THE MANAGEMENT OF DRYANDRA FOREST FOR WILDLIFE CONSERVATION

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1. INTRODUCTION

Dryandra Forest consists of a series of discontinuous pieces of bushland to the north west of Narrogin, Western Australia. These blocks cover a total area of about 20 000 ha. The main economic value of the area in the past was the development of plantations of the Brown Mallet (*Eucalyptus astringens*) and some 8100 ha were planted between 1927 and 1962. The remainder of the forest is more or less in its natural state, some of it having been cut over for Wandoo (*Eucalyptus wandoo*). With the disappearance of the economic value of the Brown Mallet as a source of tan bark the forest's main value now lies in other areas. One of these is the varied range of animals which live there.

This study was initiated at the request of the Forests Department. It was aimed at providing information on the habitat requirements of the wildlife of Dryandra Forest so that management plans for the area might be developed to ensure their persistence. The study should also assist the Department of Fisheries and Wildlife with the development of management plans for nature reserves which harbour the same species as Dryandra.

The inland part of the south west of Western Australia, between the 400 and 650 mm rainfall isohyets, was, before European settlement, an area very rich in mammals. Following agricultural development with its extensive clearing of the bush and the introduction of exotic animals, plants and disease, both the number of species and the area inhabited by them has been reduced. Only a few isolated pockets of bushland now remain which are large and varied enough to continue to provide a habitat for all the remaining extant species.

Of these areas Dryandra Forest is the largest and most diverse and it therefore presents the best long term chance of continuing to harbour all the species now present. For this reason the proper management of the area, as well as its permanent dedication as bushland, is of great importance.

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The reasons for the decline in the number and range of mammals in the south west are not clear. Obviously the physical reduction in available habitat has had a major effect but more obscure are the parts played by predators. competition and disease. One factor - the changes in the habitat due to a change in fire frequency, intensity and season - is more subtle, and poorly understood.

It is probable that of the factors mentioned above a balance has already been set between the existing mammal populations and introduced predators, herbivores and disease. However, fire induced habitat changes are something which may only be beginning to occur and not only may it be possible to prevent detrimental changes but it should be possible to improve the habitat by wise use of fire.

In order to be able to lay down prescriptions for burning it is necessary, not only to be able to predict the behaviour of fire in different types of vegetation under varied climatic conditions but also to know how the vegetation regenerates after fires and what the animals require of that vegetation in terms of food and shelter.

The complexity of an area such as Dryandra means that a researcher must make a choice between the many animals in order to keep any study fairly simple and short term. The choice in this case was the Woylie (*Bettongia penicillata*). This was for two main reasons:

1. It is an animal that has become very rare, its present range being restricted to a minute fraction of its former one, and it is known now from only three localities. These observations suggest that it may be very dependent on a particular habitat type which has disappeared in many areas. Alternatively, some other factor may be responsible, especially for the initial population "crash".

2. It has already been studied (Sampson 1971) so the basic biology is known and techniques for its capture have been developed.

The work reported here was carried out in the area of State Forest No. 51 and Reserve No. 16201 (Water Supply) to the west of the Dryandra settlement and to the east

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of the York-Williams road. In this area there is about 5000 ha of continuous bushland.

1. DESCRIPTION OF AREA

A. VEGETATION

The vegetation of the area was mapped by the Forests Department in the 1930's and the basic vegetation types as mapped have been used in this study, with some modifications and grouping.

Basically, the vegetation can be divided into 4 main categories:

1. Plateau types

The high country of the area is a laterite plateau, sometimes with light, sandy soils lying on it. The upper storey of these areas is a woodland (terminology used is that of Specht *et al.* 1974) of Powder Bark (*Eucalyptus accedens*), Jarrah (*E. marginata*) and a few Marri (*E. calophylla*). The shrub layer is diverse and spectacular when in flower. It is dominated by various species of *Dryandra*, especially *D. nobilis* and *D. armarta*. Other shrubs include *Adenanthos*, *Conospermum*, *Banksia sphaerocarpa*, *Isopogon* and *Acacia pulchella*. In some areas the mallee *Eucalyptus drummondii* occurs; occasionally in dense stands, especially on poorer soils where the upper storey is absent. There is little or no ground cover.

2. Slope types

The plateau can give way to a slope either abruptly, i.e. in a breakaway, or gradually. If there is a breakaway open-forest of Brown Mallet (*Eucalyptus astringens*) usually occur just below it. This rapidly changes into Powder Bark Slope. Where no breakaway occurs the plateau vegetation changes more gradually into Powder Bark Slope. This is a woodland of Powder Bark and the shrub layer is usually Sandplain Poison (*Gastrolobium microcarpum*) although in some areas this is replaced by *Bossiaea eriocarpa*. Further down the slope the upper storey changes to Wandoo (*Eucalyptus wandoo*) with a shrub layer composed almost entirely of Sandplain Poison. Rock Oak (*Casuarina huegeliana*) occurs on granitic soils around exposed granite outcrops.

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3. Valley types

The valley floor vegetation consists of a woodland or open-woodland of wandoo with no shrub layer and a ground cover of grasses and sedges. In heavier soils Jam (*Acacia acuminata*) occurs.

4. Alluvial types

a) On areas of alluvial white sand the dominant upper storey is Marri (*Eucalyptus calophylla*) while the understorey contains much *Leptospermum* sp. and *Hypocalymma* sp. as well as Sandplain Poison. In some areas *Dryandra sessilis* is an important understorey component. Wandoo often forms a proportion of the upper storey.

b) Alluvial soils on the slopes are covered with a closed-heath with little or no upperstorey.

B. FAUNA

(i) Mammals

The Dryandra State Forest is rich in mammals, the following having been observed or collected.

1.	*Tachyglossus aculeatus*	Echidna
2.	*Macropus fuliginosus*	Western Grey Kangaroo
3.	*Macropus irma*	Western Brush Wallaby
4.	*Macropus eugenii*	Tammar
5.	*Bettongia penicillata*	Woylie
6.	*Trichosurus vulpecula*	Brush Possum
7.	*Cercartetus concinnus*	South-western Pigmy Possum
8.	*Tarsipes spencerae*	Honey Possum
9.	*Isoodon obesulus*	Quenda or Brown Bandicoot
10.	*Myrmecobius fasciatus*	Numbat
11.	*Dasyurus geoffroii*	Chuditch or Western Native-Cat
12.	*Phascogale calura*	Red-tailed Wambenger
13.	*Antechinus flavipes*	Mardo or Yellow-footed Antechinus
14.	*Sminthopsis murina*	Common Dunnart
15.	*Pipistrellus tasmaniensis*	Tasmanian Pipistrelle
16.	*Chalinolobus gouldii*	Gould's Wattled Bat
17.	*Chalinolobus morio*	Chocolate Bat

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18.	*Eptesicus pumilis*	Little Bat
19.	*Nictophilus geoffroyi*	Lesser Long-eared Bat
20.	*Tadarida planiceps*	Little Flat Bat

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21.	*Vulpes vulpes*	Fox
22.	*Felis catus*	Cat
23.	*Oryctolagus cuniculus*	Rabbit
24.	*Mus musculus*	House Mouse

All these species except the Chuditch were known before the present work (Butler 1965). No attempt was made to collect bats during the present study although it is probable that further collecting would add *Tadarida australis* to the list.

A record of a *Pseudomys* from Dryandra (Serventy 1954) has since been shown to have been a misidentified *Mus musculus* (Baynes 1972).

It is probable that before extensive agricultural development the general area supported other species of native mammals. The following list has been compiled from Shortridge (1909,1936), Glauert (1933), Ride (1970) and examination of Museum records.

1.	*Onychogalea lunata*	Crescent Nail-tailed Wallaby
2.	*Lagorchestes hirsutus*	Western Hare Wallaby
3.	*Lagostrophus fasciatus*	Banded Hare Wallaby
4.	*Bettongia lesueur*	Boodie
5.	*Pseudocheirus peregrinus*	Common Ringtail
6.	*Macrotis lagotis*	Dalgyte
7.	*Pseudomys albocinereus*	Ashy-grey Mouse
8.	*Pseudomys shortridgei*	Shortridge's Mouse

(ii) Birds

The following birds, were recorded at Dryandra from January 1971 to April 1972.

1. Little Grebe
2. Hoary-headed Grebe
3. White-faced Heron

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4. Nankeen Night Heron
5. Black Duck
✓6. Wood Duck + Maned Duck
7. Whistling Kite
8. Australian Goshawk
9. Collared Sparrowhawk
✓10. Wedge-tailed Eagle
11. Brown Falcon
✓12. Mallee Fowl
✓13. Brown Quail
14. Banded Plover
15. Black-fronted Dotterel
✓16. Common Bronzewing ✓
✓17. Brush Bronzewing
18. Purple-crowned Lorikeet
✓19. White-tailed Black Cockatoo
✓20. Western Rosella
✓21. Port Lincoln Parrot
✓22. Red-capped Parrot
✓23. Elegant Parrot
24. Pallid Cuckoo
25. Golden Bronze Cuckoo
✓26. Boobook Owl
27. Tawny Frogmouth
✓28. Owlet Nightjar
✓29. Laughing Kookaburra
✓30. Sacred Kingfisher
✓31. Australian Bee-eater
✓32. Welcome Swallow
33. Tree Martin
✓34. Black-faced Cuckoo-Shrike
35. White-winged Triller
36. Chestnut Quail-Thrush
✓37. White-browed Babbler
✓38. Splendid Blue Wren
39. Blue-breasted Wren
40. Western Warbler
✓41. Weebill
42. Brown Thornbill Broad-tailed Thornbill
✓43. Yellow-rumped Thornbill
44. Spotted Scrub-Wren
✓45. Scarlet Robin
+ Brown Flycatcher

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46. Red-capped Robin
47. Hooded Robin
✓48. Western Yellow Robin
✓49. Grey Fantail
✓50. Willie Wagtail
✓51. Restless Flycatcher
✓52. Golden Whistler
53. Gilbert Whistler
54. Western Shrike-Thrush
✓55. Shrike-Tit
✓56. Crested Bell-Bird
✓57. Rufous Tree-Creeper
✓58. Striated Pardalote - Spotted Pardalote.
✓59. Western Silvereye
60. Brown Honeyeater
61. Singing Honeyeater
✓62. Yellow-plumed Honeyeater
63. White-eared Honeyeater
✓64. White-naped Honeyeater
65. New Holland Honeyeater
66. White-cheeked Honeyeater
67. White-fronted Honeyeater
68. Tawny-crowned Honeyeater
69. Western Spinebill
70. Little Wattle-bird
✓71. Red Wattle-bird
✓72. Magpie-Lark
✓73. Black-faced Wood-Swallow
✓74. Dusky Wood-Swallow
✓75. Grey Currawong
✓76. Western Magpie
✓77. Australian Raven

The following birds have been recorded by other observers at Dryandra but were not seen by us. The observors were:

1. Butler (1965)
2. Job (1969)
3. P. Congreve, Jan 1972 (personal communication).

1. Little Pied Cormorant (2)
2. Grey Teal (1)

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3. Australian Little Eagle (3)
4. Peregrine Falcon (1)
5. Little Falcon (1)
6. Painted Quail (2)
7. Little Quail (2)
8. Southern Stone Curlew (1)
9. Regent Parrot (1 and 2)
10. Fan-tailed Cuckoo (2)
11. Narrow-billed Bronze Cuckoo
12. Spotted Nightjar (1)
13. Fairy Martin (1)
14. Western Thornbill (2)
15. White-fronted Chat (2)
16. Rufous Whistler (2)
17. Black-capped Sitella (1 and 2)
18. Spotted Pardalote (2)
19. Brown-headed Honeyeater (3)
20. Grey Butcher-Bird (1)

This list of 97 species is a diverse one and reflects the fairly large area of Dryandra Forest as well as its largely undisturbed state. Some interesting records are:

Mallee Fowl.
Appears to be quite common over much of the area, a number of nests in current use were found while the study was in progress.

Brush Bronzewing.
Also appears to be fairly common, it was noted in 6 out of the 16 months of records.

Red-capped Parrot.
Towards the eastern edge of its range, was recorded 7 times.

Owlet Nightjar.
Seen four times while spotlighting at night.

Chestnut Quail-Thrush.
Seen once, in January 1971. At the extreme western edge of its range but has been reported from Dryandra previously (Serventy and Whittell 1967).

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Gilbert Whistler.

A westward extension of range. Seen once, in August 1971.

White-eared Honeyeater.

Also a westward range extension. Noted in both February and March, 1972. Seen previously at Dryandra (Butler pers. comm.).

White-fronted Honeyeater.

Not usually found west of the Great Southern Railway (Serventy and Whittell 1967). Noted in December 1971 and January 1972.

(iii) Reptiles

No systematic attempt was made to collect reptiles or frogs. The following is from Butler (1965) and W.A. Museum records with additions.

GEKKONIDAE	
Phyllurus millii	Barking Gecko
Diplodactylus vittatus	Festooned Gecko
PYGOPODIDAE	
Delma fraseri	Fraser's Legless Lizard
AGAMIDAE	
Amphibolurus ornatus	Rock Dragon
Moloch horridus	Mountain Devil
SCINCIDAE	
Egernia kingi	King's Skink
Egernia nitida	Salmon-bellied Skink
Tiliqua rugosa	Bob-tail
Cryptoblepharus plagiocephalus	Wall Lizard
VARANIDAE	
Varanus gouldi	Bungarra

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BOIDAE

Python spilotes	Carpet Snake

ELAPIDAE

Denisonia gouldi	Little Whip Snake
Demansia affinis	Dugite

This list is not particularly impressive and further collecting would probably add to the species.

(iv) Amphibians

HYLIDAE

Litoria moorei	Green and Golden Tree Frog

LEPTODACTYLIDAE

Limnodynastes dorsalis	Banjo Frog
Heleioporus albopunctatus	White-spotted Burrowing Frog
Heleioporus barycragus	Golden-flecked Burrowing Frog
Crinia pseudinsignifera	Crinia

The most interesting of these is the Golden-flecked Burrowing Frog which is largely restricted to the western Darling Range. Three outlying populations are known, one at Boyagin Rock, one at Dryandra and one on Bald Island off the south coast. The other species are typical of the area.

III METHODS

Monthly visits were made to Dryandra to coincide with the new moon as nearly as possible. At least 3 nights and occasionally 4 were spent working the area. The study commenced in January 1971 and continued until April 1972. The first three trips were chiefly exploratory and the trapping data reported here dates from May 1971. The techniques used were as follows:

a) Trapping.

72 cage traps were used to capture medium-sized mammals. Of these 50 were 56 x 18 x 18 cm, 12 were 76 x 38 x 38 cm and 10 were 51 x 18 x 18 cm. The bait was peanut paste

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on bread. These traps were successful in trapping woylies, bandicoots and possums and on separate occasions a brush wallaby and a native cat. Alongside each of the cage traps was placed at Elliott trap 32 x 10 x 8 cm. The bait used was a mixture of peanut paste, sultanas and rolled oats. These captured Red-tailed Wambengers, Mardos, Dunnarts and house mice.

The traps were placed in lines about 40 metres apart. They were left in the same place for 4 months, i.e. at least 12 trap-nights per trap, and then shifted to a new locality. In between trips the cage traps were left in situ with the door closed but the Elliott traps were collected and re-laid at either end of a trip. Trap lines were laid in areas supporting various vegetation types of differing fire age. The number of years since fire was determined from Forests Department records, together with ground inspection. In areas of greater than 10 years since fire an estimate was made by comparing it with known areas and examining growth rings in plants of Sandplain Poison.

b) Spotlighting.

During the early part of the study spotlight runs were done at random throughout the study area. When an animal was sited the vegetation type was noted as well as the time and the locality within the Forest.

Later, spotlighting was done over the same route every night although the direction of travel was reversed every night. In this case the vegetation was plotted against the vehicle odometer beforehand and the proportion of each vegetation type traversed was known. This route was selected so that at no stage was it within 300 m of farm paddocks.

Spotlighting was done at a vehicle speed of 11 to 13 km/h with one or two spotlights being operated, depending on staff availability. The number of spotlights was constant for one traverse.

c) Radio Tracking

Tracking of woylies was carried out in order to locate diurnal nest sites. The transmitter used was based on that described by Tester, Warner and Cochrane (1964).

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The receiver was a Sharp CBT-72 modified by the addition of a beat frequency oscillator and a loop antenna. Frequencies used were in the range 27.130 to 27.220 MHz with a 10 MHz spacing.

Animals were fitted with transmitters when taken from the traps in the early morning. They were released immediately. Tracking was then carried out later that day and on subsequent days. Only one location per day was attempted.

d) Observational.

Records were kept of all birds sited during each trip. No specific attention was allocated to reptiles or frogs but some incidental sitings and collections were made.

IV RESULTS

1. Trapping

Three species were frequently trapped and the results are given in Tables 1 and 2. Results can be summarized as follows:

a) Woylie. Woylies were captured in all vegetation types except Powder Bark Plateau. Captures appeared to be independent of the age of the vegetation except in the case of very recently burnt areas (the areas shown in Table 2 as 0.5 year old were burnt three months before trapping commenced). In the case of Powder Bark Slope the older (greater than 10 years) areas produced low capture indexes but this is not evident in Wandoo Slope. The two Marri areas trapped produced high capture indexes.

b) Quenda. No bandicoots were captured in either Powder Bark Plateau or Wandoo Flat. In other areas the index was much lower than that for Woylies. Wandoo Slope gave the best results. Captures were more frequent in older vegetations.

c) Brush Possum. Possums were captured in all vegetation types but not in all localities trapped. Powder Bark Slope produced the best results. Within vegetation types capture

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rates bore no relationship to fire age.

Other species captured were as follows:

a) Brush Wallaby. One animal was captured in recently burnt Powder Bark Slope. This species is not usually trapped and most traps used were too small.

b) Chuditch. One animal was captured in Powder Bark Slope. This species is not usually captured with the bait used in this study.

c) Red-tailed Wambenger. Five of these animals were captured, all in Powder Bark Slope. The fire ages were:

one year	-	one capture
seven years	-	two
eight and a half years	-	two

When released they ran quickly into hollow logs lying on the ground. Four of those captured in June 1971 were females with six to eight small pouch young.

d) Mardo. Captured in Wandoo Slope.

e) Common Dunnart. Also captured in Wandoo Slope.

f) House Mouse. Eighty-one house mice were captured, most between January and April 1972, in Powder Bark Plateau and Slope. Small numbers were caught in other vegetation types and at other times of the year. Results are summarised in Table 3.

2. Spotlighting

Table 4 gives the results of spotlight surveys between January and August 1971 when traverses were made over various parts of the forest. Tables 5 and 6 give the results of covering the same traverse every night between October 1971 and April 1972. Inspection of Table 6 shows that the Grey Kangaroo was the most frequently observed animal followed by the Brush Wallaby,

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Brush Possum, Tammar, Woylie and Bandicoot. Spotlighting also occasionally revealed House Mice, Dunnarts, Red-tailed Wambengers, Pigmy Possums and nocturnal birds, frogs and reptiles.

3. Radio-tracking

Between July 1971 and April 1972 ten different Woylies were tracked and 29 different diurnal refuges located. The refuges consists of a "nest" which is usually situated in a slight depression, often scratched out by the animal, under prostrate or fallen vegetation. The nest is usually lined with grass or other strand like plants. Often it is built under a dead, fallen shrub of sandplain poison but other shrubs including *Dryandra* spp., *Hypocalymona* and *Exocarpos* are used.

When tracked a woylie would usually "flush" from the refuge when the tracker was one to five metres away. Normally when tracked on succeeding days a new site would be utilised, on only one occasion did we find the same nest being reused.

The location of nests in relation to vegetation was as follows:

Plateau - 5
Plateau/Powder Bark Slope interface - 1
Powder Bark Slope - 4
Powder Bark Slope/Wandoo Slope interface - 4
Wandoo Slope - 8
Wandoo Slope/Marri interface - 4
Marri - 3

Two of the refuges - one on a wandoo slope-powder bark slope interface and one in powder bark slope - were in hollow logs. It is not known whether nest materials were taken into the logs.

For most animals two to four different refuges were located. However, in one case a female was tracked to seven refuges over a period between 16 February

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1972 and 21 April 1972. This was made possible by retrapping the animal and equipping it with a second transmitter. On one occasion we flushed a female and a large "at-heel" joey from the same nest.

All five nests located in plateau vegetation were within 50 metres of Powder-Bark Slope vegetation.

Accurate estimates of the age of the shrub layer in which diurnal refuges were located were different-- because of: difficult

1. the incomplete records of fires for the area,
2. the patchiness of some fires which were recorded.

However, it was obvious that all shrub stands used were dense and old. Areas which provided good nest sites appeared to be those which had been burned with fairly hot fires at least 10 to 15 years and probably 20 to 30 years before the study. Evidence for hot fires was the proportion of dead, fire damaged trees or tree limbs. No nests were located in areas which had been "control burnt" by the Forests Department during the preceeding 10 to 12 years. It was noted that Sandplain Poison regenerated to dense stands in areas which had 'hot' fires while regeneration was sparse in control burnt areas.

During the summer of 1971 - 72 the temperature was taken in a number of nests using a Shultheis reptile thermometer. The readings were made immediately after flushing an animal from its refuge. Temperatures recorded are as follows:

Shade Temp (^{o}C)	Nest Temp (^{o}C)
27	26
28.5	26
28.5	26
30	29.5
31.5	31.5
36	30.5
36	31.5
36.5	29
37	31

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DISCUSSION

The results of trapping (Table 1) indicate that woylies feed in all vegetation types except plateau. When time since fire is taken into account (Table 2) it seems that this has no effect. No animals were captured in recently burned Wandoo Slope or Wandoo Flat but some were taken in recently burnt Powder Bark Slope. Since the traps are presumably capturing animals which are either moving from their diurnal refuge to feed, feeding, or returning to the refuge, this suggests that woylies feed in all vegetation types, independent of fire-age, except plateau. Thus the data indicated that fire history has no effect on feeding or general movements within the home range.

On the other hand the radio-tracking data suggest that woylies only construct their diurnal refuges in areas with a well established, dense shrub layer. Sampson (1971) located nine nests at Tutanning Nature Reserve. Of these 6 were in plateau vegetation, 2 in heath and 1 in woodland. Sampson did not describe the density of the vegetation nor give its age. Department of Fisheries and Wildlife records indicate that the area Sampson worked in had not been burned since the 1940's or earlier.

The purpose of the nest seems to be principally the avoidance of temperature extremes. Sampson (1971) measured the temperature in nests built from hay by captive *B. penicillata* and found that when the air temperature was below 28°C, the unoccupied nest temperature was higher. On the other hand when the air temperature was above 32°C the nest temperature was lower. Even with air temperatures as high as 36.4°C the nest temperature did not rise above 33°. Data reported here from recently occupied nests support Sampson's conclusions; in fact the highest temperature recorded in a Dryandra nest was 31.5°C even though air temperatures were as high as 37°C.

Brush Possums were captured in all vegetation types with the poorest results in Marri and heath (Table 1). When the fire history of the trapping area is taken into account (Table 2) it can be seen that capture rates were extremely variable and independent of fire age. Subjectively trapping success in

different areas was related to the availability of trees and logs with suitable hollows rather than to any other factor.

The extremely low capture rates for the Quenda make it difficult to interpret the available data. However, it appears that this species avoids open country and plateaux and occurs only where there is a fairly dense shrub layer. Sampson (1971) found that, at Tutanning, Quendas also avoid areas with little understorey. However, he did capture this species on laterite plateaux but in his study area these are not as extensive as at Dryandra. Sampson (*loc.cit*) discussed the type of nests constructed by this species and describes one nest he found in wandoo slope vegetation. No nests were found during this study.

The trapping data for House Mice (Table 3) suggest a population "explosion" during early 1972 rather than a preference for particular vegetation types or vegetations of particular fire-age.

The data obtained from spotlight traverses (Tables 4 to 6) is of little value for three of the four smaller species - Tammar, Woylie and Quenda. Data on Brush Possum is of more value. This is directly related to visibility. No Quendas were trapped in Wandoo Flat indicating their preference for areas with a dense shrub layer where visibility is poor. Although both woylies and tammar feed in open country at least some of the time, and were observed in this country during spotlight traverses, the data are heavily biased toward this type of country because of poor visibility in other vegetation formations.

Brush Possums are much more visible than the above three species for two reasons - their arboreal habits and very bright eye-shine in a spotlight beam. The spotlighting data for this species confirm the trapping data to the extent that the species was observed in all vegetation types. The high number of sightings in Wandoo Flat compared with other formations is probably also due to better visibility rather than a real preference for this vegetation.

Spotlighting counts for the two larger species - Western Grey Kangaroo and Western Brush Wallaby - can be expected to be more reliable, particularly for kangaroos which stand above much of the shrub layer. On the assumption that the effective search strip for kangaroos was 100 m wide the spotlight counts show an average density of 1 animal per 17.2 ha. Sightings were highest in Wandoo Flat (1 animal per 11.4 ha) and lowest in

Powder Bark Slope (1 animal per 41.7 ha). Using the same assumed effective search strip the average density of Brush Wallabies is 1 animal per 62.5 ha, with very little variation between the various vegetation formations.

Dryandra Forest is a particularly important area for the woylie - only two other populations of this once widespread species are known to-day. It is of interest to note that the three areas from which woylies are known - Tutanning Nature Reserve, Dryandra Forest and the Perup-Tone Rivers area east of Manjimup have two important similarities. They are all comparatively large areas of predominantly woodland vegetation typical of much of the woodlands of the south-west before clearing. They all also have extensive stands of shrubs of the genus *Gastrolobium*. These plants contain the toxic chemical monofluoro-acetic acid. Its sodium salt is the widely used vertebrate pesticide "Compound 1080". Oliver *et al.* (1977) have shown that some native mammals in the south-west of Australia have evolved a high degree of resistance to this chemical. On the other hand the two species of exotic carnivores which are now widely established in Australia - the European Fox (*Vulpes vulpes*) and the Domestic Cat (*Felis catus*) - are very susceptible. It is noteworthy that our spotlight traverses recorded these two species very infrequently. The inference is that these carnivores are unable to inhabit dense poison country because the chemical is passed to them through the food chain.

It is clear from the work reported here that the woylie requires a dense shrub layer in which to build the nests which serve as diurnal refuge from temperature stress. The above theory makes it clear that management strategies should not only provide a dense shrub layer in the woodlands but also that it is vital that this layer be composed largely of *Gastrolobium* species.

A management plan for Dryandra Forest therefore needs to make provision for areas of slope vegetation with an old, dense layer of *Gastrolobium microcarpum*. Areas of dense *Dryandra* spp. near slopes are also valuable. More long term research and monitoring work are needed before fire prescriptions and intervals can be given precisely. In the short term, say over the next decade, the best policy would be:

1. Leave extensive areas of dense *Gastrolobium* unburnt. While there is evidence to suggest that *Gastrolobium* requires a hot

fire before good regeneration will take place it is my belief that this only needs to occur every 30 to 40 years or perhaps even longer. On the other hand it seems that the cool prescribed burns used at Dryandra over the past decade do not produce the habitat necessary for diurnal refuge sites.

2. Conduct research aimed at finding the necessary prescription for regenerating *Gastrolobium* to the required density.

3. Should summer wildfires occur at Dryandra then follow a "let burn" policy to some extent so that a substantial area of vegetation is burnt under hot conditions. This would approximate the type of fire which occurred naturally, following ignition from lightning, than would cool prescribed fires lit in Spring and Autumn.

4. Use cool prescribed burns for the purpose of fuel reduction only in those parts of the forest where it is necessary to protect property and plantations; as well as some areas throughout the forest in order to provide places from which wildfires can be controlled.

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TABLE 1.

TRAPPING RESULTS - DIFFERENT VEGETATION TYPES

Vegetation Type	Trap-Nights	CAPTURE INDEX		
		Woylie	Quenda	Brush Possum
Powder Bark Plateau	438	0	0	23.7
Powder Bark Slope	830	25.7	3.8	67.0
Wandoo Slope	620	38.2	7.8	49.4
Wandoo Flat	568	22.3	0	25.8
Marri	228	73.5	3.5	12.0
Heath	156	25.0	6.0	19.0

$$\text{Capture Index} = \frac{\text{captures}}{\text{trap-nights}} \times 1000$$

Vegetation Type	Years since fire	Trap-Nights	CAPTURE INDEX		
			Woylie	Quenda	Brush Possum
Powder Bark Plateau	4	180	0	0	33
	7	126	0	0	0
	>10	132	0	0	38
Powder Bark Slope	0.5	168	12	6	125
	1	120	50	0	25
	7	88	23	0	0
	8.5	96	52	10	83
	>10	154	7	7	71
	>10	204	10	0	98
Wandoo Slope	0.5	168	0	0	83
	1	36	28	0	0
	4.5	108	83	9	37
	7	56	36	18	107
	>10	252	28	12	20
Wandoo Flat	0.5	84	0	0	48
	2	120	33	0	58
	3	308	20	0	3
	>10	56	36	0	0
Marri	1	84	95	0	24
	>10	144	42	7	0
Heath	4.5	72	14	0	14
	8.5	84	36	12	24

$$\text{Capture Index} = \frac{\text{captures}}{\text{trap-nights}} \times 1000$$

TABLE 3.

CAPTURES OF THE HOUSE MOUSE (*Mus musculus*)

Vegetation Type	Years since fire	Trap-nights	Animals Captured	Capture Index
Powder Bark Plateau	4	180	20	111
	7	126	0	0
	10	132	21	159
Powder Bark Slope	0.5	168	13	77
	1	120	1	8
	7	88	0	0
	8.5	96	2	21
	10	154	12	78
	10	204	1	5
Wandoo Slope	0.5	168	2	12
	1	36	0	0
	4.5	108	2	19
	7	56	0	0
	10	252	0	0
Wandoo Flat	0.5	84	5	60
	2	120	0	0
	3	308	0	0
	10	56	0	0
Marri	1	84	0	0
	10	144	0	0
Heath	4.5	72	0	0
	8.5	84	2	24

$$\text{capture index} = \frac{\text{captures}}{\text{trap-nights}} \times 1000$$

TABLE 4.

RANDOM SPOTLIGHTING

JANUARY - AUGUST 1971.

ANIMALS OBSERVED

Vegetation Type	Kangaroo	Brush Wallaby	Tammar	Woylie	Quenda	Brush Possum	TOTAL
Powder Bark Plateau	12	4	0	0	0	1	17
Powder Bark Slope	27	13	1	0	0	3	44
Wandoo Slope	72	9	2	8	0	17	108
Wandoo Flat	85	7	6	7	0	23	128
Marri	12	2	4	2	0	5	25
Mallet Plantation	27	12	3	2	0	3	47
Pines and Arboretum	21	8	2	0	0	1	32
TOTAL	256	55	18	19	0	53	401

Total distance = 351 km Number of nights = 19

TABLE 5

STANDARD SPOTLIGHTING RUN

ANIMALS OBSERVED

Vegetation Type	Kangaroo	Brush Wallaby	Tammar	Woylie	Quenda	Brush Possum	TOTAL
Powder Bark Plateau	21	8	1	0	0	2	32
Powder Bark Slope	27	19	0	4	1	11	62
Wandoo Slope	163	36	9	2	2	41	253
Wandoo Flat	88	15	10	6	0	47	166
Marri	5	4	2	0	0	1	12
TOTAL	304	82	22	12	3	102	525

TABLE 6.

STANDARD SPOTLIGHTING RUN

SIGHTINGS PER 100 KILOMETRES OF VEGETATION TYPE

Vegetation Type	Kangaroo	Brush Wallaby	Tammar	Woylie	Quenda	Brush Possum	TOTAL
Powder Bark Plateau	35	13	2	0	0	4	52
Powder Bark Slope	24	17	0	4	1	10	53
Wandoo Slope	73	16	4	1	1	19	113
Wandoo Flat	88	15	10	6	0	47	166
Marri	28	22	11	0	0	6	73
TOTAL	58	16	4	2	1	20	100