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A STUDY OF SCRUB FUELS IN THE JARRAH FOREST OF WESTERN AUSTRALIA

by
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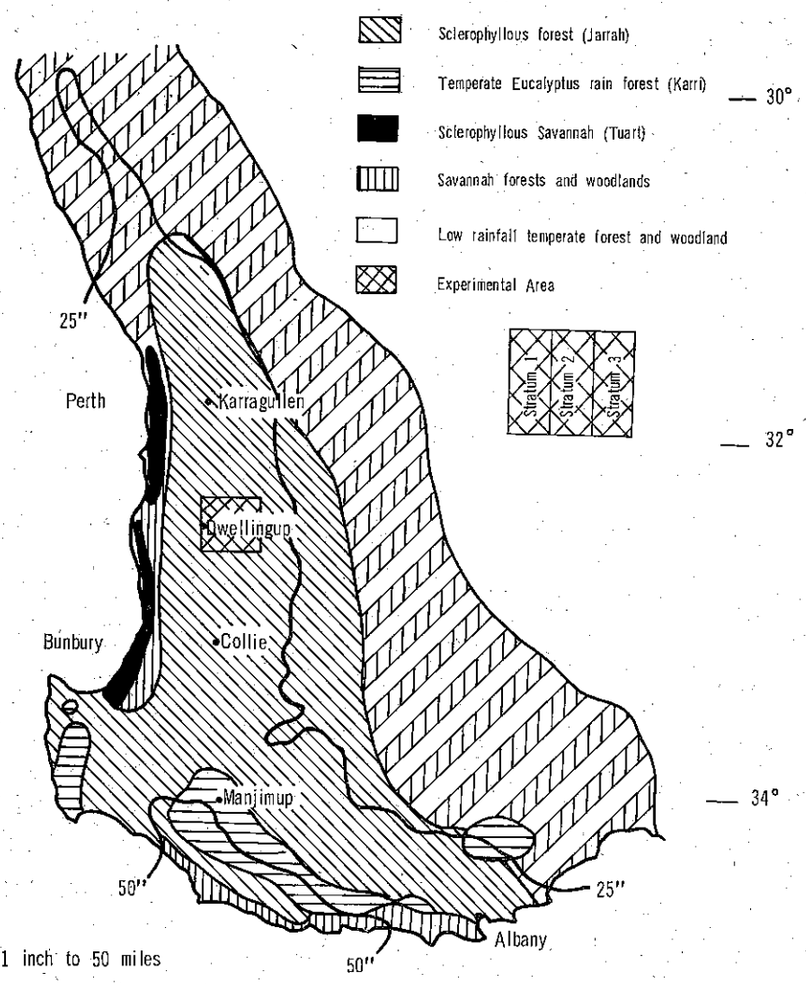

Figure 1.
Major forest formations of south Western Australia showing location of the experimental area.

SUMMARY

The understorey of "scrub", in the jarrah forest of Western Australia has been recognized as an important fuel component for forest fires. Pilot studies have revealed considerable variations in burning rates for foliage of different species, but as yet no quantitative method for fuel loadings has been developed.

The reported survey of scrub structure in jarrah forest near Dwellingup was a first step towards the development of such fuel loadings. The survey provides a list of the most common scrub species divided into inflammable and relatively non-inflammable types. This division gives a basis for rating the combustibility of particular forest areas.

The number of scrub species was similar throughout the experimental area, but the proportion of the forest floor covered by scrub was higher in the dry eastern forest. There were indications that the species composition of scrub changed with intensity of past fires. Certain species of *Leguminosae* were promoted in the environment created by intense fires. Although other species remained, their frequency of occurrence was considerably less. On the other hand, mild controlled burning in spring suppressed these *Leguminosae,* with an accompanying increase in number of plants of other species.

INTRODUCTION*

For many years foresters have recognized the important effect of scrub on the intensity of fires in the West Australian jarrah (*Euc. marginata* Sm.) forest. However, there has been little experimental work on which to assess the influence of these fuels, and the effect of a change in scrub structure on fire behaviour.

In this report the term "scrub" means the understorey of shrubs growing on the forest floor. In jarrah forest these shrubs vary between 0.5 (15cm) and 6.0 feet (1.8m) in height, cover about 40 per cent. of the forest floor, and include many different species.

There is some evidence that scrub structure alters with the frequency and intensity of past fires. These changes have been reported for a number of eucalypt forests in Austarlia (Floyd, 1966; Mount, 1965; Van Loon, 1966).

Reasons for these changes were outlined by Sweeney (1969) who pointed out that some scrub species produce seed with a dormancy mechanism. This mechanism is broken by the action of fire.

Costin (1957) noted that frequent burning in the Australian Alps changed ground vegetation from a herbaceous sward to fire resistant shrubs, which increased the inflammability of the forest. The latter type of understorey is typical of the jarrah forest which has been described as a true dry sclerophyll formation (Gardner, 1942).

Though not conclusive the evidence suggests fires were frequent in or close to jarrah forest long before European settlement (Rodger, 1961; Wallace, 1965). These fires were probably mild, although covering large areas in summer, and quite different from the intense ones which burnt through the debris left by forest and land utilization (Harris and Wallace, 1959).

* Note: Metric equivalents are given in the text but not in accompanying tables or appendices.

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The defoliation of forest trees and other environmental factors created by intense fires promoted the growth of dense fire-weed scrubs. Scrub assessment reported here set out to measure effects of past fires as one of its objectives. In particular the effect of fire intensity on scrub was considered pertinent.

The need to provide a quantitative assessment method for these fuels was illustrated by McCormick (unpublished data 1968), who compared burning rates for foliage of three scrub species. Foliage cut from eight-year-old plants was burnt in metal trays after preheating and igniting by fires burning in jarrah leaf litter. The results were clear; foliage of western prickly moses *(*Acacia pulchella* R. Br.) burnt twice as fast as netic *(Bossiaea aquifolium* Benth.) and three times as fast as ti-tree (*Leptospermum ellipticum* Endl.).

Before McCormick's work could be applied in the field it was necessary to describe the composition of scrub fuels in this forest, particularly the most common and dense species contributing to forest fuels. This was the objective for the assessment. Since it was probable that past fires, rainfall, and site quality could affect species distribution, these factors were considered in designing the study.

EXPERIMENTAL AREA

Part of the forest selected for this study had been burnt by the intense Dwellingup fires of 1961 (Rodger, 1961; Peet and Williamson, 1968) while the remainder had been controlled burnt with mild fires (Peet, 1965). In the intensely burnt area dense patches of fire-weeds were observed. Generally, scrub covered 30 to 50 per cent. of the forest floor and was one (0.3m) to three feet (0.9m) in height.

The rectangular study area was 20 miles (32km) in length on a north to south axis and 24 miles (39km) in width. It lay close to the town of Dwellingup, in prime jarrah forest (Figure 1).

The climate for the south-west of Western Australia is a Mediterranean type with hot, dry summers and cool, wet winters. Rainfall decreases quite markedly from Dwellingup to the eastern part of the experimental area (Appendix 1). Canopy cover for the forest ranged between 30 and 80 per cent., usually higher in the west. Topography is gently undulating and the soils are lateritic. This forest grows in a comparatively harsh fire environment where changes in scrub understorey can produce marked effects on fire intensity.

EXPERIMENTAL METHOD

The objective for this assessment was to define a broad pattern for scrub fuels through the experimental area, minimizing localized site differences. Plots were purposely located on upper slopes or ridges to avoid the more complex vegetation in wetter sites such as gullies and drainage flats.

Averages of annual rainfall and, therefore, site quality decreased regularly from Dwellingup eastwards (Appendix 1). The effect of this decrease was accounted for by dividing the area into three strata. Each stratum was eight miles (13km) wide in the east to west direction and twenty miles (32km) in length. Stratum 1 covered the highest rainfall area in the west, Stratum 3 the eastern forest, and Stratum 2 lay in between (Figure 1).

* Species names were taken from Blackall (1954) and Beard (1962).

Scrub types in each system were described on 50 systematically located plots which covered a total of 2,000 square feet (186m²). These plots were placed on a 1.5 miles (2.4km) grid except when it was necessary to move them from a gully or flat to an adjoining slope.

Each plot consisted of ten sampling units spaced at one chain (20m) intervals along a line. One sampling unit covered four-square-feet (0.37m²) of forest floor within which species were indentified and mapped by ocular estimate (Figure 2).

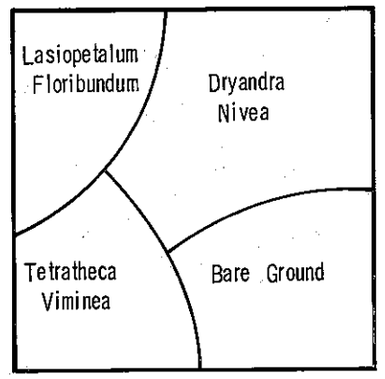

Figure 2.
Example of a mapped sampling sub plot. Percentage cover was determined by ocular estimate.

Regeneration of the tree species, casuarina (*Casuarina fraseriana* Miq.), bull banksia (*Banksia grandis* Willd.), jarrah and marri (*Euc. calophylla* R. Br.), was included to compare their frequency with that for other species.

The ten sampling units in each plot were combined into forty square feet (3.7m²) of mapped forest floor. Finally, the plots were combined in each stratum to provide a list of scrub species, the area of forest floor covered by each species and the number of times each species was observed (Appendix 2).

After the Dwellingup fires, a map of crown damage to the forest was prepared from aerial photos. Three main classes were mapped: (i) defoliation, (ii) full scorching, and (iii) lesser damage which left the upper crowns green (Peet and Williamson, 1968). The area of controlled burning added a fourth class representing mild fire intensities. These classes were compared by assessing five to six plots in each.

There had been little defoliation in Stratum 2, and very little crown damage at all in Stratum 3. For this reason only Stratum 1 represented all four intensity classes. Stratum 2 was represented by full scorching, lesser damage and controlled burning. Stratum 3 was excluded from this part of the study.

Scrub in this forest is quite inflammable and usually consumed by fire. The assessments took place during 1964 and 1965, when scrub in the Dwellingup fire area was four to five years of age. Scrub in the controlled burnt area was two to five years of age.

EXPERIMENTAL RESULTS

Differences Between Strata

Table 1 summarizes assessments in the three strata. It lists number of families and species in each stratum, number of times the species were observed, and the area covered by scrub on 2,000 square feet (186m²) of forest floor.

TABLE 1

Summary of Scrub Coverage in Each of the Three Area Strata

Strata	No. of families	No. of species	No. of observations	Area covered by scrub (sq. ft.)
Stratum 1	27	107	783	630
Stratum 2	31	105	1,058	982
Stratum 3	31	112	1,120	970

The 27 to 31 families were represented by 105 to 112 species, suggesting there were approximately equal numbers in each stratum. These species were observed more frequently and covered greater areas of forest floor in the drier Strata, 2 and 3, than in the wetter western Stratum 1.

Scrub covered 31.5 per cent. of the forest floor in Stratum 1, 49 per cent. in Stratum 2, and 48.5 per cent. in Stratum 3. To these percentages should be added areas of scrub in which the species were not identified due to a lack of flowers and fruits at the time of assessment. These covered 4.7 per cent. of the forest floor in Stratum 1, 5.1 per cent. in Stratum 2, and 7.4 per cent. in Stratum 3. Combining these results provides a similar area coverage for scrub in Strata 2 and 3, with the area in Stratum 1 much less (54, 55 and 36 per cent. respectively).

Some species were observed more frequently and covered a greater area of forest floor than others (Appendix 2). From a fire aspect these were the important ones for fuel classification.

The most common species were listed by noting those which occurred on ten or more plots in each stratum. These species contributed 69 to 92 per cent. to the total scrub cover, suggesting they were the dominants.

Some of the common species were of a denser, more spreading growth habit than others. The list was subdivided into species covering more than 20 square feet (1.9m²) of forest floor and those which covered less.

Table 2 lists species observed on more than ten plots, and covering more than 20 square feet (0.9m²). For each stratum they were divided into inflammable and relatively non-inflammable types. This division was established through a subjective assessment of burning behaviour during fires observed in this forest.

TABLE 2

Scrub Species Observed on More than 10 Plots and Covering More than 20 Square Feet of Forest Floor

Stratum	Inflammable Types	Non-Inflammable Types
Stratum 1	*Xanthorrhoea preissii* Endl. *Xanthorrhoea gracilis* Endl. *Loxocarya flexuosa* (R.Br.) Benth. *Dryandra nivea* R.Br.	*Acacia strigosa* Link *Hibbertia amplexicaulis* Steud. *Bossiaea ornata* (Lindl.) Benth. *Adenanthos barbigera* Lindl.
Stratum 2	*Xanthorrhoea gracilis* *Xanthorrhoea preissii* *Dryandra nivea* *Acacia pulchella* (R.Br.) *Pteridium aquilinum*	*Hibbertia amplexicaulis* *Hibbertia montana* Steud. *Scaevola striata* R.Br. *Bossiaea ornata* *Lasiopetalum floribundum* Benth. *Macrozamia reidlei* (Gaud) C.A.Gardn *Acacia drummondii* Lindl. *Acacia strigosa* *Trachymene compressa*
Stratum 3	*Loxocarya flexuosa*	*Macrozamia reidlei* *Hibbertia hypericoides* (DC) Benth. *Patersonia occidentalis* R.Br. *Hibbertia montana* *Brachyachne prostrata* *Bossiaea ornata*

Effect of Wildfires on Scrub Composition

Assessment results for four classes of crown damage in Stratum 1, and three classes in Stratum 2, are shown in Table 3. This table provides a summary of Appendix 3.

TABLE 3

Scrub Coverage in the Four Classes of Crown Damage
Stratum 1—200 sq. ft. of assessed area per class
Stratum 2—240 sq. ft. of assessed area per class

Crown Damage	Strata	No. of Families	No. of Species	No. of Observations	Area of Scrub (sq. ft.)
Defoliation	1	19	45	73	81
Fully Browned	1	20	48	83	77
	2	20	59	136	158
Total	....	....	....	219	235
Lesser Damage	1	15	50	88	52
	2	22	64	137	113
Total	....	....	....	225	165
Controlled Burning	1	19	42	76	41
	2	22	50	96	79
Total	....	....	....	172	120

Differences between strata were again evident, species were observed more frequently and covered a greater area of forest floor in Stratum 2 than in Stratum 1.

For Stratum 1 between 42 and 50 species were observed in four classes. They were recorded a similar number of times, but were denser and more spreading in the defoliated and fully scorched areas than on areas which had been lesser damaged or controlled burnt.

For Stratum 2, the area of scrub was higher in the fully scorched area and species numbers were less in the controlled burnt area.

For both strata, number of observations and area coverage appeared to rise with increasing fire intensity. Area coverage rose from a 120 square feet (11.1m²) total for both strata in the controlled burnt class, to 235 square feet (21.8m²) for full scorching and another increase seemed probable into defoliation (Table 3). Similarly, number of observations rose from 172 to 219.

Apparently, certain scrub species regenerated better in the environment created by intense fires. Species within the *Leguminosae* covered 38 per cent. of the area of scrub for defoliation, 40 per cent. for full scorching, dropping to 33 per cent. for lesser damage, and to 20 per cent. for controlled burning. The species contributing most to the percentages quoted for defoliation and full scorch were *Acacia strigosa* Link, *Acacia pulchella* R. Br., and *Bossiaea aquifolium* Benth.

Table 4 shows results for three plots, each a 100 square foot (9.3m²) composite of quadrats. The forest above had been defoliated by the Dwellingup fires four years previously. Each plot was dominated by one *Leguminosae* species which contributed between 95 to 220 plants to a total number between 247 and 376.

TABLE 4

Regeneration of Scrub over 100 sq. ft. of Forest Floor after Defoliating Dwellingup Fire and Following Mild Controlled Burning

	Plot 1 100 sq. ft.		Plot 2 100 sq. ft.		Plot 3 100 sq. ft.	
	A	B	A	B	A	B
Number of Species Observed	30	31	30	27	32	53
Number of Plants of Main Species						
Bossiaea aquifolium	220	12	....	....	....	....
Acacia strigosa	....	....	210	7	....	....
Acacia pulchella	....	....	....	....	95	4
Number of Plants of Other Species	325	308	247	160	376	393

A—Recorded 4 years after Dwellingup Fire of 1961.
B—Recorded 2 years after a Spring controlled burn in 1968.

The plots were controlled burnt in 1968 with mild fires (20 to 30 British Thermal Units per second per foot) in spring. Two years afterwards, the number of fire-weed plants had dropped to 4 to 12, although total numbers of plants were similar for two of the plots.

The results suggest that these three species of *Leguminosae* were promoted by intense fires, while other species were much reduced in number although still present. Mild controlled burning removed the dominance of the legumes and led to a marked increase in number of plants of other species.

DISCUSSION

This assessment is a broad survey of scrub composition in jarrah forest near Dwellingup. It separates the important species for fuel studies and indicates that structural changes may be related to past fire intensity.

Rainfall decreases regularly from Dwellingup eastwards, raising the query whether eight-mile (13km) wide strata were adequate controls for showing differences in scrub structure. However, there was no evidence of a decrease in scrub cover or number of species in the drier eastern forest. Only 62 of the 100 or so species listed in each stratum were observed throughout the area. The remainder may have a restricted habitat or be less frequent, requiring a more intensive sampling method.

These scrub fuels are secondary types. They require pre-heating and igniting by fires burning in litter before becoming available fuel (McCormick, unpublished data, 1967). To describe scrub fuels it is necessary to include estimates of litter tonnage and age of the plants, species differences, and moisture content and density of the foliage.

The most common species were subjectively divided into inflammable and relatively non-inflammable types. This provides a basis for separating inflammable forest areas from others, providing age and litter is considered. Further research has suggested measures of density, height, and tonnages of foliage in size classes may provide a means of deriving workable fuel loadings for measuring changes in fire intensity (Sneeuwjagt, 1970).

This survey indicates that mild controlled burning encourages a more varied ground flora with less of the highly inflammable fire-weeds. This effect extended over most of the jarrah forest in the Dwellingup area, from prime to marginal quality forest. Wildfires, on the other hand, had a detrimental effect on variety in the understorey and dense fire-weeds which followed them have proven a problem for subsequent controlled burning, and for general access into the forest. However, there was no evidence that any species were eliminated by wildfire and with proper controlled burning it seems that all species can be rehabilitated.

ACKNOWLEDGMENTS

This work was directed by the Conservator of Forests, Mr. W.R. Wallace and the author is indebted to Mr. W.H. Eastman for his advice on the project.

Mr. J. McCormick made a major contribution to the assessments and to the associated projects reported here.

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APPENDIX 1

Annual Rainfall (inches) for Stations East and West of Dwellingup

Station	Height above sea level (ft.)	Distance from West coast (miles)	Annual Rainfall (inches)	Period of Measurement
Mandurah	15	0	34.5	1911 to 1940
Pinjarra	28	14	36.7	1911 to 1940
Dwellingup	890	26	51.4	1927 to 1953
Duncan's Mill	1,000	41	40.0	1934 to 1943
Murradong	1,111	47	29.8	1911 to 1940
Wandering	1,114	61	27.0	1911 to 1940

APPENDIX 2

Dwellingup Scrub Assessment—Results Strata 1, 2 and 3

Listing : Species observed on 50 plots,
Number of times each was observed on 50 plots,
Area of forest floor covered by each species for 2,000 square feet of forest floor.

Family	Species	Stratum 1 N.	Stratum 1 Total Area sq. ft.	Stratum 2 N	Stratum 2 Total Area sq. ft.	Stratum 3 N	Stratum 3 Total Area sq. ft.
		3	2.85	....	....	....	....
		10	2.36	14	3.71	17	7.04
		2	0.52	9	5.90	9	1.90
		....	....	....	....	1	0.15
		5	3.29	5	1.99	10	4.21
		....	....	....	....	5	6.31
		....	....	3	1.90	2	0.82
		9	15.03	26	52.18	14	21.81
		3	3.95	1	1.01	5	2.60
		33	20.50	33	20.60	18	14.88
		1	0.18	....	....	....	....
		2	0.60	1	0.27	....	....
		10	8.59	1	3.31	15	23.05
		....	....	3	1.56	3	2.20
		1	0.10	1	0.51	....	....
		26	11.48	41	38.67	41	33.67
		18	8.87	9	5.48	6	1.63
		....	....	7	3.96	7	3.47
		....	....	....	....	2	1.08
		2	1.05	....	....	....	....
Amaryllidaceae	Conostylis aculeata R.Br.						
	" aurea Lindl.						
	" serrulata R.Br.						
Amarantaceae	Trichinium manglesii Lindl.						
Casuarinaceae	Casuarina fraseriana Miq.						
	" humilis*						
Compositae	Podilepis gracilis†						
Cycadaceae	Macrozamia reidlei C.A.Gardn.						
Dilleniaceae	Hibbertia acerosa (R.Br.) Benth.						
	" amplexicaulis Steud.						
	" crassifolia (Turz) Benth.						
	" glomerata Benth.						
	" hypericoides (D.C.) Benth.						
	" lasiopus Benth.						
	" lineata Steud.						
	" montanta Steud						
	" montanta var. major*						
	" perfoliata Endl.						
	" silvestris Diels.						
Droseraceae	Drosera microphylla Endl.						

APPENDIX 2—continued

Family	Species	Stratum 1		Stratum 2		Stratum 3	
		N	Total Area sq. ft.	N	Total Area sq. ft.	N	Total Area sq. ft.
Epacridaceae	Andersonia caerulea R.Br.	1	0.30	2	3.29	2	0.65
	Astroloma ciliatum (Lindl.) Druce	....	....	13	2.47	4	3.12
	" humifusum (Cav.) R.Br.	1	0.50	....	....	2	1.03
	" macrocalyx Sond.	19	13.52	1	0.08	6	1.34
	" pallidom R.Br.	....	....	3	0.74	4	0.95
	" prostratum R.Br.	....	....	4	0.91	....	....
	Leucopogan australis R.Br.	5	3.29	12	9.69	12	9.28
	" capitellatus D.C.	6	3.41	3	2.37	1	1.25
	" verticillatus R.Br.	8	4.82	5	3.52	....	....
	Styphelia tenuiflora Lindl.	8	6.84	2	0.40	17	11.01
Euphorbiaceae	Phyllanthus calycinus Labill.	3	1.17	12	9.69	17	13.21
	Stackstemon vermicularis Planch.	....	....	1	0.84	....	....
Goodeniaceae	Dampiera coronata Lindl.	1	3.40	1	0.40	14	3.60
	" cuneata R.Br.	....	....	26	7.62	30	12.67
	" hederacea R.Br.	1	1.06	....	....	....	....
	" linearis R.Br.	1	0.15	2	0.40	5	1.72
	Leschenaultia biloba Lindl.	10	4.87	29	10.34	35	14.75
	" formosa R.Br.	1	1.50	....	....	....	....
	Scaevola anchusifolia Benth.	....	....	1	1.30	1	0.46
	" canescens Benth.	2	0.32	1	1.14	....	....
	" pilosa Benth.	....	....	3	1.98	....	....
	" striata R.Br.	30	18.36	34	28.46	33	12.44
Gramineae	Brachyachne prostrata*	....	....	3	2.63	25	29.43
Gentianaceae	Erythraca centaurum†	....	....	....	....	1	1.27
Iridaceae	Patersonia occidentalis R.Br.	13	7.47	12	5.69	20	37.10
Leguminosae	Acacia alata R.Br.	1	0.15	2	1.00	7	2.01
	" acutata W.V.Fitzg.	1	0.77	....	....	....	....
	" cyanophylla Lindl.	3	1.90	....	....	1	0.30
	" daviesixides C.A. Gardn.	3	0.87	5	1.83	1	0.16
	" decipiens R.Br.	2	2.35	....	....	....	....
	" diptera Lindl.	3	2.77	3	0.74	9	3.83
	" drummondii Lindl.	3	9.58	15	25.40	6	11.70
	" drewiana W.V.Fitzg.	....	....	....	....	....	....
	" extensa Lindl.	....	....	....	....	1	0.30
	" glaucoptera Benth.	....	....	....	....	1	0.16
	" myrtifolia Willd.	....	....	1	0.65	....	....
	" nervosa D.C.	2	1.43	1	0.36	12	6.95
	" pulchella R.Br.	7	22.16	13	49.61	6	28.97
	" stenoptera Benth.	2	0.85	....	....	1	0.52
	" strigosa Link.	16	31.89	17	29.56	27	15.02
	" trigonophylla Meissn.	1	0.09	....	....	....	....
	" urophylla Benth.	9	8.55	13	14.18	6	3.75
	Albizzia distachya (Vent.) Macbride	1	0.15	....	....	1	0.09
	Bossiaea aquifolium Benth.	9	15.47	7	30.75	....	....
	" linophylla R.Br.	....	....	10	3.04	16	12.94
	" ornata (Lindl.) Benth.	23	44.82	38	79.33	41	99.69
	" pulchella Meissn.	....	....	....	....	1	3.84
	Daviesia cordata S. Moore	....	....	1	12.20	....	....
	" incrassata Sm.	5	2.92	7	5.10	10	7.78
	" pectinata Lindl.	5	3.35	7	3.20	19	19.15
	" pedunculata Benth.	....	....	2	0.85	....	....
	" quadrilatera Benth.	1	0.40	....	....	....	....
	" rhombifolia Meissn.	4	4.55	3	2.53	8	7.58
	Gastrolobium spinosum Benth.	1	2.00	....	....	7	7.40
	" villosum Benth.	....	....	....	....	2	2.86
	Gompholobium polymorphum R.Br.	....	....	15	3.28	7	2.25
	Chorizema ilicifolium Labill.	....	....	2	0.83	....	....
	Hovea chorizemifolia (Sweet) D.C.	18	5.39	23	8.60	15	3.25
	" trisperma Benth.	1	0.35	....	....	3	0.40
	" pungens Benth.	1	0.09	....	....	1	0.12
	Kennedya coccinea Vent.	11	4.96	7	2.34	1	0.32
	" prostrata R.Br.	11	6.79	19	10.39	18	10.86
	" stirlingii Lindl.	1	0.25	1	0.15	....	....
	Mirbelia dilata R.Br.	....	....	1	0.20	....	....
	Sphaerolobium gracile Benth.	1	0.09	....	....	....	....
	" fornicatum Benth.	....	....	1	0.06	1	0.10

* Refer Blackall † State Herbarium

APPENDIX 2—continued

Family	Species	Stratum 1		Stratum 2		Stratum 3	
		N	Total Area sq. ft.	N	Total Area sq. ft.	N	Total Area sq. ft.
Liliaceae	Agrostrocriium scabrum R.Br. (Bail.)	5	1.59	....	....	....	....
	Borya nitida Labill.	1	3.21	....	....	....	....
	Lomandra sonderi F.Muell.	26	12.44	13	6.17	10	5.02
	" flexuosa	....	....	....	....	17	20.70
	Thysanotus dichotomus R.Br.	2	1.79	....	....	....	....
	Xanthorrhoea gracilis Endl.	24	26.36	25	25.00	21	11.09
	" preissii Endl.	17	36.21	22	55.22	23	53.04
Labiatae	Hemigenia macrantha	1	5.02	1	0.21	1	0.57
Myrtaceae	Astartea fascicularis (Labill.) D.C.	5	2.63	27	8.89	14	6.71
	Agonis linearifolia (D.C.) Schau.	1	0.64	1	0.60	....	....
	Baeckia camphorosmae Endl.	....	....	4	0.72	7	5.48
	Calothamnus sanguineus Labill.	....	....	....	....	2	2.19
	Eucalyptus calophylla R.Br.	8	0.48	19	9.88	7	2.31
	" marginata Sm.	24	5.24	40	44.51	35	16.00
	Hypocalymma robustum Endl.	1	0.25	....	....	....	....
	Melaleuca lateritia Otto.	3	2.09	....	....	....	....
	" scabra R.Br.	1	0.06	1	0.21	8	10.94
	" viminea Lindl.	2	6.24	....	....	....	....
Pittosporaceae	Billardiera floribunda F. Muell.	....	....	1	0.86	....	....
	" varifolia Turcz.	....	....	2	0.56	1	0.27
	Sollya erecta C. Andrews	3	0.28	....	....	....	....
	" fusiformis (Labill.) Briq.	....	....	....	....	1	0.63
Proteaceae	Adenanthos barbigera Lindl.	31	25.41	9	11.85	2	4.50
	Banksia grandis Willd.	20	12.39	22	22.39	10	5.90
	Dryandra cuneata R.Br.	9	5.52	....	....	....	....
	" nivea R.Br.	22	22.58	23	22.97	38	64.90
	" quercifclia Meissn.	1	0.34	....	....	....	....
	" armata R.Br.	....	....	....	....	2	3.02
	" bipinnatifida R.Br.	....	....	....	....	3	1.17
	" floribunda R.Br.	....	....	....	....	2	0.34
	Banksia sphaerocarpa B.Br.	....	....	....	....	2	4.89
	Conospermum amoenum Meissn.	2	0.64	10	3.11	6	1.85
	" acerosum Lindl.	....	....	1	0.89	....	....
	Grevillea pilulifera (Lindl.) Gardn.	1	0.16	....	....	....	....
	" quercifolia R.Br.	....	....	1	0.35	3	2.74
	" wilsoni A.Cunn.	1	1.45	....	....	7	19.63
	Hakea angustifolia*	2	1.09	4	1.93	11	7.82
	" erinacea Meissn.	2	1.85	....	....	....	....
	" lissocarpha R.Br.	1	0.35	12	17.07	25	31.35
	" nitada R.Br.	....	....	1	0.50	....	....
	" petiolaris Meissn.	2	0.85	....	....	....	....
	" ruscifolia Labill.	....	....	1	0.35	....	....
	" cyclocarpha Lindl.	....	....	....	....	2	0.80
	" myrtoides Meissn.	....	....	....	....	4	3.72
	" ruscifolia Labill.	....	....	....	....	2	2.47
	Isopagan formosus R.Br.	....	....	2	0.25	14	8.26
	" tridens F.Muell.	....	....	3	2.31	5	4.30
	" teretifolius R.Br.	....	....	....	....	1	1.37
	" villosus Meissn.	....	....	....	....	1	0.40
	Petrophila diversifolia R.Br.	1	1.00	....	....	....	....
	Persoonia longifolia R.Br.	6	3.25	15	7.21	5	2.31
	Synaphea preissii Meissn.	1	0.25	....	....	....	....
	" decorticans*	....	....	....	....	1	0.15
Polygalaceae	Comesperma virgatum Labill.	....	....	1	0.10	....	....
	" confertum Labill.	....	....	1	0.08	1	0.10
Polypodiaceae	Pteridum aquilinum*	9	7.90	19	25.66	3	3.33
Ranunculaceae	Clematis aristata*	4	1.02	7	1.77	7	2.11
	Ranunculus lappaceus Sm.	3	2.00	....	....	....	....
Rutaceae	Eriostemon spicatus A. Rich.	7	2.96	....	....	....	....
	Boronia ovata Lindl.	....	....	1	0.36	....	....
	" spathulata Lindl.	21	5.29	22	10.42	9	3.88
Orchidaceae	Spiculaea ciliata Lindl.	....	....	1	0.20	....	....
Rhamnaceae	Trymalium ledifolium Fenzl.	9	7.14	16	24.89	17	22.89
Restionaceae	Loxocarya flexuousa (R.Br.) Benth.	20	25.91	29	22.64	17	20.70

APPENDIX 2—continued

Family	Species	Stratum 1		Stratum 2		Stratum 3	
		N	Total Area sq. ft.	N	Total Area sq. ft.	N	Total Area sq. ft.
Sterculiaceae	Lasiopetalum floribundum Benth.	18	13.68	29	32.80	10	10.72
	Thomasia glutinosa Lindl.	....	....	4	5.19	15	18.98
Santalaceae	Leptomeria axillaris R.Br.	1	0.09	10	4.61	....	....
Stylidiaceae	Stylidium brumonianum Benth.	2	1.14	....	....	4	2.97
	" amoenum R.Br.	....	....	....	....	8	1.52
	" ciliatum Lindl.	....	....	....	....	9	1.44
Stackhousiaceae	Stackousia brunonis Benth.	2	0.41	1	0.15	....	....
	" huegellii Endl.	....	....	....	....	....	....
Thymelaeceae	Pimelia rosea R.Br.	27	15.13	9	4.61	24	6.41
	" suaveolens (Endl.) Meissn.	1	0.20	1	0.04	5	1.55
	" multiflora†	....	....	....	....	2	0.72
Tremandraceae	Tetratheca viminea Lindl.	6	2.85	22	11.34	20	8.23
Umbelliferae	Trachymene compressa†	12	13.67	12	33.40	5	3.58
	Xanthosia atkinsoniana F. Muell.	20	17.74	29	14.85	16	9.23
	" candida Benth.	3	0.96	12	7.44	16	2.88
	" peltigera Benth.	11	4.14	34	16.77	30	7.64

* Refer Blackall † Refer State Herbarium

APPENDIX 3

TABLE 1

Stratum 1.—Comparison of Defoliation with Lesser Fire Damage over 200 square feet of forest floor.

Showing : Number of species in each family,
Number of times these species were observed on the 5 plots,
Area covered by species in each family.

Family	Defoliation			Browned Crowns			Lesser Damage			Controlled Burning		
	No. of Species	No. of Plots Obs.	Area sq. ft.	No. of Species	No. of Plots Obs.	Area sq. ft.	No. of Species	No. of Plots Obs.	Area sq. ft.	No. of Species	No. of Plots Obs.	Area sq. ft.
Amaryllidaceae	1	1	1.36	2	3	2.87	2	8	3.08	1	4	3.13
Casuarinaceae	....	....	....	1	2	2.30	....	....	....	1	1	1.30
Cycadaceae	1	2	2.85	1	1	3.58	1	1	1.00	....	....	....
Dilleniaceae	3	7	7.32	5	10	3.81	5	13	4.65	4	14	5.80
Epacridaceae	3	4	2.78	3	5	5.75	5	6	3.14	4	6	3.84
Euphorbiaceae	....	....	....	1	2	0.92	....	....	....	1	1	0.25
Goodeniaceae	3	4	4.65	2	4	1.01	1	3	2.99	2	5	1.38
Iridaceae	1	1	0.64	....	....	....	1	2	0.41	1	2	0.38
Leguminosae	13	18	31.45	10	16	27.75	10	13	8.23	9	12	7.19
Liliaceae	3	7	12.56	4	5	8.41	4	10	6.85	2	5	1.04
Labiatae	1	1	5.02	....	....	....	....	....	....	....	....	....
Myrtaceae	2	7	2.09	3	5	0.89	4	6	6.23	2	3	0.63
Pittosporaceae	....	....	....	1	1	0.12	....	....	....	....	....	....
Pestionaceae	1	1	0.62	1	3	2.71	....	....	....	1	2	1.71
Proteaceae	5	8	3.59	5	7	5.80	9	15	9.39	4	4	3.18
Polypodiaceae	1	1	0.70	1	3	2.03	....	....	....	1	2	1.50
Ranunculaceae	1	1	0.40	2	2	0.35	....	....	....	2	2	0.35
Rutaceae	1	2	0.43	1	1	0.37	2	1	0.91	2	3	0.56
Sterculiaceae	....	....	....	1	4	3.01	1	2	0.45	1	3	3.87
Stylidiaceae	1	1	0.16	....	....	....	....	....	....	....	....	....
Thymelaeaceae	1	2	1.00	1	5	3.19	1	2	1.24	1	3	1.39
Tremandraceae	....	....	....	....	....	....	1	1	0.20	....	....	....
Umbelliferae	2	3	3.06	2	3	1.37	3	5	2.82	2	3	1.54
Rhamnaceae	1	2	0.74	1	1	1.00	....	....	....	1	1	1.44

APPENDIX 3

TABLE 2

Stratum 2.—Over 240 square feet of forest floor.

Family	Fully Browned			Lesser Damage			Controlled Burning		
	No. of Species	No. of Plots Obs.	Area sq. ft.	No. of Species	No. of Plots Obs.	Area sq. ft	No. of Species	No. of Plots Obs.	Area sq. ft.
Amaryllidaceae	1	2	0.55	1	4	0.74	1	1	0.19
Casuarinaceae	1	1	0.25	1	1	0.20	....	....	....
Cycadaceae	1	2	5.92	1	2	8.40	1	3	4.39
Dillenaceae	4	12	11.97	5	12	9.91	4	9	4.47
Epacridaceae	5	8	8.18	4	6	1.87	2	2	0.26
Euphorbiaceae	1	2	0.80	2	3	2.07	....	....	....
Goodeniaceae	4	14	6.51	3	12	2.59	4	10	6.39
Gramineae	....	....	....	1	2	0.98	....	....	....
Iridaceae	....	....	....	1	1	0.35	1	1	0.30
Leguminosae	14	30	61.86	18	34	46.31	12	17	17.96
Liliaceae	3	6	12.48	3	9	10.40	2	8	8.52
Labiatae	....	....	....	....	....	....	1	1	0.20
Myrtaceae	4	13	6.68	3	5	2.20	4	12	11.74
Pittosporaceae	1	1	0.28	....	....	....	....	....	....
Proteaceae	7	13	10.87	8	14	10.88	4	8	3.17
Polygalceae	....	....	....	....	....	....	1	1	0.08
Polypodiaceae	1	1	0.40	1	1	2.60	1	4	9.68
Ranunculaceae	....	....	....	....	....	....	1	3	1.30
Rutaceae	....	....	....	1	2	0.91	1	2	0.49
Orchidaceae	....	....	....	....	....	....	1	1	0.20
Rhamnaceae	1	3	6.52	1	2	1.91	1	1	0.10
Restionaceae	1	2	1.58	1	4	2.90	1	2	1.73
Sterculiaceae	2	4	6.17	2	5	3.41	1	3	1.52
Santalaceae	1	2	0.89	1	1	0.16	....	....	....
Thymelaeaceae	2	2	3.14	1	2	0.44	1	1	0.12
Tremandraceae	1	3	2.34	1	3	1.21	1	2	0.20
Umbelliferae	4	15	10.03	4	12	2.72	4	12	6.09

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