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DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY, BUREAU OF RURAL RESOURCES

WILDLIFE AND EXOTIC DISEASE PREPAREDNESS PROGRAM - 1990/91

Title

FOX CONTROL: DETERMINATION OF DENSITY AND DISPERSAL, A PREREQUISITE FOR DISEASE CONTROL

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[The following report is divided into sections as defined in the Principal Agreement.]

STATEMENT OF RESEARCH OBJECTIVES

The major aim of the Fox Research Programme is to develop an effective and economic fox control strategy, using 1080 meat baits, in areas of conservation priority. The key objective of fox control strategies is the reduction of fox numbers, given that predation pressure in the majority of cases, is functionally related to fox abundance. It is therefore essential to be able to measure fox density as this will determine the level of baiting intensity required. Knowledge of fox dispersal is the other key to successful fox control management. Factors involved in fox dispersal will govern the frequency and timing of baiting programs.

1. FOX DISPERSAL IN A NON-BAITED POPULATION

Knowledge of various aspects of fox dispersal is a key factor to optimising control strategies. Patterns of fox dispersal will determine the timing and frequency of baiting programmes and the extent of buffer zones required. Dispersal data will also be invaluable in modelling fox population dynamics. The aim of this study is to collect dispersal data relevant to the above considerations.

The fox has been studied extensively in Europe and North America essentially because of its role as a vector of rabies. Data relating to fox dispersal have usually relied on returns of tagged animals killed on roads or collected by hunters during the fur season (Phillips *et al.* 1972; Page 1981; Trewhella *et al.* 1988). The only study examining fox dispersal in Australia was conducted by Coman *et al.* (in press) who also used tagged returns to collect data.

There are several major problems associated with the use of tagged returns which are likely to introduce a significant bias in interpretation of the dispersal data. The data do not show whether individual animals have completed their dispersal activity when they are retrieved and therefore dispersal distances may be underestimated. Also the percentage of tagged foxes retrieved is generally low and may not reflect the actual pattern of dispersal.

It was decided not to employ tagged returns in this study for the above reasons and the likelihood of very low retrieval of tagged foxes. In the areas proposed for study there is generally limited hunting and minimum public traffic, thus recovery of tags would be limited. To achieve the objectives of this research proposal, radio tracking techniques will be employed. The radio collared animals

will provide information on various aspects of dispersal relevant to control strategies:

- natural mortality of residents and juveniles,
- litter size,
- the timing, direction and distances covered by dispersing foxes,
- age structure of the dispersing population.

To study dispersal fox cubs will be captured and radio-collared. Prior to dispersal their movements and activity patterns will be recorded monthly over 5 day periods. During the dispersal phase, animals will be located twice monthly. The direction and distance travelled will be measured and any mortality determined and recorded. At the completion of dispersal animals will be killed to enable retrieval of collars for subsequent studies.

Namming Nature Reserve (Northern Sandplain) has been selected as the initial study site. The reserve is approximately 150km north of Perth and provides a large area with good access in which to conduct the research. Our initial attempts to procede with the study during December 1990 were thawted by a bushfire through the study site and an injury to the Principal Investigator. As a result state funds were used to supplement the BRR grant to allow the study to proceed in 1991.

Fox cubs are now of a suitable size for capture and radio-collaring. The initial field objective is to trap one or two individuals from each litter. Expandable radio-collars will be fitted to the cubs which will allow us to locate the den sites. The dens will then be excavated to allow capture of all foxes as soon as the animals are large enough to be collared with adult collars. Trapping is currently being conducted, and to-date 8 active dens are being monitored.

Additional animals are likely to be collected in the next two weeks of field work and it is anticipated that a sample size of 30 cubs will be monitored during this first dispersal study.

Progress of this study will be forwarded in a subsequent report.

2. DISPERSAL INTO A CONTROL BAITED AREA

2.1 Examination of Dispersal at 6 Monthly Intervals

Fox re-invasion into Watheroo National Park was conducted as part of a broader investigation examining fox density and aspects of dispersal. Watheroo National Park is situated approximately 200km north-east of Perth, Western Australia.

Fox control was initiated in Watheroo National Park during April 1989. Cyanide bait stations were used to sample the fox population. The index generated by cyanide bait stations (CPUE), described by the number of foxes killed per 100 bait stations, was found to measure relative changes in fox density (see previous reports and Algar and Kinnear in press). A cyanide baiting campaign was conducted on 3 transects in the north-western area of the Park to determine a CPUE index before the implementation of control. The CPUE index recorded was 11.4 $\pm$ 1.9 (mean $\pm$ s.e.). The entire Park was then aerially baited with 1080 meat baits at 6 baits/km^2. This baiting programme resulted in a 91% mortality of the resident radio-collared foxes.

These results indicated that a baiting intensity of 6 baits/km^2 would significantly reduce fox numbers present. If this baiting regime was used following a cyanide baiting exercise it would be reasonable to assume that the majority

of foxes collected in subsequent exercises were animals that had migrated into the area. Thus, repeating the transects used to calculate the CPUE index would provide information on dispersal into a control-baited area and the density of animals involved.

Cyanide baiting programmes were conducted every 6 months and followed by laying 1080 baits. CPUE indices of 3.1 ± 0.8 and 3.6 ± 1.0 were recorded for September 1989 and February 1990 respectively (see previous reports).

Cyanide baiting of the standard transects was again repeated in September 1990. The CPUE index for this trial was 1.8 ± 0.3 (mean ± s.e.). Analysis of the age structure of the population indicated that all foxes collected were one year of age.

2.2 The Timing and Extent of Fox Recruitment Into a Baited Area

Examination of the age structures of the foxes re-invading the baited area indicated that dispersal activity was primarily undertaken by juveniles. Juvenile foxes appear sufficiently mobile and independent to disperse from their natal ranges from January onwards. These animals would need to establish their home range pattern of activity prior to the onset of breeding (June/July). As a result, a research programme was designed to examine when recruitment occurs and the degree of recruitment at specific points in time.

As part of the cyanide baiting exercise conducted in September 1990 all tracks and firebreaks within a 100km^2 study area were baited with cyanide capsules, a follow-up 1080 baitng exercise was then conducted. 1080 meat baits were ground laid at 100m intervals to remove any remaining

resident foxes from the area. All baits not taken after 10 days were removed from the study area.

Non-toxic, tetracycline labelled meat baits were used to determine the timing and extent of migration into the study area. Tetracycline is incorporated into canine dentine at the time of uptake and appears as a yellow flourescent ring (Johnston *et al* 1989). Tetracycline labels are located within the Von Ebner lines in chronological order, it is therefore possible to assign foxes to a particular re-invasion period if labelled baits are laid at specific intervals over time. The major benefit of using a tetracycline label lies in the ability to examine migration into an area without disturbing or destroying the population during the period of study. Thus, recruitment will occur at a normal rate without being otherwise affected if animals are removed and vacated niches are created.

It was decided to examine the degree of re-invasion into the control area over three time intervals, shown in Table 1. Tetracycline baits were laid at the beginning of February and April. Foxes consuming these baits could then be assigned to a particular recruitment period based on the number and location of fluorescent rings in the dentine, as indicated.

Table 1

Period 1	January - February	2 tetracycline labels
Period 2	February - April	1 tetracycline labels
Period 3	April - June	0 tetracycline labels

A capsule containing 150mg of tetracycline-HCl was inserted into each meat bait. 120g, non-toxic meat baits, dried to 40 percent of their original weight, were used. The labelled baits were placed at 100m intervals along all tracks and firebreaks within the study area. This level of baiting intensity was used to try to ensure all foxes within the area would consume a labelled bait. The baits were left in place for four days and any baits not consumed were retrieved to avoid any confounding of recruitment period.

Examination of fox density, recruitment period and fox age classes involved was conducted at the beginning of June 1991. Cyanide baiting procedures were employed to collect foxes. Cyanide capsules were placed at 200m intervals along the network of tracks within the study site. A total of 32 foxes and 4 cats was collected over the three day period. The locations of these kills are shown in Fig. 1. The number of foxes collected, and the CPUE indices for each of six transects are given in Table 2.

Table No. 2

Transect No.	No. Foxes Killed	CPUE Index
1	2	0.8
2	11	7.2
3	2	1.3
4	9	6.4
5	7	4.0
6	1	0.6

The male/female ratio of foxes collected did not differ significantly from unity (16 males to 16 females). The

ratio of fox kills collected on the two different lures also did not differ significantly from unity (17 kills on liver-blood paste to 15 kills on condensed milk). In contrast, all cat kills resulted from the liver-blood paste lure.

Presence or absence of tracks at each bait station were recorded for each bait station along the respective transects and are presented in Fig. 2. The data once again highlight the inability of track counts to reflect fox numbers. As foxes were removed from the area remaining animals tended to increase activity along the tracks. However, by assessing areas of activity and the extent of this activity it is possible to deduce numbers of animals not removed by the cyanide baiting exercise. In total a maximum of four foxes remained alive at the end of the baiting exercise. These data indicate that cyanide baiting removed @ 90% of foxes from an area where fox density approximated 0.33 foxes per km^2.

Examination of tetracycline labels in the population has yet to be completed. We are awaiting delivery of a double-bladed isomet saw to complete the analyses. The single-bladed isomet saw used in Section 3 was no longer available. Analysis of the population age structure cannot be conducted prior to biomarker examination as the technique destroys tetracycline labels. Results of these analyses will be presented in a subsequent report.

3. MEASUREMENT OF THE EFFECTIVENESS OF DIFFERENT BAITING REGIMES

Comparison of the effectiveness of different baiting regimes (i.e. number of baits laid per km^2) is evaluated on the basis of the percentage kill of that population.
Availability of baits to any individual will depend on the

number of foxes in that area. Testing the effectiveness of different baiting regimes is dependent on knowledge of fox density for each area examined, density cannot be assumed to be the same.

Cyanide bait stations, along standard transects, are used to generate an index to fox abundance. The index, CPUE (Catch Per Unit Effort), is a measure of the number of foxes killed per 100 bait stations. To date we have shown that there is a functional relationship between CPUE and relative changes in fox density. Therefore, it is possible to use this index to ascertain whether fox densities in different areas are comparable. We have, as yet, not calibrated the index against absolute fox density for a given area and therefore are unable to provide actual density values for these study sites.

The bone labelling biomarker (tetracycline) provides a simple technique for examination of the effectiveness of baiting regimes. Tetracycline is incorporated into tooth tissue when consumed (see Section 2). Tetracycline was incorporated in non-toxic meat baits, success of a baiting programme was then judged by the proportion of the population labelled.

The experimental design for this study involved three different baiting intensities. Three sites within Watheroo, National Park, separated by a buffer of at least 6km, were aerially baited at the beginning of September 1990. A specific baiting intensity of either 3, 6 or 12 baits/ km^2 was used at each site. Cyanide baiting procedures were then used on a series of transects, within each study area, to sample the fox population and determine the percentage of the population labelled.

CPUE values for the three sites did not differ significantly and therefore it can be assumed that fox densities for the areas were comparable. The CPUE values for each site are listed in Table 3. Tooth material from the collected foxes was examined for the tetracycline label, using a single-bladed, isomet saw. The number of foxes collected at each site and the percentage of the sample population labelled are also presented in Table 3.

Table 3.

Area	Bait intensity (No. baits/km²)	CPUE	No. foxes	Fox labels (%)
Site 1	12	2.0 ± 0.5	11	73
Site 2	6	1.6 ± 0.5	10	70
Site 3	3	1.9 ± 1.2	5	100

Results of this trial show a certain ambiguity especially for site 3. At this site a low baiting intensity resulted in a higher proportion of the population being labelled in comparison to the other sites. The major problem with the trial was a low sample size available for analysis. With such a small sample size biases are introduced into the results and conclusions are inappropriate.

A number of further baiting trials are planned in which sample size will be optimised. These trials will be conducted for varying fox densities and in different geographic regions. Thus eventually it will be possible to prescribe an optimal baiting intensity for different fox densities, taking into account regional differences, for effective fox control.

Fig. 1 Fox Kill Locations

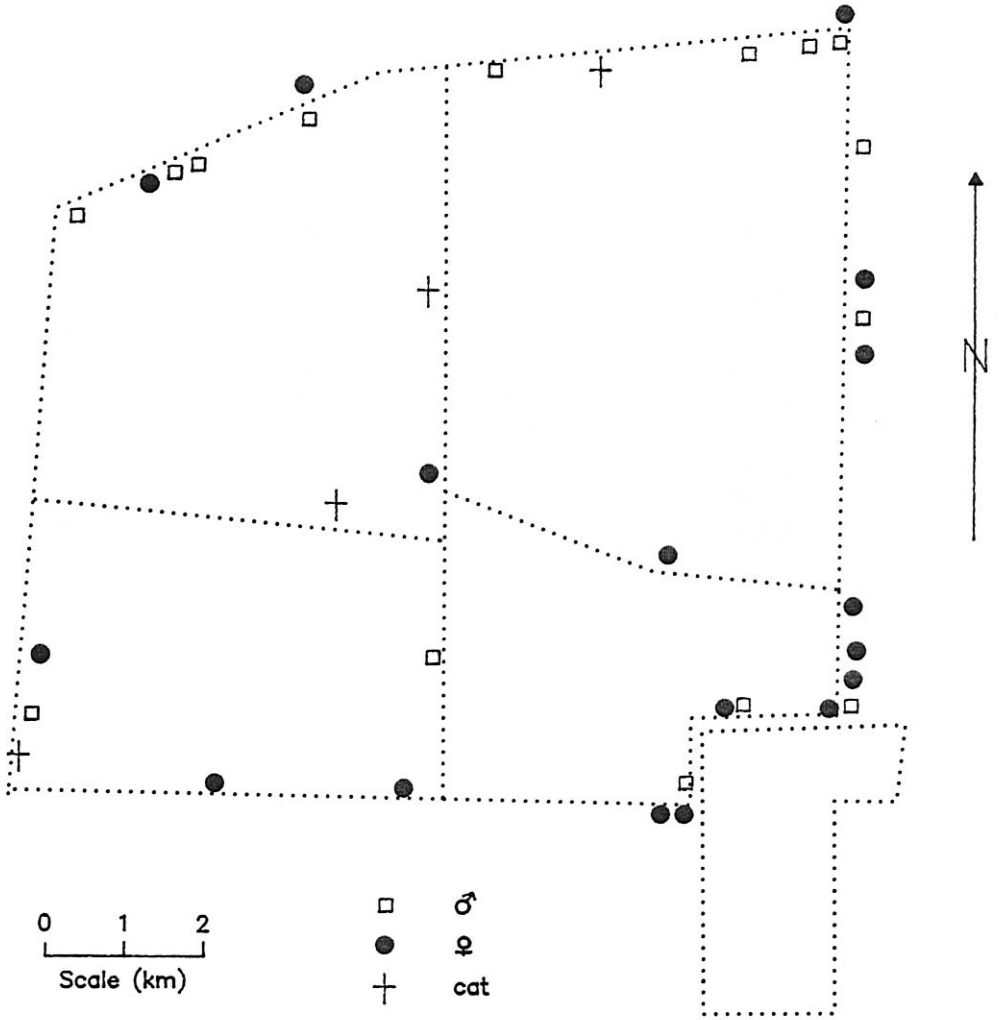
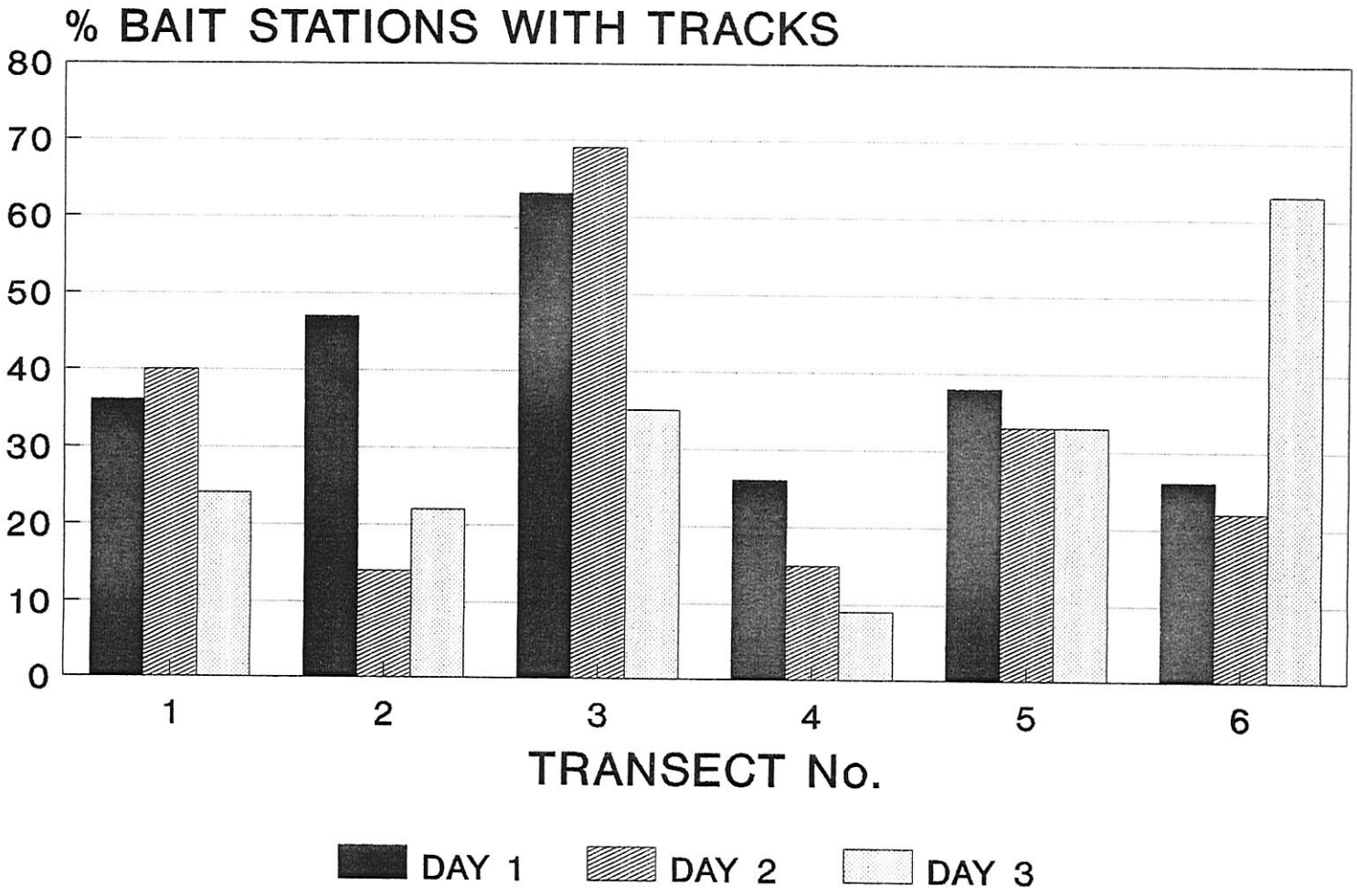


Fig. 2 Track Counts



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