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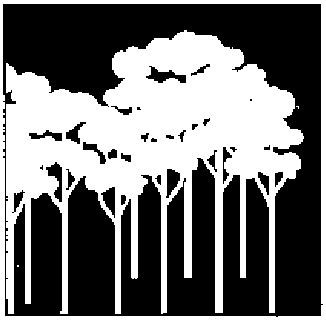

EFFECTS OF SILVICULTURAL TREATMENTS ON SPOTTED GUM MINING TIMBER PRODUCTION

By Spencer Bruskin

FORESTRY COMMISSION OF NSW
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SUMMARY

The data summarised in this paper were collected over a 17 year period from an experiment established to study the effects of silvicultural regimes on the production of mining timbers. The trial included a test of normal logging practices, logging with timber stand improvement, and clearfelling with two different stump heights. Based upon this data, at age 17 no apparent differences in growth can be found between stems originating from coppice, lignotubers or seed regeneration. Volume increments in logged treatments ranged from 3.1 to 3.9 m^3 ha^{-1} yr^{-1}. Diameter growth (DBHOB) of the 100 largest trees ha^{-1} was 1.1 cm yr^{-1} in the clearfelled treatments. Comparisons of height growth (100 tallest trees ha^{-1}) at ages 17, 26 and 44 indicated that the early height increment of 1.0 m yr^{-1} at age 17 falls to 0.8 m yr^{-1} at age 25 and is down to 0.2 m yr^{-1} at age 44. While conclusions about the management of spotted gum stands could not be reached on the basis of this one trial, several implications for management are suggested.

INTRODUCTION

This experiment was part of a 1970 Forestry Commission of New South Wales research project into the dynamics of growth for small timber production. The purpose of the project was to examine the response of coppice shoots of varying sizes and age to different methods and intensities of release and to develop growth production functions for trees and stands in those coastal forest associations managed for small timber production - primarily mining timbers (R.A. Curtin, *unpubl. data*). A number of experiments, including this one, were established in the forests near Newcastle.

In the time since the establishment of this experiment, the demise of the mining timber market has changed the management direction in these coastal forests. They are currently managed to produce small sawlogs and poles rather than mining timbers. As a result, this experiment is to be terminated.

This report summarises the data for this one experiment. Few useful conclusions can be reached on the basis of one trial located on one site for a species with the natural range of spotted gum. These data may be useful at a later date, however, when combined with other studies of the forest type.

THE EXPERIMENT

The experiment was established in 1971 - 1972 at Curtis' Paddock in Cpt. 103 of Olney State Forest to study the effects of different silvicultural regimes on the production of mining timbers. The design included a test of differences in coppice regeneration resulting from two stump heights in clearfelled treatments.

This was done because at the time mining timbers were frequently recovered working downward from the small end of the log, the loggers preferring to avoid cutting at the butt swell. The Forestry Commission would then lower the stumps to 10-15 cm because of concerns for wind firmness and decay in the resulting coppice. This experiment was designed to test the necessity of this follow-up treatment.

The compartment in which the experiment was located had been logged in 1945 for sawlogs, mining timber, and firewood. The residual trees were subsequently ringbarked. This produced an even-aged stand. The compartment history records further mining timber removal between 1969 and 1971 just prior to establishment of the experiment but the exact location within the compartment is not known (District Forester, Wyong, *pers. comm.*). The experiment plots were established and logged between November 1971 and March 1972.

The plots were located in Forest Type 74 (Anon, 1989), composed predominantly of spotted gum (*E. maculata*), ironbark (*E. paniculata*), and grey gum (*E. propinqua*). The site is at an elevation of 90 m ASL on a well-drained 12° easterly slope. The soil is described in the experiment files as "stony podsol derived from Hawkesbury sandstone with a heavy clay subsoil".

The experiment was a complete randomized block design replicated three times with each block containing five treatment plots of 0.0405 ha. each. The blocks were composed of plots that contained similar numbers of dominant and co-dominant trees. The plots in Block 1 had the highest number and those in Block 3 had the lowest. The arrangement of the plots is shown in Figure 1.

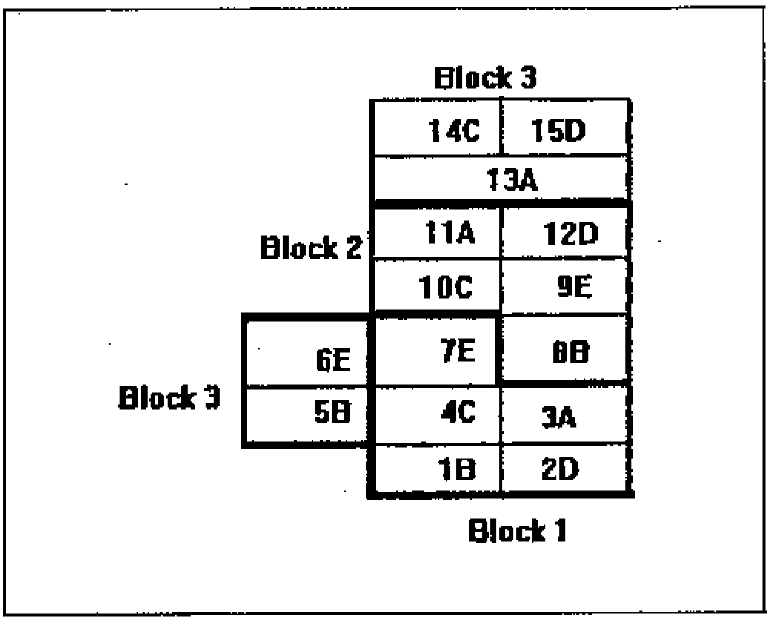

Figure 1. Layout of blocks and plots.

The following five treatments were applied:

- A - Control - no treatment
- B - Logged only
- C - Log with timber stand improvement (TSI)
- D - Clearfelled - high stumps (24 inches/60 cm)
- E - Clearfelled - low stumps (6 inches/15 cm)

The standard logging methods of the time were used in all treated plots. The "Logged" plots were selectively logged to maximize the production of commercial pit props. The "Log/TSI" plots had additional damaged trees and trees of poor form or poor quality removed after logging (R.A. Curtin, *pers. comm.*). According to the experiment records, the "Logged" treatment removed 65% of the available volume and 30% of the merchantable stems from all diameter classes. The "Log/TSI" treatment was more intense, removing 88% of the volume and 78% of the stems.

The dimensions of desirable mining timber products at the time of logging were: *props* - 1.8 to 2.4 metres long with a diameter of 8 to 16 cm; *full-round baulks* - 2.4 to 4 metres long with a diameter of 18 to 24 cm; and *half-round baulks* - 2.4 to 4 metres long with a diameter of 20 to 30 cm.

In subsequent measurements the species, diameter and bole height of each tree larger than 5 cm DBHOB was recorded as well as the heights of the 10 tallest trees in each plot. Trees were to have been given a utilization code to identify those that contained or potentially would contain a pit prop or baulk and those that would eventually produce a sawlog. Unfortunately, the system was not applied consistently over the years preventing analysis of utilization as planned.

The stumps from merchantable trees in the treated plots were numbered and the coppice stems originating from those stumps were recorded using a distinguishing code. All other regrowth, whether from lignotubers, seed, or coppice from un-numbered trees, was lumped together in one code. No coppice was recorded until it reached 5 cm DBHOB.

The experiment was measured in December 1971 prior to logging. Further measurements were taken in 1972 (after logging) and in 1973, 1974, 1977, and 1988-1989.

METHOD OF ANALYSIS

Analysis of variance was performed using the SAS General Linear Model (PROC GLM) procedure (Anon, 1987) on diameters, heights, and volumes to compare treatments. Uniformity and comparability within and between treatments was examined graphically through a series of box plots generated through the SAS Univariate (PROC UNIVARIATE) procedure using the 1989 measurements of diameters (DBHOB) and total height for the 100 largest trees per hectare in each plot.

Gross merchantable volumes were compared because of the inconsistencies in data which prevented accurate comparisons of "useful" volume as mentioned previously. Gross merchantable volume was computed using the Forestry Commission's volume table, shown below, for spotted gum:

$$V = -.0051778 + .68469*SA*LH - .829436*SA - .00873476*SA*LH2$$

Where: V = volume
SA = sectional (basal) area
LH = merchantable (bole) height

RESULTS

1. Coppice

Although the experiment was to have tested the regeneration and growth of coppice, the recording of coppice stems was conducted for pre-selected stumps only. Therefore, total coppice regeneration was not accounted for in the coding system. Coppice that developed from stumps other than those selected was recorded as general ingrowth, causing an underestimate of the total amount of coppice regeneration that occurred. Some apparent erroneous coding of the coppice from the selected stumps further confounded the system. Personal inspection of the plots showed higher levels of coppice regeneration from those stumps than earlier measurements would have indicted.

Early response of coppice after logging is believed to be faster than that for lignotubers released in the same operation. A test of the early response could not be derived from this data as trees were not measured until they reached 5 cm DBHOB. However, there was no observable difference in size between lignotuber and coppice regeneration 17 years after logging.

2. *Stand Age*

The logging treatments created differing age arrangements making direct comparisons of diameters and heights difficult. The stand was estimated to be 27-years-old in 1972 when the trial was installed. By 1989, when the most recent measurements were taken, the trees in the control plots had reached 44 years of age. However, the plots that had been clearfelled in 1972 were only 17-years-old in 1989. The other two treatments, "Logged" and "Log/TSI", were two-aged with 70% and 19% respectively of the trees dating from the original 1945 logging and the balance dating from 1972.

3. *Plot Uniformity*

The uniformity of the average diameters and heights of the best 100 trees within treatments can be seen in Table 1. This was also checked graphically using box plots from PROC UNIVARIATE. The plots appear relatively homogeneous (that is, the diameters of the "Logged" plots are similar to each other, the "High Stump" plots are similar to each other, etc.) except for plot 4C, a "Log/TSI" plot in Block 1. This plot has an average diameter 4 cm greater and a top height over 3 metres greater than the average of each of the other two "Log/TSI" plots. Regression analysis confirmed this difference to be statistically significant ($p > 5\%$).

Examination of the data for the heights of the best 100 trees in Table 1 suggested that there could be site differences at the southern end of the experiment where plots 1B, 2D, 3A, 4C, and 6E are located. The heights of the best 100 trees ha^{-1} in these plots are greater than in the other plots within the same treatments. However, the difference is not statistically significant except for plot 4C as described above. Block 1 at the southern end of the experiment lies downslope closer to a wet gully and it was Block 1 that contained the greatest number of dominant and co-dominant trees when the experiment was established.

Table 1. Plot data by treatments comparing selected stand conditions immediately after logging in 1972 with conditions in 1989. Also shown is the stocking prior to logging.

	Ave. DBHOB best 100 trees ha^{-1} (cm)		Ave. total hgt. best 100 trees ha^{-1} (m)		Stocking trees >5 cm ha^{-1}			
Plots	1972	1989	1972	1989	Pre-log	1972	1989	Block No.
Control								
3A	23.1	28.7	20.1	24.8	1333	1333	1308	1
11A	23.7	28.8	19.1	22.4	1457	1457	1852	2
13A	23.1	29.2	18.6	20.8	1407	1407	1630	3
Logged								
1B	16.7	25.4	17.8	22.3	1506	1086	1905	1
5B	18.2	25.6	17.1	21.0	1679	963	1753	3
8B	18.6	25.3	17.5	21.2	1704	1358	1901	2
Log/TSI								
4C	14.8	25.1	16.6	20.8	1778	395	2049	1
10C	11.6	20.8	12.6	17.0	1358	222	1654	2
14C	12.8	21.6	12.8	16.8	1259	370	1580	3
High Stump								
2D	*	18.1	*	18.0	1358	0	1506	1
12D	*	15.9	*	15.6	1210	0	1852	2
15D	*	18.4	*	17.0	1926	0	2420	3
Low Stump								
6E	*	18.4	*	18.9	2222	0	3012	3
7E	*	16.4	*	17.7	1778	0	2025	1
9E	*	16.5	*	16.0	1506	0	1432	2

* No data available

4. *Volume*

The gross volume before and after logging has been compared with volumes computed for 1989 (Table 2).

The differences between mean volumes of the "Log/TSI", "High Stump" and "Low Stump" plots are not statistically significant ($p>5\%$). The volume increment of the treated plots varies from 0.8 to 1.1 m^3 ha^{-1} yr^{-1}, with the greatest increment occurring on the clearfelled and TSI plots.

Table 2. Comparison of gross volume by treatment before and after logging and 17 years later.

	Control	Log	Log/TSI	High stump	Low stump
			($m^3\ ha^{-1}$)		
Before logging	81.3	105.4	72.0	92.5	79.6
After logging (1972)	81.3	37.1	9.0	0.0	0.0
1989	114.1	104.0	61.7	58.6	57.3
			($m^3\ ha^{-1}\ yr^{-1}$)		
17 year volume increment	1.9	3.9	3.1	3.4	3.4

The volumes are low compared with those found on the south coast (Furrer, 1971). The *gross* volume increment is high.

5. *Diameter and Height*

Table 3 shows the mean diameter and mean height of the best 100 trees per hectare by treatment a year after logging and as they measured in 1989.

Table 3. Mean diameter, height and increment of the best 100 trees per hectare after logging. Numbers in parenthesis are rankings.

		1973	1989	
Mean DBHOB				$cm\ yr^{-1}$
100 largest	Control	23.6	28.9 (1)	0.3
trees ha^{-1}	Logged	18.2	25.4 (2)	0.4
(cm)	Log/TSI	14.2	22.5 (3)	0.5
	High Stump	0.0	17.5 (4)	1.1
	Low Stump	0.0	17.1 (5)	1.1
Mean height				$m\ yr^{-1}$
100 tallest	Control	19.3	22.7(1)	0.2
trees ha^{-1}	Logged	17.5	21.5(2)	0.2
(m)	Log/TSI	14.0	18.2(3)	0.3
	High Stump	0.0*	16.9(5)	1.0
	Low Stump	0.0*	17.5(4)	1.0

* No measurements available

Figure 2 shows the 1989 diameter distribution within the treatments by 2 cm diameter classes. The clearfelled plots obviously lack the larger diameter classes. Although the selective logging in the "Logged" treatment retained a greater range of diameter classes than the clearfelled treatment, the merchantability of those residual stems was not tested.

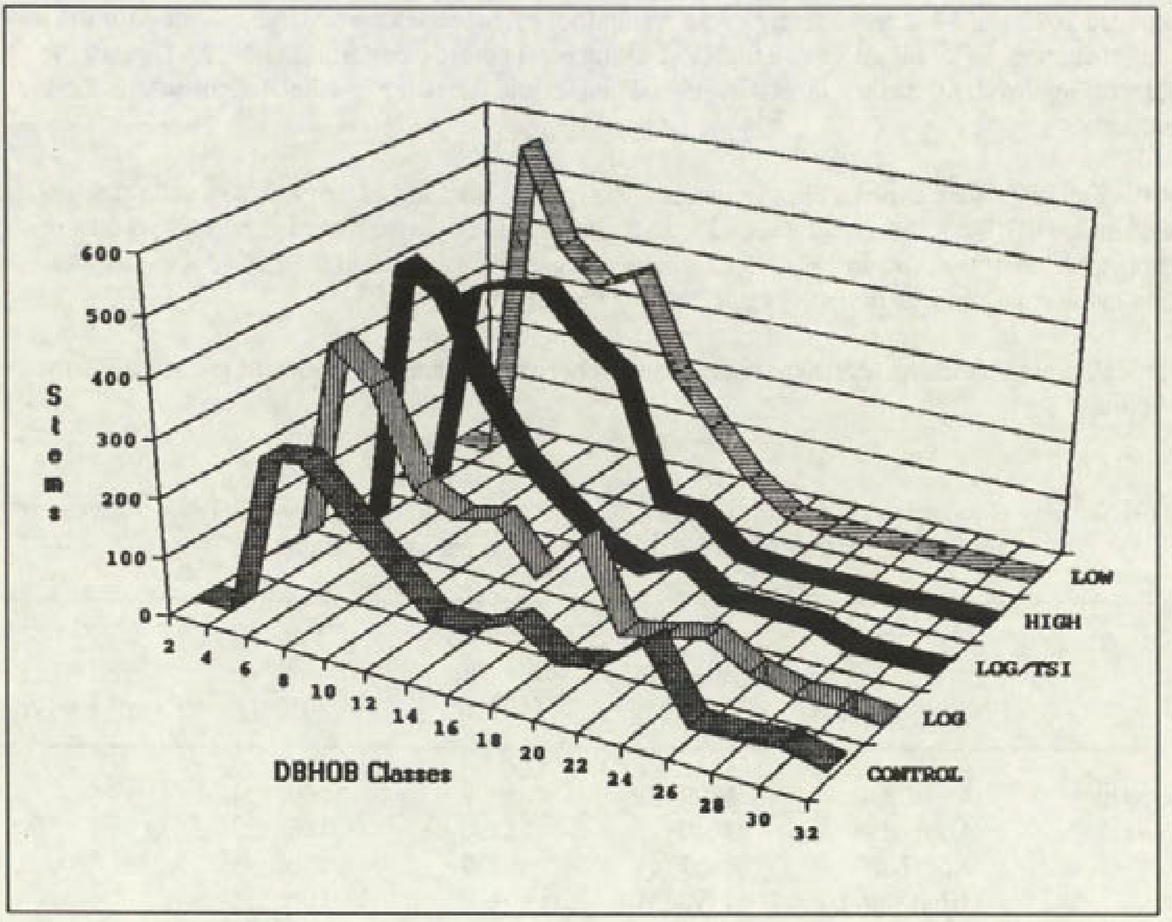

Figure 2. DBHOB distribution by 2 cm classes using the 1989 measurements, 17 years after treatment.

The difference in stump heights within the clearfelled treatments has made no apparent difference in diameter increment growth. Both clearfelled treatments have greater diameter growth than the "Logged" and "Log/TSI" treatments (Table 3).

The experiment file noted that the mean dominant height (height of the ten tallest trees) within the experimental area before the plots were installed was 20 metres. This would indicate a height increment of 0.8 m ha^{-1} $year^{-1}$ at age 25. Current height increment ranges from 0.2 m ha^{-1} yr^{-1} in the "Control" to 1.0 m ha^{-1} $year^{-1}$ within the clearfell treatments. By comparing the height increment of the same stand at age 25 (in 1971), age 17 (clearfelled plots in 1989) and age 44 (the "Control" in 1989), it appears that height increment falls off between age 17 and age 25 on this site and is fairly low by age 44.

6. *Stocking*

Stocking levels at age 17 (1989) were similar among the treated plots except for the low-stump treatment (E), which was slightly higher (Table 4). Examination of the individual plots (Table 1) shows that plot 6E (in Block 3) contained over 3000 stems per hectare while plots 7E and 9E contained 2025 and 1432 respectively. As a result, Plot 6E increases the average stocking for the low-stump treatment. Plot 6E also had a higher stocking level before clearfelling in 1972. Despite the high stocking level, 6E had the largest average diameter and the tallest average height among the low-stump plots

By 1989 all plots were experiencing an increase in apparent stocking as more regeneration reached the measurable DBHOB of 5 cm and were tallied. However, little new regeneration was found during a field inspection of the plots in 1991. This would indicate that a decline in overall stocking should begin in the near future as mortality sets in among the suppressed trees.

Although present stocking levels are high, there has been no apparent reduction in growth of diameter or volume.

Table 4. Comparison of stocking and basal area before treatment, immediately after treatment and 17 years later. Numbers in parenthesis represent rankings

		Before logging (1972)	After logging (1972)	Present (1989)	Inc. $m^3 ha^{-1} yr^{-1}$
Stems ha^{-1} > 5cm	Control	1399 (5)	1399	1597 (5)	
	Logged	1630 (2)	1136	1868 (3)	
	Log/TSI	1465 (4)	329	1761 (4)	
	High stump	1498 (3)	0	1926 (2)	
	Low stump	1835 (1)	0	2156 (1)	
BA ha^{-1} (m^2)	Control	21.1 (4)	21.1	29.6 (1)	0.5
	Logged	24.9 (1)	12.1	26.6 (2)	0.8
	Log/TSI	19.3 (5)	2.7	17.9 (4)	0.9
	High stump	22.0 (3)	0.0	17.6 (5)	1.0
	Low stump	22.5 (2)	0.0	18.9 (3)	1.1

7. *Species Composition*

The data were examined to determine if there were any changes in species composition between treatments (Table 5). All plots showed a decline in spotted gum and, in the clearfelled plots, a slight increase in grey gum. The greatest decline in spotted gum stocking occurred in the low-stump treatment with a fall of 24%. Grey gum increased in both clearfelled treatments (up 5% up in the low-stump and up 12% in the high-stump) but remained much the same in the non-clearfelled treatments.

Table 5. Species composition by treatment before logging and 17 years after logging expressed as a percent of composition.

Treatment	Species year	SG %	GG %	IBK %	WM %	TWD %	TRP %	RBA %	RM %
Control	1972	62	22	6	6	2	1	0	0
	1989	53	23	7	9	6	2	0	0
Log	1972	61	20	4	8	2	<1	4	0
	1989	53	20	8	9	4	1	4	0
Log/TSI	1972	60	21	11	4	2	<1	1	0
	1989	50	20	19	3	2	2	3	1
High stump	1972	66	22	<1	8	2	0	0	0
	1989	51	34	<1	10	3	<1	0	<1
Low stump	1972	66	12	2	3	9	<1	6	0
	1989	42	17	7	4	12	2	16	0

GG = Grey Gum
IBK = Ironbark
RB = Rough-barked Apple
RM = Red Mahogany
SG = Spotted Gum
TRP = Turpentine
TWD = Tallowwood
WM = White Mahogany

Most of the minor species were unchanged or increased marginally in all treated plots except for rough-barked apple which increased 10% in the low-stump clear-cut.

CONCLUSIONS

As stated earlier, few general conclusions can be reached about the management of spotted gum on the basis of this one trial. There are, however, a few silvicultural applications that this information suggests.

1. The "clearfelled" treatments in this experiment were only 400 m^2 in size. They might, therefore, provide a good model for regeneration and growth following a group selection treatment in the uneven-aged management of spotted gum stands on this type of site.

2. Spotted gum appears to be tolerant of high stocking levels while producing acceptable growth. This might indicate that it would respond well to the application of the light to medium regime for low site quality recommended in the blackbutt thinning guides (Horne, 1991).

3. From this study it would appear that there are no significant differences 17 years after logging between the coppice produced from high stumps and from low stumps. There is also no apparent growth and size difference between regeneration originating from lignotubers, coppice and seed.

4. Selective harvest has produced adequate regeneration as has group selection. As long as the stands are renewed from time to time by group selection to remove the accumulation of non-merchantable stems, there do not appear to be regeneration and growth problems associated with selective cutting.

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