file: NP 90/18
ESP Project Number: 38

DRAFT

Endangered Species Program 1989/90 Project Specification

for a project involving the

Australian National Parks and Wildlife Service

and the

Western Australian Department of Conservation & Land Management

entitled

Fox control in Western Australia

1. Scope.

- Assess the level of recruitment by foxes into a previously baited area (approximately 6 months previously).

- Complete the investigation of ageing techniques for foxes based upon cranial and dentition examinations.

- Estimate the density of foxes in the Gibson Desert at a site where it is proposed to re-introduce two marsupial species (dependent upon availability of CALM funding).

- Carry out a census of the rock-wallaby populations in areas where fox control measures have been in place for eight years.

- Initiate joint studies with Curtin University and the APB (WA Dept of Agriculture) with regard to the factors affecting the potency of 1080 baits during bait preparation, storage and post application.

2. Reporting Requirements.

- Provide the ANPWS Project Officer within sixty (60) days of the commencement of the project a detailed budget and schedule of work to be performed including indicative starting and finishing dates for the components of the work.

- Provide at the completion date of the project a precis of not more than two hundred and fifty (250) words summarising the significance and limitations of the study findings for the conservation of the threatened species or habitats covered by the scope of the project.

- The Western Australian Department of Conservation & Land Management Chief Investigator or the Project Officer shall prepare and provide to the Director of the ANPWS a detailed written report on all aspects of the project, including the implications for the survival of endangered species, by 15 June 1990, or by such other date as may be subsequently agreed by the ANPWS and the Western Australian Department of Conservation & Land Management.

3. Nominated Officers.

Western Australian Department of Conservation & Land Management

Project Manager: to be advised

Project Officer: to be advised

Chief Investigator: Dr Jack Kinnear ph 09 405 5137

ANPWS

Project Officer: Dr Barry Reville 062 46 6314

4. Agency Inputs and Committments.

ANPWS - $78 575; technical advice.

Payment Schedule

Initial Payment	Feb 1990	$70 575
Final Payment	Jun 1990	$ 8 000

Western Australian Department of Conservation & Land Management - Project supervision, administration, staff, equipment.

5. Completion and Acquittance.

The project shall be completed by 15 June 1990 and the funds expended shall be acquitted by 15 July 1990. Refer to General Conditions (sent with letter of offer) for details of requirements at the end of the financial year.

6. Capital Equipment.

The items of capital equipment listed below are to be returned to the ANPWS at the completion of the project.

NIL

ENDANGERED SPECIES PROGRAM: FOX ECOLOGY AND FOX CONTROL PROJECT

SUBJECT: Initial Report for the Period Jan-June, 1990.
Chief Investigator: Dr. J.E. Kinnear
Consultant: Dr. D. Algar.

[The following report is presented in accordance with the scope of the project as previously submitted.]

1. Assessment of the level of recruitment by foxes into an area previously baited six months ago.

Watheroo National Park was aerially baited with 1080 meat baits at an intensity of 6 baits/km^2 during September 1989. Previous baiting programs resulted in a 90% kill of resident foxes. The CPUE index (an effort based index) was used in February/March 1990 to examine the extent of dispersal into the park following this baiting. Seven transects in total were baited with cyanide capsules, the CPUE (mean $\pm$ s.e.) was 3.4 $\pm$ 1.0. These data indicate a considerably lower fox density compared to the original unbaited population of a year ago (see Fig. 1 for CPUE values).

Sex ratio

A total of 26 foxes was collected along the CPUE cyanide transects during the February/March baiting exercise. The sex ratio of these foxes did not differ significantly from unity.

Age structure

Analysis of the age structure of the fox population is still incomplete. A detailed examination of fox aging criteria is presented in the second section of this report.

Dispersal

CPUE data indicate that some dispersal of foxes into the previously baited area, had occurred by late February. However, the timing and extent of fox dispersal cannot be gauged from these data. A further study using tetracycline, a hard tissue marker, is planned to measure rates of dispersal over time.

2. Combined skull and tooth analyses-- a technique for aging foxes.

Results of age determinations based solely on skull suture closure have been inconsistent and ambiguous. Currently we are evaluating the use of canine annular rings (Linhart & Knowlton 1967; Monson et al., 1973; Grue & Jensen 1979; Goodwin & Ballard 1985) in an effort to relate canine pulp cavity closure and ratios (Simon & Frydendall 1980; Jenks et al., 1984; Tumlison & McDaniel 1984; Coman 1988) to age.

Using fox canine transverse sections and improvements in micro-histological techniques, we have been able to recognize annular rings in tooth cementum. This makes it possible to assign individual animals to yearly age classes (see Fig.2; Watheroo population age structure for April 1989). Unfortunately aging foxes using this technique is a very time consuming process. Examination of pulp cavity ratios and closure is a much more rapid process and should help speed up the age determination process.

Examination of canine pulp cavities has indicated that root tip closure occurs at less than one year of age. Analysis of pulp cavity/tooth width ratio has shown a significant negative relationship to yearly age classes (based on

cementum annular rings). Pulp cavity ratios (mean ± s.e.) are plotted against yearly age classes in Figure 3. It must be emphasized however, that the number of individuals examined is small (n=66). Examination of all tooth samples from Watheroo is currently being undertaken; these results will further clarify the relationship between pulp cavity ratio and age classes. Results of these analyses will be forwarded in subsequent reports.

3. Estimation of the density of foxes in the Gibson Desert Nature Reserve (GDNR) at a site where it is proposed to re-introduce two marsupial species.

Preliminary investigation of the status of the fox in the GDNR commenced in May 1989. A further field study was conducted in May 1990 to assess fox density in the proposed re-introduction site. It is planned to use this information to develop a baiting regime for the protection of the species to be relocated. In total, 52km of cut-line track was cyanide baited to determine CPUE indices for the area. The general study area, relocation site and cyanide transects are shown in Figures 4 and 5 respectively.

Unfortunately, extremely heavy rainfall occurred during the field trip, seriously limiting the number of bait transect days available. Only four animals (2 dingoes and 2 foxes) were collected during this exercise; their kill locations are indicated in Figure 5. CPUE values are not presented because it was not possible to bait any transect for three consecutive days.

Evidence of activity along the tracks was also extremely low. Location of fox kills confirmed their preference for the sandy spinifex plains.

Fox and dingo scats were collected in the study area and stomachs were removed from the cyanide kills. Results of the analyses will be presented on completion.

4. Rock-Wallaby Census

In 1982, an experimental fox control programme was initiated in the Nangeen Hill area near Kellerberrin, W.A. and maintained for four years (Kinnear *et al.*, 1988). A census in 1986 revealed that rock-wallaby populations increased wherever the fox was controlled. Control populations (i.e., no fox effort made to control foxes) either declined or increased by relatively smaller amounts.

This experiment was maintained for an other four years. In Feb-Mar 1990, a census of all populations was again carried out. The results are illustrated in Fig. 6.

We may conclude from this census that those populations subject to fox control increased or maintained their numbers. Furthermore, those populations not given the benefit of fox control either crashed or showed no increases.

This work is currently in preparation for publication.

5. Bait Potency Research: A Joint Project with *Curtin University* and *CALM*

Fox control by baiting with 1080 represents a holding action until some form of biological control becomes available. It is necessary management procedure in order to protect endangered species at risk. It is important to make the baiting procedure as cost efficient and effective as possible, and to minimize the risk to non-target species and the environment.

A contract was negotiated and signed between *Curtin University* (Health Sciences, Microbiology) to carry out research on aspects relating to the baiting procedure (see attached enclosure for details).

This research has been in progress for only a short period at this writing. Experiments are currently in progress.

Micro-biological Assay

The micro-biological assay research on 1080 has yielded some encouraging results already. Sodium monofluoroacetate (1080) is notoriously difficult to analyze quantitatively in complex substances such as meat and other bait materials. It is therefore difficult to relate the amount of 1080 to actual bait potency except by feeding it to a target species. Some progress towards developing a microbiological assay for 1080 in baits have been achieved. A microbe (*Bacillus* sps.) was isolated from an aquatic habitat has proven to be sensitive to 1080. Work is continuing.

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MID-YEAR REPORT (DEC 1990) TO THE AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE

ESP PROJECT NUMBER 38 (file:700/3/9)

Project Title: Control and Ecology of the Red Fox *Vulpes vulpes* in Western Australia

Nominated Officer
Chief Investigator: Dr. Jack Kinnear Ph. (09) 405-5137
Department of Conservation and Land Management, Wildlife Research Centre, P.O. Box 51, Wanneroo, 6065.

Consultants: Dr. Dave Algar
Ms. Nicky Marlow

The items outlined in the Scope section are discussed in the order listed in the Project Specification.

Fox Control: Effectiveness of Different Baiting Intensities.

The optimal baiting level (i.e. number of baits laid per km^2) for large conservation areas such as National Parks is not known. The effectiveness of different baiting regimes is evaluated on the basis of the percentage kill of the targeted fox population. Testing the effectiveness of different baiting regimes is therefore dependent on knowledge of fox density

Cyanide bait stations, are used to generate an index of fox abundance along standard transects. 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 positive correlation between CPUE and changes in fox density.

The hard tissue labelling biomarker (tetracycline) is being used to assess the effectiveness of baiting regimes. Tetracycline is incorporated into teeth where it produces a fluorescence in labelled tissues under uv light.

Is CPUE indicating that actual densities were the same or that the different baiting regimes had a dif rate of kill?

The experimental design for this study involved aerially baiting (Sept. 90) three areas within Watheroo National Park, separated by a distance of at least 6km. Three levels (3, 6 or 12 baits/km²) of baits containing tetracycline were applied. Standard cyanide baiting procedures were used within each study area, to generate CPUE indices and to determine the percentage of the population labelled.

The CPUE values (mean ± s.e.) for each area are listed in Table 1. The values for the three areas did not differ significantly and therefore it can be assumed that fox densities were comparable. The number of foxes collected at each site, and the percentage of the sample population labelled with tetracycline, are also presented in Table 1.

i.e % that would take 1080 baits

Table 1

Area	Bait intensity	CPUE	No. Foxes	% labelled
Site 1	12/km²	2.0 ± 0.5	11	73
Site 2	6 /km²	1.6 ± 0.5	10	70
Site 3	3 /km²	1.9 ± 1.2	5	100

Anomalous results are apparent for site 3. The lowest baiting intensity resulted in a higher proportion of the fox population being labelled in comparison to the other sites.

The major problem with the trial was a low sample size obtained from site 3. In an effort to resolve the above anomaly, a number of baiting trials are planned in which the sample area will be increased.

Fox Dispersal Studies: Immigration into a Baited Area.

In Watheroo National Park, immigration was estimated from CPUE indices at six monthly intervals. Seven standard cyanide transects were used. Track

Therefore conclude that there was no significant difference in the effect of the different baiting regimes.

activity was recorded at each bait station during the cyanide exercise. By the end of the three day baiting period, track activity was either non-existent or negligible.

Following each cyanide baiting exercise, the entire area was aerially baited with 1080 meat baits laid at an intensity of 6 baits/km^2. The purpose of this 1080 baiting program was to remove any undetected resident foxes from the area. Thus, six months later, one can reasonably assume that any foxes collected by cyanide baiting would be immigrants.

The CPUE index for each study period (mean ± s.e.) are presented in Figure 1. Included within this figure are the CPUE values for the initial baiting exercise during April 1989. This previously undisturbed (i.e. non-baited) population was used to determine if there was a parallel change in the CPUE index following a known change in fox density. This proved to be the case; details of this experiment have been described in previous reports. It is apparent that the index has remained low–an indication that subsequent control efforts have been effective.

The April 1989 CPUE value (obtained from a unbaitied population) has a substantial juvenile component which would have inflated the CPUE index. These animals were born in the park and presumably the majority would have eventually dispersed in the absence of baiting. All subsequent trials would not have included this juvenile component because the timing of the baiting programs would have eliminated natal recruitment.

Removal of the juvenile component from the April 1989 data, results in a CPUE value (mean ± s.e) of 4.4 ± 0.5. Comparison of this CPUE value and the indices for subsequent baiting exercises indicates no significant difference, at the 5% level, except between data for April 1989 and September 1990. These results suggest that yearly immigration is able to fill the vacated niches of the previous resident with one major difference–the immigrants are young animals.

Age Structure: Changes Under Control Conditions

To be able to model and optimize control strategies it is essential to know the age structure of foxes that disperse into control baited areas. Fox age classes have been determined on the basis of pulp cavity closure and ratios, and also, the number of annular rings in the canine cementum. Examples of age classification of foxes are presented for the Watheroo National Park populations in Figures 2-5.

Figure 2 indicates the age structure for the Watheroo resident fox population prior to the implementation of any control measures. This data represents a undisturbed (non-baited) fox population. Age classes up to 5 years of age are well represented within the population which is in marked contrast to the age structures of subsequent baited populations. Thus it is clear, that repeated baitings (twice yearly) of an area the size of Watheroo National Park, profoundly affects the age structure of the fox population (see Fig. 2-5).

Approximately half of the foxes collected in April 1989 were classified as juveniles. These results, based on a mean litter size (4.5), suggest that some dispersal of juveniles out of the park had already occurred, but juvenile mortality cannot be excluded. Radio-tracking of a number of immature individuals support the former hypothesis, as certain radio-tagged individuals had dispersed prior to the baiting program.

Figure 3 indicates the age structure of the fox population sampled in September 1989. These animals were all classified as adult as natal recruits would still have been in the den at this time. Analysis of tooth material indicated that the majority of these foxes were one year of age. These animals would have immigrated into the area following the initial baiting. Similarly, most of the foxes collected in February 1990 (Fig. 4), were <1 year old. All foxes collected from cyanide transects in September 1990 were one year of age (see Fig. 5).

Such results indicate that dispersal into control areas is primarily undertaken by sub-adults. Dispersal occurs prior to February and may continue for an as

yet, undefined period up to the time of breeding (June-July). The significant juvenile component associated with immigration into baited areas has important consequences in terms of modelling processes for control programs. Modelling studies using this data are planned.

Factors Affecting 1080 Potency

Field trials designed to determine the loss of 1080 from prepared meat baits during preparation, storage and in the field were completed and partially analyzed. The analysis has been hampered due to difficulties associated with the determination of fluoride ion which tends to combine with complex biological materials in a non-linear manner thus making analyses difficult to perform and to interpret.

After experiencing these difficulties, the analyses was put on hold pending development of a promising new bioassay technique for 1080. This aspect is discussed below.

Development of a Bioassay for 1080 in bait materials.

Encouraging progress has been made in this area. The lack of a simple technique that does not require expensive instrumentation for analyzing 1080 has hampered progress. A brief description of the technique has been submitted for publication to an international journal. A copy of this manuscript has been included.

Preliminary analyses of factory prepared meat baits have yielded promising results. More tests are necessary, but we anticipate that the assay will be viable. When the tests are complete, the assay will be used to complete the potency trials. Other uses are planned.

Dampier Archipelago Rock-Wallaby Census

This work has been completed and has been submitted to *Australian Wildlife Research* for publication. A copy of the manuscript is included in this report.

Fitzgerald River National Park: Predation Ecology

This study has been on hold pending the outcome of a policy review on the dieback problem which has just been completed. The study will commence early in 1991.

Contact Rate Studies

Ms. Nicky Marlow took up her appointment as a consultant on September 1. After a period of orientation, she launched a program designed to provide information on the contact rate of foxes. The contact rate is a critical epidemiological parameter because it determines, to a large extent, the transmissibility or spread of a given vector.

At this stage a biological control agent has not been selected, but a sexually transmitted agent has been proposed. The sexual contact between individuals will be estimated by investigating the genealogy of various fox families and sub-populations using DNA finger-printing. If foxes are found to be largely monogamous, this will preclude the use of a venereally transmitted virus, and the use of arthropod borne and/or directly transmitted viruses will need to be investigated instead.

To date, some aspects of this study have been initiated. The study site has been selected and a technical officer has been employed. Equipment and supplies have been ordered. Twenty radio-collars have been purchased and five have been fitted–three cubs, an adult female and an adult male.

A contract arranging for the DNA fingerprinting analyses has been signed and of six blood samples are currently being analyzed at Curtin University. A screening program for the presence of viruses within the fox population has also commenced; plasma samples have being shipped to Canberra for serological analyses.

Liaison

Contact with Dr. Mark Bradley (molecular biologist) and Dr. Andrew Cleary (virologist, CSIRO Wildlife, Canberra) has been established. A collaborative working relationship has emerged, and as a result of this we have supplied them with samples of fox gonads for their studies.

Drs. Brian Coman and Alan Newsome arrived in Perth in mid-October. Study sites were visited and profitable discussions on various aspects of the fox project were held.

Jack Kinnear and Nicky Marlow attended the fertility conference in Melbourne (Nov. 21-24). We came away encouraged by the progress and prospects in this field.

The conference enabled us to meet up with the CSIRO group working on the biocontrol of the fox. An informal meeting was held which proved to be very productive. New approaches and ideas were debated. What was pleasing was the co-operative spirit displayed by the group. Such meetings are very valuable exercises and are to be encouraged.

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ESP PROJECT NUMBER 38

YEAR END REPORT (JUNE 1991) TO THE AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE

Project Title: Control and Ecology of the Red Fox *Vulpes vulpes* in Western Australia

(file:700/3/9)

Nominated Officer

Chief Investigator: Dr. Jack Kinnear Ph. (09) 405-5137;
Fax (09) 306-1641
Department of Conservation and Land Management, Wildlife Research Centre, P.O. Box 51, Wanneroo, 6065.

Consultants: Dr. Dave Algar
Ms. Nicky Marlow

The items outlined in the Scope section are discussed in the order listed in the Project Specification.

1. Effectiveness of Different Baiting Intensities.

This scope item was completed and discussed in detail in the previous report. The lessons learned are summarized below.

The results of this initial trial were inconclusive and as such, serve to emphasise and highlight the problems associated with small sample sizes of foxes within limited geographical areas. Further baiting trials which vary the application density (i.e., no. of baits/unit area) have been designed which should address the sampling problem. Details of these trials will be described the Scope of Consultancy Services 1991/1992.

2. Determination of the Extent and Timing of Dispersal into a Control (Baited) Area.

The current research program at Watheroo National Park is an ongoing program which is designed to determine level and timing of immigration into a

baited control area. Background information can be found in the previous report. This work has continued as follows.

The study area in Watheroo National Park was depopulated of foxes following the September 1990 cyanide baiting exercise using 1080 at an intensity of 10 meat baits/km^2. This was done to ensure that any remaining resident foxes surviving the cyanide transects were removed from the area, thus assuring that any subsequent sampling would represent migrant foxes.

To measure dispersal into the control area, non-toxic tetracycline labelled meat baits were laid at the beginning of February and April 1991. The tetracycline baits were placed at 100m intervals along a 60km network of tracks and firebreaks within the study area. The baits were located along these tracks for a period of four days and then removed. Any foxes consuming a bait would be labelled or tagged with tetracycline as tetracycline is incorporated into tooth tissue (Von Ebner's lines) at the time of lay. Thus, labels will appear in a chronological order and will reflect the date when a fox consumed a non-toxic tetracycline bait.

One of the major advantages of using a tetracycline label is that it is possible to monitor immigration into a baited area over time without disturbing the population.

Follow up sampling of the migrant fox population is planned for June/91 using cyanide. Foxes retrieved will be examined for the number and location of tetracycline rings present in the canine dentine. The tetracycline labels will enable each fox to be assigned to a particular recruitment period and the CPUE will provide an estimate of density.

3. Gibson Desert Nature Reserve Project

This project which has been operational since May 1989 has been funded by CALM, ANPWS and private industry. This year the project was placed on hold for a period pending confirmation of industry support. Funds were finally allocated after a lengthy financial review which was considered necessary because of the recession. The proposed baiting program had to be cancelled because of this delay.

In lieu of the baiting program, additional studies were carried out with regard to the following: predator (fox, cat, dingo) densities, habitat use, home range and dietary analyses of stomach contents and scats. A fox was trapped and fitted with a transmitter. The results are described below.

May 1991 field trip

Fox density in the study area, based on cyanide transects, and on observations of tracks and scats, was very low, Only 3 foxes were killed (2 male, 1 female), giving a CPUE index of 0.6. All foxes which crossed the transect, visited a bait station and were subsequently killed. The 60 km of cyanide transect was positioned through the centre of the proposed Boodie (*Bettongia lesuseur*) release site and intersected 3 geological units and 6 major vegetation types. No dingos were killed and there were no signs of recent dingo presence in the area.

All fox kills occurred in one geological unit; along an ancient drainage system (CzK) in the north-west corner of the Reserve. This system is characterised by dense swathes of spinifex and outcrops of calcrete fringed by claypans and grove/intergrove mulga (*Acacia aneura*). Numerous old Boodie warrens exist along this system.

Gut contents, faeces and canines (for ageing) were taken from all foxes killed. In addition, about 40 scats were collected during the course of this field trip. At this stage, scat and gut content analysis has not yet commenced, but from casual observation, diet consists mainly of small native mammals such as the Ningaui (probably *N. ridei*), an assortment of insects , a few lizards and some vegetation.

A single male fox was trapped in a snare trap and fitted with a radio collar. The animal was monitored for four days, largely on foot and by vehicle where access permitted, before being "lost" to the tracking equipment. During this time, the fox moved in a rough circle with a radius of 2-3 km. Activity was mostly nocturnal but about 30% of its active time was during daylight. The fox denned at night and during the day in old Boodie and rabbit warrens, and in at least one instance, rested up under a spinifex clump. Over the four days, the fox used at least 6 separate dens. Most of its active time was spent hunting and foraging along paleo drainage lines (CzK) and interspersed

mulga and claypan country (CzC). Occasionally, the fox ventured onto the less productive spinifex buckshot plains (CzS) but never used the sparsely vegetated laterite hills. The average displacement of this fox was about 3.1 km/day, although on day 5, he had travelled beyond the range of the tracking equipment. Towers, or extensions to the existing grid lines, will need to be constructed to re-locate the animal and to facilitate future radio tracking exercises.

During the cyanide transects, 3 feral cats were killed, 2 were sighted at separate locations and 3 other baits were removed resulting in the cats receiving a sub-lethal dose. Cat density in this area was more than double that of fox, with the cat CPUE index being 1.6 (based on 8 cats), which is still comparatively low.

The gut contents of killed cats consisted of skinks, geckos, Ningaui, an assortment of insects and the occasional mulga parrot and zebra finch feathers. The large number of skinks in each gut was particularly significant. Cats were killed and observed on all landform units and vegetation types, even the sparsely vegetated spinifex laterite hills.

Currently, cats may be a greater problem than foxes in this area. Not only are they in greater numbers, but they are utilizing the entire landscape. It appears that during drought, cats are better able to persist than foxes. This may be because cats are better reptile hunters. In spite of drought, reptiles are still relatively common on all landforms, whereas mammal numbers (including rabbits) have declined dramatically. Cats also prey on native mammals, birds and insects, but reptiles probably form the cats staple diet in severe drought as is the case now. This situation could be reversed during good seasons when native mammals and rabbits increase, resulting in an increase in foxes. This hypothesis requires testing as the outcome will affect predator control strategies.

In addition to the above work, 200 pitfall traps were installed and opened for 4 days. Pitfall trapping will provide data on the impact of feral predator control on resident mammals and reptiles, with 100 traps located in an area to be baited and 100 in an area to remain unbaited. Pre-baiting monitoring will continue for a further 12 months when one area will be broadacre baited using aircraft.

This work has confirmed that fox numbers are low in a desert environment, a finding that has important implications for biocontrol. It means that if biological control is to be effective in desert environments, a vector will have to be able to persist at low host densities.

This work also shows that foxes can persist in drought years. It has also demonstrated that foxes can be radio-collared and tracked in the desert, and that cats are more numerous, widespread, and that cats utilize the full range of habitats available. Both cats (in particular) and foxes prey on native vertebrates.

Future work will focus on predator control and the response of prey populations to predator control.

4. Factors Affecting 1080 Potency

Field trials designed to determine the loss of 1080 from prepared meat baits during preparation, storage, and in the field, were put on hold pending development of a promising new bioassay technique for 1080. Progress in this area is discussed below.

5. Development of a Bioassay for 1080 in Bait Materials.

A brief description of the technique has been accepted for publication by ***Letters in Applied Microbiology*** — an international journal. A description of the technique was also presented at the recent **Vertebrate Pest Conference** held in Adelaide. Considerable interest was apparent.

Research on the assay has been extended to bait materials (primarily meat baits) in an effort to standardize the technique for this material. Recoveries of 1080 have been erratic which is a reflection of the fact that 1080 tenaciously binds to meat as shown by R. Parker at the conference using NMR/Mass Spectrometry methods. Simple aqueous extracts yield recoveries of 40-50 percent which is in agreement with Parker's work. Work is underway to improve recoveries. Enzymatic digestion may be necessary.

It is encouraging to report that the assay remains promising. All that remains is to improve and standardize the recovery of 1080 from meat.

6. Dampier Archipelago Rock-Wallaby Census

This work has been completed and has been accepted for publication by *Australian Wildlife Research* subject to minor revision. The significance of this work is that it shows that the fox is a damaging predator in undisturbed environments. It has been argued that fox predation is only significant in disturbed or degraded environments.

This work also highlights the need to exclude foxes from islands supporting wildlife.

7. Fitzgerald River National Park: Predation Ecology

Fitzgerald River National Park is a large nature reserve that still supports many species of threatened mammals and birds. This study aims to identify and extend the range of species affected by fox predation.

The Park was partitioned into two sections and one section was aerially baited with 1080 meat baits (8400 baits) on February 27, 1991 (see enclosure). An extensive public relations effort was made to inform the Fitzgerald rural community (see enclosure) about the purpose of the baitings.

Standard cyanide transects (20 km) were made in the two sections to assess the effectiveness of the baiting. Some results are as follows:

Area 1 (baited area): North section of dual firebreak called Northern Fireline between Quiss Road and 400 meters east of Fitzgerald River.

Area 2 (unbaited): Continuation of Northern Fireline. Transect starts 10 km east of Drummond Track and continues east for 20 km to the West River.

The CPUE indices for the two sections (see enclosure) are:

Area 1 (Baited area): Cyanide transect over 3 consecutive days . **Three** foxes collected.

14/03/91	fb1	Male on milk lure.
15/03/91	fb2	Female on milk lure.
15/03/91	fb3	Male on milk lure.
16/03/91	No foxes killed on this day.	

Area 2 (unbaited): Cyanide transect over 3 consecutive days.
Nine foxes collected.

18/03/91	fu1	Male on liver lure.
18/03/91	fu2	Female on liver lure.
18/03/91	fu3	Male on milk lure.
18/03/91	fu4	Male on liver lure.
18/03/91	fu5	Female on milk lure.
19/03/91	fu6	Male on milk lure.
20/03/91	fu7	Male on milk lure.
20/03/91	fu8	Male on milk lure.
20/03/91	fu9	Female on milk lure.

A substantial reduction in the CPUE is evident. Follow up baitings are planned, and putative prey populations will be monitored.

8. Contact Rate Studies

This project was proposed and initiated by N. Marlow as described in the previous report.

Twenty six foxes have been collared and blood sampled. These samples have been sent to Curtin University for DNA fingerprinting and to the CSIRO for viral screening.

Eighteen radio-tagged foxes remain alive in the study area. More foxes will be collared with radio-transmitters and the movements and social contacts will be monitored during the breeding season using radio-telemetry. Cubs will be

The CPUE indices for the two sections (see enclosure) are:

Area 1 (Baited area): Cyanide transect over 3 consecutive days . **Three** foxes collected.

14/03/91	fb1	Male on milk lure.
15/03/91	fb2	Female on milk lure.
15/03/91	fb3	Male on milk lure.
16/03/91	No foxes killed on this day.	

Area 2 (unbaited): Cyanide transect over 3 consecutive days.
Nine foxes collected.

18/03/91	fu1	Male on liver lure.
18/03/91	fu2	Female on liver lure.
18/03/91	fu3	Male on milk lure.
18/03/91	fu4	Male on liver lure.
18/03/91	fu5	Female on milk lure.
19/03/91	fu6	Male on milk lure.
20/03/91	fu7	Male on milk lure.
20/03/91	fu8	Male on milk lure.
20/03/91	fu9	Female on milk lure.

A substantial reduction in the CPUE is evident. Follow up baitings are planned, and putative prey populations will be monitored.

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Twenty six foxes have been collared and blood sampled. These samples have been sent to Curtin University for DNA fingerprinting and to the CSIRO for viral screening.

Eighteen radio-tagged foxes remain alive in the study area. More foxes will be collared with radio-transmitters and the movements and social contacts will be monitored during the breeding season using radio-telemetry. Cubs will be

DNA fingerprinted to establish family relationships. This study will provide information with respect to the mating system of foxes.

9. Scientific Liaison

Contact with scientists involved in fox research has continued. In March, J. Kinnear attended a meeting at CALM'S expense to discuss the Biological Control CRC proposal in Canberra with CSIRO Wildlife. Kinnear attended the Vertebrate Pest Conference in Adelaide and delivered two papers. The recent Feral Cat Workshop provided an additional opportunity for fruitful liaison.

Contact with overseas visitors were made as a result of visits by Drs. Clare Fitzgibbons and Chris Cheesman from the U.K. The former has carried out research in Africa on predation, and the latter on vertebrate pests in England.

HEAD OFFICE
G.P.O. Box 636
Canberra, ACT 2601
Telephone (06) 2500200
Facsimile (06) 2500399
Telex AA62971

Australian National Parks and Wildlife Service

DIRECTOR: Peter Bridgewater Ph.D.

700/1/9
ESP no: 38
ebm:ebm

21-Oct-1991

SENT DIRECT

The Executive Director
Department of Conservation and Land Management
PO Box 104
COMO WA 6152

Dear Dr ~~Shea~~ Syd

ANPWS ENDANGERED SPECIES PROGRAM (STATE AGENCY FUNDING)

Control and ecology of the red fox, Vulpes vulpes in Western Australia, Phase 3

I refer to your acceptance of the General Conditions for funding under the Endangered Species Program and the advice from:

Dr J Kinnear
Department of Conservation and Land Management

that the Project Specifications for the above project have been agreed. Enclosed is a copy of the agreed Project Specifications. You will shortly receive the initial payment due under these specifications. I should like to draw your attention to the fact that payments other than the initial payment are made after receipt of satisfactory reports.

Yours sincerely

Peter Bridgewater

Encl Project Specifications, General Conditions

Copy to Chief Investigator

Dr J Kinnear
Department of Conservation and Land Management
PO Box 104
COMO WA 6152

1/ Man Wildlife KMN 25/10
2/ Dr J. Kinnear

file: 700/3/9
ESP Project Number: 38

Endangered Species Program 1991/92 Project Specification

for a project involving the

Australian National Parks and Wildlife Service

and the

Western Australian Department of Conservation & Land Management

entitled

Control and ecology of the red fox, Vulpes vulpes, in Western Australia, Phase 3

1. Scope.

- Complete age determination analyses of foxes recolonising Watheroo National Park, previously depopulated of foxes. Complete the tetracycline analyses of canine teeth collected from foxes recolonising Watheroo National Park.
- Conduct a wide area-baiting intensity trial to determine the effectiveness of different levels of baiting. Conduct trials to calibrate the CPUE derived from cyanide transects. Collect information pertaining to the social structure and age of foxes.
- Carry out studies on dispersal of foxes.
- Determine the level of migration by foxes into an area not subject to fox control.
- Conduct a broad-acre baiting program in the Gibson Desert Nature reserve during March 1992.
- Complete the development of of the 1080 microbiologcal assay for analysing 1080 in bait materials.
- Complete trials designed to identify environmental and microbiological factors that affect the potency of 1080 baits during preparation, storage, and in the field.
- Continue predator control program and studies on the predation ecology of the fox in relation to native fauna in the Fitzgerald River National Park.
- Continue studies designed to evaluate the contact rate between foxes.
- Initiate studies designed to measure the reduction in the level of predation pressure required to enable prey populations to increase and maintain viable populations.
- Liaise with scientists and organisations involved in fox research.

2. Reporting Requirements.

Provide the ANPWS Project Officer within sixty (60) days of the commencement of the project a detailed budget and schedule of work to be performed including indicative starting and finishing dates for the components of the work.

Provide at the completion date of the project a precis of not more than two hundred and fifty (250) words summarising the significance and limitations of the study findings for the conservation of the threatened species or habitats covered by the scope of the project.

The Western Australian Department of Conservation & Land Management Chief Investigator shall prepare and provide to the Director of the ANPWS a detailed written report on the progress of the project by 15 December 1991.

The Western Australian Department of Conservation & Land Management Chief Investigator shall prepare and provide to the Director of the ANPWS a detailed written report on all aspects of the project, including the implications for the survival of endangered species, by 15 July 1992, or by such other date as may be subsequently agreed by the ANPWS and the Western Australian Department of Conservation & Land Management.

3. Nominated Officers.

Western Australian Department of Conservation & Land Management

Chief Investigator: Dr Jack Kinnear ph 09 405 5137

ANPWS

Project Officer: Dr Barry Reville 06 250 0280

4. Agency Inputs and Commitments.

ANPWS - $165 665; technical advice.

Payment Schedule

Initial Payment	Jul 1991	$85 665
Progress Payment	Dec 1991	$70 000
Final Payment	Jul 1992	$10 000

Western Australian Department of Conservation & Land Management - Project supervision, administration, staff, equipment.

5. Completion and Acquittance.

The project shall be completed by 15 July 1992 and the funds expended shall be acquitted by 15 August 1992. Refer to General Conditions (sent with letter of offer) for details of requirements at the end of the financial year.

6. Capital Equipment.

The items of capital equipment listed below are to be returned to the ANPWS at the completion of the project (purchased during Phase 1).

Night vision equipment $7 000

Endangered Species Program:
A Co-operative Program Between the Australian National Parks and Wildlife Service (ANPWS) and Western Australian Department of Conservation & Land Management (CALM)

General Conditions relating to each project conducted under the Program

1. Project specifications

For each project the ANPWS, in consultation with the CALM, shall compile Project Specifications which states, *inter alia*, the Scope and Reporting Requirements of the project, and the Completion Date for the project.

Unless otherwise agreed in writing by the Director of the ANPWS, each project is to be completed by the Completion Date, in accordance with the Scope and Reporting Requirements defined within the Project Specifications.

The CALM Project Supervisor or Project Officer will keep the ANPWS Project Officer informed of the progress of work under the schedule supplied in accordance with the Project Specifications.

2. Payments

ANPWS funding for each project is detailed in the Project Specifications. Funds will be advanced to the CALM by the ANPWS on the basis of the agreed project activity and the estimated phasing of expenditure.

If changes occur which significantly affect the estimated phasing of expenditure (e.g later commencement date, unavailability of suitable personnel), the ANPWS is to be advised of the revised phasing of funds required, so that adjusted levels of advances can be determined.

3. Return of used funds

The Director of the ANPWS is to be advised no later than one month before the Completion Date if it is anticipated that any of the funds provided by the ANPWS for the project will not be utilised.

For projects with a Completion Date of 30 June 1992, reimbursement of those unutilised funds must be made no later than 20 June 1992.

For projects with a Completion Date other than 30 June 1992, any unutilised funds not previously reimbursed must accompany the acquittance.

4. Acquittal of funds

For all projects, an acquittance of funds stating that funds have been expended in accordance with the Project Specifications must be forwarded to the Director of the ANPWS no later than **sixty (60)** days after the Completion Date. For projects continuing into 1991/92, the CALM shall submit to the ANPWS a financial statement of expenditure for each project as at 30 June 1991. For projects continuing into 1992/93, the CALM shall submit to the ANPWS a financial statement of expenditure for each project as at 30 June 1992.

5. Engagement of staff

Where staff are to be engaged by the CALM, they shall not thereby become in the service or employment of the Commonwealth.

6. Insurance

The CALM shall be responsible for effecting all insurances required under Worker's Compensation legislation and for taking all other such action requisite as employer in relation to CALM employees engaged in the project.

7. Indemnity

The CALM shall indemnify and keep indemnified the Director of the ANPWS from and against any claim, demand, action, suit or proceeding that may be made or brought by any person against the Director of the ANPWS or the employees or agents of the Director of the ANPWS or any of them in respect of personal injury to or the death of any person whomsoever or loss of or damage to any property or any other loss or damage whatsoever arising out of or as a consequence of an unlawful act or a negligent act or omission by the CALM or its employees or agents in the course of carrying out the project and also from any costs and expenses that may be incurred with any such claim, demand, action, suit or proceeding.

8. Animal ethics

Where a project will involve the use and care of living non-human vertebrate animals, the CALM will be responsible for obtaining review and approval for such experimentation from a recognised animal ethics committee operating under the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.

The CALM shall, prior to the commencement of any such experimentation, provide the Director of the ANPWS with a certificate of compliance with the appropriate guidelines. The Director of the ANPWS reserves the right to withdraw from a project should such a certificate not be provided. If the Director of the ANPWS withdraws from a project the unexpended funds must be returned forthwith together with an acquittance of expenditure.

9. Reports

The ANPWS shall be given first option for publishing any reports produced as part of the project.

If the report is not published by the ANPWS, the Director of the ANPWS is to be provided with six copies of any report, plan of management or other written document produced as part of a project in accordance with the Reporting Requirements in the Project Specifications.

The format of any reports to the ANPWS are to be agreed to between the ANPWS Project Officer and the CALM Project Supervisor or Project Officer.

In addition the CALM Chief Investigator will supply a copy of the final report upon digital media , and suchdigital reports must be in either the Microsoft Word or the Word Perfect word processing formats, upon five and one quarter (5.25) or three and one half (3.5) inch diskettes formatted to IBM XT/AT compatible specifications.

10. Supply of raw data sets

At the completion of the project the CALM agrees to provide the Director of the ANPWS with copies of the mutually agreeable raw data sets in a form to be agreed between the Director of the ANPWS and the CALM.

11. Copyright

The copyright and custodianship of all raw data obtained by the ANPWS from the CALM will remain with the CALM. At the completion of, and during the course of the project, the Director of the ANPWS agrees not to disclose any raw data owned by the CALM to a third party without the written permission of the CALM.

The funding is provided by the ANPWS on the understanding that each of the involved parties may use the results of the project and any related material for purposes connected with their respective statutory functions.

12. Acknowledgement of the ANPWS

Any publications or media releases resulting from the project must acknowledge the assistance given by the ANPWS.

Copies of all subsequent publications including journal papers must be provided to the Director of ANPWS.

Control and Ecology of the Red Fox (*Vulpes vulpes*) in Western Australia Phase 3

Mid-year Report, Dec. 1991

File 700/3/9
ESP Project Number:38

Chief Investigator: Dr. Jack Kinnear

SCOPE OBJECTIVES

1. **Watheroo study**: Age determinations and the analysis of tetracycline labled teeth of foxes collected during the course of this study have not been completed. Prior to this report, we have had access locally to a single bladed *Isomet* saw (for sectioning teeth) but this is no longer available. Ideally we would prefer a double bladed model as very thin sections can be cut which can be directly read for growth rings and tetracycline deposits without further treatment. Use of a single bladed system is time consuming and laborious.

In lieu of this, we are currently negotiating with the Ontario rabies research group to perform the analyses. They have perfected the technique, and if arrangements can be made, canine teeth will be posted to Canada. This would speed up the analyses enormously.

If no arrangements can be made, then we will need to invest in a double bladed model at a cost of $10,000.

2. **Wide area baiting trial**: Three sites have selected; field studies at two sites have been completed and the third will have been completed by the end of December.

3. **Dispersal studies**: Fourteen active fox dens have been located at this writing. Cubs will be collected and radio-tagged early in the new year and their activities monitored throughout the dispersal phase. Mortality data will also be obtained during the course of this study.

4. **Movement of foxes into areas without fox control:** this study will commence early in 1992.

5. **Gibson Desert:** baiting trial to proceed in March 1992.

6. **Biological Assay:** Progress on the assay has been satisfactory with one exception. We have shown that the assay can be used to analyse 1080 in soils, oat grains, and fresh meat. However, dried meat has posed problems as recovery of 1080 has been too low – only 60-65 percent. We now have reason to suspect that microbial degradation may have been occurring during the drying period. Further studies are in progress to check on this possibility.

7. **1080 Potency Trials:** progress in this area awaits resolution of the problems affecting analysis of 1080 in dried meat.

8. **Predator control in Fitzgerald River National Park:** The designated fox control area of the park was baited with 1080 meat baits in October. Four weeks latter, standard cyanide transects were made through the unbaited and baited areas. The unbaited area of the park yielded 11 foxes; the baited area yielded only one fox. Clearly, the 1080 baiting is effective; it will be repeated in March.

9. **Contact Rate Studies:** experience with conventional radio-telemetry have proven to be of little value. A new approach using novel technology is being considered.

A venereally transmitted GEM vector would have many desirable properties as an agent for controlling fertility in foxes. Should such a virus be selected, its suitability as a vector would depend on the mating system of foxes. Information about this aspect can be gained from DNA fingerprints. Material for DNA fingerprinting foxes and fox litters have been collected. Analyses are currently underway at Curtin University and should be completed by April.

10. **Predation Pressure Studies:** Work has commenced at Tutanning Nature Reserve. The objective of this exercise is to relate fox density to predation pressure exerted by foxes on prey species. Initial studies will focus on measuring the recoloniziation rate and fox density within Tutanning subject to fox control.

11. Liaison

While on long-service leave from CALM (Sept - Dec.), I attended two scientific conferences. The first conference – on Wildlife Telemetry; Sept 13-18 – was held in Aberdeen Scotland. It was well organized and the quality of the papers was generally very high. Apart from the knowledge gained from the presentations, I also benefited from discussions with technical staff representing the various telemetry suppliers. I outlined our need for technology to measure contact rate. I came away with some fresh insights and some possible solutions which I am currently following up.

In October, I also attended a joint conference on *Rabies and Wildlife Diseases* in Nancy, France. This event was poorly organized and in general, less rewarding. Still, there were some highlights; in particular, a keynote address by Roy Anderson on epidemiological models and concepts.

In North America, I visited with Prof. Charles J. Krebs at UBC in Vancouver. He was most interested in the fox studies underway in Australia. Indeed, he is currently involved in a study of the ten year cycle involving hares and associated species. The cycle is driven by predation processes. Dr. Krebs will be taking sabbatical leave in Australia next year. He plans to visit W. A. and is keen to learn more about fox research. We plan to organize a small workshop on predation during his visit.

J.E. Kinnear, Ph.D.
11 December, 1991

ESP PROJECT NUMBER 38

(file:700/3/9)

MID-YEAR REPORT (DECEMBER 1992) TO THE AUSTRALIAN NATIONAL PARKS AND WILDLIFE SERVICE

Project Title

Control and Ecology of the Red Fox *Vulpes vulpes* in Western Australia

Nominated Officer
Chief Investigator: Dr. Jack Kinnear
Consultants: Dr. David Algar
Dr. Nicola Marlow

Western Australian
Department of Conservation and Land Management, Wildlife Research Centre, P.O. Box 51, Wanneroo, 6065.

Ph. (09) 405-5137 ♦ Fax (09) 306-1641

TABLE OF CONTENTS

SCOPE ITEMS

Please note this report covers the period July 1 to November 15, 1992.

1. DISPERSAL

1.1 Radio-Tracking Study at Watheroo National Park (NP)

Capture of cubs for radio-collaring has begun and will be continued until the end of November. To date, 8 animals have been captured and a further 22 are sought to attain a statistically viable sample. New expandable collars are being fitted to each cub and blood samples for DNA analysis and viral screening have been taken. The movements of radio-tagged foxes will be monitored during the dispersal phase.

1.2 Monitoring Immigration Of Foxes Into An Area Not Subject To Fox Control (Kalbarri NP)

Thirty-six foxes were collected from cyanide transects in the northern area of Kalbarri NP during August 1992. In total, 72.6 km of transect was baited over a three day period in an area of approximately 180 km^2. Five transects were used and their respective CPUE indices are 4.2, 2.2, 4.9, 2.2, 1.5.

Examination of the canines of the Kalbarri sample to determine the presence of the tetracycline biomarker is underway but is not completed. Similarly, the aging analysis for the population is underway (See Section 8). These results will be presented in the final report.

The demographic information obtained for the Kalbarri sample is presented in Section 2.1.

2. SOCIAL ORGANISATION

2.1 Kalbarri NP Cyanide Kill.

Of the 36 foxes collected, 22 were vixens and 14 were males. This ratio was not significantly different from a 1:1 ratio (X^2=1.78, p>0.05). 86% of the vixens had either cubs in utero or had given birth. The litter size (mean ± s.e.) was 3.5 ± 0.4. Spleen samples were taken from all individuals and these await analysis as soon as the new micro-satellite and PCR technique for obtaining DNA profiles is completed (See section 6). Blood samples and ovarian tissue have been sent to the Vertebrate Biocontrol Centre (VBC: CSIRO Division of Wildlife & Ecology, Canberra) for viral antibody analysis and for reproductive protein sequencing.

2.2 Radio-Tracking Study (Watheroo NP).

An area of approximately 80 km^2 has been selected within Watheroo NP for this study. To date, 20 adult animals have been fitted with the newly developed proximity radio-collars (See previous report). Further trapping is being conducted for cub dispersal and this will allow more adults to be captured. An attempt will be made to radio-collared the entire population of foxes within the study site. This will allow us to determine social organisation from location data, home-range, and contact-rate between individuals. Intensive radio-tracking will commence in January 1993.

2.3 Large-Scale Intensive Sampling of a Fox Population

The study site has been selected and mapped at Carnarvon. Biomarker baits were laid in November and the sampling will commence in December 1992. The timing of this experiment is critical, because during this period, cubs are mobile but have not yet dispersed. This enables the foxes' social organisation to be identified as either socially regulated or environmentally regulated. Equipment is on site and liaison with local land holders has been completed.

3. BAIT-UPTAKE TRIALS

3.1 Large-Scale Intensive Sampling Of Foxes

Analysis of tetracycline biomarker in canines from wide-area baiting intensity trials (see section 2 of previous report) has been completed.

Bait uptake refers to the percentage of the fox population that are labelled with the biomarker i.e., those foxes that have eaten a bait, not the number of baits that were consumed.

The results indicate that bait uptake is predominantly in the range of 80-90% for the two baiting intensities; indeed, uptake tends to be higher at the lower baiting regime. At this stage, these results suggest that bait consumption may reach an asymptote at application rates of about 5 baits/km^2.

Data from Big Soak Plains indicate a lower bait uptake (65%) but a wind-shift during the baiting programme caused baiting intensity to be lower than the stipulated 5 baits/km^2 across the entire site. In fact, baiting intensity was only 3.3 baits/km^2, implying that uptake drops rapidly at a baiting intensity of less than 5/km^2.

These results may well be conservative, because foxes are not killed by the non-toxic baits, and therefore they are able to consume more baits over time thereby reducing bait availability to other individuals in the area.

Significantly, our baiting uptakes are considerably higher than those reported overseas. The mean for overseas bait uptake is 63.8 ± 8.76 (s.d.) percent.

Even more striking is the difference in the density of baits laid (baits/km^2). The overseas mean value is 21.1 ± 9.75. vs 5 baits/km^2 in WA.

The high baiting uptake achieved in WA augurs well with regards to the bait delivery of a sterility antigen that is being developed by Dr. Mark Bradley of the VBC Fox Group, Canberra.

Additional data on baiting efficiency will be collected during the large scale intensive sampling of foxes in Carnarvon this December. Tetracycline baits were laid over this study area in November.

3.2 Watheroo NP Radio-Tracking Study.

Tetracycline labelled baits are to be laid prior to the calibration of the CPUE index in August 1993. This trial, which is part of a multi-purpose experiment, will yield additional data on bait uptake.

4. REFINEMENT OF THE CYANIDE TECHNIQUE

4.1 Cyanide Capsules.

Attempts to develop a more robust cyanide capsule capable of surviving more than one day's fields usage will be undertaken following the results of the Carnarvon experiment.

4.2 Cyanide Additives

Commercial grade (98% pure) sodium cyanide is hygroscopic, causing the cyanide powder to cake. This caking results in fewer fox kills. Use of free-flowing agents (e.g. Tixalex) has overcome this problem as shown by field trials. Also, the incorporation of this agent into the cyanide results in better capsule quality control.

4.3 Scent Trials

Examination of different scent trails was conducted along 300 km of railway reserves. Five treatments were used:

1) freshly killed sheep.
2) tyre drag.
3) tyre drag plus meat-meal lure.
4) tyre drag plus fish-meal lure.
5) control- no treatment

Both these artificial lures (meat or fish meal) were laid at a rate of 5litres/km. Treatments were randomised within a block: each block was

separated by a buffer of >3km. Each treatment was run for 1 km, and immediately followed by the next treatment. Within each treatment, raked plots (1m wide and the width of the track) were established at 100m intervals. Analysis was based upon the presence/absence of fox tracks at each station.

The results demonstrate that scent trial created by dragging a sheep was the most effective lure for attracting foxes to bait stations. A statistical analysis will be presented in the final report.

4.4 Food Lures

Two sites were selected to test fox preferences for different food lures. The lures comprised:

1) condensed milk combined with icing sugar.
2) raw liver blended with blood to form a paste.
3) cooked liver in vegetable oil.
4) sardines blended in fish oil.

A smorgasbord presentation was used at each site and appropriately coloured wax capsules were used to contain the cyanide. The order of placement of the lures around the central peg was randomised at each site. Data interpretation is based upon the number of foxes killed per attractant type.

The results indicate that there was no significant difference in the preference by foxes for milk and the two liver types of lure. However, the fish based attractant was significantly less attractive. A full statistical analysis will be included in the final report.

4.5 Risk To Non-Target Species

Alternative ways of presenting cyanide baits to avoid risks to non-target prey will be investigated later in this financial year.

5. POPULATION DENSITY (CALIBRATION OF THE CPUE INDEX)

5.1 Large-Scale Intensive Sampling Of Fox Populations

This experiment will be performed during December 1992. It will enable the estimation of population decline due to cyanide baiting. Additionally, it will increase our knowledge about the relationship between CPUE indices and known fox densities.

5.2 Radio-Tracking Study (Watheroo)

This study will be conducted in August 1993. Cubs in utero.

This experiment will commence in January 1993.

6. DEVELOPMENT OF THE MICROSATELLITE AND PCR TECHNIQUE FOR OBTAINING DNA PROFILES FOR FOXES

6.1 Development Of The Micro-Satellite And PCR Technique

The application of DNA fingerprinting (DNA profiles) to fox populations requires an efficient fox sampling technique. Cyanide bait transects sample fox populations efficiently without serious bias, but the use of cyanide leads to DNA degradation within six hours after death which negates the use of standard (Jefferies) probes.

This situation has necessitated the development of a new system that is not affected by cyanide induced degradation of DNA. Research on the development of a microsatellite and PCR method of obtaining profiles has been progressing well, and several promising results have been obtained. A poly CA probe has been very successful in identifying the presence of DNA sequences suitable for producing DNA profiles. Sequencing of the appropriate DNA primer for these fragments is being done by the VBC in Canberra. It is anticipated that this method of obtaining profiles from samples may be available for use in January 1993.

6.2 Analysis Of DNA Samples To Determine Sexual Contact Rate And Parentage Of Fox Litters

Spleen samples for DNA analysis were obtained from all of the 36 foxes killed by cyanide in North Kalbarri NP (See Section 1.2). Spleen samples from the embryos of all of the pregnant vixens were obtained to determine the relationships between the foxes in that population using DNA profiles. Seventy-three embryos were sampled and from these it will be possible to determine if there was multiple paternity of single-litters of cubs and also whether one male sired more than one litter. These results will determine the minimum contact rate that must have occurred to account for the observed relationships and will reveal the mating strategies that occur in wild fox populations.

It is important that we have a thorough understanding of mating strategies because these will largely determine the level of sterility that must be imposed upon a fox population to successfully reduce that population with biological methods.

6.3 Analysis Of Samples To Determine The Relationships Between Cubs And Vixens For Social Organisation Investigations

Because the ratio of vixens to cubs and vixens to male foxes is different for the mated pair social system and the dominance hierarchy system, we are interested in determining the sex ratio of the population and how many viable cubs are produced by each vixen. The large-scale kill at Carnarvon in December will provide a comprehensive sample of foxes and from these, the sex and cub:vixen ratios will be obtained. If environmental factors cause high cub mortality to occur, DNA profiles from each cub can be used to determine whether only a few vixens were responsible for producing most of the cubs, which would indicate that a dominance hierarchy was operating, or else if most vixens produce only a few cubs each, then a mated pair system would be operating.

7. SAMPLING (Biological Materials for VBC Investigations)

Blood samples have been obtained from all individuals collected along cyanide transects or captured as part of the radio-tracking studies. These

samples have been sent to the VBC Canberra for viral antibody analysis as have fox ovaries and testes for reproductive protein sequencing.

8. COMPLETION OF TOOTH ANALYSIS (Age, Biomarker Labels)

Since delivery of the *Isomet* saw and barrier filters intensive analysis of previously collected canine samples has been undertaken. A VBC appointed Laboratory Technician has been trained in aging and biomarker detection techniques. The majority of the tetracycline samples have been completed and age analysis is currently underway. Detailed results will be presented in the final report

9. GIBSON DESERT PROJECT

This study has continued in association with the translocation of Boodie (*Bettongia lesureur*) and Golden Bandicoot (*Isoodon auratus*) to a site in the Gibson Desert.

Following unseasonable heavy rain throughout winter months, a prolific rejuvenation of plant and animal activity resulted. Attempts to visit the site were aborted because of the wet conditions, and the effort to test the effectiveness of aerial baiting had to be abandoned.

An aerial baiting was successfully carried out in August when 2500 baits were dropped in the 40 x 40 km zone around the release site.

Cyanide transects through the baited area yielded no predator victims. It was concluded that the baiting was largely effective in removing foxes.

Later inspections for fox and cat footprints yielded one fox track and eleven cat tracks. No interest in baits was evident by the resident cat population.

Monitoring of predators will continue and predator control will be implemented as required.

10. 1080 BIOASSAY

Work is continuing on the refinement of the assay for dried meat baits. The assay works well for soil and other biological materials, but in the

case of meat, recovery of known amounts of 1080 have been low and variable. New methods are being trialed.

11. FITZGERALD RIVER NATIONAL PARK (FRNP).

The FRNP was baited during October. This was the forth baiting over a 2 year period with the object of testing a prescribed baiting frequency (spring/autumn baitings, 6 baits/km^2) over a large area to determine if this level of baiting is adequate to produce prey responses. Censuses of prey populations will begin in February 1993.

12. PREDATOR-PREY STUDIES

Forty woylies (*Bettongia penicillata*, sourced from Dryandra State Forest) were released into Boyagin Nature Reserve. The objective of this translocation is to allow woylies to increase to the carrying capacity (K) of the reserve while the reserve is under predator control. Once K is reached, it is then planned to perform some manipulative experiments recommended by the VBC as described previously under this Scope item.

13. LIAISON

The Fox Group attended the opening of the Vertebrate Biocontrol Centre held in Canberra in October. Intensive discussions with VBC colleagues and advisers took place. It was agreed that a greater research emphasis on predator-prey relationships was necessary. Such studies are planned for the next fiscal year.

Dr. Mark Bradley of the VBC Canberra, paid a visit to WA and participated in a CALM workshop designed to inform CALM regional managers about the latest developments and future plans regarding fox research and control. His presentation was well received. A field trip to Dryandra State Forest was made to illustrate the prey response to fox control.

Discussions involving Dr. Bradley were held with Professor Wetherall at Curtin University regarding the DNA profiling research described in Scope item 6.1. As a result of this meeting, it was agreed that VBC would assist in regard to DNA sequencing — a step that will speed up the

development. There is a possibility that the Curtin Research may prove useful with regard to problems associated with immune response heterogeneity.

A meeting with Professor Shellam and staff (UWA Department of Microbiology) involving Bradley, Kinnear and Marlow was held at Queen Elisabeth Medical Centre regarding fox virology. Prof. Shellam offered to screen fox sera for antibodies to Cytomegalovirus (CMV). If foxes are shown to carry CMV, then it might prove to be a virus suitable for genetic engineering. Arrangements were made to provide samples and to collect salivary glands.

J. Kinnear presented a seminar to Murdoch University Veterinary staff and students. Prof. Clark has since written offering their assistance in regard to fox research.

J.E. Kinnear
D. Algar
N. Marlow
20 November, 1992.