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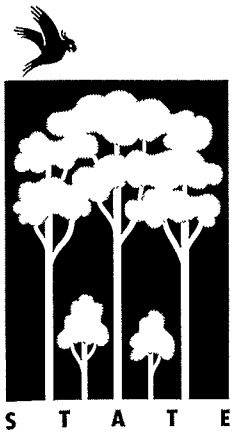
THINNING SCHEDULES FOR BLACKBUTT REGROWTH FORESTS

By Ross Horne



STATE FORESTS
RESEARCH DIVISION

THINNING SHEDULES FOR BLACKBUTT REGROWTH FORESTS

by

ROSS HORNE

RESEARCH DIVISION
STATE FORESTS OF NEW SOUTH WALES
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CONTENTS

ABSTRACT

By analysing four decades of experimental data from the north coast of New South Wales, thinning schedules have been prepared for regrowth blackbutt forests. Assuming that the production of sawlogs (nominally set at about 80 cm dbhob) is the objective, the time taken for the mean of the largest 50 trees ha^{-1} to reach 80 cm dbhob has been estimated. A number of variable intensity thinning schedules applied at about ages 15, 30, 45, 60 years on average and better-than-average sites, have been compared for size distribution and rotation length.

The management implications from the results are broadly two-fold. In order to produce 80 cm dbhob trees in less than 100 years for stands of the lower site quality category, there is little option but to apply a schedule of heavy intensity thinnings. However, in the case of higher site quality stands, there is an option of producing 80 cm trees in about 70 years by the application of a heavy thinning schedule, ***or alternatively*** to considerably increase the sawlog yield by applying a less intense thinning schedule over an 80 to 90 year rotation.

INTRODUCTION

In New South Wales, blackbutt (*Eucalyptus pilularis* Sm.) is the most commercially important native tree. Often occurring as pure stands, it naturally occupies coastal and escarpment areas, where it regenerates easily in frost-free areas. Extensive past logging of virgin stands and the occurrence of occasional wildfires have resulted in large areas of regeneration, which have now grown to form regrowth forests that show promise of future high yield[1].

In 1982, a schedule to thin north coast, even-aged blackbutt regrowth stands was formulated from thinning-response analysis of experimental data. The purpose of this schedule was to promote stand growth to sawlog size as quickly as possible. As thinning opportunities were expected to be infrequent because of the uncertainty of smallwood markets at that time, the 1982 schedule prescribed relatively heavy thinnings. Thinning regimes were set at levels to optimise both piece size and yield per hectare (Horne and Robinson, 1988). They were meant to apply to even-aged stands of average quality, with first thinning occurring under 25 years of age. Details of the schedule are shown in a number of north coast management plans (Anon, 1984).

Since that time, due to an improvement in the smallwood market, thinning from below has increased to include a wide variety of site qualities and stand ages such that the existing 1982 schedule is not always appropriate. As the perceived end-product of these regrowth stands is still sawlogs, a closer examination of growth data from these stands is warranted to determine the growth options available to the forest manager.

This paper analyses growth data from long-running research experiments to estimate the range of end-point results from a series of four sequential selective thinnings for two site quality classes. The practical desirability of the various thinning intensity sequences is examined by determining and comparing the estimated time to grow a final sawlog crop (50 trees ha^{-1}) to an average 80 cm dbhob. The aim is to provide a schedule that will grow the final crop trees to 80 cm in a reasonably short time *while at the same time retaining as much of the rest of the stand for as long as possible.*

1 Notes on the silviculture of major N.S.W. forest types. Part 4. Blackbutt types. State Forests of N.S.W. *(Unpubl. report).*

DATA BASE

The major portion of the data analysed comes from a thinning experiment (H04204) located in Orara East State Forest 536, near Coffs Harbour. Here, extensive blackbutt regeneration followed a wildfire in 1942. The experiment was measured at ages 13, 17, 22, 32, 37, 39 and 45 years with variable thinning regimes applied at 13, 17, 22, 39 and 45 years. The thinning history and growth parameters prior to treatment at age 10 and at the most recent measurement (age 45) are shown in Appendices 1, 2 and 3. To extend the age range of the Orara East experiment, current measurement data from blackbutt experimental plots from other locations and older than 50 years were included in the analysis. These are located in Landsdowne State Forest 291 (Pinchgut H04213 and Juhles Mountain H04212), Bellangry State Forest 524 (H04301), Middle Brother State Forest 284 (H04208), Pine Creek State Forest 537, Tamban State Forest 526, Lower Bucca State Forest 29 (all H04301) and Whian Whian State Forest 173 (H04203). Growth parameters for these plots are shown in Appendix 4.

The Orara East thinning experiment consists of 27 plots established at age 10 years in 1942 fire regeneration. Of the other trials analysed, Pinchgut (1) and (2) are recorded as regenerating in 1932, Juhles Mountain (1) and (2) in 1912, Middle Brother (1) and (2) in 1929, Whian Whian in 1928, Lower Bucca (1) in 1917, Lower Bucca (2) and (3) in 1924. Three other locations, Tamban, Pine Creek and Bellangry, are virgin stands and have been regarded as having an age of about 100-plus years.

METHOD

The growth data from 25 Orara East plots and 13 older age plots were stratified as follows:

1. SITE QUALITY

Based on predominant height data from blackbutt experimental stands[2], two site qualities were recognised. Stands with a predominant height above the line shown in Figure 1 were considered to be above average site quality and those below the line, below average site quality.

2. THINNING INTENSITY

Based on the progressive thinning regimes shown in Figure 2, the total 38 plots were stratified into thinning intensity classes as follows:

Intensity	Site Quality	
	High	Low
	(number of plots)	
Unthinned	5	2
Light	7	7
Medium	3	4
Heavy	4	6

3. STAND DBHOB STRATIFICATION

The experimental plots within a given site quality and thinning intensity class were then stratified into successive 50 tree ha^{-1} strata, at ages 17, 22, 32, 37 and 45 years for each of the Orara East plots and at the age of the most recent measurement for the older age plots. Based on the dbhob of individual trees, the stands were ranked as the largest stratum (trees ranked 1-50), the next largest stratum (trees ranked 51-100) and so on. In this way differences in thinning response occurring to specific sections of the stand could be identified and the effect of retaining or removing an extra stratum quantified by comparison with equivalent strata from unthinned plots.

To determine the rotation time for each thinning regime, the diameter of the tree of average basal area for the largest stratum (trees ranked 1-50) was plotted at each age (Figures 3 and 4) and the data trend extrapolated, where necessary, to estimate the age at which the diameter of the largest 50 trees ha^{-1} would reach 80 cm. To extend the age-range beyond 45 years and to test the trend shown by the Orara East plots, older-age data from other locatons were plotted as points labelled with capital letters (Figures 3(c), 3(d), 4(c) and 4(d)).

This process was repeated to determine the average diameter that each of the lower strata had reached by rotation age.

[2] Blackbutt Thinning Experiment - Orara East State Forest. Horne 1979 *(Unpubl. report)*.

RESULTS AND DISCUSSION

The schedules determined here are based on the assumption that thinnings may take place around the ages 15, 30, 45 and 60 years. From Figure 2, Table 1 has been prepared to show the stocking ha^{-1} and approximate average spacing of sequential thinnings at these ages for four thinning intensity categories and two site quality categories. The stockings of the unthinned plots for both site qualities are also shown at these ages.

Inclusion of the older-age plots in Figures 3(c), 3(d), 4(c) and 4(d) is consistent with the trends in the Orara East data and allowed better estimates of the time required for the largest 50 trees ha^{-1} to reach the assumed rotation size of 80 cm dbhob. These time estimates are also shown in Table 1 for each thinning intensity category and the unthinned control on two site qualities.

For higher than average site locations, Table 1 shows the rotation time is increasingly longer for lower intensity thinnings, varying from 62 years to 102 years for maximum thinning intensity through to unthinned. However, little reduction was gained by light thinning on this site type (100 years for light thinning compared with 102 years for no thinning).

For lower than average site quality locations, Table 1 shows the rotation time is likewise estimated to increase with lower intensity thinnings but, generally speaking, 20 to 50 years longer than on the better sites (80 years to 150 years plus). However, on the lower site type there is a marked difference in the estimated rotation time for unthinned stands compared with that of light intensity thinnings but little difference between light (108 to 150+ years) and medium (106 to 108 years) intensities.

Table 2 summarises the information in Figures 3 and 4 to give a 50 tree stratum diameter distribution. At the estimated rotation age, the largest 50 trees ha^{-1} are predicted to average 80 cm dbhob. The average dbhob of residual lower strata are shown for three thinning intensities and an unthinned control on two site categories.

It is clear that to produce 80 cm dbhob sawlogs in under a century on sites of lower site quality, there is little option but to apply a heavy intensity thinning schedule. However, in the case of higher site quality, there is an option of producing 80 cm sawlogs in about 70 years by the application of a heavy thinning schedule ***or*** alternatively to considerably increase the sawlog yield by applying a less rigorous thinning schedule over a 80 to 90 year rotation.

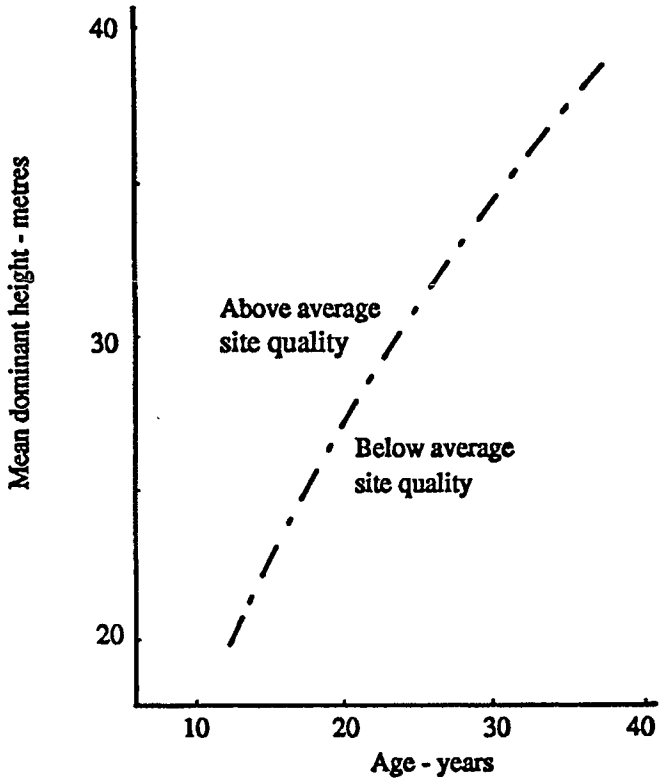

Figure 1. A relationship to determine two site quality indices for regrowth blackbutt.

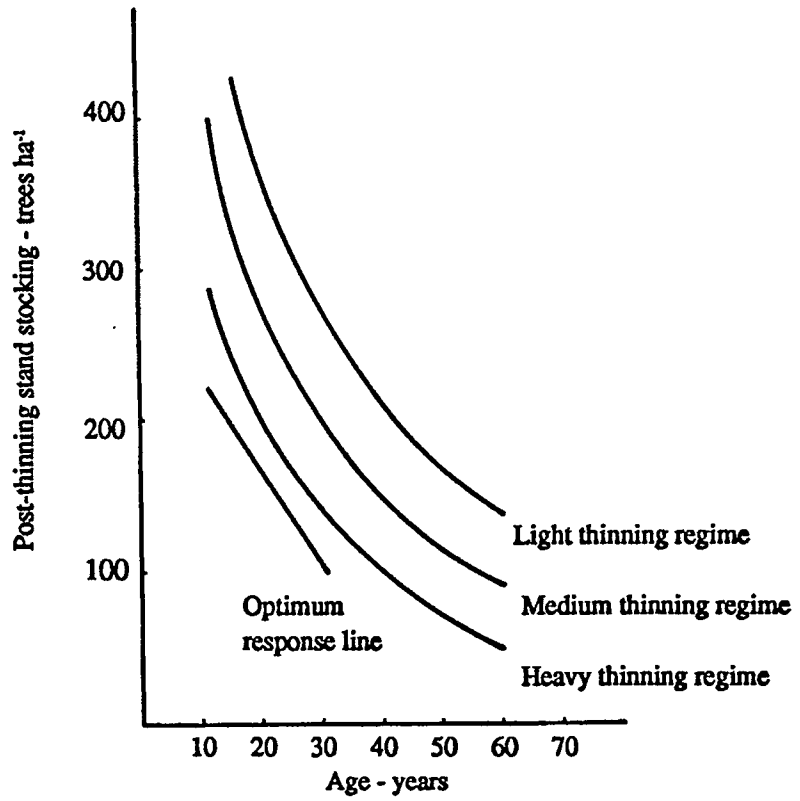

Figure 2. A stocking - age relationship for four thinning regimes.

Figure 3(a). High site quality - high intensity thinning.

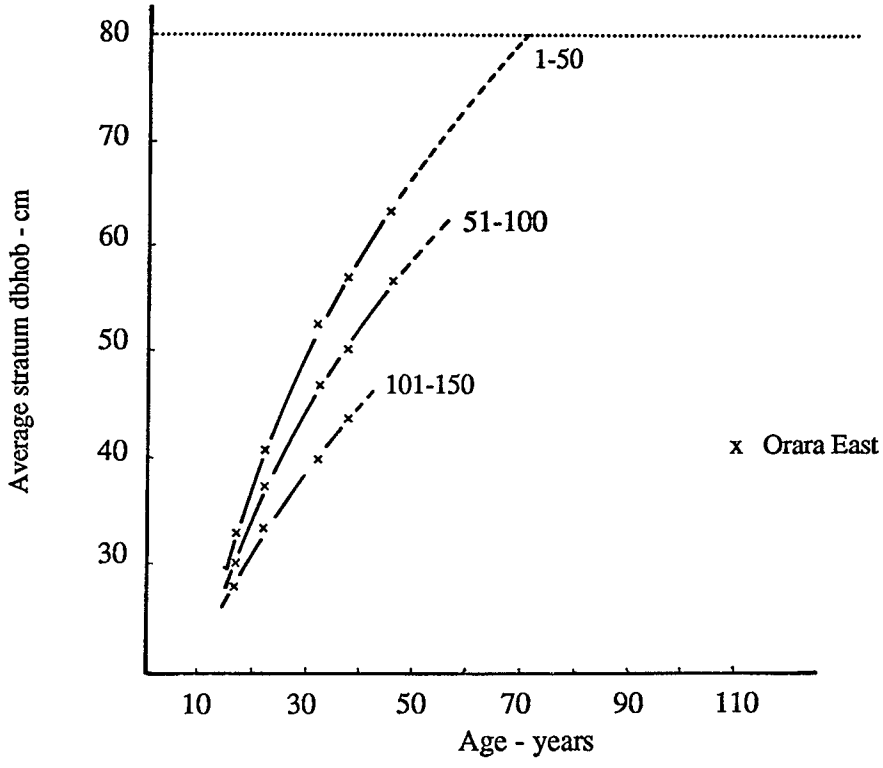

Figure 3(b). High site quality - mid intensity thinning.

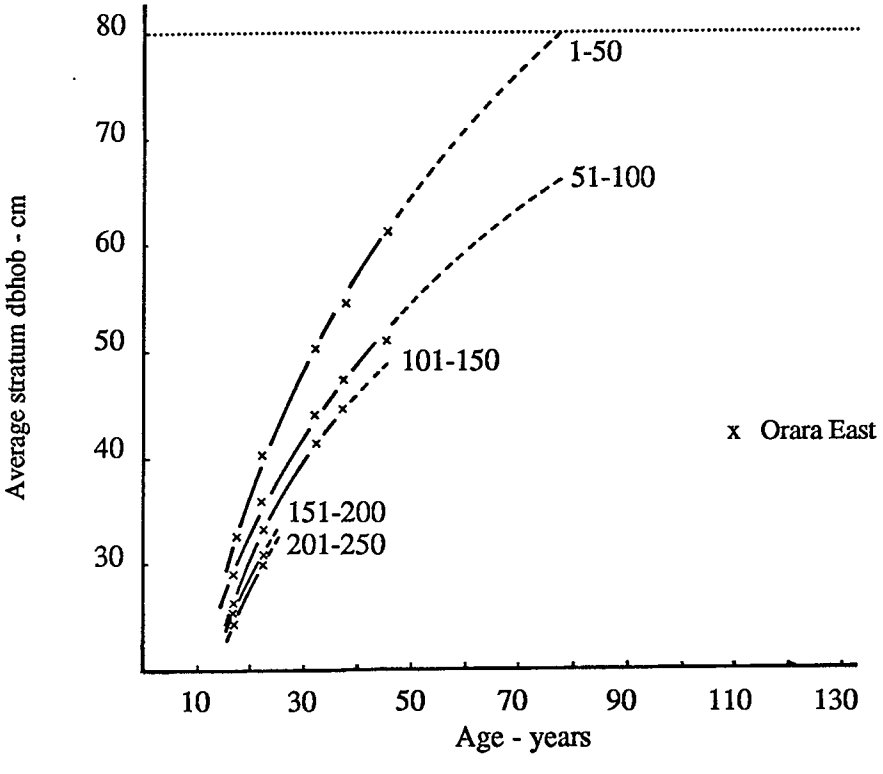

Figure 3(c). High site quality - low intensity thinning.

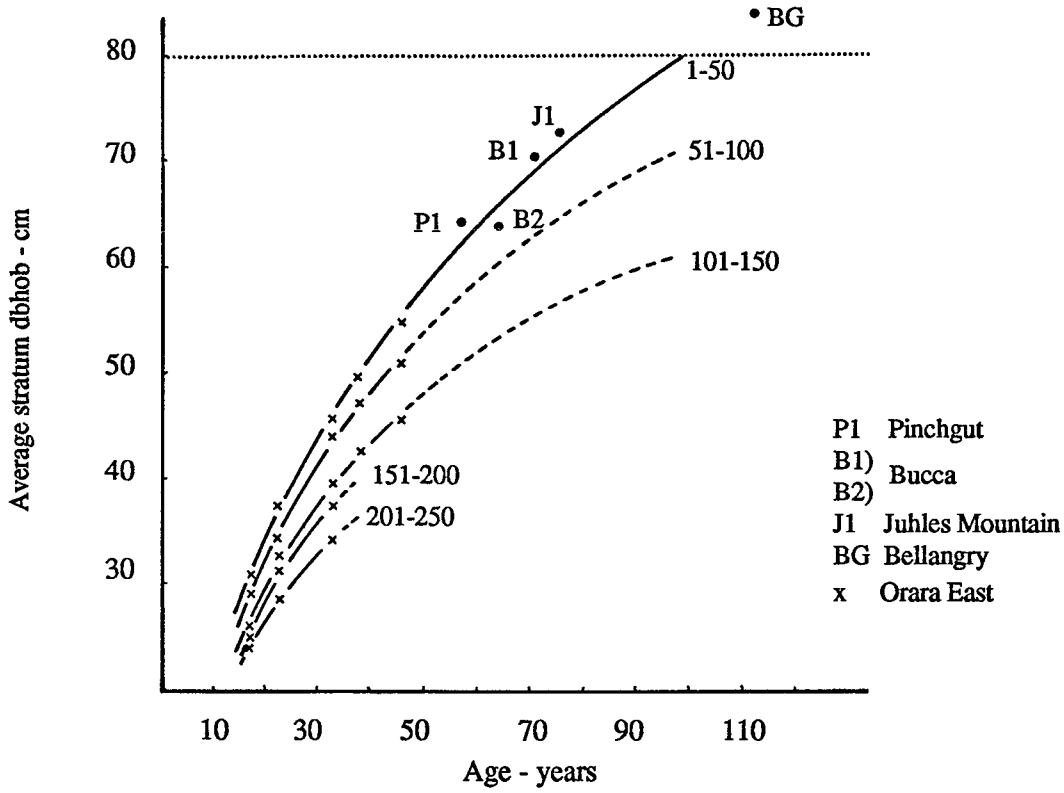

Figure 3(d). High site quality - no thinning.

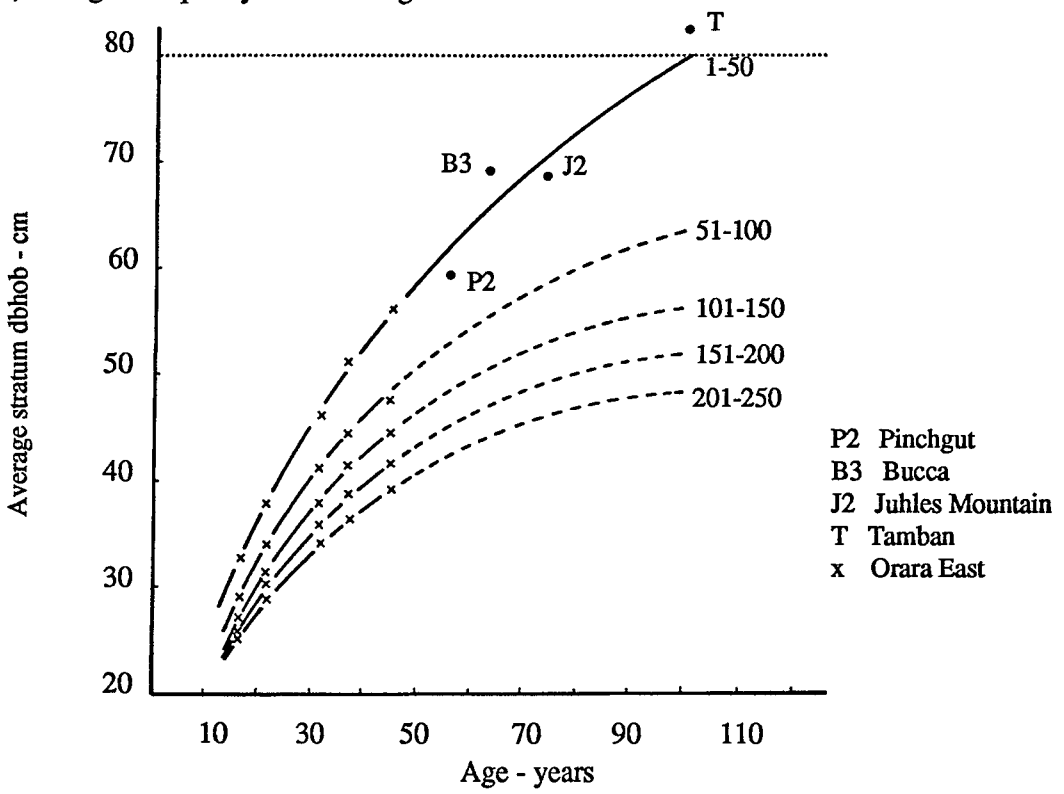

Figure 3. A dbhob - age relationship for ranked 50 tree ha^{-1} strata on better than average sites. (a) heavy intensity thinning, (b) medium intensity thinning and (c) light intensity thinning. The largest 50 tree stratum has been extrapolated to determine the stand age at which this stratum reaches maximum sawlog size (average 80 cm dbhob).

Figure 4(a). Low site quality - high intensity thinning.

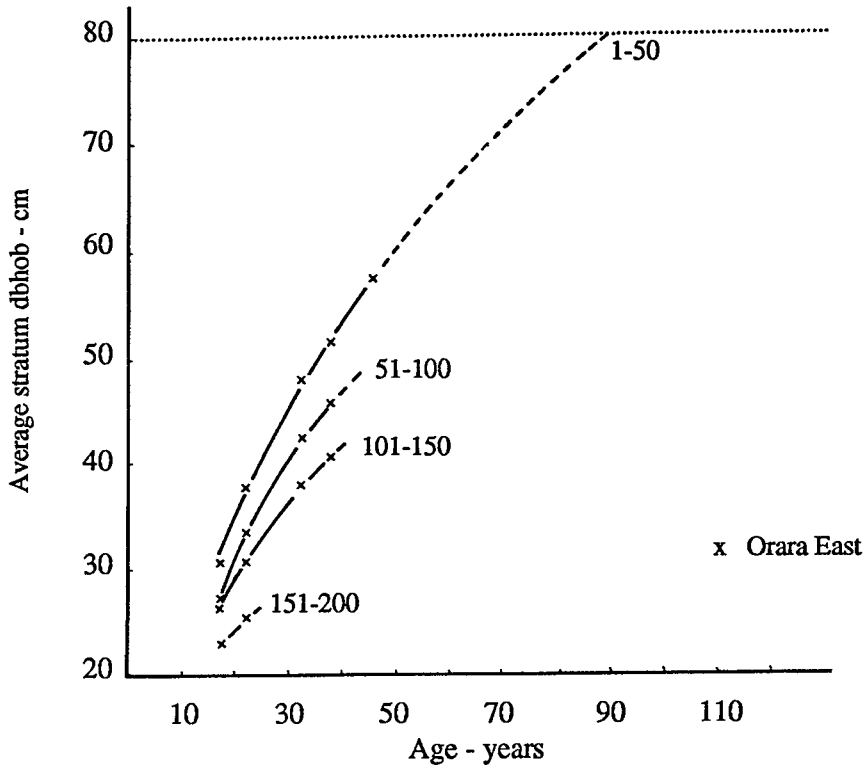

Figure 4(b). Low site quality - mid intensity thinning.

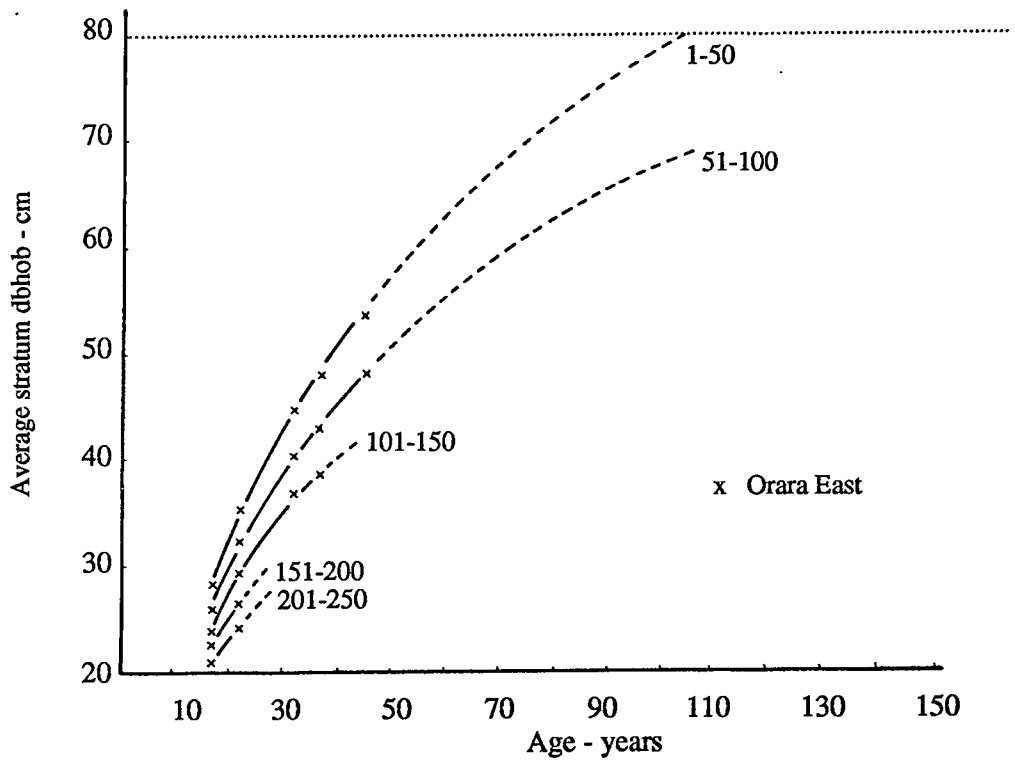

Figure 4(c). Low site quality - low intensity thinning.

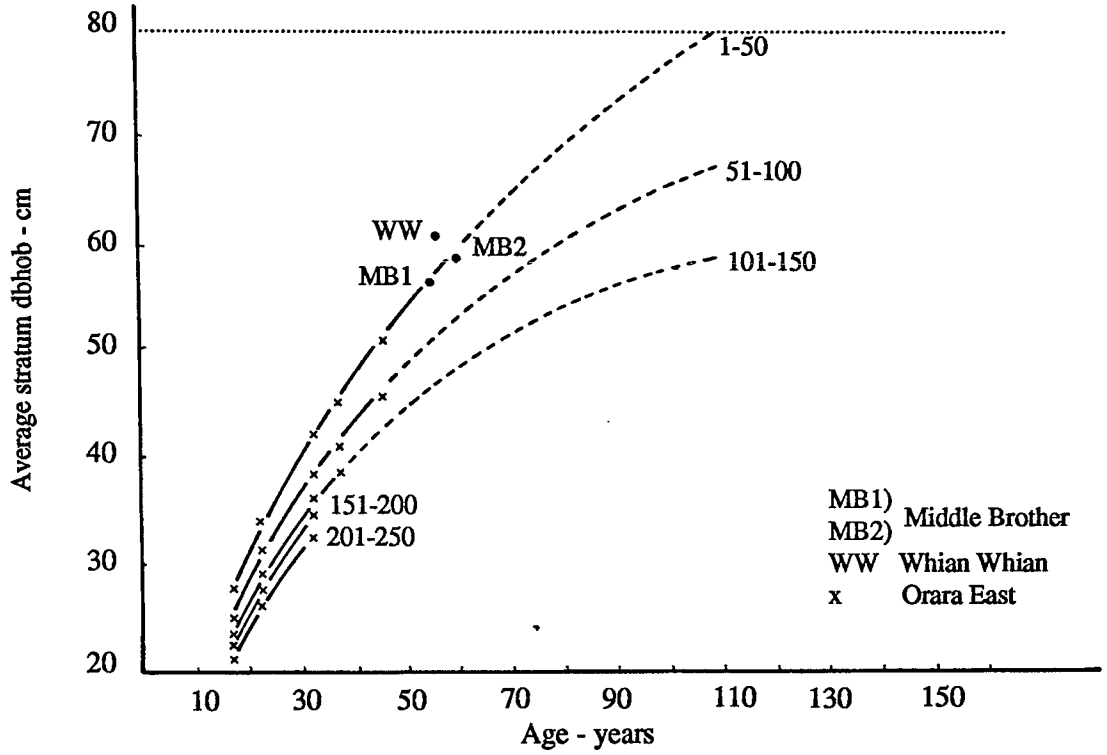

Figure 4(d). Low site quality - no thinning.

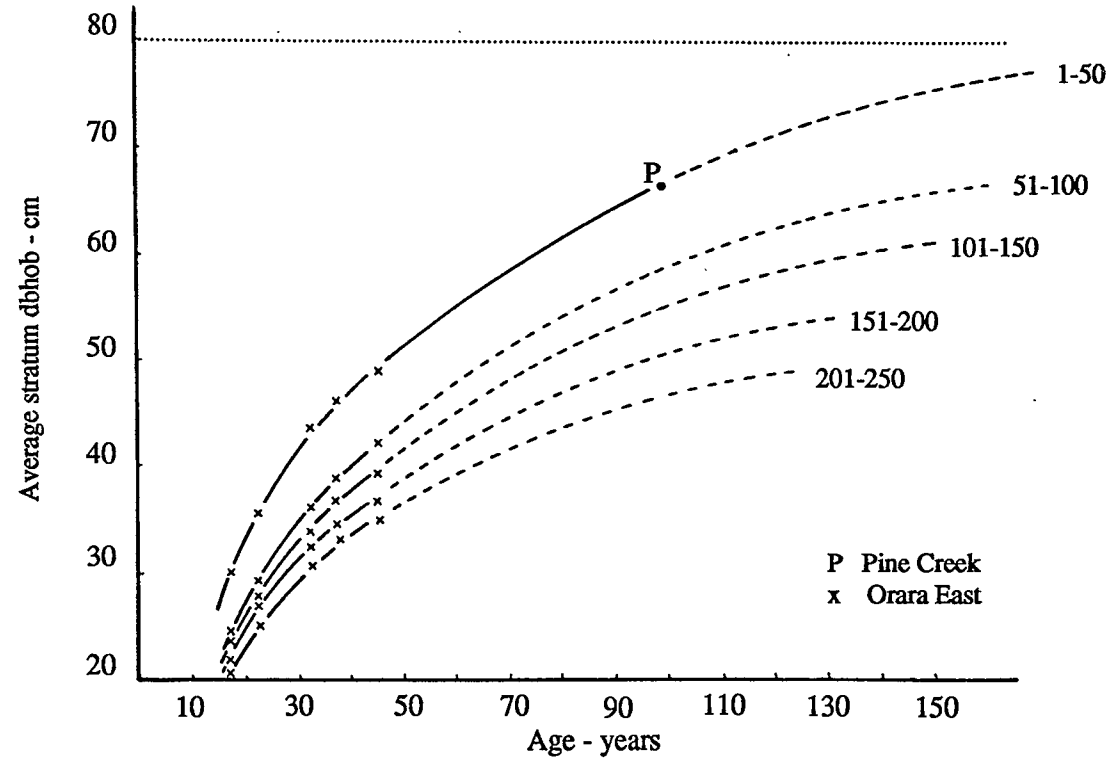

Figure 4. A dbhob - age relationship for ranked 50 tree ha^{-1} on lower than average sites. (a) heavy intensity thinning, (b) medium intensity thinning and (c) light intensity thinning. The largest 50 tree stratum has been extrapolated to determine the stand age at which this stratum reaches maximum sawlog size (average 80 cm dbhob).

Table 1. Varying intensity thinning prescriptions and the stand rotation time is shown for regrowth blackbutt on two site quality classes. The rotation time is estimated as the time taken for the 50 largest diameter trees per hectare to reach an average of 80 cm dbhob.

Thinning intensity	Thinning age (yr)				Site quality	
					High	Low
	15	30	45	60	Rotation age (yr)	
	(trees ha^{-1}) (tree spacing to 0.25 m^2)					
Maximum (current)	200 (7.00)	100 (10.00)	50 (14.00)	— —	62	80*
Heavy	260 (6.25)	130 (8.75)	80 (11.00)	50 (14.00)	70	89
Medium	350 (5.25)	190 (7.25)	130 (8.75)	90 (10.50)	78	106
Light	450 (4.75)	260 (6.25)	180 (7.50)	130 (8.50)	100	108
Unthinned	1476 (2.75)	1328 (2.75)	929 (3.25)	700* (3.75)	102	
	1990 (2.25)	1688 (2.5)	1238 (3.00)	900* (3.25)		150+

* Estimate only

Table 2. Comparison of stand diameter distributions when the 50 largest diameter trees ha^{-1} reach an average of 80 cm dbhob as a result of varying thinning schedules on two site quality classes.

Thinning intensity	Rotation age (yrs)	Av. dbhob of lower strata				
		1-50	51-100	101-150 (cm)	151-200	201-250
				High site quality		
High	70	80	—	—	—	—
Medium	78	80	67	—	—	—
Low	100	80	72	62	—	—
Unthinned	102	80	64	57	52	48
	Low site quality					
High	89	80	—	—	—	—
Medium	106	80	70	—	—	—
Low	108	80	68	59	—	—
Unthinned	150^{+}	80	70?	65?	55?	50?

CONCLUSIONS

To produce 80 cm sawlogs in a reasonable time (i.e. less than 100 years), stands of lower site quality require a schedule of regular and heavy intensity thinnings. However, greater thinning schedule flexibility applies to stands identified as high site quality. A range of thinning schedules has been determined whereby these stands can be managed for the option of increased sawlog yield and/or reduced rotation length.

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Appendix 1. Orara East thinning experiment. Pre-treatment measurement of all 27 plots established in 1952 (age 10 years).

Plot	Stocking (trees ha^{-1})	Av. tree diameter (cm)	Basal area (m^2 ha^{-1})	Dominant height (m)
1A	1823	12.24	24.10	20.1
1B	1205	13.20#	18.22	21.6
1C	1610	9.90	14.07	18.0
1D	1764	10.79	18.37	21.3
1E	2727	9.35	20.99	17.7
1F	2603	10.00	23.94	18.9
1G	1645	10.04	16.02	17.7
1H	2149	10.38	21.33	18.6
1J	2742	8.72	19.06	17.1
2A	1531	12.60	22.69	19.5
2B	2643	10.12	24.54	18.9
2C	2309	11.23	25.62	18.9
2D	2655	9.66	22.53	19.8
2E	2124	10.81	22.82	20.4
2F	1247	10.96	13.72	19.2
2G	1124	10.29	10.30#	19.5
2H	1581	11.09	17.44	19.8
2J	1210	11.53	14.32	21.3
3A	2717	9.19	20.46	16.8
3B	2507	8.98	18.55	17.7
3C	2878	9.29	22.97	17.4
3D	2347	9.30	17.76	15.5#
3E	1964	11.27	22.53	18.3
3F	1754	9.46	14.58	17.4
3G	1618	10.76	16.08	18.3
3H	2556	9.47	20.84	16.2
3J	1840	9.70	16.11	18.3
Average	2033	10.39	19.26	18.7

Parameter value significantly different from the all-plot average

Appendix 2 Orara East thinning experiment. The thinning history showing residual stockings for all plots between the ages 11 and 45 years.

Plot	Age (yr)							
	11	13	17	22	32	37	39	45
	(trees ha^{-1})							
1A	1759	469	272	272	272	272	124	119
1B	672	351	272	212	212	208	114	119
1C	642	371	346	346	346	346	188	193
1D	465	277	173	148	148	148	84	84
1E	390	272	272	272	272	257	133	148
1F	302	277	173	148	148	148	89	89
1G	311	217	217	217	208	208	128	128
1H	277	203	173	173	173	173	104	114
1J	192	192	149	124	124	124	79	79
2A*	1483	1483	1471	1446	1211	1088	915	779
2B	655	445	445	210	210	210	136	136
2C	680	358	358	358	346	346	198	198
2D	470	260	210	148	148	148	99	87
2E	470	260	260	260	260	260	148	148
2F	321	210	173	148	148	148	99	99
2G	346	210	210	210	210	210	136	136
2H	272	210	173	173	161	161	111	111
2J	210	124	124	124	111	111	74	74
3A*	2105	1990	1990	1990	1693	1397	1211	1075
3B	1013	593	346	260	260	260	161	136
3C	692	321	321	321	321	321	198	198
3D	618	408	346	272	272	272	136	124
3E	470	260	260	260	260	272	124	124
3F	470	432	210	148	148	148	99	99
3G	334	210	210	210	210	210	124	124
3H	346	272	210	173	173	173	111	111
3J	259	173	148	124	124	124	74	74

* Unthinned plots

Appendix 3. Orara East thinning experiment. Summary of growth parameters at age 45 years.

Plot	Average dbhob cm	Basal area $m^2 ha^{-1}$	Predominant height m	Bole height m	Merchantable volume $m^3 ha^{-1}$
1A	50.6	24.14	38.4	22.1	245.9
1B	56.1	29.58	43.2	21.3	294.0
1C	45.2	31.59	41.6	20.4	302.1
1D	61.2	24.84	42.6	22.7	257.2
1E	44.7	23.65	39.4	19.2	217.3
1F	58.9	24.39	38.2	20.0	236.7
1G	55.2	30.97	39.6	20.3	296.5
1H	55.3	27.59	25.6	18.0	247.4
1J	50.8	16.16	37.0	16.1	134.4
2A*	30.4	66.62	40.1	17.8	599.5
2B	53.2	30.43	41.0	19.6	286.7
2C	47.5	35.51	41.2	21.4	347.5
2D	50.3	17.46	44.0	26.0	190.4
2E	52.9	33.51	33.8	-	-
2F	62.0	30.07	41.8	20.9	299.4
2G	55.0	32.83	43.2	20.5	314.6
2H	54.7	26.27	41.1	19.8	250.7
2J	67.2	26.48	43.8	24.0	284.5
3A*	23.9	58.63	38.6	15.6	440.7
3B	44.2	21.32	40.4	19.4	196.3
3C	45.6	32.58	38.4	18.3	288.4
3D	45.7	20.52	37.0	19.4	190.1
3E	53.1	27.89	40.2	23.1	286.2
3F	49.5	19.22	40.0	17.9	169.8
3G	49.4	24.13	42.8	19.1	223.3
3H	48.6	20.83	38.3	17.7	181.9
3J	55.6	18.09	42.4	17.2	157.8

* Unthinned plots

Appendix 4. Blackbutt growth data from plots older than 50 years at a variety of locations.

Plot location	Age (yr)	Stocking (trees ha^{-1})	Average dbhob (cm)	Predominant height (m)	Bole height (m)	Merchantable volume (m^3 ha^{-1})
Pinchgut 1	56	371	36.7	46.0	19.1	472.0
Pinchgut 2	56	603	30.9	47.2	17.8	566.8
Juhles Mtn 1	74	364	40.1	51.7	19.2	594.3
Juhles Mtn 2	74	334	36.1	48.2	15.2	476.3
Bucca 1	69	358	29.4	38.9	11.9	287.4
Bucca 2	63	400	24.9	45.0	8.9	210.8
Bucca 3	63	632	22.9	42.0	9.3	261.3
Pine Creek	100+	435	35.7	44.1	15.2	457.2
Middle Brother 1	59	845	26.4	38.0	14.5	435.3
Middle brother 2	59	340	36.2	37.5	15.2	360.2
Whian Whian	55	340	40.4	41.1	21.2	517.0
Tamban	100+	276	35.5	57.7	15.7	422.8
Bellangry	100+	193	48.5	48.5	22.2	677.4

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