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SCHOOL OF BIOLOGY

WORK EXPERIENCE REPORT

" A General Study into the Biology of the Rat-kangaroo, *Bettongia penicillata* "

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Duration: December, 1982

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CONTENTS

Introduction:

The duration of the work experience program for the forestry department consisted of a general study into the biology of the rat-kangaroo (*Bettongia penicillata*) or woylie, with particular emphasis placed on population distribution and its relating factors.

The area of study was in the Yendicup block within the Perup forest, approximately fifty kilometers east of Manjimup. A detailed map of the study area is given in figure 1 below.

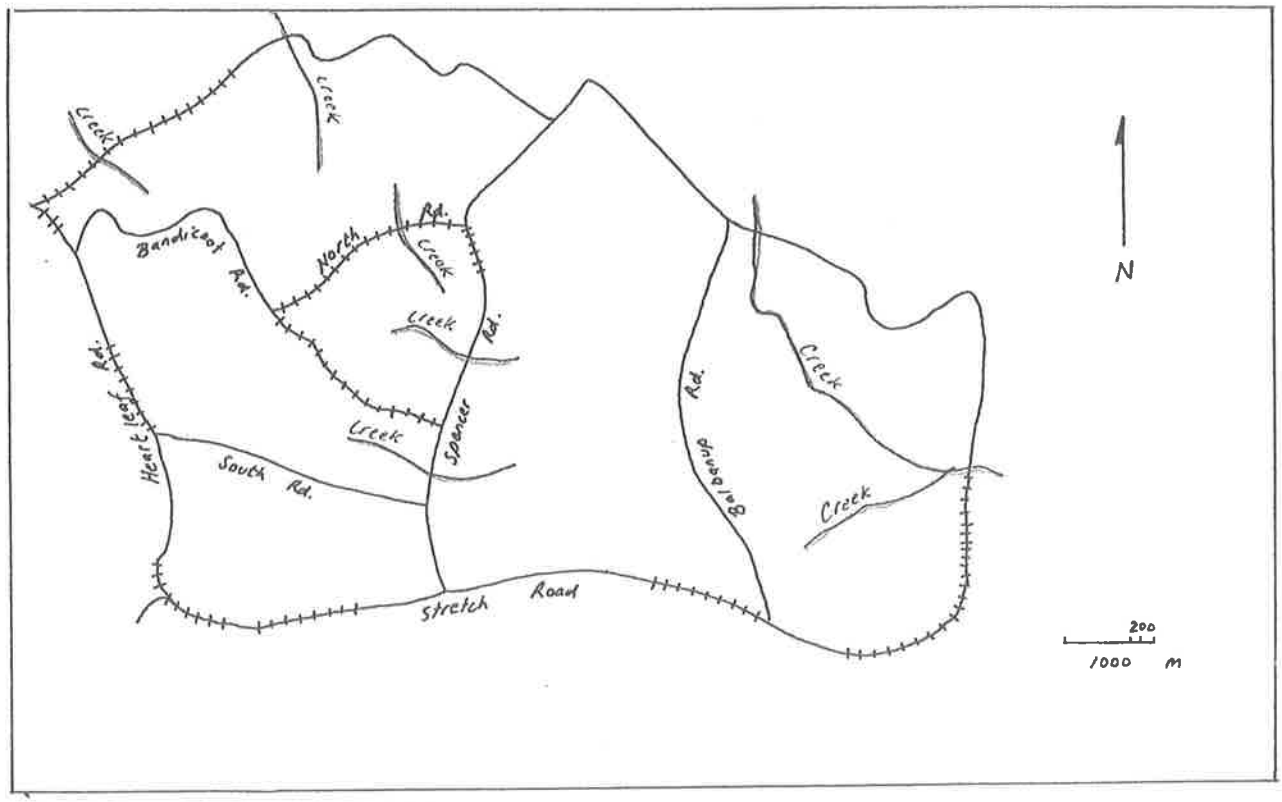


Figure 1. Yendicup Block; Perup

Diary:

The activities undertaken incorporated three basic areas of study:

1. Trapping of woylies.
2. Vegetation surveys.
3. Nest transects.

The aim of the work experience program was to obtain imformation from

each of these three areas and by statistical analysis arrive at some conclusions as to the distribution of woylies in the Perup region.

For the purpose of the study, the Yendicup block was divided into three different sites. Each site contained a hypothetically high woylie population and a hypothetically low woylie population, referred to as "good" and "poor" areas respectively. Areas were allocated "good" or "poor" population status based on previous trapping results.

Although individual tasks are looked at in depth in the following sections, a brief summary or diary of the work experience program is found below.

Day 1:	am	Familiarisation with trapping/nest transect/vegetation techniques. Set traps.
	pm	
Day 2	am	5:30-10:00 am.Clearing and resetting of traps, recording of data.
	pm	Nest transects/vegetation surveys.
		8:30-9:30pm Tabulation of data.
Day 3	am	Trapping
	pm	Nest transects/vegetation
		Tab. of data
Day 4	am	Trapping
	pm	Nest/vegetation
Day 5	am	Clear traps and reposition to next site.
	pm	Nest/vegetation
Day 6	am	Completion of nest transects and vegetation surveys
	pm	where aplicable.

At the completion of the above timetable in site 1, the process repeated for sites 2 and 3. Additional activities included a spotlight survey, composition of a species list and monitoring of the field weather station.

Trapping

As was explained in the previous section, a total of three sites were trapped for the rat-kangaroo. Each site was trapped for a period of four consecutive nights.Forty traps were allocated to the poor area traplines and forty to the good which totalled eighty traps per site. The trapping plan is summarised in the table below.

Table 2 : Summary of trapping plan.

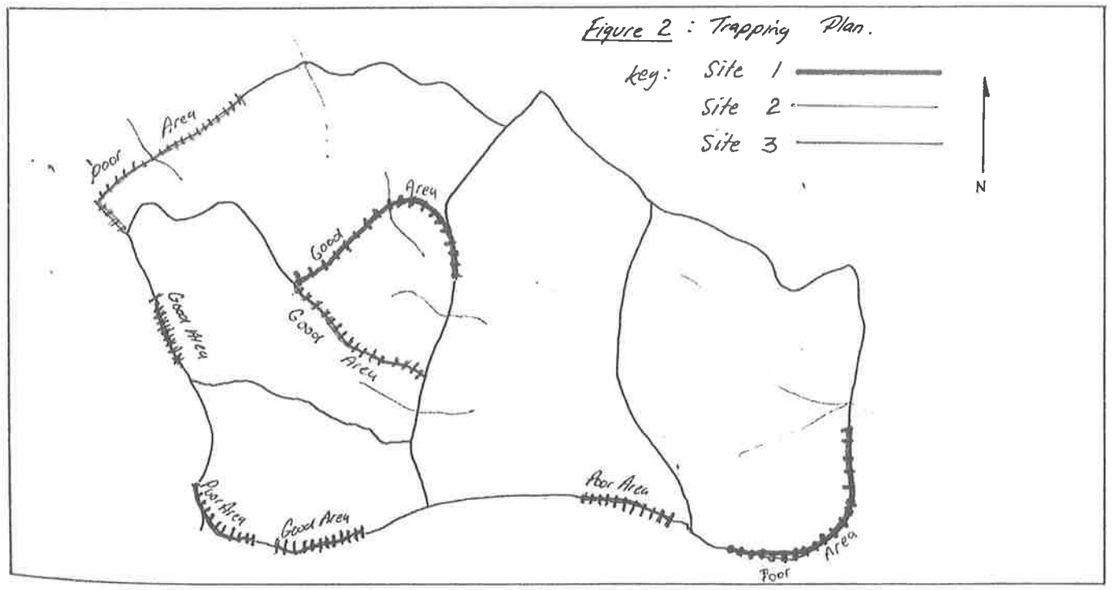
	No Traps		Nights Trapped	
	poor	good	poor	good
Site 1.	40	40	4	4
Site 2.	40	40	4	4
Site 3.	20+20	20+20	4	4

Note 1. Due to the limited number of traps available and the amount of time required to clear a trapline, the three sites were trapped at different times rather than in one effort.

2. Site 3 was subdivided into two poor areas and two good areas with each subdivision allocated 20 traps.

The specific positions of the various sites on the Yendicup block can be seen on the second map (figure 2).

Figure 2 : Trapping Plan.



Method: The method of trapping the woylies was by the use of box traps

baited with universal bait (see plate 1).The forty traps to each area were placed at fifty metre intervals for a distance of two kilometres and set prior to the first nights trapping.

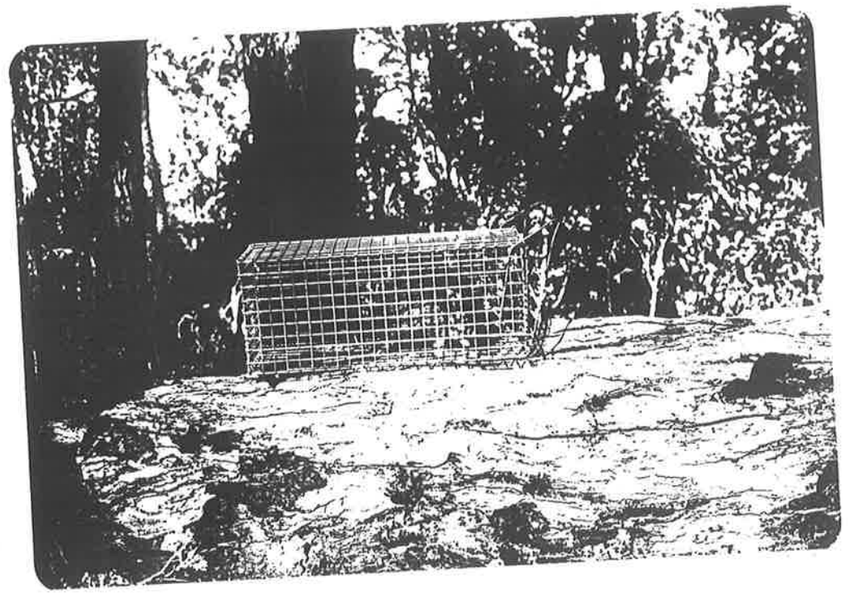


Plate 1 ►
Box trap used in trapping of woylies

Two important points were noted in the laying of the traps:

(i) It was essential that the door and area in front of the cage was not obstructed by plant or soil material as this could easily foul the closing mechanisim and allow escape of the animal.

(ii) Cages had to be placed in such a position as to be shaded from the next mornings sun; although woylies are nocturnal marsupials and are caught at night; the cage may not be checked until midmorning. The woylie therefore must not be subjected to such unecessary heat strees as the full morning sun.

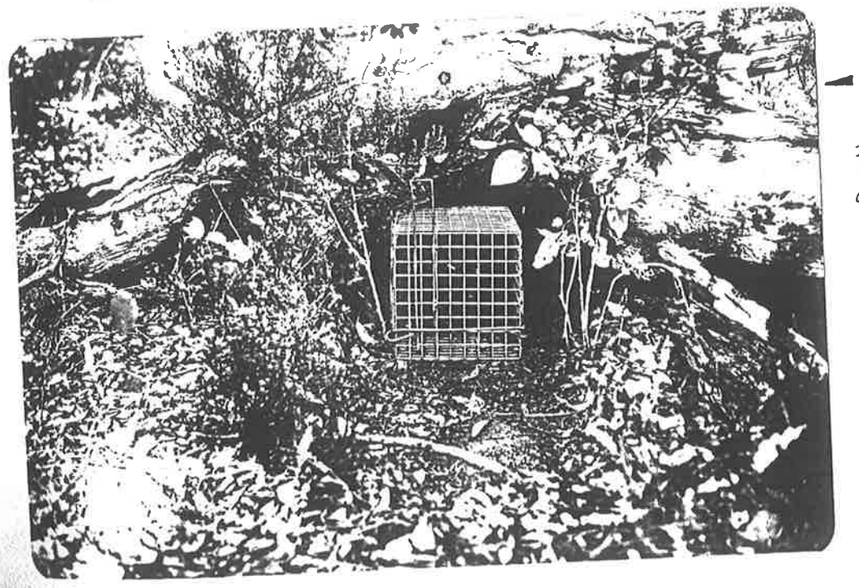


Plate 2.
Note cage shaded from direct sunlight and area cleared in front of cage door.

The morning following a nights trapping, the traps were cleared and the subsequent data recorded. The parameters measured for each woylie caught were:-

1. locality of capture
2. tag number
3. sex
4. teeth formula
5. weight
6. pes length
7. relevant comments eg. presence of joey etc.

The measurements above were simply standard measurements made in the regular monitoring of the Perup woylie population by the forestry department. The raw data relating to the individual animals was therefore of little relevance to our particular study, however the numbers of captures in the particular areas was valuable in indicating population density in the "good" and "poor" study locations. A summary of the trapping data obtained in the three traplines is contained in the table below.

		Site 1.		Site 2.		Site 3.		Total
		Good Area	Poor Area	Good Area	Poor Area	Good Area	Poor Area	
Total N° Trappings		31	9	45	17	30	4	136
Total N° woylies (♀ + ♂)		25	6	38	7	24	3	103
Total N° Animals		15	5	26	6	15	3	70
% Capture	total	25.83	7.5	37.5	15.04	25.42	3.48	
	woylies	22.80	5.12	33.6	6.79	21.42	2.63	

Table 3 Summary of trapping data for sites 1, 2 and three.

Note: It was necessary to include both a total % capture and a woylie % capture as the capture of other marsupials and reptiles would otherwise incorrectly influence final data.

The graph below summarises the average percent capture for the three sites trapped.

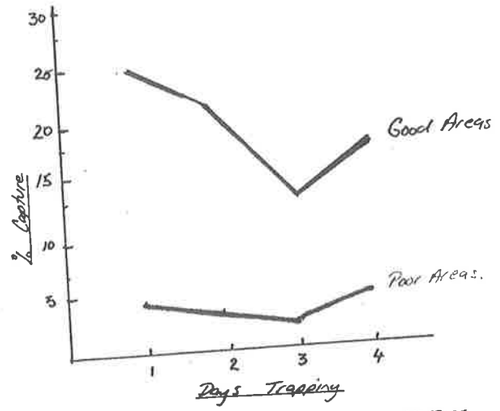


Figure 3. Percent capture versus day of trapping woylies.

Discussion: The results of the trapping in the three sites define clearly the distribution of woylies between "poor" and "good" areas. The graph above shows the proportion of captures which occured in the good areas compared with the poor. Captures in the good area at no time fell below 75% greater than the poor in terms of sucess rate.

With only four nights of trapping, the time period was insufficient to correlate any fluctuations in % capture with other variables such as weather or temperature patterns, however this would provide interesting information as to the activity of the woylie if pursued for a longer time.

The most interesting revelation from the trapping results was not only that it supported the hypothesis that population distribution varied according to "poor" and "good" areas , but that it could vary so markedly in such a small distance between sites. Considering the range that a woylie is capable of covering, one would assume the distribution to be approximately the same in all areas. The fact that the results conflict with this assumption suggests that differences in some aspects of the environment must cause certain regions to be unfavourable and others favourable ie that patches of acceptable habitat exist.

In the final discussion the factors which cause this pattern of distribution will be discussedin full.

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Vegetation Surveys

In order to effectively compare differences between "good" and "poor" trapping sites a comprehensive analysis of vegetation in all sites was made. As all traplines were layed adjacent to a dirt road, the vegetation was analysed each side of the road to ensure the vegetation covered was relevant to the study. Forty quadrats were recorded for both "good" and poor areas over the trapping period, ie

	No. of quadrats	
	poor area	good area
Site 1.	40	40
Site 2.	40	40
Site 3.	40	40

The position of the quadrats was assigned randomly by the use of a random number table. The resulting random number allocated the distance into the forest from the road, following a specified compass bearing. This prevented any possible bias influenceing results such as dense bush, heavy logging etc which otherwise may have subconciously been avoided.

The quadrat size was two metres square and within this quadrat the following parameters were measured:-

1. Location - noted as the distance and compass bearing from the road.
2. Percent cover - a visible estimate of percentage ground cover within the quadrat.
3. Average height (cm)
4. Number of clumps - the number of groupings or clumps of vegetation.
5. Species present - dominant species within quadrat. For ease of notation species were assigned letters and a field herbarium assembled.
6. Number of diggings - indication of presence of woylies/tammars/bungarras.
7. Logging/debris (%) - indication as a percentage of presence of logging and debris within quadrat.
8. Visibility (m) - This was simply a subjective estimate of the visibility afforded to a predator in persuit of a woylie.This measurement was made by estimating the visibility at predator height (eg. fox) for all four points of the compass and dividing this number by four to give an average value.

9. Comments - any comments relating to vegetation type eg. logged area laterite/sand/ridge/open woodland.

Data; Asummary of the data for all three sites is found in the table below.

	Site 1.		Site 2.		Site 3.	
	Good Area	Poor Area	Good Area	Poor Area	Good Area	Poor Area
% Cover	32.7 ± 24	23.4 ± 12.5	41·8 ± 20.0	28.7 ± 18.8	50.5 ± 21·3	31.7 ± 19·2
Clumps	3.0 ± 2·7	2.9 ± 1·5	2·5 ± 6·0	2.6 ± 0·7	3·4 ± 1·0	2.1 ± 0·9
Nº Digs	2.6 ± 3·2	0·8 ± 1·1	2·5 ± 1·0	1·2 ± 1·4	4·4 ± 2·4	3.1 ± 2.1
Height (cm)	57 ± 24	37.5 ± 17·7	53·5 ± 21·5	29·2 ± 12·1	46.2 ± 16·2	26 ± 9·9
Visibility (m)	7.1 ± 3.1	16·8 ± 4·6	6·3 ± 2·5	9·2 ± 2·1	4·9 ± 1·0	8·23 ± 2·6

Table 4. Summary of vegetation data.

A t-test was carried out on the above raw data using the following hypotheses:-

(1) Ho: mean % cover good area = mean % cover poor area.
Ha: mean % cover not equal.

(2) Ho: mean No. clumps good area = mean No. cluumps poor
Ha: mean No. clumps not the same.

(3) Ho: mean No. diggings good area = mean no diggings poor.
Ha: mean No. diggings not the same.

(4) Ho: mean vegetation height good area = mean vegetation height poor.
Ha: mean vegetation height not the same.

(5) Ho: mean visibility in good area = mean visibility in poor.
Ha: mean visibility not the same.

Hypothesis	Site 1	Site 2	Site 3
1 % Cover	1.7172 / N.S.	2.6196 / *	3·5908 / *
2 Nº Clumps	0·1761 / N.S.	−0·37696 / N.S.	5·2925 / *
3 Nº Diggings	5·0225 / *	4·1851 / *	2·2328 / *
4 Height	3.5796 / *	5.4081 / *	5·8276 / *
5 Visibility	−9.4878 / *	−4.7404 / *	−6·54·75 / *

Table 5 Summary of t-test performed on vegetation data.

Key: t_{critic} 0·05 [2][58] = 2·00
N.S = Not Significant at $\alpha = 0.05$
* = Significant at $\alpha = 0.05$

THe following conclusions can therefore be drawn from the above statistical analysis:

% Cover: No significant difference for % cover in site 1. Percent cover for sites 2 and 3 were significantly higher in the good areas compared with the poor (at = 0.05)

No. of clumps: Only site 3 showed a significant difference in number of clumps of vegetation. (at = 0.05)

No. of Diggings: All three sites showed a significantly higher number of diggings in good areas compared with poor. (= 0.05)

Vegetation height: All three sites were significantly greater in height in good areas compared to poor. (= 0.05)

Visibility: In all three sites the poor areas afforded significantly better visibility to a predator than the good areas. (= 0.05)

Disscusion : From the above calculations and general observations made at each site, poor and good areas contrast conclusively. Plates 3 and 4 are photographs of representative sections of poor and good areas. In the good area, the differing factors above ie. height, visibility and percent cover, as well as effects of heavy logging are obvious.

◄ Plate 3

Good Area, Site 1.
Note understorey density, effects of logging etc.

Plate 4 ►

Poor Area, Site 3.
Note : - high visibility
- low height
- low % cover

The sparsity and openess of the poor area in the photograph explains the reletively high visibility reading recorded for the area.

As well as the vegetation parameters previously discussed, species occurence and diversity must also be considered. A comprehensive list of all species found in the Yendicup block during the work experience period is found in the appendix. This was basically compiled from plants identified from our feild herbarium and is therefore only an indication of plants present at that time of the season.

The list bolow shows major species distribution for the three sites.

No.	Species	Site 1.		Site 2.		Site 3.	
		Good	Poor	Good	Poor	Good	Poor.
1	Leucopogon capitillatus	𝍸 𝍸 𝍸 III	IIII	𝍸 𝍸 𝍸 I	𝍸 𝍸 𝍸 𝍸 I	𝍸 𝍸 𝍸 II	𝍸 I
2	Bossiaea ornata	𝍸 IIII	𝍸 𝍸 𝍸 II	𝍸	III	𝍸 IIII	𝍸 𝍸
3	Hakea lissocarpa	𝍸 𝍸 𝍸 II	𝍸 𝍸 III	𝍸 𝍸 IIII	𝍸 𝍸 𝍸 II	𝍸 𝍸 𝍸 II	𝍸 𝍸 𝍸 II
4	B. linophyla	𝍸 I		III	𝍸	𝍸	
5	L. Verticillatus	𝍸 II		𝍸 I	IIII	𝍸	I
6	Xanthorrhoea gracillis	II	I	IIII		III	
7	Hibbertia inconspicua	I	II		II		
8	Trimalium lasiofolium				IIII	I	I
9	Macrozamia reidlei	𝍸 III	I	𝍸 𝍸 I	III	𝍸 II	
10	Jarrah	IIII		𝍸 I	𝍸	III	I
11	L. propinqeus	I	𝍸	III	I	I	
12	Hibbertia glaberrima		𝍸 II	III	I		
13	Lecopogon pulchellus		𝍸 IIII	I		I	I
14	Banksia grandis				𝍸		
15			IIII				
16	Hypocalymma augustifolia		𝍸 I			I	𝍸 II
17			I				
18	Dryandra nivea		IIII		I		
19	Astrophile		I				

Table 6. Major species distribution, Sites 1, 2 and 3.

In terms of species distribution, the results were somewhat varied. The initial aim was to analyse the species which occured in each area and from the presence of different species observe some trends regarding poor and good sites. For example, work by Havel (1975) on the southwest flora shows the definite affinity of some plants to poor infertile soils and others to fertile soils.

In some cases these trends did actually occur.

eg. High soil fertility: L capitillatus, B ornata, L. verticillata, Macrozamia reidleii.

Low soil fertility: Dryandra nivea, Banksia grandis, Hypocalymma augustifolia.

Although these trends were observed in isolated cases (marked in table above) they were by no means universal for all the sites. For this reason, the distribution of species in general must be considered fundamentally the same.

Due to time limitation no soil analysis was carried out on the soil and

therefore no nutrient levels are available. In general terms, Christensen describes the Peruo as consisting of " broad, flat, seasonally swampy drainage lines seperated by low ridges. Yellow podsolic soils occur on the drainage lines while the ridges are basically sandy gravels with occasional boulders and sheets of laterite pavement."

The Yendicup block has been under a controlled burn program, under management of the forests department, for a number of years. The fire history of the block is outlined in the diagram below.

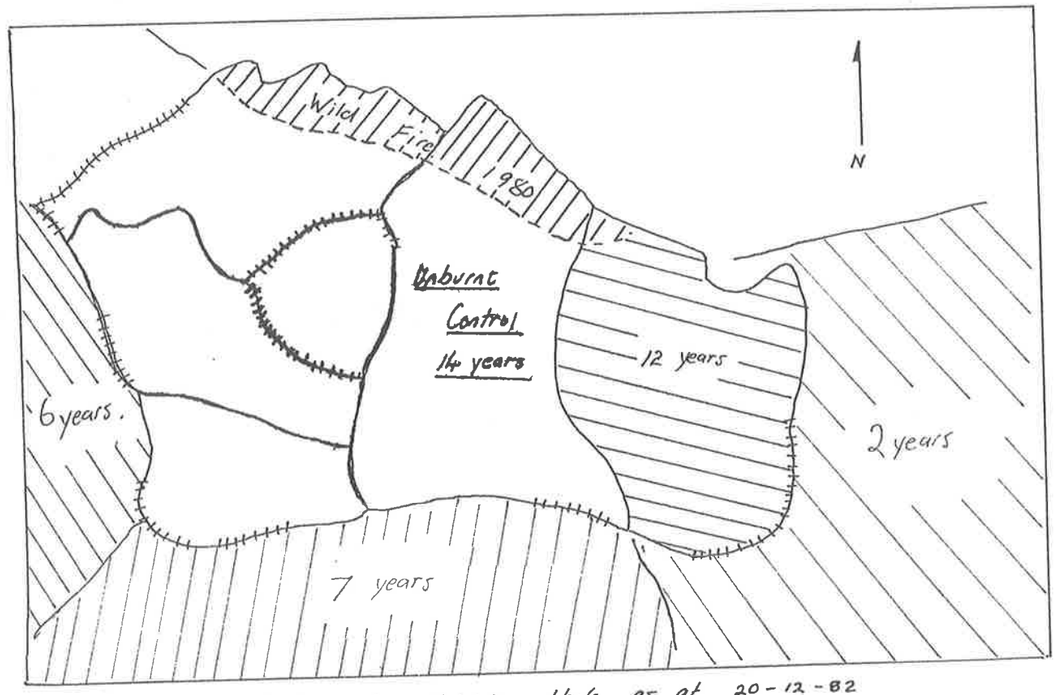

Figure 4. Burn history for Yendicup block as at 20-12-82

As can be seen, the actual study area is predominantly an unburnt control. The central area in question has not been burnt for a period of fourteen (since fire management began in the Perup). The exception to this is the region marked across the top of the block. This is the region burnt in a wildfire in 1980. Effects of the intensity of the fire are reflected clearly in the extensive regeneration of the fauna (plate5). The wildfire burnt itself out approximately 1000 metres from the begining of the trapline in poor area 2 however when considering the population results from the two other replicates, the effects of the wildfire on present woylie poulation appears negligible.

In summary, although specific differences did occur, the species

occuring in poor and good areas were fundamentally the same. Differences did occur however in the percent cover, the average height of the understorey, and the visibility in poor and good areas. The degree of fallen logs and debriswas also substantialy lower in poor areas, contributing to the openess of the eucalyptus woodland. Effects of fire on woylie distribution was found to have no major influence in our particular area as the study was carried out in an unburnt control section.

In the final discussion. the way in which these vegetation differences interact with population disribution and building of nests will be discussed.

Plate 5
Effects of Wildfire.
Note extensive regeneration

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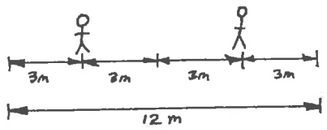
Nest Transects

The third task of the work experience program was the quantitative surveying of woylies nests. The woylie, as it is a nocturnal mammal, spends daylight hours in an elaborate, well camouflaged nest. The number of nests in a particular area is a good indication of woylie population and a good indicator of vegetation suitability.

The nests are constructed over shallow depressions in the soil from bark stripped from fallen trees or large limbs. Construction material may however vary according to the location.

Method: The tecnique used in locating nests was simply by walking a predetermined distance through the forest and by sight, finding and recording the position of the nests. By two people working together. each covering a three metre area on either side, the number of nests for a transect of 2 km x 12 m was effectively recorded.

ie.

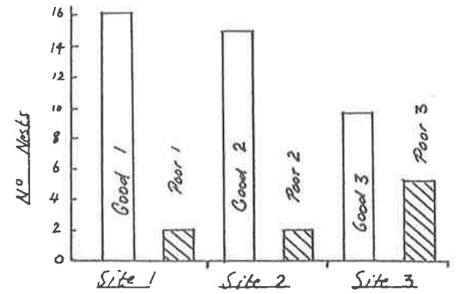


Where possible the transects were taken 1 km each side of the road for each site to give a more accurate survey of the nests surrounding the trapline. Accurate orientation and measurement of distance was vital in ensuring that each nest could be relocated if necessary.

In an effort to obtain as much information as possible from the nest transects, the nests located were classified according to their age:- usually apparent by their state of repair. The three subdivisions were:

1. New nests: Nests inhabited or recently occupied and completely intact with roof still remaining. (see plate 7)
2. Old nests: Nests which were partially broken down, usually with "floor" and "walls" of bark still remaining.
3. V.old nests: Only the depression and few remnants of bark to indicate presence of nest.

Results: Full data on number and location of nests for transects in all three sites are found in the appendix however the graph below summarises the nest transect results.



Graph 1. Graph shows number of nests versus sites in terms of good and poor areas.

Discussion: On completion of the transects and location of all nests over a total area of 144 000 square metres it was noted that three distinctive nesting sites tend to be preferred by the woylie.

Type 1. Nest located under fallen logs.In the heavily felled areas where previous logging had obviously effected the vegetation, many nests were found built into a depression dug underneath a jarrah log. Plate 6 shows a fairly recent and intact nest found in the good area of site one.

Plate 6 ►

Type 1: Nest located under fallen log

Type 2. Nest located under Xanthorrhoea gracillis. In areas where stands of Xanthorrhoea gracillis were common, nests were suprisingly easy to locate. The long overhanging "leaves" of the blackboy form a natural cavity between stem and leaves, thus making them an ideal

place for concealment. Plate 7 clearly shows such a nest. also giving an indication of size and material used for construction. The nest in this case was exposed for the photograph but as can be seen from the right hand side of the picture, under normal conditions the nest would be almost impossible to find.

Plate 7

Type 2 : Nest located und Xanthorea gracillus

Plate 8

Type 3 : Nest located under small bush. Nest is in centre of picture giving indication of camouflage. (See plate 9 for close up)

Plate 9

Nest type 3.

Type 3. Under small bush eg. B. ornata/L. capitillatus. These sites for nests were also common in areas where reasonably dense bushes of B. ornata and L. capitillatus were found. The nest was most often well under the cover of the shrub, thus afforded concealment by both the overhanging plant and the considerable amount of leaf litter which builds up due to wind. Plates 8 and 9 emphasise the camouflage provided by the bush and accumulated leaf litter. This particular nest location type was found primarily in the "good" areas as the L. capitillatiss and B. ornata tended to be more sparse and lacked the density to provide cover for nesting sites in the "poor" areas.

The graph summarising the nest results shows that a definite difference exists between nest numbers in the poor areas and nest numbers in the good. Sites one and two displayed the most contrast between good and poor but even in site three the number of nest in the good was double that found in the poor.

The difference in numbers suggests a marked woylie population difference in "good" and "poor" areas. Possible reasons for this variation will be viewed in the final discussion where all influencing factors can be taken into consideration.

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Discussion

From the combined results of trapping, nest transects and vegetation surveys, the hypothesis that the woylie is distributed into certain high population areas was found to be true. Supporting this definite distribution pattern were the fact that:-

1. There was a substantialy higher number of animals trapped in "good" areas than "poor".
2. There was an increased number of diggings found in high population or "good" areas indicating greater presence of woylies.
3. A higher number of nests were found in the good areas.

Investigation into important environmental factors such as vegetation proposed some possible explanations for the woylie distribution pattern.

1. Protection against predation. In all three sites, the vegetation was characteristicly higher in understorey, percent cover,(with exceptio of site 1), and density, in the good compared with poor areas. This feature of the vegetation is advantageous when considering predation of the woylie. Sparse open woodland with reduced understorey would provide little cover or protection from hunting predator such as the fox. The agility and capability of the woylie to move at speed through thick vegetation would be of less advantage in open areas, where visibility is at a maximum. In contrast, the good areas provide maximum cover to the woylie and minimum visibility to the fox, an ideal situation for reducin predation pressure.
2. Suitability for construction of nests. The suitability of the vegetation sites for construction of nests could also be a major factor influencing woylie distribution. This could involve two limiting factors. Firstly the presence of suitable locations in which to build the nests. If the woylie is to spend daylight hours inside the nest it must be camouflaged to protect it from both heat and predators. To obtain this degree of camouflage there must be suitable plants, logs or debris under which the nest can be built. In the case of the poor areas the vegetation was to a large extent unable to provide this camouflage This was evident when working on nest transects in the poor areas. The transcets were completed in a far shorter time because obstacles capabl of hiding a nest were so few and far between.

The second limiting factor for construction of nests is availability materials. In the good areas where fallen logs were abundent, on almost all los evidence of bark stripping by the woylies could be seen. The

considerable logging in the area meant that the woylie was not limited by construction materials in the building of it's nest.
In the poor areas however, there were far less fallen logs and branches. Although it would in no way be impossible to construct nests in the poor areas, the abundence of material and the suitability of the vegetation for camouflage in the good areas suggests a more favourable proposition.

3. Availability of food. The woylie obtains its food by digging for fungi in the ground at night. The average number of diggings found per quadrat in the good areas was significantly higher than that of the poor areas. This indicates that the woylie is feeding in the good area more than the poor however, conclusions beyond this fact can not be made. The concentration of feeding in the good areas could be due to one of the above factors ie. an alternative explanation of the population pattern,but the possibilit that food availability influences woylie distribution can not be ruled out.

As is the case with many biological studies a clear cut explanation need not necessarily exist. Other features of the habitat or characteristics of the woylie itself may be responsible. These factors, interacting with those already mentioned could be responsible for the population distribution of the woylie. Wether the answer lies in one exclusive parameter or a combination of many can only be established by further work. Valuable insight however, was gained into the complexity of studying a particular species and the way it relates to environment.

In conclusion, the work experience program can be considered invaluable experience in the practical and theoretical application of biology. The techniques learnt and used provided familiarisation with procedures relevant to future work, and the work was a source of interest and satisfaction.

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APPENDIX

SPECIES LIST Yendicup Block - December 1982

Acacia pulchella
Acacia saligna
Astartea fascicularis
Astroloma pallida
Banksia grandis
Boronia crenulata
Boronia spathulata
Bossiaea eriocarpa
Bossiaea linophylla
Bossiaea ornata
Brachysema praemorsum
Casytha sp.
Centanium australe
Clematis pubeseens
Comesperma conferta
Conostylis sp.
Danthonia pilosa
Daviesia preissii
Dianella revolutus
Dryandra
Dryandra nivea
Dryandra sessilus
Eucalyptus marginata
Gastrolobium bilobum
Glischrocaryon aureum
Grevillea pulchella
Hakea lissocarpa
Hakea prostrata
Hakea trifurcata
Hakea varia
Hibbertia cunninghamii
Hibbertia inconspicua (?)
Hibbertia racemosa
Hibbertia sp.
Hypocalymma angustifolia
Isotoma hypocrateriformis
Kunzea micrantha
Lepidosperma leptostachyum
Lepidosperma sp.
Lepidosperma sp.
Leptomeria cuninghammii
Leptospermum erubeseens
Leucpogon australis
Leucopogon capitillatus
Leucopogon oxycedrus
Leucopogon pulchellus
Leucopogon propinquus
Leucopogon verticillata
Loxocarya fasicularis
Loxocarya flexuosa
Macrozamia reidlei
Patersonia sp.
Persoria longifolia
Petrophile serruriaea
Phylanthus calycinus
Pimelia longifolia
Pimelia nervosa
Pimelia rosea
Pimelia suaveolens
Ptilotus manglesii

SPECIES LIST (cont..)

Scaevola atriata
Sollya heterophylla
Stackhousia brunonis
Stylidium
Synaphaea petiolaris
Trymalium ledifolium
Verticordia pennigera
Viminaria juncea
Waitzia accuminata
Waitzia sp.
Xanthorrhoea gracilis

Sampling Intensity

Formula used to determine number of samples required:-

$$n = \frac{s\ t}{d}$$

where n=number of samples required

s = standard deviation

t = normal deviate at confidence limit level and given degrees of freedom (from table)

d = margin of error (arithmetric mean times designated accuracy)

VEGETATION SURVEY: raw data

9/12/82.

GOOD SITE: (1)

BEGIN. PT.: 258

sp.IN	%CoV	CLUMPS	N°. DIGS	HT (cm)	VISIBIL. (m)	SPP.	Loa	DEBRIS ek	COMMENTS.
16W	15	1	–	60	8	i	45		
57	25	2	1	100	8	B,i,C	20		
10	45	3	4	90	1	C,D	5		
57	95	1	2	30	6	A,D,F	--		OPEN THICKETT D &
05	35	2	0	70	6	D,E,A	--		Gastrolobium bilobe.
65	30	3	11	60	4	A,C.	–		
09	25	3	2	70	9	C,I	–		
56	15	3	1	50	8	i,A,G	–		
12	15	4	3	50	7	i,J,C	–		
0	35	1	3	50	10	A,C,J	–		
59	0	0	3	0	18	–	5% (Log)		
10	10	3	0	70	9	C,E	–		
52	15	2	2	50	13	C,X	–		
06	10	2	1	90	10	I,C	20		
61	15	2	1	100	7	D,C	70		
08	50	4	–	60	8	E,E,C	–		
73	40	4	–	70	6	K,E,C	--		
21	20	3	2	40	7	A,C,I	5		
67	–	1	11	10	4	A,I	5		
24	20	1	0	90	8	I,A,C	10		
	START 259								
7E	85	3	0	55	4	B,F,A	0		
3	40	4	5	45	5	E,I,B	5		
4	30	2	2	70	6	D,B,A	0		
7	40	4	0	40	7	D,I,A	40		

2) Logging / felling → creates rubbish (slash) ⇒ reduced visibility ie logs in view → reduc. view.

2) minimal effect (if any) of logging tracks.

3) Diggings — source? — goannas
— mogilies
— bandicoot

— predom mogilies?

4) Effect of tree density → determin understorey density.
- but if poor soil → ↓ tree density and also understorey.

DIST. IN	% COVER	CLUMPS.	N°. DIGS	HT (cm)	VISIB. (m)	SPP.	LOGG / DEBRIS	COMMENTS
40	50	3	6	60	5	BE.	15	—
61	20	3	0	55	4	B,E,C	50	
8	50	4	4	45	7	A,J,B	5	
83	20	3	10	30	5	J,AB	0	
17	90	5	3	70	5	B,C	5	

VEGETATION STUDY

SITE 1 (POOR AREA).

BEGIN: 231 (NTH).

T. IN.	% COV.	CLUMPS	N°. DIGS	HT (cm)	VISIBILITY (m)	SPP.	LOGGING / DEBRIS	COMMENTS.
49	5	6	0	20	20	B, F	—	↑ ROCKY - EXTRUS^N LATERI
9	5	1	1	60	20	C, E	—	
1	1	—	0	25	25	I, A, C	—	SPP. INTO LATERITE SOIL.
28	10	8	2	25	5	C	10% ROCK	SINGLE DIGS.
205	5	1	0	20	20	K, J, M	—	
361	35	4	0	40	15	M, L, G	—	"
145	45	4	0	35	20	M, C, P	5%	↑ GRAVEL.
151	50	3	1	10	20	F, C, G.	—	
					EAST			
8	25	3	4 (10)	45	15	F, M, C	—	↓ LATERITE
7	40	5	0	30	25	P, M, R	—	—
40	20	5	1	40	25	F, M, R	—	—
20	5	3	—	40	10	C, M, R	—	LOGGING TURNAROUND
					SOUTH.			
1	35	5	1	20	15	F, K, E	15	MOVING SLICK INTO BANKSIA
49	10	2	1	10	15	K, E, I	—	
8	15	2	0	30	20	C, B, L	—	
16	15	4	0	40	20	J, K, V	10	↑ LATERITE
56	5	2	0	20	10	A, G, C	0	
81	5	3	0	20	15	B, C, L	5	
51	1	1	1	10	20	E	10	
10	20	2	1	40	20	B, C.	—	
57	15	5	1	20	20	A, B, C	5	
4	10	2	0	40	15	E	15	

CHANGE → ∴ VALLEY FLOO

227 NTH.

DIST. N	% Cov.	Clumps	N° Diggs	HT (cm)	Visib. (m)	Spp.	Logs / Debris	Comments
36	5	2	0	40	15	O, C	5 (debris)	
126	20	3	0	40	10	C, B, A	10	
168	40	2	0	50	15	K, B, C	0	
239	5	1	0	5	20	L, G.	15 (rock)	
	EAST.							
67	45	4	3	50	8	B, O, X.	5	
	SOUTH.							
65	35	3	3	60	12	B, C, L	0	
119	30	2	1	50	15	B, X, L	0	
213	60	3	2	80	7	B, M, I	0	

FOOR SITE 2.

BEGIN 133.

STN	% Cov.	Clumps	N° Diggs	HT (cm)	Visib (m)	Spp.	Log / Debris	Comments.
2 (S)	55	3	1	35	8	A, D, C	5	
4	35	2	0	50	11	D, β, E	0	PRESENCE GRASSES.
7	20	2	2	25	6	A, I, G	10 (BRANCH)	
35	45	1	2	45	7	γ, C, D	5	
56	30	3	0	40	11	J, C, R	0	J = SAPLING. APPEAR. AGAIN / D. nivea / A. palladin.
(W)	10	3	0	15	12	Δ, e, A.p.	10	
	30	3	0	25	8	D, I, C	15	
4	25	3	5	20	9	E, A, C	5 (TREE)	- SAPLINGS.
6	40	3	2	45	6.5	A, C	0	FOUND: 1 OLD WOYLIE NESTS UNDER X. gracilis
8	5	2	3	5	10	C, e	0	NEW NEST. → SURR. → OPEN.
(S)	20	2	1	20	9	A, C, GRASS	10	
W)	25	3	1	25	10	C, A, N	5	AREA : T LATERITE & S. grandis
	55	4	0	45	9	A, J		
	30	2	2	30	8	C, B, H	10 (FALLEN BRANCH)	2 OLD WOYLIE NESTS. [X. gracilis : HT = 25-30cm.]
	10	3	0	20	15	E, C, A	10 (LAT. EXT)	OLD NEST: UNDER: M. reichii
	129	START.						
(N)	10	2	0	20	9	A, H, G	10	
4	5	2	1	15	11	GRASS, L	0 (↑LAT)	TRANSECT THRU S. grandis stand
0	10	2	4	20	10	J, A, N	45	LOGGED AREA.
6	40	2	0	20	8	A, C, H		
2 (W)	30	2	0	45	13	I, GRASS	15	
(S)	10	3	1	15	11	A, N, GRASS		
2	13	2	0	15	10	N, A, RL		AREA : ↑ LAT & S. grandis.
2	15	3	1	20	8	C, N, A		NE SEEDLINGS.
7	53	3	0	40	7	J, A, K		
4	20	4	5	30	7	A, C		BACK ONTO RIDGE : No S. grandis
(S)	20	2	1	30	10	A, C, H		
	90	3	0	40	8	A, J, R		
73	30	2	2	35	10	A, GRASS, B	15.	
70	35	3	1	45	7	C, A, E	0	
54	45	3	1	40	6	C, A	5.	

GOOD SITE (2) 315 – 2

START : 300. (SOUTH)

ST IN	% COV	CLUMPS	N° DIGS	HT (cm)	VISIBIL (m)	SPP.	LOG/DEBRIS cm.	COMMENTS.
6(S)	20	4	5	80	5	E, I, A	5	
3	45	4	3	30	8	A, K, F	5 (LATERITE)	RIDGE – LATERITE.
6	70	4	1	50	8	A, B, A	15 (FALLEN LOG)	
0	20	1	3	50	10	I, A, C	40 (TREE FALL)	
4	15	1	6	60	6	J, E, C	10	↑ # DIGS IN G. bilob. Hick
0 (W)	20	3	1	40	6	J, A, C	10	
68	50	4	6	60	5	I, C, M	0	
31	35	3	2	20	8	A, C	0	
7 (N)	45	2	3	40	5	I, C, J	0	
0	30	3	4	50	5	C, I, A	5	
3	40	3	4	65	5	I, C, D	0	
4	45	3	5	40	5	C, A, K	15 (LOG)	
8	20	3	2	60	2	D, I, C	70 (CUTTING)	LOGGED AREA.
5 W	45	2	1	30	7	A, F	5	
11	5	1	4	10	5	C J	40	

START 300 → SOUTH.

3 (S)	45	2	1	80	5	C, A	0	
1	50	3	3	75	6	B, A	20	
2	55	3	0	50	7	Z.	0	
0	15	3	4	55	8	J, E, A	0	
4	20	2	4	20	10	F, L	0	SANDY AREA, NUM D
71	50	1	5	50	9	I, D, L	5 (STUMP)	
(W)	40	1	6	70	10	I	0	OPEN SAND.
31	15	2	1	30	5	A. A. pulchella	20	FELLED AREA.
10	40	3	2	50	10	I, A, Y		
49	40	2	0	65	10	A, C.	0	
12	25	3	2	40	6	I, J, F		
(N)	50	3	4	80	7	B, C, A	5	
3	40	4	0	60	2	C, E	20 (FALLEN TREE)	UNDER X. gracil
2	55	3	3	55	4	L. L, A	5	NEW NEST (12m
12	100	1	0	100	0	B, E, L	5	END.

GOOD 3A (START 50 – N).

IN	% COV.	N° CLUMPS	N. DIGS.	HT [cm]	VISIB (m)	SPP	LOGGING	DEBRIS	COMMENTS.
(N)	60	3	4	70	6	J, A, A1	10		
	35	3	7	40	4	C, A, I	10		
	70	3	5	45	5	B, A, C	10		
	45	4	4	30	4	B, A, H	7		
	10	2	5	15	5	B, C xx	25		
	55	4	4	70	5	J, B, C			SAPLINGS = J
	85	4	6	60	4	C, A, E			
	40	3	6	45	4	B, A			
(S)	50	4	14	30	6	C, P, E1			
	55	4	4	47	6	M, B, E1			
	80	4	5	50	5	F, A, B			
E)	45	4	4	65	4	B, C, I	5.		
	75	4	5	50	6	B, C, I			
	55	4	3	45	7	F, E, A			

SITE 3B (92)

V)	45	3	3	40	5	I, E, A	5 (LATERITE)	
2	10	1	2	30	4	C, D	85	
	65	4	9	55	4		10	
5)	80	3	1	90	3	D, A, C	10	
	40	4	4	40	7	C, A, D	20	
	80	5	2	50	3	A, D	10	
	5	3	2	15	5		15	LOGGED AREA.
	60	5	3	55	5	F, C	–	
	55	5	3	50	4	C, A	–	
E)	50	1	3	60	6			
	15	2	3	25	5	C, E	75 (DEBRIS)	
	30	4	4	50	5	C, A, I	15 (TREE)	
N)	55	4	6	45	6	I, K, C		↑ LOOSE LATERITE
	65	3	3	50	4	A, J		B. limbata :
	55	4	5	35	5	A, C, D		under-storey.
	45	2	3	35	4	A, E, I		

POOR 3A (39).

IST. IN	% COV	CLUMPS	Nº. DIGS	HT (cm)	VISIB (m)	SPP.	LOGGING/DEB.	COMMENTS.
85 (N)	45	3	1	30	12			LOW UNDERSTOREY IN
24	60	3	6	45	11			HAKEA.
90	10	2	6	30	8			SANDY, GREY SOIL
62	5	1	3	10	8		10	
54	35	2	2	15	10			
79 (N)	10	3	5	15	8			
87	45	2	3	45	7			
2	5	0	7	10	11			
81	20	1	1	40	5		15	
54	30	2	3	20	7			
96 (S)	50	3	0	30	10			
25	20	3	4	25	10			
2	10	1	2	15	11			
15	15	1	1	35	5		15.	
14	10	2	3	15	5		25.	
	POOR 3B START 69							
96 (S)	35	4	1	30	9			
4	35	2	6	35	8		20	
20	20	2	6	25	6			10m : NEW NEST. - UNDER
76	65	4	3	35	10			FALLEN LOGS.
28	15	1	2	25	4		10	↑ LOOSE LATERITE
31 (N)	50	2	5	30	7			
76	75	2	3	20	5			
41	30	2	7	15	15			
73	15	1	1	15	7		15	
40	55	3	3	40	6			
(N)	55	2	0	30	5			
32	45	3	4	30	7			
52	25	1	2	20	9			
8	30	2	1	30	12			MM CLUMPS GRASSES
35	20	2	3	20	9			ON SAND.

19/12/82.

LOCAL VEG. STUDY. (SITE 3)

POOR : 66.

ST IN	% COV.	CLUMPS	Nº. DIGS	HT. (cm)	VISIB. (m)	SPP.	LOG/DEBRIS	COMMENTS.
43 (S)	55	3	2	30	8		-	PREDOM. BROWN CLAY SOIL
0	30	2	1	25	8		15 (BRANCH)	
17	50	3	2	35	7		-	
98	10	2	3	20	8		-	M. prícissi. STAND ON RT.
93	60	3	2	35	10		-	
5 N	10	2	1	25	6		30 (CUT LOG)	LOOSE LAT. & SAND.
90	20	1	3	25	10		-	
8	55	2	2	50	8		-	
12	30	2	1	25	7		15 (FALLEN BR.)	
4	45	3	1	45	6		-	
	START 66.							
49 (N)	35	2	2	25	5		20	
73	40	3	2	25	8			
3	65	3	2	35	6·5			
18	50	3	4	25	14			
28	60	3	3	35	9			
17	80	4	1	55	5			
41	45	2	4	45	3			
37	50	2	4	40	0			2m. MED. UNDERSTOREY.
1	40	2	0	40	7			
65	40	1	2	35	6			
	THICKET OF HAKEA :						45-50	% COVER ON
	GROUND LEVEL. DIFFICULT. TO MOVE THROUGH							
	BECAUSE OF HAKEA UNDERSTOREY. : SPINDLY							

19/12/82.

LOCAL VEG. STUDY.

CCCD (START 59).

1ST IN.	% Cov.	CLUMPS	N° DIGS	HT (cm)	VISIB (m)	SPP.	LOG/DEBRIS	COMMENTS.
4 (N)	60	3	0	60	2		-	
63	15	2	5	25	5		50 (LOGGING)	
31	80	2	3	75	5		-	
86	10	2	11	20	6		5	
35	45	2	3	50	3		10 (TREE)	
20	10	1	6	25	5		-	
97	50	3	11	50	2		-	
6	90	4	3	80	4		25 (FALLEN	
2	50	2	3	40	4		30 TREE).	
31	10	1	3	10	4·5		-	
8 (S)	30	4	7	50	3·5		15 (TREE)	
3	50	3	1	70	6		-	
10	70	3	5	50	5		-	
41	55	3	4	40	6		15	
0 E	60	2	0	45	4		-	
64	40	3	2	50	3		-	
6 (W)	75	3	3	55	5		-	46 m. NEW WOYLIE.
79	30	2	2	45	4		-	
86	55	4	7	70	3		10	↑↑ LATERITE
35 (N)	100	4	3	60	3		10	

20/12/82.

LOCAL VEG STUDY.

START 53 - POOR.

1ST IN	% Cov.	CLUMPS	N°. DIGS	HT (cm)	VISIB (m).	SPP.	LOG/DEBRIS	COMMENTS.
25 (N)	50	3	6	50	3	B, P, I	10	
78	20	2	0	15	7		-	
23	40	1	3	55	2	I, J, A	30 (CUTTING)	
80	25	1	3	45	5	I, C, B	-	
95	35	3	4	50	6	B, C	-	↑ LATERITE.
1 (W)	80	2	2	55	3	B, C, J	-	
43	50	2	2	45	4	B, C, I	15 (	
78 (S)	75	3	4	65	6	B, A	-	
29	20	2	3	35	10		10	
87	40	3	6	35	4		-	
92 (S)	40	4	4	35	5	P	10	
5	10	1	2	15	7		10 (TREE)	
53	15	1	2	20	6	I, B, C	5	
89	50	2	0	50	4	B, A, J	20	STAND JARRAH SAPLIN
19	40	1	2	35	6	A, C, B	5	
38 (E)	45	3	3	20	7	A, C, I	-	
52 (N)	35	2	2	45	6·5	B, I, P	-	
4	60	1	2	55	6	B	5	
21	20	2	4	30	3·5	I, B, P	-	
64	25	1	2	30	8.		-	

Nesting Sites Data.

Site 1. Good Area.

Date	Site N°	Dist. In	Transect	Location Nests	Totals: wallabies	Totals: Bandicoot	Comments.
/82	1. (Pt 259)	200m (E)	500m (N)	13 m new 282 m old 450 m V.old	3		Area logged - num. clearings
	2. (Pt 289)	200m (N) 150m (N)	230m (W) 270m (S)	20m V.old 258m v.old 440m new 445m v.old	4		Direction change at heartleaf valley.
	5. (Pt 260)	200m (W)	500m (N)	150 m new	1		
2/82	7. (Pt 269)	300m (E) 250m (E)	250m (N) 200m (S)	13m old 33m new 91m V.old 126m old 130m V.old 133m V.old 200m V.old	7		under X. preissii under B. ornata B. ornata + m. [illegible]
	8. (Pt 283)	200m (NW)	180m (SW) 120m (NW) 200m (E)	25m new	1		

Total transect length = 2.0 km
Total number of nests = 16

Nesting Sites Data.

Site 1. Good Area.

Date	Site N°	Dist. In	Transect	Location Nests	Totals: wallabies	Totals: Bandicoot	Comments.
-/12/82	1. (Pt 259)	200m (E)	500m (N)	13 m new 282 m old 450 m V.old	3		Area logged - num. clearings
	2. (Pt 289)	200m (N) 150m (N)	230m (W) 270m (S)	20m V.old 258m v.old 440m new 445m v.old	4		Direction change at heartleaf valley.
	5. (Pt 260)	200m (W)	500m (N)	150 m new	1		
0/12/82	7. (Pt 269)	300m (E) 250m (E)	250m (N) 200m (S)	13m old 33m new 91m V.old 126m old 130m V.old 133m V.old 200m V.old	7		under X. preissii under B. ornata B. ornata + m. [illegible]
	8. (Pt 283)	200m (NW)	180m (SW) 120m (NW) 200m (E)	25m new	1		

Total transect length = 2.0 km
Total number of nests = 16

Site 1. Poor Area.

Date.	Site N°	Dist. in	Transect	Locat. Nest	Totals Woylie	Totals Bandicoot	Comments
1/12/82	3 (Pt 230)	200m (N)	500m (E)	305 m Kold.	1.		
	4. (Pt. 218)	200m (W) 150m (W)	250m (N) 250m (S)	286 old.		1.	change of vegetation to sparse
1/12/82	6. (Pt 232)	100m (E)	250m (E) 250m (N) 500m (E)	435 yo.	1.		under X. pressure

Total length transect 2km

Total Nests 2

Nesting Sites

Good Area. : Site 2

Site N°	Dist in	Transects	Locat. Nests	Totals Woylies	Totals Bandicoots.	Comments
				n o vo		
1. (Pt 308)	200m (N)	1000m (W)	28m V. old	1 : 1 2		
			476 new	(4)		
			500 old			
			560 V. old			
(Pt 313)	600 (NE)	500 (NW)	256m old	3 1		All three
			256m old	(4)		in close proximity
			260m old			under small xanthorea
			417m V. old			
(Pt 302)	100m (S)	500m (W)	232 new	3 4		NB. Occupied by woylie
				(7)		Under B. linafilla
			248m new			
			310 m V. old			
			342m V. old			
			350 V. old			
			390 V. old			
			420 New			

TOTAL TRANSECT = 2 km

TOTAL N° NESTS = 15.

Nesting Sites

Poor Area : Site 2

Site N°	Distance in	Transect	Locat. Nests	Totals		Comments
				Woylies	Bandicoots	
				n o vo.		
(Pt. 132)	200m (S)	400m (W)		1		
		100m (S)		(1)		
		500 (E)				
(Pt. 132)	400m (S)	294m (S)				
		275m (W)				
		70m (S)				
		70m (S)		(1)		
		275m (E)	176m vo	1		Under Zania
		294m (N)				

TRANSECT LENGTH = 2km

N° NESTS = 2.

19/12/02

Nesting Sites

Good Area 3

Site N°	Distance in	Transects	Location Nest	Totals Woylies	Totals Bandicoot	Comments
				n. o. v.o.		
	200m (W)	500m (N)	36m New	3 1		Under L Cyathistis
			37m New	(4)		small bush, single clu
			69m New			between fallen log and Xan
			421m V. old			
	150m (E)	500m (S)	291m V. old	(1) 1		
(Pg 57)	180m (N)	600m (W)	171m new	2 1	1new 1 old.	In small clump of Ja
						saplings and L. capitel
			213m new Bandicoot			
			400m old	(3)		Under B. Ornata
			401m old bandicoot			
			486m new			Under fallen log
	200m (S)	500m (E)	46 V. old	1		
			238 new	1 (2)		Under Jarrah sapling
						fallen log, dead tree

TRANSECT LENGTH = 2km

N° NESTS = 10.

17/12/82 - 20/12/82

Nesting Sites

Poor Area 3

Site N°	Distance in	Transect	Location nest	Totals Woylies	Totals Bandicoot	Comments.
				n. o. v.o.		
1. (PE 66)	500m (S)	500m (W)				
2.	250m (N)	500m (E)				
(PE 33)	300m (S)	500m (NW)	30m V. old	1 2		
			256m V old	(3)		
			262m new			
3.	200m (N.)	500m (W)	500m new bandicoots		2 new.	Note: Bandicoot inside
			600m new bandicoots		(2)	

TOTAL LENGTH = 2 km.

N° NESTS = 5 [3 W + 2 BC].