EVALUATION OF EUCALYPTUS GLOBOIDEA GROWN ON MATAKANA ISLAND

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Report No. 36 November 1996

FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

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An inventory in a 60 year old untended mixed species stand of *Eucalyptus saligna*, *E. botryoides* and *E. globoidea* on Matakana Island determined a sawlog yield of 680 m^3/ha and a pulp yield of 369 m^3/ha. Five *E. globoidea* trees were selected, cut into sawlogs and sawn on a portable sawmill. The overall conversion to sawn timber of 59.5% (% round log volume for actual board size) was relatively high reflecting the symmetry and size of the study logs. However this was reduced to 42.2%. When boards containing compression heart were removed. There was major distortion of sawn boards in the form of crook. When taking into account both the crook and surface checking from open air drying, the potential round log conversion to dressing and better grades reduced from 37% to 19.9%. Most of the high value end uses for eucalypts are for clears and clear cuttings grades. Accounting for both timber distortion and drying degrade, the round log conversion to these grades was a poor 12.6%. With only minor kino present and no apparent decay, the main factor contributing to the low clears recovery was the presence of numerous small intergrown knots, apparently resulting from epicormic shoots. Sample tree average densities were consistently high but there was considerable within and between tree variation in occluded internal branch associated defects, effects of log end splitting, distortion of timber off-the-saw and propensity for surface checking.

BACKGROUND

Matakana Island is a large low elevation sand island situated in the Bay of Plenty between Tauranga and Waihi Beach. A major part of the island is established in plantations, some of which were planted in the 1930's. Of the older stands, there are around 250 ha of mixed species Eucalypts. *Eucalyptus saligna* and *E. botryoides* are main surviving species, but originally many more species were planted. Among the latter is *E. globoidea*, a stringybark eucalypt for which there is minimal utilisation knowledge within New Zealand but a species that is showing considerable promise for solid wood plantation forestry. During the period in which this study was undertaken, Eucalypt stands were being harvested for sawlog and pulp.

In late 1994, a miller working on the island agreed to let NZ FRI research staff carry out a resource evaluation study on the stand he was currently harvesting and milling. At the time of the study the miller was sawing *E. saligna*, *E. botryoides* and stringybark eucalypts for an Auckland sawn timber market with arisings destined for a local landscape timber market. The saw mill was a portable type with vertical and horizontal circular blades and was located within the stand. Saw kerfs for the mill were, 6.4 mm for the vertical and 6.8 mm for the horizontal saw. Much of the timber from the milling operation was transported green to Auckland where it was initially air dried and subsequently kiln dried.

The study stand was an approximately 60 year old mixed *E. saligna*, *E. botryoides*, *E. globoidea* stand with occasional other minor *Eucalyptus* spp. The intention of the study was to carry out a MARVL inventory in suitable parts of the stand and then monitor the conversion of selected *E. globoidea* trees.

METHODS

Five MARVL (Deadman and Goulding, 1979) inventory plots were assessed in parts of the stand containing predominantly *E. saligna*, *E. botryoides* and *E. globoidea*. Five *E. globoidea* trees, representing the diameter range, were selected for the sawing study. These were photographed, assessed for form, diameter and height and felled. Full stems were sectionally measured and cut into 14 sawlogs. Fractures on log ends were mapped. Discs were cut from log ends for future density assessment.

The sawing strategy adopted consisted of laying each candidate log on a fixed bed and lowering the sawing carriage to make horizontal cuts of (approximately) 58, 115, or 165 mm (plus saw kerf) with vertical cuts at 58 mm (plus saw kerf) intervals. The preferred target dimension was 165 * 58 mm followed by 115 * 58 mm. There was no apparent effort to avoid or cut around the compression heart zone or to favour either quarter or flat sawing. During the sawing operation, detailed sawing diagrams were drawn and each piece of timber was numbered so that its location in the log cross-section was recorded. The dimensions of each piece were measured green and where possible, dry (width and thickness at the same point on each piece to the nearest mm and length to the nearest cm). Each piece was graded green off-the-saw to NZ Standards NZS 3631:1988 with a clear one face grade added. Timber from the study was filleted and air dried on site. After air drying, timber was re-graded.

Sawing conversion and grade recoveries were determined for the following:

- total sawing conversion green, with and without docking (to remove log end splits and end checks),
- grade recoveries green with docking
- conversions and grade recoveries with and without; inclusion of compression heart, distortion from sawing (green), distortion from sawing (green and dry), and checking during drying.

Conversions and grade recoveries were determined for actual sawn sizes rather than target dimensions.

RESULTS

1. Stand Yield

Results of the stand inventory are provided in Table 1.

Table 1. Inventory results.

Stocking Stems/ha	**DBH** cm	**MTD** cm	**Basal Area** m2/ha	**MTH** m	**Total Merch. SL**
693	**42.3**	**66.8**	**91.3**	**43.0**	**1,049.0**

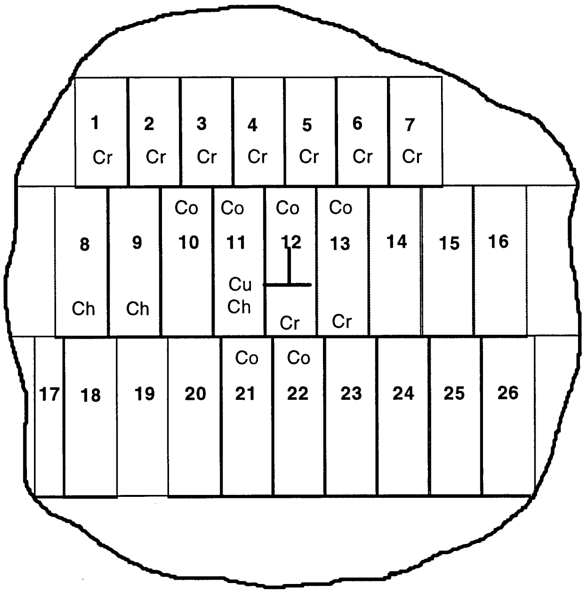
		Log Yields in m3/ha			
Clean SL	**Small branch SL**	**Large branch SL**	**Other SL**	**Total Sawlog**	**Pulp**
561.0	**40.7**	**66.1**	**12.0**	**679.8**	**369.2**

SL = sawlog. Small to large branch size limit is 6 cm. Sawlog minimum small end diameter inside bark (sed) is 35 cm.

2. Sawing Pattern.

Figure 1 illustrates the typical sawing pattern used. The pattern was effectively "through and through" with flitch thicknesses of approximately 58, 115, and 165 mm and final board thicknesses of approximately 58 mm. The sawing strategy resulted in a mixture of flat and quarter sawn boards. The pattern meant that the central portions of logs were sawn into boards with at least some compression heart. A large proportion of boards (particularly those around 165 mm wide) sawn on the quarter had severe crook. For a number of logs, the crook was concentrated on one side of the log but this varied within the tree and did not appear to clearly relate to tree lean or crown branching configuration.

Figure 1. Typical sawing pattern. Large end view of the butt log from tree 4 with sawing pattern superimposed.



3. Sample tree and log parameters.

Tree and log parameters for the sample trees and logs are provided in Table 2.

Table 2. Sample tree parameters.

Tree	DBH cm	Ave. Basic Density kg/ m^3	Height m	Log	Lgth. m	SED mm	Vol. ub m^3	Taper mm/m	Sweep mm/m	Sapwood Depth mm	Branch a/b
1	71.9	687	43.4	1	5.5	512	1.396	20	5	12	-
				2	5.5	459	1.046	11	3	15	-
				3	5.2	400	0.752	11	4	17	-
				4	4.9	374	0.594	7	7	20	a
2	55.2	644	40.2	1	5.5	428	0.908	8	4	25	-
				2	5.3	388	0.650	7	3	20	-
				3	4.9	342	0.510	7	5	20	a
3	52.0	714	broken	1	4.9	328	0.572	19	11	13	-
4	83.8	698	42.0	1	5.5	570	1.794	23	5	30	-
				2	5.5	527	1.301	8	4	25	-
				3	5.5	484	1.057	5	7	25	-
				4	5.5	418	0.890	13	5	20	b
5	58.8	721	36.1	1	5.2	374	0.743	16	7	14	-
				2	4.9	334	0.488	8	7	12	-

Logs are coded for the type of branching; '-' no visible branches, 'a' = branches ≤ 6 cm and 'b' = branches over 6 cm.

Trees had generally very good external appearance over the portions of the stem from which sample logs were cut. All logs were straight, symmetrical and only the butt logs had moderate taper. Most were free of branches with the exception of the uppermost logs in trees 1, 2 and 4. Average densities were determined for disc from log ends and these are summarised in Table 2. Average tree densities were considerably higher than the 612 - 655 kg/ m^3 range reported for other New Zealand studies (Harris and Young, 1980; Bier, 1983; and Haslett, 1990). The sapwood for all logs was comprised of a narrow band with a average 19 mm depth.

4. End Splitting and Checking.

The felling which took place on the 25th August 1994 was carried out with considerable care to avoid the falling stems impacting against logs and stumps. All logs had end splits which were apparent immediately after log making and these visibly opened and new minor splits appeared over the following week prior to sawing on the 31st August. End splits translated into splits on the ends of some boards which required docking. The volumes lost from end splits are summarised by log, tree and height class in Table 3.

Table. 3. Reduction in % round log conversion due to end splits by log, tree and height class.

Log No	1a	b	c	d	2a	b	c	3a	4a	b	c	d	5a	b
% Convn.	0.8	3.7	0	0.8	1.9	7.5	7.6	1.2	6.6	2.5	1.0	2.5	0	0

By	**No. Logs**	**% Covn. loss**
Tree		
1	4	1.3
2	3	5.7
3	1	1.2
4	4	3.2
5	2	0
Log Height Class		
butt	5	2.1
2nd	4	3.4
3rd	3	2.9
4th	2	1.6
Total	14	2.5

End splits caused around 2.5% loss in total conversion. There were significant between tree differences in the effects of end splits. The impact of log end splits was greatest for second logs. Splits associated with stresses imposed during cross-cutting were anticipated but these appeared to be of only minor consequence.

5. Sawing and drying results.

5.1. Green grade recovery by tree and log height class.

The data summary in table 4 provides measures of the conversion and grade recovery potential of the 14 study logs as much of the 'mill performance' influence has been disregarded in this data set. The table provides conversion and grade recoveries by tree and log height class. Overall conversions are for docked timber assessed as actual sawn dimensions and ignores sawing associated timber distortion (ie. crook and bow). The compression heart zone is considered here separately from the box grade.

Table. 4. Conversion and grade recoveries green ignoring distortion due to sawing.

By:	**Total Log Volume m^3**	**Covn. % rd. log**	**Grade Recovery % sawn**							
Tree			**compn.**	**b**	**d**	**f**	**s**	**p**	**x**	**c**
1	3.788	65.6	38.1	8.9	14.3	7.0	18.7		5.2	7.8
2	2.068	56.9	25.1	7.7	33.1	10.3	18.3		4.8	0.8
3	0.572	48.2	17.0	26.5	33.0		18.1			5.4
4	5.042	58.0	28.0	8.7	36.4	12.1	12.0		2.4	0.4
5	1.231	56.3	13.1	2.2		8.7	16.4	19.3	15.3	25.0
Log	**ht. class**									
butt	5.413	60.0	32.0	3.3	28.7	5.0	10.5	4.1	5.8	10.6
2nd	3.485	58.6	21.5	13.1	25.3	9.5	23.5		4.8	2.3
3rd	2.319	61.7	36.5	0	18.9	15.7	23.6		4.5	0.8
4th	1.484	56.3	23.8	33.5	21.6	15.7	4.4		1.0	
Total	12.701	59.5	29.1	8.7	25.1	9.4	15.8	1.8	4.8	5.3

(rd. = round, compn. = box grade with compression heart, b = box, d = dressing, f = factory, s = shop, p = premium, x = clear 1 face, and c = clear both faces.)

Ignoring distortion in sawn timber that could be attributed to log making and sawing variables, the overall conversion was 59.5%. The largest diameter tree had the greatest overall conversion and correspondingly, the smallest had the lowest conversion. There was no clear trend in conversion by log height class. A relatively large component of the sawn timber (29.1%) was graded as 'box' because of the presence of compression heart. Dressing and No. 1 cuttings were the next main grades with relatively small amounts of all other grades. All sample trees yielded similar amounts of cuttings grades (around 18 - 28%). However, there was considerable between tree variation in overall grade distribution with tree 5 in particular having a high 'cuttings' and generally better grade recovery. For grade recoveries by log height class, the butt logs had a slightly better recovery of higher grades, while at the other end of the range, the two fourth logs converted to mainly box and dressing grade.

There was a relatively small amount of kino present with only five of the 220 boards in the study being down graded to box because of it. Fall down from clears grade to dressing and better was largely due to the presence of branches. There were numerous small inter-grown branch defects on boards from trees one to four inclusive but noticeably fewer on boards from tree five. Although there were no epicormic shoots present at the time of the study, the size and condition of the knots were consistent with those formed from short lived epicormic shoots. These shoots are unusual in New Zealand grown *E. globoidea* (E. H. Bunn pers. comm.). Twenty two of the 220 boards were down graded to box because of branch related defects (12 of these were from the 'branchy' upper logs of trees two and four). There was no visible decay present in any of the study logs.

5.2. Degrade from timber distortion and from drying.

The 'conversion' columns in Table 5 indicate the potential of the study logs while the 'losses' columns apportion degrade from 'dressing and better' grades. The 'all timber' data provide total sawing conversions which are quite high for the equipment used reflecting the symmetry of the logs. Column 2 has the substantial component with compression heart removed. The third column provides conversions to the higher value grades ignoring sawing and drying related degrade. The fourth column provides the final saleable dressing and better grade recoveries for the actual operation with 41.8% of potential dressing and better grades removed because of timber distortion and checking during drying. (Column 4 is adjusted down by 4.4% for shrinkage losses during drying to an approximately 20% moisture content.) The round log conversion to dressing and better grades is 19.9% or 12.6% for cuttings and clears grades. In columns 5, 6 and 7, the degrade is separated into: timber distortion off-the-saw (the principal component), distortion both off-the-saw and from drying, and degrade resulting from checking during drying.

Table 5. Conversions and grade recoveries showing the effects of sawing related degrade by tree and log height class.

		Conversion (% round log vol)				**Loss in dressing and better (% sawn)**		
		1. all timber (green)	**2. minus comprn zone** (green)	**3. dressg. and better no distortn** (green)	**4. dressing and better, with distortn & checkg** (dried)	**5. distortion dressing and better,** (green) **(to box)**	**6. distortion dressing and better,** (gr+dry) **(to box)**	**7. checking dressing and better,** (dry) **(to eng)**
By Tree	**1**	65.6	40.6	34.7	18.0	21.1	31.4	14.3
	2	56.9	42.6	38.2	17.3	18.2	35.8	16.9
	3	48.2	40.0	27.3	26.1	0	0	0
	4	58.0	41.8	36.7	18.2	32.1	32.1	16.1
	5	56.3	48.9	47.7	34.3	19.4	19.4	5.3
By log ht. class	**butt**	60.0	40.8	32.7	26.3	15.7	20.1	8.9
	2nd	58.6	46.0	38.4	17.0	23.1	26.6	27.1
	3rd	61.7	39.2	39.2	20.1	38.8	42.7	3.6
	4th	56.3	42.9	24.0	3.1	39.3	67.1	19.7
All logs		59.5	42.2	37.0	19.9	24.1	29.9	13.9

Compn = compression heart, dressg = dressing, distortn = timber distortion, gr = green sawn.

Most degrade occurred at sawing and appeared as crook in pieces that were quarter sawn. Table 5 illustrates a trend of increasing sawn timber distortion with increasing log height class and decreasing log diameter. The increased incidence of distortion in quarter sawn timber from small dimension logs is consistent with the long established theory of a greater tension wood gradient across small dimension stems (Jacobs, 1955). Surface checking in air drying was another large source of degrade with nearly 14% of dressing and better grades dropping to building grade because of severe surface checks.

There were large between tree differences in the amount of degrade. Tree 3 was small and yielded only one sawlog, had a poor overall conversion and recovery of dressing and better grades, but had no degrade associated with sawing or drying. Tree 5 had a better grade recovery, some sawing problems, but minor surface checking. For the data summaries by log height class, there is bad surface checking in second logs. The large amounts of distortion associated with sawing for third and fourth logs and surface checking in fourth logs may partly reflect between tree differences. A sample of boards from each log were cross-cut and there was no apparent internal checking. The average round log conversion for all study logs is illustrated in figure 2.

DISCUSSION

The study provided the opportunity to look at the growth and form of a mixed Eucalypt stand on a warm coastal North Island site and also provided an indication of the potential sawing conversion of untended *E. globoidea* trees. The sawing equipment and sawing strategy adopted were inappropriate for the species with the result that a large portion of green sawn boards had significant crook. However, sawing results ignoring crook and surface checking after drying still provided a reasonable assessment of the quality of the trees sampled.

Overall conversion was high given the constraints inherent in using a portable mill with relatively large saw kerfs. It is probably more appropriate to consider conversion to sawn timber minus compression heart as a measure of the conversion potential of the *E. globoidea* logs sawn in the study. Compression heart material does have a possible market for end uses such as landscaping where strength is not critical but durability essential. The green grade recovery results, without sawing related timber distortion could have been obtained with a more appropriate log making and sawing strategy and hence these data are a useful measure of the study logs potential sawn timber grade recovery.

Log handling and sawing strategies can be employed to eliminate much of the timber distortion problem in sawing eucalypts (Haslett 1988, and Haslett 1990). Major improvements would have resulted by sawing shorter log lengths (4.8m or less for the smaller diameter logs). The amount of timber distortion increases with the square of the length (Jacobs, 1955). ‘Flat sawing’ would have been appropriate for small diameter logs while the use of straightening saw cuts could have eliminated much of the distortion in ‘quarter sawn’ timber. The apparently high total conversion (ignoring distortion) was also a result of using actual board sizes rather than nominal or target sizes. The rational here was that the study aimed entirely at determining the solid wood potential of the study logs and was not aimed at evaluating milling practices.

The five study trees represented a range in piece size but all were typically symmetrical and most study logs had no visible external branches. There were however large between tree differences in; sawing conversion, grade recovery, distortion of green sawn timber and surface checking. All trees had high basic density but it is interesting to observe that the two highest density trees had the least problems in terms of end splitting, checking and timber distortion 'off-the-saw'. There is an obvious need to investigate the heritability of important wood properties that are associated with the stability and dying performance of this and other favoured *Eucalyptus* spp. If these wood properties are largely heritable, there is the opportunity to screen out likely poor performing trees from future breeding programmes and thereby improve the processing performance of future plantations.

The scope of the study was quite limited but provided some important observation at minimal cost. Many more studies are needed before definitive answers about the utilisation potential of selected Eucalypt species are known. For the study reported here and for most similar studies there are sample size constraints that limit the value of the end results. For instance:

— small tree sample size (particularly as large between tree differences were observed) with only a few logs representing different elements within the stand,
— the effect of site on the study sample (ie. results may apply to the study site only),
— the effect of silviculture and age (similarly, growth, conversion and grade recovery results may be quite different for both different silviculture regimes and stand age), and
— the sample may represent a limited genetic base (there may be large between and within provenance effects; in this instance provenance is unknown).

This study would have also benefited from: a more representative sample of stand log qualities, a thorough investigation of wood properties and better and more appropriate, sawing and drying strategies, facilities and equipment.

CONCLUSIONS

An inventory in an approximately 60 year old untended mixed species stand of *Eucalyptus saligna*, *E. botryoides* and *E. globoidea* on Matakana Island determined a sawlog yield of 680 m^3/ha and a pulp yield of 369 m^3/ha. Trees were generally of good form and were being harvested for sawlogs. Five *E. globoidea* trees from across the stands diameter range were selected, cut into sawlogs and sawn on a portable sawmill. Sample trees had relatively high basic density (an average of 696 kg/ m^3) compared to other studies of New Zealand grown trees. The overall sawing conversion (green), including timber with compression heart and ignoring sawing and drying related degrade, was 59.5% (of round log volume). With compression heart removed, this dropped to 42.2% while the conversion to dressing and better grades was 37%. Air dried timber grade recoveries (as % sawn and ignoring sawing and drying related degrade) in decreasing order of yield were: box with compression heart (29.1%), dressing (25.1%), shop (15.8%), factory (9.4%), remaining box (8.7%), and lesser amounts of clears and premium grades.

A "through and through" sawing pattern was used and this resulted in a mix of quarter and flat sawn timber. The log making strategy, sawing equipment and sawing and drying strategies used were inappropriate for the species and resulted in considerable timber distortion off-the-saw (29.9% of potential dressing grade and better was reduced to box, primarily because of crook) while surface checking during open air drying was significant (a further 13.9% of dressing and better reduced to building grade).

The clear grade recovery (10.1% of total sawn timber or 8.1% after drying) of study logs was poor and this was largely due to numerous small inter-grown knots visible on the surface of the sawn timber. Many of these knots were likely to have been caused by short lived epicormic shoots. There was little kino present and no visible rot.

As well as within tree differences there were major between tree differences in: occluded internal branch associated defects, effects of log end splitting, distortion of timber off- the-saw and propensity for surface checking. Large between tree differences in such critical factors indicates that sample sizes must necessarily be large and repeated across siting, silviculture and seed source variables before definitive answers on the sawing performance of New Zealand grown *E. globoidea* can be provided.

ACKNOWLEDGMENTS

The FRI gratefully acknowledges the generous assistance of Mr G. Lett of Tauranga in providing facilities, equipment and general support for the study at personal cost. The Forest and Farm Management Cooperative provided $5,000 which greatly assisted the data analysis and 'write-up' stages of the study. Ken Gilchrist of the Wood Processing Division of FRI carried out the density analysis of stem sections cut from log ends. The NZ FRI research staff involved were; Errol Hay, Cate MacLean, Steve Gatenby, John Moore, Te Waa Owens, Ken Gilchrist and Alan Somerville.

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Caption:
Figure 2. Average round log conversion of all study logs.