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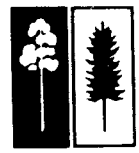

VARIATION IN ESTIMATES OF QUADRAT STOCKING WITH TIME, IN REGENERATED COUPES OF ASH EUCALYPTS

BY

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ODC 236.4 : 524.634 : 176.1 *Eucalyptus* spp.

Keywords : eucalypts, *Eucalyptus regnans*, *E. delegatensis*, four-milacre quadrat, regeneration, seedlings, stocking

SUMMARY

The reliability of the stocked 4-milacre quadrat method for assessing eucalypt regeneration stocking on coupes one year after seeding, was investigated by re-examination of coupes at ages 2, 3, 4, 7 and 10 years after seeding.

Four coupes were chosen in the 7-year-old age-class and five coupes in each of the remaining age-classes, unevenly distributed in Toolangi, Alexandra and Upper Yarra Forest Districts, and seeded with *Eucalyptus regnans* F. Muell. (mountain ash), *E. delegatensis* R. T. Baker (alpine ash), or both.

On reassessment, the stocking on coupes aged 2 and 3 years was found to be significantly higher ($P < 0.05$) than those recorded at age 1. In contrast, on coupes aged 4 and 10 years, stocking was not significantly different than those at age 1. On the 7-year-old coupes, the average stocking was significantly less ($P < 0.05$) than had been recorded at age 1, though the reduction was attributable to abnormal mortality on one coupe, with the remaining three coupes showing little variation from stocking at age 1.

Although the precise reasons for the increases in stocking observed on coupes aged 2 and 3 years are not clear, an analysis of seedling heights on stocked quadrats aged 2 and 3 years suggested that continuing germination after age 2 was not a significant contributing factor. Further study is necessary to identify the reasons for these observed increases in stocking and to ensure that regeneration surveys are achieving their intended purpose.

INTRODUCTION

The stocked 4-milacre quadrat method for assessing eucalypt regeneration at age 1 (1 year following seeding) has been used in Victorian State forests for many years. As practised, a coupe is deemed satisfactorily stocked if more than 73% of 4-milacre quadrats contain at least one seedling at age 1 or if more than 65% of quadrats contain one or more seedlings when assessed at age 2 or older (Forests Commission Victoria 1973).

Claims have recently been made that stocking of eucalypt coupes increases with time after the standard regeneration survey at age 1; in some instances it has been suggested that these increases continue to occur for at least several years after the initial survey. For example, when coupes in the high elevation mixed eucalypt forests of the Bendoc area of East Gippsland, which initially had been assessed as under-stocked, were re-surveyed several years later, it was found that many of the coupes had reached a satisfactory stocking level (Adams*, pers. comm. 1982).

The aims of this study were to compare more extensively (than for Bendoc) the results of regeneration surveys made one year after seeding with results of reassessments 1 to 9 years later and, where any changes in stocking were observed, to identify when these had occurred, if possible.

SELECTION OF STUDY COUPES

The criteria used to select coupes for inclusion in the study were as follows:

(i) Site preparation on all coupes had included slash burning of logging residue to produce an ash seedbed. However, the conditions of burning and the quality of ashbeds may have varied between coupes.

(ii) The coupe had been seeded (either aerially, by hand, or from seed-trees) with ash-type eucalypt species, predominantly *Eucalyptus regnans* F. Muell. (mountain ash).

(iii) An initial regeneration survey using the stocked quadrat method had been undertaken on the coupe one year following seeding.

(iv) Coupe stocking at the time of the initial survey was within the range 50-80% by 4-milacre quadrats wherever possible. In practice, it was necessary to include some coupes with greater than 80% stocking in order to obtain sufficient coupes in all age-classes.

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* Adams, J., formerly Forester, Orbost Forest District.

(v) No enrichment work had been undertaken since the initial survey, thus any increase in stocking with time could not have been due to later aerial or hand application of seed or planted seedlings.

(vi) Standing seed sources were minimal, thus any increase in stocking could not be attributed to further incoming seeds.

(vii) All coupes were located in the same region (Central Victoria), so that variation in results due to differences in forest type, climate, and associated vegetation species was minimised.

Five coupes were sampled in each of the following age-classes: 2, 3, 4 and 10 years, and four were sampled in the 7-year age-class. Details of the selected study coupes are given in Table 1. Notably, coupe age was not independent of location: there was a preponderance of young stands in Toolangi District and older stands in Upper Yarra District.

SAMPLING PROCEDURE

Each of the 24 study coupes was reassessed using the same standard stocked 4-milacre quadrat method that was used for the initial survey of the coupe at age 1 year. Generally, the quadrats were spaced according to an 80 m x 20 m grid over the coupe, except for the largest coupes, on which a 160m x 20 m grid was used in an attempt to obtain a similar sample size for quadrats on small versus large coupes.

Each quadrat was classified as either stocked or unstocked, depending on the occurrence of one or more (vigorous) stems. Also, for this study, all stems on every fifth quadrat were counted and stem heights assessed using the following classification:

Height-class I	≦	20 cm
Height-class II		20-60 cm
Height-class III		60-100 cm
Height-class IV		1-2 m
Height-class V	>	2 m

RESULTS

Comparison of Initial and Final Stocking Estimates

Initial and final stocking results for each study coupe are given in Table 2, together with the mean stocking for each age-class. Differences between initial and final stockings for each age-class were analysed by chi-quare, to test if final stocking was equal to initial stocking.

Stockings at ages 2 and 3 years were found to be significantly higher ($P < 0.05$) than the corresponding stocking at age 1; stockings at ages 4 and 10 were not significantly different to those at age 1; and stocking at age 7 was significantly less ($P < 0.05$) than that at age 1.

Table 1. Details of study coupes on which regeneration surveys were carried out to examine variation in estimated stocking with time.

Regeneration age at time of 1982 re-survey (years)	Coupe number and name	Area (ha)	Species*	Date of seeding	Date of initial survey	No. of quadrats assessed	Initial† stocking (%)
2	2.1 Toolangi, Aeroplane Tk, 04/855-57, Area 2	32	*Eucalyptus regnans* (mountain ash)	1980	1981	92	69
	2.2 Toolangi, Ecks Rd, 05/981	83	*E. regnans*	1980	1981	n.r. ††	77
	2.3 Toolangi, Gincase Rd, 04/886	18	*E. regnans*	1980	1981	105	78
	2.4 Toolangi, Aeroplane Tk, 04/855-57, Area 1	12	*E. regnans*	1980	1981	34	80
	2.5 Alexandra, Quartz Ck Rd 4/80	25	*E. delegatensis* (alpine ash)	1980	1981	153	80
3	3.1 Toolangi, Mt Road, Comp. 886	23	*E. regnans*	1979	1980	89	59
	3.2 Upper Yarra, Federal Shortcut, 79/8/S	22	*E. regnans/ nitens* (shining gum)	1979	1/80	89	60
	3.3 Toolangi, Murrindindi Rd, Comp. 951	40	*E. regnans*	1979	1980	81	78
	3.4 Toolangi, Devils Staircase, 05/988	40	*E. regnans*	1979	1980	81	84
	3.5 Upper Yarra, Mississippi Ck, 79/10/S	3	*E. regnans*	1979	1/80	17	88
4	4.1 Toolangi, Siberia, 06/908	5	*E. regnans*	1978	1979	20	67
	4.2 Alexandra, East Green Hill, 1/78	24	*E. delegatensis*	1978	1979	n.r.	75
	4.3 Alexandra, East Green Hill, 4/78	5	*E. delegatensis*	1978	1979	n.r.	75
	4.4 Toolangi, Devils Staircase, 05/988, 06/910,913	90	*E. regnans*	1978	1979	181	78
	4.5 Alexandra, East Green Hill, 2/78	3	*E. delegatensis*	1978	1979	n.r.	88
7	7.1 Upper Yarra, Tungsten Ck, 75/2/S	23	*E. regnans*	5/75	6/76	135	71
	7.2 Upper Yarra, Charlie Ck, S/9/75	6	*E. regnans*	8/75	7/76	51	84
	7.3 Upper Yarra, Big Ck Basin, 75/1/S	9	*E. regnans*	5/75	2/76	78	90
	7.4 Upper Yarra, King Ck, 75/1/S	12	*E. regnans*	6/75	6/76	86	90
10	10.1 Upper Yarra, Britannia Ra, S/6/72	28	*E. regnans/ delegatensis*	5/72	5/73	106	65
	10.2 Upper Yarra, Powles Ck, S/7/72	6	*E. regnans/ delegatensis*	5/72	5/73	30	67
	10.3 Upper Yarra, Muddy Ck Rd, S/14/72	27	*E. regnans/ delegatensis*	5/72	3/73	90	69
	10.4 Upper Yarra, Muddy Ck Rd, S/10/72	9	*E. regnans/ delegatensis*	5/72	3/73	35	71
	10.5 Upper Yarra, Overon Fireline, S/16/72	7	*E. regnans/ delegatensis*	5/72	5/73	35	71

* Nomenclature follows Willis (1972).
† From District records.
†† Not recorded.

Regeneration age in 1982 (years)	Coupe No.	Area (ha)	No. of quadrats assessed (initial survey)	Initial stocking (%)	Mean initial stocking (%) per age-class	No. of quadrats assessed (final survey)	Final stocking in 1982 (%)	Mean final stocking (%) per age-class	Change in stocking (%) (final stocking - initial stocking)	χ^2 (chi-square test statistic)†	Degrees of freedom (n-1)
2	2.1	32	92	69		89	90		21		
	2.2	81	n.r.§	77		138	86		9		
	2.3	18	105	78	76	105	82	86	4	10.6*	3
	2.4	12	34	80		41	95		15		
	2.5	25	153	80		92	78		-2		
3	3.1	23	89	59		66	83		24		
	3.2	22	89	60		65	97		37		
	3.3	40	81	78	74	81	86	92	8	35.7*	3
	3.4	40	81	84		91	92		8		
	3.5	3	17	88		30	100		12		
4	4.1††	5	20	67		38	47 (66)		-20 (-1)		
	4.2	24	n.r.	75		71	86		11		
	4.3	5	n.r.	75	77	44	84	75 (79)	9	11.5 (5.5 n.s.)	3
	4.4	90	181	78		198	85		7		
	4.5	5	n.r.	88		31	74		-14		
7	7.1	23	135	71		74	74		3		
	7.2	6	51	84	84	30	37	69	-47	28.6*	2
	7.3	9	78	90		47	89		-1		
	7.4	12	86	90		72	76		-14		
10	10.1	28	106	65		86	59		-6		
	10.2	6	30	67		31	61		-6		
	10.3	27	90	69	69	41	74	69	5	3.3 n.s.	3
	10.4	9	35	71		34	68		-3		
	10.5	7	35	71		34	82		11		

† Null hypotheses : final stocking = initial stocking.

†† Coupe 4.1 suffered abnormally severe frost and snow damage to established seedlings in the winter of 1982. Figures in brackets have neglected this damage by classing quadrats with only recently killed seedlings as stocked.

* Significant difference between initial and final stocking ($P < 0.05$); n.s. no significant difference.

§ Not recorded.

Table 2. Initial and final stocking percentages for study coupes on which regeneration surveys examined variations in estimated stocking with time.

Of the 24 coupes re-assessed in this study, 14 were initially satisfactorily stocked and 10 understocked. At the time of the later survey, 20 of these coupes were satisfactorily stocked. In 15 of the coupes, overall stocking had increased; and in 9 of the coupes stocking had decreased. At the final survey, 13 coupes remained stocked; 7 coupes had changed from being 'unsatisfactorily regenerated' at age 1 to being 'satisfactory'; 3 coupes remained understocked; and 1 had deteriorated from 'satisfactorily regenerated' to 'unsatisfactory'.

Analysis of Number and Height of Seedlings Per Quadrat

The proportions of quadrats in each age-class containing various seedling numbers are given in Table 3.

Table 3. Proportions of quadrats in each age-class containing various seedling numbers in a regeneration survey of variations in estimated stocking with time.

Regeneration age in 1982 (years)	Proportion (%) of quadrats per age-class containing given numbers of seedlings							Mean stems per quadrat
	Seedlings per quadrat							
	0	1	2	3	4	5-10	> 10	
2	12	14	8	3	4	14	45	17.4
3	5	5	9	7	7	20	47	14.7
4	17	7	16	11	6	18	25	8.0
7	21	15	17	6	2	31	8	4.2
10	39	22	9	10	3	15	2	2.2

At age 2 and 3 years, most of the quadrats surveyed had more than 5 stems. By age 10, the average number of stems per quadrat had fallen considerably, with most of the quadrats studied having 1 or less stems. From age 3 to 10, the number of quadrats with 1 or less stems increased substantially, while the number of quadrats with more than 10 stems decreased. The mean number of stems per quadrat decreased steadily from 17.4 at age 2 years to 2.2 at age 10 years. The 3-year age-class had the greatest number of quadrats (47%) with more than 10 stems, though at age 2 the number of quadrats with more than 10 stems was also high (45%).

In Figure 1 the mean number of seedlings of each height-class per quadrat is plotted against the time since seeding of the study coupes. Due to rapid height growth, by age 2, height-class IV seedlings (1-2 m) were the most common and class I seedlings (≤ 20 cm) the least. From age 3 onwards, class V seedlings were by far the most common, with the frequency of all other classes decreasing to almost zero between 4 and 7 years after regeneration.

Further details of the height-class distribution of seedlings in each age-class are presented in Appendix I, and individual quadrat data are contained in Appendix II.

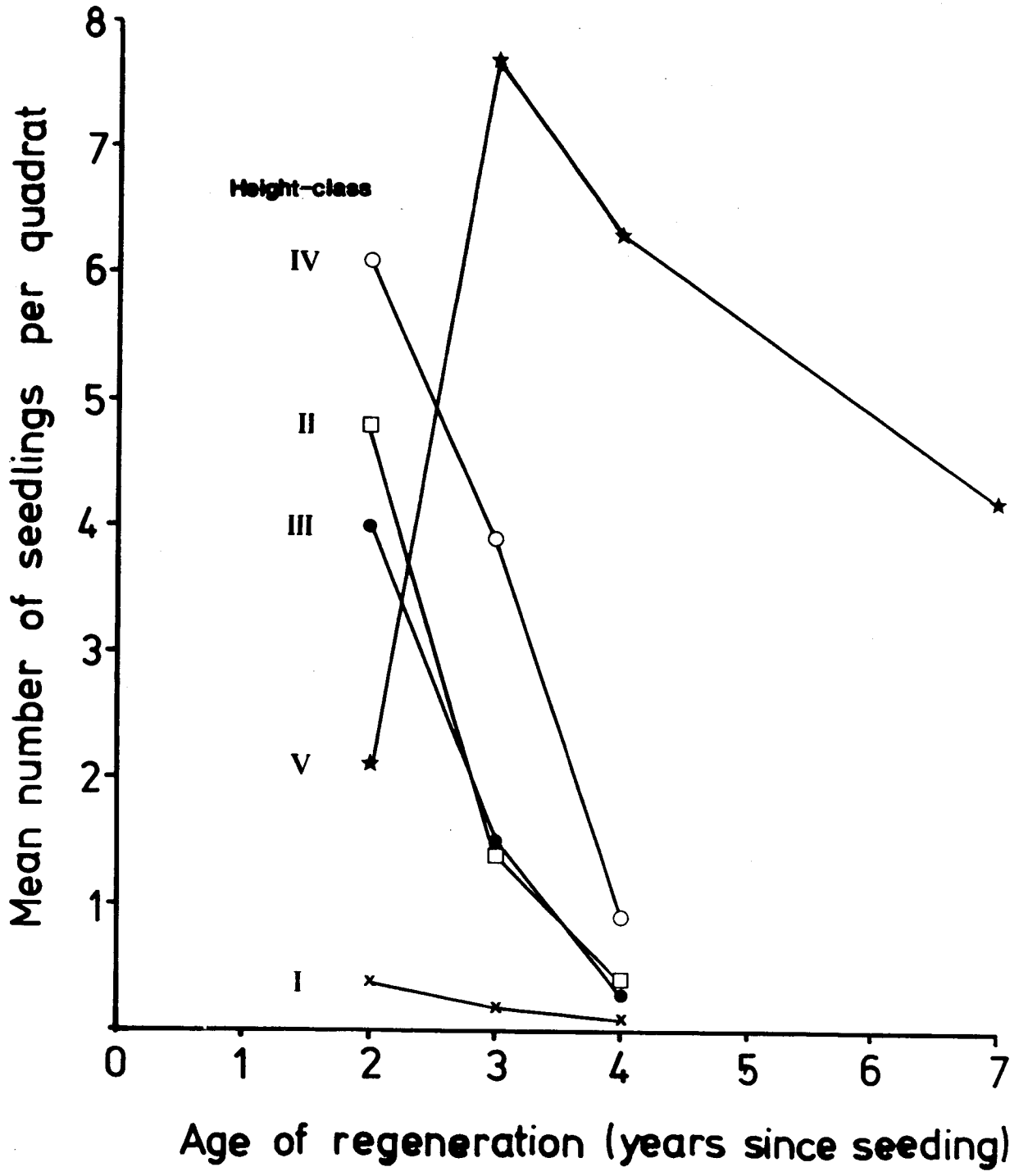

Figure 1. The change in number of seedlings of each size-class per quadrat with time, in a regeneration survey of variations in estimated stocking with time.

Height-class	I	≤ 20 cm
	II	20 - 60 cm
	III	60 - 100 cm
	IV	1 - 2 m
	V	> 2 m

DISCUSSION

Factors Responsible for Changes in Stocking with Time

The results in Table 2 reveal substantial variation in stocking between coupes in each age-class, which may partially obscure the differences between age-classes.

The magnitude of variation in initial stocking among coupes is similar for all age-classes, with final stockings of the 4 and 7-year age-classes markedly more variable than the others.

Each of these two age-classes contain one abnormal coupe in which adverse conditions have caused a substantial reduction in stocking percentage. Measurement of a larger sample of coupes in these two age-classes could be expected to reduce the influence of such abnormal coupes, thus decreasing the variation between coupes and increasing the final stocking percentages in Table 2. In particular, the significant decrease in average stocking at age 7 (predominantly due to one of the abnormal coupes) is unlikely to be real.

Even though three of the five coupes within the 4-year-old age-class were found to increase in stocking, by the time of reassessment the stocking on coupe 4.1 had decreased from 66.6% to 47.4%, which was sufficient to substantially decrease the average stocking of this age-class. This decrease was caused mainly by the abnormally severe winter of 1982, in which heavy snowfalls and frost damage killed many established seedlings that had already survived three previous winters. Many recently-killed seedlings were detectable on each quadrat at the time of reassessment; these seedlings were tallied separately and the quadrat stocking that would have been expected, but for the uncharacteristic severity of the 1982 winter, was determined. Coupe 4.1 results, counting recently killed seedlings as alive, are indicated by the figures in brackets in Table 2. Although this reduced the variation in final stocking between coupes, a chi-square test still did not show a significant difference between final stocking at age 4 and initial stocking.

Abnormal results should be expected occasionally on some coupes because they are not uniform in character and each experience different environmental conditions between survey times.

Some seedlings may not survive for long after the initial survey due to intense competition from well-established ground vegetation. The likelihood of such failure could probably be predicted from observations of the relative development of the competing vegetation during the initial survey. Recent germinants would be expected to suffer most from competition and natural factors (such as frost). Although physical and biological factors are responsible for seedling deaths in the early years, mortality in later years is likely to be due to competition between them.

The data of Figure 1 and Appendix I indicate that by age 10, stocking had decreased substantially due to competition between established stems. The observation that initial and final stockings at age 10 are not significantly different therefore suggests that a real increase in stocking did occur between age 1 and some later age (age 2 or 3 perhaps) and that stocking has since diminished as dominant stems have suppressed their competitors.

A number of independent factors may act singly or together to cause the increase in stocking that has been recorded in this study at ages 2 and 3 and has been subjectively recognised in the field. The increase may be due to operator error, limitations in the stocked quadrat technique, or a natural, biological increase in seedling numbers. These are discussed.

Operator Error

Perhaps the most obvious cause of an increase in stocking is that seedlings that are present at the time of the initial survey are not observed (and hence not recorded). At the time of a second survey though, these seedlings may have grown sufficiently to be easily visible. If seedlings are missed at the time of the first survey, this may be due to the assessor not spending enough time searching the entire quadrat, or the seedling being too small to be visible. These problems would probably be more common on coupes that revegetate rapidly.

Limitations in the Stocked Quadrat Technique Presently Used in Victoria

The Forests Commission Operational Information Leaflet on this subject (Forests Commission Victoria 1973) may be too stringent in its definition of an "acceptable seedling". A proportion of seedlings at the 2-leaf stage or younger that are observed but "unacceptable" by definition, may survive to become healthy acceptable seedlings. This factor is probably only of minor importance because most field staff would probably record the presence of any visible seedling, provided it was living and healthy.

Increase Due to Natural, Biological Factors

Germination takes place after the time of the first survey, as implied in the findings of Hastings (1973), who noticed that some *E. regnans* stands aged between 17 and 23 years had estimated present densities considerably higher than those estimated initially. He suggested that the original surveys were done too early.

Grose (1960) also detected a definite natural increase in milacre stocking from year 1 to year 2 in *E. delegatensis* R.T. Baker (alpine ash) coupes that were slash burnt and then naturally seeded from retained trees (Table 4).

Table 4. Increases in milacre stocking in young *Eucalyptus delegatensis* (alpine ash) stands from age 1 to 2 years (from Grose 1960).

Coupe	Stocking at year 1 (%)	Stocking at year 2 (%)	% of quadrats at year 2 that contained recent seedlings
1	53	58	55
2	32	56	45
3	40	53	36

Campbell* (pers. comm. 1982) found that following sowing of *E. regnans* in autumn, the majority of germination occurred in late autumn and early winter. However, the germination of seed sown in late autumn, and in winter, was mostly delayed until autumn and spring of the second year. Few, if any, of these late germinants are expected to survive.

Pederick (1955) and Cunningham (1960) found that seeds of *E. obliqua* L'Hérit. (messmate) and *E. regnans* will either germinate or become non-viable, respectively, within 12-18 months of being cast onto a seedbed. Grose (1960) considered that seeds of *E. delegatensis* for germination in the second and subsequent springs following sowing can be provided naturally only by seedfall from retained seed sources during the preceding year. The extent of late germination is dependent on continuation of a receptive seedbed.

Bren (1971) compared stockings at age 19 months with stockings at age 21 months and found that the older coupes had significantly more seedlings. This was substantiated by the observation that seedlings ranged in height from 5 to 50 cm, which suggests that seedlings may have germinated at different times.

Seed-tree regeneration methods can give rise to delayed germination. Grose (1960) found that most of the seeds shed in capsules from seed-trees of *E. delegatensis* (30-60% of total annual seedfall) - which occurs in autumn and winter - are not released till the following summer. These seeds do not germinate until spring of the following year, as they do not after-ripen while enclosed in capsules. However, Grose (1960) suggests that most of this seed shed in capsules is either taken by insects or becomes non-viable within the capsules, and so contributes little to the distribution of regeneration.

Further research is required to satisfactorily determine the extent to which each of these factors contribute to the recorded increases in stocking observed in this study. Whether such increases are also observed in other areas and other forest types under a different range of environmental conditions remains to be seen, and is worthy of study.

Changes in Seedling Numbers and Heights with Time

The number of seedlings detected per quadrat was highly variable (Appendix II), thus the seedling density data in Figure 1 may be misleading, as they are weighted towards the densities of the heavily stocked quadrats. For example, at age 2, densities ranged from 0 to 169 seedlings per quadrat.

At age 2, 13% of quadrats contained only seedlings $\leq$ m in height; at age 3, this percentage had dropped to a meagre 1.6%. Thus, small seedlings mainly occur in conjunction with taller seedlings from age 2 onward, indicating that late germination contributes little to quadrat stocking after age 2. The critical time for extra germination that leads to establishment, perhaps, is between year 1 and 2; this period was not closely studied in this work.

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* Campbell, R. G., Research Officer, State For. and Lands Serv.

The analysis of stocking and height data presented in this report has assumed that survey results for coupes of one age can be compared with the results for different coupes of another age. As suggested earlier, this assumption of uniformity in stocking variation among coupes may not be entirely valid, particularly because of the relationship between coupe age and location. Therefore, only broad trends should be apparent from such analysis. A further weakness lies in the fact that seedling height cannot be taken as a precise measure of age. The results of this study must therefore be seen as indicative only. However, the data collected do suggest that delayed germination sufficient to cause a marked increase in apparent stocking on the quadrats studied was unlikely beyond 2 years after seeding.

CONCLUSION

Final stocked quadrat regeneration surveys undertaken in the 2nd and 3rd years following seeding in ash-type eucalypt coupes tend to give higher stockings than surveys undertaken in the first year. Surveys undertaken more than 3 years after seeding do not tend to give higher stockings. The precise reasons for these apparent increases up to 3 years after seeding are not clear, though the results do not support the contention that extra seed germination occurring after the 2nd year is important. Further work is necessary to identify the reasons for increased stocking and to ensure that regeneration surveys are achieving their intended purpose.

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APPENDIX I

Height-class distribution of seedlings on 4-milacre quadrats in various age-classes in a regeneration survey of variations in estimated stocking with time.

Age-class	No. of quadrats	Height-class	% of quadrats containing seedlings of each height-class	% of seedlings in each height-class	Mean no. of seedlings of each height-class per quadrat
2	100	I	19%	2.3%	0.4
		II	58%	27.8%	4.8
		III	62%	22.8%	4.0
		IV	66%	35.1%	6.1
		V	31%	12.0%	2.1
TOTAL				100.0%	17.4
3	121	I	14%	1.5%	0.2
		II	39%	9.8%	1.4
		III	47%	10.0%	1.5
		IV	79%	26.6%	3.9
		V	75%	52.1%	7.7
TOTAL				100.0%	14.7
4	71	I	6%	0.7%	0.1
		II	15%	4.9%	0.4
		III	17%	4.1%	0.3
		IV	31%	11.0%	0.9
		V	72%	79.3%	6.3
TOTAL				100.0%	8.0
7	48	I	0%	0%	0
		II	0%	0%	0
		III	0%	0%	0
		IV	0%	0%	0
		V	79%	100%	4.2
TOTAL				100%	4.2
10	59	I	0%	0%	0
		II	0%	0%	0
		III	0%	0%	0
		IV	0%	0%	0
		V	59%	100%	2.2
TOTAL				100%	2.2

APPENDIX II

Seedling numbers and heights for individual 4 milacre quadrats in a regeneration survey of variations in estimated stocking with time.

(a) Age-class = 2 years

Quadrat No.	Seedlings						Quadrat No.	Seedlings					
	Total No.	No. per height-class						Total No.	No. per height-class				
		I	II	III	IV	V			I	II	III	IV	V
1	33	2	6	6	19		51	4		3	1		
2	20		1	4	11	4	52	31		1		16	14
3	46	1	8	10	17	10	53	6		1		5	
4	15	2	9	3	1		54	15			1	14	
5	16		3	5	8		55	22		12	7	3	
6	52	3	10	7	24	8	56	16		12	3	1	
7	54	3	23	17	11		57	11		1	4	6	
8	1				1		58	3			1	2	
9	93	5	25	23	31	9	59	22		4	8	10	
10	1	1					60	2		1		1	
11	7	1	3	3			61	15			7	8	
12	2		1			1	62	2		2			
13	0						63	0					
14	0						64	7		2	1	2	2
15	6	1	4	1			65	25		1	2	13	9
16	39		10	7	19	3	66	0					
17	8		4	2	2		67	34			3	18	13
18	0						68	48		1	3	20	24
19	26	1	14	8	3		69	5				5	
20	11			2	9		70	3			1	2	
21	16		1	11	4		71	1					1
22	1		1				72	32		4	2	22	4
23	0						73	38			1	19	18
24	88	3	69	14	2		74	27		9	8	10	
25	24	6	13	3	2		75	22		2	5	15	
26	16		7	4	5		76	2				2	
27	2				2		77	19		2	1	11	5
28	3		3				78	20		4	4	11	1
29	28		1	1	5	21	79	6			5	1	
30	36	1	4	10	19	2	80	10		2	5	3	
31	4		2	2			81	7		1	5	1	
32	1		1				82	2			1	1	
33	11		2	1	6	2	83	1					1
34	4		2	1	1		84	1				1	
35	0						85	7			2	5	
36	7		1	2	4		86	0					
37	23	1	9	8	5		87	1					1
38	169	4	72	56	37		88	1					1
39	119		12	16	73	18	89	1					1
40	47		7	26	14		90	12				9	3
41	2		1	1			91	0					
42	18	1	13	4			92	6				1	5
43	15	1	5	3	6		93	1					1
44	0						94	0					
45	36	1	22	12	1		95	0					
46	2			1	1		96	9			1	1	7
47	81	3	44	32	2		97	1				1	
48	1			1			98	4					4
49	40		3	2	20	15	99	8		1		7	
50	8		2	6			100	1					1

(b) Age-class = 3 years

Quadrat No.	Seedlings						Quadrat No.	Seedlings					
	Total No.	No. per height-class						Total No.	No. per height-class				
		I	II	III	IV	V			I	II	III	IV	V
1	2					2	62	7		1	2	4	
2	6				2	4	63	7		1		6	
3	20					20	64	9			1	6	2
4	12				4	8	65	14				4	10
5	24			1	2	21	66	1					1
6	42		1	2	6	33	67	30				6	24
7	14		1	6	1	6	68	3					3
8	15				7	8	69	15				4	11
9	17			1	10	6	70	6		2	1	1	2
10	1					1	71	2					2
11	6			1	5		72	2		1		1	
12	21		2	3	9	7	73	5		1	1	2	1
13	2				1	1	74	26	1	4	11	9	1
14	9		1	1	3	4	75	0					
15	4				4		76	2			1		1
16	4				4		77	0					
17	9				6	3	78	3		1	1	1	
18	3		1	1	1		79	1		1			
19	3					3	80	23		2	6	7	8
20	23				3	20	81	5		1	3	1	
21	14			1	7	6	82	11	1	4	4	1	1
22	12				7	5	83	0					
23	1					1	84	7	1	3	3		
24	0						85	7			2	5	
25	0						86	8		5			3
26	4				1	3	87	16				6	10
27	26				6	20	88	3					3
28	7				1	6	89	67		6	7	37	17
29	28				2	26	90	22		1	7	12	2
30	20				8	12	91	4		1	1	2	
31	7		1		4	2	92	35	4	20	6	5	
32	9			1	1	7	93	1				1	
33	5				1	4	94	27	1	2	1	8	15
34	24				2	22	95	13		4	1		8
35	6				1	5	96	4		1	2		1
36	2					2	97	22		2	1	9	10
37	26	1	5	2	11	7	98	12	2	2	3	3	2
38	2				1	1	99	2			1	1	
39	6				3	3	100	39				4	35
40	5			1	4		101	5				3	2
41	4				1	3	102	4			2	2	
42	33		1	2	12	18	103	6	1	3	1	1	
43	53			1	6	46	104	70	2	14	7	20	27
44	4				1	3	105	3					3
45	3			1		2	106	8	1	5			2
46	1				1		107	45	1	8	6	3	27
47	7			1	4	2	108	57		3	4	12	38
48	12		1	4	7		109	42	3	8	4	6	21
49	9				4	5	110	26		1	1	8	16
50	10				5	5	111	18	3	5	2	4	4
51	16				4	12	112	34	1	11	13	3	6
52	3				1	2	113	65	2	4	11	14	34
53	2				2		114	18		1	3	3	11
54	17				1	16	115	13		4	3	3	3
55	2				1	1	116	27				5	22
56	2				1	1	117	41	1	8	9	14	9
57	13				2	11	118	0					
58	27			1	6	20	119	95	1	16	11	11	56
59	27				6	21	120	17			2	9	6
60	10				2	8	121	19		1	1	4	13
61	12		2	2	8								

(c) Age-class = 4 years

Quadrat No.	Seedlings						Quadrat No.	Seedlings					
	Total No.	No. per height-class						Total No.	No. per height-class				
		I	II	III	IV	V			I	II	III	IV	V
1	9	1	3		3	2	37	5	1			2	2
2	15	1	10	3	1		38	0					
3	16	1	4	1	4	6	39	2				2	
4	13					13	40	1					1
5	4		1			3	41	0					
6	3					3	42	1				1	
7	2			2			43	0					
8	3					3	44	9		2	1	3	3
9	2		1			1	45	6		1		1	4
10	6					6	46	26		3	2	6	15
11	2					2	47	0					
12	14					14	48	0					
13	20					20	49	18				2	16
14	32		1	1	5	25	50	0					
15	19					19	51	10					10
16	3					3	52	3					3
17	8					8	53	4					4
18	2					2	54	21					21
19	1					1	55	5					5
20	1					1	56	5					5
21	1			1			57	0					
22	2				2		58	3			2	1	
23	18					18	59	2				2	
24	2					2	60	14			2	4	8
25	3				1	2	61	11				2	9
26	3				1	2	62	11					11
27	30				1	29	63	0					
28	6					6	64	2					2
29	0						65	0					
30	2			1		1	66	10			1		9
31	3					3	67	12					12
32	0						68	65		1		3	61
33	2					2	69	12					12
34	31		1	6	12	12	70	4					4
35	4					4	71	21				3	18
36	0												

(d) Age-class = 7 years

Quadrat No.	Seedlings						Quadrat No.	Seedlings					
	Total No.	No. per height-class						Total No.	No. per height-class				
		I	II	III	IV	V			I	II	III	IV	V
1	3					3	25	10					10
2	1					1	26	3					3
3	5					5	27	12					12
4	5					5	28	9					9
5	8					8	29	2					2
6	6					6	30	19					19
7	8					8	31	0					
8	5					5	32	8					8
9	12					12	33	6					6
10	2					2	34	9					9
11	2					2	35	0					
12	2					2	36	8					8
13	1					1	37	0					
14	1					1	38	9					9
15	0						39	2					2
16	0						40	2					2
17	0						41	4					4
18	1					1	42	0					
19	1					1	43	5					5
20	16					16	44	1					1
21	0						45	0					
22	2					2	46	1					1
23	2					2	47	5					5
24	0						48	3					3

(e) Age-class = 10 years

Quadrat No.	Seedlings						Quadrat No.	Seedlings					
	Total No.	No. per height-class						Total No.	No. per height-class				
		I	II	III	IV	V			I	II	III	IV	V
1	0						31	0					
2	0						32	7					7
3	4					4	33	0					
4	10					10	34	0					
5	0						35	0					
6	1					1	36	0					
7	1					1	37	0					
8	1					1	38	1					1
9	2					2	39	1					1
10	21					21	40	8					8
11	6					6	41	3					3
12	3					3	42	0					
13	1					1	43	1					1
14	3					3	44	0					
15	3					3	45	0					
16	0						46	0					
17	4					4	47	0					
18	0						48	6					6
19	2					2	49	0					
20	3					3	50	0					
21	0						51	0					
22	1					1	52	0					
23	1					1	53	2					2
24	5					5	54	5					5
25	2					2	55	3					3
26	0						56	2					2
27	6					6	57	0					
28	6					6	58	1					1
29	1					1	59	1					1
30	1					1							