. nitens* butt log could be constrained to the rate found in the *E. globulus*, it is likely that the *E. nitens* could be processed economically, as higher recoveries of select material could be expected from pruned logs.

4.1.2 Board distortion

Distortion is changes in the shape of a board away from a flat, straight evenly shaped piece. It includes cup, bow, twist, spring or a combination of these. Value is lost when distortion affects satisfactory milling into the required profile or the spring or bow of the milled board is outside of the product tolerances established in Australian Standard 2796.

In this study, there was an unexpected high loss in recovery when skim-dressed boards were milled into final products, especially of *E. globulus*. Current industry experience appears to be that some improvement in grade recovery can be expected from milling rough-sawn or skim-dressed boards. The results in Section 3.6.1 indicate a reverse of this.

This casts doubt on assumptions of board and value recovery based on the assessment of skim-dressed material only.

At the Tasmanian sawmills *E. globulus* boards appeared to suffer more distortion through the drying process than *E. nitens* boards. This is highlighted in the high incidence of downgrade of *E. globulus* boards due to boards not meeting dimensional requirements. For example, 12% of sawn volume from the thinned-pruned *E. nitens* butt logs was rejected and 30% of sawn volume from the thinned-pruned *E. globulus* butt logs was rejected. The high level of reject was due to formed tongue-and-groove boards having pieces of the tongue or groove missing making the boards unacceptable at any grade under the relevant Australian standard.

Quartersawn boards of both species cut at normal full length (5.4 – 6.0 m) can be expected to incur significant downgrade from spring distortion when graded to current Australian Standards 2796 for high quality machined products.

Like internal check, distortion may potentially be reduced by tuning processing regimes, particularly drying regimes and sawing allowances. In the long term, improvements in silviculture and breeding may reduce occurrences of the stresses in the wood that contribute to this defect.

4.2 Other observations

Other observations from the study include:

- There was an unexpectedly high recovery of high-value Select grade material from unpruned top logs when compared with pruned butt logs from the same trees. This appears to be mostly due to internal checking exposed during machining of butt log material.
- An apparently high recovery of Select grade material from pulp log managed *E. nitens* processed at ITC could not be verified by processing at Gunns Ltd due to mixing of material during processing. This deserves further attention. Pruning adds significantly to the cost of growing trees. It appears possible that trees planted at a high stand density may self-prune to a reasonable extent, producing a reasonable volume of clearwood from a proportion of the long rotation stand.
- The ratio of tangential to radial shrinkage was high at slightly over two. This suggests that the material is likely to experience cupping with changes in environmental conditions in service, particularly for backsawn boards.

4.3 Conclusions

The results of the study indicate that future, economically-viable production of high value traditionally sawn products from these types of plantations will require:

- different processing techniques to provide better control over value-limiting factors such as distortion, collapse and internal checking.
- sawing equipment optimised to handle this resource.

If these technical issues can be overcome sufficiently to justify capital outlay on tooling, some optimism can be held for the future of an industry based on production of both new and existing sawn products from a suitably managed plantation resource.

Further research is needed to:

- address value-limiting factors of internal check, collapse and distortion:
    - while growing the resource, through improvement in breeding and silvicultural techniques; and
    - after milling, through refining drying and milling processes;
- better quantify whole-of-process product values; and
- clarify recovery of sawn appearance material from full rotation, high stand density unpruned *E.nitens* and *E.globulus*.

Research that involves processing a plantation resource through facilities clearly unable to optimally handle or process the raw material is unlikely to yield encouraging results.

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Appendices

Appendix 1: Forests sampled and log types evaluated

A1.1 Victoria - 47-year-old *E. globulus* - unthinned, unpruned

Owner: Grand Ridge Plantations, ex-VPC.

Species: *E. globulus*, probably subspecies pseudo *globulus*.

Plates 14 and 15: Run-of-the-bush sawlogs harvested from a 47-year-old stand of fibre-managed plantation E. globulus in Gippsland, Victoria (pictures courtesy of Simon Gatt, Grand Ridge Plantations)

One load of end-coated logs was delivered to ITC Heyfield where they were stored under waterspray until sawing.

At the mill the logs were cross-cut under direction from Ensis-Wood Quality staff to produce two sawlogs. Log lengths were 2.7 m and 2.8 m.

A1.2 Victoria - *E. globulus* and *E. nitens* - 13-year-old - established at low stocking and early pruned and thinned

Established and owned by Frank Hirst.

Silviculture

The stand was established a relatively low stocking of 100 trees per hectare, with five trees planted in close proximity at each planting location (totalling 500 established seedlings per hectare - Figure 25). At around one year the groups were culled to leave the single best tree in each group. The remaining trees pruned in three lifts and grown largely without competition for most of their life.

13-year-old *E. globulus* and *E. nitens* from this site were evaluated.

.x.x.x.x.x…………x.x.x.x.x………...
← 10m → ↑

1m 10m
→ ←
………...x.x.x.x.x………..x.x.x.x.x..↓

Seedling layout for a 100 SPH final crop and the author's sheep amongst 10-month-old groups of eucalypts planted to this pattern. (Figures and caption reproduced from Hirst 2004)

Figure 25: Layout of low-stocking stands at establishment, each five-tree group was culled to retain the single best tree at around age one year (reproduced from Hirst 2004).

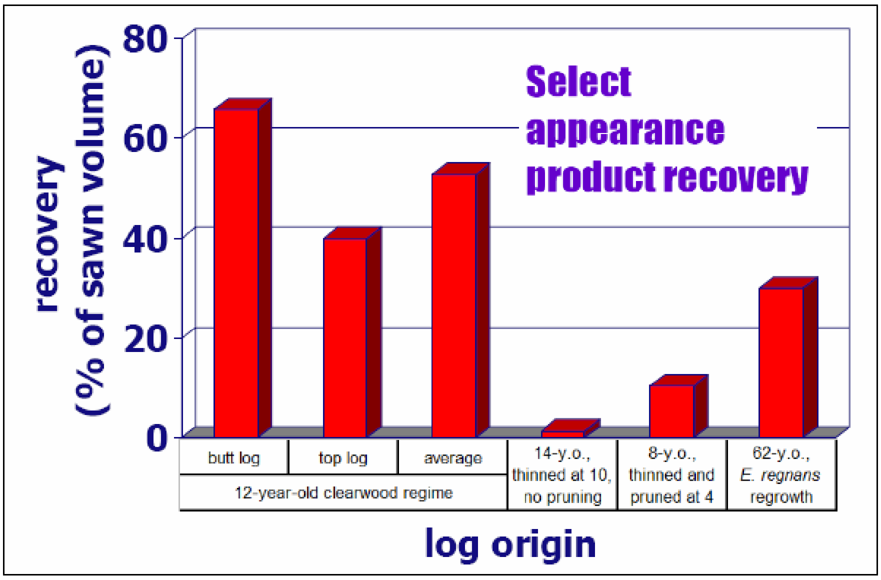
Plate 16: 13-year-old pruned *E. nitens*.

Plate 17: 13-year-old pruned *E. nitens*.

The stand has been the subject of two previous sawing studies: at age 12 years by Garry Waugh through University of Melbourne (Figure 26 below); and at age 14 years by Russell Washusen (CSIRO, ensis).

Figure 26: Recovery of *Select* appearance product (of total sawn volume) at age 12 years compared with other stands. Figure reproduced from presentation by Waugh (2004).

Butt and "top" logs refer to lowest and second 3 metre logs.



Log selection

At the mill the logs were cross-cut under direction from Ensis-Wood Quality staff to produce two sawlogs. Log lengths were 2.7 m and 2.8 m for the 47 year-old *E. globulus* and 3.2 m and 3.3 m for the 13-year-old *E. globulus* and *E. nitens*.

A1.3 Tasmania - *E. nitens* - 26-year-old - thinned and pruned and control (no thinning or pruning) - Gunns' - Ridgley

The sampled trees were part of a Gunns Ltd plantation at St George's Rd, Ridgley in north-west Tasmania (Plate 18 to Plate 21). The site was fairly sheltered from prevailing south-west winds. The thinned and pruned trees were surrounded on all sides by approximately six rows of unthinned and unpruned trees, which were sampled as fibre-grown. Edge trees were not sampled for sawlog due to heavy branching.

Silviculture

The stand was established in 1979 at 3 m × 3 m spacing, an estimated actual initial stocking 1070 stems per hectare. Two varieties were planted: Mt St Gwinear, Victoria (78% of planted trees) and Anemdo Forest, Southern NSW (22% of planted trees).

The thinned and pruned part of the stand had the following treatment applied:

- Pruned to 2.1 m height early in 1985 (age 5.5 years);
- Pruned to 4.2 m height late in 1985, non-commercial thinned to 450 sph (age 6 years); and
- Pruned to 6.3 m height early in 1986, non-commercial thinned to 220 sph (age 6.5 years).

At time of harvest, there was approximately one hectare of thinned and pruned trees. Surrounding this was approximately 1.5 ha of unthinned and unpruned trees with approximately 420 sph surviving. Approximately one-third of the stand was felled for this project.

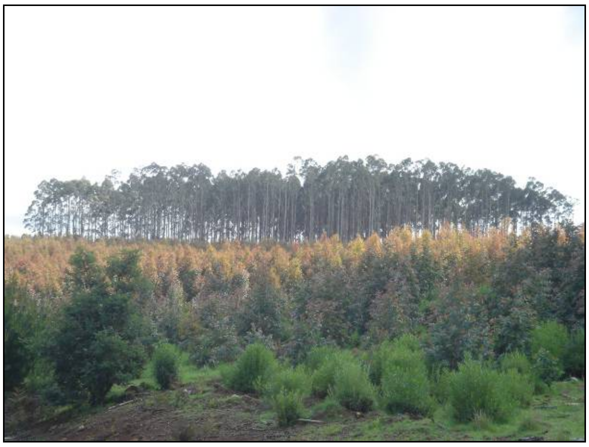


Plate 18: 26-y.o. stands viewed from a distance beyond replanted *E. nitens* plantation.

Plate 19: Trees in the thinned and pruned portion of the stand.

The thinned and pruned stand has been subject to studies of pruning-induced decay by Forestry Tasmania and others.

The site may not be representative of sawlog-managed sites in Tasmania generally due to early-age disease infestations here.

Plate 20: Trees in the thinned and pruned portion of the stand.

Plate 21: Trees in the fibre-managed (un-thinned and un-pruned) portion of the stand.

Sawlog specification

Sawlogs for the project were of minimum 25 cm SED underbark. Bush logs were approximately 5.5 m in length. Logs were docked in half for sawing, with maximum sawn log length 2.9 m.

Pre-felling

The stand was mapped and each tree assessed for DBH over bark. Estimates of bark thickness and tree taper were made to calculate number of stems required. Each tree to be felled from the thinned and pruned area had two 12 mm cores extracted from the south-west side using a Trecor™ bit (see Plate 22); one from approximately 600 mm above ground, the other from 1200 mm. Cores were stored in alcohol for possible future examination.

Felling

Harvest took place from 5th – 10th October 2005. Trees were mechanically felled, debarked and cut to approximately 5.5 m length (Plate 24). Sawlogs were end-sealed, colourcoded and tagged for identification. They were then moved to the road by a forwarder (Plate 25) and loaded onto the trucks for transport to the two mills; Gunns Lindsay St mill in Launceston (approximately 180 km) and the Integrated Tree Cropping mill at Newood, near Geeveston (approximately 400 km). Weather was cool and wet for transport. Pulpwood was sent to Gunns Longreach woodchip mill.

Sawlogs harvested

Approximately equal volumes of three groups of logs were sampled from the two tree types:

- Pruned butt logs from the thinned and pruned area
- Unpruned 2nd and 3rd top logs cut from above the pruned butt logs
- Logs from the unthinned and unpruned control area.

73.68 tonnes were delivered to ITC's Newood mill and 79.09 t to Gunns' Lindsay St mill.

All residual material was sent as pulpwood, a total of 193.70 tonnes.

Plate 22: Extracting cores.

Plate 23: Smooth epicormics; not graded as defects unless a branch stub or wound pierced the bark.

Plate 24: Mechanical debarking of a log from the unthinned and unpruned area.

Plate 25: Forwarder loading truck with logs from the unthinned and unpruned area.

Harvesting

All thinned and pruned trees east of a north-south line were harvested; 62 trees in total.

103 trees were harvested from the unthinned and unpruned area, and from these, 80 logs 5.5 m long were selected for sawing.

Sawlog

It was intended that both sawmills receive the same quantity of each of the three batches. However, Gunns received an excess of unthinned and unpruned logs and fewer top logs from the thinned and pruned area, and vice-versa for ITC.

A1.4 Tasmania - *E. globulus* - 19-year-old - early thinned and pruned - Ulverstone

The sampled trees were situated on a farm at Ulverstone. The coupe was 3.2 ha, situated on a north–facing hillside. The stand was clearfelled with all merchantable volume.

Silviculture

The following information was provided by Private Forests Tasmania. The site was prepared in 1984/85 with rip and mound work and spraying for weed control. The plantation was established at approximately 1,000 SPH with extensive replanting the following year to replace failed stock. First and second pruning lifts were carried out in 1988 and 1989. The stand was thinned in 1989/90 using chemical and a gas axe, reducing stocking to approximately 260 SPH. An inventory plot in 1993 indicated 263 SPH with average DBH of 25.5 cm, average height of 17.8 m with a mean annual increment of 16.5 m^3/ha/yr. Current annual increment at the time was 34.5 m^3/ha/yr, indicating that the trees were still actively growing.

Plates 26 and 27: 19-year-old thinned and pruned *Eucalyptus globulus* plantation at Ulverstone, Tasmania.

Harvesting

The stand of approximately 1280 trees was clearfelled and 55 stems selected for 5.5 m long sawlogs. The remainder of the material, 512.02 tonnes, was sent for woodchips.

Harvest took place from 23-28 November 2005. Trees were mechanically felled, debarked and cut to approximately 5.5 m length (Plate 32). They were then moved to an accessible area by a forwarder (Plate 33) and loaded onto the trucks for transport to the two mills: Gunns' Lindsay St mill in Launceston (approximately 130 km); and ITC mill at Newood, near Geeveston (approximately 350 km). Logs for Gunns were end-sealed with Dussek-Campbell Log-Shield prior to transport, but unfortunately logs for ITC were not. Pulpwood was sent to Tasfibre's Bell Bay woodchip mill.

One truckload of sawlog was sent to each of the two Tasmanian sawmills.

Several of the trees were not pruned to sufficient height; some of the sawlogs exhibited significant butt swell (Plate 28) and/or defects associated with presence of unpruned high branches (Plate 29). Some decay in the knotty core was also observed (Plate 30), although this was not widespread.

Plate 28: Butt flare

Plate 29: High branch.

Plate 30: Decay around the knotty core.

Plate 31: Knot in board from high branch.

Sawlogs for the project were of minimum 25 cm SED under-bark. Bush logs were approximately 5.5 m in length. Selected logs were the best available from the stand. Logs with excessive sweep, butt flare, branches or evident defect were avoided. Logs were docked in half for sawing, with maximum sawn log length 2.835 m.

Approximately 26 m^3 of log were delivered to ITC's Newood mill and 24 m^3 to Gunns' Lindsay St mill.

Plate 32: Mechanical harvesting.

Plate 33: Snigging.

Appendix 2: Summary of appearance grading criteria by ITC Ltd

DEFECT	1. SELECT	2. STANDARD (Medium Feature)	3. MERCH (High Feature)
Graded To:	2 Faces/2 Edges	1 Face/2 Edges	Worst Face
Internal Check	Not Permitted	Not Permitted	No Limitation
Surface Checks	Not Allowed	Not to exceed 2mm in depth	No Limitation
Sound Knots/Burls	No greater than 20mm wide or 1/6 of width. One per 2m in length	No greater than 30mm wide or ¼ of width. One in any 1m length.	No Limitation
Tight Gum Vein	Not greater than 2mm wide, and not exceeding ½ aggregate length of board.	Not greater than 5mm wide, and not exceeding aggregate length of board.	No Limitation
Loose Gum Vein	Not Permitted	Not greater than 3mm wide, not intersecting an end. Aggregate length 1/6 of board.	Not greater than 5mm wide, and not exceeding aggregate length of board.
Brown Stain	Slight	No Limitation	No Limitation
Hobnail	No Limitation	No Limitation	No Limitation
Gum Pockets	Not Permitted	No greater than 6mm wide. Length max 75mm. Not exceeding 1 per 1500mm of length.	No Limitation
Black Speck	Slight	No Limitation	No Limitation
Pinholes and Holes	Not Permitted	No greater than 3mm in diameter. 6 per 100x100 area and not associated with decay.	Scattered
Decay	Not Permitted	Not Permitted	Not Permitted
Heart Wood	Not Permitted	Not Permitted	No Limitation
End Splits	Not exceeding 12mm in length	Not exceeding 12mm in length	Up to 150mm in length

Appendix 3: Green sawn recovery

Table 19. Board recovery from log, *E. nitens* from St. Georges Road, Ridgley, Tasmanian, processed by Gunns. All boards 25 mm nominal dry thickness except for 38 mm shown.

	Log grade - board thickness		Nominal dry board width (mm) 150	125	100	75	50	Total	Log	Recovery (%)
Pruned butt logs	All - 28mm	Pieces	232	373	305	223	84	1217		
		Vol (m^3)	2.349	3.147	2.062	1.129	0.284	8.970		
	All - 38 mm	Pieces	0	0	27	68	0	95		
		Vol (m^3)	0.000	0.000	0.277	0.523	0.000	0.800		
	All - all	Vol (m^3)						9.770	28.142	34.7
Top log	All	Pieces	11	50	54	35	10	160		
		Vol (m^3)	0.111	0.422	0.365	0.177	0.034	1.109	3.616	30.7
Unthinned/ unpruned	1 - 28mm	Pieces	4	11	1	2	2	20		
		Vol (m^3)	0.041	0.093	0.009	0.010	0.007	0.159	0.512	31.0
	2 - 28mm	Pieces	40	52	77	34	10	213		
		Vol (m^3)	0.405	0.439	0.521	0.172	0.034	1.570		
	2 - 38 mm	Pieces	0	0	36	33	0	69		
		Vol (m^3)	0.000	0.000	0.369	0.254	0.000	0.623		
	2 - all							2.194	6.157	35.6
	3 - 28mm	Pieces	9	95	76	53	15	248		
		Vol (m^3)	0.091	0.802	0.513	0.268	0.051	1.724	5.553	31.0
	4 - 28mm	Pieces	27	114	108	54	26	329		
		Vol (m^3)	0.273	0.962	0.728	0.273	0.088	2.324	7.507	31.0
	5 - 28mm	Pieces	30	146	273	233	91	773		
		Vol (m^3)	0.304	1.232	1.841	1.180	0.307	4.863	16.524	29.4
	6 - 28mm	Pieces	18	27	49	93	59	246		
		Vol (m^3)	0.182	0.228	0.331	0.471	0.199	1.410	4.845	29.1
	All 28mm	Pieces	128	445	584	469	203	1829		
		Vol (m^3)	1.296	3.755	3.941	2.374	0.685	12.051		
	All sizes	Vol (m^3)						12.674	41.097	30.8
All	28mm	Pieces	371	868	943	727	297	3206		
		Vol (m^3)	3.756	7.324	6.367	3.680	1.002	22.130		
	38mm	Pieces	0	0	63	101	0	164		
		Vol (m^3)	0.000	0.000	0.646	0.777	0.000	1.424		
	All sizes	Vol (m^3)						23.554	72.856	32.3

Table 20. Board recovery from log, *E. nitens* from St. Georges Road, Ridgley, Tasmanian, processed by ITC. All boards 25 mm nominal dry thickness.

	Log grade		Board nominal dry width (mm) 200	150	125	100	75	50	Total	Log	Recovery (%)
Thinned pruned butt logs	1	Pieces	3	255	203	150	85	73	769	32	
		Vol (m^3)	0.041	2.623	1.740	1.029	0.437	0.250	6.121	15.536	39.4
	2	Pieces	0	77	110	111	57	44	399	18	
		Vol (m^3)	0.000	0.788	0.938	0.758	0.292	0.150	2.926	7.295	40.1
	3	Pieces	0	15	31	28	12	7	93	5	
		Vol (m^3)	0.000	0.153	0.264	0.191	0.061	0.024	0.693	1.719	40.3
	4	Pieces	0	11	5	11	27	14	68	5	
		Vol (m^3)	0	0.112	0.042	0.075	0.137	0.047	0.414	1.128	36.7
Unpruned top logs	1	Pieces	0	1	4	8	5	2	20	1	
		Vol (m^3)	0	0.010	0.034	0.054	0.025	0.007	0.131	0.320	40.8
	2	Pieces	0	25	11	9	2	3	50	2	
		Vol (m^3)	0	0.262	0.096	0.063	0.010	0.010	0.442	1.006	44.0
	3	Pieces	2	94	80	63	38	28	305	13	
		Vol (m^3)	0.028	0.974	0.691	0.435	0.197	0.097	2.420	5.712	42.4
	4	Pieces	1	102	92	82	62	32	371	16	
		Vol (m^3)	0.014	1.059	0.796	0.568	0.322	0.111	2.870	6.602	43.5
	5	Pieces	0	206	357	413	222	109	1307	68	
		Vol (m^3)	0.000	2.145	3.098	2.867	1.156	0.378	9.644	23.793	40.5
Unthinned unpruned logs	1	Pieces	2	39	29	32	17	14	133	5	
		Vol (m^3)	0.027	0.398	0.247	0.218	0.087	0.048	1.023	2.549	40.2
	2	Pieces	0	15	15	18	9	6	63	2	
		Vol (m^3)	0.000	0.153	0.127	0.122	0.046	0.020	0.469	1.074	43.6
	5	Pieces	0	11	29	65	56	39	200	11	
		Vol (m^3)	0.000	0.112	0.247	0.442	0.286	0.133	1.219	3.297	37.0
	6	Pieces	0	0	0	9	14	3	26	2	
		Vol (m^3)	0.000	0.000	0.000	0.061	0.071	0.010	0.141	0.367	38.5
Total		Pieces	8	851	966	999	606	374	3804	180	
		Vol (m^3)	0.110	8.790	8.320	6.881	3.127	1.286	28.513	70.399	40.5

Table 21. Board recovery from log, *E. globulus* from Ulverstone, Tasmanian, processed by Gunns. Boards 25 mm nominal dry thickness.

Log grade		Board nominal dry width (mm) 150	125	100	75	50	Total	Log	Recovery (%)
1	Pieces	40	62	91	23	5	221	10	
	Vol (m^3)	0.405	0.523	0.614	0.116	0.017	1.676	5.067	33.1
2	Pieces	82	142	216	31	10	481	28	
	Vol (m^3)	0.830	1.198	1.458	0.157	0.034	3.677	11.946	30.8
3	Pieces	33	50	89	23	6	201	12	
	Vol (m^3)	0.334	0.422	0.601	0.116	0.020	1.493	4.824	31.0
4	Pieces	23	27	23	8	4	85	5	
	Vol (m^3)	0.233	0.228	0.155	0.041	0.014	0.670	1.958	34.2
5	Pieces	2	3	8	1	0	14	1	
	Vol (m^3)	0.020	0.025	0.054	0.005	0.000	0.105	0.273	38.4
Total	Pieces	180	284	427	86	25	1002	56	
	Vol (m^3)	1.823	2.396	2.882	0.435	0.084	7.621	24.069	31.7

Table 22. Board recovery from log, *E. globulus* from Ulverstone, Tasmanian, processed by ITC. All boards 25 mm nominal dry thickness.

Log grade		Board nominal dry width (mm)					Total	Log	Recovery (%)
		150	125	100	75	50			
1	Pieces	111	121	115	60	51	458	17	
	Vol (m^3)	1.163	1.057	0.803	0.314	0.178	3.515	9.087	38.7
2	Pieces	98	155	162	106	106	627	23	
	Vol (m^3)	1.029	1.356	1.134	0.556	0.371	4.446	10.990	40.5
3	Pieces	11	44	59	53	38	205	9	
	Vol (m^3)	0.115	0.385	0.413	0.278	0.133	1.324	3.539	37.4
4	Pieces	12	16	35	19	11	93	4	
	Vol (m^3)	0.126	0.140	0.246	0.100	0.039	0.651	1.856	35.1
5	Pieces	0	2	7	7	3	19	1	
	Vol (m^3)	0	0.018	0.049	0.037	0.011	0.114	0.313	36.3
Total	Pieces	232	338	378	245	209	1402	54	
	Vol (m^3)	2.434	2.955	2.644	1.286	0.731	10.050	25.785	39.0

Appendix 4: Sawn board recovery by board grade, nominal board width and log grade

Recovery is defined as the volume of sawn boards, without allowance for volume that would be lost/docked off the ends of boards, assuming boards to be 2.7m long, with the minimum graded length of 1.8m (i.e. if a 1.8m length of Select grade wood occurs a board would be graded as Select-grade independent of the defects occurring outside the 1.8m select length).

Areas shaded grey indicate no available results.

Recovery of select grade sawn boards - nominal board dimensions as a fraction of log volume

1	species			*E. globulus*	*E. globulus*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. nitens*	*E. globulus*	*E. globulus*
2	age			47	13	13	26	26	26	26	26	26	19	19
3	silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
4	location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
5	sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
6		log grade 1	200mm				0.0%	0.0%	0.5%	0.0%			0.0%	0.0%
7			150mm				7.0%	0.0%	11.1%	1.5%			9.3%	1.3%
8			125mm				7.0%	0.0%	7.6%	2.5%			8.0%	1.3%
9			100mm				4.4%	6.3%	5.0%	4.0%			7.4%	3.7%
10			75mm col arch				0.0%	6.3%	2.0%	1.3%			0.0%	0.7%
11			50mm				0.5%	2.1%	0.5%	0.4%			1.0%	0.1%
12			total log grade 1				18.8%	14.8%	26.7%	9.7%			25.7%	7.0%
13		log grade 2	200mm				0.0%	0.0%	0.0%	0.0%			0.0%	0.0%
14			150mm				3.4%	8.0%	8.5%	1.5%			4.0%	1.5%
15			125mm				5.5%	1.7%	10.2%	3.1%			6.0%	1.3%
16			100mm				5.6%	3.4%	4.4%	3.0%			5.7%	3.7%
17			75mm col arch				0.0%	0.5%	1.9%	2.4%			0.0%	0.5%
18			50mm				0.6%	0.3%	0.0%	0.4%			1.5%	0.1%
19			total log grade 2				15.0%	13.9%	25.0%	10.4%			17.2%	7.2%
20		log grade 3	200mm				0.0%	0.0%		0.0%			0.0%	0.0%
21			150mm				5.1%	4.4%		0.0%			2.0%	1.4%
22			125mm				5.2%	3.4%		0.0%		1.8%	4.8%	1.3%
23			100mm				6.1%	3.9%		0.0%			7.6%	4.3%
24			75mm col arch				0.0%	1.8%		0.0%			0.0%	1.0%
25			50mm				0.2%	0.4%		0.4%			1.2%	0.1%
26	total recovery select		total log grade 3				16.6%	13.8%		0.4%			15.6%	8.0%
27	(nominal dry width x 25mm	log grade 4	200mm				0.0%	0.2%		0.0%			0.0%	0.0%
28	thick x average group		150mm				1.8%	3.1%		0.8%			3.3%	2.2%
29	length)		125mm				0.7%	4.1%		0.6%		1.2%	1.4%	1.6%
30			100mm				0.6%	3.4%		2.0%			5.4%	2.5%
31			75mm col arch				0.0%	1.8%		0.8%		0.7%	0.0%	0.8%
32			50mm				2.9%	0.7%		0.4%		0.2%	0.5%	0.1%
33			total log grade 4				6.0%	13.2%		4.6%			10.6%	7.2%
34		log grade 5	200mm					0.0%	0.0%	0.0%			0.0%	0.0%
35			150mm					1.7%	0.6%	0.0%			0.0%	1.4%
36			125mm					2.5%	0.8%	0.0%		0.2%	2.7%	2.1%
37			100mm					2.6%	3.1%	2.4%			2.2%	6.0%
38			75mm col arch					1.5%	2.9%	1.8%		0.6%	0.0%	0.8%
39			50mm					0.6%	0.2%	0.4%		0.3%	2.2%	0.0%
40			total log grade 5					8.9%	7.6%	4.7%			7.0%	10.3%
41		log grade 6	200mm						0.0%	0.0%				
42			150mm						0.0%	0.0%				
43			125mm						0.0%	4.8%		0.0%		
44			100mm						1.8%	0.0%				
45			75mm col arch						0.0%	2.9%		0.8%		
46			50mm						0.9%	0.4%		0.4%		
47			total log grade 6						2.8%	8.2%				
48		**log grades 1-3**					**18%**	**14%**	**26%**	**10%**			**20%**	**7%**
49		**all log grades**					**17%**	**11%**	**17%**	**9%**			**19%**	**7%**

Recovery of medium feature grade sawn boards - nominal board dimensions as a fraction of log volume

species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
age			47	13	13	26	26	26	26	26	26	19	19
silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
	log grade 1	200mm				0.0%	0.0%	0.5%	0.0%			0.0%	0.0%
		150mm				2.1%	0.0%	1.2%	1.8%			2.3%	1.3%
		125mm				1.2%	0.0%	2.6%	1.4%			2.7%	1.9%
		100mm				0.6%	2.1%	0.8%	1.3%			1.3%	1.0%
		75mm col arch				1.1%	1.6%	0.2%	0.0%			1.2%	0.0%
		50mm				0.2%	0.0%	0.0%	0.3%			0.4%	0.0%
		total log grade 1				5.3%	3.7%	5.3%	4.8%			7.9%	4.3%
	log grade 2	200mm				0.0%	0.0%	0.0%	0.0%			0.0%	0.0%
		150mm				1.4%	2.0%	0.9%	0.7%			3.0%	1.6%
		125mm				1.7%	0.8%	1.6%	2.9%			4.2%	2.0%
		100mm				1.0%	0.7%	0.6%	0.6%			2.8%	1.1%
		75mm col arch				1.5%	0.0%	0.0%	0.0%			2.0%	0.0%
		50mm				0.3%	0.0%	0.3%	0.3%			0.9%	0.0%
		total log grade 2				5.8%	3.5%	3.5%	4.5%			13.0%	4.7%
	log grade 3	200mm				0.0%	0.0%		0.0%			0.0%	0.0%
		150mm				1.1%	1.8%		2.0%			1.1%	1.4%
		125mm				1.9%	1.0%		1.5%		0.7%	4.0%	1.9%
		100mm				1.0%	0.9%		0.0%			2.7%	1.2%
		75mm col arch				2.7%	0.5%		0.0%			2.7%	0.0%
		50mm				0.3%	0.1%		0.3%			0.6%	0.0%
total recovery medium feature (standard) (nominal dry width x 25mm thick x average group length)		total log grade 3				6.9%	4.4%		3.8%			11.1%	4.5%
	log grade 4	200mm				0.0%	0.0%		0.0%			0.0%	0.0%
		150mm				1.5%	1.1%		2.3%			3.3%	2.2%
		125mm				0.4%	1.3%		0.0%		1.4%	7.2%	2.5%
		100mm				1.3%	0.8%		3.0%			4.3%	0.7%
		75mm col arch				2.7%	0.5%		0.0%		0.5%	0.0%	0.0%
		50mm				0.3%	0.2%		0.3%		0.0%	0.4%	0.0%
		total log grade 4				6.3%	3.9%		5.6%			15.2%	5.4%
	log grade 5	200mm					0.0%	0.0%	0.0%			0.0%	0.0%
		150mm					0.8%	0.3%	0.0%			0.0%	1.4%
		125mm					1.2%	1.3%	0.0%		1.1%	0.0%	3.1%
		100mm					1.1%	1.4%	2.4%			8.6%	1.7%
		75mm col arch					0.0%	1.2%	0.0%		1.2%	0.0%	0.0%
		50mm					0.2%	0.3%	0.3%		0.0%	2.2%	0.0%
		total log grade 5					3.2%	4.6%	2.7%			10.8%	6.2%
	log grade 6	200mm						0.0%	0.0%				
		150mm						0.0%	0.0%				
		125mm						0.0%	0.0%		0.0%		
		100mm						0.0%	0.0%				
		75mm col arch						5.5%	0.0%		0.0%		
		50mm						0.0%	0.3%		0.0%		
		total log grade 6						5.5%	0.3%				
	log grades 1-3					**6%**	**4%**	**5%**	**5%**			**11%**	**5%**
	all log grades					**6%**	**4%**	**5%**	**5%**			**11%**	**5%**

Recovery of high feature grade sawn boards - nominal board dimensions as a fraction of log volume

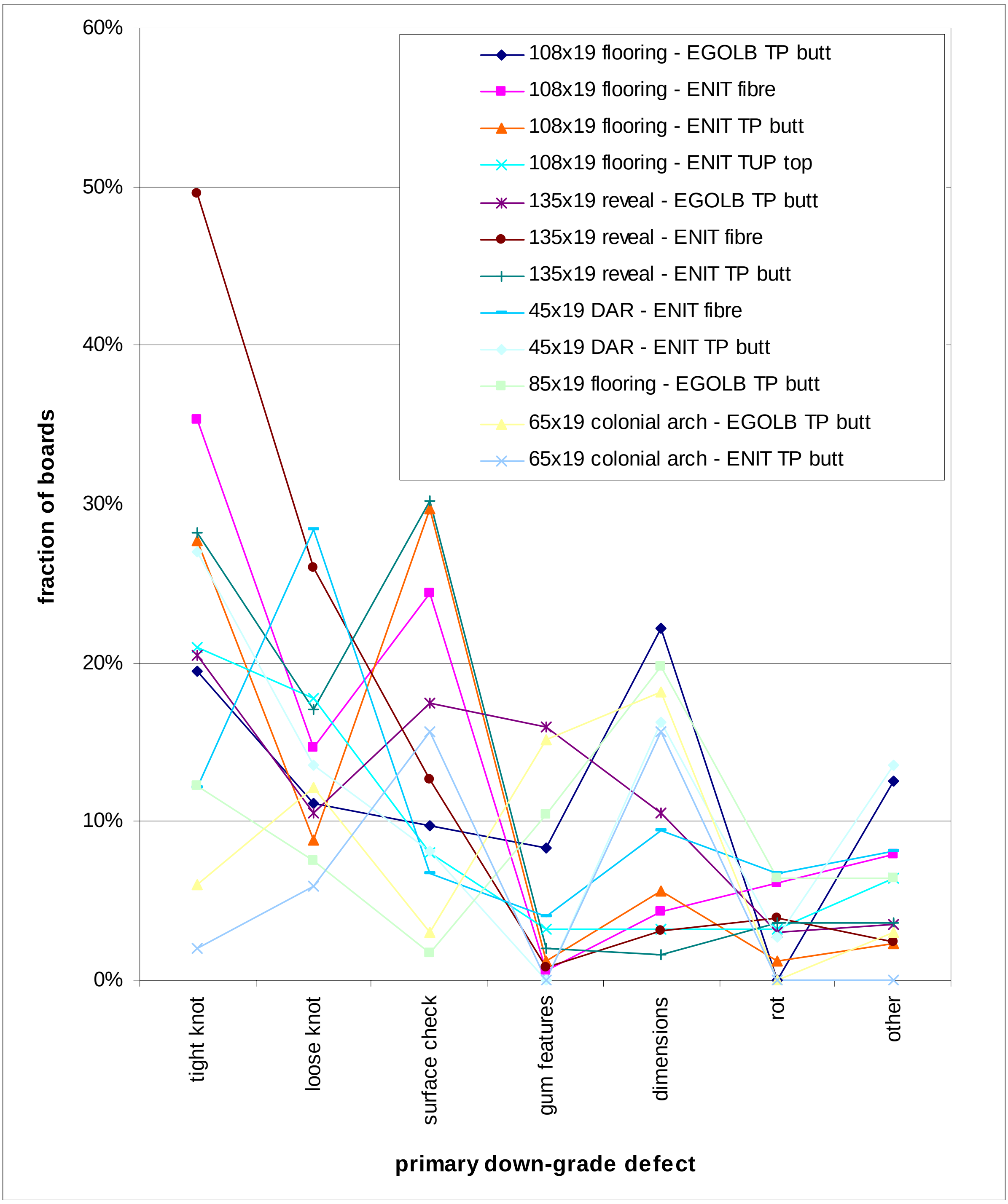
species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
age			47	13	13	26	26	26	26	26	26	19	19
silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
	log grade 1	200mm				0.0%	0.0%	0.0%	0.0%			0%	0.0%
		150mm				8.1%	3.2%	1.2%	7.1%			1.0%	4.1%
		125mm				4.1%	10.5%	0.3%	5.3%			0.7%	1.8%
		100mm				1.8%	8.4%	1.1%	3.2%			0.5%	1.5%
		75mm col arch				1.6%	0.0%	0.8%	0.0%			0.9%	0.0%
		50mm				0.9%	1.1%	1.1%	0.3%			0.5%	0.0%
		total log grade 1				16.6%	23.2%	4.4%	16.0%			3.7%	7.4%
	log grade 2	200mm				0.0%	0.0%	0.0%	0.0%			0%	0.0%
		150mm				5.5%	13.1%	2.8%	4.7%			1.5%	4.9%
		125mm				6.5%	7.5%	1.6%	5.1%			1.5%	1.9%
		100mm				3.2%	2.0%	5.0%	4.4%			1.3%	1.5%
		75mm col arch				2.2%	0.5%	1.9%	0.0%			1.7%	0.0%
		50mm				1.2%	0.7%	1.9%	0.3%			0.6%	0.0%
		total log grade 2				18.6%	23.8%	13.2%	14.5%			6.5%	8.3%
	log grade 3	200mm				0.0%	0.0%		0.0%			0%	0.0%
		150mm				3.8%	12.0%		20.0%			0.0%	4.3%
		125mm				7.6%	6.8%		2.9%		3.6%	2.9%	1.8%
		100mm				3.2%	3.5%		3.5%			1.7%	1.7%
		75mm col arch				0.9%	1.2%		0.0%			3.7%	0.0%
		50mm				1.1%	0.8%		0.3%			1.2%	0.0%
total recovery high feature (nominal dry width x 25mm thick x average group length)		total log grade 3				16.6%	24.4%		26.7%			9.5%	7.9%
	log grade 4	200mm				0.0%	0.4%		0.0%			0%	0.0%
		150mm				6.5%	7.4%		2.3%			0.5%	7.0%
		125mm				1.8%	6.8%		5.0%		1.4%	1.8%	2.3%
		100mm				5.8%	3.7%		7.5%			2.5%	1.0%
		75mm col arch				9.0%	2.6%		0.0%		2.1%	0.0%	0.0%
		50mm				1.0%	0.9%		0.3%		0.0%	1.3%	0.0%
		total log grade 4				24.1%	21.7%		15.1%			6.2%	10.3%
	log grade 5	200mm					0.1%	0.0%	0.0%			0%	0.0%
		150mm					6.0%	2.8%	0.0%			0.0%	4.4%
		125mm					9.6%	5.9%	10.6%		2.4%	2.7%	2.9%
		100mm					7.7%	9.4%	4.8%			4.3%	2.4%
		75mm col arch					3.2%	5.7%	0.0%		3.5%	0.0%	0.0%
		50mm					1.1%	3.1%	0.3%		0.0%	0.0%	0.0%
		total log grade 5					27.7%	26.9%	15.8%			7.0%	9.7%
	log grade 6	200mm						0.0%	0.0%				
		150mm						0.0%	2.9%				
		125mm						0.0%	4.8%		1.0%		
		100mm						3.7%	3.9%				
		75mm col arch						16.5%	0.0%		4.9%		
		50mm						5.5%	0.3%		0.0%		
		total log grade 6						25.7%	11.9%				
	log grades 1-3					**17%**	**24%**	**7%**	**16%**			**6%**	**8%**
	all log grades					**18%**	**26%**	**17%**	**16%**			**6%**	**8%**

Recovery of reject grade sawn boards - nominal board dimensions as a fraction of log volume

species			E. globulus	E. globulus	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. nitens	E. globulus	E. globulus
age			47	13	13	26	26	26	26	26	26	19	19
silviculture			fibre	wide spaced, pruned	wide spaced, pruned	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned upper log (unpruned)	fibre	thinned, pruned butt log	thinned, pruned butt log
location			Gippsland	Gippsland	Gippsland	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ridgley	Ulverstone	Ulverstone
sawn			ITC Heyfield	ITC Heyfield	ITC Heyfield	ITC Newood	ITC Newood	ITC Newood	Gunns	Gunns	Gunns	ITC Newood	Gunns
	log grade 1	200mm							0.0%				0.0%
		150mm							0.0%				0.2%
		125mm							0.0%				2.7%
		100mm							0.0%				4.3%
		75mm col arch							3.6%			1.2%	1.0%
		50mm							0.0%				0.2%
		total log grade 1							3.6%				8.5%
	log grade 2	200mm							0.0%				0.0%
		150mm							0.0%				0.3%
		125mm							0.0%				2.8%
		100mm							0.0%				4.4%
		75mm col arch							4.0%			1.1%	0.7%
		50mm							0.0%				0.2%
		total log grade 2							4.0%				8.4%
	log grade 3	200mm							0.0%				0.0%
		150mm							0.0%				0.3%
		125mm							0.0%		4.7%		2.7%
		100mm							0.0%				5.1%
		75mm col arch							9.6%			1.1%	1.3%
		50mm							0.0%				0.3%
		total log grade 3							9.6%				9.6%
reject (nominal dry width x 25mm thick x average group length)	log grade 4	200mm							0.0%				0.0%
		150mm							0.0%				0.4%
		125mm							0.0%		4.7%		3.4%
		100mm							0.0%				3.0%
		75mm col arch							5.3%		0.0%	5.2%	1.0%
		50mm							0.0%		0.7%		0.4%
		total log grade 4							5.3%				8.3%
	log grade 5	200mm							0.0%				0.0%
		150mm							0.0%				0.3%
		125mm							0.0%		2.0%		4.3%
		100mm							0.0%				7.1%
		75mm col arch							5.4%		0.0%	11.3%	1.1%
		50mm							0.0%		1.0%		0.0%
		total log grade 5							5.4%				12.8%
	log grade 6	200mm							0.0%				
		150mm							0.0%				
		125mm							0.0%		2.6%		
		100mm							0.0%				
		75mm col arch							8.7%		0.0%		
		50mm							0.0%		2.1%		
		total log grade 6							8.7%				
	log grades 1-3					**0%**	**0%**		**4%**			**0%**	**9%**
	all log grades					**0%**	**0%**	**0%**	**4%**			**0%**	**9%**

Appendix 5: Primary reason for board downgrade

The primary reason for all boards assessed.



Appendix 6: Assumptions underlying estimation on mill-door log value

Calculations by Russell Washusen - Ensis

Capital expenditure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1. INFRASTRUCTURE																ASSETS	Dpn rate (%)
Office (130m2)	130,000															52,000	60
Staff Facilities (130m2)	130,000															52,000	60
Weighbridge	100,000															40,000	60
Transformer and housing	100,000															40,000	60
Roads Infrastructure and site prep	100,000															40,000	60
Log storage-dams	10,000															10,000	0
Log storage-Hot mix surface	200,000															0	100
Log storage-Sprinkler system	20,000															0	100
Contingencies	79,000															0	100
	869,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	234,000	

Capital expenditure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
2. SAWMILL																ASSETS	Dpn rate (%)
Sawmill buildings																	
Green mill 70x40 m	840,000															0	100
Sawshop 10x10 m	30,000															0	100
Maintenance shop 10x6 m	18,000															0	100
Electrical / lighting	150,000															0	100
Sprinkler / water storage / pumps	230,000															0	100
Contingencies	126,800															0	100
Sawing equipment																	
Log merchandising foundations	45,000															0	100
Sawmill foundations	45,000															0	100
Dust extraction foundations	12,000															0	100
Sawshop foundations	7,000															0	100
Log merchandising	300,000					300,000					300,000					0	100
Bark conveyor/storage	78,000															0	100
Loading equipment (1 x 966 Cat)	79,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	0	NA
Infeed systems (2)	161,700															0	100
Log Scanner	80,000															0	100
Log headrig system	1,000,000															0	100
Twin resaws	700,000															0	100
Scanning multirip	750,000															0	100
Trim saw/docking system	533,000															0	100
Residue system	148,000															0	100
Sawdust extraction	105,000															0	100
Sawdust bin	50,000															0	100
Chipper and transfer system	134,000															0	100
Chip bin	20,000															0	100
Loading ramps for residue	53,000															0	100
Board segregation	335,000															0	100
Board sorter system	2,000,000															0	100
Mechanical installation	298,000															0	100
Walkways/safety barriers	250,000															0	100
Compressor and air lines	75,000															0	100
Saws	40,000															0	100
Gantry crane	15,000															0	100
Communication systems	40,000															0	100
Saw doctor	600,000															0	100
Mill vehicles	120,000					120,000					120,000					48,000	40
	9,468,500	158,000	158,000	158,000	158,000	578,000	158,000	158,000	158,000	158,000	578,000	158,000	158,000	158,000	158,000	48,000	

Capital expenditure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
3. DRYING EQUIPMENT																ASSETS	Dpn rate (%)
Fork lift for Lyctid treatment (1)	200,000															50,000	75
Lyctid treatment centre	100,000															0	100
12 tonne fork for loading kilns (3)	600,000															150,000	75
6 tonne fork (2)	280,000															70,000	75
Kilns (3)	2,010,000															0	100
Kiln installation	150,000															0	100
Heating system and installation	2,500,000															0	100
	5,840,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	270,000	

Capital expenditure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
4. DRYMILL																ASSETS	Dpn rate (%)
Dry mill 100x40 m	600,000															240,000	60
Electrical / lighting	80,000															32,000	60
Sprinkler / water storage / pumps	180,000															72,000	60
Contingency	86,000															0	100
Optimising docker	300,000															0	100
Multirip	150,000															0	100
predressing	250,000															0	100
Storage 100x40 m	780,000															0	100
Dust extraction	220,000															0	100
3.0 tonne loader (3)	135,000															33,750	75
	2,781,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	377,750	

Operating Expenses

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. OVERHEADS																
Manager (1)	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	125,000	
Marketing/accountant (2)	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	
Office (2)	50,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	
Accountancy costs	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	
Electricity connection	0	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	
Insurance-buildings	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	
Insurance-Stock	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	106,000	
Insurance-Public liability	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	
Insurance-Directors/office liability	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	
Motor vehicle operation	18,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	
Land lease	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	
Legal costs	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	
Quality assurance	0	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	
Yard maintenance	0	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	
Waste disposal	0	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	
Contingencies	0	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	
Administration expenses	150,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	
	788,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	

Operating expenses

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2. SAWMILL																
Staff: Green mill (20)	250,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	
Electricity: green mill	50,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	420,000	
Maintenance (2)	50,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	
Repair motor in fork lift	0	0	0	0	0	0	0	30,000	0	0	0	0	0	0	0	
Motor vehicle operation	0	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	108,000	
Motor vehicle repairs	24,000	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	57,600	
General repairs/maintenance	0	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	
	374,000	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,865,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	
3. DRYING SYSTEMS																
Staff: air and kiln drying (10)	240,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	480,000	
Energy kiln drying	100,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	
Lyctid treatment	0	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	
Repair fork lift	0	0	0	0	0	0	0	20,000	0	0	0	0	0	0	0	
Repair fork lift	0	0	0	0	0	0	0	60,000	0	0	0	0	0	0	0	
Repair fork lift	0	0	0	0	0	0	0	30,000	0	0	0	0	0	0	0	
Maintenance (1)	0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
Motor vehicle operation	0	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	
Motor vehicle repairs	8,000	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	
General repairs/maintenance	0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
	348,000	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,445,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	
4. DRY MILL																
Staff: air and kiln drying (26)	150,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	
Electricity: dry mill	0	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	201,600	
Packaging	0	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	122,400	
Repair forklift	0	0	0	0	0	0	0	30,000	0	0	0	0	0	0	0	
Maintenance (1)	0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
Motor vehicle operation	0	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	
Motor vehicle repairs	8,000	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	
General repairs/maintenance	0	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
	158,000	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,809,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	

Profit and loss (taxation)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
EXPENSES																
Infrastructure																
Office 130m2	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	
Staff Facilities	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	
Weighbridge	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	
Transformer	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	
Roads Infrastructure and site prep	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	
Log storage-dams	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Log storage-Hot mix surface	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	13,333	
Log storage-Sprinkler system	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	
Contingencies	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	5,267	
Sawmill buildings																
Green mill 70x40 m	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	56,000	
Sawshop 10x10 m	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	
Maintenance shop 10x6 m	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	
Electrical / lighting	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	
Sprinkler / water storage / pumps	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	15,333	
Contingencies	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	8,453	
Sawing equipment																
Log merchandising foundations	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
Sawmill foundations	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
Dust extraction foundations	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	
Sawshop foundations	467	467	467	467	467	467	467	467	467	467	467	467	467	467	467	
Log merchandising	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	
Bark conveyor/storage	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	5,200	
Loading equipment	79,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	158,000	
Infeed	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	10,780	
Log Scanner	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	5,333	
Chipper canter system	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	66,667	
Twin log edger system	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	46,667	
Cant/board edger system	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
Trim saw/docking system	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	35,533	
Residue system	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	9,867	
sawdust extraction	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	
sawdust bin	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	3,333	
chipper and transfer system	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	8,933	
chip bin	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	1,333	
Loading ramps for residue	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	3,533	
Board segregation	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	22,333	
Stripping frames	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	133,333	
Mechanical installation	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	19,867	
Walkways/safety barriers	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	
Compressor and air lines	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	
Saws	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	
Gantry crane	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
Communication systems	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	2,667	
Saw doctor	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	
Mill vehicles	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	
Fork lift for Lyctid treatment	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	
Lyctid treatment centre	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	6,667	
Fork for loading kilns	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	
	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	
Drying equipment																
Kilns	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	402,000	
Kiln installation	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	
Heating system and installation	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	
Dry mill																
Dry mill 100x40 m	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	
Electrical / lighting	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	
Sprinkler / water storage / pumps	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	
Contingency	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	5,733	
Optimising docker	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	
Multrip	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	
predressing	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	16,667	
packaging	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	52,000	
Dust extraction	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	14,667	
Loader	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	
Infrastructure costs	788,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	1,241,000	
Production costs (sawmill)	374,000	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,865,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	1,835,600	
Production costs (drying)	348,000	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,445,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	1,335,200	
Production costs (dry mill)	158,000	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,809,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	1,779,200	
Wood costs	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	-386,768	
	3,234,865	5,804,232	5,804,232	5,804,232	5,804,232	5,804,232	5,804,232	5,974,232	5,804,232	5,804,232	5,804,232	5,804,232	5,804,232	5,804,232	5,804,232	0
INCOME																
Wood products	0	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000
Sale mill vehicles	0	0	0	0	0	24,000	0	0	0	0	24,000	0	0	0	0	0
Infrastructure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sawmill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drying systems	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drymill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL INCOME	0	11,895,000	11,895,000	11,895,000	11,895,000	11,919,000	11,895,000	11,895,000	11,895,000	11,895,000	11,919,000	11,895,000	11,895,000	11,895,000	11,895,000	11,895,000
PROFIT/LOSS	-3,234,865	6,090,768	6,090,768	6,090,768	6,090,768	6,114,768	6,090,768	5,920,768	6,090,768	6,090,768	6,114,768	6,090,768	6,090,768	6,090,768	6,090,768	11,895,000
TAXATION	-970,460	1,827,230	1,827,230	1,827,230	1,827,230	1,834,430	1,827,230	1,776,230	1,827,230	1,827,230	1,834,430	1,827,230	1,827,230	1,827,230	1,827,230	3,568,500

Appendix 7: ENSIS report on sawing trials in Victoria

THE JOINT FORCES OF CSIRO & SCION

Commercial in Confidence

Client Report No. 1674

Determining the economics of processing project:

Product quality and value from Victorian plantation-grown *E. globulus* and *E. nitens* using slab sawing and air-drying strategies.

R. Washusen, A. Morrow and

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R. Washusen, A. Morrow and

M. Bojadzic

Date: 31st May 2006

CLIENT: UNIVERSITY OF TASMANIA / FWPRDC

Contract No: FFP 04/231

EXECUTIVE SUMMARY

Objective

The objectives of this study were:

- To determine the recovery of solid wood products and product value from available *E. nitens* and *E. globulus* plantations in Victoria using conventional slab sawing/air-drying strategies.

Key Results

The major results of the study were:

- The stands assessed were 47-year old unpruned *E. globulus,* and 13-year old pruned *E. nitens* and *E. globulus.* The three plantations were located in Gippsland. In total 72.9 m^3 of logs were made available for the trials.
- Prior to sawing all logs were graded into 6 sawlog grades (grades 1-6). Grades 1, 2, 3 and 4 corresponded to current Victorian Grades A, B, C and D. Grade 5 and 6 were below existing sawlog specifications.
- The overall sawlog quality from the 47 year-old *E. globulus* was good. 96% of the logs processed were Grade 1, 2 and 3. In contrast the sawlog quality was poorer from the 13-year-old pruned stands with 34% and 30% of logs Grade 1, 2 and 3 for the *E. globulus* and *E. nitens* respectively. The main reason for poorer quality was small diameter and surface defects that indicated the presence of kino pockets.
- The difference in log quality had a major impact on product quality and recovery. Product values ranged from $75 to $266 ($/m^3 of log input) with values generally increasing in all resources as log quality improved.

Application of Results

As with a number of earlier studies these results show that both pruned and unpruned plantation-grown *E. globulus* and *E. nitens* can produce good recoveries of high quality timber. However, the results clearly highlight the importance of log quality and the need to produce consistently high yields of logs at least equivalent to grade 2. This most likely will be achieved in pruned plantations by allowing them to grow to an older age before harvest. However, there were also some wood quality problems found in both pruned stands in the form of kino pockets that led to down-grading of logs. The reason that this defect was so prevalent in these stands is unclear.

CLIENT REPORT No: 1674

Determining the economics of processing project:

Product quality and value from Victorian plantation-grown *E. globulus* and *E. nitens* using slab sawing and air-drying strategies.

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31st May 2006

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Information for Ensis abstracting:

Contract number	FFP 04/231
Report ID number	1674
Products investigated	Conventional appearance products
Wood species worked on	Plantation grown *E. globulus and E. nitens*
Other materials used	
Location	Gippsland, Victoria

INTRODUCTION

Eucalypt plantation forestry in southern Australia has developed rapidly in recent years. Much of the existing resource comprises *E. globulus* (mainly in Western Australia and Victoria) and *E. nitens* (mainly in Tasmania). While most of this resource is managed to provide logs for the pulp and paper industry there is potential for these plantations and future plantations to provide logs for the production of sawn timber, potentially supplementing supplies from native forests. While recent trials using both pruned and unpruned sawlogs in conventional hardwood mills have produced encouraging results (Washusen and McCormick 2002, Washusen *et al.* 2004, Washusen 2006) there is little economic data available to verify if plantation-grown resources can be processed profitably using the existing sawing and wood drying systems available to native forest sawmillers. This information is needed to improve the decision-making capacity of forest managers and the existing hardwood industry about utilization of young plantation-grown eucalypts.

The trials described in this report were a first step in determining the economics of processing plantation-grown eucalypts in existing hardwood mills. The resources selected for this present study were 13-year old pruned plantation grown *E. nitens and E. globulus* and 47 year-old unpruned *E. globulus*. Processing involved the application of conventional quarter-sawing and back-sawing strategies to produce slabs (boards dimensioned in thickness but not width) for uncontrolled air-drying followed by reconditioning and kiln drying.

MATERIALS AND METHODS

Log selection

Logs for the processing trials were selected by the University of Tasmania and delivered to the Neville Smith Timbers Industries (now ITC) sawmill at Heyfield, Victoria. The plantations were 47-year-old unpruned *E. globulus* and 13-year-old pruned *E. globulus* and *E. nitens*. A single truck-load of logs was selected from each plantation. There were 27.7 m^3, 25.4 m^3 and 19.8 m^3 of logs from the plantations respectively. At the mill the logs were cross-cut under direction from Ensis-Wood Quality staff to produce two sawlogs. Log lengths were 2.7 m and 2.8 m for the 47 year-old *E. globulus* and 3.2 m and 3.3 m for the 13-year-old *E. globulus* and *E. nitens.*

Sawlog grading

The logs were graded using the Victorian log-grading card. Many of the 13-year-old *E. globulus* and *E. nitens* were below minimum sawlog specification because of small diameter and/or the presence of swellings associated with kino pockets that produced defective quarters on Victorian grading rules. These residual logs were retained in the trial by allocating two additional grades making 6 grades in all. The log quality indicators of the 6 grades are summarised in Figure 1. Figure 1 does not include pipe because this defect was not evident in any log. Grades 1, 2, 3 and 4 are equivalent to Victorian A, B, C and D.

	GRADE					
	1	2	3	4	5	6
25-30 SED				0		1+
>30-35 SED			0	1	2+	
>35-40 SED		0	1	2	3+	
>40-45 SED		1	2	3	4	
>45-50 SED		1	2	3	4	
>50-55 SED	0	1	2	3	4	
>55-60 SED	0	1	2	3	4	
>60-65 SED	0	1	2	3	4	
>65-70 SED	0	1	2	3	4	
>70-75 SED	0	1	2	3	4	
>75-80 SED	0	1	2	3	4	
>80-85 SED	0	1	2	3	4	
>85-90 SED	0	1	2	3	4	
>90-95 SED	0	1	2	3	4	
>95-100 SED	0	1	2	3	4	
Sweep	<20% of diameter over 2.4 m length					
Grain	<1:10		<1:8			
tight kino <3mm width : length % of diameter	25	200	ul			
tight kino >3mm width : length% of diameter	25	100	ul			
loose kino/kino pockets/shakes : length % of diameter	25		100	200		
stain	light		dark			

allowable defective quarters

Figure1: Summary of log quality indicators for the 6 grades of logs used in the trials

Sawing

Sawing was conducted in the Neville Smith Timber Industries mill at Heyfield, Victoria. For the sawing the logs were grouped by species, plantation, log grade and diameter. Each log group was tracked through the mill by allocating a colour code to both log-ends using a sequence of 8 colours. In the case of Grade 3 and 4 logs from the 13-year-old stands small numbers of logs in one or both of the grades was overcome by combining the logs to simplify tracking of boards.

Logs smaller than 30.0 cm were back-sawn and the larger logs quarter-sawn. In both cases a slab sawing strategy was applied to produce a green slab thickness of 32 mm to allow for sawing thickness variation and shrinkage and to produce a nominal 25 mm thick board after drying and skip dressing. Small-dimensioned slabs and poor quality wood were resawn to produce nominal 50 x 25 mm tile battens. The remaining slabs were identified with a code relevant to each log group, racked and covered with Hessian for drying in July 2005. Recoveries of green tile battens were tallied at completion of sawing.

Drying, dressing and product grading

The slabs were air-dried by Neville Smith Timbers Industries using the current production methods for ash timber. In April 2006, when the slabs were below fibre saturation point they were kiln dried to final moisture content using standard drying schedules for ash eucalypts.

After drying, the boards were planed, edged, docked and graded by Neville Smith Timber Industries staff, according to the appearance grading criteria specified in Table 1.

After planing, edging and docking length, width, thickness and grade were tallied for each board by Ensis-Wood Quality staff.

Table 1: Summary of appearance grading criteria by Neville Smith Timber Industries

DEFECT	1. SELECT	2. STANDARD	3. MERCH
Graded To:	2 Faces/2 Edges	1 Face/2 Edges	Worst Face
Internal Check	Not Permitted	Not Permitted	No Limitation
Surface Checks	Not Allowed	Not to exceed 2mm in depth	No Limitation
Sound Knots/Burls	No greater than 20mm wide or 1/6 of width. One per 2m in length	No greater than 30mm wide or ¼ of width. One in any 1m length.	No Limitation
Tight Gum Vein	Not greater than 2mm wide, and not exceeding ½ aggregate length of board.	Not greater than 5mm wide, and not exceeding aggregate length of board.	No Limitation.
Loose Gum Vein	Not Permitted	Not greater than 3mm wide, not intersecting an end. Aggregate length 1/6 of board.	Not greater than 5mm wide, and not exceeding aggregate length of board.
Brown Stain	Slight	No Limitation	No Limitation
Hobnail	No Limitation	No Limitation	No Limitation
Gum Pockets	Not Permitted	No greater than 6mm wide. Length max 75mm. Not exceeding 1 per 1500mm of length.	No Limitation
Black Speck	Slight	No Limitation	No Limitation
Pinholes and Holes	Not Permitted	No greater than 3mm in diameter. 6 per 100x100 area and not associated with decay.	Scattered
Decay	Not Permitted	Not Permitted	Not Permitted
Heart Wood	Not Permitted	Not Permitted	No Limitation

End Splits	Not exceeding 12mm in length	Not exceeding 12mm in length	Up to 150mm in length

Recovery calculations

Log volume was calculated with the equation 1 using information recorded during log preparation.

(1) $$V = \left[\pi \left(\frac{D1 + D2 + D3 + D4}{4} \times \frac{1}{2} \right)^2 \right] \times L$$

Where:
V = log volume (m^3)
D1=log small end diameter 1 (m)
D2=log small end diameter 2 (m)
D3= log large end diameter 1 (m)
D4=log large end diameter 2 (m)
L=log length (m)

The measurements of dried boards used to calculate recovery were: 250x25, 225x25, 200x25, 175x25, 150x25, 125x25, 100x25, 75x25, 100x19, 150x12, 125x12, 100x12, 75x12 and 50x25mm.

Product recovery for each log group was determined from log volume and board volume and expressed as board volume as a percentage of log volume. Recoveries calculated for each group of logs and each log grade: 1, 2, 3, 4, 5 and 6 were:

- Grade recovery: recovery of all graded boards as a % of log volume
- Recovery of Select and Standard grade and better as a % of log volume

In addition, the following product quality indicators were calculated for each log group:

- The percentage of Select and Standard grade boards shorter then 1.8m were calculated as a percentage of the total volume of Select and Standard grade.
- The percentage of the boards of Select and Standard grade longer then 1.8m and equal to or wider than 150 mm were calculated as a percentage of the total volume of Select and Standard grade.

Product value calculations

Product value was calculated for each log group using Victorian ash wholesale prices at May 2006 (Table 2). This information was provided by Neville Smith Timber Industries after allowing reduction in the price of “Merch” grade to reflect loss of volume during processing. In addition the following discounts were applied to Select and Standard grade boards:

- A discount of 10% was applied to all log groups, as the average length of product was less then 3.0 m.

- A discount of 50% was applied to the volume of Select and Standard grade boards shorter then 1.8m in length to all log groups.

Table 2: Victorian ash wholesale price list May 2006.

WHOLESALE TIMBER PRICE LIST at MAY 2006				
WIDTH (mm)	THICK (mm)	SELECT ($/m3)	STANDARD ($/m3)	MERCH ($/m3)
50	12			
75	12			
75	16	1270.00	900.00	350.00
100	12.2			
50	25	1215.00	970.00	350.00
125	12			
100	16	1400.00	1110.00	350.00
150	12			
75	25	1360.00	1005.00	350.00
125	16	1400.00	1110.00	350.00
150	16	1500.00	1200.00	350.00
100	25	1455.00	1120.00	350.00
125	25	1460.00	1165.00	350.00
150	25	1510.00	1190.00	350.00
175	25	1215.00	970.00	350.00
200	25	1790.00	1535.00	350.00
225	25	1440.00	1200.00	350.00
250	25	1770.00	1225.00	350.00
275	25	1770.00	1225.00	350.00

RESULTS AND DISCUSSION

Log volumes and log quality

The numbers, volumes and mean diameter of logs from the three plantations are presented in Table 3; and Table 4 and 5 show the number of logs in each grade category for the three resources, and their corresponding log volumes. Mean log volume data in each grade category for the three resources are presented in Table 6. Generally the log quality from the 2 pruned plantations was poor with only 34% and 30% of logs Grade 3 or better (Victorian C-grade and better) for the *E. globulus* and *E. nitens* respectively with most below the preferred log quality of the hardwood industry in Victoria. The main reason for poor quality was small diameter and the presence of surface defects on the logs usually associated with kino pockets. In contrast 96% of the logs processed from the 47-year-old *E. globulus* were Grade 3 or better.

Table 3: Overall log numbers, log volumes and mean log diameter for the three plantations.

	47 year-old *E. globulus*	13 year-old *E. globulus*	13 year-old *E. nitens*
Total Log Volume [m^3]	27.7	25.4	19.8
Number of Logs	58	80	56
Mean Log Diameter [cm]	46.0	34.5	36.3

Table 4: Number of logs for each log grade and plantation.

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* - number of logs	10	39	7	2		
13 year-old *E. globulus* - number of logs		9	18	20	8	25
13 year-old *E. nitens* - number of logs		10	7	11	16	12

Table 5: Mean log diameter for each grade and plantation.

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* - mean log diameter [cm]	61.7	43.7	38.5	*		
13 year-old *E. globulus* - mean log diameter [cm]		42.3	37.1	34.7	37.6	29.9
13 year-old *E. nitens - mean log diameter [cm]*		43.3	*	37.1	37.5	30.8

*	3 & 4 Grade logs combined
*	3 & 4 Grade logs combined

Table 6: Log volumes for each log grade and plantation

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* - log volumes [m^3]	8.3	16.4	3.0	*		
13 year-old *E. globulus* - log volumes [m^3]		4.2	6.4	6.2	3.0	5.7
13 year-old *E. nitens* - log volumes [m^3]		4.8	*	6.3	5.8	2.9

*	3 & 4 Grade logs combined
*	3 & 4 Grade logs combined

Product recovery and value

Recovery of all boards as a % of log volume and recovery of Select and Standard grade as a % of log volume for each log grade and plantation are presented in Table 7 and Table 8. Information about product length and width are presented in Tables 9 and 10 and product value per log input in Table 11.

In general, product recovery, board lengths and product values declined with log quality. However, there was a great deal of variation in product quality between resources for a given log grade. For example, for grade 2 logs (equivalent to Victorian B-grade) the recovery of Select and Standard grade for the two *E. globulus* plantations ranged from 9.7 and 20.9 (% log vol) (Table 8) despite relatively similar total recoveries (Table 7). This led to some variation in product value between these two resources. The reason for this variation was not determined in this trial, however, data on grade limiting defects was collected and could be analysed if it were considered necessary to determine the cause of differences. One of the differences between these resources was that the 13-year-old trees had been pruned while the 47-year-old trees were unpruned. This single factor could account for the differences.

Table 7: Recovery of all boards for each log group as a % of log volume

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* recovery all boards (% of log volume)	33.1	28.3	23.4	*		
13 year-old *E. globulus* recovery all boards (% of log volume)		32.7	25.9	23.0	22.1	22.2
13 year-old *E. nitens* recovery all boards (% of log volume)		24.3	*	27.6	26.2	18.7

* (red)	3 & 4 Grade logs combined
* (yellow)	3 & 4 Grade logs combined

Table 8: Recovery Select and Standard boards as a % of log volume for each log group

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* recovery select & standard grade (% of log volume)	19.6	9.7	6.7	*		
13 year-old *E. globulus* recovery select & standard grade (% of log volume)		20.9	9.2	5.1	6.3	1.4
13 year-old *E. nitens* recovery select & standard grade (% of log volume)		13.2	*	10.3	8.0	1.6

* (red)	3 & 4 Grade logs combined
* (yellow)	3 & 4 Grade logs combined

Table 9: % of Select and Standard boards shorter <1.8m

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* - % of select & standard boards <1.8m (all width)	20.4	38.6	49.3	*		
13 year-old *E. globulus* - % of select & standard boards <1.8m (all width)		20.9	24.4	49.3		
13 year-old *E. nitens* - % of select & standard boards <1.8m (all width)		12.8	*	15.8	18.1	19.5

*	3 & 4 Grade logs combined
*	3 & 4 Grade logs combined

Table 10: % of Select and Standard boards longer >1.8 and wider >=150mm

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* - % of select & standard boards >1.8m, width>=0.150m	25.1	4.1	0.0	*		
13 year-old *E. globulus* - % of select & standard boards >1.8m, width>=0.150m		7.7	7.4	3.2		
13 year-old *E. nitens* - % of select & standard boards >1.8m, width>=0.150m		10.5	*	1.7	2.2	0.0

*	3 & 4 Grade logs combined
*	3 & 4 Grade logs combined

Table 11: Mean log recovery value [$/log]

	Log grades					
	1	2	3	4	5	6
47 year-old *E. globulus* - mean log recovery value [$/log]	221	66	39	*		
13 year-old *E. globulus* - mean log recovery value [$/log]		120	54	37	44	20
13 year-old *E. nitens* - mean log recovery value [$/log]		88	*	59	70	13

*	3 & 4 Grade logs combined
*	3 & 4 Grade logs combined

The most important information obtained in these trials is summarised in Figure 2 which gives the product value per cubic metre of log input to the mill. This indicates that product value ranged from $75 to $266 with again some inconsistency between resources for Grade 2 logs. The most encouraging finding is that Grade 2 logs from 13-year-old *E. globulus* produced similar product quality and value as Grade 1 logs from the much older 47-year-old *E. globulus*. However, the great deal of variation in log quality and product quality from both the 13-year-old *E. globulus* and *E. nitens* suggests that considerable improvement in log and wood quality would be desirable.

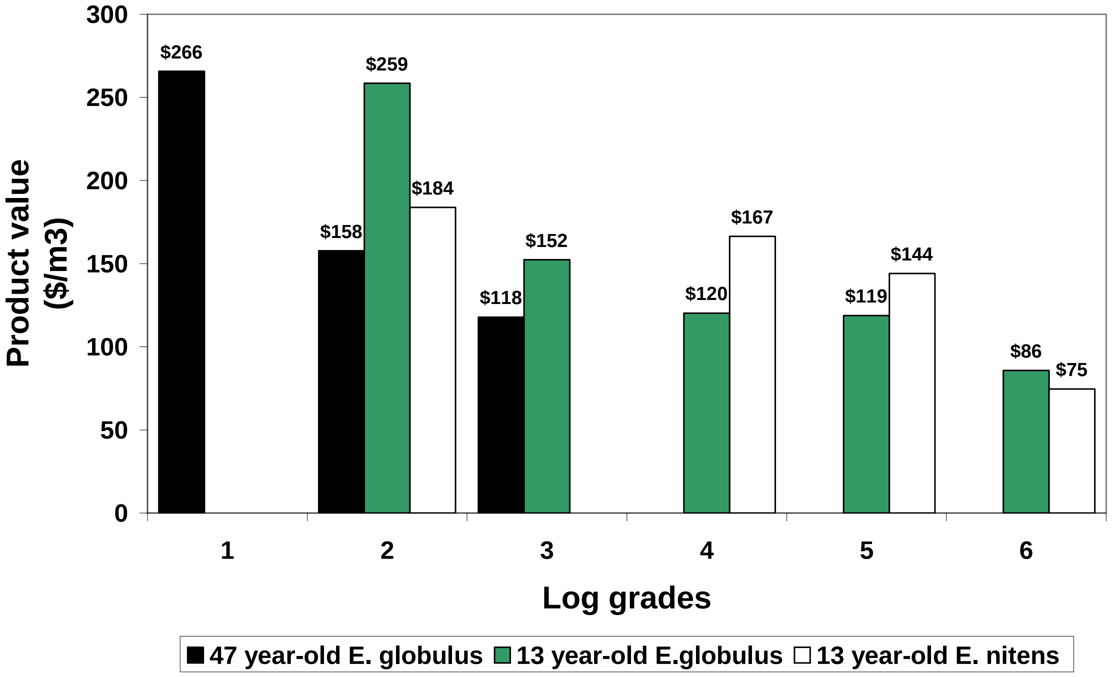

Figure 2: Product value per cubic metre of log input for the three plantations and 6 log grades.

CONCLUSIONS

As with a number of earlier studies these results show that both pruned and unpruned plantation-grown *E. globulus* and *E. nitens* can produce good recoveries of high quality timber. However, the results clearly highlight the importance of log quality and the need to produce consistently high yields of logs at least equivalent to grade 2. This most likely will be achieved in pruned plantations by allowing them to grow to an older age before harvest. However, there were also some wood quality problems found in both pruned stands in the form of kino pockets that led to down-grading of logs. The reason that this defect was so prevalent in these stands is unclear.

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