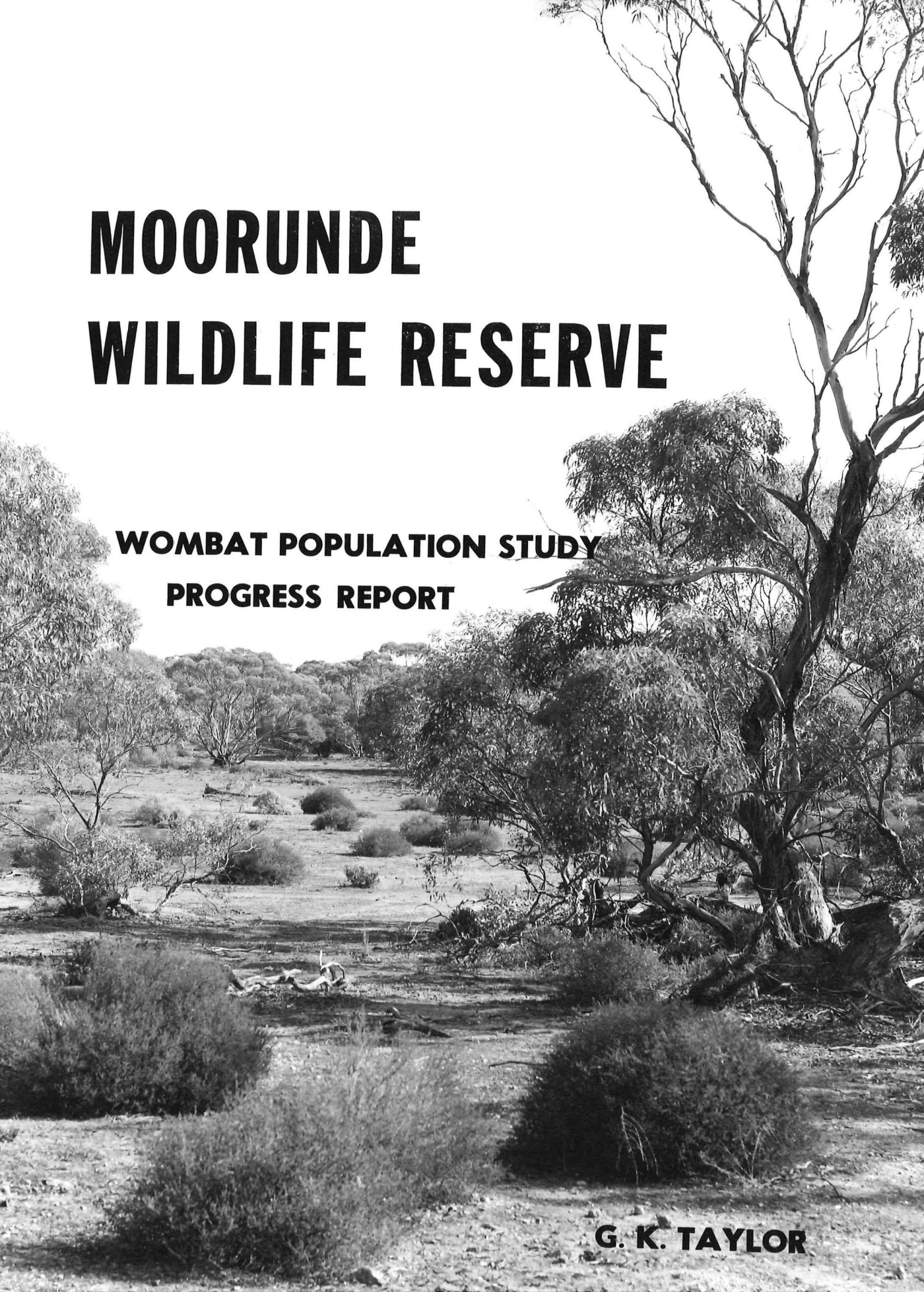
MOORUNDE WILDLIFE RESERVE

WOMBAT POPULATION STUDY
PROGRESS REPORT



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BY

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C O N T E N T S

INTRODUCTION

The wombat is Australia's largest burrowing animal.

The Hairy-nosed Wombat (Lasiorhinus latifrons) is now almost completely confined to South Australia and in 1970 was proclaimed the faunal emblem of the State.

Although Hairy-nosed Wombats are abundant on the Nullarbor Plain, the areas near Adelaide where the animals exist in their natural state have been gradually diminishing under pressure of agricultural and pastoral pursuits, and it has become increasingly important to have land set aside for the preservation of the species and to provide opportunity for observation of these unique marsupials within easy travelling distance of the city.

In 1968, following a successful appeal to the Public for funds, the Natural History Society of S.A. established Moorunde Wildlife Reserve specifically to provide a permanent sanctuary for the Hairy-nosed Wombat.

The Reserve consists of 2020 hectares of Mallee scrub and grassland near Blanchetown and was up to the time of purchase part of a sheep station.

The rainfall is variable, averaging 260 mm per year.

Severe drought during 1967-1968 had devastated the pasture and many of the wombats had died of starvation.

The policy adopted by the Society was to provide fencing and allow the flora and fauna to recover at its own pace free from the competition of sheep and with the minimum of interference by man.

The purpose of the author's study is to evaluate the effects of this policy in terms of wombat population and to provide the Management Committee with data upon which policy decisions can be based.

THE STUDY PROJECT

AIM

The value of Moorunde as a wombat reserve should be judged by its ability to sustain a viable community of wombats in perpetuity.

Thus the fundamental objective of this study is to establish population trends over a sufficient period of time to encompass the extremes of climate that this generally arid region experiences.

PROCEDURE

Initially it was intended that the study would take the form of a periodic inspection of the entire Reserve noting signs of activity at each wombat warren and recording wombat sightings.

GENERAL INSPECTION AND INITIAL SURVEY

At the beginning of the study no comprehensive examination of the Reserve area had been made, information was limited to that observed in the easily accessible parts and areas close to the fence lines.

The first step in the study, then, was to systematically examine the whole Reserve on foot locating and plotting the position of warrens on a map and at the same time noting any signs that indicated habitation by wombats.

To facilitate location of warrens, aerial photographs of the area were obtained from the Lands Department and the Reserve area was then divided on a grid system spaced to coincide with the strainer posts of the fences (approximately 95 metres apart) (Fig. 1).

The first field inspection in the study programme began on 15th August, 1970. The author, assisted by several enthusiastic helpers, walked across the Reserve in lines approximately 200 metres apart. Whenever a warren was located, a sketch was made of the layout of the burrows in the warren and a numbered tag attached to a convenient nearby tree for identification purposes.

To locate the position of the warren it was sometimes possible to recognise the shape of the clearing from the aerial photograph. This was especially so with larger warrens.

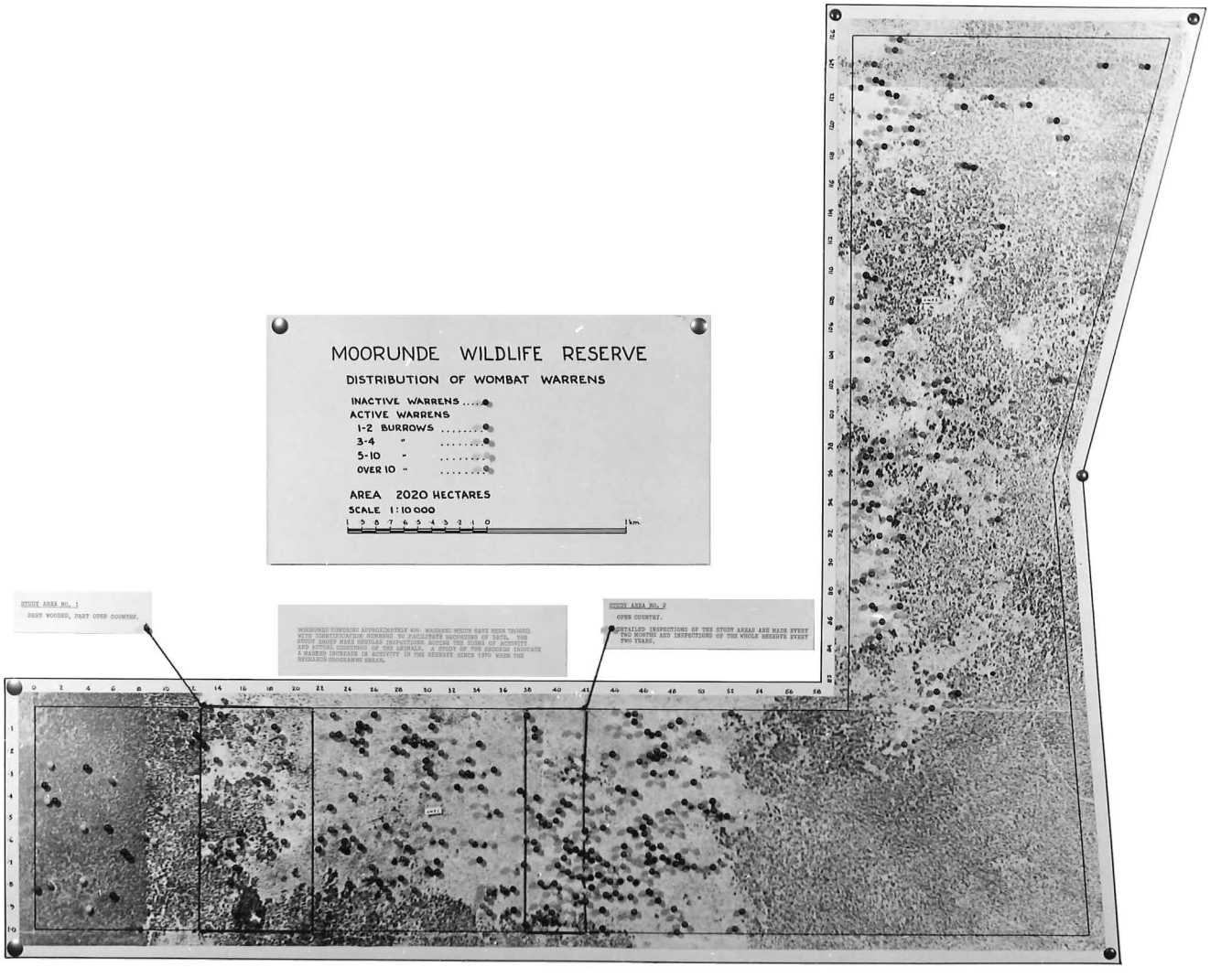


FIG. 1 Aerial photograph of the Reserve showing distribution of wombat warrens.

For the others it was necessary to take compass bearings from two known points. Mallee landscape is notorious for its lack of prominent features so flags attached to fibreglass fishing rods were erected in the tops of the tallest trees at two identifiable points about a kilometre apart to serve as datum points. After correction for magnetic deviation, the intersection of the plotted bearings gave an accurate location of the warren and its position was then defined in terms of co-ordinates on the grid.

When examination of the area between the flags had been completed the first flag was moved about a kilometre beyond the second and the process repeated until the whole Reserve had been covered.

The initial survey occupied five weekends from August, 1970 to February, 1971, and involved well over 100 kilometres of walking.

Now, for the first time we had a broad picture of the Reserve's features and some idea of the task that lay ahead.

On completion of the survey a map was prepared to show the distribution of all the warrens that had been located and allotted identification numbers.

During subsequent inspections additional warrens have been discovered and are included on the distribution map (Appendix 4).

The present total stands at 399 warrens comprising more than 2000 burrows.

FINDINGS OF THE INITIAL SURVEY

The survey revealed a wide variation in vegetation communities which can be divided into three distinct types viz.

1. Mallee scrub with an understorey of small shrubs and plants including Cassia, Eremophila, Saltbush and Bluebush species (Fig. 2).
   This occupies about 65% of the total area of the Reserve.
2. Shrub and grass community, the shrubs being predominantly Geijera, occupying most of the remaining area. (Fig. 3).
3. Grassland existing in a number of large clearings; the species include Stipa, Bassia and Danthonia. (Fig. 4).

FIG. 2
Mallee scrub - Eastern end of Reserve.

FIG. 3
Geijera shrub and grassland community.

FIG. 4
Grassland in an exceptionally wet year (1974).

The distribution of wombat warrens was found to have a very marked dependence on the vegetation type.

In the Mallee areas the warrens were either very widely spaced or completely non existent. This is presumably due to the sparse supply of suitable food grasses in the scrub cover.

The scene changes dramatically, however, where the Mallee gives way to the shrub and grassland areas. Here the warrens are rarely more than 100 metres from their neighbour and the density of warrens increases as the number of shrubs diminishes.

The size of warrens varies tremendously, ranging from single burrows to complex systems with as many as 62 interconnected burrows. (Fig. 8).

The large warrens give the impression of permanence, the core of the community, whereas many of the smaller warrens appear to be only casually occupied or visited.

The soil in which the burrows are dug also shows some variation.

Most of the Reserve has a thin layer of soil covering a calcrete (cemented limestone) shelf in turn overlying softer strata. (Fig. 5).

The wombats have exploited this formation by penetrating the calcrete shelf at points of weakness and burrowing into the softer substrata utilising the shelf as a roof. (Fig. 6).

In the few areas where deep clay soil exists, burrows are much less durable and are subject to collapse during seasons of unusually high rainfall. These warrens appear to have been redug many times over. (Fig. 7).

Whilst establishing the distribution of the warrens and burrows is a simple process, a census of the wombat population is another matter. Difficulties arise from the fact that wombats are rarely seen and thus defy simple counting methods, they use different burrow entrances from time to time and may even change residence from one warren to another.

Some warrens not regularly inhabited may receive casual visits from residents of nearby warrens.

A recognised method of obtaining an accurate census

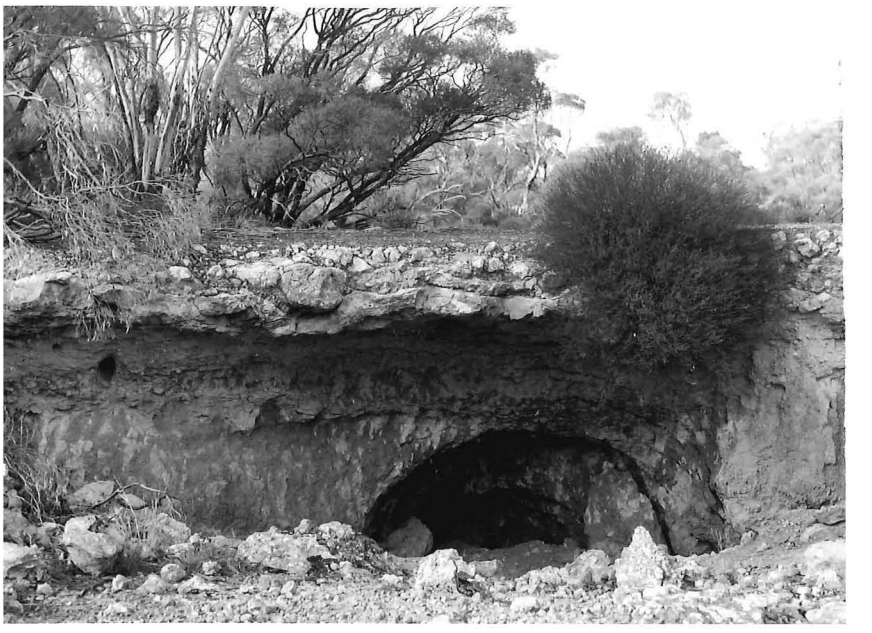


FIG. 5.
Soil profile exposed in a sink hole.

FIG. 6.
Wombat burrows beneath the calcrete shelf.

FIG. 7.
A burrow in deep clay soil.

of animals in an area is to capture and tag the animals. However, the method is very time consuming and transgresses the Society's policy that any study must involve minimum disturbance to the wombats.

Instead, a method was adopted of recording signs of activity at each burrow at regular intervals on the assumption that trends in activity level would reflect trends in population.

Signs that are recorded are :-

Actual wombat sightings.

The sound of a wombat retreating into the depths of the burrow when disturbed by man's approach.

Footprints and/or droppings whose size indicate the size of the animal.

During the initial survey signs of activity were recorded at 715 burrows (39% of the total), and these active burrows were represented in 264 warrens (65% of the total warrens).

Although the remains of many wombats who perished in the 1967-68 drought were seen on the inspection, it was heartening to see that so many warrens seemed to have survivors to form a breeding nucleus that could increase into large communities like those that apparently flourished in earlier times.

It was obvious that with so many warrens in such a large area, it would be impossible to carry out inspections frequently enough to give any more than rather generalised information on the progress of the Reserve. It was decided then, to space these general inspections at two-yearly intervals and to supplement the information with data collected more frequently in a smaller sample area.

STUDY AREAS

In July, 1971 an area 1.6 km x 0.8 km was selected for more intensive study. (Fig. 10).

Designated as Study Area No. 1, it contains samples of each of the three vegetation communities in approximately the same proportions as the Reserve as a whole.

The thirty-two warrens with a total of 273 burrows were surveyed using an alidade (Fig. 9), and mapped

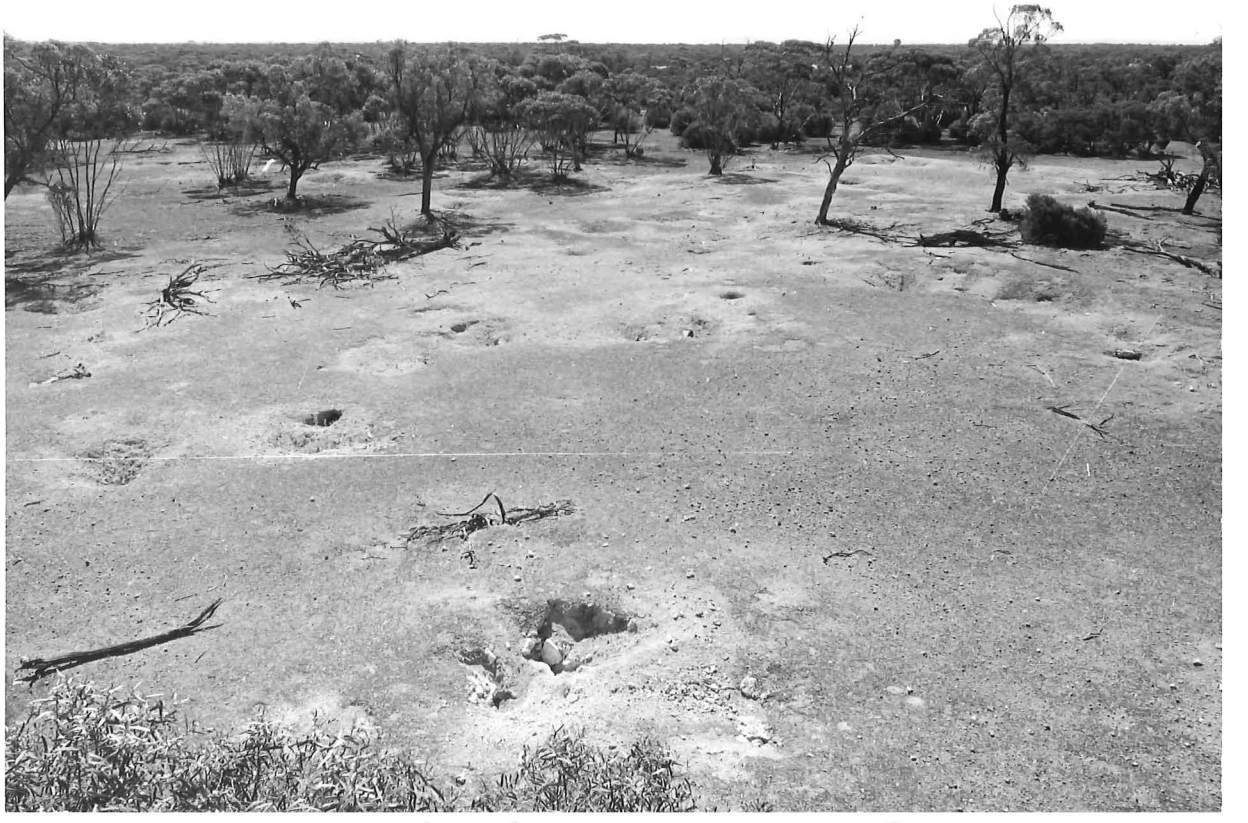
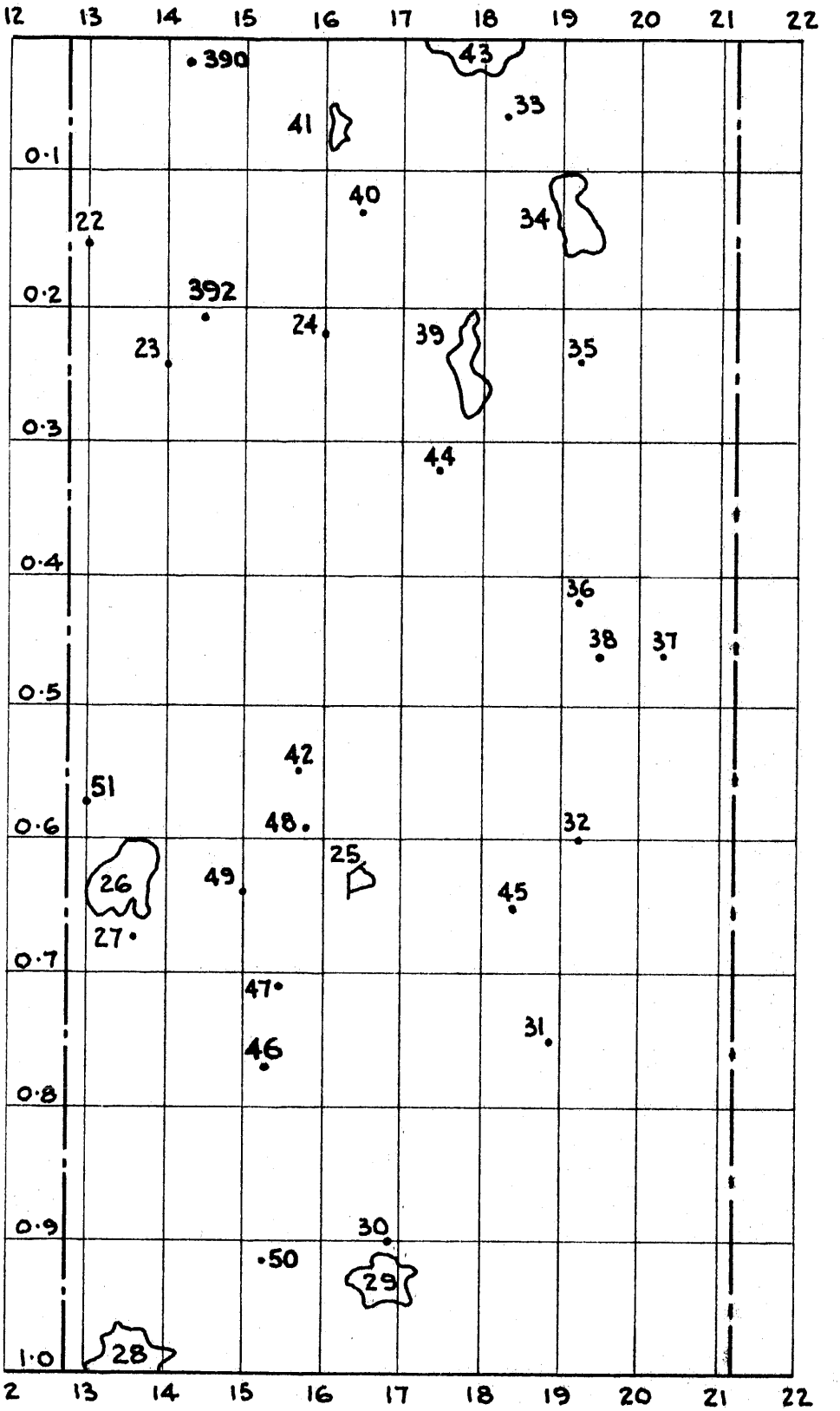


FIG. 8 *One of the larger warrens in the Reserve.*

FIG. 9 *An alidade was used in mapping warrens in the Study Areas.*

MOORUNDE WILDLIFE RESERVE
Nº1 STUDY AREA 0·5 SQ. MILES.

PORTION OF SECTION 162



SCALE 8" = 1 MILE

FIG. 10

separately to scales of 1 : 100 to 1 : 400, depending on the overall size of the warren. It was also desirable to know how the individual entrances were interconnected by underground passages. This was determined by pegging a tarpaulin over one burrow and vigorously pumping the centre of the tarpaulin by hand to induce a draught of air through all the interconnected entrances. A frame with cloth ribbons attached held at each burrow in turn detected air flow which proved that a connection existed. The interconnections are depicted by dashed lines on the map. (Fig. 11).

The maps were assembled into a loose leaf binder with data sheets provided to record evidence of activity for each burrow at each inspection. (Fig. 12).

Code numbers have been adopted to designate various observations to save time in taking field notes.

viz. 0 - No activity, sticks and leaves blocking the entrance.

1 - No recent activity.

2 - Signs of small wombat, i.e. small footprints and/or droppings.

3 - Old tracks and droppings.

4 - Fresh droppings near entrance.

5 - Fairly fresh tracks and droppings.

6 - Fresh tracks and droppings.

7 - Very fresh tracks and droppings.

8 - Entrance freshly cleaned out.

9 - Wombat heard retreating down burrow.

10 - Wombat sighted.

It was decided to make inspections at two-monthly intervals so that seasonal variation in activity could be observed.

After the preliminary work had been done and the collection of data became a routine procedure, it was found that time was available for extra studies, so in December, 1973, Study Area No. 2 was selected.

This is an area 1.6 km x 0.6 km containing 279 burrows grouped into 47 warrens, the highest warren density in the Reserve. (Fig. 13). The dominating vegetation is Geijera shrub and open grassland.

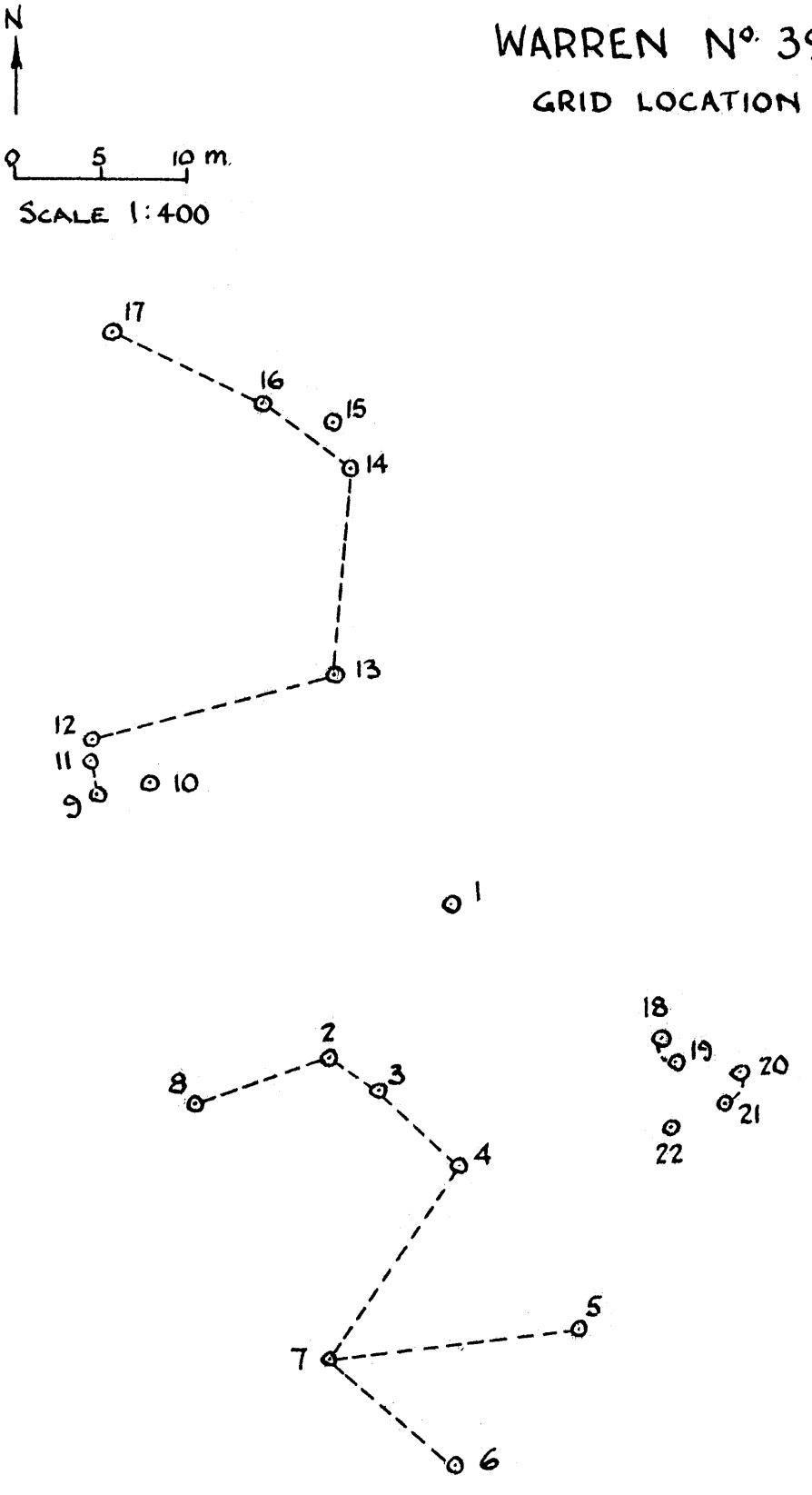

N
WARREN Nº. 39
GRID LOCATION 17·8-0·24
0 5 10 m.
SCALE 1:400
17
16
15
14
13
12
11
9
10
1
18
19
20
21
22
2
8
3
4
5
7
6

FIG. 11.

WARREN Nº 39

BURROW Nº	10.10.71	5.12.71	26.2.72	9.7.72	29.10.72	24.3.73	30.6.73	7.10.73	31.12.73	23.2.74	20.4.74	22.6.74	17.8.74	12.10.74	21.12.74	8.2.75	6.4.75	31.5.75	26.7.75	18.10.75	13.12.75	7.2.76	4.4.76	30.5.76	24.7.76	23.10.76	8.1.77
1	5	4	3D	0	0	0	3T	7	0	0	0	7	6	5T	04	0	0	1	0	0	0	0	0	0	0	0	0
2	5T	6	5T	0	6T	7	7	7	6	6	8	6	5	6	6	34	5	5	0	6	6	3	6	5	5	6	7
3	6	3T	0	0	0	0	0	0	0	0	0	7	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	0	0	0	0	1	0	0	0	0	0	0	6	1	0	0	0	1	5	0	5	6	3	1	1	1	0	0
5	0	4	1	0	1	0	1	1	0	0	0	0	0	0	3	1	1	1	1	5	1	1	1	6T	1	1	1
6	1	5T	3T	1	0	0	0	1	6T	0	1	62	5	1	1	0	3T	14	5	6	6	5	5	6	5	1	1
7	1	1	0	0	7	3T	0	1	6D	4	3T	5	1	1	3	1	1	14	5	5	6	5	6	6	5	5	5
8	5D	4	6T	6T	7	7	8	7	6	72	1	7	6	7T	6	14	14	14	5	5	6	34	6	6	6	6	1
9	5T	6	6T	0	5	6T	7	6	5D	8	3	6	7	5T	5	7T	8	7	7	6	1	6	5	6	7	7	7
10	5	6	0	0	0	0	0	6T	0	0	1	7T	7	1	5	1	1	1	5	14	1	1	1	1	1	1	1
11	5T	6	8	6T	1	7T	7	8	7	8	1	7	7	5T	6	62	7	14	5	6	1	6	6	6	6	1	7
12	6T	6	8	6T	1	7T	6	8	7	7	1	7	7	6T	6	1	7	14	14	6	1	6	6	6	6	5	7
13	5T	6	6	7T	7	0	6	6T	6T	7	8	7	6T	6	7	0	6T	0	0	7	1	5	5	6	7	5	7
14	0	4	4	0	1	0	6T	6D	0	6	8	6	5T	1	0	0	34	5	5	62	62	5	5	6	7	1	7
15	0	0	0	0	0	0	0	0	0	0	0	7	7	6	5	5	1	1	0	14	1	1	5	1	1	1	1
16	1	6	6T	0	1	7T	7	7	7	7	3	7	7	6	1	0	5	0	0	5	9	6	6	6	7	6	6
17	1	4	1	7T	7	0	7	7	6	7	5T	7T	7	1	7	6	14	14	14	5	6	14	5	3	3	6	14
18	D	0	0	0	0	0	7	6	7T	6	1	6	5T	6	7	14	5	1	6	6	1	5	5	6	7	6	1
19	INSPECTED	0	8	0	0	0	7	6	1	6	1	7	5	6	1	0	6	1	6	6	1	5	5	6	7	6	5
20	NOT	0	6T	0	0	0	0	6	7T	6	1	5T	5T	1	5T	3	5	5	5	6	5	6	6	9	7	5	1
21		0	0	0	0	0	0	0	0	5T	1	6T	5T	6	6	5	5	1	6	6	1	5	1	6	7	1	5
22		4	6	0	0	0	0	6D	7	0	6T	7	5	1	1	0	1	1	1	1	1	1	0	0	0	0	0

FIG. 12.

MOORUNDE WILDLIFE RESERVE

STUDY AREA No. 2

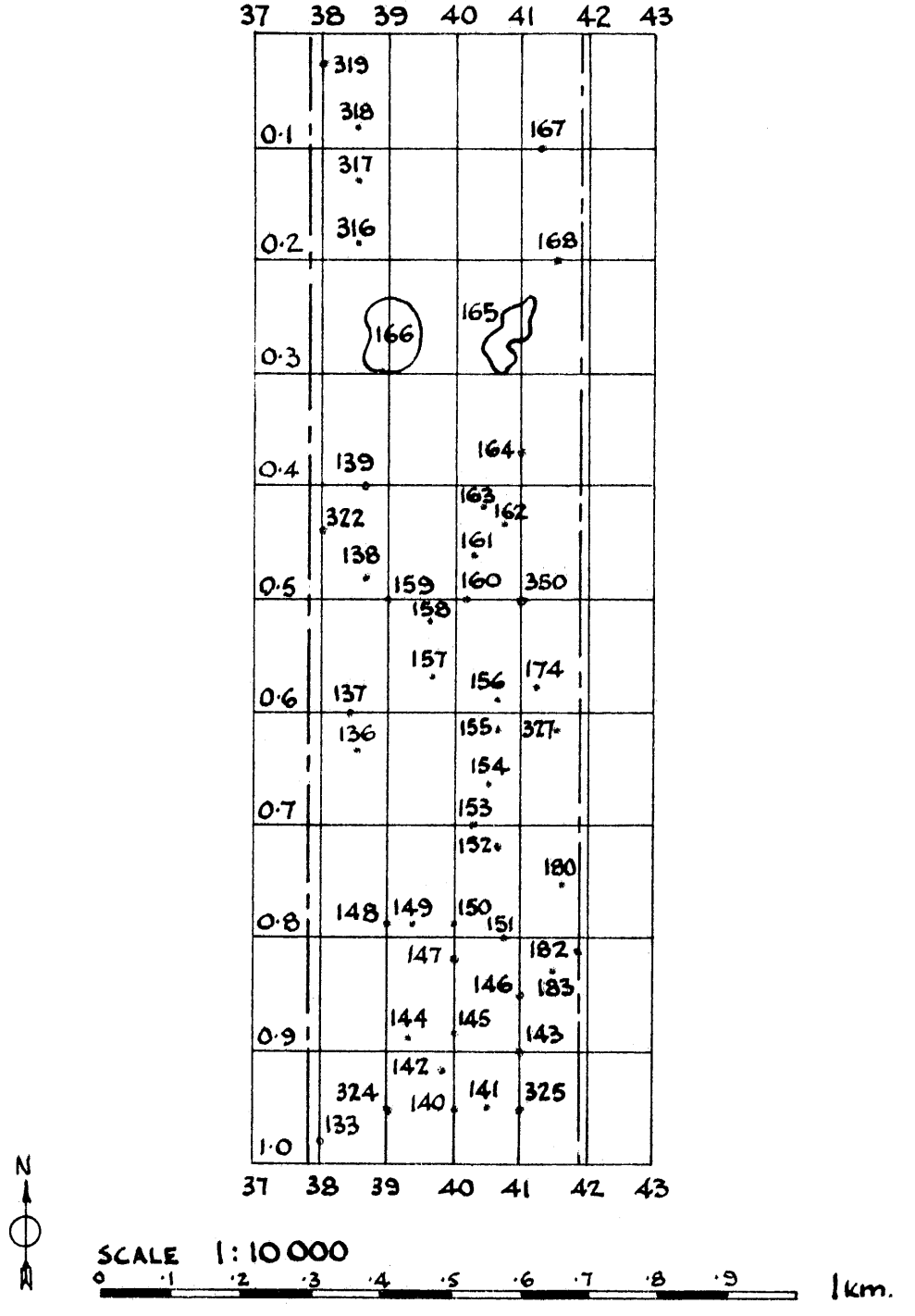


FIG. 13.

Data is collected in the same way as in Study Area No. 1.

From the outset I had doubts on how this data should be interpreted with respect to population estimates. To assume that each burrow showing recent activity was occupied by a wombat would have resulted in an unrealistically high figure and was not supported by any confirming evidence.

CARBON DIOXIDE DETERMINATIONS

At an early stage of the study an attempt was made to determine whether a burrow was occupied by measuring the temperature and the carbon dioxide content of the air in the burrow. It was argued that an occupied burrow would be slighly warmer and the carbon dioxide content higher due to animal respiration.

Many air samples, including some from burrows where wombats were observed, were collected and tested, giving carbon dioxide content varying from 300 parts per million (0.03%) to 2500 parts per million (0.25%). Outside air was found to contain 240 parts per million (0.024%) carbon dioxide. (Fig. 14). Temperatures were found to be remarkably constant at 72°F (these tests were in Summer 1971).

It is significant that all determinations of carbon dioxide were either very high or very low. The high levels were invariably from burrows with only a single entrance, the low levels from burrows with multiple entrances. The high level of carbon dioxide in single entrance burrows appears to be the product of decomposition of excreta accumulated in a stagnant air space.

The efficient ventilation provided by multiple entrances ensures a low level of carbon dioxide and may well be the main reason for having several entrances.

Enlightening as they were regarding the ventilation of warrens, the carbon dioxide determinations were concluded to be unsatisfactory for testing the presence of wombats and were consequently discontinued.

ANIMAL ACTUATED CAMERA

At every visit during the early stages in the study a camera was set up near an apparently well used burrow and a treadle switch buried in the walk path so that the

FIG. 14 The carbon dioxide content of air in burrows was determined by a modified Pettenkoffer's method.

FIG. 15. A wombat tripped a camera as he emerged through a switch mechanism set up in the burrow entrance.

camera with synchronised flashlight would be triggered when a wombat emerged. With visits to the Reserve spaced at one to two months, opportunities to set up the camera were infrequent and more often than not proved fruitless.

This experience put the interpretation of observed data under further question.

Other questions, too, remained unanswered.

Why were there so few sightings of wombats even in areas where they were obviously numerous?

Since they must use the burrows sometime, when do they leave and when do they return?

ACTIVITY RECORDER

By December, 1971 it was decided that the only satisfactory way to resolve these questions was to have a continuously operating device which could record the arrivals and departures of wombats from each burrow of a selected warren.

Design of a suitable instrument to do this commenced in January, 1972 and construction in the home workshop started in June. It was installed in a warren in January, 1973. (Fig. 16).

At each burrow entrance in the warren a flap operated switch (Fig. 15) is installed and wired with buried cables to the centrally placed recording instrument in which a waxed paper chart advances at the rate of approximately 30 mm a day. As any switch is activated by the passage of a wombat a solenoid operated stylus registers the event on the chart, defining whether the movement was into or out of the burrow. (Fig. 17).

The instrument has 21 channels, one registering midday and midnight and the others for connection to individual burrows.

In the early stages many problems arose with the switch design and wiring, and a number of modifications were made before reliable recording was achieved. From December, 1973 onwards recording has been almost continuous with only occasional breaks for maintenance purposes.

From the charts the following information can be read. (Figs. 18 and 19).

1. The time at which a wombat leaves the warren

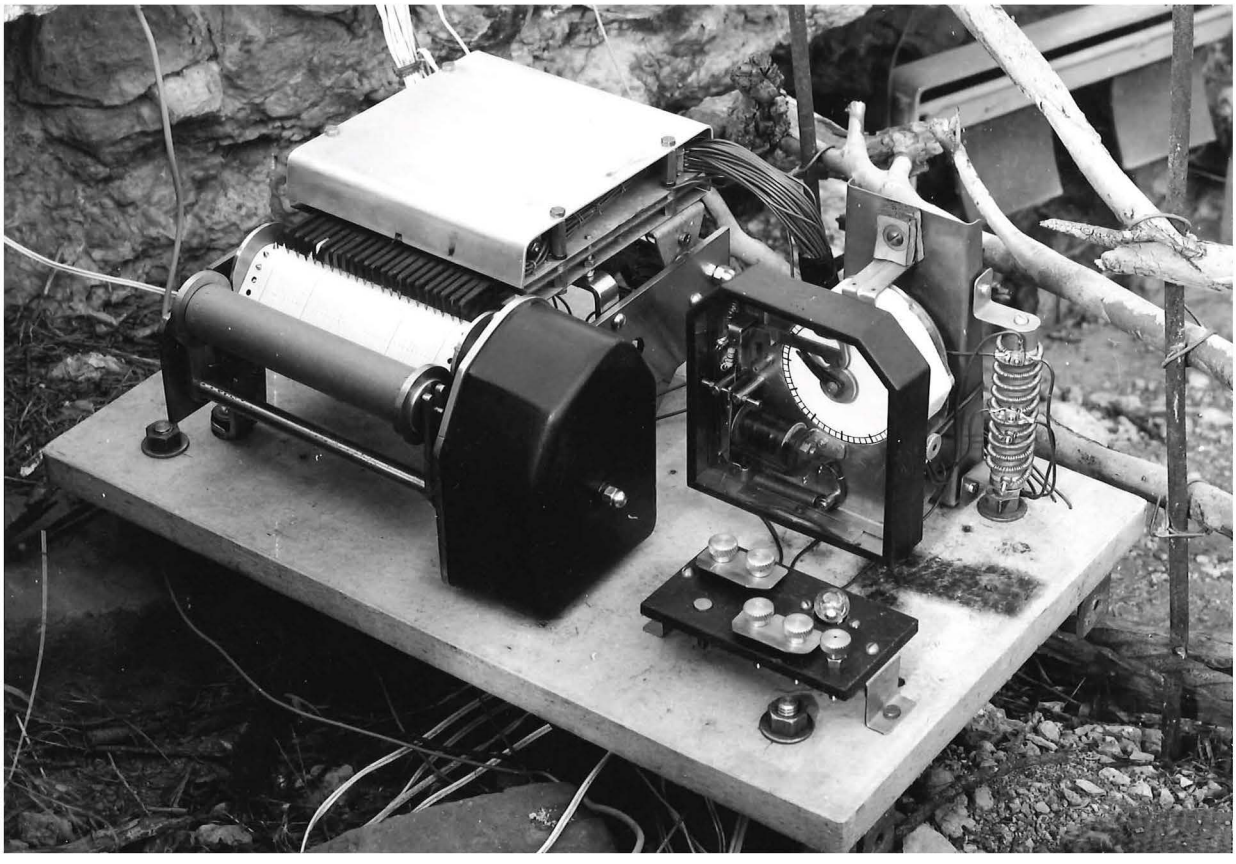


FIG. 16. Recording mechanism used to record arrivals and departures of wombats to and from their burrows.

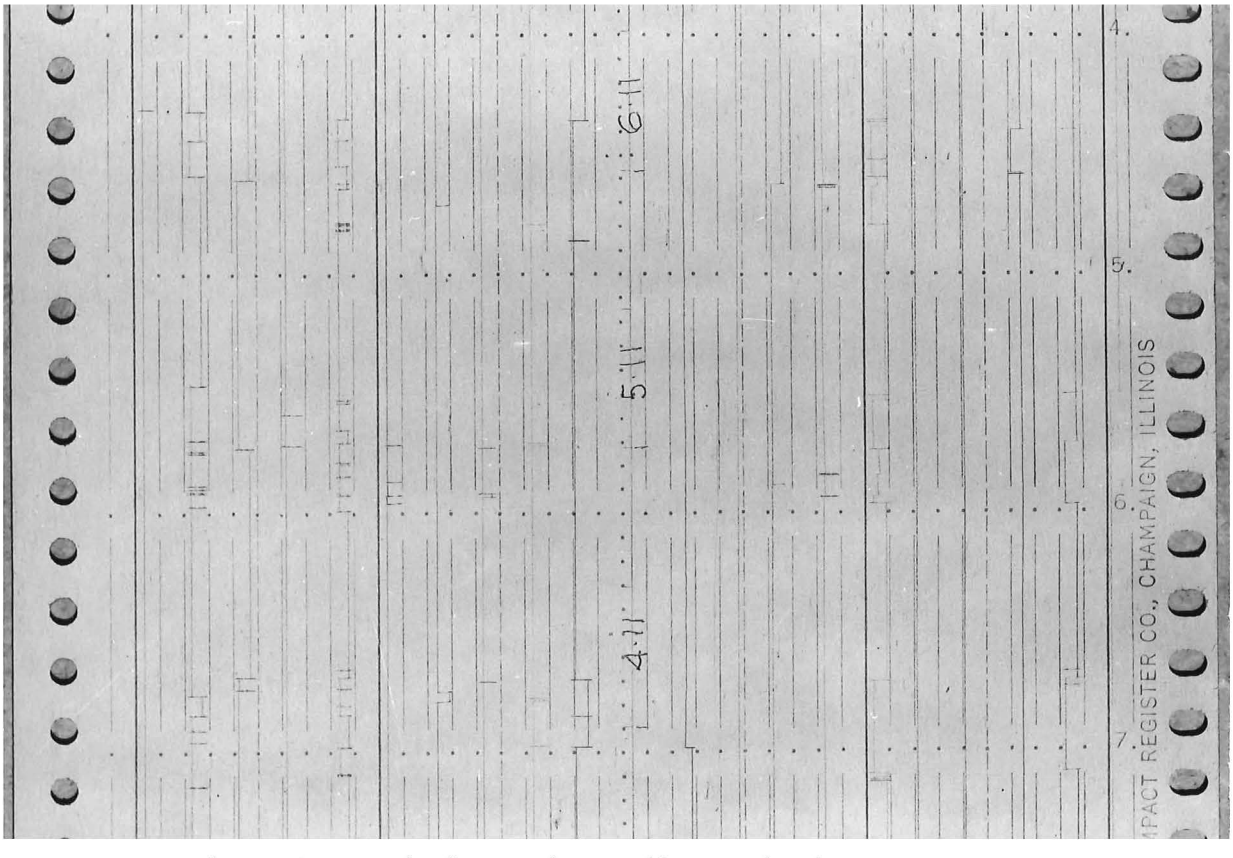


FIG. 17. A section of chart from the activity recorder.

FIG. 18.
A measuring microscope used in reading activity charts.

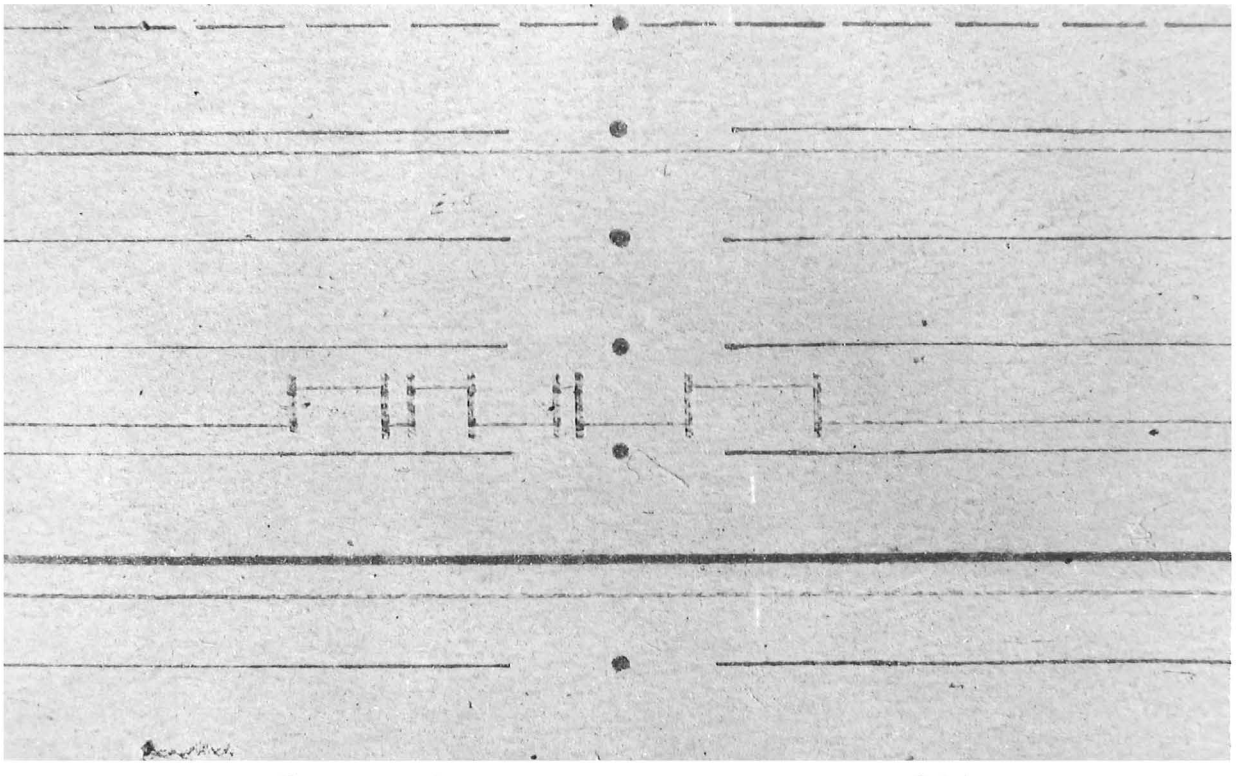


FIG. 19 Close-up view of a section of chart.

and by which burrow entrance.

2. The time at which a wombat returns and by which entrance.
3. The period of time spent out wandering and feeding.
4. The number of wombats out at any one time giving a guide to the population of the warren.

From this data can be determined the effect on wombat activity of the climatic seasons and this can eventually be extended to include the effect of drought and flush years.

RESULTS

The procedure for the population study has developed into the correlation of data from three main sources.

1. The activity recorder operating continuously at one warren.
2. Regular two-monthly inspections of two Study Areas.
3. Regular two-yearly general inspections of all warrens in the Reserve.

ACTIVITY RECORDER

The data provided by the activity recorder will be discussed first because of its importance in the interpretation of the observed signs of activity in both the Study Areas and the Reserve as a whole.

The visual signs of activity such as scratchings, tracks and droppings are regularly recorded at all burrows of the warren where the recorder is installed. It is therefore a simple matter to relate these signs to actual wombat use of the burrows where the observations were made.

The code numbers used to designate various activities have been listed on page 6.

Activity represented by code numbers 0, 2, 4, 8, 9 and 10 require no clarification but the age of evidence designated by numbers 1, 3, 5, 6 and 7 was uncertain until analysis of the recorder charts established a pattern as follows :-

Code No.			Average No. of days since burrow was used
1	-	No recent activity	12
3	-	Old tracks and droppings	4
5	-	Fairly fresh tracks and droppings	4
6	-	Fresh tracks and droppings	3
7	-	Very fresh tracks and droppings	1

It was apparent that code numbers 3 and 5 did not represent a significant difference, so the use of Code No. 3 was discontinued.

Since the ultimate aim of the study is to estimate population, it was important to know if any reliable relationship existed between the number of burrows showing signs of activity and the number of wombats residing in the warren.

To arrive at the number of wombats residing in the warren an analysis of each night's activity is made to determine the minimum number of wombats that will satisfy the sequence of arrivals and departures recorded on the chart for that night. The average population (P) for each month is then calculated and is depicted on the graph (Fig. 20).

On the same graph also is plotted the number of burrows that had been used at some time during the previous four nights (symbolised B4) i.e. burrows showing activity that would be designated as 5, 6 or 7 averaged over a month.

From these figures the ratio of B4 to population = $\frac{B4}{P}$ has been derived and is shown on the same graph.

By applying this ratio to the observations in the Study Areas and the Reserve as a whole, an approximate population estimate is made possible and its use will be demonstrated in the sections on the general inspections and Study Areas.

The recorder very quickly explained why few sightings had been made of wombats during daylight. It indicates that the wombats leave their burrows almost exclusively at night, the time of departure and the period spent outside varying with the seasons.

The pattern of activity for the four seasons is shown graphically in Fig. 21.

Some other conclusions deduced from the charts are :-

1. Rain has a marked influence on activity. During nights of wet weather the wombats make many excursions from their regular burrows and visit other burrows, giving the impression that rain is treated as quite an exciting event. Following heavy rains burrows are often cleaned out.

   The graphs reflect the influence of rainfall also in that the seasons of higher rainfall, Winter and Spring 1974, 1975 and 1976, show high levels of activity, whereas Summer 1973-74, 1974-75 and 1975-76 and Autumn 1976

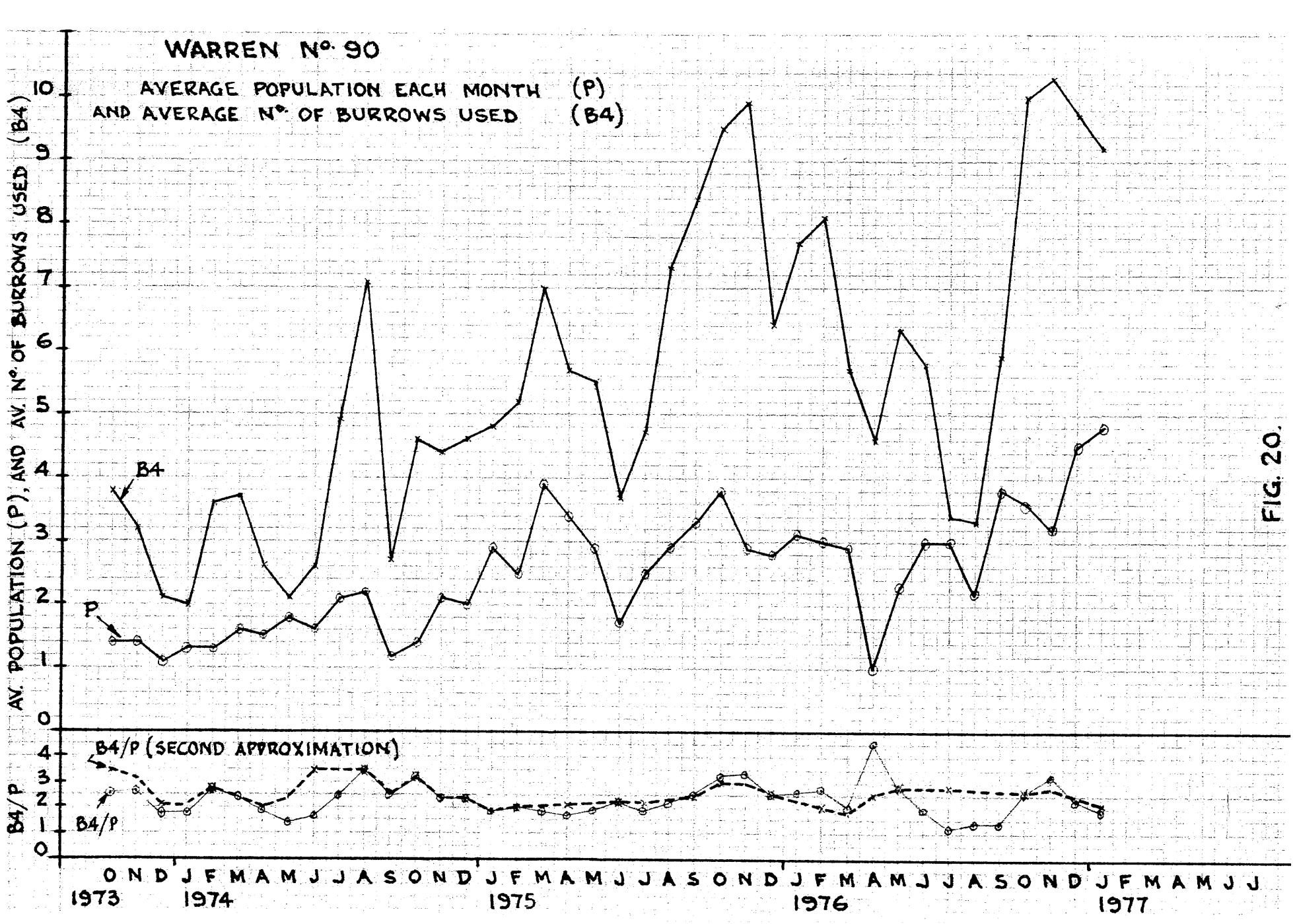

WARREN Nº 90
AVERAGE POPULATION EACH MONTH (P)
AND AVERAGE Nº OF BURROWS USED (B4)
AV. POPULATION (P), AND AV. Nº OF BURROWS USED (B4)
B4
P
B4/P (SECOND APPROXIMATION)
B4/P
B4/P
0 1 2 3 4 5 6 7 8 9 10
0 1 2 3 4
O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J
1973 1974 1975 1976 1977

FIG. 20.

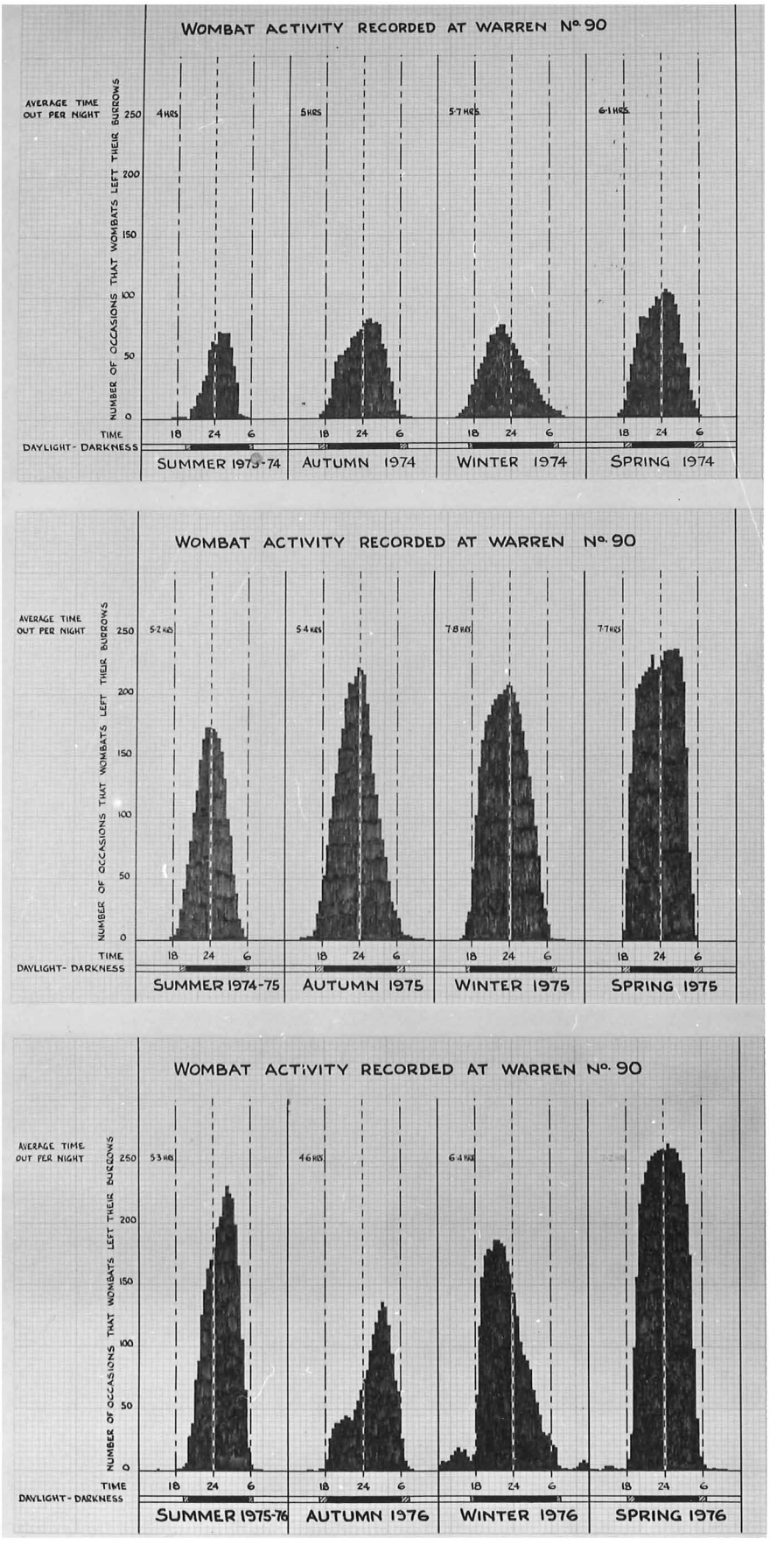


FIG. 21. Wombat activity at Warren No. 90 for each climatic season 1973 - 1976.

all having received relatively low rainfall show a considerably lower activity level.

2. The wombats seem generally to be creatures of habit, using one or two entrances consistently for long periods, but then will change to using alternative entrances for a time. There is also considerable interchange of population between Warren No. 90 where the recorder is installed and a neighbouring Warren No. 91.

3. Some of the burrows receive only casual visits on rare occasions.

4. Several wombats may share the same burrow; their relationship to each other has not been established.

5. Excursions during daylight are extremely rare and from actual sightings it appears that they emerge either to lie close to their burrow entrances absorbing the sunshine or to wander about in light rain. Daylight excursions are much more frequent during long periods of low rainfall when food is scarce.

6. The wombats are particularly disturbed by human visits to their warren. Each time the warren is visited, the wombats' activity for the ensuing night is restrained, with only the boldest wombats venturing out generally much later in the night than usual.

   I therefore make only the essential visits to change the chart and battery at monthly intervals to ensure that the record is as representative of the wombats' normal behaviour as possible.

   This shyness explains why I have only on rare occasions managed to capture photographs of the wombats with animal actuated cameras. It is apparent that greater success could be achieved if the camera could be left for more than the one night, but it has rarely been opportune to do this. The photograph (Fig. 15) was obtained during a three day visit to the Reserve.

7. There has been a marked population increase in the warren in the past three years.

STUDY AREAS

No. 1 Study Area has been inspected at approximately two-monthly intervals since July, 1971 and No. 2 Study Area since December, 1973.

Analysis of the data collected over the period of study gives an indication of :-

1. The burrows and warrens that are in constant use.
2. Warrens in use for certain periods.
3. Warrens and burrows which receive only casual visits.
4. Abandoned warrens.

Activity in the Study Areas has been depicted in graphs showing the number of active burrows (i.e. those used in the previous four days as designated by Code Nos 5 - 10) and active warrens at each inspection. (Figs. 22 and 23).

This demonstrates seasonal variations in activity superimposed on a general trend to increased activity.

The rainfall figures on the same graphs illustrate that the variations in activity are attuned to rainfall, the least activity occurring during the dry months of the year.

The general increase in activity is evidently due to increased population.

Initially, an attempt to estimate population was made by assuming that any connected set of burrows in which one or more entrances were in regular use contained one wombat. Data collected since then by the activity recorder has proved such an estimate to be on the conservative side by demonstrating that several wombats may occupy a set of connected burrows.

The activity recorder described in the previous section has provided the means to a much more reliable population estimate.

The ratio of burrows showing signs that they were used during the previous four days (B4) to the population (P), i.e. B4/P allows a first approximation of the population for each Study Area at each inspection.

The Study Areas are of sufficient size to expect that the population will be reasonably stable, i.e. there should not be any sudden changes from one inspection to the next. Therefore a second approximation has been derived by smoothing out the population graph for each

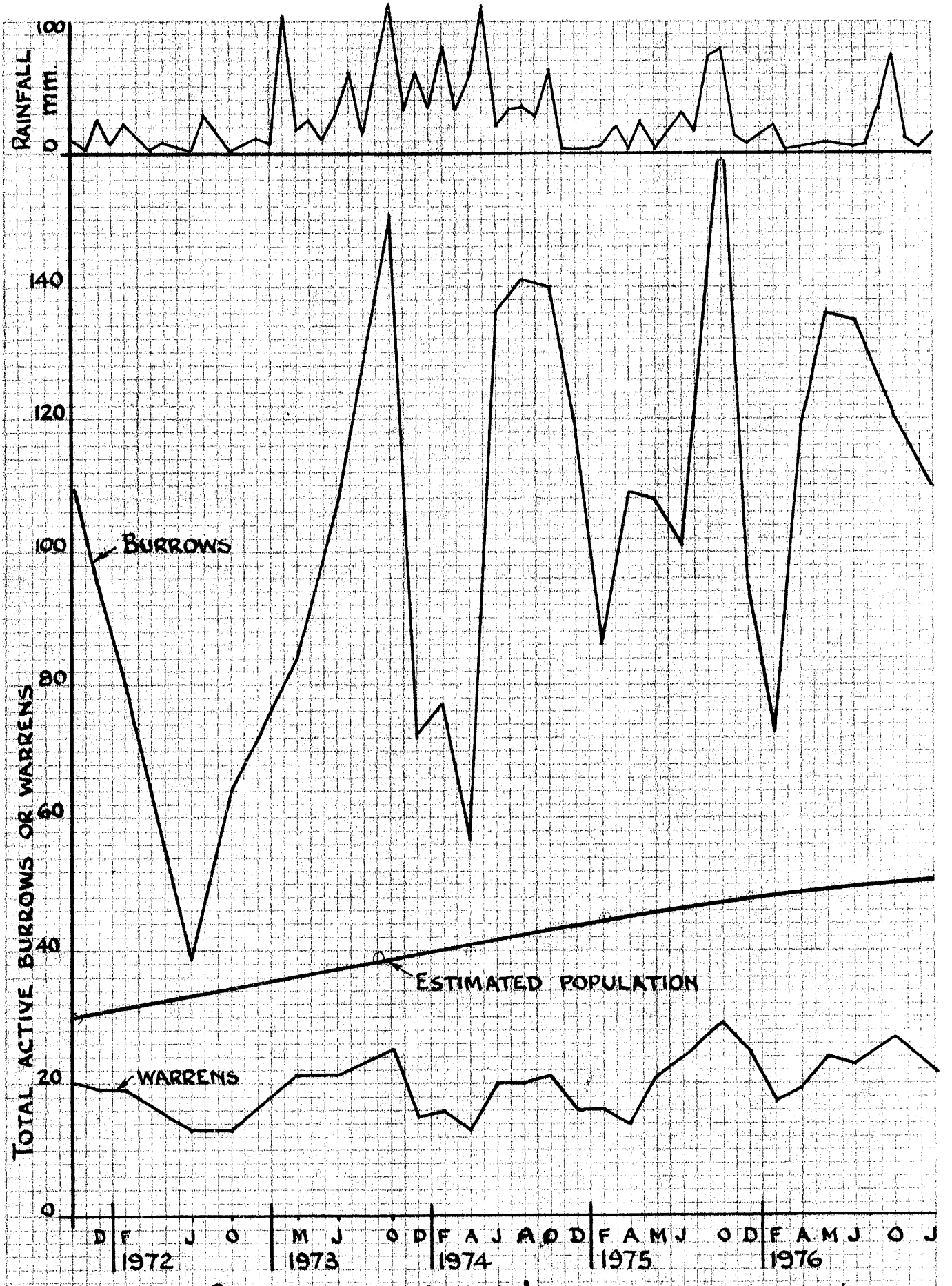


FIG. 22. STUDY AREA No. 1

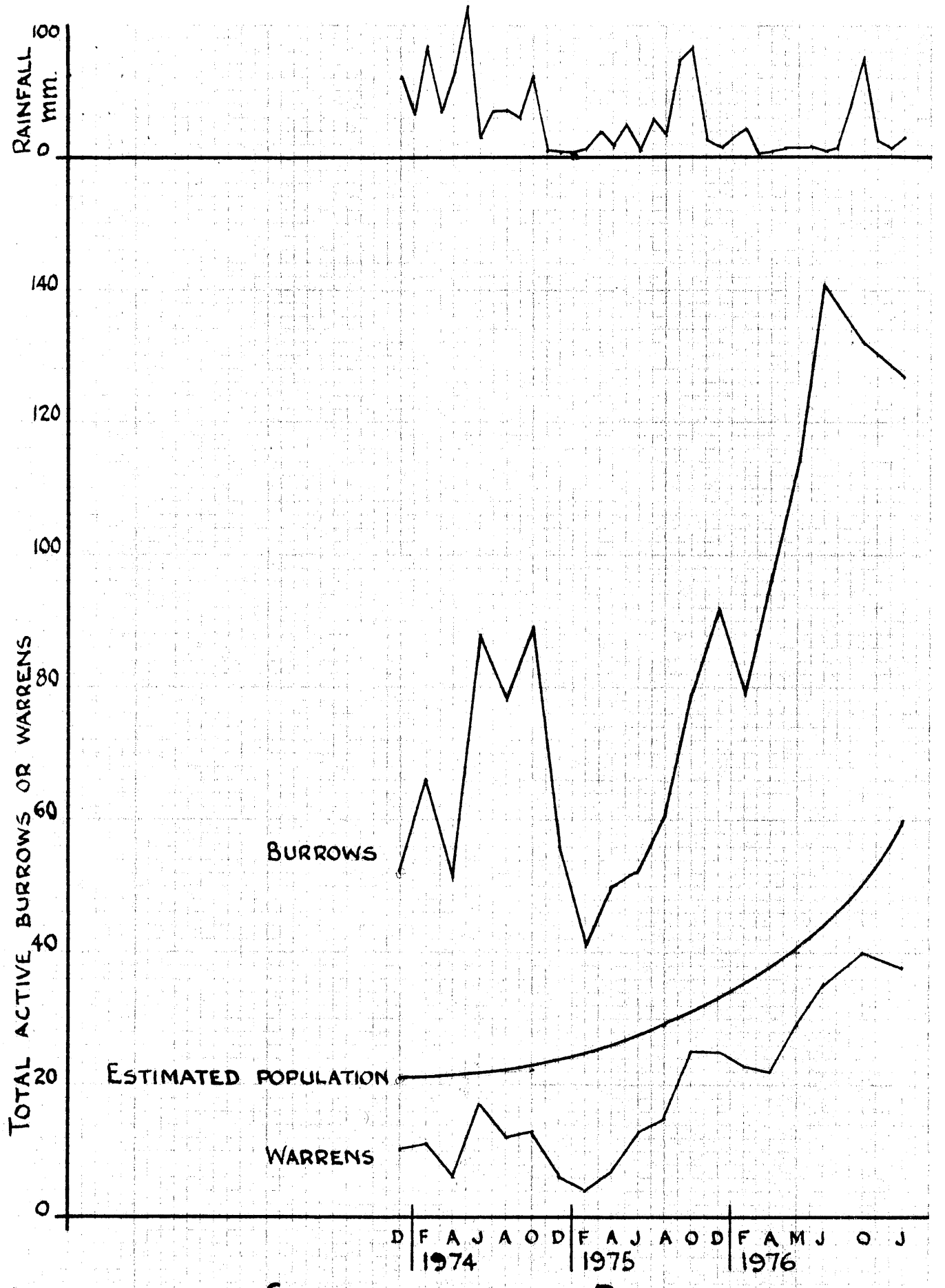


FIG. 23 STUDY AREA No. 2

Study Area. (See Figs. 22 and 23.).

When estimates of population in other parts of the Reserve are to be made, a second, more accurate B4/P is calculated from the smoothed population graph and this is shown on the graph Fig. 20.

It is of interest to note that in Study Area No. 1 which consists of Mallee shrub and grassland, the population made modest gains from 1971 to 1975 and appears to have levelled off at about 50 wombats in 1976, whilst in Study Area No. 2 which is shrub and grassland, the population appears to have doubled in the period 1974-1976. It appears that this substantial gain is the result of migration of some wombats from areas like Study Area No.1 to the better pasture available in the type of country represented by Study Area No. 2.

Although detailed study of migration does not come within the scope of this project, the activity recorder results indicate that migration from warren to warren does occur and the results of the general inspections demonstrate that distribution of the population is affected by annual rainfall.

The manner by which the migration develops is suggested by casual observations in the Study Areas. Observations suggest that each warren represents an element in a coherent social system rather than merely a family of wombats living in isolation. Pads radiate from each warren to adjoining ones and to nearby pasture which may be shared by the inhabitants of several warrens. The result is a network of trails interconnecting the warrens over extensive areas and is not unlike the organisation of human population into towns and cities connected by their road systems.

Thus opportunity is provided for neighbouring wombats to socialise and at times change residence.

It is fascinating to see how precisely the wombats follow their trails. A well-used pad consists of two distinct parallel ruts, one worn by the left feet and one by the right (Fig. 24).

The trails are generally punctuated by rubbing posts where the wombats pause to have a good scratch (Fig. 25).

During years of vigorous grass growth the wombats tend to forage mainly in the precincts of the home warren and the trails are infrequently used. However, during

FIG. 24. A wombat trail leading to pasture areas.

FIG. 25. A fallen tree with convenient projections serves as a rubbing post for wombats.

Summer and in dry years, as the nearer pastures become depleted, the wombats are forced to range even wider to obtain adequate food. It is during this time that the trails become well developed, constantly extending to reach more distant pastures.

It appears that there comes a time when some of the wombats realise the advantage of taking up residence in warrens closer to the food source and thus migrate in the direction of the grassland.

When conditions improve many wombats return to the Mallee, suggesting that they favour these areas when sufficient food is available.

GENERAL INSPECTION

Every two years a general inspection of all warrens in the Reserve is undertaken and similar data to that recorded in the Study Areas is also recorded for each of the more than 2000 burrows in the Reserve.

Observations are now on record for 1970, 1972, 1974 and 1976 and the numbers of active burrows (i.e. those designated by Code Nos 5 - 10) are plotted on the graph. (Fig. 26).

The graph illustrates that seasonal fluctuations have a pronounced effect on the distribution of the wombats in the Reserve (see rainfall graphs Appendices 2 and 3).

It indicates that in years of high rainfall and bountiful food supply, substantial populations of wombats can be maintained in the sparsely scattered warrens in the Mallee areas.

However, in dry years a considerable proportion of the wombats migrate to the areas of grassland where conditions are more favourable. This is evident in the graph where it can be seen that in 1972, a particularly dry year, activity in the Mallee areas was low, but in the grasslands the activity was correspondingly higher.

In 1973 and 1974 when exceptionally high rainfall brought an almost unbelievable growth of grass (Fig. 27) throughout the Reserve, the distribution can be seen to have become much more uniform with many wombats returning from the grassland to the Mallee.

In 1976, the second of two consecutive dry years, the migration from the Mallee to the grassland is again

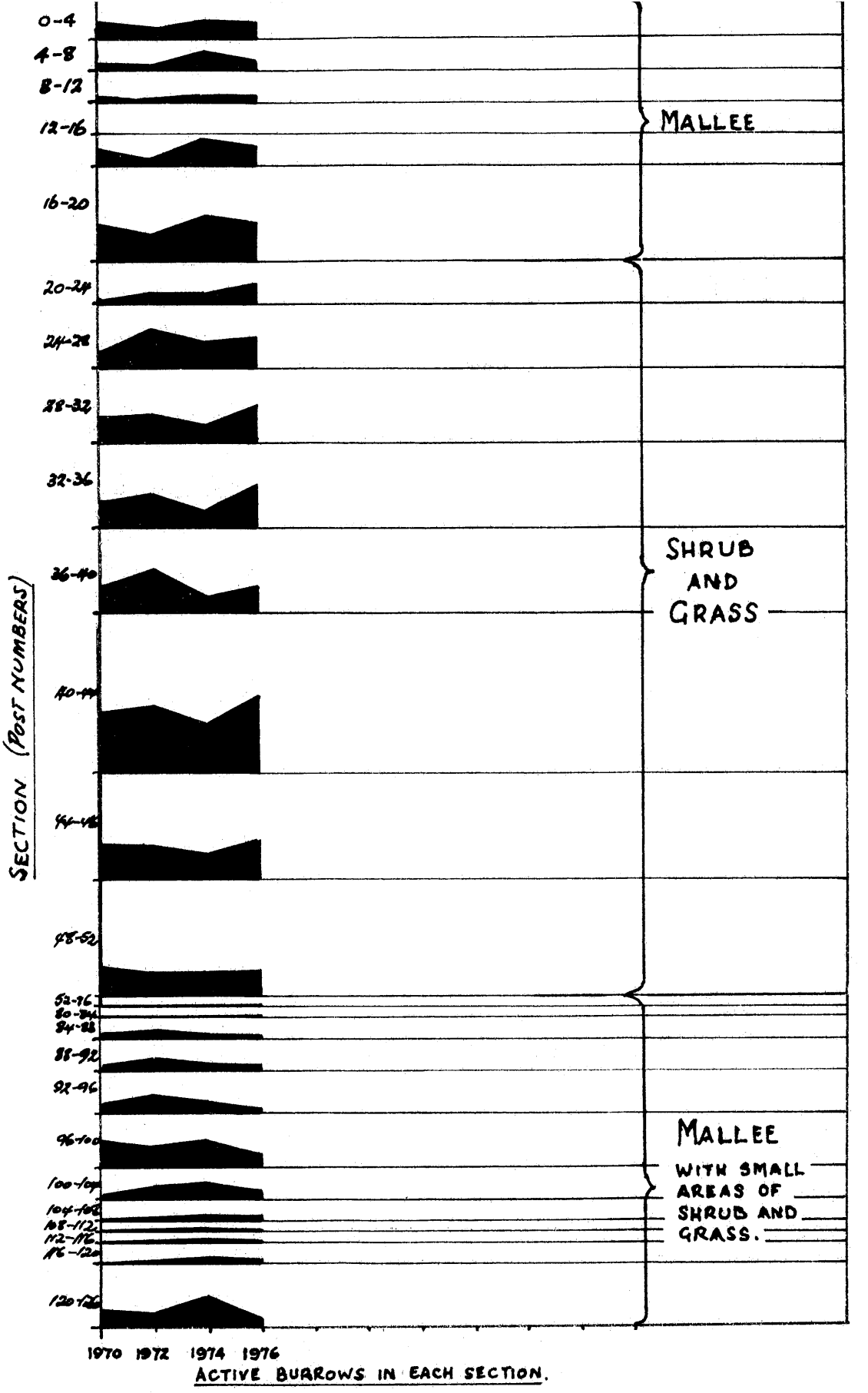


FIG. 26. Graph showing changes in activity patterns in the Reserve as a whole observed during the four inspections in the years 1970-1976.

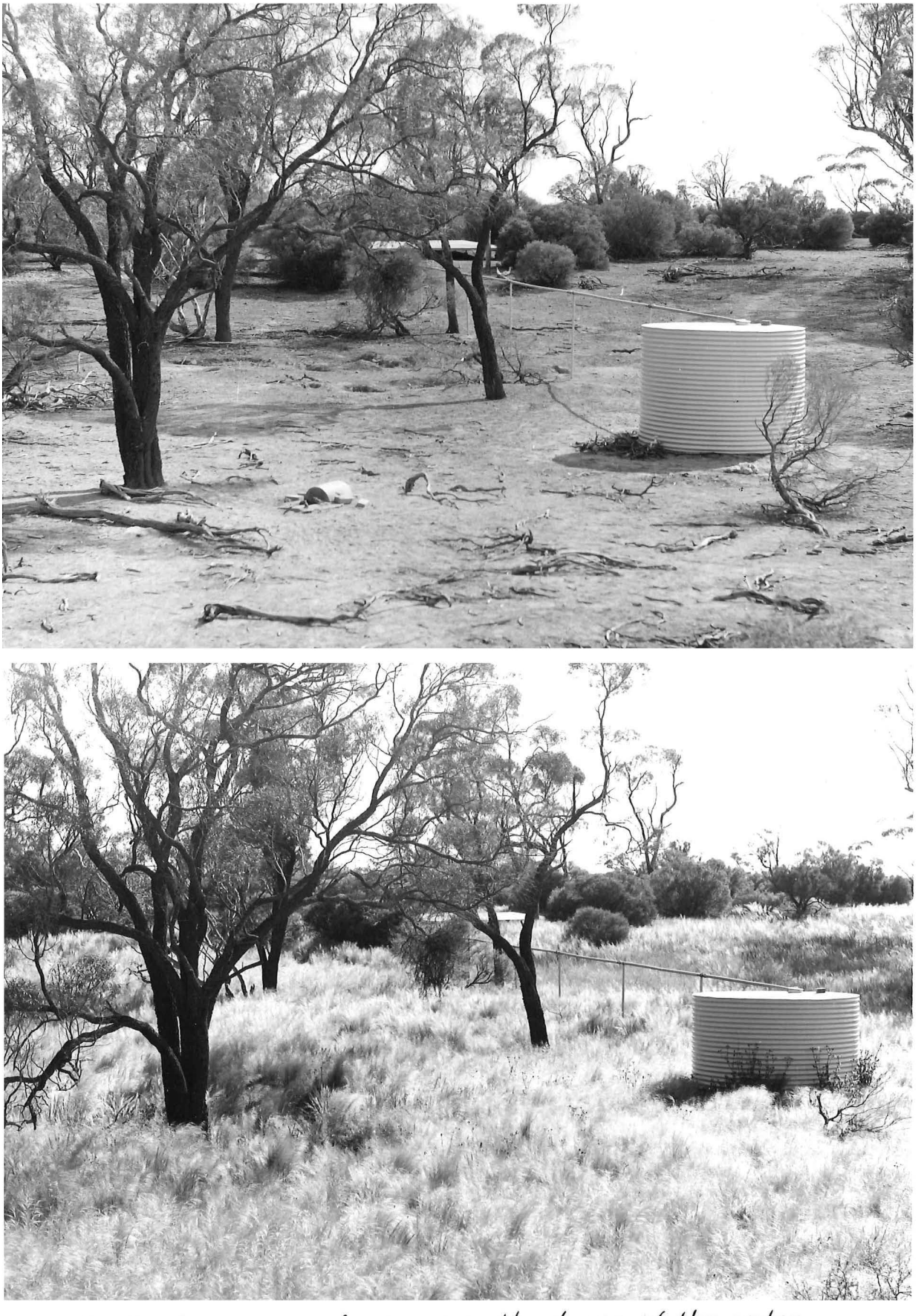


FIG. 27 Comparison of grass growth at one of the water points in 1972 (upper) and in 1974 (lower).

apparent resulting in 32% loss in the Mallee and a gain of 36% in the grasslands.

This trend is confirmed by reference to graph Fig. 23 showing the pronounced population rise in Study Area No.2 located in the grassland.

The original aim of this Study project was to estimate the overall wombat population in the Reserve and to observe trends over a period of time. The foregoing research conducted over a period of six years has enabled what is believed to be a reasonable estimate. No pretence is made that the resulting figures are absolutely precise, but are considered sufficiently reliable to assess the trends in population since the study began in 1970.

The method of estimation has been described on page No. 13 and a summary of the calculations appears as Appendix 1.

The estimated populations at the four general inspections are :-

1970	-	290 wombats	
1972	-	310 wombats	(7% increase)
1974	-	350 wombats	(13% increase)
1976	-	370 wombats	(6% increase)

There has therefore been a modest but continuing increase in population, the higher increments occurring understandably in the years of higher rainfall and therefore greater food availability.

It is of interest to note that a population increase occurred even in 1972, a year of rainfall only marginally above the record low of 1967 when the area which has since become Moorunde Wildlife Reserve was devastated by drought that killed a great number of wombats.

It is also noteworthy that all wombats sighted within the Reserve have appeared healthy and in good condition, whereas in recent dry years wombats have been seen in poor or distressed condition in adjacent areas where they live in competition with sheep.

It is apparent that at this stage the Reserve still has adequate capacity to sustain at least the present population even in poor years.

SUMMARY

It is felt that the objective of the population study, i.e. to estimate population and establish trends has been achieved with reasonable accuracy. Whilst the population estimate cannot be regarded as an accurate census, it is considered that the estimating methods evolved from precise recording of activity with continuously operating instruments in a small sample area, combined with regular inspections of larger study areas, are valid in assessing trends.

The Study has demonstrated that very little can be taken for granted and the process of collecting basic reliable data has provided a tremendous amount of information that was not envisaged when the study began.

The activity recorder in particular is providing a wealth of data on the habits of the wombats, their changes in feeding patterns with seasonal changes, their reaction to rainfall and many other fascinating features of their lifestyle unobtainable by any other means.

The study, in the period of six years, has encompassed extremes of climate ranging from very dry (124 mm in 1972) to the wettest ever recorded for the area (579 mm in 1973), as well as several more or less average years. See rainfall graphs Appendices 2 and 3.

The fact that population has continually increased even in adverse years indicates that the full carrying capacity of the Reserve has not yet been reached. When it has, it must be expected that the population will fluctuate depending on the benevolence of the seasons.

The study confirms that the action taken by the Natural History Society to exclude sheep from the Reserve has allowed natural regeneration of the area, thus providing conditions favourable to the recovery of the wombat population.

It is obvious too, that in the process, other wildlife, birds as well as animals have benefitted from the generally improved conditions.

Other side benefits have accrued from the author's becoming generally familiar with the Reserve during the many inspections involved in the study. For example, when it was seen that exotic Stemless Thistles and Horehound were choking many warrens, a well informed

Management Committee was able to initiate a weed control programme that used the limited available resources to maximum effect.

The study, though limited in its scope to aspects relevant to the estimation of population of the Hairy-nosed Wombats in Moorunde Wildlife Reserve, has been very satisfying in many ways to the author and the knowledge derived from it has been well worth the effort.

It is felt that the trend of results justifies the decision to continue the study along its present lines so that up to date information will be available to the Management Committee when policy decisions are to be made.

APPENDIX 1

DETERMINATION OF POPULATION

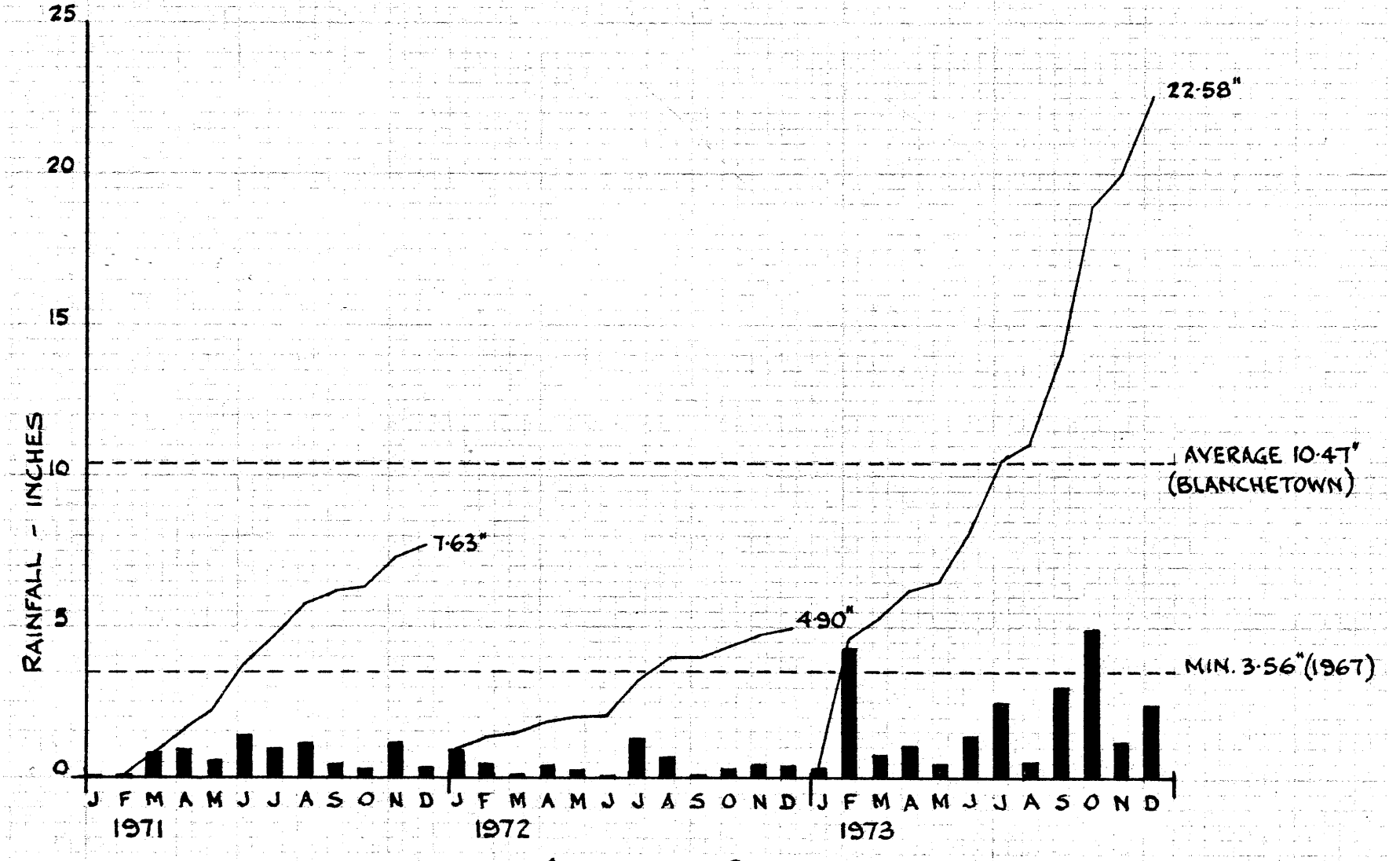
1. From analysis of activity charts determine :-
   (a) B4 for each month, i.e. the average number of burrows which have been used in the previous four nights.
   (b) Average population (P) for each month.
2. Calculate B4/P.
3. Analyse data from Study Areas to determine B4, i.e. activity designated by code numbers 5 - 10.
4. Using B4/P from 2 above, estimate populations at the Study Areas.
5. Plot the population on a graph and smooth out the curve on the assumption that changes in population will be gradual.
6. From the smoothed graph, calculate a second approximation of B4/P for each month.
7. Apply this figure to the observations during the general inspection to obtain estimated population.

Date of Inspection	Warren Nos Inspected	Active Burrows	$\frac{B4}{P}$	Estimated Population
Aug. 1970	1 - 67	168	3.0	56
Oct. 1970	79 - 137) 316 - 322)	134	3.0	45
Dec. 1970	140 - 242	270	2.2	123
Jan. 1971	243 - 280	88	2.0	44
Feb. 1971	281 - 315	50	2.0	25
1970 TOTAL ESTIMATED POPULATION				293
				Say 290

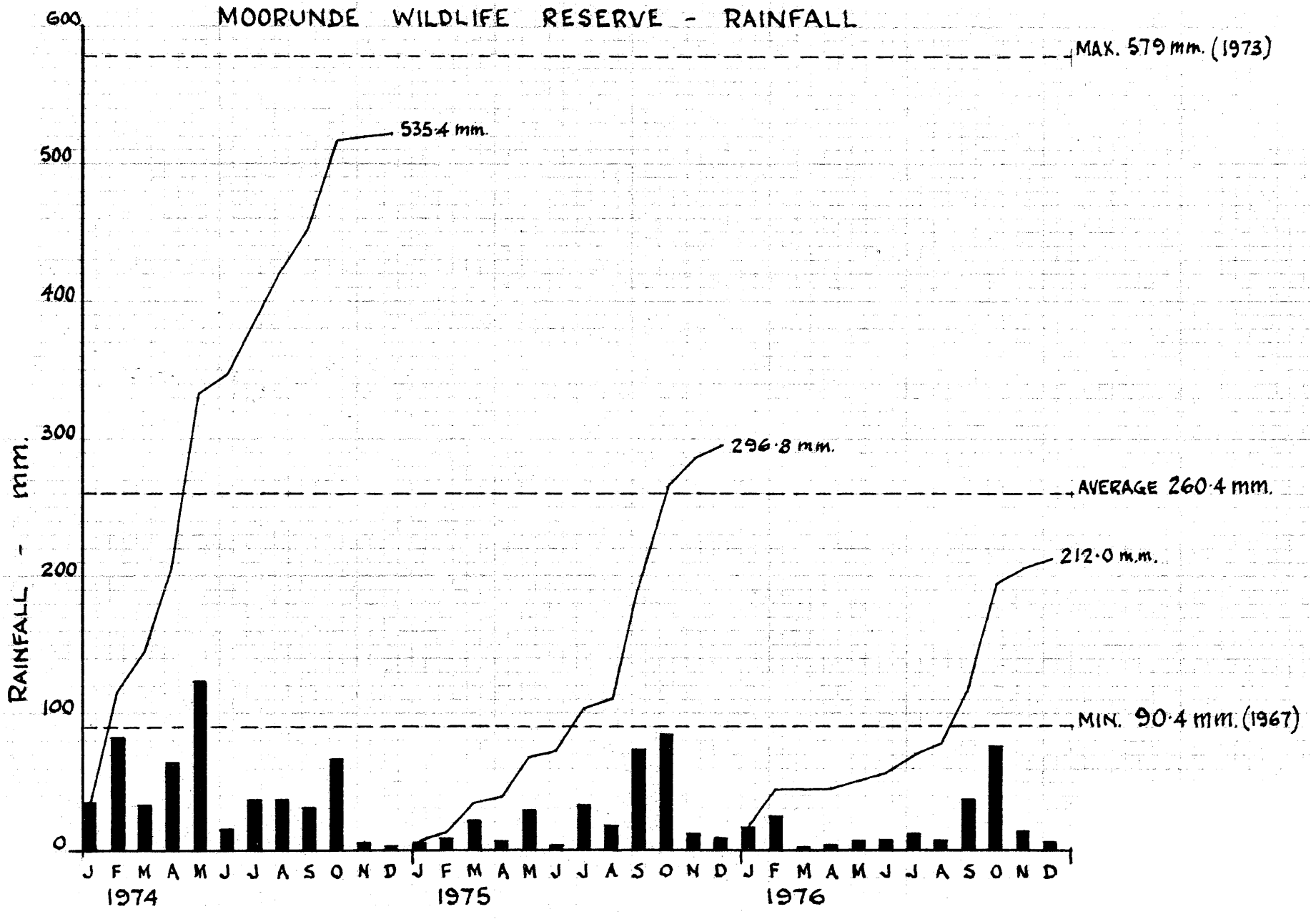
Date of Inspection	Warren Nos Inspected	Active Burrows	B4/P	Estimated Population
Aug. 1972 to Nov. 1972	1 - 241, 316 - 360	617	3.0	206
March 1973 to April 1973	242 - 305, 361 - 375 377, 378, 380, 382	182	2.0	91
May, 1973	306 - 315, 376, 379, 381	17	2.5	7
Aug. 1973	383	2	3.0	1
Sept. 1973	384 - 389	12	2.5	5
1972	TOTAL ESTIMATED POPULATION			310
Sept. 1974 to Dec. 1974	1 -121, 383, 388 - 389, 393	344	2.5	137
Jan. 1975	384, 385, 320 - 328, 122 - 180, 193 - 201	137	1.8	68
March 1975	202 - 205, 222 - 236, 238 - 240, 333, 359 343 - 353	48	2.0	24
May, 1975	181 - 192, 206 - 221, 237, 241 -245 249, 253-262 329 - 332, 334 - 342, 354 - 358, 361 - 371, 387	79	2.1	37
June 1975	246 - 248, 250 - 252, 264 - 319, 372 - 382	187	2.1	89
				355
1974	TOTAL ESTIMATED POPULATION			Say 350

Date of Inspection	Warren Nos Inspected	Active Burrows	$\frac{B4}{P}$	Estimated Population
Nov. 1976	1 - 105, 383, 388, 389, 394 - 397	339	2.8	121
Jan. 1977	Remainder	524	2.1	250
				371
1976	TOTAL ESTIMATED POPULATION			Say 370

MOORUNDE WILDLIFE RESERVE - RAINFALL



APPENDIX 2


MOORUNDE WILDLIFE RESERVE - RAINFALL
MAX. 579 mm. (1973)
535·4 mm.
296·8 mm.
AVERAGE 260·4 mm.
212·0 m.m.
MIN. 90·4 mm. (1967)
RAINFALL - mm.
600
500
400
300
200
100
0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1974
1975
1976

APPENDIX 3

Appendix 4

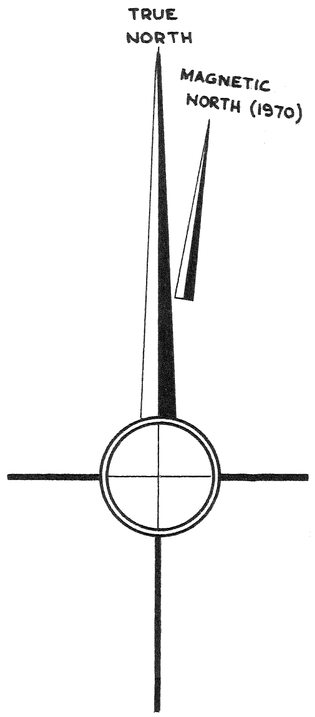
MOORUNDE WILDLIFE RESERVE

DISTRIBUTION OF WOMBAT WARRENS

COUNTY EYRE

HUNDRED OF SKURRAY - SECTIONS 162, 163 AND 164

AREA 5,000 ACRES
2020 HECTARES



1970 MAGNETIC DECLINATION IS 8°-00'
MEAN ANNUAL CHANGE 3' EASTERLY

LEGEND

WOMBAT WARREN
LARGE 15
SMALL 12

MALLEE SCRUB

GRID SPACING
Nos. 1-126 ON RAIL FENCE POSTS - APPROX. 103 YDS. (95 METRES)
DECIMAL FIGURES - " 0·1 MILES (160 ")

COMPILED IN 1970 BY G.K. TAYLOR
REVISIONS
1 MAY 1973 - WARRENS NUMBERED AND ACCURACY OF LOCATION IMPROVED.
METRIC EQUIVALENTS ADDED.

SCALE 4" = 1 MILE

0 ·1 ·2 ·3 ·4 ·5 ·6 ·7 ·8 ·9 1

1 ·9 ·8 ·7 ·6 ·5 ·4 ·3 ·2 ·1 0 1 km.