THE INTRODUCED EUROPEAN RED FOX (*Vulpes vulpes*)

A SERIOUS THREAT TO NATIVE MAMMALS OF THE SOUTH-WEST

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A SERIOUS THREAT TO NATIVE MAMMALS OF THE SOUTH-WEST

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SUMMARY

During the last few years the woylie (Bettongia penicillata), an animal on the rare and endangered species list, has almost entirely disappeared from some of the remaining areas where it was still common. A trial attempt to re-establish the species in one of these areas, the northern sector of the Perup Fauna Priority Area was initiated in October 1977.

The results of this trial suggest that the main factor preventing successful re-establishment of the new woylie colony is the introduced red fox (Vulpes vulpes). These findings have a wider implication than the disappearance of one species, the woylie. This becomes obvious when the problem of the introduced fox is examined in greater detail and the history of its introduction into Australia is examined in relation to the decline in native fauna species.

It is not possible to obtain irrefutable proof that the fox was largely responsible for the decline in the numbers and distribution of many species of native fauna which occured shortly after its introduction to this continent. Nor is it possible to prove conclusively that it is the fox which is responsible for the failure of these species to recover their former numbers and distribution. However the circumstantial evidence for this is so strong that it appears to be almost irrefutable.

It is concluded that if we are to retain our native fauna, fox numbers must be reduced and maintained at low levels, at least within certain key fauna refuges.

INTRODUCTION

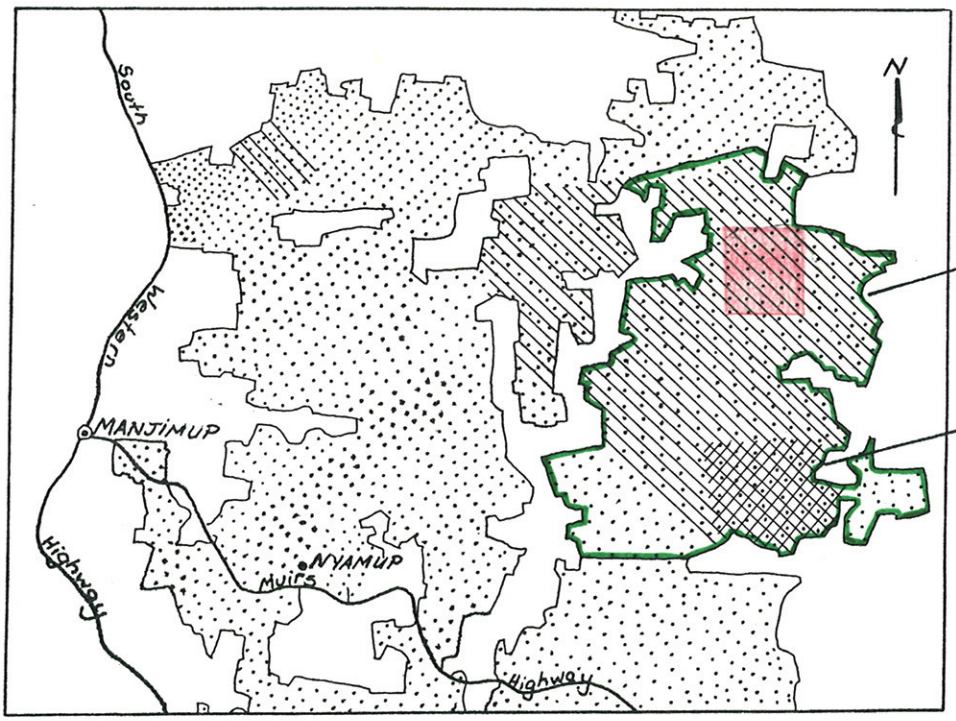
During the years of 1971 and 1972 when the first trapping and spotlight surveys were being done in the forest blocks which were later to become the Perup Fauna Priority Area, the woylie was common throughout the area (Map 1). At the time, no proper traps had yet been acquired, but woylies were captured frequently in a variety of 'home made' traps, and the capture rates were very high (see Table 4). Animals were also recorded regularly on spotlight survey runs, and the characteristic diggings, which they make whilst searching for hypogean fungi, were to be seen everywhere (Fig. 1a and Photo 1a and 1b). It was the high woylie population, more than any other single factor, that was the reason for the area being set aside as a Fauna Priority Area within State Forest.

A major study of the woylie was initiated in the southern sector of the Perup forest in 1974. In this area the woylie population still remains high today, in the northern sector however, the woylie population has 'crashed'. Regular spotlight surveys along a three kilometre route indicate a fall in population numbers some time in 1975 (Fig. 1a). Trapping in 1976 confirmed the absence of the woylie in this area when a total of 260 trap nights failed to yield a single woylie. It had hitherto been thought that only the ringtail possum (Pseudocheirus peregrinus) population had declined. The absence of woylie sightings on the possum surveys was not considered significant since this technique was not considered a reliable method of recording woylies. It is of interest also to note the fall off in numbat (Myrmecobius fasciatus) sightings recorded in the Perup area since 1972 (Fig. 1b).

To confirm this discovery further trapping, a total of 400 trap nights, was carried out in and around the northern sector,

Map 1.

Map showing former and present Woylie distribution in the forest areas to the east of Manjimup.



Perup Fauna Priority Area.

Study Area.

State Forest.

Former extent of population (pre 1973/74)

Present extent of population.

Scale

0 20 40 Km

Fig 1(a)

Sightings of Ringtail and Brushtail Possums and the Woylie along a 3·2 km spotlight survey run on Balbanup road, North Perup for the period 1973-78.

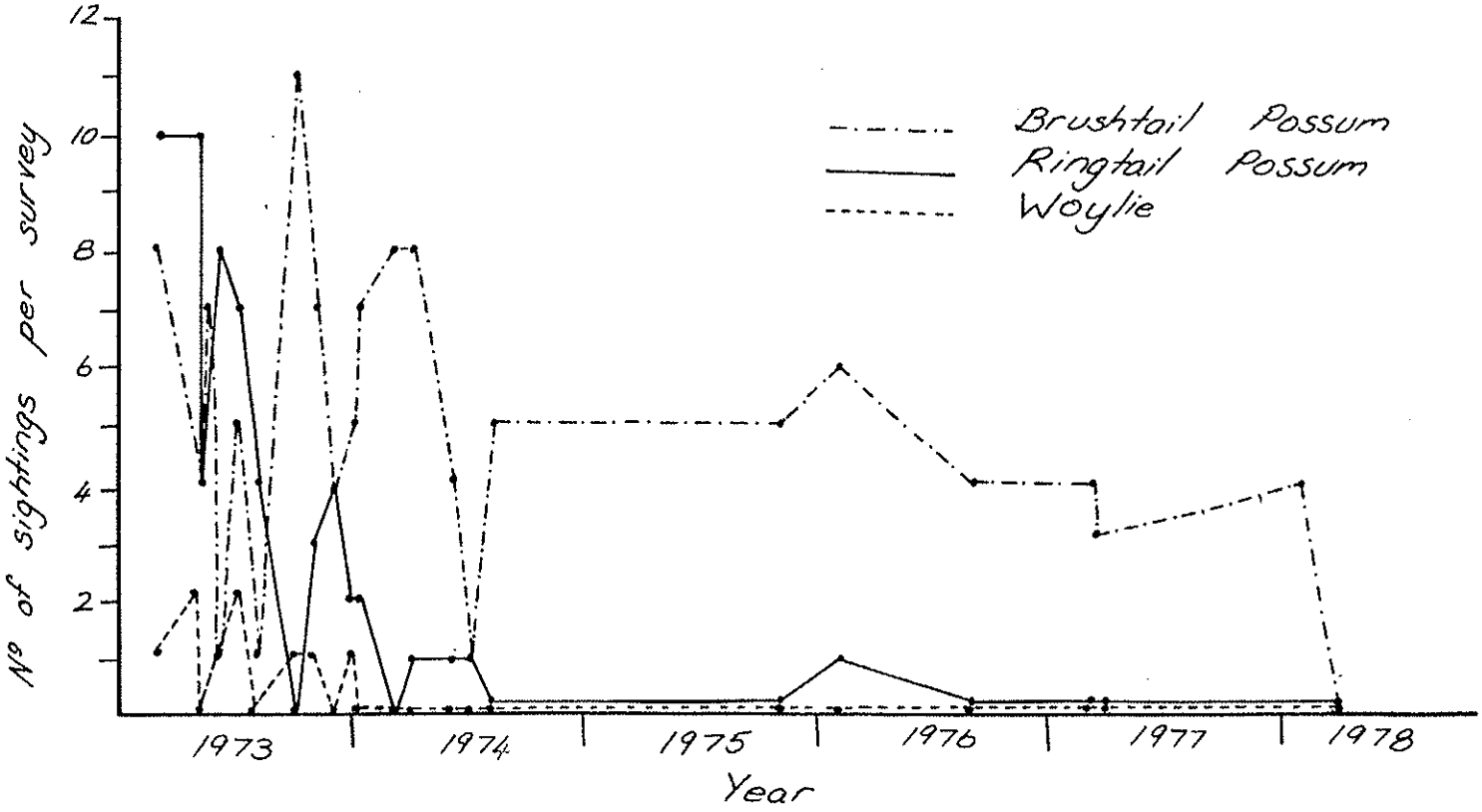


Fig 1(b)

Numbat sightings recorded in the Perup area from the period 1972-78 (incidental sightings)

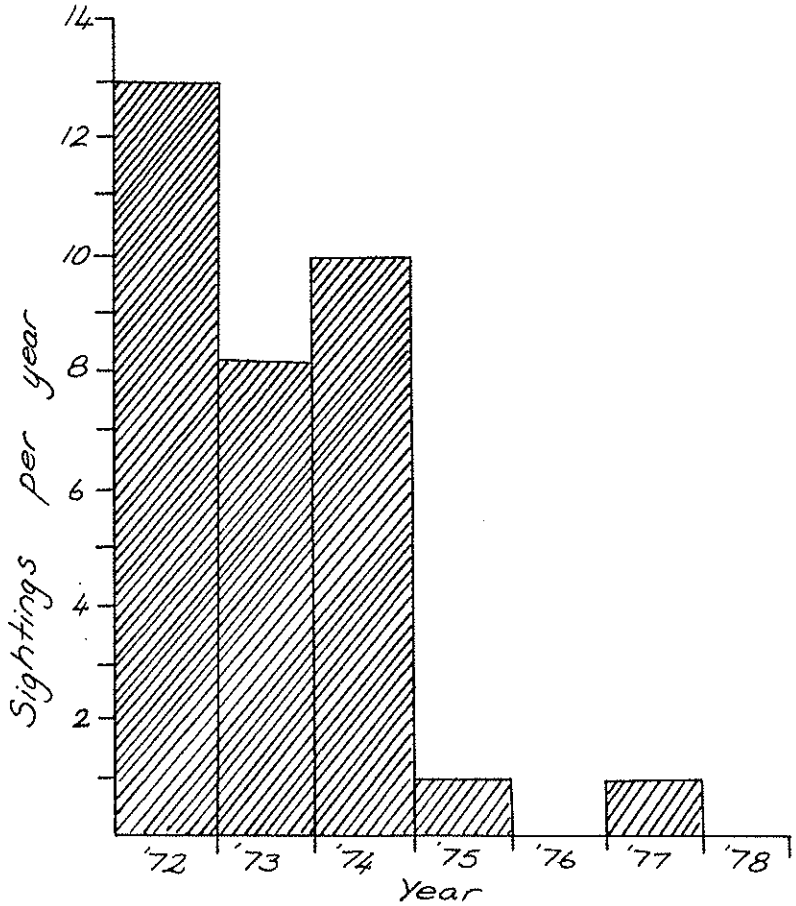
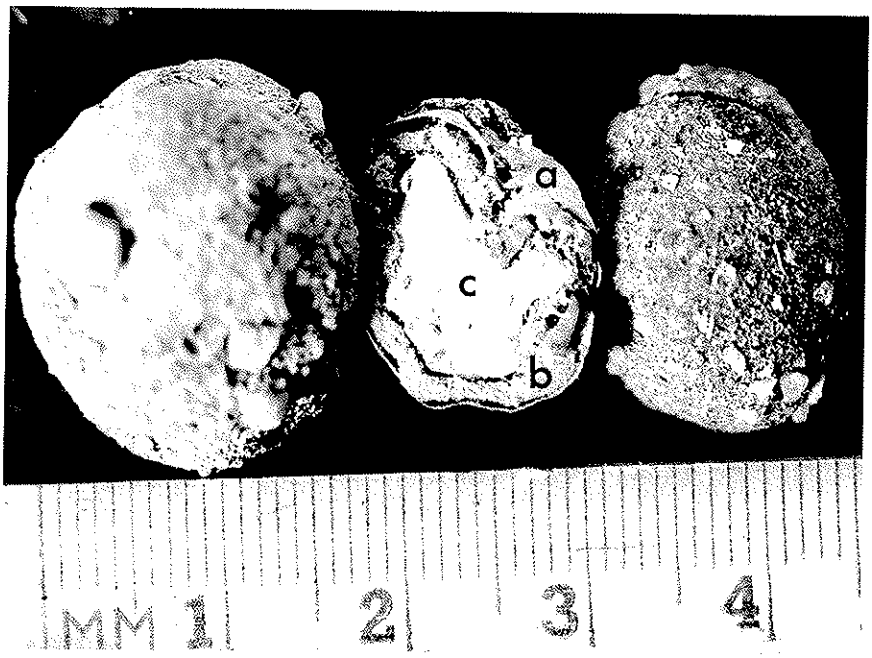


PHOTO 1a

Characteristic digging made by a woylie in its search for hypogean fungi. Remains of the outer covering or peridium of fungi as seen in this photo are not always present.

PHOTO 1b



Hypogean fungi eaten by the woylie, a species of Mesophellia. a = outer covering or peridium.
b = spore layer.
c = central columella eaten by the woylie.

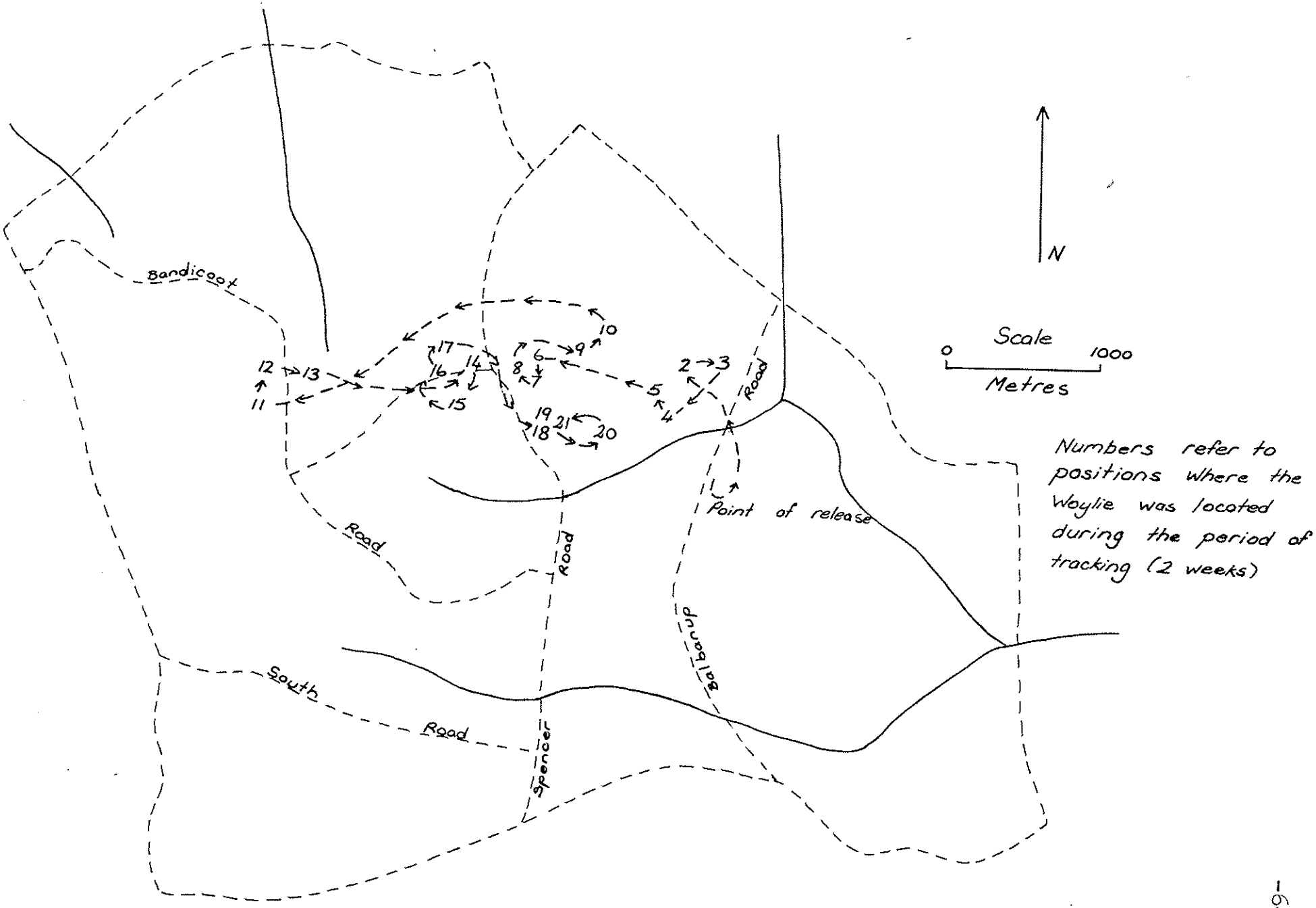
in areas previously known to have contained good woylie populations. No woylies were captured, and since it was thought that some form of disease epidemic might be responsible for the sudden decline, it was feared that the southern woylie populations might suffer the same fate.

For this reason it was decided to attempt to re-establish the northern populations, as soon as possible, by means of artificial re-seeding with woylies from the south.

Such a project was considered feasible on the basis of data which was already available (Christensen 1977). Hence, it was known that woylies released into areas outside of their own home range do not stray too far from the point of release. At least a portion of the animals survive, even when released into areas where other woylies are already established. Since the woylie breeds rapidly, three young per year, it seemed likely that released animals would quickly re-colonize the empty northern areas.

A trial release, to test the feasibility of radio tracking released animals, and to establish the most suitable area for the release was carried out in 1977. A young male woylie, fitted with a radio transmitter, was released in the Balbanup Road area, where most of the woylie captures had been made in 1971/1972.

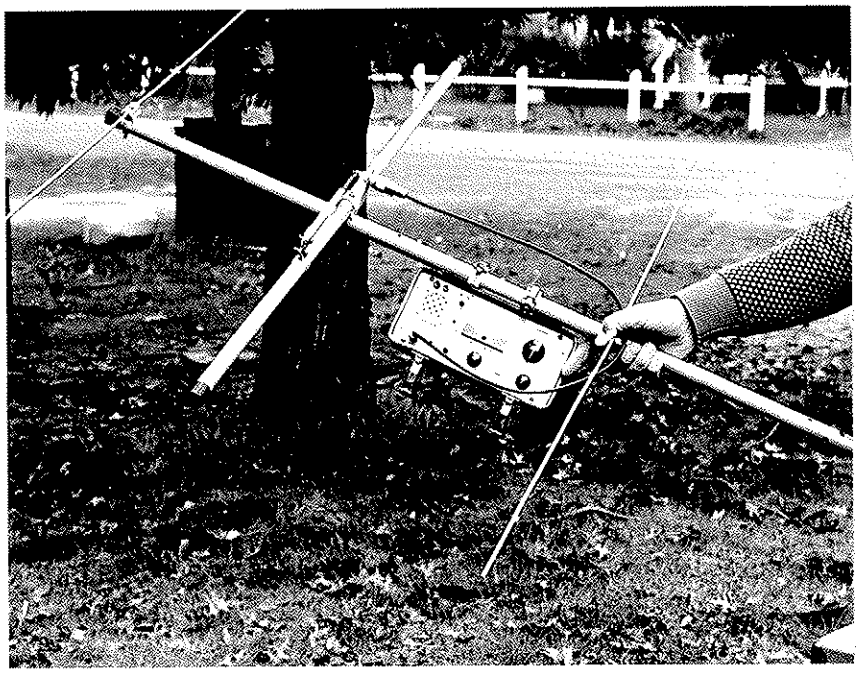
The results of this trial indicated that radio tracking was feasible. The animal appeared to 'deliberately choose' an area and to settle there (Map 2), it showed no signs of travelling large distances which would make radio tracking difficult.



Map 2.

Detailed movements of initial trial release, Woylie fitted with radio transmitter.

PHOTO 2a



Twelve Channel AVM Radio Receiver with hand held directional antenna.

PHOTO 2b

Woylie fitted with collar transmitter.

TRIAL DESIGN AND METHODS

The entire central portion of the northern Perup, an area totalling some 4000 to 5000 hectares, was selected for the trial. Access tracks were constructed, and a total of 37 kilometres of roads and tracks were surveyed, mapped and marked with numbered tags at 100m intervals (Map 3). This network of marked points was used as the basis of a radio tracking grid system on which the movements of the animals fitted with transmitters could be plotted. The points also serve as trapping points, and if needed, spotlight survey sightings can also be plotted accurately using this system.

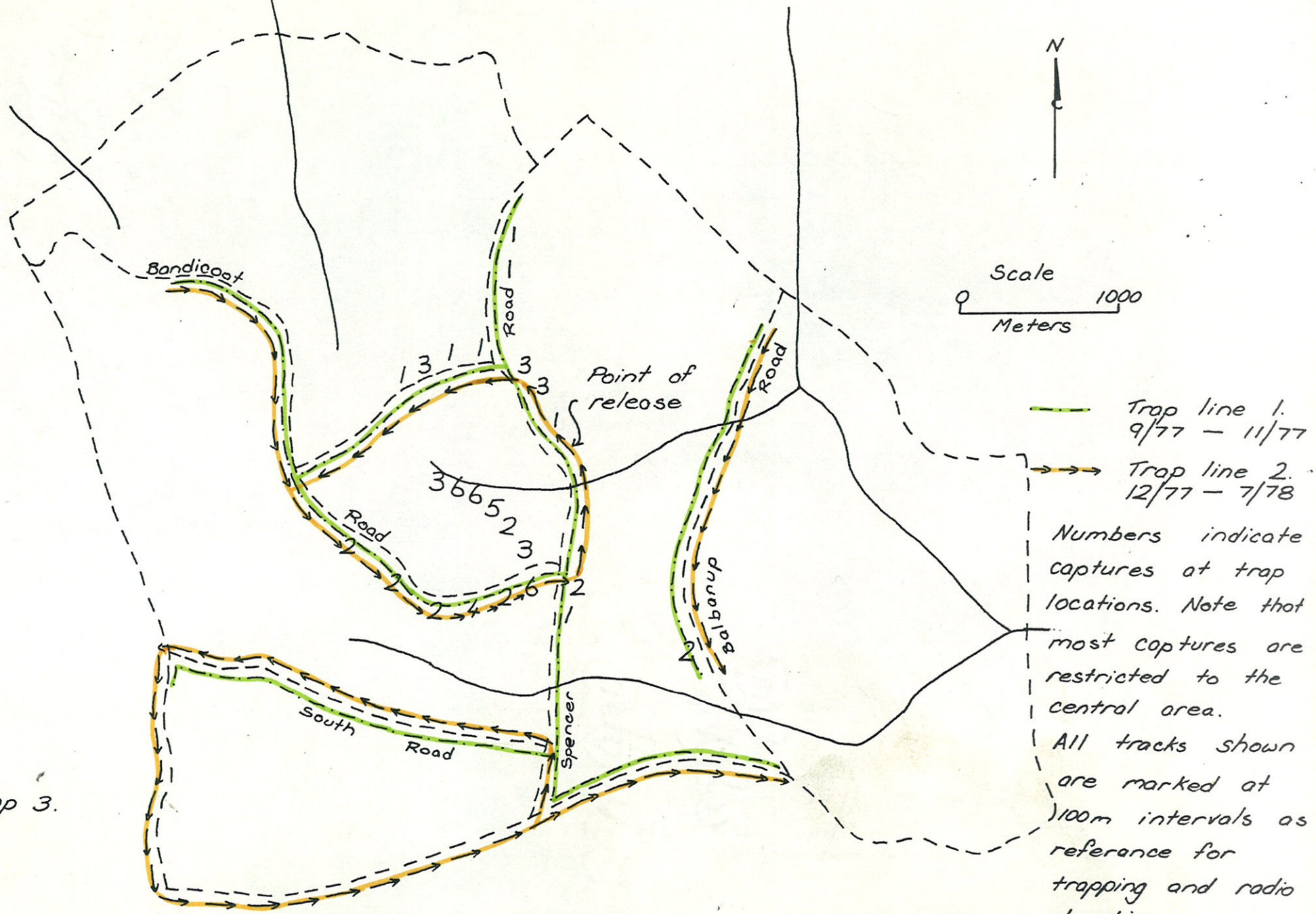
The closing of the area under dieback quarantine regulations was an early set-back to access. However following upgrading of the tracks, permission was received to work in the area under permit and subject to special regulations. Normal access is thus still possible, except during periods of rain.

Over the period 27th September 1977 to 6th October 1977, a total of 52 animals, males and females were released at a point near the centre of the area, and close to the area previously selected by the initial trial animal (Map 3). The released woylie population was monitored using three separate techniques, radio tracking, the capture-mark-release method, and digging activity.

Six of the animals released, three males and three females were fitted with radio transmitters similar to those used by Christensen (1977), (see photographs 2a and 2b).

The movements of these animals were recorded using a triangulation technique (Christensen 1977) and the results were plotted on a map of the area.

All animals released were ear tagged and weighed to the



Map 3.

Location of trap lines and Woylie captures

PHOTO 3

Skulls found near the entrance to foxes den on Possum Road, North Perup. Top row - tammar. Centre row - brushtail possum. Bottom row - woylie.

PHOTO 4

Skull of fox found recently dead, apparently healthy and in good condition, in Gastrolobium thicket in the Perup area. This animal appeared to have died from poisoning as a result of eating native fauna, (see text). Note left upper canine deeply imbedded in marri capsule.

nearest gram. Their movements and condition is being monitored by trapping and weighing. Standard 'possum' type traps are used over a four night period at intervals of one to two months. Initially the trap lines were located where it was thought the woylies were most likely to settle. Later the traps were placed in the areas where captures were made (Map 3). Spot trapping after pre-baiting with wheat is being carried out at present to determine whether any woylies occur outside of the main area covered by the trapping grid. To date no animals have yet been located outside this central area.

Presence and distribution of woylies is also being monitored by recording the digging activity, on a monthly basis, on 16 plots, located on six different sites (Map 4). This technique is an excellent indicator of woylie presence (Christensen 1977).

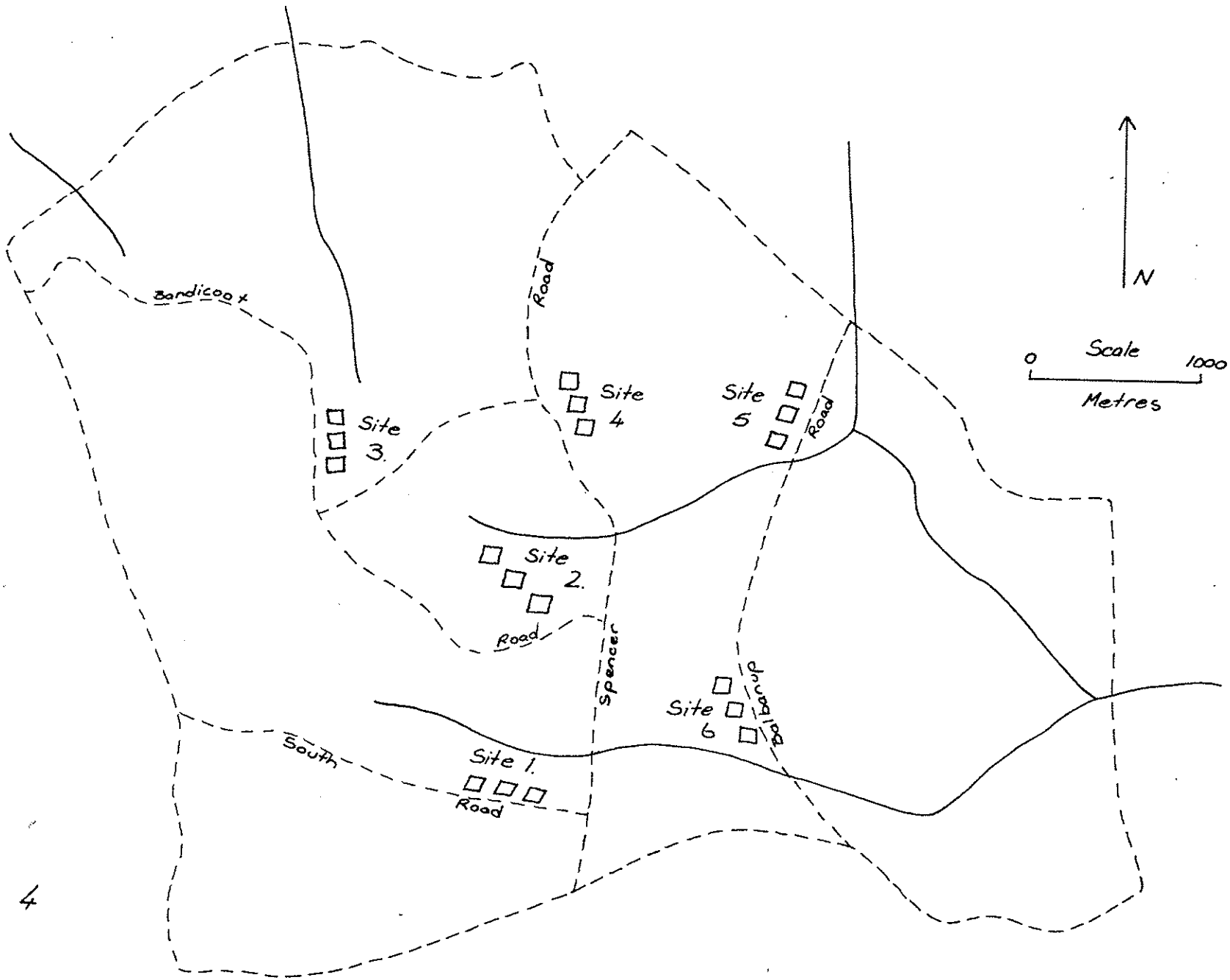
Spotlight surveys have been used to a limited extent. These may be increased if it is warranted.

RESULTS

(i) Radio Tracking.

None of the six woylies fitted with radio transmitters were recorded more than 2.5 kilometres from the point of release (Map 5). Three animals, all the females, left the general area in which they were released. One of these returned, its transmitter subsequently cut out and was later removed. The remaining two, were taken by foxes, one being buried half eaten in an old foxes den, (Table 1).

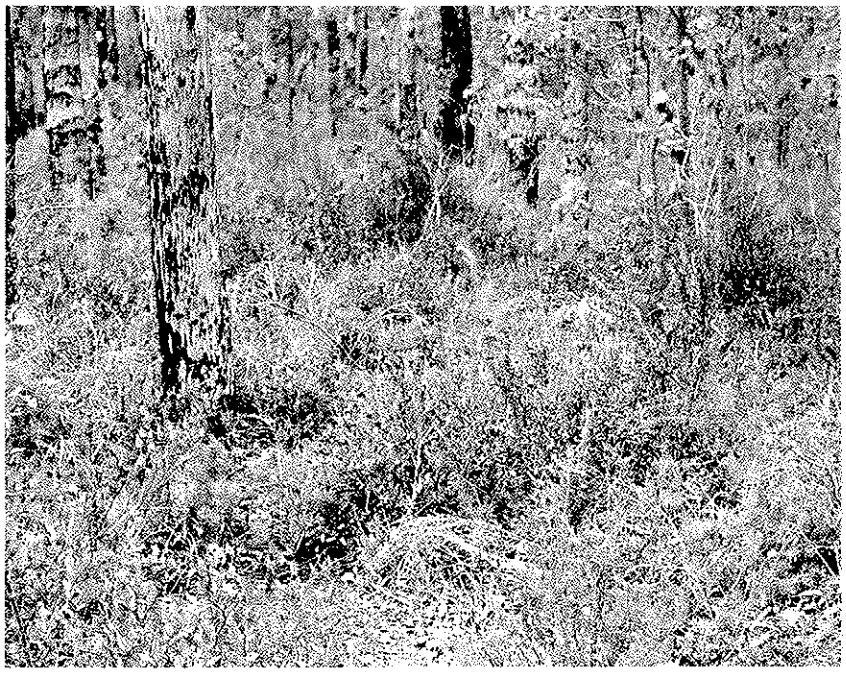
One of the males which stayed in the general area where it



Map 4

Location of digging plots

PHOTO 5



Typical ridgetop woylie nesting site South Perup. Note the dense understorey of Bossiaea ornata. The population of woylies in this area is high.

PHOTO 6

Most of the ridges in the North Perup forest have a sparse open understorey unsuitable for the woylie as nesting sites. The woylie has now disappeared from such areas.

PHOTO 7

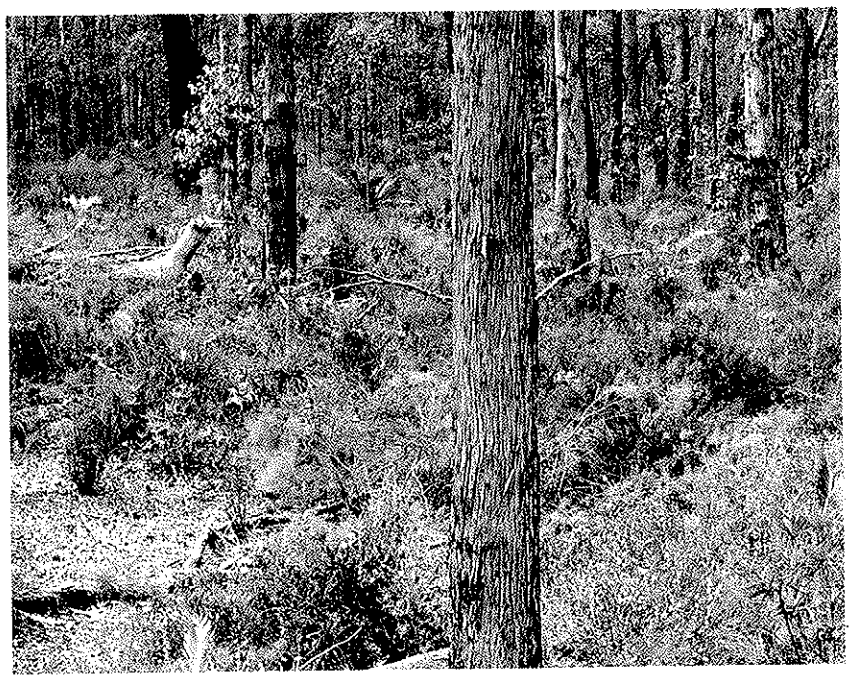
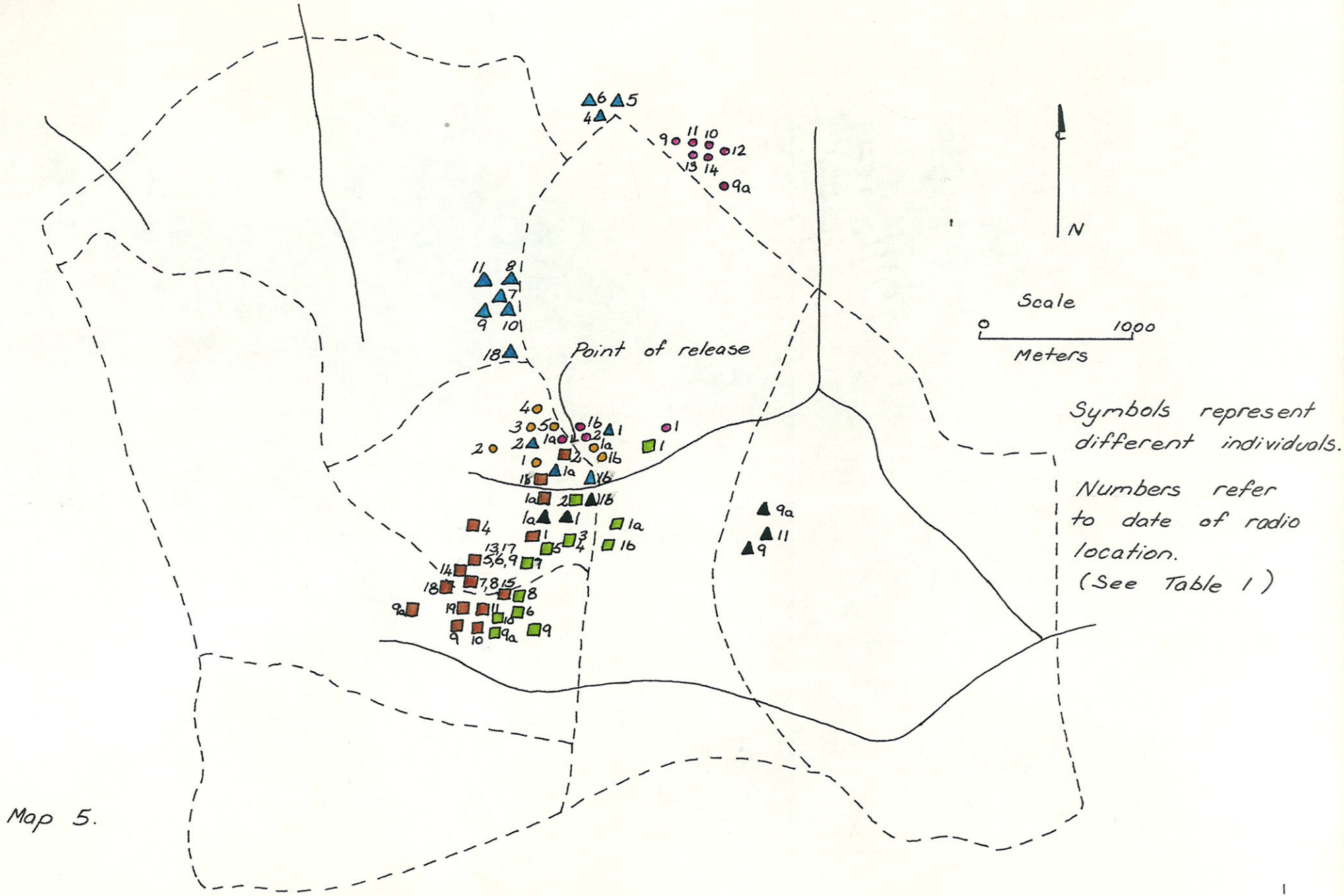


PHOTO 8

The understorey shrub on the ridges in the central area where woylies still survive in the north Perup is comparatively dense, compared to that found elsewhere in the area. Woylies occur at low to medium densities.



Map 5.

Recorded locations of 6 Woylies fitted with radio transmitters

TABLE 1

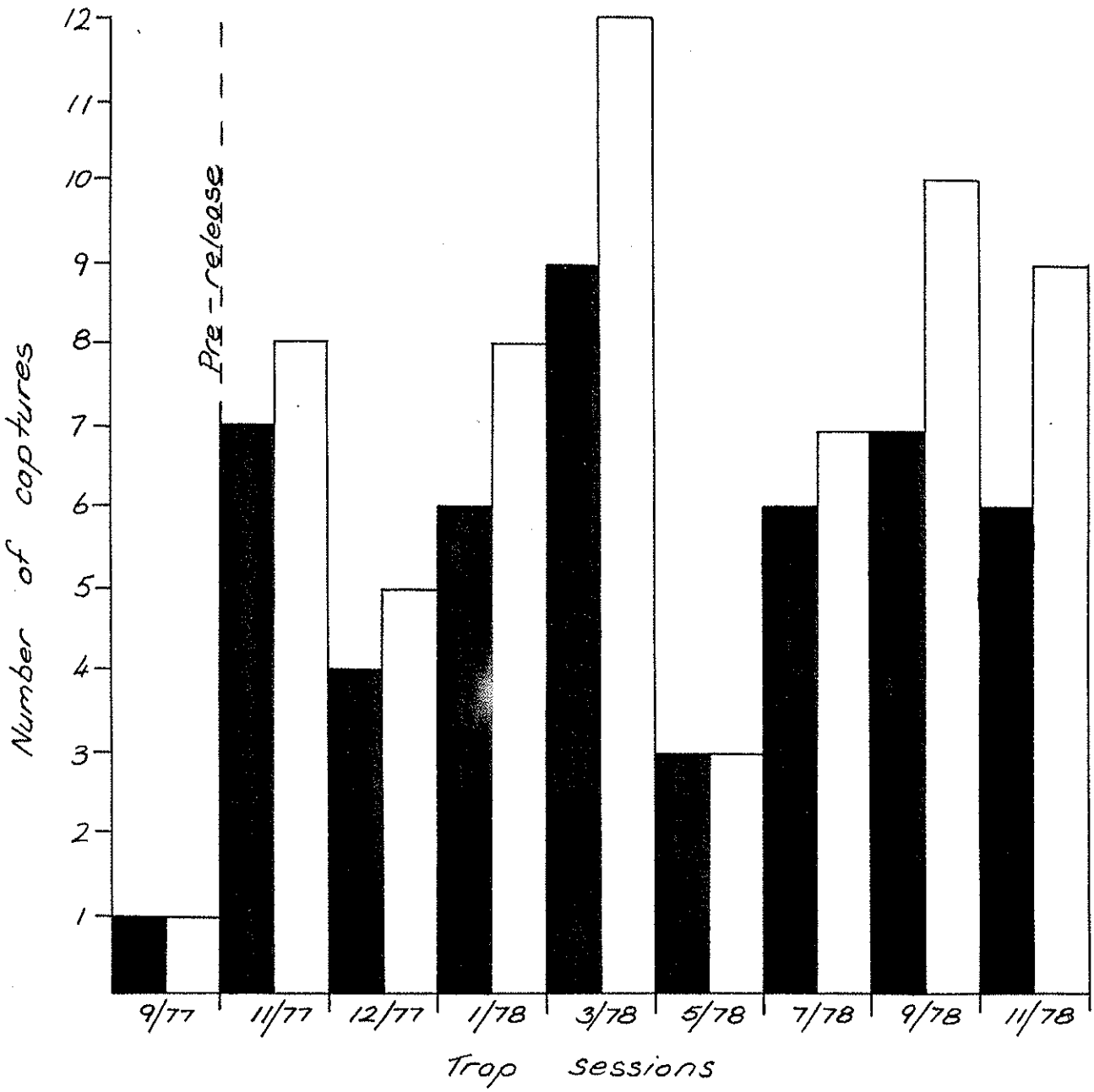
FATE OF THE SIX WOYLIES FITTED WITH RADIO COLLARS - NORTH PERUP RE-ESTABLISHMENT TRIAL.

Date of radio Location	Woylie identification, Channel and Ear Tag Number					
	CH1 ● 1107 ♂	CH4 ▰ 1103 ♂	CH4/4 ▲ 1093 ♀	CH11/2 ● 1101 ♀	CH11/4 ▲ 1109 ♀	CH12 ▰ 826 ♂
4-10-77	*	*	*	*	*	*
5-10-77	*	*	*	*	*	*
7-10-77	*	*	*	-	-	-
11-10-77	*	*	-	-	*	*
13-10-77	*	*	-	-	*	*
16-10-77	-	*	-	-	*	*
21-10-77	-	*	-	-	*	*
24-10-77	-	*	-	-	*	*
25-10-77	-	*	*	*	*	*
28-10-77	-	*	-	*	*	*
31-10-77	-	-	-	*	*	*
7-11-77	-	-	-	*	-	-
15-11-77	-	-	-	*	-	*
17-11-77	-	-	-	*	-	*
22-11-77	-	-	*	Dead (fox)	-	*
23-11-77	-	-	Dead (fox)		-	*
24-11-77	-	-			-	*
25-11-77	-	-			*	*
28-11-77	-	-			Trans-mitter cut out	Trans-mitter cut out
	Disappeared (predated - fox?)					

* indicates dates on which the animal was located and its position plotted.

Fig 2

Woylie Captures per Trap Session



Number of individuals

Number of captures

One trap session = 356 trap nights

was released is still there and appears to have settled down. The fate of the remaining two is unknown but it is suspected that they have been taken by foxes (Table 1). No signals were received from the transmitters of these two animals after nine and 24 days respectively. A wide search, using an aircraft fitted with receiving equipment, failed to locate them. Since the mean life of the transmitters in the field has been found to be 192 days* (range 32 - 232 days) it seems unlikely that both transmitters cut out. The most likely explanation for their disappearance is predation, almost certainly by foxes. Transmitters are often damaged when the woylie to which they are attached, is killed and eaten by a fox.

The fox is the main predator of the woylie in the Perup area (Christensen 1977). Further evidence of this was provided during this study. Along with the remains of the radio tracked woylie found in a foxes den were the remains of a least three other woylies, one whose ear tags were recovered, four sub-adult tammars (Macropus eugenii), three brush tail possums (Trichosaurus vulpecula) and a young kangaroo (Macropus fuliginosus) (see photograph 3).

(ii) Trapping.

From the start, few animals were caught, and re-captures during each trap session are low (Fig. 2, Table 2). The mean capture percent following the release of animals into the area is 2.2%. This is low when compared to a mean of 9.18% in unburnt forest in Boyicup Block in the Southern sector of the Perup forest.

* Data from 11 control animals used in previous studies (Christensen 1977).

TABLE 2

DETAILS OF CAPTURED WOYLIES

- NORTH PINRUP TRIAL

Woylie No.	Origin of woylie	Trap Sessions							
		Nov 77	Dec 77	Jan 78	March 78	May 78	July 78	Sept 78	Nov 78
16/17	R	*					*		
826	R				*		*	*	
1122	R	*		*		*	*	*	
1109	R	*		*	*				
1083	R	*							
1081	R	*	*						*
1134	R	*							
1178	N		*						
1146	R		*	*	*				
1184	N		*						
36/37	N		*						
1091	R			*	*	*	*	*	*
1136	R			*	*				
1113	R			*			*		
70/1317	N			*					*
1144	R				*				
1194	N				*				
74/75	N				*			*	
1196	N					*	*	*	*
1097	R							*	
1305	N							*	
1319	N								*

R = Released animal

N = New animal (not released)

* = Captures

Note low re-capture rate (33.3%) of new animals when compared with released animals (69.2%).

TABLE 3

PERCENTAGE OF FEMALES RECORDED WITH JOEYS DURING EACH TRAP SESSION

Trap Session	Number of females caught	Number of females with joeys	%
11/77	2	1	50
12/77	2	1	50
1/78	2	2	100
3/78	4	4	100
5/78	1	1	100
7/78	3	2	66.66
9/78	1	0	0
11/78	1	1	100
	16	12	70.8

Moreover, a sum total of only 22 animals have been captured in 2860 trap nights over the 13 months since the releases. The trap lines cover an area of approximately 1600 hectares. In Boyicup Block, on an area of approximately 140 hectares, a total of 82 woylies were caught in 1303 trap nights, over a similar period of time during 1975/76. The reson for the low recapture rate (33.2%), of the new woylies as compared with the released animals (69.2%) is not known. It may be because the majority are sub-adult animals and the mortality amongst these is known to be high (Christensen 1977).

Examination of the distribution of captures indicate that the woylies, in particular the 'resident', animals captured three or more times, are all concentrated in a comparatively small area close to the centre of the study area. This is the general area originally chosen by the trial release animal and it is also close to where the original 52 animals were released. Baiting with wheat over the rest of the trial area indicated that this may be the only area where there are any woylies left.

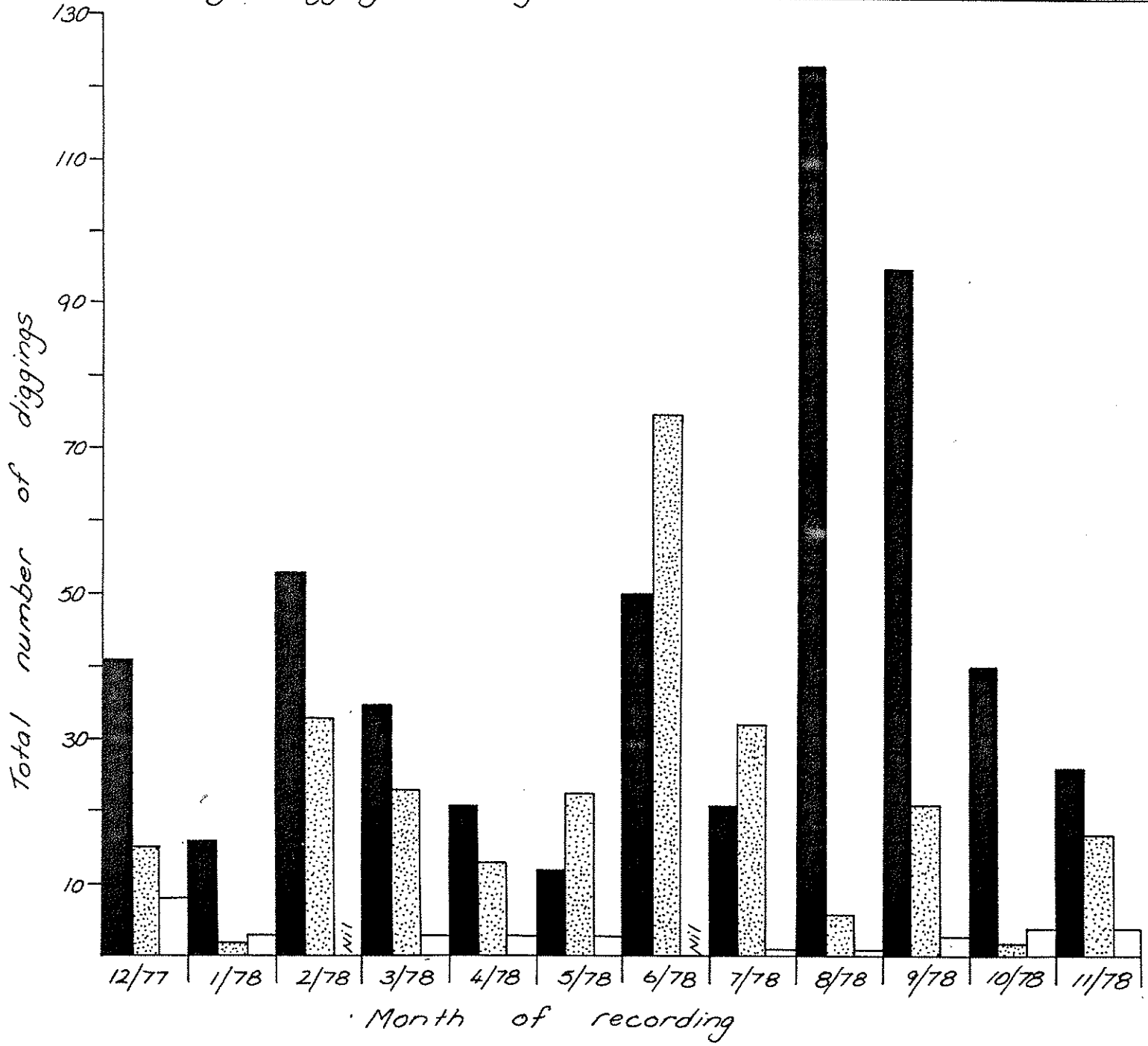
There is evidence that the small established population is breeding normally (Table 3). Furthermore, two of the three new animals caught during the last trapping session were sub-adult animals born in the area. Weight changes of animals in the population appear to conform with normal seasonal fluctuations observed in the south of the Perup.

(iii) Digging Activity.

The location of plots with the highest digging activity co-incides with the areas along Bandicoot and Spencer Road, where

Fig 3.

Monthly Digging Activity Recorded on Three Paired Sites



South and Bandicoot roads (Sites 1 and 2)

Bandicoot and Spencer roads (Sites 3 and 4)

Bolbanup road (Sites 5 and 6)

Sites have been paired to simplify presentation.

Diggings on each site were recorded on three separate 15 x 15 m plots. (See map 4)

the majority of woylie captures have been made (Fig. 3). A fairly high proportion of the diggings on the South Road plots have been made by the short nosed bandicoot (Isoodon obeselus). There is a striking lack of digging activity on the Balbanup Road plots, an area where only two woylies were captured very early on in the study.

A considerable amount of time has been spent in looking for digging activity in other parts of the study area. Heartleaf (Gastrolobium bilobum) thickets especially, sites on which the woylie is known to concentrate on during the winter months, have been examined. As yet, no other areas of active digging activity have been located, outside of the main trapping area.

DISCUSSION OF RESULTS

The trial shows some measure of success. However fewer animals than expected appear to be surviving, and these are confined largely within one relatively small area. An examination of this area shows it to be a typical woylie site. A ridge with a comparatively dense understorey shrub cover, suitable for nesting sites, occurs between two shallow valleys with sandy soils typcial of woylie feeding areas.

Superficially similar sites occur elsewhere within the study area but the one chosen by the released woylies appears to have a denser understorey shrub cover (see photographs 5 - 8).

As already mentioned the fox is a major predator of the woylie, and it is an important factor restricting its present distribution.

Small differences in shrub density may mean the difference between a woylie population surviving or being reduced and ultimately eliminated by predation (Christensen 1977).

The presence of a denser understorey cover is almost certainly the reason why the woylie is still plentiful in the southern Perup area. In fact its persistance in this area, contiguous with the northern area from which it disappeared, is perhaps the strongest evidence against a disease epidemic being responsible for the decline in 1972-74. Similarly, the evidence strongly suggests that fox predation is responsible for the comparatively poor initial survival and subsequent failure of the remaining population to expand rapidly. The situation appears to be similar to that observed during the first year or two following fire in Boyicup Block: ie. Predation is very high until such time as the understorey shrub recovers to a reasonable density again.

These conclusions focus attention on the wider aspect of the introduced fox as a factor of serious consequence in fauna management.

GENERAL DISCUSSION

As mentioned above, an epidemic disease seems an unlikely explanation for the 1973/74 population crash. There is in fact very strong circumstantial evidence that this population 'crash' was due to predation by the fox. Most people living in rural areas have noted an increase in fox populations over the last four or five years. This has been evident by the increased number of road deaths, and also sightings of foxes. This general increase is

confirmed by officers of the A.P.B. (pers. comm.) who further suggest that it is due to a reduction in the widespread use of the rabbit poison 1080 (active ingredient, Sodium fluoroacetate).

The fox obtains a large proportion of its food by scavenging and may suffer secondary poisoning eating rabbits poisoned with 1080 bait (see Meldrum et al 1957). Native mammals have a high degree of resistance to 1080, the fox does not, (King et al 1978, Oliver et al 1977). Consequently rabbit poisoning, started in the early 1950's, appears to have kept the fox population at a low level. Baiting was phased out almost completely in the South-west over the period 1972 to 1974. Evidence that the recent increase in the fox population is association with the reduction in 1080 baiting is provided by data from an A.P.B. rabbit study area near Cape Naturalist. Similarly their data from near Chidlow shows a massive increase in the fox population which closely parallels that from Cape Naturalist (Table 4).

Regarding the decline in native fauna during earlier times, Wood Jones (1924), considered fox predation to be the major cause of extinction of mainland populations of Bettongia leseur and G. gaimardi, and he assumed that the woylie would share the same fate. Troughton (1967) says of a related species Potorous tridactylus...."Only protection and the absence of the fox in Tasmania can ensure the survival of this interesting relic of the ancient marsupial stock". Marlow (1958) points to the greater abundance of small ground-living marsupials in many frox-free areas of Australia.

It is interesting to note that, in the absence of the fox, both the potoroo (P. tridaclylus) and the bettong (Bettongia cuniculus) are still common in Tasmania. In addition, both the

TABLE 4

DATA SHOWING THE CORRELATION BETWEEN REDUCED 1080 RABBIT POISONING, AN INCREASE IN THE FOX POPULATION AND A DECREASE IN THE WOYLIE POPULATION.

Cape Naturaliste Data			Chidlow area	The Woylie - North Perup and Dryandra			
				Captures			Spotlight. Woylies/ 2 Km.
Year	* Poisoning	Spotlight. Foxes/ 100 Km.	Spotlight. Foxes/ 100 Km.	Nos.	Trap nights	** % capture	
1968	8066	Nil	-	-	-	-	-
1969	6800	Nil	-	-	-	-	-
1970	4900	Nil	-	-	-	-	-
1971	5500	-	-	12(79)	39(2840)	30.7(2.8)	2(1)
1972	4600	-	-	10	41	24.3	0.88
1973	2600	-	2.4	53	244	21.7	Nil
1974	700	4.9	17.2	-	-	-	Nil
1975	50	5.1	19.2	(Nil)	(160)	(Nil)	Nil(Nil)
1976	93	5.7	31.1	Nil	260	Nil	Nil
1977		3.8	37.1	Nil	400	Nil	Nil
1978		8.2	34.9	(Nil)	(227)	(Nil)	Nil(Nil)

Cape Naturaliste and Chidlow data after A.P.B. research, (pers. comm.).

* = packets of 1 shot 1080 poison laid in the shires of Margaret River, Busselton and Capel. Similar reductions have taken place in other South-west shires.

() = Dryandra data, 1971 data after Burbidge (1977).

** = Capture percentages are very high due to the type of traps used at the time.

\- = No data available.

brushtail (Trichosaurus vulpecula) and the ringtail possum (Pseudocheirus peregrinus) are present in high enough numbers to allow the taking of over a quarter of a million pelts last year alone.

On a recent trip to Tasmania I kept a count of road casualities observed during seven days travelling whilst touring the island. Most of the travelling was along main roads and much of it through farming districts. Only recent kills, easily identifiable from the car whilst travelling, were recorded. A total of 206 native animals were recorded as follows:
Macropus giganteus, 1; Macropus rufogriseus and Thylogale peregrinus, 50; Bettongia gaimardii, 4; Trichosaurus vulpecula, 97; Pseudocheirus peregrinus, 1; Vombatus ursinus, 8; Isoodon obeselus, 20; Perameles gunii, 7; Dasyurus maculatus, 2; Sarcophilous harrisii, 3; Tachyglossus aculeatus, 7; (in addition six further individuals of this species were observed crossing roads); Ornithorhynchus anatinus, 1; Two introduced species were also recorded; Lepus europaeus, 6; and Oryctolagus cuniculus, 9. The figures illustrate the incredible abundance of native fauna on this island as compared to the mainland. Similarly, high populations of many species of medium-sized marsupials still exist on many of our off-shore islands.

A number of studies have been made in recent years of the food of the fox in Australia. Whilst many of these have been fairly extensive and complete in themselves, they have done little to assist the case against the fox. For example most studies indicate a high scavenging component, particularly of domestic stock (eg. Coman 1973 and McIntosh 1963) or from carcasses of kangaroos and emus (Mortensz 1971). Introduced species, such as the rabbit (Oryctalogus cunniculus) and the house mouse (Mus musculus) also form a major component of their diet (see Ryand and Graft 1974).

Small and medium sized marsupials therefore do not figure prominently as an item in the foxes diet. There is however good reason for this. At the present time most of the sensitive medium sized native mammals, and perhaps many of the smaller species, have either disappeared forever, or populations have been reduced to very low numbers. Naturally enough therefore these species can now only form a very small proportion of any foxes diet. It is only under conditions such as those prevailing in the present Perup study, that one might expect these now rarer species, to form any substantial portion of the foxes diet. Before their decline, many species of native fauna undoubtedly formed a large component of the foxes diet.

In areas where native species manage to hold their own they may still form a portion of the diet of foxes. Calaby (1966) records rock wallaby fur in the scats of foxes living near a colony of these animals in New South Wales. Radio tracking studies indicate that it is the main predator of the woylie and the tammar (Christensen 1977) and also of the quokka in the karri forest area (unpubl. data).

It is in fact the very abundance of introduced species, such as the rabbit and the house mouse, both well adapted to predation by the fox, which enables the fox to maintain continued pressure on the native fauna. Were it not for the presence of a constant and plentiful food supply, in the form of these introduced species, the fox would have reached a balance with the native fauna long before their numbers had been reduced to the present low levels. Any predator can only persist in balance with its prey species.

These facts are in general agreement with many of the observed phenomena regarding the modern distribution and abundance

of native fauna (Harlow 1958). In the South-west Burbidge (1977) brings attention to the fact that the three remaining areas in which woylies are known to exist, Tutanning Reserve, Dryandra Forest and the Perup, all have extensive stands of shrubs of the genus Gastrolobium.

These plants contain the toxic compound monofluoro-acetic acid, the sodium salt of which is a consituent of 1080. Dr. D.L. Ride once related a case of which he had heard, to me, of pigs being fed woylies and subsequently dying. It would appear that the woylies, which have a high degree of resistance to fluoro-acetate, had eaten Gastrolobium and that the pigs suffered poisoning as a result. I have personally observed a similar case. A recently dead fox, apparently healthy and in good condition, was found in a heartleaf (Gastrolobium bilobum) thicket in the Perup area. The fox appeared to have died in convulsion as a result of poisoning. The ground around the animal was extensively scratched and disturbed and it had, in its mouth, a hard dry marri (Eucalyptus callophylla) capsule, bitten through with its canine teeth (Photo 4). This type of behaviour appears to be typical of that observed in dogs poisoned with 1080 (Meldrum et al 1957).

In the South-west there appears to be three main chapters to the fox-native fauna story:

(i)

An initial and widespread decline in medium sized native mammal species such as the woylie, the quokka (Setonix brachyurus), the brush and ringtail possums and the tammar (Macropus eugenii). This appears to have occurred between the years 1933 - 1944, depending on the locality, (Perry 1973, Serventy 1954, White 1952). This follows the first recorded sighting of the fox on the South-

coast in 1915 and its recorded spread throughout the South-west by the mid to late 1930's (Land undated)

The woylie disappeared from the Donnybrook Sunkland area, where it was common in 1919 (Perry 1971), and the quokka, once widely distributed, became restricted to a few small isolated pockets of dense swamp thickets. The ringtail and brushtail possum, once numerous throughout the South-west forests, became restricted in numbers and distribution. The highest survival of fauna occurred in the most favourable situations, areas such as Dryandra, Tuttanning and Perup, which also contain extensive thickets of poison (Gastrolobium sp.).

Following the initial decline of the native fauna, the presence of introduced species in high numbers, particularly the rabbit, has enabled the fox to persist and maintain pressure on the native species.

(ii)

Introduction of rabbit baiting, using 1080, during the early 1950's appears to have resulted in a limited revival of some species. Serventy (1954) records an apparent increase in species of native fauna in Dryandra and other areas during this period, and Perry (1973) refers to an increase in the ringtail and brushtail possums since their virtual disappearance by 1945.

(iii)

A further contraction of the range of some species occured following the phasing out of 1080 rabbit baiting commencing during 1972. This decline is still going on and has so far resulted in very reduced woylie populations in Dryandra and the

North Perup and possibly also Tuttanning*.
The ringtail possum population has almost entirely disappeared in the Perup and the numbat may be present only in very low numbers (Figs. 1a and 1b). The brushtail populations in the Perup are reduced and road casualties are no longer recorded in the Bridgetown and Kirup areas where they were plentiful until about 1973/74.

These are the known and documented results, when the final effects are fully known, the picture is likely to be a sad one indeed.

RECOMMENDATIONS

The following immediate action is recommended:

(i) Limited mammal surveys should be carried out in Dryandra forest and Tuttanning reserves to determine the extent of the damage to fauna populations. The Dryandra forest survey can be undertaken by the Forests Department.

(ii) The hypothesis, "that the fox is largely responsible for the present low numbers of some species of native fauna, and that the reduced 1080 rabbit poisoning programme has further aggravated the situation" should be tested.

The present woylie re-seeding study in the Perup provides an ideal situation in which to do this. Fairly extensive data are available on the ringtail and brushtail possum populations as well as the woylie. Regular spotlight surveys have been carried out in the study area over the last seven years. In addition detailed trapping data are available for the woylie population for the last

* J. Kinnear pers. comm.

year. If the fox can be eliminated from the area, or at least reduced to a very low level of population, any changes in native fauna population, particularly that of the woylie, can be monitored in detail

It is therefore proposed to bait the foxes in the north Perup study area, that portion of the Perup Fauna Priority Area north of Boyicup/Cranbrook Road, using 1080. The A.P.B. are willing to assist in this and a doseage lethal to the fox, but one which is not harmful to the native fauna will be used.

It may be necessary to further boost the woylie population with animals from the south in order to obtain quick results. Trapping in the south Perup, Dryandra, and that to be commenced by J. Kinnear in Tuttanning, will provide a control situation.

Subsequent action, assuming that the hypothesis is proven in the north Perup Study should include:

(a)

The initiation of a programme of fox poisoning in all reserves and areas where it is considered that this would benefit the native fauna. Such a programme may require further research to determine the most effective and economical method of achieving fox control in these area. Further studies may also be required into re-seeding areas with populations of native species.

This will entail a joint programme including, Wildlife Research, A.P.B., Forests Department and other interested authorities.

(b)

Because of the expense of a continuing programme of poisoning and the likelyhood that the fox may attain a degree of tolerance to 1080 in the long term, methods of biological control should be investigated. Like the rabbit, it seems likely that the most

effective method of control will be to introduce one of the serious diseases suffered by foxes in their natural homeland. Investigation into the problems of introducing disease should therefore be undertaken.

CONCLUSIONS

The situation is serious. Many of our once numerous species of native fauna now occur only in low numbers and some, like the woylie and perhaps also the numbat, our State Fauna emblem, may be in a precarious position.

Events move quickly, the population 'crash' documented in the north Perup occured over a very brief period of time indeed.

There may already be too little time left to await results from the proposed Perup poisoning study. Perhaps it would be desirable to poison the fox populations in Dryandra forest area and at Tutanning immediately.

Whatever action is decided upon, baiting with 1080 can only ever be a stop-gap measure. The problem has its parallel in the rabbit plague, and like the rabbit, biological control, by means of a suitable disease of foxes is the only long term effective means of controlling fox populations and keeping their numbers down to reasonable levels.

It is realized that many problems are associated with the introduction of biological control measures such as those envisaged. However it is my belief that if we do not attempt it we may loose a large part of our native fauna heritage.

REFERENCES

Burbidge, A.A. (1977). The management of Dryandra forest for wildlife conservation. Departmental report, Dept. of Fisheries and Wildlife.

Calaby, J.H. (1966). Mammals of the Upper Rishmond and Clarence Rivers, New South Wales. CSIRO Div. of Wildl. Res. Tech. Paper No. 10.

Christensen, P.E.S. (1977). The biology of Bettongia penicillata Gray 1837 and Macropus eugenii Desmarest 1804, in relation to fire. Ph. D. thesis. Univ. of W.A. Zoology Dept.

Coman, B.J. (1973). The diet of the Red foxes Vulpes vulpes L., in Victoria. Aust. J. Zool., 21, 391-401.

Jones, F. Wood. (1923-25). The mammals of South Australia. Adelaide, Govt. Print. Pt. 1 Monotremes and the carnivorous marsupials; 1-31. Pt. 2 Bandicoots and the herbivorous marsupials; 131-270. Pt. 3 Monodelphia; 271-458.

King, D.R., Oliver, A.J. and Mead, R.J.(1978). The adaptation of some Western Australian mammals to food plants containing fluroacetate, (in press).

Long, J.L. (undated). Introduced birds and mammals in Western Australia. Ag. Prot. Board. of W.A. Tech. Series 1.

Marlow, B.J.G. (1958), A survey of the marsupials of New South Wales. CSIRO Wildl. Res. 3, 71-114.

McIntosh, D.L. (1963). Food of the fox in the Canberra district.

CSIRO Wildl. Res. 8, 1-20.

Meldrum, G.K. and Bignell, J.T. (1957). The use of Sodium fluoroacetate (Compound 10 80) for the control of the rabbit in Tasmania. The Aust. Vet. J., 186-196.

Mortensz, P.N. (1971). Observations on the food of the fox, Vulpes vulpes, in an arid environment. CSIRO Wildl. Res. 16, 73-75.

Oliver, A.J., King, D.R. and Mead, R.J. (1977). The evolution of resistance to Fluoroacetate intoxication in mammals. Search Vol. 8, No. 4, 130-133.

Perry, D.H. (1971). Observations of a young naturalist in the lower Blackwood Valley in the year 1919. West. Aust. Natur. 12(2): 46-47.

Perry, D.H. (1973). Some notes on the decline and subsequent recovery of mammal populations in the South-west. West. Aust. Natur. 12(6): 129-131.

Ryan, G.E. and Croft, J.D. (1974). Observations on the food of the fox (Vulpes vulpes (L)), in Kinchega National Park, Menidee, N.S.W. Aust. Wildl. Res. 1: 89-94.

Serventy, D.L. (1954). The recent increase of the rarer native mammals. West. Aust. Nat. 4(6), 128-141.

Troughton, E. (1967). Furred animals of Australia. Angus and Robertson. Sydney.

White, S.R. (1952). The occurence of the quokka in the South-west. West. Aust. Natur. 3(5): 101-103.