
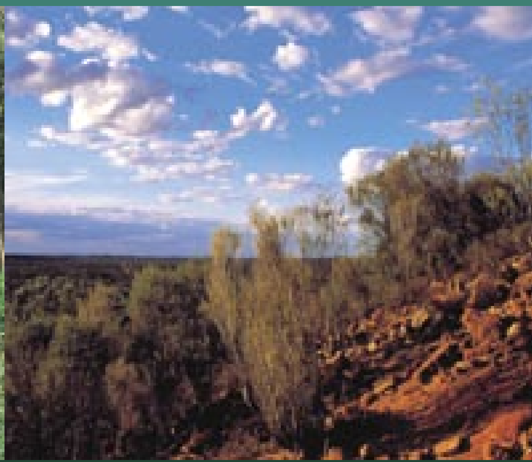


PARKS VICTORIA TECHNICAL SERIES

NUMBER 20

Adaptive Experimental Management of Foxes

Annual Report: July 2003 - 2004

Authors: A. Robley and J. Wright

September 2004

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First published 2005

Published by Parks Victoria
Level 10, 535 Bourke Street, Melbourne Victoria 3000

Authors:

Alan Robley – Research Scientist, Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment.

John Wright – Team Leader, Research Co-ordination, Parks Victoria.

National Library of Australia
Cataloguing-in-publication data

Includes bibliography.
ISSN 1448-4935

Citation:

Robley, A, and Wright, J (2004). *Adaptive Experimental Management of Foxes. Annual Report July 2003 – June 2004*. Parks Victoria Technical Series No. 20. Parks Victoria, Melbourne.

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Parks Victoria Technical Series No. 20

Adaptive Experimental Management (AEM) of Foxes

Annual Report: July 2003 – 2004

Alan Robley

Arthur Rylah Research Institute for Environmental Research

John Wright

Parks Victoria

September 2004

EXECUTIVE SUMMARY

The Fox Adaptive Experimental Management (AEM) project was initiated in 2001 by Parks Victoria in partnership with the Arthur Rylah Research Institute for Environmental Research (ARIER) to measure the costs and benefits of a range of fox control strategies. This report presents the results from the third year of implementation of the project.

In its third year, the project continued to deliver fox baiting at each of the six parks involved, as well as monitor bait-take and fox activity. Monitoring of native fauna was also established at each of the parks.

Major findings to date relate to differences in the effectiveness of different baiting strategies in reducing fox activity. At sites implementing annual baiting programs (Coopracambra and Hattah-Kulkyne National Parks), there has been substantial reduction in bait-take, which has remained low relative to the free-feed period at the start of the program. This is assumed to represent a reduction in fox abundance, and this assumption is strengthened by the trend in fox activity on sand-plots, which has been lower after poisoning began. Levels of bait-take at Coopracambra and Hattah-Kulkyne are very different. This may be a result of a difference in underlying fox density and the landscape surrounding these two parks.

A similar picture is emerging from the pulsed baiting program at Wilsons Promontory National Park where there has been an overall decline in bait-take since the beginning of the poisoning program. The relative level of bait-take at Wilsons Promontory is much higher than that for both Hattah-Kulkyne and Coopracambra. This suggests that factors other than surrounding landscape may influence fox density (e.g. reliability of food supply, local habitat complexity). This may in turn have an influence on the intensity of baiting required to manage fox populations. The pulsed program at the Grampians National Park was only initiated in 2003-04.

The two seasonal programs (Eumeralla Coastal Reserve, Little Desert National Park) do not appear to be reducing and/or maintaining a reduced level of fox abundance as indicated by bait-take. This is true of both the high-intensity and the low-intensity baiting programs at Little Desert National Park. In addition, sand-plot activity levels have been variable within seasons and from year to year. Although the landscape context of Eumeralla Coastal Reserve is different to that of Little Desert, the pattern of bait-take and sand-plot activity in this seasonal program is similar.

At all sites there remains a constant, though variable residual level of bait-take. It is not known if this is due to dispersing or immigrating foxes or a combination of both. What is clear however, is that even high-intensity, continuous programs are unable to remove all foxes for

even a short period of time. This reinforces the need to apply constant pressure on the fox population to maintain a reduced level of density.

The results from the sand-plot monitoring at Coopracambra National Park indicate that the fox control program has also brought about a change in wild dog activity levels. This is supported by results from activity monitoring undertaken on the Project Deliverance sites (Robley et. al. 2004). Reducing wild dog populations in areas of forested habitat and where they are not threatening agricultural values, may impact upon ecosystem function, although the significance of this is unknown.

Prey-species monitoring was successfully implemented in all parks, with a number of species being recorded within parks for the first time, e.g., Southern Brown Bandicoot (Coopracambra National Park) and Long-nosed Potoroo (Coopracambra National Park, Grampians National Park). These results are encouraging; however it will be a number of years before we can expect to see any changes in prey-species abundance. Initial analysis of the Project Deliverance results suggests that prey-species responses will be patchy rather than uniform, and that it may take at least 4–5 years of consistent fox control before a response is detectable.

While we made every attempt to include the critical components of experimental design in this AEM project, it was not possible to randomise treatments, collect pre-treatment prey-species monitoring data, replicate most of the treatments or establish control sites. This places some limitations on the universality of the results and will limit the robustness of the inferences that can be made.

To increase the reliability of the outcomes there are some additional sources of variation that should be accounted for, these include;

- structural complexity of the monitoring locations within each site
- previous management histories (e.g. time since last fire)
- temperature, rainfall, soil type and general floristic composition of each monitoring site.

As managers at each site become more aware that they are applying an apparent sub-optimal strategy, they will naturally wish to alter their approach. However, changing the management strategy at sites too early will limit the capacity of this project to provide a solid understanding of the real differences in the effectiveness and efficiency of different management strategies.

Similarly, managers need to be provided with adequate resources to be able to deliver fox control and monitoring consistently and in accordance with the design of the project.

Inconsistent baiting effort results in greater variation in bait-take and greater difficulty in interpreting any patterns; the same holds true for prey-species monitoring.

The Fox AEM project is progressing as planned and while trends in the effectiveness of some baiting strategies are emerging, new issues such as the landscape context and the composition of the residual fox populations, and the relationship between indices and actual changes in abundance are emerging. Prey-species monitoring has produced interesting results but, as was originally noted, it will take a number of years to provide a robust indication of the effectiveness of the different control strategies.

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INTRODUCTION

In 2001, Parks Victoria instigated a project in partnership with the Arthur Rylah Research Institute for Environmental Research (ARIER) to measure the costs and benefits of a range of fox control strategies using an Adaptive Experimental Management (AEM) approach. A detailed explanation of the Fox AEM project is presented in the Methods Section. For further information on adaptive management see Walters (1997).

In 2003-04, Parks Victoria undertook 69 fox control programs in parks and reserves across the State, with a similar number of programs running in recent years. These fox control programs mainly involve 1080 poison baitings at a range of spatial and temporal intensities. The Fox AEM project was established in response to recognition by Parks Victoria of the need to increase its understanding of the efficiency and effectiveness of its natural values management program, including the different strategies used to control foxes. The range of sites at which fox control is undertaken, and the range of strategies implemented across these sites, provide an ideal opportunity for applying an AEM approach.

This project is not intended to answer all the questions regarding the control of foxes on the Parks Victoria estate. It is intended to test the applicability of the AEM approach to pest management in Victoria's parks and reserves, as well as to examine some aspects of the effectiveness and efficiency of different fox control strategies. If the project is successful, the approach could be expanded to build a greater understanding of the best ways to deliver effective and efficient fox control.

The Fox AEM contributes to the implementation of a range of State and Federal Government strategies, including:

- State of the Parks
- Victorian Pest Management: A Framework for Action (VPMF)
- Good Neighbour Program
- Victoria's Biodiversity
- Regional Catchment Action Plans
- Threat Abatement Plan for Predation by European Red Fox
- Second Generation Landcare
- Landcare Action Priority.

Although it has been running for only three years, the Fox AEM project is already yielding some useful and interesting results. These include:

- improved understanding of the effectiveness of different baiting strategies in reducing fox activity (and by inference, abundance)
- new records for species of medium-sized native mammals in some parks
- increased understanding regarding effective monitoring of control operations
- increased sharing of experience and information between staff across the state.

This document is the annual report for the third year of the project and provides data and information on the project to date. Results on the effectiveness of the fox control program in reducing fox activity for each park and the initial results of prey species monitoring are presented. The implementation and outcomes of the AEM approach are also discussed. This report also identifies issues with the AEM approach and suggests actions for the further implementation and improvement of the AEM project.

OBJECTIVE

The objective of the Fox AEM project is to determine the relative costs and benefits of different fox control strategies by implementing a program that will:

- measure the effects of different combinations of spatial and temporal intensities of fox control on fox activity and on the responses of prey species
- measure the costs of each fox control strategy and ultimately compare the costs and benefits of the different strategies
- assess the effectiveness of the AEM approach to landscape-scale pest management.

This is the third annual report for the Fox AEM program and updates information on the progress of the project. It is not intended that this report fulfils the above objectives; rather it aims to present information on the progress of the program.

METHODS

Overview

The design of the project was developed through a series of workshops involving staff from Parks Victoria and ARIER. These workshops identified Parks Victoria's objectives for fox control, the range of control techniques applied and the questions Parks Victoria wished to address through the Fox AEM project. The proceedings of these workshops describe the process undertaken and the questions identified (Choquenot and Robley, 2001a, 2001b).

A central component to Adaptive Experimental Management programs is the use by the management agency of features of experimental design to obtain reliable knowledge about management activities. Ideally, the treatments applied at each park should have been allocated at random (Sit and Taylor 1998), which would allow for generalisation of the results. This was not possible due to the large scale of the control operations and the desire of managers to implement programs consistent with historic or proposed control strategies for each site. Pre-treatment assessments of fox and native species abundance would have allowed stronger inferences to be made about the effectiveness of the control operations. A number of parks have treatment and non-treatment sites that will allow for comparisons and trends to be assessed. However, pre-treatment variation between treated and non-treated sites can not be accounted for a priori and thus makes interpretation of differences in treatment and non-treatment sites problematic. We have attempted to replicate the timing and intensity of treatments; however, this was not possible for all combinations of timing and intensity of treatments due to some pre-existing control programs.

Study Sites

Six parks are involved in the Fox AEM project. These parks either had existing fox control operations or had a new program designed to suit this AEM project. The parks are:

- Coopracambra National Park
- Eumeralla Coastal Reserve
- Grampians National Park
- Hattah-Kulkyne National Park
- Little Desert National Park
- Wilsons Promontory National Park.

Originally, the project included Discovery Bay Coastal Park, however this site was excluded from the project at the end of 2002-03 and an alternative site was established in Eumeralla

Coastal Reserve on the nearby Codrington coast. At Discovery Bay, highly energetic tides result in Hooded Plovers (the target species) nesting far back in the secondary dune system, making monitoring changes in nest and fledgling success impossible. In addition, bait-stations are constantly eroded and baits are lost due to tidal movement. While protection of Hooded Plovers remains a concern at the site, the difficulty in implementing control and monitoring programs means that little would be gained from retaining this site as part of the overall AEM project.

The Fox AEM project will also take advantage of a large-scale fox control project known as Project Deliverance (Murray and Poore 2002), which operated in eastern Victoria between 1998 and 2003. This project will offer results from additional spatial and temporal intensities of control operation and provide a control site for Coopracambra National Park. Details of methods and sites for Project Deliverance are given in Appendix 1.

Treatment Sites (fox control)

At each of the parks involved in the project, a specific combination of timing and intensity of fox control using 1080 poisoned baits is being implemented (Table 1). The timing of baiting operations has been divided into three categories.

Timing:

- Continuous - annual programs. Baits are checked and replaced every two to three weeks throughout the year.
- Continuous - seasonal programs. These programs bait on a continuous basis but the baiting occurs within a specific period each year. The period during which baiting occurs is dictated by a number of factors including the timing of available resources, seasonal access to areas, or the period a prey-species is thought to be most at risk from predation.
- Pulsed programs. This strategy is specific to Wilsons Promontory National Park and the Grampians National Park baiting program. Baiting is continuous for a specific period with a break of several weeks between ‘pulses’ of baiting.

Note that in the first 2 years of the Fox AEM project and in the five years prior, the baiting program at the Grampians National Park was focused around the perimeter of the park. Data from the perimeter-baiting program were examined and the results presented in the 2002 - 2003 annual report (Robley and Wright 2003). It was apparent from these data that there had been no decline in bait-take over seven years and it was likely that this program was simply harvesting surplus foxes. In December 2003, this program was changed to a pulsed baiting program that operates in internal areas of the park.

Intensity:

Intensity of baiting is measured by the number of baits laid per square kilometre and is also divided into three categories:

- High >0.6 baits/km^2
- Medium 0.2 - 0.6 baits/km^2
- Low <0.2 baits/km^2

These intensities are relative to the parks involved in the project and reflect the range of control activities in place across the Parks Victoria estate at the beginning of the Fox AEM project. A full description of the baiting programs is given below. Data from Project Deliverance will be used to supplement the outcomes from the Fox AEM project and increase our understanding of fox control. Results from Project Deliverance are summarised in Appendix 1.

Table 1. The fox control strategies being implemented in the Fox AEM project.

	Timing		
Intensity	Continuous – annual	Continuous – seasonal	Pulsed
High	Hattah-Kulkyne NP Deliverance West Coast	*Eumeralla	Wilsons Promontory NP – Isthmus #Grampians NP – Red Rock
Medium	Deliverance East Coast Deliverance Stony Peak	Little Desert NP - East Block	Wilsons Promontory NP – Central **Grampians NP – Internal
Low	Coopracambra NP	Little Desert NP - Central Block	Wilsons Promontory NP – South

*this program is currently under review, ** this is a new program, # this program has been incorporated into the internal Grampians baiting program.

BAITING PROGRAMS AT EACH PARK

Coopracambra National Park

Prior to the establishment of the Fox AEM project, there was no fox control undertaken in the park. The program covers 118 km of track with 75 bait-stations spaced at 1.2 – 1.5 km intervals. 1080 poisoned FoxOff™ baits are buried 12-15 cm below the surface in specifically constructed bait-stations and bait-stations are checked and all baits replaced every three weeks.

Hattah-Kulkyne National Park

The baiting program covers approximately 60% of the park, with the remaining 40% acting as the experimental control, or non-treatment site. Baiting using free-feeds initially and then1080 poisoned liver is carried out on a continuous, annual basis with 137 bait-stations spaced at 1-km intervals and stations checked and replaced every two to three weeks. As of May 2004 liver has been replaced with 1080-poisoned FoxOff™ to comply with Department of Primary Industries' policy.

Little Desert National Park

The Little Desert has been divided into three discrete sites:

- The East Block is 477.8 km^2 containing 220 km of internal and perimeter tracks. This site has 137 bait-stations spaced at approximately 1.5 km intervals.
- The Central Block is 451.2 km^2 with 132 km of track. There are 88 bait-stations placed 1.5 km apart.
- The West Block is 374.1 km^2 and is a non-treatment site that acts as an experimental control.

The baiting program runs from approximately October / November to March / April with bait-stations checked and baits replaced every three to four weeks.

Eumeralla Coastal Reserve

This program was established to replace the baiting program at Discovery Bay Coastal Park which was removed from the Fox AEM project due to difficulties in implementing baiting and monitoring. The focus of the baiting program at Eumeralla is the protection of nesting shorebirds (Hooded Plovers). A seasonal baiting program using 1080 poisoned FoxOff™ baits, runs from October / November to March / April each year. Bait-stations are located along the northern (inland) boundary of the reserve and along the beach. Bait-stations are spaced at 1 km intervals covering approximately 44 km and these are checked and replaced every two weeks.

Monthly spotlight shooting by a professional shooter is used to supplement this program. Shooting is carried out on several private properties that adjoined the northern boundary of the reserve.

Grampians National Park

The baiting program at the Grampians National Park was altered in June 2003. The perimeter-baiting program that was in place for several years (1997- 2003) prior to the AEM project and for the first two years of the AEM project was assessed as having little long-term effect on fox abundance (see Robley and Wright 2003 for details). The new program consists of baiting 444 km of internal tracks, with 407 bait-stations placed at 1-km intervals. Baits are checked weekly and replaced two times over a period of nine weeks (with a four-week break between pulses). This is repeated four times per year beginning in mid-winter, mid-spring, mid-summer and mid-autumn. Factors determining the number of pulses per year were the availability of staff and track access at particular times of the year. However, the four pulses cover critical times in the life history of foxes, i.e. winter breeding and summer dispersal.

Wilsons Promontory National Park

Wilsons Promontory has been divided into four management areas:

- The Yanakie Isthmus, which is a high-intensity baiting area
- The Central section, which is a low-intensity baiting area
- The Southern section, which is a medium-intensity baiting area.

Fox control is not currently done in the northeast section of the park. The baiting program consists of pulsed baiting using poisoned 1080 FoxOff™ baits, with bait-stations at 1-km intervals. A pulse of baiting lasts for six to eight weeks. At the end all untaken baits are retrieved and replaced at the beginning of the next pulse several weeks later. A total of 158 bait-stations are operated within the park, with 48 in the Isthmus, 88 in the Central area and 22 in the Southern section. There is no free-feeding, and liver bait is used on beaches when increased amounts of beach-wash are available. Baits are checked every week during a pulse with taken baits replaced.

Non-treatment sites (no fox control)

Fox activity patterns and prey response can show year-to-year variation making interpretation of changes in fox activity and prey response difficult in the short term. To improve the ability to infer change related to fox control, a number of non-treatment (no baiting, experimental control) sites have been established. These will act as reference points against which changes in fox activity and potential prey responses can be measured to aid interpretation of the variation in fox and prey responses from year to year due to factors other than effects of fox control (Table 2).

It was not possible to establish non-treatment sites for each treatment or at each park due to logistical constraints. Non-treatment sites have been established at Hattah-Kulkyne and Little Desert National Parks for both changes in fox and prey-species abundance and at the Grampians National Park for changes in fox abundance only. The Stony Peak site in the Deliverance program provides an experimental control site for the Coopracambra program (for changes in fox and prey species abundance). The Stony Peak site is similar to Coopracambra National Park in terms of location, geography, geology and topography as well as the dominant vegetation communities. There is potential to implement a non-treatment site in the northeast section of Wilsons Promontory National Park, however access to this location is difficult. It would be possible to establish prey response monitoring at the non-treatment site in the Grampians, however financial and logistical constraints prevent this.

Table 2. Parks with areas that are designated non-treatment sites.

Park	Location of non-treatment (control) sites	Baiting programs non-treatment sites provide control for
Hattah-Kulkyne NP	Eastern section of park	Western section annual high-intensity baiting program
Grampians NP	Outside internal baiting area	Pulsed baiting program covering internal area
Little Desert NP	Western Block	Seasonal eastern (High) and central (Medium) blocks baiting
*Project Deliverance	East Coast West Coast Stony Peak	West Coast annual high-intensity, and East Coast and Stony Peak annual medium-intensity baiting

*These sites are monitored as part of Project Deliverance.

RESPONSE OF FOXES

Initial Knockdown

The percentage of baits taken over time is often used to measure the effectiveness of a control program. This is calculated by dividing the number of baits taken by the number of baits available and standardised by the number of days between checks. This takes into account that some bait was not available and that the time baits were available varies between checks. The advantage of using percentage bait-take is in its operational efficiency, it is simple to calculate and data are collected in the course of implementing the control program. This measure is particularly useful where there has been a period of free feeding (Coopracambra and Hattah-Kulkyne National Parks) prior to fox control operations (Saunders et. al. 1995).

The effectiveness of the initial knockdown period was analysed by comparing the difference between indices recorded before (i.e. during the free-feed period) and after poison-baiting had commenced to quantify the effect of 1080 poisoning on fox populations. The mean bait-take was first arcsine transformed prior to being compared using Student's t-test. Pre- and post-baiting sample variances were compared for homogeneity using Bartlett's test before t-tests were used to determine the effects of the 1080 poisoning campaign.

Sustained Control

To look at the long-term impact of baiting we used generalised linear modelling (GLM) to undertake an analysis of covariance (ANCOVA). We examined the change in the rate of bait-take between seasons or years depending on the program. We plotted arcsine transformed daily bait-take against time. Time was calculated as the number of days between successive baiting periods (generally every three weeks) from the beginning of each season or year. If baiting was reducing the size of fox populations we would expect a decline in bait-take through time.

The baiting program in the Grampians was changed from a continuous program to a pulsed program in December 2003. Baiting is now undertaken four times per year for nine weeks in later winter, spring, summer and autumn. However, as data are only available for the first 4 months of this program, we present only mean, standard error and 95% confidence limit estimates for bait-take in this report.

Decline in Abundance

Caching of baits, multiple bait-takes by foxes and bait-take by non-target species can influence the usefulness of bait-take as a measure of success (Saunders *et. al*. 1999).

Hence, an independent measure of changes to fox activity is also required to assess the usefulness of bait-take as an index of fox activity (see Changes in fox activity below).

To provide an indication of the number of foxes that the baiting programs have removed from a park to date, we assess the number of baits 'taken'. We assume (conservatively) that 25% of 'taken' baits are not available to foxes either because they have been cached and not eaten (see Thomson and Kok 2002), taken by a non-target species, or were not lethal when taken. It is also assumed that of the remaining 'taken' baits, each one has killed a fox.

These figures are presented to provide a feel for the number of foxes that each program is affecting. The actual relationship between baits taken by foxes and the reduction in abundance is not known.

Changes in fox activity

Fox activity monitoring using sand-plots is being done to measure the effectiveness of control operations independent of bait-take and may more closely reflect true changes in fox activity. Fox activity is monitored before and after seasonal control operations or periodically during continuous programs by recording the presence of fox prints on sand-plots. Sand-plot monitoring involves laying sand across low-use vehicle and walking tracks and checking the sand-plots periodically to record the presence of species prints. The number of sets of fox prints on a sand-plot is used to calculate a relative index of activity (Allen *et. al*. 1996, 2003).

In addition to fox activity, the activity or presence of other predators (dingoes / wild dogs and feral cats) and native species are also recorded using this method. Results from this project will be used to investigate the relationship between changes in fox activity as measured by sand-plots and through percentage bait-take. It is hoped that we will be able to determine a meaningful relationship, allowing us to rely solely on bait-take to monitor activity in future, which is operationally more efficient than sand-plot monitoring.

Response of native species

To determine which of the combinations of timing and intensity of fox control being tested in the Fox AEM project produce a positive biodiversity gain, a set of monitoring protocols for species considered as being at risk from fox predation has been developed (Robley and Choquenot. 2002). The next step was to determine which of these species are present in the parks involved in the Fox AEM project, and to collect that information in a way that allowed the level of effort required to detect changes in species abundance to be determined (Robley and Wright 2003).

To be able to detect a doubling of the population over a several-year period it was determined that seven trap sites operated over two sampling sessions each in late spring /

early summer would provide sufficient data to assess changes in abundance. We anticipate that this level of effort will be sufficient to do so, with 85% confidence that a change has taken place and that we have not erroneously concluded an increase had occurred. However, the monitoring protocols will not allow us to differentiate between a perceived increase in population due to changes in prey behaviour and a real increase in the population.

Prey-species monitoring

Sites for prey-species response monitoring within each park were selected on the basis of either records in the Atlas of Victorian Wildlife, suitability of habitat based on descriptions in the literature of species habitat requirements, local knowledge provided by Parks Victoria staff, or a combination of all three.

Seven sites were established at Coopracambra, Wilsons Promontory and the Grampians National Parks, while 21 sites were established at Little Desert National Park (7 in each block) and 14 sites were established at Hattah-Kulkyne National Park (seven in the baited area and seven in the non-baited area) (Table 3). Monitoring at Eumeralla Coastal Reserve occurred over most of the baited area.

Cage traps were used in the Grampians, Wilsons Promontory and Coopracambra to assess changes in prey-species abundance. At each trap site within the park, traps were laid out in three lines of 10 traps, with traps spaced at 25-metre intervals and lines spaced at 50-metre intervals. Traps operated for several nights over two sessions with a minimum of two weeks and a maximum of four weeks between sessions.

At the Grampians National Park an additional four sites were selected for monitoring Smoky Mouse, Heath Mouse and Pygmy-possums. At each of these sites, 20 Elliott traps were positioned on the ground and spaced at 25-metre intervals in two lines of ten traps. Lines were separated by 50 metres. Traps were baited with a blend of honey, peanut butter and oats and monitored for several nights.

In all cases, captured animals were individually marked to enable recaptures to be identified and facilitate data analysis. Traps were covered with a plastic bag, placed under shrubs to provide shelter and some nesting material placed inside each trap. All traps are visited as close to dawn as possible to reduce trap-induced stress. All trap-deaths are recorded as specimens lodged with the Museum of Victoria.

Pit-fall traps were used at Little Desert and Hattah-Kulkyne National Parks. At each trap site, two lines of 20 buckets (290 mm diameter x 400 mm deep) were placed 10 metres apart. Each bucket was individually numbered. A ‘Y’-shaped fibreglass flywire drift-fence, held erect by steel pegs, was placed over each bucket. The arm of each section of the 'Y' extended 2 metres from the centre of the bucket. Buckets were not baited and were monitored daily for several nights. Animals were individually marked to enable recaptures to be identified and to facilitate data analysis. Buckets were operated over several nights for two sessions with a minimum of two weeks and a maximum of four weeks between sessions. Nesting material (small polystyrene cups or cardboard rolls) was provided in all traps. At these sites the herptofauna was grouped based on Agamids (dragon) Gekkonids (geckos) Pygopodids (lizards) Scincids (skinks) and snakes (families have been grouped into one class) to make summarising the data easier.

Monitoring at Eumeralla Coastal Reserve used the protocol for monitoring Hooded Plovers developed by Weston and Morrow (2000) and details are given in their report and in Ressom (2001). Briefly, the method used to survey Hooded Plover nest success at Eumeralla Coastal Reserve involved searching for and rechecking nests weekly over the period September – March, covering as much of the area in which fox baiting occurs as was feasible. For each nest, the presence of eggs and chicks was recorded when first detected, and the fate of nests, eggs and chicks was recorded on subsequent visits. As far as possible, the timing and duration of searches was kept consistent each month.

Two approaches were adopted to locate nests: 1) observing the behaviour of adult birds, and 2) methodical searches of suitable habitat. Once a nest was located, its location was recorded on a Global Positioning System to allow the nest to be quickly rechecked at a later date. Flagging tape was used to mark the general location of the nest, but was placed several metres away from the nest.

Table 3. Detection techniques used at each park, the number of sites selected and the nominal target species for each park.

Park	**Detection Technique**	**Number of trap sites**	**Target Species**
Hattah Kulkyne NP	Pitfall bucket traps	14 (7 treatment, 7 non-treatment)	Mallee Ningaui Mitchell's Hopping Mouse
Little Desert NP	Pitfall bucket traps	21 (7 in each of the three blocks)	Silky Mouse Western Pygmy Possum
Grampians NP	Elliott traps Cage traps	4 7	Long-nosed Potoroo Southern Brown Bandicoot Smoky Mouse Heath Mouse
Codrington	Nest, egg and chick survival	20 km coast line	Hooded Plover
Wilsons Promontory NP	Cage traps	7	Long-nosed Potoroo Southern Brown Bandicoot
Coopracambra NP	Cage traps	7	Long-nosed Bandicoot Ringtail Possum Long-nosed Potoroo

			Southern Brown Bandicoot Long-nosed Potoroo

RESULTS

Results from the 2003-2004 year of the Fox AEM project are presented with the previous year's (2002-2003) results. Results for bait-take and fox activity monitoring are presented separately for each park. We also present a comparison of bait-take and fox activity among parks to evaluate the effectiveness and efficiency of each control strategy to date.

The 2003–2004 year was the first year the complete prey-species response monitoring protocol was implemented at each site. Prey-species monitoring results are presented in a separate section of the results.

Fox control – Annual programs

Hattah-Kulkyne National Park

Bait-take

Although fox control at Hattah-Kulkyne was planned as a continuous, annual program, it has been punctuated by periods where baiting was not undertaken (Figure 1) due to discontinuity of staff and resources. This highlights one of the difficulties in implementing continuous baiting programs over the long-term. The impact of this disruption on the overall effectiveness of the control program is difficult to determine. It is likely that the ecotone between the natural habitats of the park and the adjacent agricultural habitats provide a diversity of food resources for foxes. Foxes from these ecotonal areas would provide a ready source of immigration into the Park.

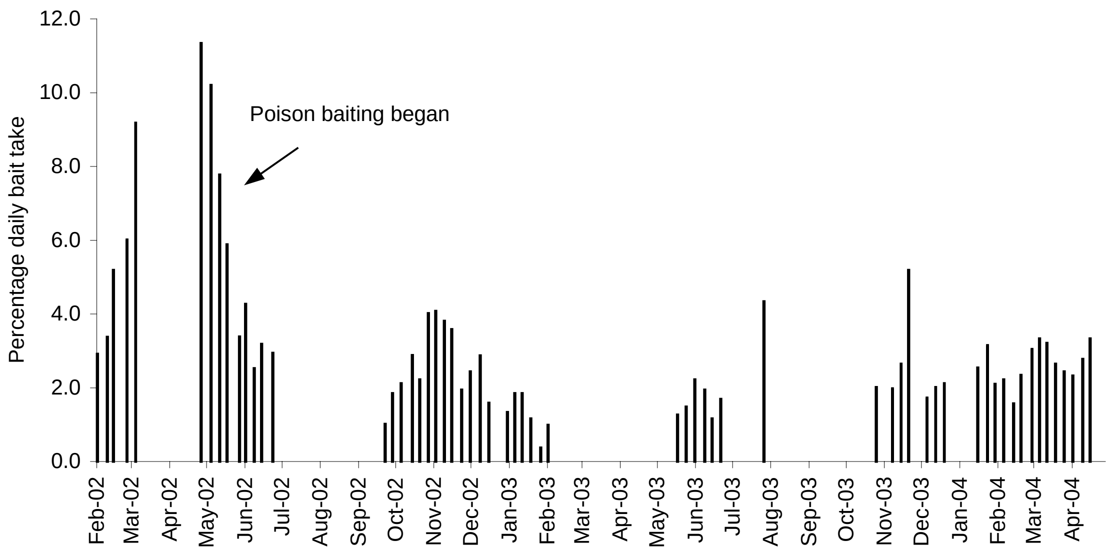


Figure 1. Percentage Daily Bait-take at Hattah-Kulkyne National Park.

Initial Knockdown

Students t-test on the arcsine transformed data revealed a significant difference between free-feed and poison bait-take ($t = 3.41$, $p = 0.014$, $df = 6$). Indices of abundance, similar to ours, assume that baits are interfered with at random. However, this assumption is violated because of contagion (Bamford 1970) that is manifested in the data as progressively higher frequencies of interference with baits. To remove the effects of contagion, percentage bait-take should be calculated from data collected after the asymptote has been reached, this has not be done in this case as free-feeding ceased before the asymptote was reached.

Sustained Control

We found a significant difference between years in the rate of bait-take ($F_{1,50} = 22.61$ $p = 0.00$) (Figure 2). In the first year bait-take declined steadily, while in the second year the rate of bait-take was constant ($F_{1, 48} = 13.58$ $p = 0.001$).

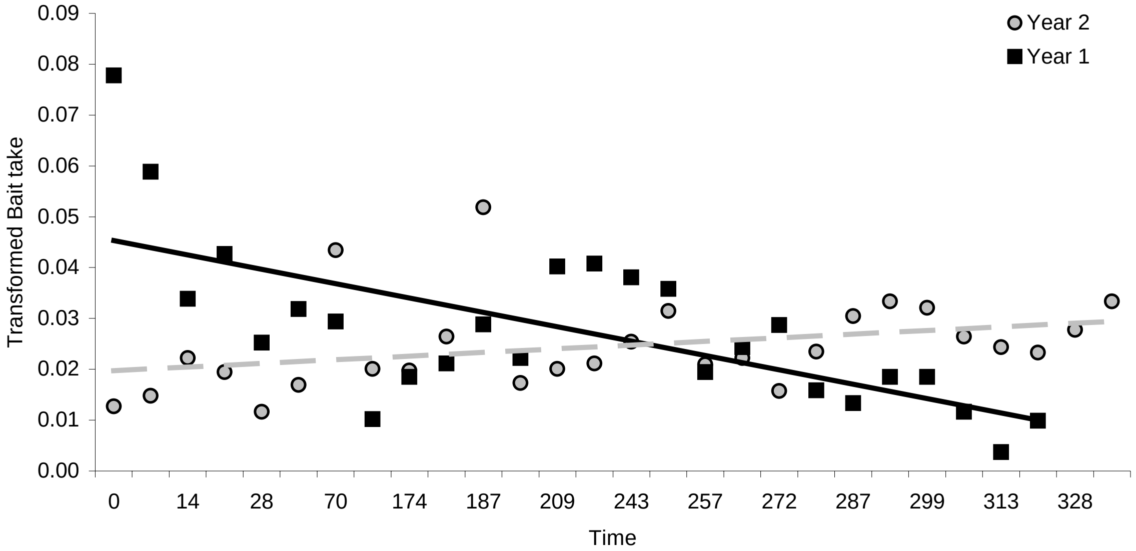


Figure 2. Difference in bait-take between the first and second year of poisoning at Hattah-Kulkyne National Park. Percentage bait-take was converted into proportions and arcsine transformed. Time is the number of days from the beginning of each baiting year.

Changes in fox abundance

Between January 2003 and May 2004 a total of 4185 baits were laid. The majority of baits were not taken by foxes and showed no signs of being disturbed. Of the baits laid, 3048 (72.8%) were removed and destroyed by Parks Victoria staff. Of the remaining baits, 169 (4%) were disturbed, i.e. the bait-station was investigated by an animal but the bait remained in place and was eventually collected and destroyed, 277 (6.6%) were dug up and left at the bait-station. The remaining 690 baits (16.5%) were taken, most likely by foxes. If we assume that 25% (173 baits) were cached and not eaten then 517 baits were presumably consumed by foxes in the 16-month period. This represents an average 32 foxes / month removed from Hattah-Kulkyne National Park between January 2003 and May 2004.

Activity monitoring

Fox activity in the baited area at Hattah-Kulkyne decreased markedly (89%) after the poison baiting program began in late March 2002 (Figure 3). Fox activity also decreased significantly (74%) on the non-treated site following the beginning of the fox control operation. This suggests that the non-treatment site may not be wholly independent from the treatment site. The non-overlapping 95% confidence limits post-poisoning suggests that despite the possible non-independence activity was higher on the non-treatment site. Data for early 2003 have been collected but are not available for inclusion in this report.

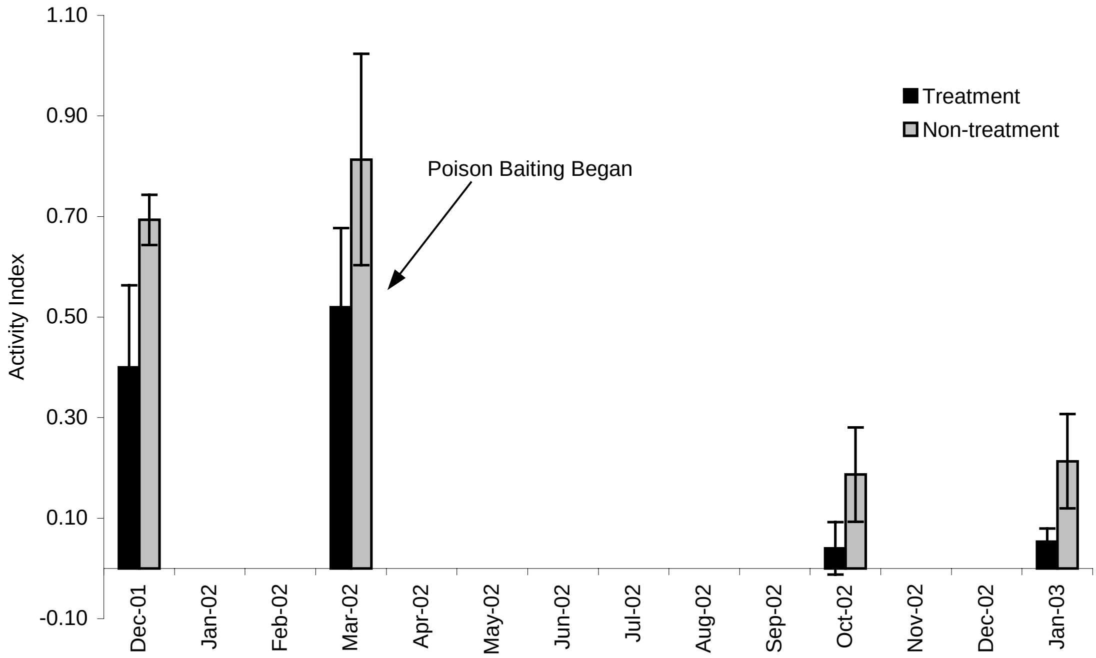


Figure 3. Fox Activity at Hattah-Kulkyne National Park. Bars are 95% confidence limits.

Coopracambra National Park

Bait-take (Foxes)

A free-feed period using non-poisoned FoxOff™ baits was undertaken between December 2001 and late January 2002 and poison baiting began in January 2002. The continuity of the baiting program has been maintained with a combination of contract and staff time. The discontinuity of contracts has placed strain on staff resources.

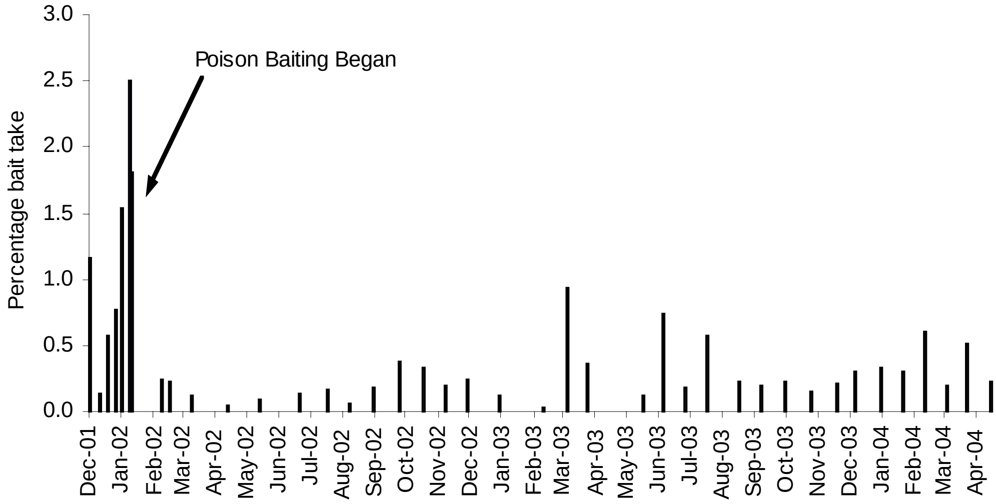


Figure 4. Percentage daily bait-take for foxes at Coopracambra National Park.

Initial Knockdown

There was a significant difference between the free-feed period and the poison bait-take ($t = 2.28$, $p = 0.03$, $df = 38$).

Sustained Control

We also tested the difference in the rate of bait-take between the first year (Jan-02 – Dec-02) and second year (Jan-03 – Dec-03) using the GLM approach used for Hattah-Kulkyne National Park.

We found no significant difference between years in the rate of bait-take ($F_{1,28} = 0.54$ $p = 0.48$), i.e. the rate of decline in bait-take in the first year was not significantly different than in the second year (Figure 5). This suggests that following the initial decline immediately following the free-feed period bait-take has stabilised at a constant lower level.

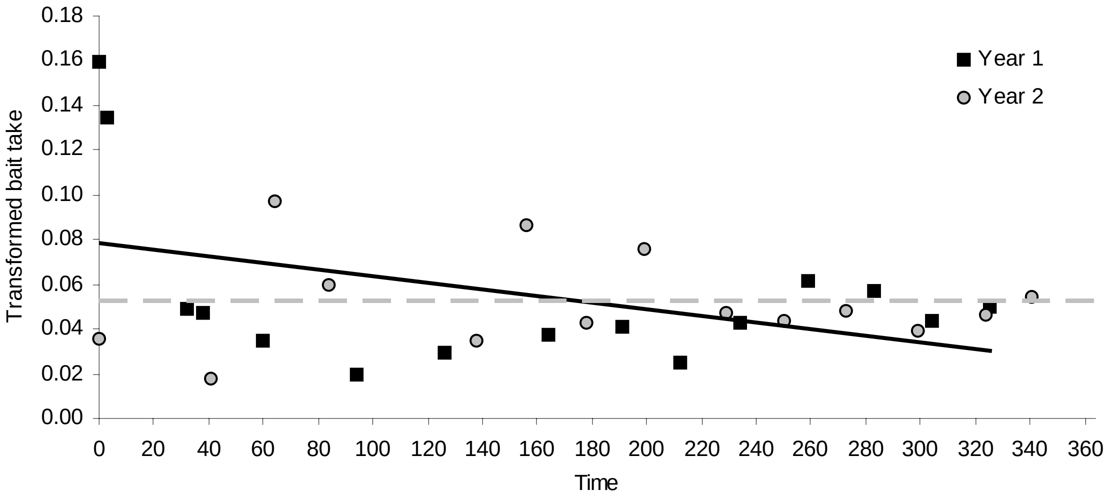


Figure 5. Bait-take across time for the first and second year of the poison-baiting program. Bait-take was converted into proportions and arcsine (square root) transformed. Time is the number of days since the beginning of poisoning in each year. Lines are regression lines.

Bait-take (Dogs)

Bait-take attributed to dogs during the free-feed period was more consistent than for foxes (Figure 6). Bait-take during the free-feed period was assessed weekly. This frequency of inspection may have been adequate to allow contractors to determine the species that had dug up the bait, however it is important to note that the ability to differentiate fox and dog sign reliably varies with the experience of the operator. We have assumed the operators' experience was sufficient to correctly distinguish fox and wild dog prints. If operators were able to differentiate bait-take by foxes and dogs reliably, then the consistently low level of bait-take after the commencement of poisoning would suggest that this poisoning program has reduced the abundance of wild dogs (Dingoes and their hybrids).

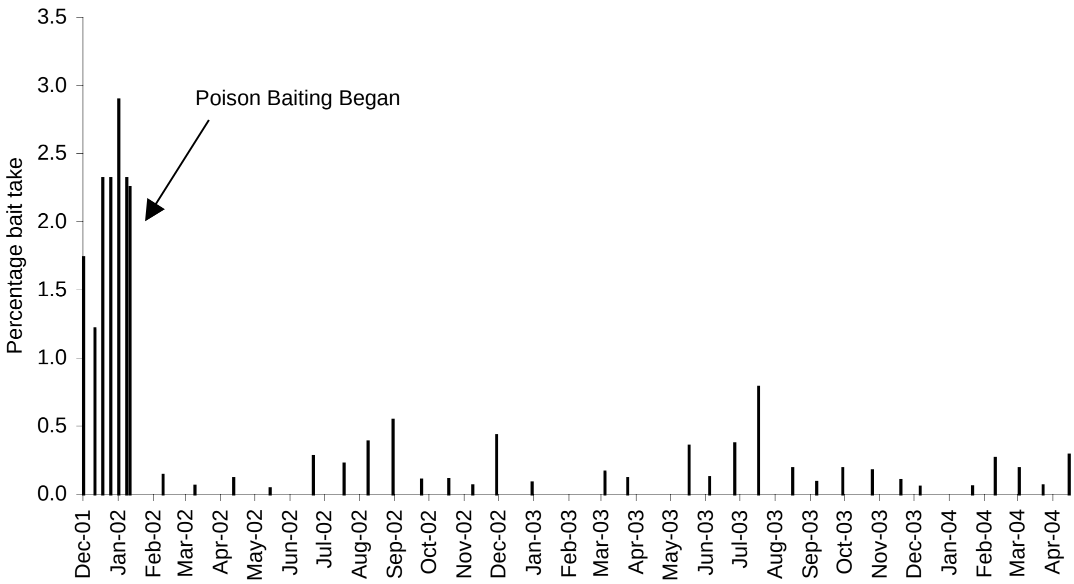


Figure 6. Percentage daily bait-take for dogs (Dingoes / Wild Dogs) at Coopracambra National Park.

Initial Knockdown

The results from the student t-test for unequal variance showed that there was a significant difference in bait-take between the free-feed and the time since baiting began ($t = 9.67$, $p < 0.00$, $df = 6$).

Sustained Control

We also tested the difference in the rate of bait-take between the first year (Jan-02–Dec-02) and second year (Jan-03–Dec-03) using GLM approach used for Hattah-Kulkyne National

Park. We found no significant difference between years in the rate of bait-take ($F_{1, 27} = 2.13$ $p = 0.16$), i.e., the rate of decline in bait-take in the first year was not significantly different than in the second year (Figure 7). This suggests that following the initial knockdown immediately following the free-feed period bait-take has stabilised at a constant lower level.

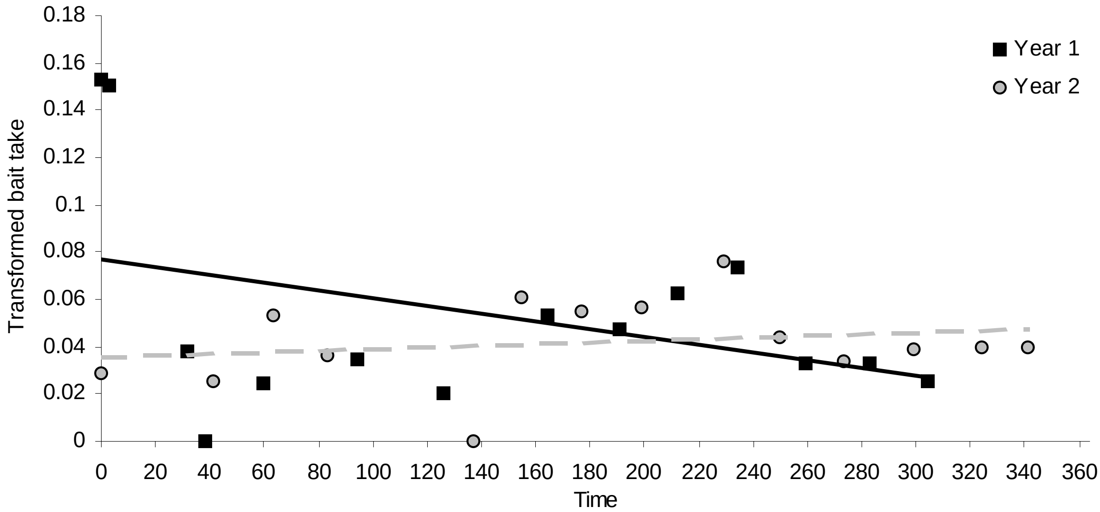


Figure 7. Difference between the first and second year of poison bait-take by wild dogs. Bait-takes were converted into proportions and arcsine (square root) transformed. Time is the number of days since the beginning of poisoning in each year. Lines are regression lines.

Change in Predator Abundance

Of the total number of baits laid between March 2003 and May 2004 185 were taken (13.6%; foxes and dogs combined). If we assume that 25% of these were cached (see explanation Hattah-Kulkyne National Park) and not eaten then 125 foxes and wild dogs have been removed during the 14-month period. Of the baits laid during this period 1.5% (19) were dug up and exposed, but not taken and 4.7% (64) were disturbed but not dug up, indicating that for some of the time baits were not attractive or palatable.

Activity monitoring (Foxes)

Fox activity monitoring is scheduled to be undertaken four times per year (i.e. once every three months [Figure 8]). However, as a result of weather making access difficult or lack of availability of staff or contractors this schedule has not been met each year. Poison baiting began in late January 2002. Fox activity was measured twice prior to poisoning. Following the instigation of poison baiting fox activity declined, however it has remained variable and this variance confounds the interpretation of the impact the poisoning program has had on the level of fox activity. For example, in May and October in 2003 and April 2004 activity was no less than during the pre-poisoning period.

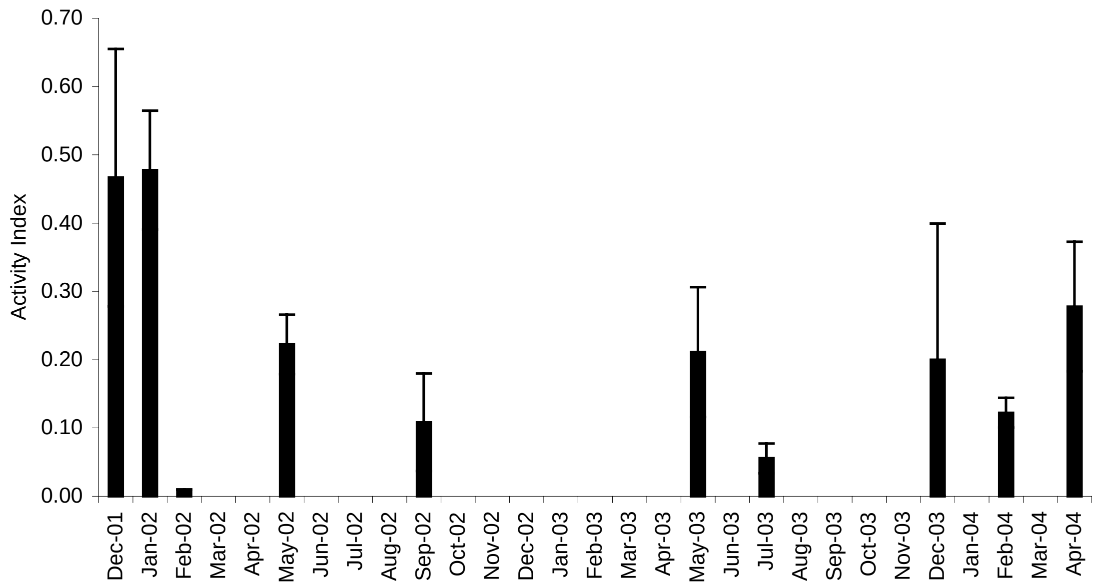


Figure 8. Fox activity at Coopracambra National Park. Baiting began in late January 2002. Bars are 95% confidence limits.

Activity monitoring (Wild Dogs)

The activity of wild dogs has remained highly variable since monitoring began and there is no real discernible trend in the data (Figure 9). This may be a reflection of the highly mobile nature of wild dogs (typically they have home ranges 3 times as large as foxes) or the difficulty in differentiating between fox and dog tracks or a combination of both.

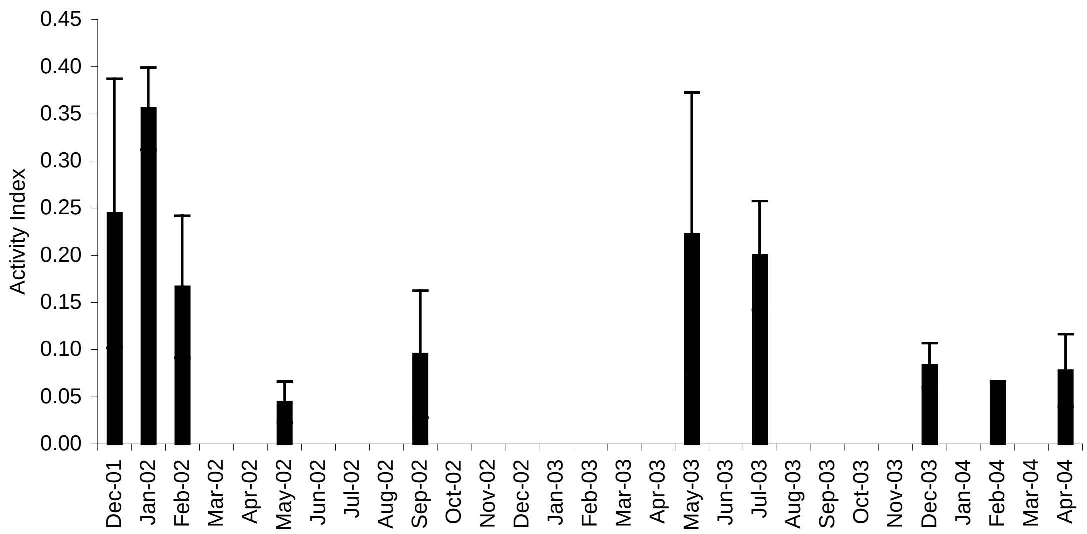


Figure 9. Dog activity at Coopracambra National Park. Baiting began in late January 2002. Bars are 95% confidence limits.

Activity monitoring (Cats)

Feral cat tracks have been recorded on sand-plots on seven of the ten sampling occasions. The three sessions that cats were not detected were in January, February and May 2002 (Figure 10).

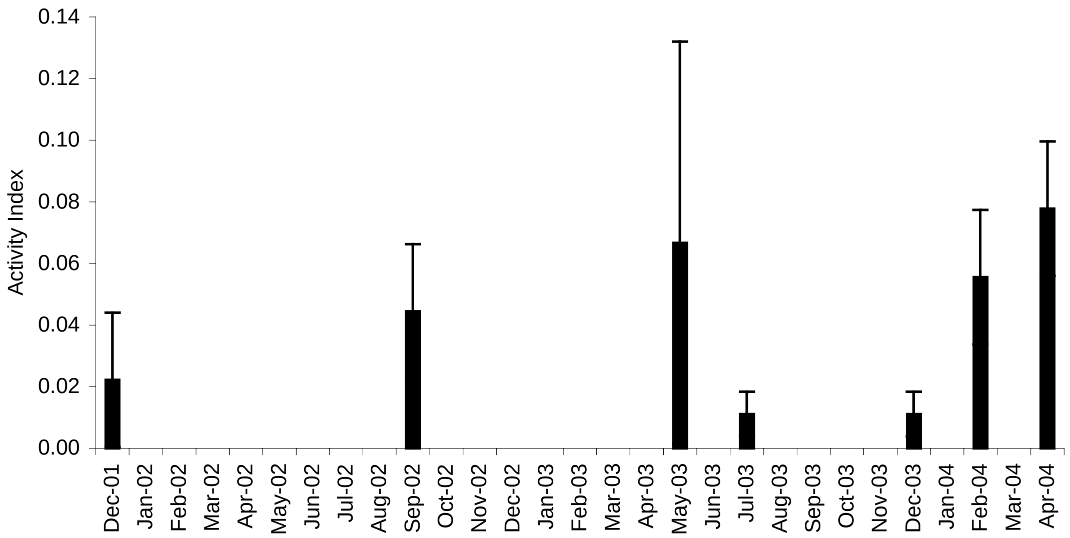


Figure 10. Cat activity at Coopracambra National Park. Baiting for foxes began in late January 2002. Bars are 95% confidence limits.

Fox Control - Seasonal Programs

Little Desert National Park

Bait-take

Three different treatments are applied at Little Desert National Park, with baiting being applied at different intensities in the Central and Eastern Blocks of the park. There was no free-feeding prior to the commencement of the Fox AEM as this program was already under way.

Sustained Control

We analysed the pattern in bait-take within each season and across the three years (01/02, 02/03, and 03/04) for each treatment block (Eastern and Central) separately. In the Eastern Block there was not significant difference within season ($F_{1, 15} = 1.12$ $p > 0.01$) or between years ($F_{1, 15} = 1.12$ $p > 0.01$). On the Western Block there was no difference within season ($F_{1, 16} = 2.73$ $p > 0.01$) but there was an effect between years ($F_{1, 16} = 7.15$ $p < 0.05$). The effect of treatment was due to higher bait-take in the Central Block in year two than in year one. There was a significant difference in bait-take among the two treatment intensities in year one (non-overlapping 95% confidence intervals) but not in any other year (Figure 11).

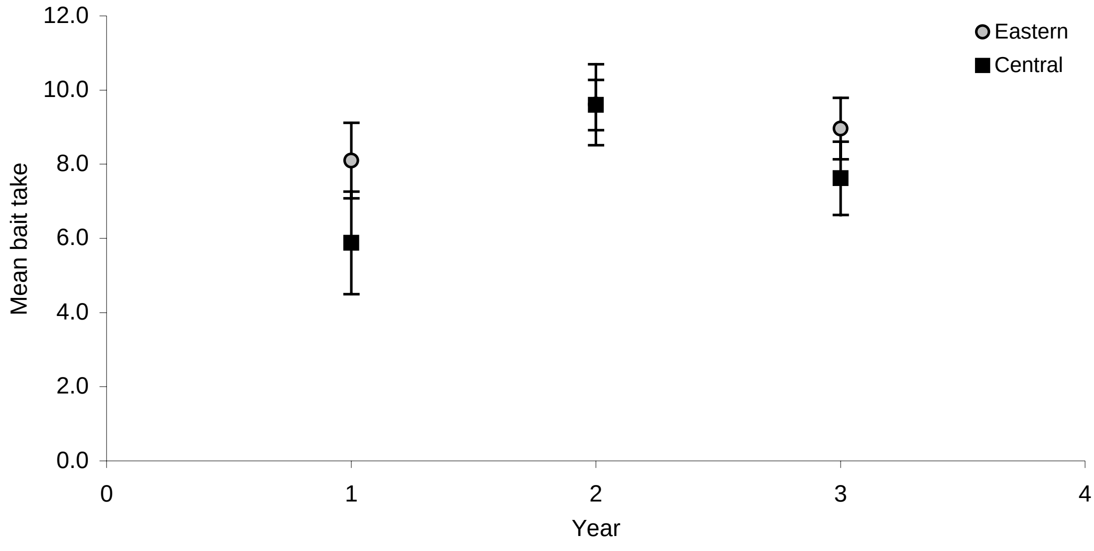


Figure 11. Percentage daily bait-take on each block at Little Desert National Park over the first three years of the Fox AEM project. Bars are 95% confidence limits.

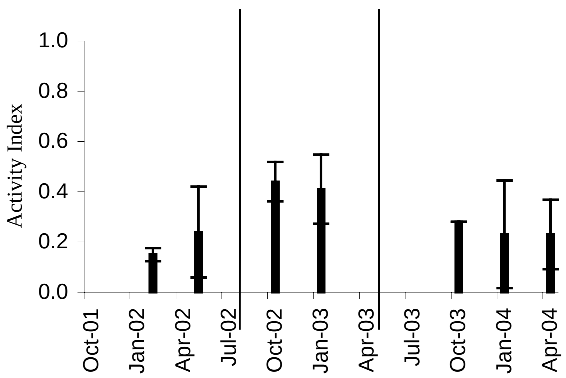
Change in Predator Abundance

Of the total number of baits laid between November and March 1024 (31%) were taken from the Eastern Block and 898 (33%) from the Central Block. If we assume that 25% of these were cached (see Methods Section) and not eaten, then 256 and 225 foxes have consumed a bait, and assuming these were lethal, have been removed during this program from the Eastern and Central Blocks respectively.

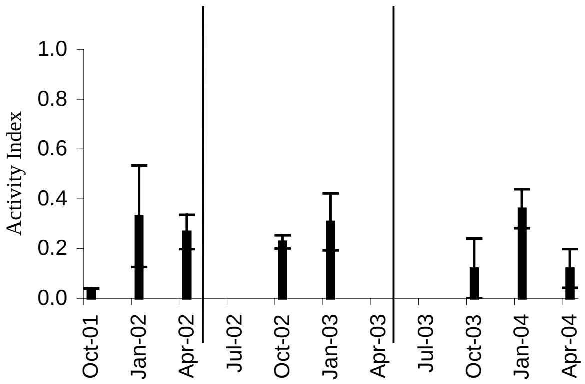
Activity Monitoring

Fox activity in the Eastern Block (high-intensity baiting) was higher in year two than in the first year and the third year (2003-2004) (Figure 12a). However, there was no difference between the first and third year, suggesting year-to-year variation in fox activity but no sustained or longer-term decline since the program began. Activity in the Central Block (low-intensity) has remained relatively consistent among years, with some within-year variation (Figure 12b). In the Western Block (non-treatment), activity appears to have declined after Apr-02 in the first year and then remained at a lower level, with the lowest activity level being recorded in Apr-04 (Figure 12c).

a)



b)



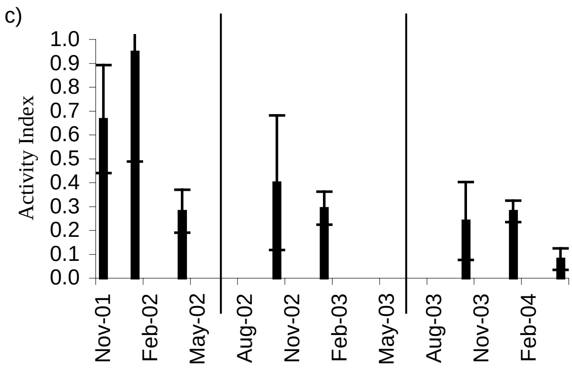


Figure 12. Activity index of foxes in a) Eastern Block, b) Central Block and c) Western Block of Little Desert National Park. Bars are 95% confidence limits.

Eumeralla Coastal Reserve (Codrington)

Bait-take

Bait-take was variable across the program with no overall decrease in percentage daily bait-take being evident through time. However, while no net decline in bait-take was evident, visual inspection of data (Figure 13), suggests a cyclical nature to bait-take, with a general decline to mid-December apart from a single spike in late-November. This was followed by an increase to mid-January, another decrease to mid-February and a slight increase towards the end of the program.

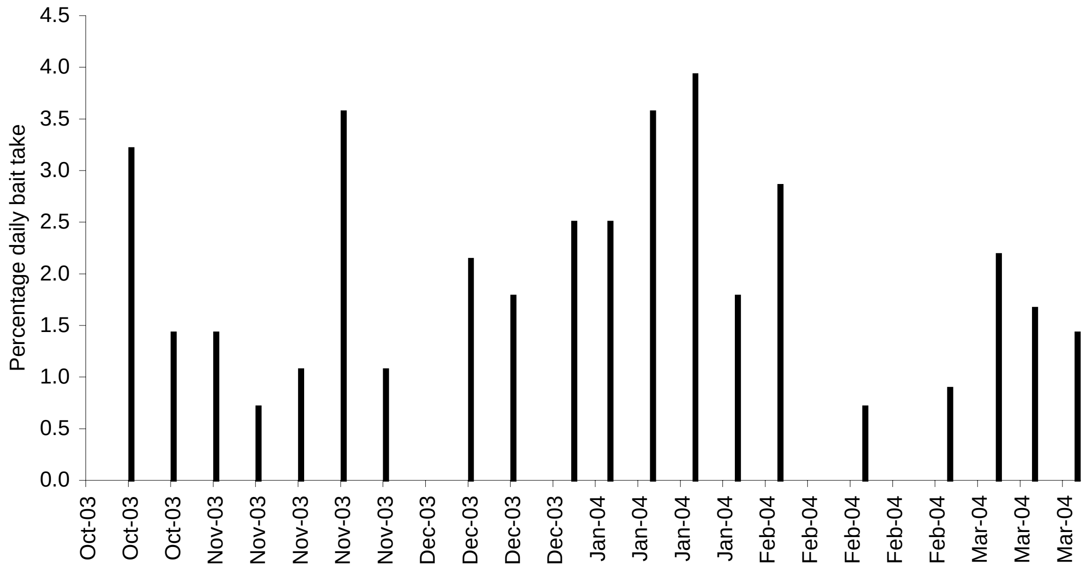


Figure 13. Percentage daily bait-take at Eumeralla Coastal Reserve.

Change in fox abundance

Of the 466 baits that were laid between October 2003 and February 2004, 160 (34%) were taken. If we assume that 25% (40) of these baits were cached, or not eaten, then 120 were presumably eaten by foxes.

Fox Control (Shooting)

The unique geographical configuration of Eumeralla Coastal Reserve, a linear coastal strip no wider than 1 km and backed by farming enterprises, and its size (1515 ha) allows the additional control tactic of shooting that would not necessarily be used in much larger parks. Shooting was conducted between November 2003 and February 2004 on the private property adjoining the reserve. This coincided with the poison-baiting program. A licensed professional shooter operated over 140 nights on seven properties. The date, sex, estimated age and location of all foxes shot was recorded.

A total of 39 foxes were shot, 11 females and 28 males. Foxes were separated into age classes based on the age assigned to them by the shooter. The number of foxes shot in each age class is shown in Figure 14. The majority of foxes that were shot (59%) were pups.

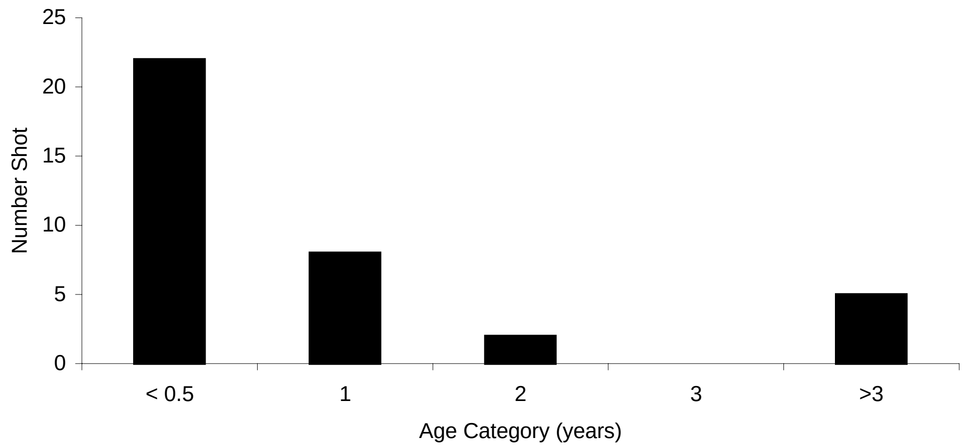


Figure 14. Age distribution (years) of foxes shot adjacent to Eumeralla Coastal Reserve.

Activity monitoring

Fox activity showed no detectable difference from beginning to end of the Hooded Plover breeding season (Figure 15).

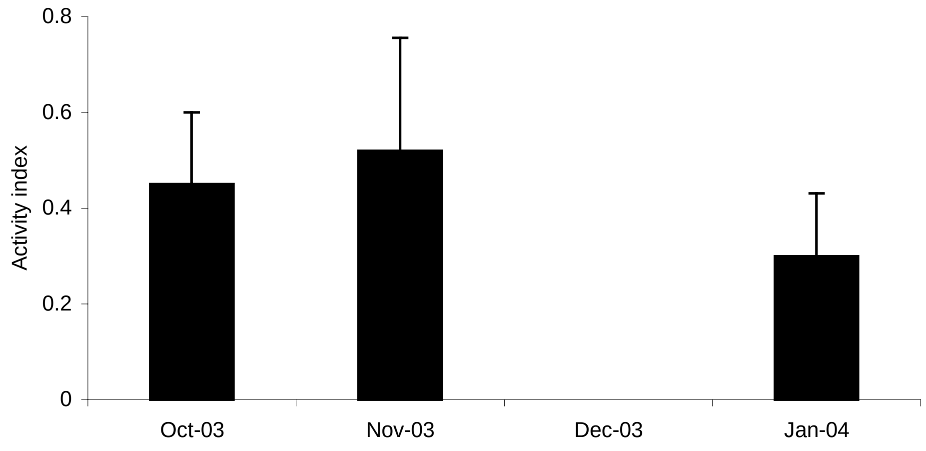


Figure 15. Fox activity for Eumeralla Coastal Reserve. Bars are 95% confidence limits. Note: monitoring was undertaken over only two days in January due to bad weather.

Fox Control - Pulsed Programs

Grampians National Park

Bait-take

An initial pulse was planned for winter 2003, however, this was not implemented due to delays in establishing bait-stations caused by inclement weather conditions and proximity of establishing baits at the end of the perimeter-baiting program. The first pulse was undertaken in late October to early December 2003 and the second in late January to early March 2004. Figure 16 shows the daily percentage bait-takes for each pulse.

Initial Knockdown

Bait-take increased steadily during the first pulse until its completion, with no sign of the rate of bait-take declining ($\bar{x}$ 1.8, SD 1.05, 95% CL 0.62 – 1.48). This is not surprising as the rate at which foxes encountered bait-stations would have increased with time. Bait-take was generally higher during the second pulse ($\bar{x}$ 2.14, SD 0.82, 95% CL 1.48 – 2.80).

As a crude comparison, the mean daily percentage bait-take for the previous perimeter-baiting program was higher than has been recorded during the two pulses of the new program ($\bar{x}$ 4.4, SD 2.0, 95% CL 3.9 – 4.9). This comparison needs to be interpreted with caution, as the two programs are quite different in the spatial layout and the number of baits laid.

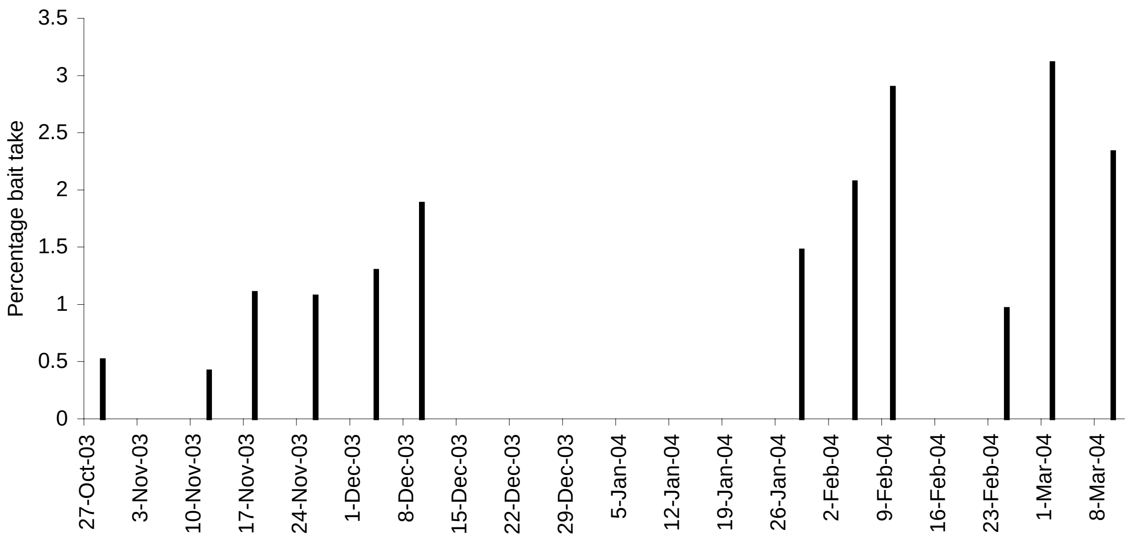


Figure 16. Percentage Daily Bait-take, Pulse 1 and 2, Grampians National Park.

Changes in fox abundance

In each pulse 2400 baits were laid. The majority of baits were not taken and showed no sign of being disturbed. Of the baits laid, 4290 (88%) were removed and destroyed by Parks Victoria staff. Of these 30 (0.7%) were disturbed i.e. the bait-station was investigated by an animal but the bait remained in place and was eventually collected and destroyed and 10 (0.2%) were dug up but left in situ. The remaining 578 baits (12%) were taken, mostly by foxes. If we assume that 25% (144) of these were cached and not eaten then 433 baits were taken and presumably eaten by foxes over the two pulses.

Whether this rate of removal of foxes is sufficient to allow native species to respond faster than the fox population can replace poisoned individuals, either by reproduction, immigration or a combination of both, and what the source of these foxes is, remains unanswered at present.

Activity Monitoring

Sand-plot activity monitoring in the Grampians has undergone a number of modifications since the project began. In 2002, sand-plots were constructed as 1 m x 1 m plots set off to the side of tracks. This was done as it was thought vehicle traffic on many of the tracks could affect the results. In 2003, these sand-plots were rebuilt as strips across tracks in less accessible areas. These strips were 1 m wide and spanned the width of tracks. This resulted in an increased rate of detection. As a consequence of this change in sand-plot design, data from 2003 cannot be directly compared to results from previous years.

Of the 16 sand-plots established in the Grampians, seven are wholly located inside the new baited area (including the old Red Rock area), four are on the boundary of the baited and unbaited area, and five are located outside the baited area.

The initial monitoring session for the newly designed sand-plot monitoring program was undertaken in December 2003 (Figure 17). This was after the first baiting session under the new regime. There was no detectable difference in fox activity between the baited and unbaited area. A second monitoring session was undertaken in March 2004 during the second pulse. The 95% confidence limits between the baited and unbaited area did not overlap, indicating fox activity was less in the unbaited area than in the baited area.

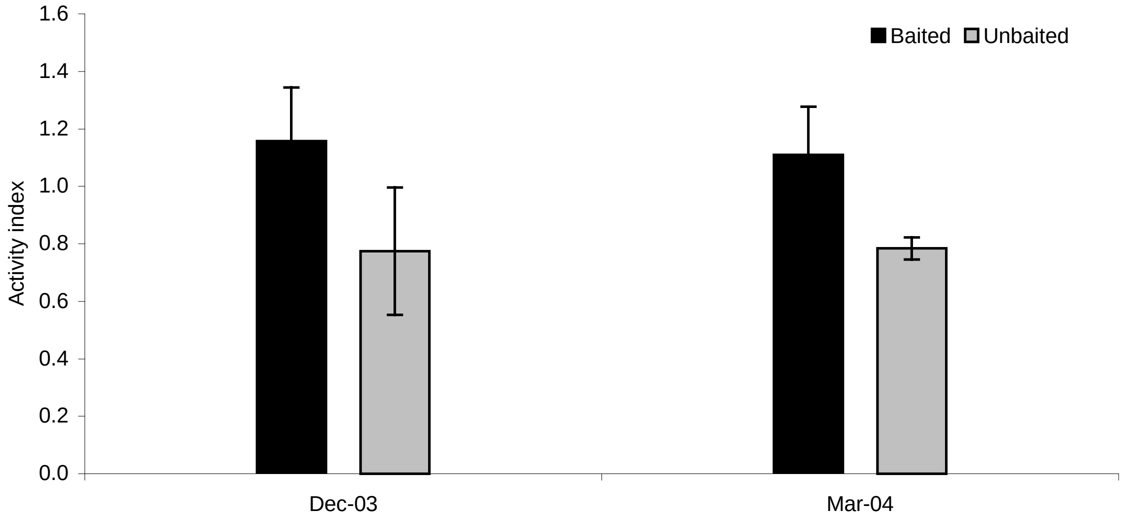


Figure 17. Fox activity for the first two pulses of the new baiting regime. Bars are 95% confidence limits.

Wilsons Promontory National Park

Bait-take

The Wilsons Promontory baiting program differs from the Grampians in that three different intensities of baiting are applied in different areas of the park, there are four pulses per year and the program has been in place since April 2001.

Initial Knockdown

Analysis showed that bait-take differed with time, but not with baiting intensity, with a significant interaction between time and baiting intensity ($F_{1, 2} = 17.5$ $p > 0.001$).

Given that there was no significant effect of baiting intensity we combined the three areas and averaged the percentage daily bait-take to look at the overall trend (Figure 18). Bait-take declined steeply from April 2001 (the period of the first pulse) to November 2001 (the period of the third pulse), and has remained relatively constant and below that of August 2001 since then. The non-overlapping confidence limits strongly suggest that the first year of the pulse program was effective at reducing bait-take, and that this program has maintained a lower level of bait-take in the subsequent two years.

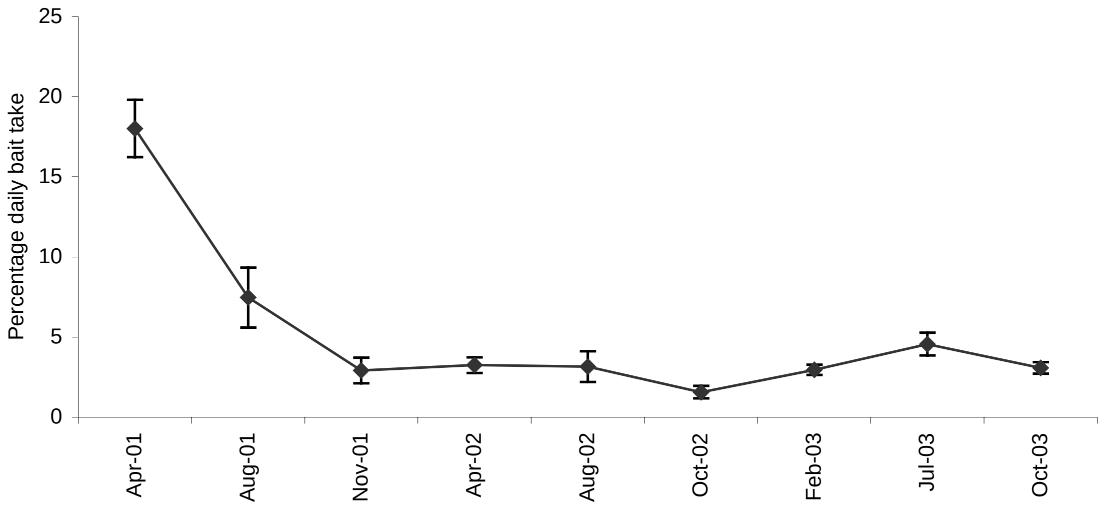


Figure 18. Overall percentage daily bait-take per pulse at Wilsons Promontory National Park. Bars are 95% confidence limits.

Changes in fox abundance

On the Isthmus a total of 739 baits were laid over the course of the nine pulses. Of these, 41% or 307 were taken. If we assume 25% (77 baits) were either cached and not eaten or made otherwise unavailable to foxes, then approximately 230 poison baits were consumed by foxes. In the central area a total of 1576 baits were laid with 49% (784 baits) taken. If we discount 25% of these, then around about 588 baits were consumed. In the south-west 551 baits were laid during the 9 pulses and 353 of these were taken (64%). Allowing for 25% to be cached or removed, 264 foxes probably died from eating the remaining poison baits. In total, 1082 foxes, or 32 foxes / month, could have consumed poison baits during the previous 34 months.

Activity Monitoring

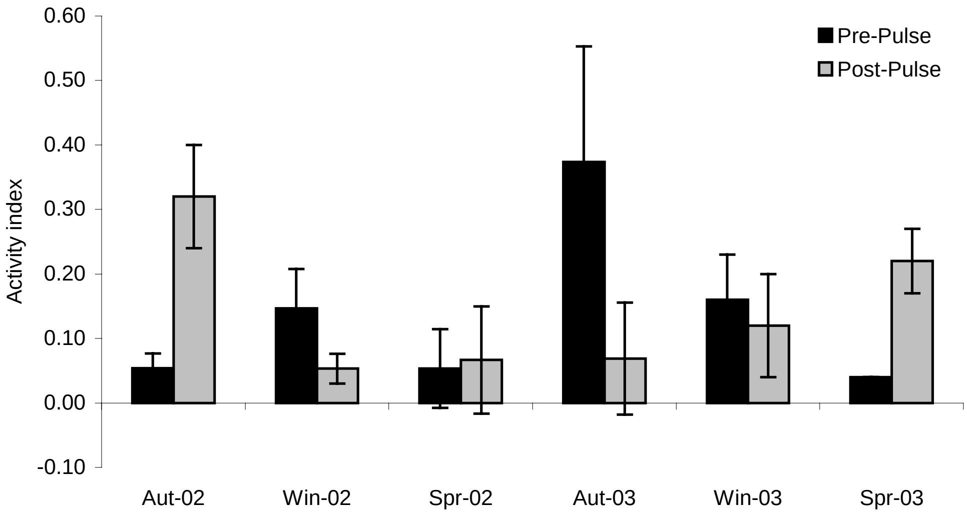
Activity monitoring was not implemented until the beginning of poison baiting pulse 4, April 2002. This was due to delays in getting the sand required for construction of sand-plots certified weed and fungus free, weather, staff rostering and budgets.

This restricts our capacity to investigate the broad effect of the fox control program on fox activity levels, as by the time activity monitoring had been put in place, fox abundance had declined, as suggested by the rapid decline in bait-take (Figure 18 above). Instead, we look at activity levels pre- and post-baiting pulse on each of the three treatments (Figures 19a, b, and c).

There is no trend in the level of activity pre- and post-pulse on any of the three treatment areas. This is not unexpected, as bait-take remained low relative to the initial two pulses in April and August 2001.

This supports the bait-take data, which indicated that there was no real difference in bait-take between areas, and since the initial knockdown, bait-take has remained relatively unchanged.

a)



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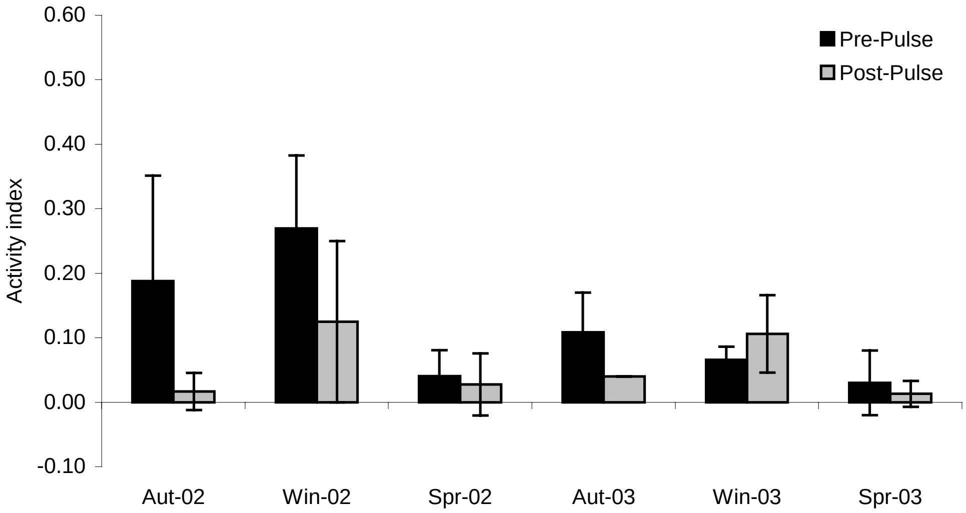

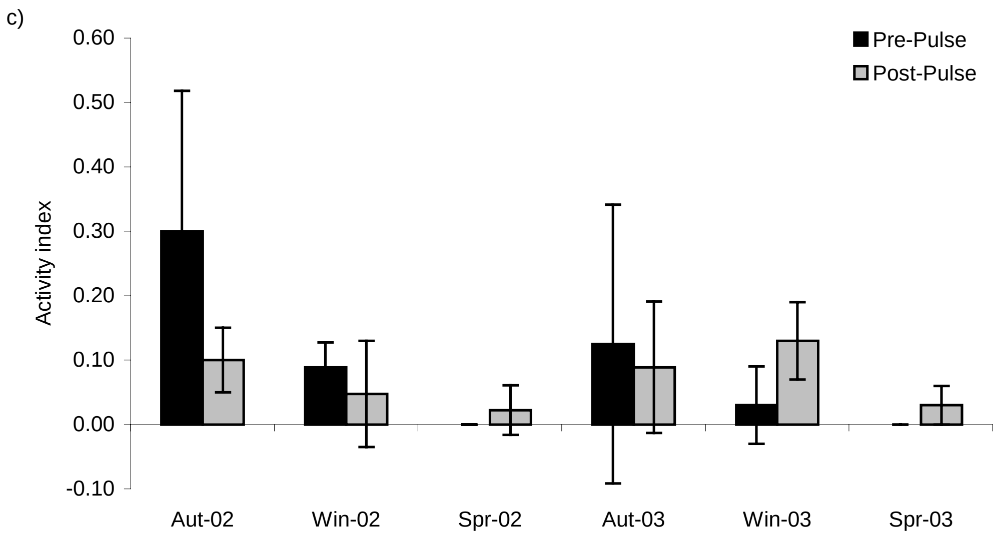

Figure 19. Fox Activity at Wilsons Promontory National Park.
a) Isthmus, b) Central, c) South West. Bars are Standard Deviations.

Prey-Species Monitoring

Hattah-Kulkyne National Park

Prey species monitoring was intended to be undertaken in late spring and early summer, however, delays in undertaking monitoring meant that the first session was not completed until December 2003. This meant that the second session would have been carried out in late January 2004. As monitoring in future years will be undertaken in late-spring and early-summer and because of animal welfare concerns related to animals being in traps at times of extreme diurnal temperatures, the second monitoring session was cancelled.

Nineteen species from five groups were captured over the seven nights of pitfall trapping in the treatment sites (Appendix 2) and 24 species from six groups were captured in the non-treatment sites (Appendix 2).

Capture rates were highest for skinks, geckos and dragons, and were generally higher on the non-treated sites (Figure 20). Mammals and snakes were the only group captured more often on the treatment site than the non-treatment site. Amphibians were only captured on the non-treatment site and snakes on the treatment site. As this is the first year of prey-species monitoring and fox control has been in place only a short while, these differences are perhaps a reflection of underlying habitat and micro-environmental conditions. If foxes were regulating the abundance of species within these groups it would be expected that capture rates would increase on the treatment sites in relation to those on the non-treatment sites.

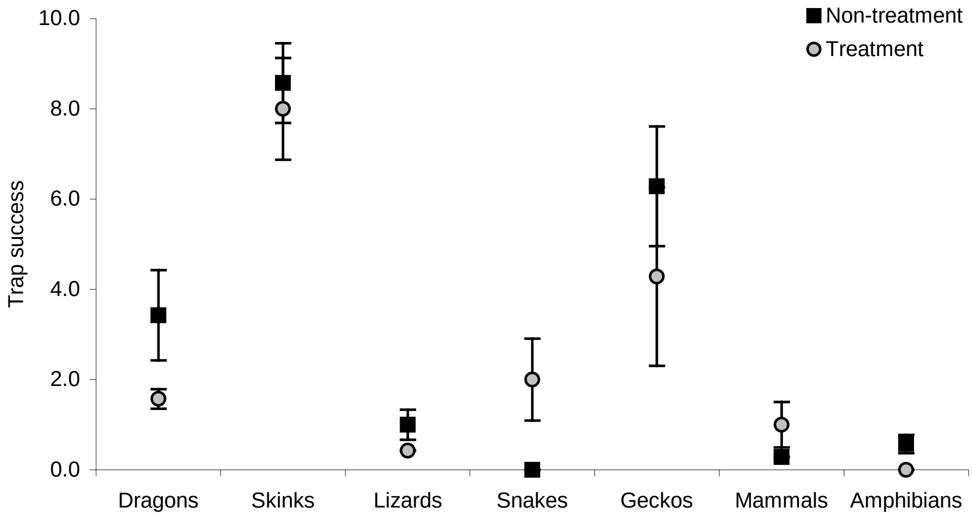

Figure 20. Prey-Species Response at Hattah-Kulkyne National Park.

Trap success = captures / 100 trap nights. Bars are standard deviation of species capture rates within a group. Amphibians were captured only on the non-treatment site and snakes only on the treatment site.

Coopracambra National Park

We captured 7 mammal species a total of 30 times over two trapping sessions, four of which were the target species (i.e. Southern-brown Bandicoot [*Isoodon obesulus*], Long-nosed Bandicoot (*Perameles nasuta*) and Long-nosed Potoroo [*Potorous tridactylus*]). The fourth species was thought to be a Long-footed Potoroo (*Potorous longipes*). One individual was captured, but escaped before morphometric measurements and a thorough inspection could be undertaken. Hair samples collected were sent to B. Triggs (Dead Finish, Genoa) for analysis. The result was that the hair was probably (95% sure) from a Long-footed Potoroo. The three remaining species were the Common Ringtail Possum (*Pseudocheirus peregrinus*), Bush Rat (*Rattus fuscipes*) and Swamp Rat (*Rattus lutreolus*).

Of the target species captured, the two Southern Brown Bandicoot females had small pouch young (one was subsequently recaptured with the pouch young), one of the Long-nosed Potoroo females captured had a single pouch young, and one of the female Long-nosed Bandicoots had two pouch young. Capture rates for the three more frequently captured target species are shown in Figure 21.

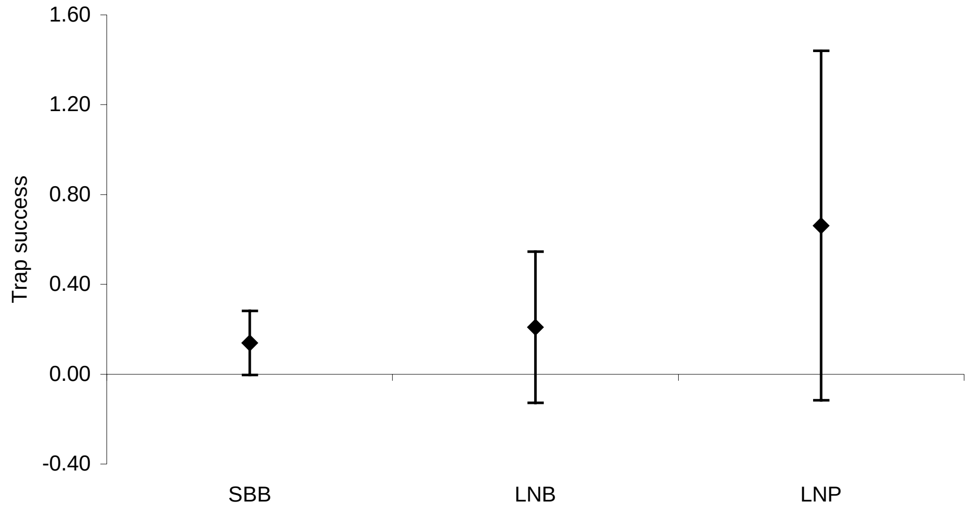

Figure 21. Trap success of targeted prey species.

Trap success = captures / 100 trap nights. SBB – Southern Brown Bandicoot, LNB – Long-nosed Bandicoot, LNP – Long-nosed Potoroo. Bars are 95% confidence limits.

Other Data

Predator Diet

Predator scats were opportunistically collected from tracks and around sand-plots and bait-stations. Overall, 18 fox and 15 dog scats were analysed. This analysis revealed that foxes had consumed a wide range of small and medium-sized mammals (Appendix 3). The most common prey item in the fox scats was the Common Ring-tailed Possum, making up > 90% by volume of all scats found with this species. The next most common item was *Antechinus* and *Rattus spp*. One scat contained a small amount (20% by volume) of Long-nosed Bandicoot, the remainder was made up of Bush Rat.

The most common species found in the dog scats were the Common Wombat and Brush-tailed Possum both > 90% by volume. Swamp Wallabies and Common Ring-tailed Possum were also present.

Rainfall

The variation in mean rainfall data indicates that the park has received below average rainfall since mid-2002 to January 2004 (Appendix 4).

Little Desert National Park

Overall 24 species were captured with a total of 651 captures. In the Eastern Block 19 species from seven groups were captured over the seven nights of pitfall trapping, in the Central Block 15 species from seven groups, and in the Western Block 19 species were captured (Appendix 2). By far the majority of animals captured were herptofauna (Figure 22). At all three sites skinks were the most common group captured, with the Obscure Skink dominating captures. Lizards and amphibians were the next most commonly captured group, including the Spade-foot Toad and the Lined Worm-lizard. A notable capture was the Bardick, which is listed as Vulnerable in Victoria.

Only four species of mammal were captured across all three sites. These were the Western Pygmy-possum, Common Dunnart (Vulnerable in Victoria), Silky Mouse and the introduced House Mouse. Of the native mammal species captured, Silky Mice were the most common, being captured in all sessions on all sites.

Capture rates for the different groups varied between blocks. There was a trend to capture less dragons and skinks on the Central Block and marginally less amphibians on the Eastern Block (Figure 22).

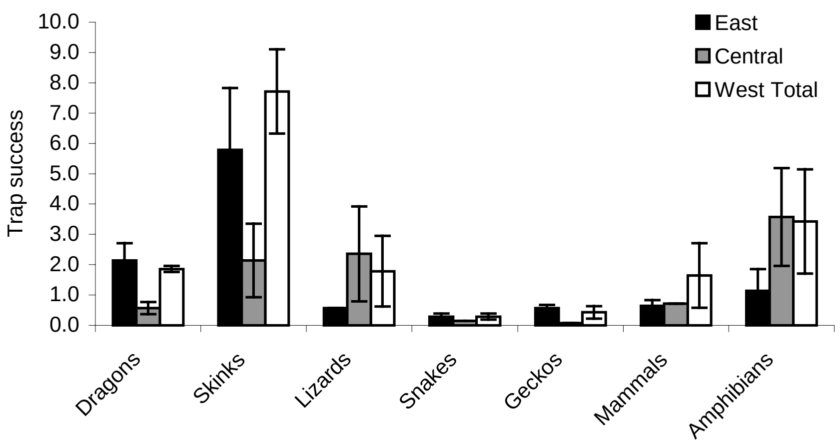

Figure 22. Prey-Species Response at Little Desert National Park.

Trap success = captures / 100 trap nights. Bars are standard deviation of species capture rates within a group.

Eumeralla Coastal Reserve (Codrington)

Nest fate and hatching success

In all, 56 Hooded Plover nests were found during this survey. These were either on the beach or in the fore dune. Thirty nests failed (77% of nests where the fate was determined). Five kinds of nest fate, representing thirty-nine nests (69.6% of all nests), were described based on positive evidence (Table 4). The cause of failure of seventeen nests (30.4% of all nests) could not be determined due to the absence of observable evidence. Overall, 16.1% of discovered nests survived to hatch (Table 4).

This survey found that fox predation accounted for approximately 23.4% of nest failures. Evidence for the presence of foxes remained prevalent on the beach and fore dunes throughout the survey period. Domestic dogs were responsible for the loss of two nests (4.3% of nest failures) close to the Yambuk estuary. This part of the survey area experiences heavy visitation during summer months and unleashed dogs were often observed on the beach close to nesting Hooded Plovers (Rick Ressom pers. obs.).

One type of nest fate, which accounted for 21.3% of nest failures, was due to the predation of eggs by the Silver Gull (*Larus novaehollandiae*). This species was the most common bird observed in the survey area, and it was not unusual to encounter flocks of more than sixty birds scouring the beach and fore dunes.

Table 4. Nest fates recorded during this survey (for discovered nests).

Fate	Cause	Number of nests	Percentage of nests	Percentage of nest failures
Successful	Hatched	9	16.10	
Failed	Fox	11	19.60	23.40
Failed	Silver Gull	10	17.80	21.30
Failed	Flooding	7	12.50	14.90
Failed	Dog	2	3.60	4.30
Failed	Unknown	17	30.40	36.10
Total		56	100.00	100.00

Grampians National Park

Overall we had 188 captures of eight species of mammals (Appendix 2). Of these four were the target species Southern Brown Bandicoot (four captures, all female), Long-nosed Potoroo (two captures, all male), Common Brushtail Possums (six captures, two males and one female) and Heath Mouse (98 captures, 30 females and 19 males). The Southern Brown Bandicoot female had four pouch young, lost one and was subsequently recaptured twice with three of the original pouch young in place. We also had 15 captures of three female and six male Western Pygmy-possums. Capture rates for the four target species are shown in Figure 23.

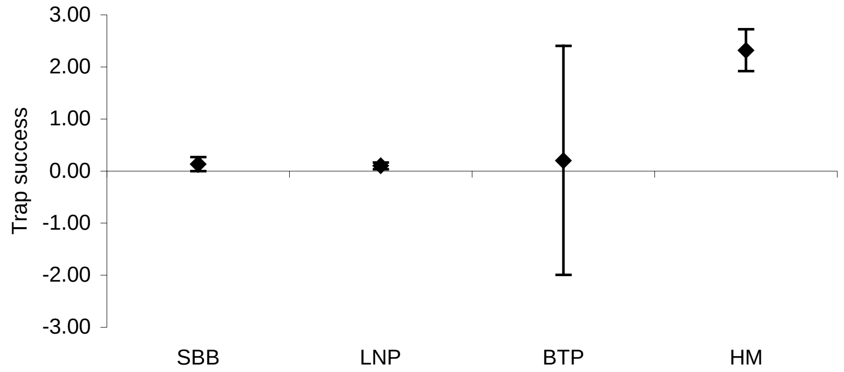

Figure 23. Prey-Species Response at Grampians National Park.

SBB – Southern Brown Bandicoot, LNP – Long-nosed Potoroo, BTP – Brush-tailed Possum, HM – Heath Mouse. Trap success = captures / 100 trap nights. Bars are 95% confidence limits of capture rates between sessions.

Four fox scats were collected and the contents analysed, revealing brush-tailed possum.

Wilsons Promontory National Park

It was planned to survey seven trapping sites for the presence of three target species, as was done for Coopracambra and the Grampians. Unfortunately, only three sites were established in time to undertake surveys in 2003-2004. Despite this setback, two of the three target species were captured during the spring 2003 trapping session (Figure 24). These species were Long-nosed Bandicoot (five captures, two females and one male) and Long-nosed Potoroo (48 captures, four females, nine males).

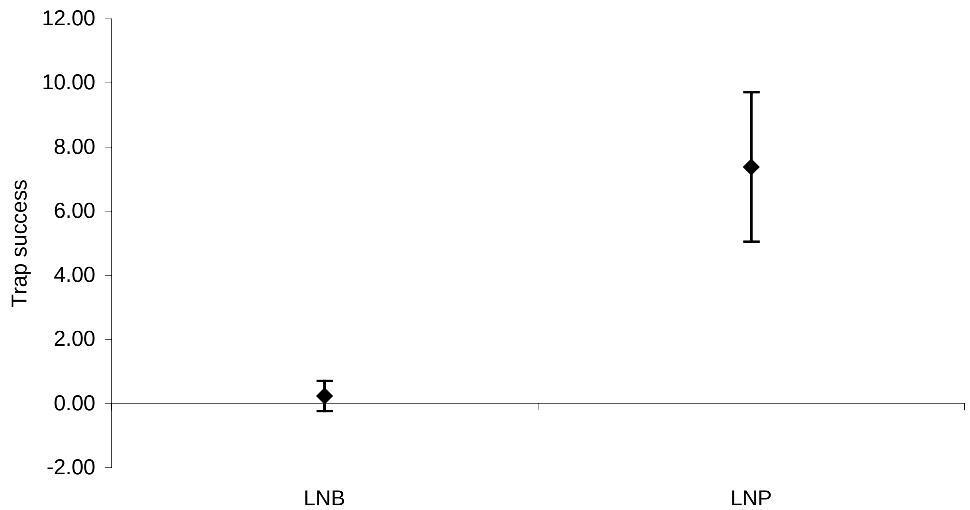

Figure 24. Trap success of target species at Wilsons Promontory National Park.

LNB – Long-nosed Bandicoot, LNP – Long-nosed Potoroo. Trap success = captures / 100 trap nights. Bars are 95% confidence limits of capture rates between sessions.

Other Data

Predator Diet

Predator scats were opportunistically collected from tracks and around sand-plots and bait-stations. Overall, 17 fox and 22 dog scats were analysed; this revealed that these predators had consumed a wide range of small, medium-sized and larger mammals (Appendix 3). The most commonly occurring item in the fox scats was European Rabbit. Rabbit typically made up greater than 60% by volume of the scats analysed. Other species of interest recorded were the New Holland Mouse, Long-nosed Bandicoot, Common Ring-tailed Possum, and Common Brush-tailed Possum.

Interestingly, the Long-nosed Bandicoot had not been recorded in the initial trapping; this is considered to be one of the target species for the program.

Swamp Wallaby dominated the sample of dog scats, with Common Wombat and European Rabbit also present. Species of interest recorded in these scats were Long-nosed Bandicoot, Ring-tailed and Brush-tailed Possum. Hog Deer was also recorded from a single scat.

Rainfall

Variation in the mean long-term rainfall pattern suggests that Wilsons Promontory has consistently received below average rainfall since mid-2002 (Appendix 3).

DISCUSSION

There are two equally important outcomes from the Fox AEM program. The first is a greater understanding of the efficiency of the differing fox control strategies (including costs) and the second is a better understanding of the response by native mammal species to these strategies. It is still too early to present information on the cost / benefits of the various control strategies as some programs (e.g. Grampians) are relatively new and require time to determine any impact on levels of bait-take and fox activity. However, it is possible to consider the direction that some of the strategies appear to be heading in and discuss some of the issues surrounding the ongoing implementation of the program.

Effectiveness of the various fox control strategies

The annual programs at Coopracambra and Hattah-Kulkyne National Parks have both been successful at initially reducing fox activity based on comparisons of levels of free-feed bait-take. The assumption that reduced bait-take relates to a reduction in fox abundance is strengthened to some degree by the trend in fox activity, which was lower after poisoning began.

The levels of bait-take at Coopracambra and Hattah-Kulkyne are very different and may be a result of a difference in underlying fox density and the landscape surrounding these two parks. This may in turn have an influence on the intensity of baiting required to manage fox populations. Coopracambra is heavily dissected by rugged, mountainous terrain dominated by moist and dry foothill forest; National Park in NSW and State Forest in Victoria surround the park. Hattah-Kulkyne is moderately undulating dominated by Mallee and Riverine Grassy Woodlands and is surrounded by agricultural enterprises. The low-intensity baiting applied at Coopracambra may not have been successful at Hattah-Kulkyne if the underlying densities were much higher at Coopracambra. Knowledge of the underlying densities may influence the design of future baiting programs.

A similar picture is emerging from the pulsed program at Wilsons Promontory National Park. Overall, bait-take has declined since the beginning of the poisoning program. However, the three treatment areas may not be independent as there was no detectable difference in the rate of change in bait-take between the Isthmus, Central and South West baiting program. Unfortunately, sand-plot activity results cannot be used to assist in disentangling the three intensities, as it did not begin until after the initial decline in bait-take had occurred. The relative level of bait-take at Wilsons Promontory is much higher than that for both Hattah-Kulkyne and Coopracambra. This suggests that factors other than surrounding landscape may influence fox density (e.g. on-site reliability of food supply, local habitat complexity).

In May 2004, the type of bait used was changed from deep fried liver to FoxOff™ due to the Department of Primary Industries no longer supplying the liver bait. The impact of changing bait type will be assessed in the 04 / 05 annual report. Initial observations include a sharp increase in bait-take.

It is not possible to draw any conclusion form the baiting program at the Grampians National Park, as there have only been three pulses undertaken since the new program began.

In contrast to the reduction in bait-take observed at the parks undertaking annual programs, the two seasonal programs do not appear to be reducing and / or maintaining a reduced level of bait-take. Neither the high-intensity nor the low-intensity baiting-program at the Little Desert National Park has caused a reduction in bait-take and sand-plot activity levels have been variable, and remain unchanged within a season or from year to year. Similarly, although the landscape context of Eumeralla Coastal Reserve is different to that of Little Desert, the pattern of bait-take in this seasonal program is similar. There was no discernible decline in bait-take or activity recorded and while predation was identified as the cause of Hooded Plover nest failure in 24% of recorded cases, it was not possible to determine if the control program was effective in reducing this impact.

At all sites including those with a demonstrable reduction in bait-take there remains a constant residual level of bait-take. It is not known if this is due to dispersing or immigrating foxes or a combination of both. What is clear however, is that even high-intensity, continuous programs are unable to remove all foxes for even a short period of time. This reinforces the need to apply constant pressure on the fox population to maintain a reduced level of density.

In an attempt to provide an estimate of the number of foxes that each baiting program may have removed, we have assumed that 25% of baits taken are not consumed. This is likely to be an underestimate of the potential impact of baiting, as foxes are known to revisit and consume cached baits (Thompson and Kok 2002, van Polen Petel 2001). Whether the level of reduction in fox abundance achieved, even by the high-intensity annual programs, is sufficient to allow native species to respond faster than the fox population can replace poisoned individuals, either by reproduction, immigration or a combination of both, and what the source of these foxes is, remains unanswered at present.

Other predators

The results from the sand-plot monitoring at Coopracambra National Park indicate that the fox control program has also brought about a change in wild dog activity levels. It may be possible that incorrect identification of prints on sand-plots occurred due to poor quality material being used in the initial months of the program. This was rectified with a change in the delivery of the program and an improvement in the material used to construct the sand-plots. A variety of contractor and Parks Victoria staff have at various times undertaken the sand-plot monitoring, and the general low level of activity has remained consistent through these changes, suggesting that wild dog activity is in fact lower now than during the free-feed period.

The possibility that a baiting program using 1080 poisoned FoxOff™ can reduce wild dog populations is supported by results from activity monitoring undertaken on the Project Deliverance sites (Robley et al. 2004). In that study, wild dog activity was lower on treatment sites compared to the paired non-treatment sites that had been subject to continuous fox control over the previous four years. Reducing wild dog populations in areas of forested habitat and where they are not threatening agricultural values may impact upon ecosystem function, although the significance of this is unknown.

The sand-plot monitoring program is not designed to assess changes in the relative abundance of feral cats. Cats are unlikely to travel along lengths of roads and tracks for the same distances as foxes and wild dogs (Mahon *et. al*. 1998). Thus, the level of precision in the detection of feral cats is likely to be unreliable. It is not possible to tell from the data collected whether there has been any increase in cat activity since the program began. If an increase is detected in future years, this does not necessarily mean that the abundance of cats has increased; it may be they have altered their behaviour as a result of reduced activity by foxes and dogs.

Prey-Species Monitoring

Prey-species monitoring was successfully implemented in all parks, with a number of species being recorded within parks for the first time (e.g. Southern Brown Bandicoot [Coopracambra National Park] and Long-nosed Potoroo [Coopracambra National Park, Grampians National Park]). At this stage, target species have been recorded in all parks, however they have been encountered in very low numbers, and not at all trapping locations.

These results are encouraging, as the effort being expended on prey-species monitoring appears to be sufficient to detect those species that we are most interested in. In addition, while the initial sampling indicates low abundances, this is consistent with our expectations that foxes are suppressing prey populations. It is hoped that if baiting reduces fox populations, we will see a shift in abundance and / or site occupancy by prey species. However, while bait-take and sand-plot results are suggesting differences between seasonal and annual baiting-programs, it will be a number of years before we can expect to see any changes in prey-species abundance.

Initial analysis of the Project Deliverance results suggests that prey-species responses will be patchy rather than uniform, and that it may take at least four to five years before a response is detectable. Long-nosed Potoroos appear to have responded to fox control on one of the three Project Deliverance treatment sites (Murray and Poore 2004). However, this is not a uniform response and is restricted to a specific location within the treatment site. There was also an increase in capture rates on the paired non-treatment site, albeit to a lesser degree. This suggests that Long-nosed Potoroos have responded to a change in underlying environmental conditions and that the removal of predation threat has allowed for a greater rate of increase. No response from other target species at these or the other two treatment sites has been reported.

At Eumeralla Coastal Reserve the nesting success of Hooded Plovers was higher than in any previous study of the survey area and possibly the highest recorded in Victoria (Weston 2001). Hatching success (16.1%) was also higher than in any other areas of the Victorian coast. However, fledging success (0.30) remained within the range of 0.30 to 0.50, recorded over three previous surveys of the Eumeralla study area (Weston and Morrow 2000, Ressom 2001, 2002). Overall, reproductive success in the survey area is poor and the failure of nests (19.6%) to hatch and chicks to fledge indicates that existing measures to control the major predator (the fox) are only partially effective. The complex landscape matrix of the reserve makes the interpretation of fox management outcomes problematic.

Issues

While we made every attempt to include the critical components of experimental design in this AEM project, it was not possible to randomise treatments, collect pre-treatment prey species monitoring data, replicate most of the treatments or establish control sites. This places some limitations on the universality of the results and will limit the robustness of the inferences that can be made.

To increase the reliability of the outcomes there are some additional sources of variation that should be accounted for by the Fox AEM project. These include:

- measuring the structural complexity of the monitoring locations within each site
- recording previous management histories (e.g. time since last fire)

- measuring temperature, rainfall, soil type and general floristic composition of each monitoring site.

The variability that these contribute to the prey-species response can be accounted for in future analysis and aid in the interpretation of observed patterns in prey-species response.

Changes to the programs at any of the sites involved in the Fox AEM project should be considered in the context of the overall Fox AEM project. One consequence of the AEM approach is that some management strategies may be found to be more effective than others. As managers become more aware that they are managing in an apparent sub-optimal manner they will naturally wish to alter their approach. However, changing the management strategy at sites too early will limit the capacity of this project to provide a solid understanding of the real differences in the effectiveness of different management strategies.

Similarly, managers need to be provided with adequate resources to be able to deliver fox control and monitoring consistently and in accordance with the design of the project. Inconsistent baiting effort results in greater variation in bait-take and greater difficulty in interpreting any patterns (e.g. Hattah-Kulkyne National Park).

Where components of the project such as baiting and / or sand-plot monitoring are out-sourced, the contractors need to be well supervised and experienced and must comply with the methods used in this project.

The Fox AEM project is progressing as planned and while trends in the effectiveness of some baiting strategies are emerging, new issues such as the landscape context and the composition of the residual fox populations, and the relationship between indices and actual changes in abundance are emerging. Prey-species monitoring has produced interesting results but, as was originally noted, it will take a number of years to provide a robust indication of the effectiveness of the different control strategies.

ACKNOWLEDGMENTS

Many people have contributed to the design and implementation of the AEM project since it began, including:

Project participants

Sally Troy	Manager, National Parks and Conservation Research
Ian Walker	Manager, National Parks and Conservation Programs
Kate Millar	Chief Ranger Environmental Programs (East Region)
Jonathon Stevenson	Environmental Planner
Phil Pegler	Team Leader Environmental Programs
Alison Marion	Planner
David Choquenot	Scientist, Landcare Research, NZ.
Alan Braithwaite	Ranger-In-Charge, Little Desert National Park
Bruce Taylor	Field Services Officer, Little Desert National Park
Mal Pye	Field Services Officer, Little Desert National Park
Damien Skurrie	Ranger, Little Desert National Park
Dave Ryan	Ranger, Discovery Bay
Don McCarthy	Ranger, Discovery Bay
Phil Murdoch	Ranger-In-Charge, Hattah-Kulkyne National Park
Jeremy Tscharke	Ranger, Hattah-Kulkyne National Park
Anthony Stasiak	Ranger, Hattah-Kulkyne National Park
Andrew Wise	Mallee Catchment Management Authority
Peter Sandell	Environmental Project Officer
Robyn Korn	Ranger, Coopracambra National Park
Elaine Thomas	Ranger, Wilsons Promontory National Park
Matt Hoskins	Ranger, Wilsons Promontory National Park
Mick Keenan	Ranger, Wilsons Promontory National Park

Graham Parkes	Ranger-In-Charge, Grampians National Park
Mike Stevens	Environmental Team Leader, Grampians National Park
Susan Hansen	Ranger, Grampians National Park
Andrew Dennis	Ranger, Grampians National Park
Marcel Hoog Antink	Ranger, Codrington Coastal Reserve
Nick Cleaman	Scientist, Arthur Rylah Research Institute
Rick Ressom	Contractor – Hooded Plover and fox monitoring, Eumeralla Coastal Reserve

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APPENDICES

Summary of Project Deliverance

The aim of Project Deliverance was to determine the response of ‘critical-weight range’ mammals to effective fox control in mesic forest habitats in Far East Gippsland (Murray and Poore 2002).

Three locations, the West Coast, East Coast and Stony Peak (Figure A1) were established in 1998 as part of a larger project undertaken independently from this study. For full site descriptions and details of that project see Murray and Poore (2002). In relation to the Fox AEM this project was a continuous–annual baiting program, and the West Coast is considered high-intensity and the East and Stony Peak locations are medium-intensity control programs.

Briefly, each location comprised a poisoned ‘treatment site’ where 1080 poisoned FoxOff™ bait were buried from 1999 onwards, and a paired non-treatment site where baits without poison were laid at the same rate and intensity as on the treatment site. Six months prior to poison baits being laid, free-feed baits (i.e. non-poisoned baits) were laid on both sites at all locations. This was done, in part, to enable an assessment of the initial knockdown in foxes once poisoning began. The treated and non-treated sites were between 7000 and 14000 hectares and were separated by a minimum of 3 km. Paired sites were matched for dominant vegetation community and structure, topography and geographic location. Paired sites were close enough to experience the same general weather patterns and were assumed to be far enough apart to be considered independent in relation to fox movement. Sites were not randomly allocated due to the physical area each site occupied and the availability of suitable locations (i.e. no previous control activities) and treatments were allocated subjectively.

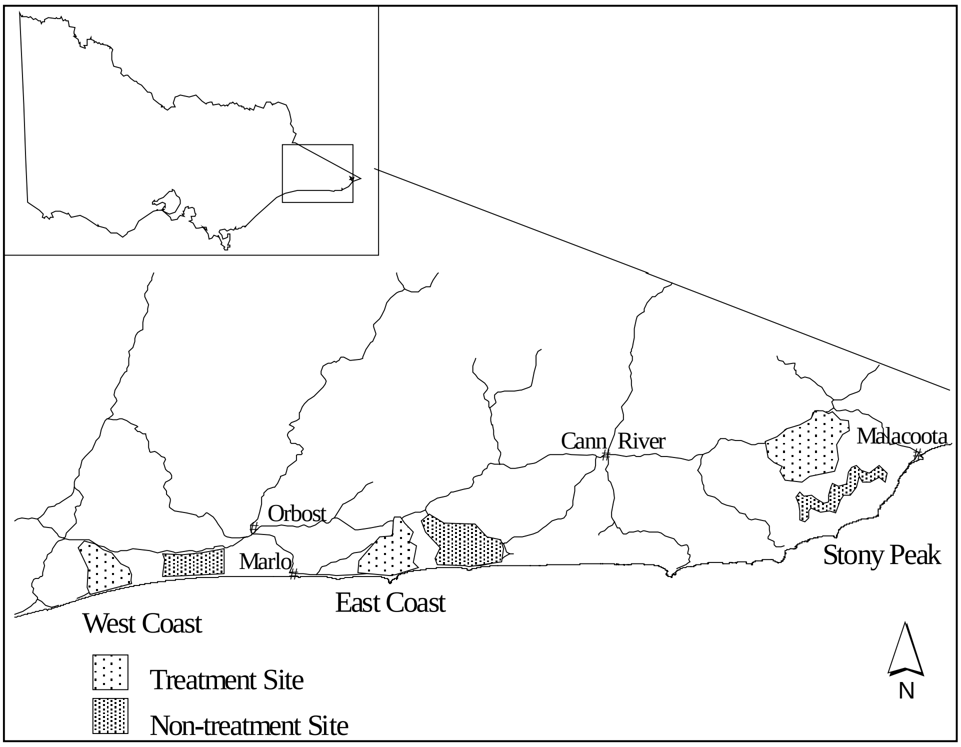

Figure A1. Project Deliverance locations with treatment and non-treatment sites.

Bait-take

Murray and Poore (2002) provided no formal analysis of the change in bait-take. However, graphs provided in their reports indicate that bait-take declined rapidly (within a month) of the beginning of the poisoning program and has remained low in the subsequent four years. Average bait-take on the high-intensity West Coast site declined from an average of approximately 88% during the free-feed to less than 10% over the following four years (recalculated from Murray and Poore 2004). On both the East Coast and Stony Peak sites bait-take was not high during the free-feed (50% and 70%) and bait-take declined to between 10% and 20% on both these sites over the last four years (recalculated from Murray and Poore 2004).

Recent sand-plot activity monitoring undertaken by the Arthur Rylah Institute for Environmental Research (Robley *et. al*. 2004) indicates that there is significantly less fox and wild dog activity on treated sites compared to non-treated sites.

Prey-Species Monitoring

At the time of writing no formal, peer-reviewed analysis of the prey-species monitoring undertaken by Project Deliverance was available. However, there are indications that prey-species response has been limited to one (Long-nosed Potoroo) or perhaps two (Southern Brown Bandicoot) species at specific sites.

This is supported by recent work undertaken by the Arthur Rylah Institute for Environmental Research assessing the rates of detection of medium-sized mammals on treated and non-treated sites using grids of hair tubes (Robley *et. al.* 2004). This work showed that results were not uniform across all sites and that while some species were detected at higher rates on treated sites, there were plausible alternative explanations for the observed differences, including differences in starting densities, alternative predators present in the system, changes in structural complexity, changes in species behaviour, and insufficient time for a coherent response to be detectable. This is possible due to the lack of pre-treatment data, randomisation of the treatment / non-treatment pairs, the small sample size (i.e. three locations) and small sample sizes of hair tubes (three grids x 100 tubes per site).

Species Captured in Prey-Species Monitoring

Table A2.1. Species captured at the fox control (treated) sites, Hattah-Kulkyne National Park in December 2003.

Trap success = captures / 100 trap nights, trap nights = XX, pitfall traps = XX). The herptofauna groups are based on Agamids (dragon) Gekkonids (geckos) Pygopodids (lizards) Scincids (skinks) and snakes (families have been grouped into one class).

Group	Common Name	Species Name	Trap Success
Dragon	Nobbi Dragon	*Amphibolurus nobbi*	0.71
Dragon	Mallee Military Dragon	*Ctenophorus fordi*	0.57
Gecko	Beaded Gecko	*Lucaseum damaeum*	3.71
Gecko	Tessellated Gecko	*Diplodactylus tesselatus*	0.29
Gecko	Eastern Stone Gecko	*Diplodactylus vittatus*	0.29
Lizard	Southern Legless Lizard	*Delma australis*	0.43
Mammal	Mallee Ningaui	*Ningaui yvonneae*	0.86
Mammal	Little Pygmy-possum	*Cercatetus lepidus*	0.14
Skink	Bougainville's Skink	*Lerista bougainvillii*	3.43
Skink	Spotted Burrowing Skink	*Lerista punctattovittata*	1.71
Skink	Boulenger's Skink	*Morethia boulengeri*	1.00
Skink	Regal Striped Skink	*Ctenotus regius*	0.71
Skink	Murray Striped Skink	*Ctenotus brachyonyx*	0.57
Skink	Grey's Skink	*Menetia greyii*	0.43
Skink	Desert Skink	*Egernia inornata*	0.14
Snake	Banded Snake	*Simoselaps australis*	1.71

Snake	Blind Snake	*Ramphotyphlops sp.*	0.14
Snake	Mitchell's Short-tailed Snake	*Suta nigriceps*	0.14

Table A2.2. Species captured at the non-fox control sites, Hattah-Kulkyne National Park in December 2003.

Trap success = captures / 100 trap nights, trap nights = XX, pitfall traps = XX). The herptofauna groups are based on Agamids (dragon) Gekkonids (geckos) Pygopodids (lizards) Scincids (skinks) and snakes (families have been grouped into one class).

Group	Common Name	Scientific Name	Trap Success
Amphibian	Pobblebonk Frog	*Limnodynastes dumerilii*	0.43
Amphibian	Spotted Marsh Frog	*Limnodynastes tasmaniensis*	0.14
Dragon	Mallee Military Dragon	*Ctenophorus fordi*	2.14
Dragon	Nobbi Dragon	*Amphibolurus nobbi*	1.14
Gecko	Beaded Gecko	*Lucaseum damaeum*	3.71
Gecko	Tessellated Gecko	*Diplodactylus tesselatus*	0.86
Gecko	Southern Spiny-tailed Gecko	*Diplodactylus intermedius*	0.57
Gecko	Eastern Stone Gecko	*Diplodactylus vittatus*	0.57
Gecko	Marbled Gecko	*Christinus marmoratus*	0.43
Gecko	Tree Dtella	*Gehyra variegata*	0.14
Lizard	Southern Legless Lizard	*Delma australis*	0.71
Lizard	Red-tailed Worm-lizard	*Apraisia inaurita*	0.14
Lizard	Burton's Snake-lizard	*Lialis burtonis*	0.14
Mammal	House Mouse	*Mus musculus*	0.14
Mammal	Common Dunnart	*Sminthopsis murina*	0.13
Skink	Bougainville's Skink	*Lerista bougainvillii*	2.57
Skink	Spotted Burrowing Skink	*Lerista punctattovittata*	1.86
Skink	Regal Striped Skink	*Ctenotus regius*	1.43
Skink	Boulenger's Skink	*Morethia boulengeri*	1.43
Skink	Murray Striped Skink	*Ctenotus brachyonyx*	0.57
Skink	Carnaby's Wall Skink	*Cryptoblepharus carnabyi*	0.29
Skink	Grey's Skink	*Menetia greyii*	0.29
Skink	Desert Skink	*Egernia inornata*	0.14

Table A2.3. Species captured at the Eastern Block, Little Desert National Park in 2003.

Trap success = captures / 100 trap nights, trap nights = XX, pitfall traps = XX). The herptofauna groups are based on Agamids (dragon) Gekkonids (geckos) Pygopodids (lizards) Scincids (skinks) and snakes (families have been grouped into one class).

Group	Common Name	Scientific Name	Session 1	Session 2
Amphibian	Southern Bullfrog	*Limnodynastes dumerilii*	0.0	0.1
Amphibian	Spade-foot Toad	*Neobatrachus sp.*	1.7	0.4
Dragon	Mallee Tree Dragon	*Amphibolurus norrisi*	0.0	1.0

Dragon	Painted Dragon	*Ctenophorus pictus*	1.6	1.1
Dragon	Eastern Bearded Dragon	*Pogona barbata*	0.1	0.4
Gecko	Marbled Gecko	*Christinus marmoratus*	0.3	0.1
Gecko	Eastern Stone Gecko	*Diplodactylus vittatus*	0.4	0.3
Lizard	Lined Worm-lizard	*Aprasia striolata*	0.3	0.9
Mammal	House Mouse	*Mus musculus*	0.1	0.0
Mammal	Silky Mouse	*Pseudomys apodemoides*	0.7	0.1
Mammal	Common Dunnart	*Sminthopsis murina*	0.0	0.3
Skink	Carnaby's Wall Skink	*Cryptoblepharus carnabyi*	0.1	0.0
Skink	Garden Skink	*Lamprophpholis delicata*	0.4	1.0
Skink	Bougainville's Skink	*Lersita bougainvilli*	0.1	0.0
Skink	Grey's Skink	*Menetia greyii*	0.1	0.1
Skink	Obscure Skink	*Morethia obscura*	4.4	5.1
Snake	Bardick	*Echiopsis curta*	0.0	0.1
Snake	Mitchell's Short-tailed Snake	*Suta nigriceps*	0.3	0.1

Table A2.4. Species captured at the Central Block, Little Desert National Park in 2003.

Trap success = captures / 100 trap nights, trap nights = XX, pitfall traps = XX). The herptofauna groups are based on Agamids (dragon) Gekkonids (geckos) Pygopodids (lizards) Scincids (skinks) and snakes (families have been grouped into one class).

Group	**Common Name**	**Scientific Name**	**Session 1**	**Session 2**
Amphibian	Southern Bullfrog	*Limnodynastes dumerilii*	1.3	0.0
Amphibian	Spade-foot Toad	*Neobatrachus sp.*	5.1	0.7
Dragon	Mallee Tree Dragon	*Amphibolurus norrisi*	0.1	0.7
Dragon	Painted Dragon	*Ctenophorus pictus*	0.1	0.1
Gecko	Marbled Gecko	*Christinus marmoratus*	0.0	0.1
Lizard	Lined Worm-lizard	*Aprasia striolata*	0.0	4.6
Lizard	Common Scaly-foot	*Pygopus lepidopodus*	0.0	0.1
Mammal	Silky Mouse	*Pseudomys apodemoides*	0.7	0.7
Skink	Eastern Striped Skink	*Ctenotus orientalis*	0.0	0.4
Skink	Garden Skink	*Lamprophpholis delicata*	0.0	0.4
Skink	Bougainville's Skink	*Lerista bougainvilli*	0.0	3.9
Skink	Grey's Skink	*Menetia greyii*	0.0	0.1
Skink	Obscure Skink	*Morethia obscura*	1.1	6.0
Snake	Mitchell's Short-tailed Snake	*Suta nigriceps*	0.0	0.3

Table A2.5. Species captured at the Western Block, Little Desert National Park in 2003.

Trap success = captures / 100 trap nights, trap nights = XX, pitfall traps = XX). The herptofauna groups are based on Agamids (dragon) Gekkonids (geckos) Pygopodids (lizards) Scincids (skinks) and snakes (families have been grouped into one class).

Group	Common Name	Scientific Name	Session 1	Session 2
Amphibian	Southern Bullfrog	*Limnodynastes dumerilii*	0.0	1.0
Amphibian	Spade-foot Toad	*Neobatrachus sp.*	1.9	4.0
Dragon	Mallee Tree Dragon	*Amphibolurus norrisi*	1.1	0.6
Dragon	Painted Dragon	*Ctenophorus pictus*	0.9	1.1
Gecko	Marbled Gecko	*Christinus marmoratus*	0.1	0.6
Gecko	Eastern Stone Gecko	*Diplodactylus vittatus*	0.0	0.1
Lizard	Lined Worm-lizard	*Aprasia striolata*	2.6	0.9
Mammal	Western Pygmy Possum	*Cercartetus concinnus*	0.0	0.1
Mammal	Silky Mouse	*Pseudomys apodemoides*	0.3	2.9
Skink	Blue-tongue Lizard	*Trachylosaurus rugosus*	0.1	0.0
Skink	Eastern Striped Skink	*Ctenotus orientalis*	1.7	3.0
Skink	Eastern Striped Skink	*Ctenotus robustus*	0.1	0.0
Skink	Garden Skink	*Lamprophpholis delicata*	0.3	0.1
Skink	Bougainville's Skink	*Lerista bougainvilli*	1.0	2.0
Skink	Grey's Skink	*Menetia greyii*	0.1	0.1
Skink	Obscure Skink	*Morethia obscura*	5.0	1.9
Snake	Bardick	*Echiopsis curta*	0.1	0.0
Snake	Mitchell's Short-tailed Snake	*Suta nigriceps*	0.0	0.4

Results of scat analysis from parks in the Fox AEM

Table A3.1. Percentage occurrence of dietary items found in scats collected at Coopracambra National Park.

% M = percentage mammals, % I = percentage insect, % B = percentage bird, % P = percentage plant (g= grass), % O= percentage other (b.d = bone).

Species	Common Name	Scientific Name	% M	% I	% B	% P	% O
Fox	Swamp Antechinus	*Antechinus swainsonii*	98			2 g	
Fox	Swamp Antechinus Rattus sp. Ring-tailed Possum	*Antechinus swainsonii.* *Rattus sp.* *Pseudocheirus peregrinus*	90 5 5				
Fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	100				
Fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	100				
Fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	100				

Fox	Swamp Antechinus	*Antechinus swainsonii*	95		5		
Fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	99				
Fox	Swamp Antechinus	*Antechinus swainsonii*	95			5 g	
Fox	Long-nosed Bandicoot Bush Rat	*Perameles nasuta* *Rattus fuscipes*	20 80				
Fox	Brown Antechinus	*Antechinus agilis*	80		20		
Fox	Eastern Pygmy-possum	*Cercarticus nanus*	90	10			
Fox	Ring-tailed Possum Bush Rat	*Pseudocheirus peregrinus* *Rattus fuscipes*	80 20				
?fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	100				
?fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	100				
?fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	90	20			
?fox	Platypus	*Ornithorhynchus anatinus*	100				
?fox	Antechinus sp.	*Antechinus sp.*	10		90		
?fox		---			100		
Dog	Kangaroo	*Macropus sp.*	10				90 b.d
Dog	Swamp Wallaby	*Wallabia bicolour*	95				5 b.d
Dog	Swamp Wallaby	*Wallabia bicolour*	90				10 b.d
Dog	Common Wombat	*Vombatus Ursinus*	98				2 b.d
Dog	Common Wombat	*Vombatus Ursinus*	90				10 b.d
Dog	Ring-tailed Possum	*Pseudocheirus peregrinus*	100				
Dog	Brush-tailed Possum	*Trichosurus sp.*	20				80 b.d
Dog	Swamp Wallaby Ring-tailed Possum	*Wallabia bicolor* *Pseudocheirus peregrinus*	60 20				
Dog	Common Wombat	*Vombatus Ursinus*	10			10 g	80 b.d
Dog	Brush-tailed Possum	*Trichosurus sp.*	100				
Dog	Common Wombat	*Vombatus Ursinus*	98				2 b.d
Dog	Brush-tailed Possum	*Trichosurus sp.*	100				
Dog	Common Wombat	*Vombatus Ursinus*	95				5 b.d
Dog	Brush-tailed Possum	*Trichosurus sp.*	90				10 b.d
Dog	Common Wombat	*Vombatus Ursinus*	90				10 b.d

Table A3.2. Percentage occurrence of dietary items in scats collected at Wilsons Promontory National Park.

% M = percentage mammals, % I = percentage insect, % B = percentage bird, % P = percentage plant (g= grass), % O= percentage other (b.d = bone).

Species	Common Name	Scientific Name	% M	% I	% B	% P	% O
Fox	European Rabbit	*Oryctolagus cuniculus*	95			5g	
Fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	100				
Fox	Swamp Rat	*Rattus lutreolus*	100		20		
Fox	European Rabbit	*Oryctolagus cuniculus*	5	5		90s	
Fox	Eastern Pygmy Possum	*Cercartetus nanus*	100				
Fox	Black Rat	*Rattus rattus*	80	20			
Fox	Brush-tailed Possum	*Trichosurus sp.*	70			30s	
Fox	Long-nosed Bandicoot	*Perameles nasuta*	30		40	20s, 10g	
Fox		---			100		
Fox	Ring-tailed Possum	*Pseudocheirus peregrinus*	95			5g	
Fox	New Holland Mouse Swamp Antechinus	*Pseudomys novaehollandiae* *Antechinus swainsonii*	70 25		5		
?fox	European Rabbit	*Oryctolagus cuniculus*	98			2g	
?fox	European Rabbit	*Oryctolagus cuniculus*	20		80		
?fox	European Rabbit	*Oryctolagus cuniculus*	100				
?fox	Black Rat	*Rattus rattus*	80				
?fox	Swamp Wallaby	*Wallabia bicolor*	80			20g	
?fox	Brown Antechinus	*Antechinus agilis*	100				
Dog	Ring-tailed Possum	*Pseudocheirus peregrinus*	99.9+				20b.d
Dog	Common Wombat	*Vombatus ursinus*	85			5g	10
Dog	European Rabbit	*Oryctolagus cuniculus*	99.9+				
Dog	Swamp Rat	*Rattus lutreolus*	95				5 b.d
Dog	Swamp Wallaby	*Wallabia bicolor*	80		15		5.b.d
Dog		---			90		10b.d
Dog Fox	Swamp Wallaby European Rabbit	*Wallabia bicolor* *Oryctolagus cuniculus*	95 60		 2. 40		1.5b.d
Dog	Swamp Wallaby	*Wallabia bicolor*	90				10b.d
Dog	Swamp Wallaby	*Wallabia bicolor*	98				2 b.d
Dog	Swamp Wallaby	*Wallabia bicolor*	90				10b.d
Dog	Swamp Rat	*Rattus lutreolus*	89.9+		10		
Dog	Australia Fur Seal	*Arctocephalus pusillus*	98				2 b.d

Species	Common Name	Scientific Name	% M	% I	% B	% P	% O
Dog	Hog Deer	*Axis porcinus*	95				5 b.d
Fox Dog	Ring-tailed Possum Common Wombat	*Pseudocheirus peregrinus* *Vombatus ursinus*	100 95				2.5b.d
?dog	Swamp Antechinus Swamp Wallaby	*Antechinus swainsonii* *Wallabia bicolor*	75 20				5 b.d
?dog	Swamp Wallaby	*Wallabia bicolor*	80		20		
?dog	Swamp Wallaby	*Wallabia bicolor*	95				5 b.d
?dog	Long-nosed Bandicoot European Rabbit	*Peramles nasuta* *Oryctolagus cuniculus*	30 65				5 b.d
?dog	Brush-tailed Possum	*Trichosurus sp.*	95				5 b.d
?dog	Swamp Wallaby Rattus sp.	*Wallabia bicolor* *Rattus sp.*	90 5				5 b.d
?dog	Long-nosed Bandicoot	*Perameles nasuta*	80		10		10b.d
?dog	Common Wombat	*Vombatus ursinus*	95				5.b.d

Key: M Mammal I Insect B Bird P Plant O Other material g grass s seeds b.d bone dust.

Variation in mean monthly rainfall (MM) for each of the AEM study sites

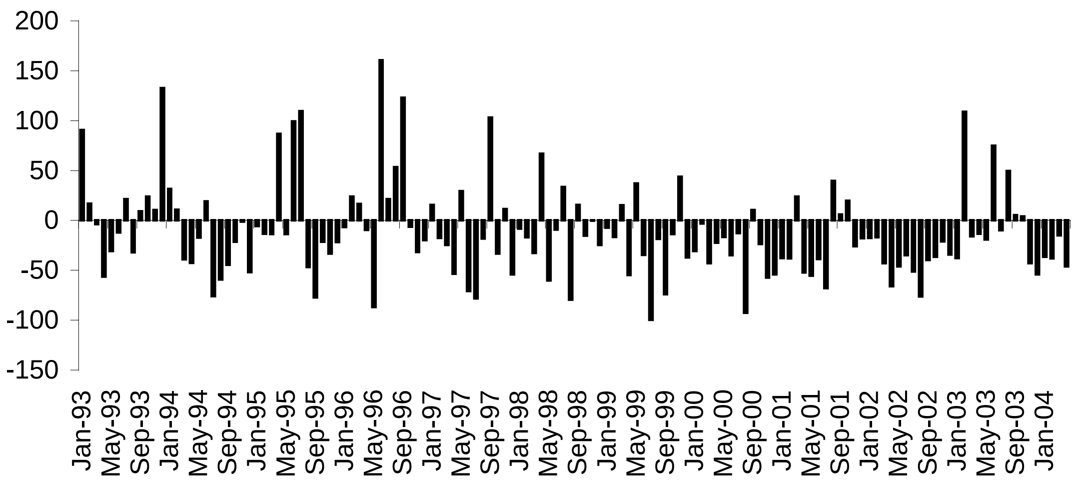

Figure A4.1. Variation in mean monthly rainfall (mm) at Grampians National Park. Data are for Halls Gap.

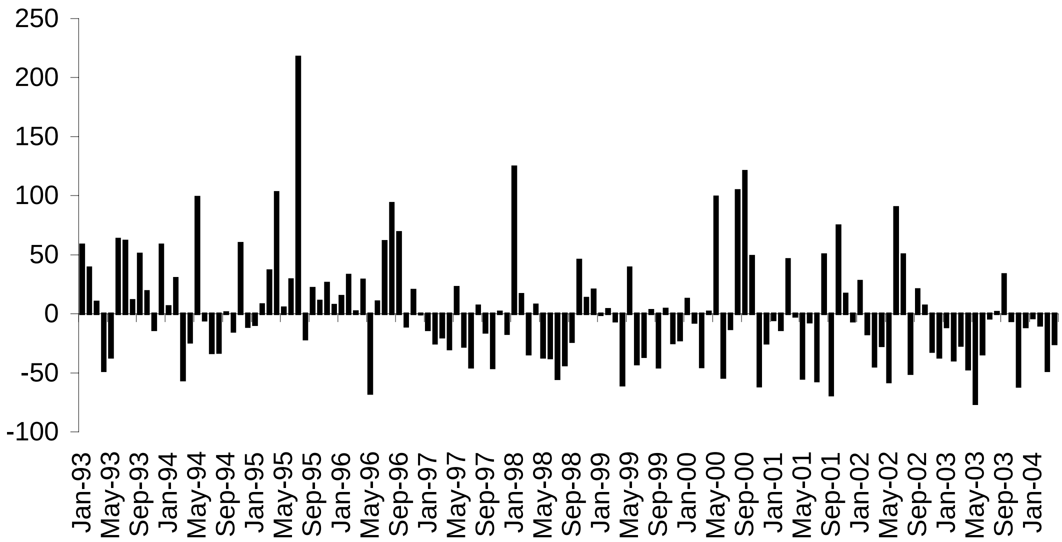

Figure A4.2. Variation in mean monthly rainfall (mm) at Wilsons Promontory National Park. Data are for Tidal River.

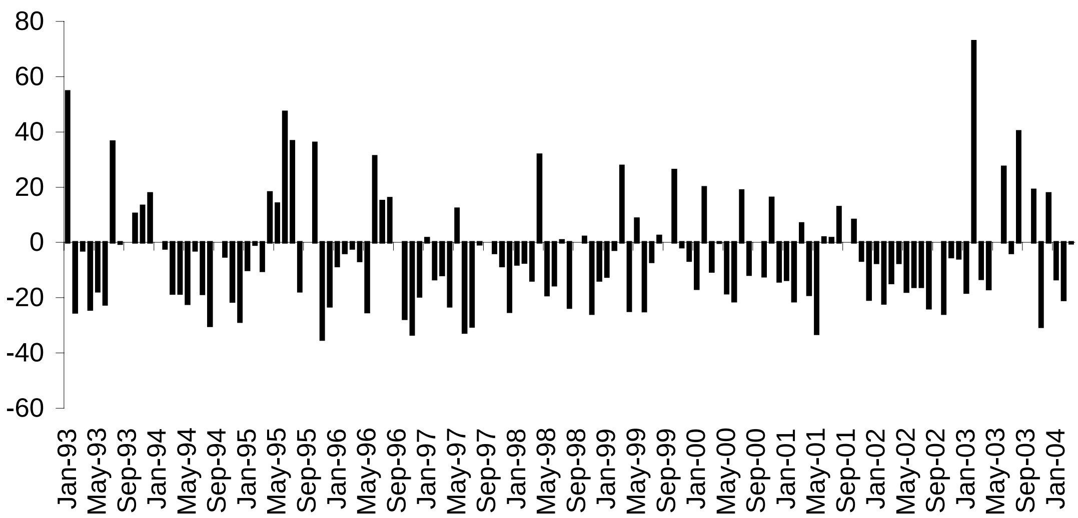

Figure A4.3. Variation in mean monthly rainfall (mm) at Hattah-Kulkyne National Park. Data are for Gerang Gerung.

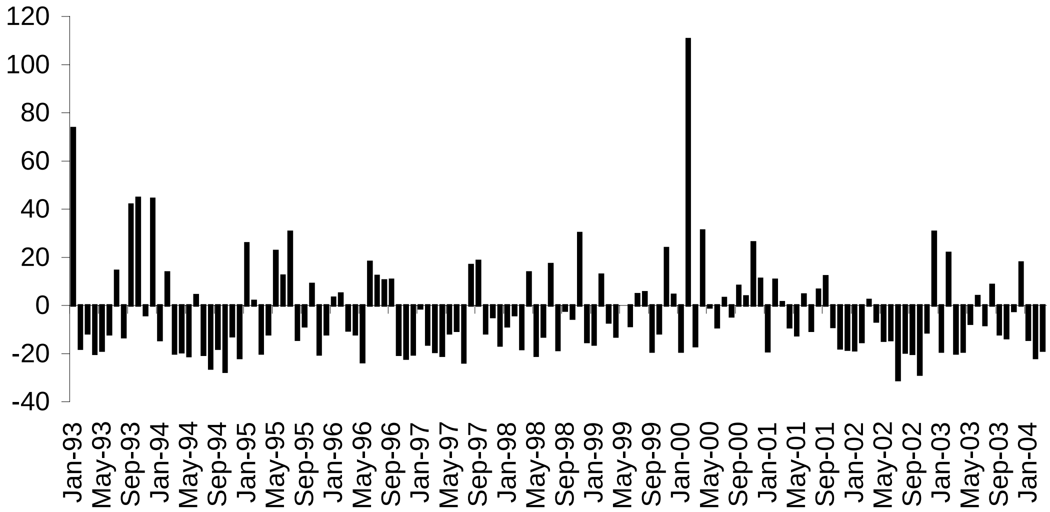

Figure A4.4. Variation in mean monthly rainfall (mm) at Little Desert National Park. Data are for Nulkwyne Kiamal.

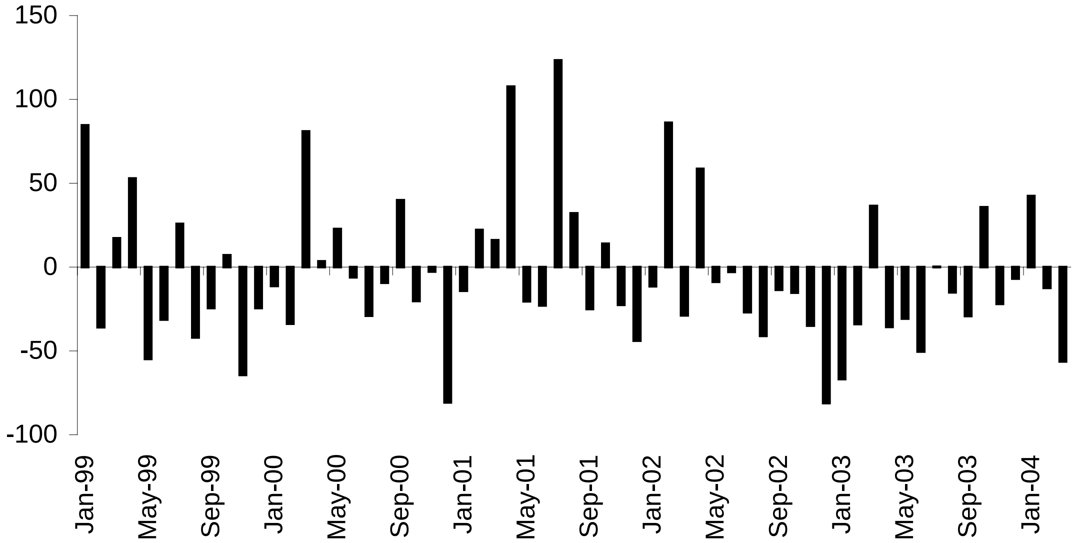

Figure A4.5. Variation in mean monthly rainfall at Coopracambra National Park. Data are for Wangarabell. No data was available for 1993 – 1998. Long-term average calculated from 1962 – 1972 and 1999 – 2004.

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