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Fox control in urban conservation reserves: An analysis of bait uptake and public perceptions in the Perth metropolitan area

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FOX CONTROL IN URBAN CONSERVATION RESERVES: AN ANALYSIS OF BAIT UPTAKE AND PUBLIC PERCEPTIONS IN THE PERTH METROPOLITAN AREA

By

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ABSTRACT

As the world's population becomes increasingly urbanised, the need for people to see nature on their doorstep is becoming more appealing. The city of Perth (Western Australia) has large areas of bushland that have been reserved as conservation estate, and therefore are only minimally modified by urban development. But while many of these urban bushland reserves contribute highly to biodiversity in the form of vegetation, vertebrate surveys have indicated a low diversity of fauna. These areas have the potential to function in a more complete manner as nature reserves with significant conservation value by supporting populations of native animals which once inhabited these areas.

In Western Australia the Department of Conservation and Land Management has achieved success at fauna re-introductions as part of its Western Shield Program due to intensive predator control, in particular foxes. Fox control is achieved by baiting using toxic 1080 baits. Fox control using 1080 baits has also been effective in semi-urban areas of Perth and Sydney. But in a highly urban / residential area baiting poses potential lethal risks to domestic animals.

Three parks in the Perth Metropolitan Region were used to determine an effective method for urban fox control that maximises bait uptake by target species (fox) and minimises uptake by non-target species. Two bait types were tested, together with four different bait presentation methods, combined to give a total of eight treatments. Two seasons were also tested, to see if fox activity differed.

The potential risks of poison baiting to target and non-target animals in an urban area leads to social concerns for the people who live near or use the areas where baiting would take place. Therefore another aim of this study was to establish the level of support for fox control in the Perth Metropolitan Region, as well as the level of awareness Perth people have for Western Shield, and the risks associated with 1080 baits. A questionnaire was constructed and distributed to the users and nearby residents of two of the three parks used in this study.

Although foxes showed no clear preference for a particular bait type or presentation method, techniques were found that reduced bait uptake by non-target animals. Tethering was an effective method to reduce birds such as ravens moving the baits, while an effective public awareness campaign seeking responsible dog control was found to reduce uptake of baits by dogs.

Level of support for fox control in Perth was high, even though many of the questionnaire respondents were not aware of the Western Shield program.

This study has shown there is the potential for effective predator control to be undertaken in Perth, with the support of park users and residents. Perth has the potential to lead the way in urban ecology. With Kings Park and Botanic Gardens already renowned for its flora attractions, in the future it could be a leader in urban fauna conservation.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

1) Incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution or higher education;
2) Contain any material previously published or written by another person except where due reference is made in the text;
3) Contain any defamatory material.

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This study was undertaken with approval from the Edith Cowan University Animal Ethics Committee and the Edith Cowan University Human Research Ethics Committee.

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CHAPTER 1

INTRODUCTION

1.1 Introduced vertebrate pests in Australia

Since the first arrival of humans in Australia, animals have accompanied them, usually to aid in hunting, for food or companionship. The dingo (*Canis lupus dingo*) was possibly one of the first faunal introductions into Australia, arriving from Asia about 4000 years ago aided by Aboriginal people (Fleming *et al.*, 2001). The arrival of the first European seafarers 500 years ago introduced a new wave of biological introductions, some intentional, and some not. It is thought the first cats (*Felis catus*) found their way onto Australian shores from shipwrecks off the coast four or five centuries ago (Fox, 1995), although this cannot be confirmed (Abbot, 2002; Gaynor, 2000). Between 1840 and 1880 more than 60 species of vertebrate pests were introduced into Australia (Myers, 1986). Acclimatisation societies attempted to redistribute animals and plants around the globe for mankind's betterment and pleasure (Low, 1999); many introductions failed, while others prospered.

1.2 The European red fox in Australia

The first introduction of the European red fox (*Vulpes vulpes*, hereafter referred to as the fox) into Australia cannot be confirmed. Early unsuccessful imports of the fox were

possibly made into Victoria as early as 1845 (Long, 2003), yet according to Rolls (1969) the first successful introductions occurred in southern Victoria in 1871. Its dispersal across Australia was rapid, reaching South Australia by the 1880's, Queensland by 1900 and Western Australia by 1910 (Wilson *et al.*, 1992). The fox is now distributed throughout the southern half of Australia except (until recently) Tasmania, yet it is not found to inhabit the tropical areas of Australia. The distribution of foxes is similar to rabbits (*Oryctolagus cuniculus*), highlighting the importance of rabbit in their diet (Saunders *et al.* 1995).

When rabbits are in abundance, the fox relies on it as its primary food source (Catling, 1988; Molsher *et al.* 2000; Read & Bowen, 2001). The fox is an opportunistic predator, preying on lambs and other livestock, as well as contributing to the decline of many native animals (Burbidge & McKenzie, 1989; Kinnear *et al.* 1988; Lunney & Leary, 1988; May & Norton, 1996; Saunders *et al.*, 1995), and is therefore recognised as a serious environmental and agricultural pest in Australia.

The movement of foxes into urban areas was likely a reflection of the changing urban landscape following World War II. The patchwork of urban reserves, parks and gardens, together with an abundant supply of waste from an affluent society favoured their survival (Marks & Short, 1996).

1.3 Urban foxes

Foxes are known to inhabit every mainland capital city of Australia except Darwin (Marks & Bloomfield, 1999). In Perth, the first recording of a fox sighting was entered into the Catalogue of the Western Australian Museum in 1937 (Kitchener & Vicker, 1981). According to Long (1988), several foxes were killed in 1927, within a few miles of Perth. More recently, of the ground vertebrate fauna in 34 vegetation remnants within the Perth metropolitan area surveyed by How and Dell (2000), the fox was recorded by sighting or tracks in four vegetation remnants. The fox is known to be present in Kings Park and Botanic Garden, Bold Park and Whiteman Park (BGPA, 2000; KPBG, 1995; WPBM, unpubl.). Urban foxes are common in cities in Europe, particularly Britain, and North America (Marks & Bloomfield, 1999), with many factors leading to the colonisation of urban areas by foxes (Lloyd, 1980).

Foxes are the main wildlife vector of the disease rabies in Europe, and in the event of an outbreak, the presence of foxes in an urban area would present a problem (Trewhella *et al.*, 1991). For this reason, urban foxes have been studied extensively in Britain (eg. Doncaster & Macdonald, 1991; Harris, 1981; Harris & Smith, 1987; Harris & Trewhella, 1988; Kolb, 1984; Trewhella & Harris, 1988; Trewhella *et al.*, 1991;Wilkinson & Smith, 2001). Australia and Antarctica are the only continents that are free of rabies. If European fox rabies was to enter Australia, the fox is the major rabies host for that strain, and would be responsible for spreading and maintaining the disease (Garner, 1992). Apart from distribution and density studies conducted in urban

Melbourne to consider the potential of oral vaccination for rabies control (Marks & Bloomfield, 1999), no other studies concentrating on urban foxes have been undertaken in Australia.

Urban foxes differ from rural foxes in their diet, behaviour and density. The fox is well regarded as an opportunistic predator, but in an urban environment scavenging for food from human waste forms part of the urban fox's diet (Harris, 1981). Lloyd (1980) described urban foxes as more sociable than rural populations, and is a reflection of the necessity for living in close proximity to other foxes due to a higher density per unit area in urban environments. In Australia the density of rural foxes varies according to the productivity of their environment, ranging from 0.9 foxes per square kilometre in arid grazing land in New South Wales, to 4.6 –7.2 foxes per square kilometre in temperate grazing land in New South Wales (Saunders *et al.* 1995). Urban fox distribution and abundance is related to variations found within the urban habitat, with the difference in the urban geography of Australian cities to that of British cities seeming to reflect the differences in urban fox densities (Marks & Bloomfield, 2001; Robinson & Marks, 2001).

According to Robinson and Marks (2001), Melbourne has 16% of the land area devoted to parks and gardens within 3km of the city centre. Marks and Bloomfield (1999) found foxes in Melbourne to favour areas of thick vegetation provided by parks and gardens, vacant land and other open spaces. In Melbourne the highest density of foxes was recorded at the industrial site of Webb Dock, with a mean density of 16 foxes per

km^2. In contrast to this, the Melbourne Royal Botanic Gardens recorded the lowest density with 3 foxes per km^2. In Britain, Harris and Rayner (1986) found foxes to be more abundant in residential areas than in city centres or industrial zones. Urban fox densities in several British cities were found to be as high as 15 adult foxes per km^2 (Harris & Rayner, 1986; Harris & Smith, 1987).

In comparison to Melbourne, the Perth Metropolitan Region has 18% of its original vegetation (51,200 ha) protected under the Bush Forever Plan (WAPC, 2000). Given that Perth has large areas of native vegetation to support urban fox populations, and that foxes are known to be present in Perth, it seems unusual that no action has been taken in the past to control them. In Western Australia, the fox is a declared animal under the Agriculture and Related Resources Protection Act 1976. Fox control is the responsibility of the landholder, and their numbers in the wild are required to be controlled, although this is not binding on Crown Land (Saunders *et al.*, 1995; P. Mawson, pers. comm.).

1.4 Control of the red fox in rural Australia

In Australia methods of fox control usually involve shooting, trapping, fumigation of dens, exclusion fencing or baiting (Lund, 2001). Poison baiting using 1080 baits is widely used to control foxes (Saunders *et al.*, 1995), as it is considered the most cost effective and efficient method (Lund, 2001). The toxin 1080 was first introduced in Australia in the 1950's for rabbit control. In 1958 it was discovered to be effective for

fox control, and has since been used to control other vertebrate pest species, for example wild dogs, dingoes, feral pigs and rabbits with one shot oats (DoA, 2002; Fleming *et al.*, 2001; Saunders *et al.*, 1995).

Sodium monofluoroacetate (1080) is a naturally occurring compound found in more than 40 plants species in Australia, of which 38 are found in the south-west of Australia (DoA, 2002; Oliver *et al.*, 1979). In Western Australia, native animals have acquired a tolerance to 1080 with an evolutionary exposure to fluoroacetate bearing vegetation (Oliver *et al.*, 1979), and therefore are not at risk to baits laced with the 1080 toxin. In contrast, introduced animals will succumb to the effects of the poison because they have not coevolved with the natural toxin in their environment. In southeastern Australia, no fluoroacetate bearing plant species are found and many of the native animals have a low tolerance to 1080. In particular carnivorous marsupials such as the tiger quoll (*Dasyurus maculatus*) and the eastern quoll (*D. viverrinus*) are very sensitive to 1080, and are likely to receive a lethal dose from ingesting one bait (Belcher, 1998) (More recently however, Kortner *et al.* (2003) found that although quolls will remove baits, they are unlikely to ingest them). In the east of Australia baits are therefore required to be buried beneath the surface in a hole 80-100 mm deep to minimise take by non-target species. In Western Australia, the Department of Agriculture recommend the burying and tethering of baits if they are to be laid near residential areas (DoA, 2001).

Research on the biological control of foxes is at an experimental stage in Australia, with fertility control being developed by the Pest Animal Control Cooperative Research Centre (Environment Australia, 1999). Methods of fertility control currently being trialled include cabergoline, which aims to reduce the reproductive success of vixens (Marks *et al.* 2002). The results of research involving the biological control of foxes may not be finalised for many years as extensive testing is required before release of the agent will be permitted.

1.5 Control of the red fox in rural Western Australia

In Western Australia, the Department of Agriculture gives baiting approval to landholders to carry out their own fox control using 1080 where foxes are preying on livestock. In non-agricultural areas of rural Western Australia, the Department of Conservation and Land Management (CALM) has been undertaking fox control in its conservation estates as part of a native fauna recovery program called Western Shield.

Western Shield aims to control foxes with regular baiting, then return native animals to their former habitats through captive breeding and translocation. The program covers 3.5 million hectares of Western Australia using dried kangaroo meat baits delivered by aircraft at a density of one bait per 20 hectares, and it is estimated 80-100% of foxes are killed (Morris, 2000). Since the program began in 1996 three species of mammal have been removed from the State's threatened fauna list (Friend *et al.*, 2001). In addition to this, seven marsupial species belonging to six families have been successfully re-

introduced to 15 sites that they previously inhabited, and a positive population response has been recorded for 11 marsupial species present at 25 sites (Kinnear *et al.*, 2002).

The eradication of foxes on islands has also been successful in Western Australia, with self-introduced populations on islands in the Dampier Archipelago being eradicated in 1980, with regular baiting continuing since 1985. A population of Rothschild's rock-wallaby (*Petrogale rothschildi*) was near extinction in the 1970's, but has now recovered (Burbidge & Morris, 2001).

1.6 Control of urban foxes

In Europe, urban foxes are controlled to slow the rate of spread of rabies. In Australia foxes are not controlled in any highly urbanised areas, however fox control programmes are underway on the outskirts of Sydney and Perth.

In the Sydney North Region, the Warringah Council together with five other local councils applied successfully for a special off-label permit to control foxes in this urban area. Baiting commenced in 2000 using Foxoff® baits containing 3mg of 1080. Analysis of pre and post program fox density studies showed that the fox population had been reduced from 33% to 11% in the Ku-ring-gai National Park. At this early stage it is too early to measure the effects the baiting program has had on wildlife populations, yet the community response has been far more positive than initially expected (Mason, 2002).

Whiteman Park is a conservation reserve in the north-eastern suburbs of Perth. Since 1990 management of the park has involved an intensive fox control program, with the aim to increase fauna values within the park (WPBM, unpubl.). Whiteman Park is one of the last areas on the Swan Coastal Plain thought to have a near complete range of fauna; increasing population numbers of the black-gloved rock wallaby (*Macropus irma*) that inhabit the park are an indicator that the fox control program has been effective (J. Wallace, pers. comm.).

Together with fox control programs elsewhere in Western Australia, these two urban fox control programs have shown that by controlling foxes, native fauna can recover, and in an urban area. But, consideration needs to be given to the risks to non-target species associated with a fox control program.

1.7 Non-target issues associated with pest control

Any method used to control or eradicate an invasive species must be specific to that target species. In a poison baiting program, if there are potential non-target animals at risk, the poison used must have either no significant impact on them or be presented in a way that makes it unavailable to them (Burbidge & Morris, 2001). The development of bait stations may be needed to restrict access by non-target animals. Morris (2001) developed a bait station for the eradication of black rats (*Rattus rattus*) on Barrow Island that prevented access by four non-target animals. Design features included a lid to prevent access to the bait by large macropods, and placing the bait at least 13cm

below the lid to restrict the brushtail possum (*Trichosurus vulpecula*) reaching the bait. Another option is to remove some or all of the non-target animals from the area to be baited, then return them after the bait is no longer effective (Burbidge & Morris, 2001).

Developing an understanding of the population ecology and feeding behaviour of the target and non-target species can provide a framework to ensure baiting programmes are more selective to the target species (Moro, 2001). Identification of a biological difference between species can be exploited in the eradication of invasive species (Moro, 2001).

1.7.1 Non-target issues associated with 1080 baiting

Poison baiting using 1080 impregnated into meat baits remains the most widespread and effective way of controlling foxes across Australia (Saunders *et al.* 1995). While there are many advantages to 1080 baiting, the most significant disadvantage is the potential risk to non target species (DoA, 2002). In areas other than Western Australia, there are many native animals at risk from poison baiting, due to their lower tolerance of 1080 (Belcher, 1998, Dexter & Meek, 1998). Bait medium, bait manufacture and presentation methods are critical for minimising impacts on non-target animals. Bait presentation methods include burying baits and increasing the distance between bait stations (Glen & Dickman, 2003a).

Domestic dogs are the most prevalent non-target species at risk from 1080 baits in urban areas. Dogs (*Canis familiaris*) belong in the canidae family with the fox; therefore their sensitivity to 1080 is similar. Sensitivity of an animal to a toxin is generally expressed as the lethal dose LD_{50}, an estimated dose, which if administered to each individual in a population would kill 50% of that population (McIlroy, 1981). LD_{50} values are expressed as the milligrams of 1080 required per kilogram of body weight of the target species, i.e. mg/kg. The LD_{50} value for a dog is 0.11 mg/kg, similarly, the LD_{50} value for a fox is 0.12 mg/kg (DoA, 2002). Many studies have been done to minimise impacts to dogs. Methods to reduce uptake of baits by dogs can include using fewer baits and using a bait that is preferentially eaten by foxes. But because of the similarities in the feeding behaviour of the fox and the dog, this is impossible to achieve.

Regardless of the effectiveness of a bait program design, once baits are presented, there are risks that cannot be controlled. Foxes cache baits by moving them from their original location and then either burying or hiding them elsewhere (Saunders *et al.*, 1999). In a poison-baiting program the fox may cache one or more baits before succumbing to the deadly effects of a single bait, leaving those (lethal) caches available to be taken or consumed by non-target species (Saunders *et al.*, 1999). Studies have found foxes will cache up to 25% of baits taken in agricultural areas (Thomson and Kok, 2002) and 33% of baits taken in semi-urban areas (van Polanen *et al.*, 2001). The movement of baits by non-target species is another factor that could pose risks to other non-target species. Thomson and Kok (2002) found birds were the most common

animal to move baits; some baits were found up to 400 metres away from their point of origin.

A responsible baiting program will remove any poison baits not taken within a given time, but there is the risk that baits will remain undetected and become a potential risk to non-target species. Fleming (1997) reported a rate of 58% total bait uptake by foxes over a period of two days, leaving up to 42% of baits for removal by other species, should the fox succumb to the lethal effects of one single bait.

Informing the public that baits are in the area and that dogs are at risk, and therefore keeping dogs out of an area that has been baited, is probably the most effective way to reduce the risk to dogs.

1.8 Public concerns regarding 1080 baiting

In rural Western Australia there has been encouraging support from the local communities regarding the Western Shield program. Similarly the corporate communities have also supported the program by offering sponsorship money (Armstrong, 1998). The challenge now lies in achieving this community support in an urban area.

At Whiteman Park making regular contact with Park neighbours every six months via postal mail to inform them of baiting procedures, and placing warning signs around the

park to advise visitors about baiting, have been successful strategies to communicate the message of fox control programs. In the last two years, Park staff have found the carcasses of approximately six dogs, although no contact was made with the Park from the public about any of the dogs. It was therefore assumed the dogs had strayed from their home, and their whereabouts were unknown by their owners (J. Wallace, pers. comm.).

It is important to recognise that the community may be concerned over the introduction of a toxic baiting program in an urban area due to the potential risks to domestic animals. If a fox-control program were to be introduced to Kings Park and Botanic Gardens (KPBG) and Bold Park, and other bushland reserves in the Perth Metropolitan Region, an extensive public awareness campaign would need to be undertaken, and the public will need to accept the initiation of such a program. But, whilst it is necessary to recognise the concerns the public would have regarding a baiting program in urban areas, it is also important that the community understand the benefits of such a program being implemented.

1.9 Aims of this study

Predator management in rural southwest Western Australia has been successful at controlling the European red fox (*Vulpes vulpes*), and has been the precursor for the recovery of threatened native fauna (particularly mammals) (Burbidge & Morris, 2001;

Kinnear *et al.*, 2002). Although the fox has inhabited the Perth Metropolitan Region for more than 60 years (Kitchener & Vicker, 1981), no co-ordinated attempt has been made to control the population.

In Perth there are large areas of bushland that have been reserved as conservation estate, and therefore are only minimally modified by urban development. These areas have the potential to become nature reserves with significant conservation value by supporting populations of native animals which once inhabited these areas, particularly if fox control can be achieved.

Throughout Australia, numerous studies have been conducted that have analysed bait uptake during fox control programs (e.g. Dexter & Meek, 1998; Fleming, 1997; Glen & Dickman, 2003b; Thomson & Algar, 2000), with the aim to minimise bait uptake by non-target species, while maximising bait uptake by target species. Thomson and Kok (2002) placed miniature radio transmitters in dried meat baits in rural Western Australia, to investigate the caching of baits by foxes, and the uptake of baits by non target species. The study found baits that are cached by foxes and moved by birds pose a potential hazard to non target species.

The study by Thomson and Kok (2002) provides initiative for this study. If similar methodology could be used in an urban area, it would give an indication of the rate of uptake of baits by target and non target species, should a fox control program using toxic baits be implemented in Perth bushland reserves. By placing transmitters in non-

toxic baits, and using sand plots to determine what species visit or take baits, any potential risks would be realised, and therefore a baiting program may be modified to minimise poisoning risks to non target animals.

The specific aims of this study were to:

- Test different bait presentation methods and analyse bait visitation and removal by target and non-target species to determine a safe method for fox control in Perth urban reserves such as Bold Park and Kings Park bushland, and
- Survey the users and nearby residents of each park to establish the level of understanding and awareness of fox control, and the degree of support for it in these urban areas.

The feasibility of implementing a fox-control program within Perth urban reserves will be considered, taking into account the results of the baiting trials, and public concerns about the risks of such a program taking place in a highly urbanised environment.

1.10 Thesis structure

Chapter 2 details the study sites used in this project, with a brief background into the Perth Metropolitan region, and each of the Parks where the study took place: Kings Park and Botanic Gardens, Bold Park and Whiteman Park. Chapter 3 concentrates on the bait uptake aspect of the study, detailing the methodology used, results obtained,

with a brief introduction and discussion. Chapter 4 concentrates on the social element of the study: the public perceptions of fox control in an urban area. The methodology used, results obtained are detailed, and a brief introduction and discussion are included. A general discussion (chapter 5) links the two components of the study and considers the potential for fox control in the Perth Metropolitan Region. Some suggestions for management are discussed here.

CHAPTER 2

STUDY SITES

2.1 Location of study

The study took place within three bushland reserves within the Perth Metropolitan Region: Kings Park and Botanic Gardens (KPBG), and Bold Park (both recognised as urban reserves), and Whiteman Park (recognised as a semi-urban reserve)(Fig. 1). Perth City was established in 1829, and is situated on the Swan Coastal Plain on the southwestern coast of Australia, with a population of approximately 1.46 million people (DPI, 2003). Perth experiences a Mediterranean climate with hot, dry summers and mild, wet winters. The annual mean rainfall is 869 mm, falling over 199 rain days, with 80% falling between May and September (BoM, 2003).

Perth has large areas of bushland that have been reserved as conservation estate, and therefore are only minimally modified by urban development. With the implementation of government policies such as Bush Forever, regionally significant bushland sites in the Perth Metropolitan Region are identified for protection. Each site is representative of regional ecosystems and habitats, and each site plays a role in the conservation of regional biodiversity (WAPC, 2000). Currently, three Government Authorities undertake management of these urban bushland reserves. The Botanic Gardens and Parks Authority manage KPBG and Bold Park, The Department for Planning and Infrastructure are responsible for Whiteman Park, and eight regional parks are managed by CALM. Management authorities recognise the importance of

biodiversity, and work to ensure that the native biological diversity of their bushland is conserved. But while many of these urban bushland reserves contribute highly to biodiversity in the form of vegetation (Keighery *et al.* 1990), vertebrate surveys have indicated a low diversity of fauna (How and Dell, 1990, 1992).

The clearing of native vegetation and infilling of wetlands in Perth has made way for urban development leading to the destruction, modification or fragmentation of habitat for numerous animal species. Kitchener *et al.* (1978) listed 33 mammal species alone ·t once occurred on the Swan Coastal Plain, though only 12 of those species were ·.orded in their 1978 survey. Likewise, six species of birds have become locally extinct from the Perth Metropolitan Region with many more species declining in abundance (How and Dell, 1992).

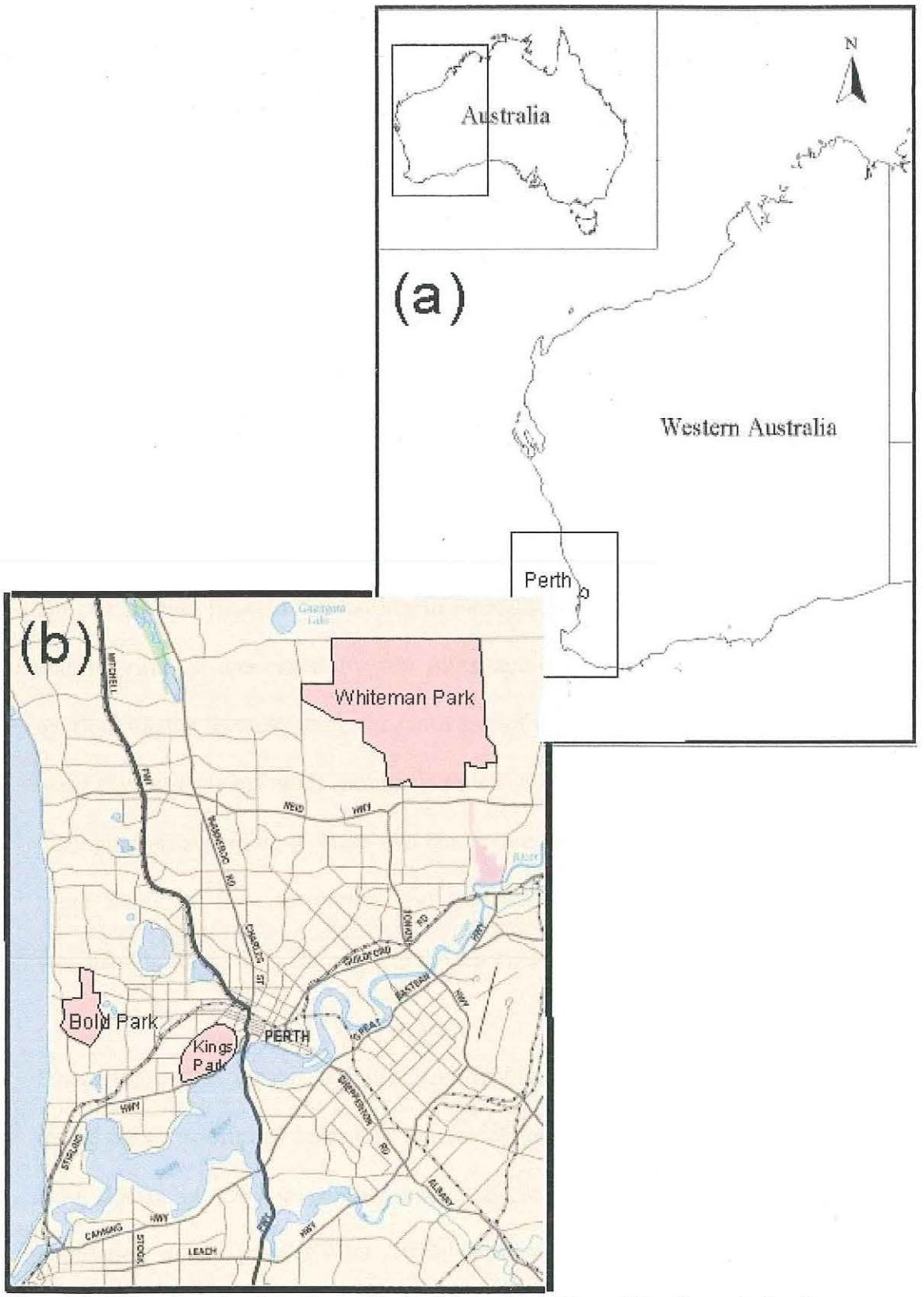

Figure 1. Map showing location of Perth (a), and location of the three study sites within the Perth Metropolitan Area (b) used in the baiting trials.

2.2 Kings Park Bushland

Kings Park and Botanic Garden (389122E, 646346N) is an A-class reserve that is situated 1.5km west of the Perth Central Business District (CBD)(Fig. 1b). It comprises 400 ha, of which approximately 267 ha is bushland and is managed by the Botanic Gardens and Parks Authority (BGPA). The bushland is popular for recreation, education and enjoyment of natural remnant vegetation, in particular wildflower viewing (KPBG, 1995).

Kings Park and Botanic Garden lies in the central section of the Swan Coastal Plain, and is visually dominated by Mt Eliza and the underlying exposed escarpment overlooking the Swan River to the north east of the park. The remainder of the park is generally low lying with minimal relief. Vegetation within the bushland is distinguished according to these two distinctive landform reliefs, with a mixed closed heath found on the escarpment, and *Eucalyptus, Allocasuarina* and *Banksia* open woodland to forest found throughout the remainder of the bushland (KPBG, 1995).

Fauna known to inhabit the bushland include seven species of native mammal, including six species of bats; four species of frog, and 23 species of reptile (How & Dell, 2000). In 1989, a wildfire burnt 120 ha of the bushland, affecting the bird population in the Park (KPBG, 1995; Recher, 1997). A study by Recher (1997) recorded forty species of bird along a transect in the park from 1986 to 1995. Five species of introduced mammals are present in the bushland. Foxes are known to inhabit

Kings Park bushland, yet no measures are currently in place to control them. Previously the bushland management team had undertaken the practice of gassing fox dens between 1992 and 1999 but this technique for population control remained ineffective. Dogs are permitted into Kings Park and Botanic Garden, but by law must be kept on leads; this is often not adhered to by dog owners.

2.3 Bold Park

Bold Park (383488E, 646754N)(Fig. 1b) was declared an A-class reserve in 1998, and is managed by the Botanic Gardens and Parks Authority. It is 437 ha of native coastal bushland that lies approximately 6 km west of the Perth CBD. The park lies within the Spearwood and Quindalup dune systems; topography ranges from 10 to 80 m above sea level. The park is topographically dominated by Reabold Hill, which, at 84.8 m above sea level is the highest point on the Swan Coastal Plain (BGPA, 2000).

There are a number of key bushland reserves surrounding Bold Park that provide important ecological corridors within the Perth Metropolitan Region. The bushland is managed for conservation, education and recreation purposes (BGPA, 2000).

Native mammals have declined in Bold Park since European settlement (BGPA, 2001), and only three native mammal species are known to inhabit the park. Eighty seven bird species have been sighted in the park, as well as 64 reptile and 13 frog species (BGPA, 2001). Five species of introduced mammals are present in the park, including foxes,

yet management has not previously utilised any form of fox control. Rabbits are a problem in Bold Park, by feeding on, and destroying revegetation work undertaken in the park (M. Buist, pers. comm.). Dogs are permitted in Bold Park, but by law must be kept on leads.

2.4 Whiteman Park

Whiteman Park (399335E, 647673N) is located approximately 16 km from the Perth CBD, in the northeast corridor of the Metropolitan Region and covers an area of more than 3600 ha (Fig. 1b). The Western Australian Planning Commission is responsible for the administration and management of Whiteman Park. The park supports a number of different land uses, broadly categorised as: shooting ranges, leased property, equestrian complex, cattle grazing, areas of conservation and areas of recreation. Whiteman Park is popular for recreational activities, with about 30 000 visitors each year (WPBM, unpubl.).

The landform is typical of the Swan Coastal Plain, generally flat with little significant relief. Wetlands and swamps are interspersed throughout the Park. The park is situated over the southern part of a shallow unconfined aquifer of the Gnangara Mound. Vegetation is a mix of *Marri, Banksia* and *Jarrah* woodlands interspersed with some heathland (WPBM, unpubl.).

The park has a near complete range of fauna that once occurred on the Swan Coastal Plain, including eight species of native mammals, 104 bird species, 32 reptile species and seven amphibian species. Introduced species in the Park include foxes, cats and rabbits (WPBM, unpubl.). The success in animal conservation has been achieved through management strategies including the maintenance of native vegetation, a conservative fire regime, and importantly, the control of introduced predators, in particular foxes. Dogs are allowed into the Park, but dog owners are advised to keep their dogs on a lead. Signs are positioned prominently in the park, warning dog owners of the dangers to their dogs, in an attempt to minimise dogs finding and ingesting baits (Figures 2 and 3).

Figure 2. Sign at the main entrance of Whiteman Park informing Park users of the fox control program using 1080 baits, and that dogs should be kept on a lead.

Figure 3. Sign at a side entrance into Whiteman Park, informing Park users of the fox control program using 1080 baits.

Fox Control Within Whiteman Park

For the purpose of this study Whiteman Park was chosen because it could provide a reference site to KPBG and Bold Park; in the former foxes are known to be present and are currently being controlled, whereas in the latter two parks the fox populations are not managed.

Whiteman Park is authorised to use 1080 baits, and has done so since 1990. Baiting is conducted year round, usually on a six to eight week cycle. Dried kangaroo meat baits and egg baits are used containing 4.5 mg of 1080. Meat baits are presented tethered to a metal post at a height of 300 mm off the ground, whereas egg baits are placed on top of white PVC poles, also at height of 300 mm off the ground, with the aim to minimise take by non-target species (J. Wallace, unpubl. data).

For the duration of this study, baits containing 1080 were presented at Whiteman Park whenever baiting trials were not underway there. Also, prior to the studies being undertaken in June, no toxic baits were presented for the month of May.

CHAPTER 3

ANALYSIS OF BAIT TAKE

3.1 Introduction

Predator control programs that use 1080 baits in Australia aim to be effective by minimising bait uptake by non-target species, while maximising bait uptake by target species. Studies undertaken throughout rural Australia are continuously discovering new ways to achieve this efficacy (Allen *et al.*, 1989; Belcher, 1998; Dexter & Meek, 1998; Fleming, 1997; Glen, 2001).

For foxes in Australia, Thomson and Algar (2000) considered the most appropriate baiting rate to control target species. For control programs to be effective, baits must be delivered at a rate that maximises uptake by foxes, but minimises the number of baits required. The potential risk to non-target animals is therefore reduced, by effectively delivering the amount of baits required to target foxes and minimising non target take.

Studies have been done to test the efficacy of bait types and their attractiveness to target and non-target species (e.g. Marlow, 2003; Saunders & Harris, 2000). Martin *et al.* (2002) studied the efficacy of three types of non toxic predator baits to a variety of native non-target species to determine which species need to be monitored during fox

control programs. Saunders and Harris (2000) investigated the effectiveness of adding chemical attractants to poison baits to enhance bait discovery by foxes. Their study showed that beef flavour and sugar enhanced bait uptake, but the trials were conducted on captive foxes, therefore it was determined further studies needed to be conducted to asses the uptake of bait with flavour enhancers by free-ranging foxes.

Glen and Dickman (2003a) looked at two alternative bait station designs to minimise bait take by non-target species. Their study found that burying baits in the ground, rather than under mounds, would reduce uptake by spotted-tailed quolls (*Dasyurus maculatus*), but this method did not determine if bait uptake by foxes increased.

More recently, studies have considered the caching behaviour of the fox in Australia (e.g. Saunders *et al.*, 1999; Thomson & Kok, 2002; van Polanen Petel *et al.*, 2001). Foxes are known to cache food as a means to secure any surplus food for times of shortage (Lloyd, 1980). Saunders *et al.* (1999) looked at the caching of baits by foxes on agricultural lands by inserting small radio transmitters into Foxoff® baits. Van Polanen Petel *et al.* (2001) found that bait palatability influenced the caching behaviour of foxes. Thomson and Kok (2002) used transmitters in dried meat baits in rural Western Australia and found that foxes cached 25% of baits taken, at distances of up to 380 m from where they were taken.

More specifically, ravens (*Corvus coronoides*) are known to cache food (Heinrich & Pepper, 1998), hiding any surplus food in the ground and covering it with dirt or debris

(Savage, 1995). The study by Thomson and Kok (2002) also considered the uptake of baits by non-target species, which took 3% of baits on offer. Of the non-target species to take baits in the study, birds were the most common, and in some cases the baits had been dropped 400 m away from where they were laid.

Maintaining a low economic cost associated with predator control is also an important issue for a fox control program as the ongoing costs of operation are often high (EA, 1999). In Western Australia the annual cost of Western Shield in 2002 was $1.25 million, with baiting operations accounting for a large part of the program (CALM, 2003). In an effort to reduce costs, CALM has begun to produce their own bait. 'Probait' has been designed to be more economical to manufacture, and to be more palatable to the target species (fox). Probaits are currently being trailed by CALM in rural areas for their effectiveness at fox control. Marlow (2003) reported on the effectiveness of Probait in rural areas of Western Australia, and compared it to the currently used alternative in Western Australia (dried meat bait), produced by the Department of Agriculture. Her study found that the uptake of Probaits by foxes was lower than the dried meat baits, although it could be less of a hazard to the non-target carnivores, such as the chuditch (*D. geoffroyi*).

While efforts to reduce costs and bait uptake by non-target species in a baiting program to control foxes may be anthropocentrically beneficial, it may jeopardise the efficacy of the program by reducing bait uptake by target species and therefore risking potential benefits to conservation. In an urban area, fox control programs must be even more

efficient at targeting foxes, and reducing bait uptake by non-target species than in rural areas. The higher occurrence of non-target animals such as dogs and cats in an urban area leads to a greater risk that they will find and ingest a toxic bait.

This chapter aims to:

- Evaluate a number of different bait presentation methods designed to reduce uptake by non-target species and maximise uptake by target (fox) species in three urban bushland reserves in the Perth Metropolitan Region.
- Identify a bait presentation that will minimise caching by foxes.
- Compare the bait uptake by foxes at Whiteman Park to the bait uptake by foxes at KPBG and Bold Park, to examine if fox control at Whiteman Park has decreased fox activity.
- Compare target and non-target species' preferences to the new bait developed by CALM (Probait) with the currently used alternative, dried meat bait.

3.2 Methods

Bait preparation

Two types of baits were used in the trials: dried kangaroo meat, obtained from the Department of Agriculture, Vertebrate Pest Research Section, Forrestfield, and Probait, a sausage-style bait developed by CALM. All baits used were non-toxic for these trials.

Dried kangaroo meat baits are currently used for fox control in Western Australia by private landholders and CALM. The dried meat baits vary in size and weight, but are approximately 75 mm long, 45 mm wide, and weigh 45 g. For this study the meat was prepared before drying for insertion of a radio transmitter, similar to the methodology used by Thomson and Kok (2002), and is briefly described. Before drying the meat, a 16mm diameter wooden tube was inserted into, but not through each bait. Baits were dried for three days. After drying the tube was removed leaving a hole for the insertion of a small radio transmitter. The aerial of the transmitter will protrude from one end of the hollow. The transmitter fits securely into the hollow created therefore there is no risk of it falling out of the bait (Fig. 4).

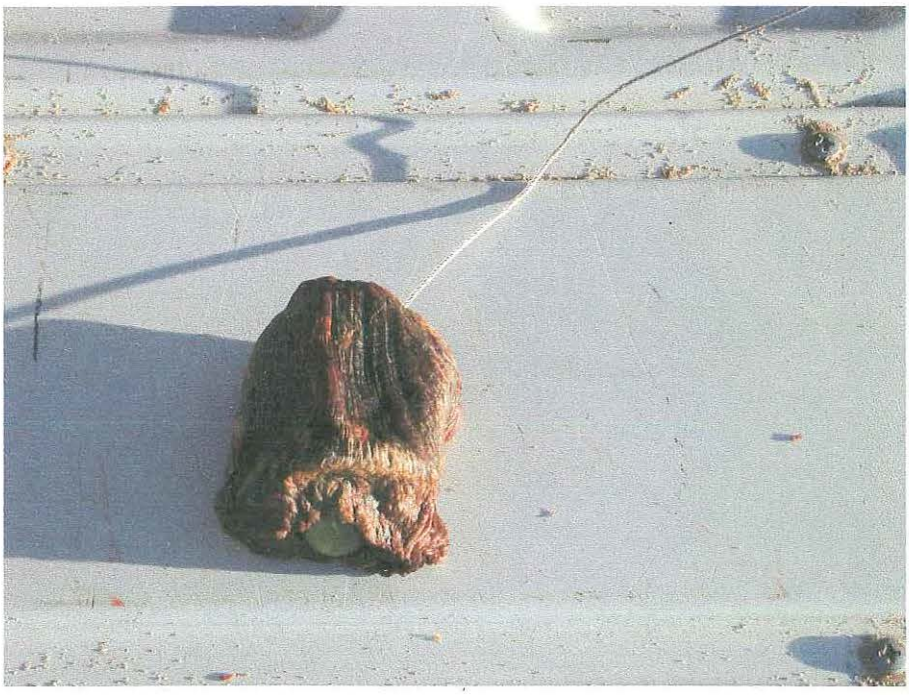

Figure 4. Dried kangaroo meat bait used in the trials showing the position of the inserted radio transmitter.

Probaits are made from a mixture of meat, the three main ingredients being minced kangaroo meat, pork fat and a canine 'digest', a commercial flavour enhancer for dog food. They are a hard bait, designed to reduce the risk that non-target species will bite into the bait. They measure approximately 85 mm long and 25 mm in diameter, weighing approximately 50 g. A transmitter was inserted by drilling two small holes through the bait (7/64 drill bit), then threading the aerial of the transmitter through these holes (Fig. 5). Another hole was drilled through the centre of the bait for the purpose of tethering the bait.

Figure 5. Probait used in the trials showing the inserted transmitter. This bait differs to the dried meat bait in size, texture and composition.

The radio transmitters (model SS-2, 150MHZ: Sirtrack Ltd, New Zealand) used in the study weigh 8.5 g, are 30 mm long by 15mm wide with a 200 mm whip aerial. Each transmitter emitted a unique frequency, so that it could be located. Signals can be picked up to 200 m from the source, and the attached battery is switched on or off with a magnet. During the trials, all transmitters were tested for signal strength before being inserted into the bait, to minimise loss of transmitters, baits and therefore results.

Pilot Studies

Pilot study 1: Track Identification

Glen (2003b) noted observer error on six occasions out of 106 prints left in sand due to inexperience during the early stages of fieldwork. A pilot study was therefore conducted to learn and recognise the tracks left in sandplots by various animals, and particularly those between the target species (fox), and non-target species (dog). This pilot study aimed to avoid any mis-identifications between prints of the various animals once the experiment commenced.

Two methods were used. Identification by viewing the prints of cats and dogs of various sizes was undertaken at the RSPCA Animal Shelter, Malaga. Animals had their feet wet by staff, and then were walked along a section of concrete; a photograph of the prints was taken for future reference. Further identification was undertaken at the Kings Park Bushland, with four plots cleared and scented with tuna oil to attract animals to leave a print. Track identification throughout this study was assisted using Triggs (1996) and in-field experience from CALM staff.

Pilot study 2: Effect of Transmitters on Baits

The assessment of bait take when transmitters are present has been tested previously in other studies involving dried kangaroo meat baits (Thomson and Kok, 2002; Saunders *et al.* 1999), and no signs of bias by foxes was shown to the presence of transmitters in

baits. It was thus assumed that kangaroo meat baits with transmitters had no effect on bait uptake for the current trials. However, to maintain consistency with past trials on dried meat baits, this study tested whether there was a difference in uptake of Probait with and without a transmitter.

A total of 96 baits were presented alternately with and without transmitters (n=48 with and n= 48 without transmitters) in Bold Park over three nights to test the null hypothesis that the presence of a transmitter in a Probait does not influence the frequency of bait uptake. Probaits were presented untethered and uncovered, as the assumption was made that this presentation would maximise uptake based on previous studies (Thomson & Kok, 2002). Baits were presented late (after 1600hr) in the afternoon and then collected early (before 0800hr) the following morning to maximise uptake by foxes and to minimise uptake by non-target species.

Analysis of bait visitation and removal

Bait Presentation

Bait trials were conducted over two seasons: Season 1: late autumn/early winter (June and July, 2003), and Season 2: late winter/early spring (August and September, 2003). A difference in bait uptake between seasons was expected due to the reproductive biology of the fox. Females are reproductively active from July to October. The gestation period lasts 51 to 53 days, with most cubs born during August and September (Saunders *et al.* 1995), correlating with Season 2 for this study.

Two types of bait were trialled (Dried meat bait, Probait) to test if the target species (fox) shows a preference for either bait. Although Whiteman Park staff currently use egg baits containing 1080 for their fox control program, for the purpose of this study egg baits were not a practical option, since a transmitter needed to be attached to each bait to obtain data on the fate of baits if removed. Also, many foxes are attracted to baits that are old, and smell rotten, but due to the methodology used in this study, baits were only left out for one night and this did not allow time for the egg baits to develop a rotten smell (P. Thomson, pers. comm.).

Four different bait presentation techniques were assessed: tethered, untethered, covered, uncovered. Tethering involved tying a 1.6 mm tie-wire to the bait, and then attaching it to a steel tent peg (Fig. 6), which was buried into the ground. Tethering aimed to reduce baits being removed by target or non-target species, with the intention that baits be consumed where they are presented. Covered baits were those which were sheltered under a small shrub. This technique aimed to minimise birds from seeing the bait from above.

The combination of the two types of bait and the four presentation methods combined to give a total of eight treatments (Table 1).

Table 1. Presentation options used for baiting trials conducted in each park. Bait trials were conducted in the winter and spring 2003. The table illustrates eight bait presentation options for one night, which were then duplicated (n=16). Eight Probaits, and eight dried meat baits were presented each night; of these eight, four were presented tethered, four were presented untethered, then of these four, two were presented covered, and two were presented uncovered.

Probait	Tethered	Covered
		Uncovered
	Untethered	Covered
		Uncovered
Dried meat bait	Tethered	Covered
		Uncovered
	Untethered	Covered
		Uncovered

Figure 6. Photograph showing a dried meat bait attached to a tether with 1.6mm tie-wire. A transmitter has also been inserted.

Within KPBG and Bold Park, four treatment blocks were defined which covered a large section of each Park (Figs. 7 & 8). Within each treatment block, 16 sites were chosen at random by walking. Sites were separated at an average distance of 100 m, but no further than 10 m from a walking trail. Foxes are known to use trails within their home range to move from one place to another (May & Norton, 1996). At Whiteman Park however, the baiting stations that are currently used for 1080 bait presentation were selected for this study (Fig. 9).

One treatment block was trialed by duplicating the eight treatments, and these were presented randomly on sixteen plots. Each treatment block was surveyed once only each night to minimise the chance of an animal becoming habituated to the presence of

baits in the area. Sampling moved to another treatment block on consecutive nights, until all four blocks were surveyed. The bait trials were then repeated in another Park, until all three Parks had been surveyed. Each treatment block was resurveyed after 3 weeks to increase sampling effort to n=16 per treatment, per season.

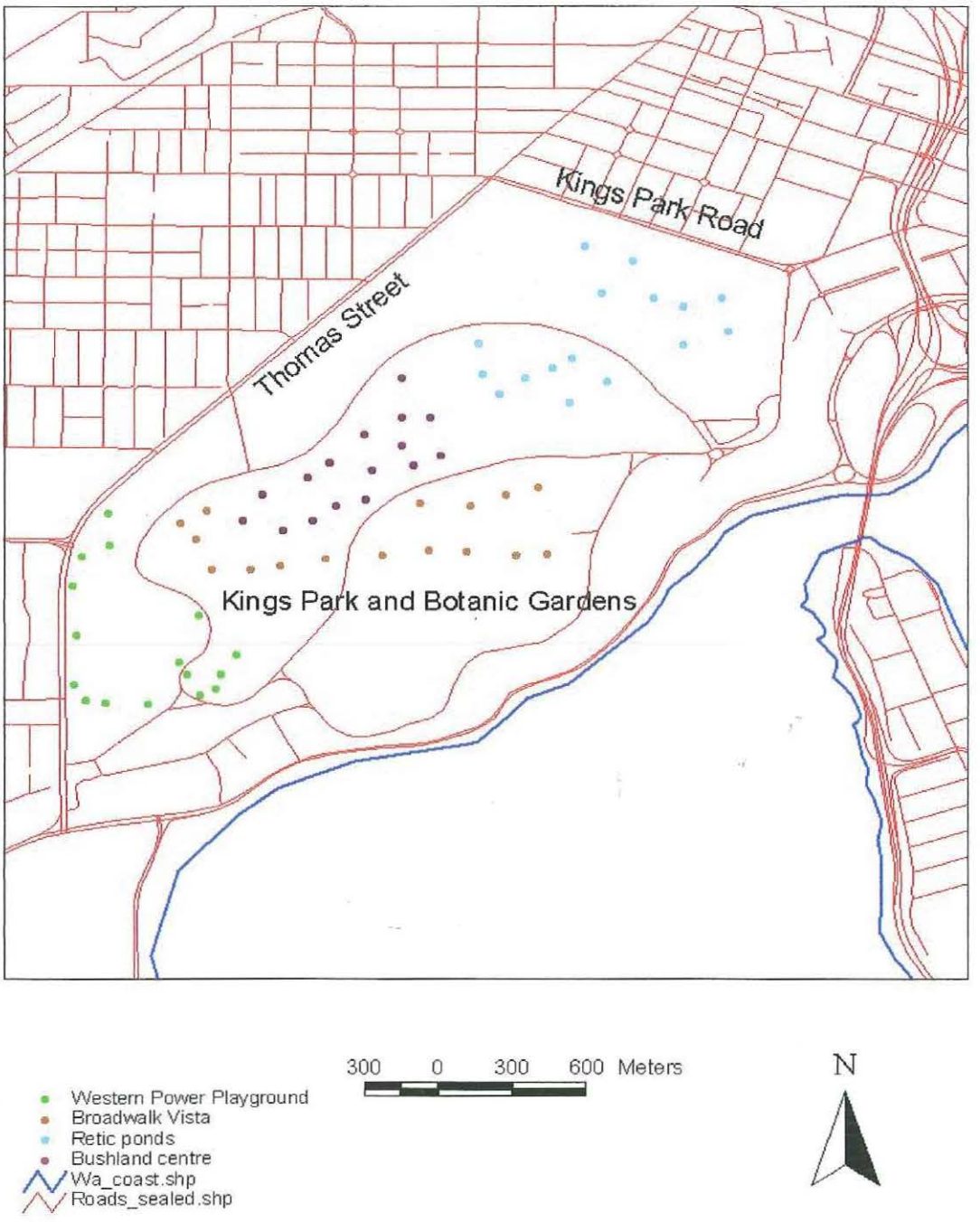

Figure 7. Map showing the four sampling locations within KPBG (Western Power Playground, Broad walk Vista, retic. ponds, and bushland centre) used in the baiting trials.

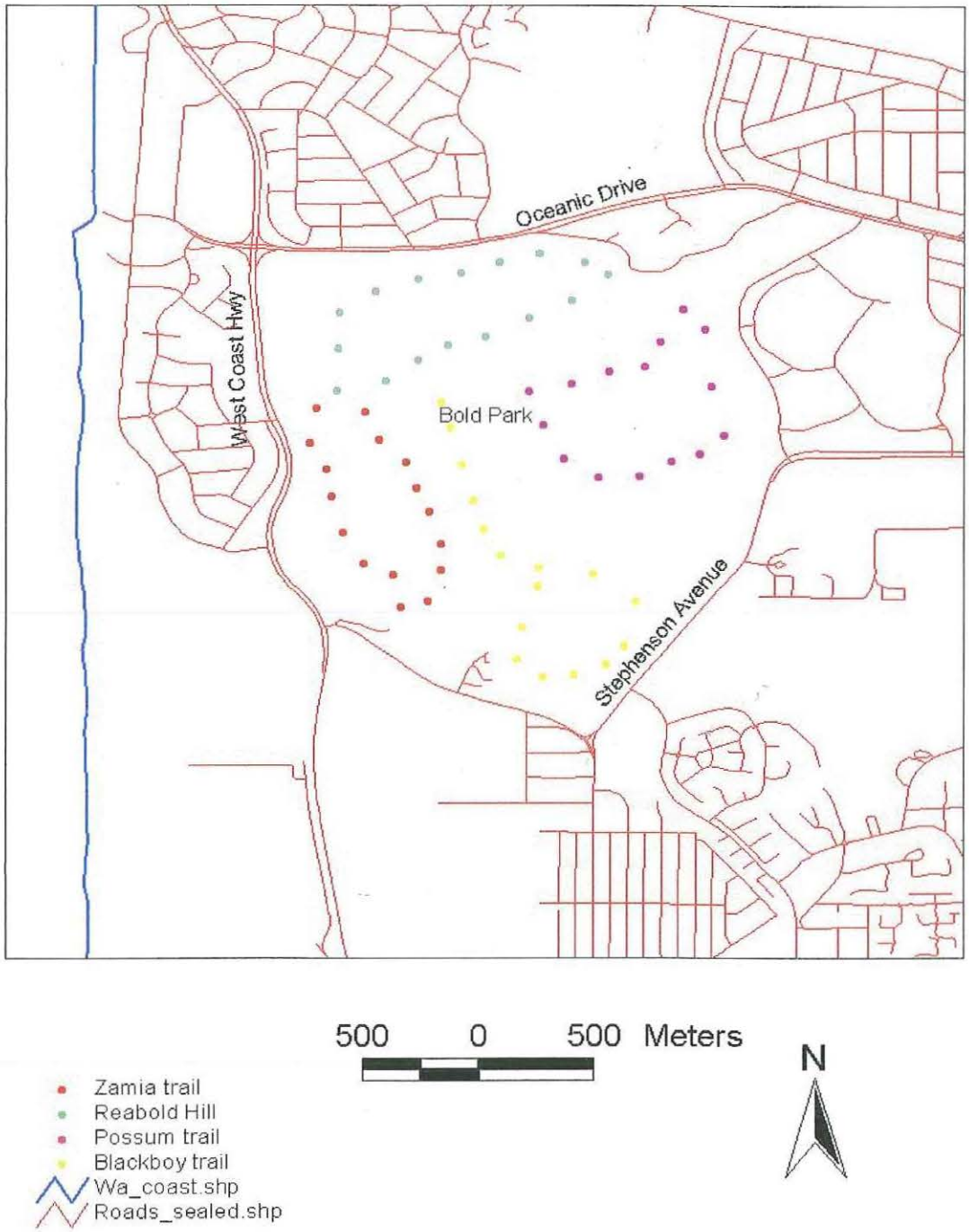

Figure 8. Map showing the four sampling locations within Bold Park (Zamia trail, Reabold Hill, Possum trail and Blackboy trail) used in the baiting trials.

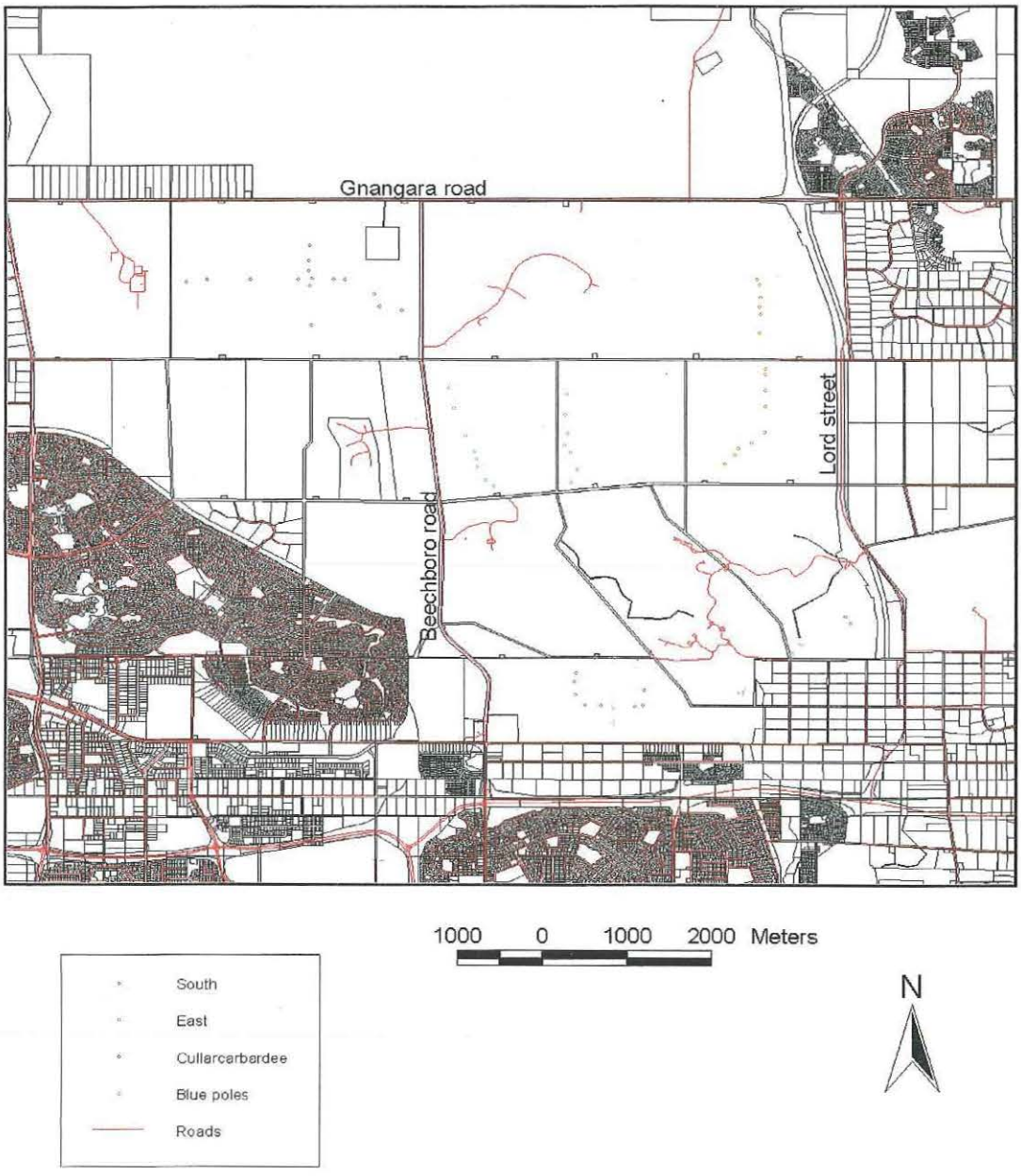

Figure 9. Map showing the four sampling locations within Whiteman Park (South, East, Cullacabardee and Blue Poles) used in the baiting trials.

Baits were presented on sandplots, 1 x 1 m in area, and cleared of any leaf debris. Plots were raked to loosen the sand and to aid track identification. Baits were presented late afternoon (after 1530hr) and examined early (0630hr) the following morning to coincide with the nocturnal nature of the fox (Saunders *et al.* 1995). Any bait not taken was collected. Details of visits and bait take by target and non-target species were determined from prints left on the sandplots.

If baits were removed from the sand plot, radio tracking determined the location of a bait and its fate (eaten, cached, moved). A Global Positioning System (GPS) was used to record the location of where a bait was taken, and these data were plotted using a Geographic Information System (Arcview) to determine the distance baits were moved from their initial location.

If baits were cached, the details were recorded. Location was obtained with a GPS to determine the distance the cache was made from the site where removed. Other details were noted such as the type of vegetation the cache was made in or near, and the location of the cache to any walkways. Cached baits were then left *in situ* for one week. After seven days the transmitters were located again and baits were retrieved if still there. Location was again recorded with a GPS, as foxes are known to move their caches (Thomson & Kok, 2002; Saunders *et al.* 1999) and it was noted whether or not the fox ate the cache.

Data analysis

For the samples obtained from each of the three parks, and over two seasons, chi-square tests were used to compare the frequency of bait visits and bait removals between treatments. Yates correction was used where degrees of freedom equalled one.

The power of any statistical test is increased as the sampling efforts increase (Fowler *et al.* 1998). Although this study presented 16 replicates of each treatment for each season in each park, data for analysis relied on the occurrence of animals visiting and/or removing the treatments. Therefore if visits and/or removal to treatments are low, sampling sizes will be low, and data analysis may not be able to be undertaken as expected frequencies will be less than five. Chi square testing states that all expected frequencies should exceed five (Fowler *et al.* 1998).

3.3 Results

Pilot Studies

Pilot study 1: Track Identification

Track identification at the RSPCA was unsuccessful, with wet prints on concrete not leaving an identifiable enough print to obtain a photograph for future reference. The tuna oil used as an attractant at Kings Park Bushland failed to attract any animals. However, prints of a fox and dog were found elsewhere along various sand tracks

within the bushland and photographs were obtained for comparison and to aid in future identification (Figs. 11 and 12).

Figure 11. Fox print. The fox print is consistent in proportional size, approximately 60mm long, 45mm wide (Macdonald, 1987). This photo would be indicative of a fox running. The standing fox print would be similar except without the two claws visible, as foxes tend to retract their claws when standing. The fox print is somewhat rounder and 'neater' than a dog print.

Figure 12. Dog print. A dog print will vary in size, but differs subtlety from the fox print. Either the two middle claws, or all four claws are often visible, and a print appears more elongated in shape compared to a fox print. In contrast to a fox print, there is only a small gap between the central pad and the toe pads (Triggs, 1996).

Pilot study 2: Effect of Transmitters on Probaits

There was no significant difference ($\chi^2_{1,\ 0.05,}$ =0.9) in the uptake of Probaits with or without a transmitter, supporting the null hypothesis that the presence of a transmitter in a Probait does not influence the frequency of bait uptake.

Analysis of bait visitation and removal

A total of 768 baits containing active transmitters were presented over two seasons and three parks. Assessment was possible on 762 baits. Of the six where no assessment could be made, three were removed from the sand plots with no prints visible. The

remaining three were visited by both a dog and fox, therefore accurate assessment could not be made to distinguish which species removed the bait. Eight transmitters could not be located, however, six of these were known to be taken by dogs (from print evidence) and were included in the results. In total, 186 (24.4% of total presented) baits were visited, of which 118 (15.5%) were removed.

Analysis of bait visitation and removal by target species

The target species (fox) visited 69 (9%) baits and took 60 (7.9%) of the 762 baits presented over the two seasons and three parks combined, with 87% of baits removed of those visited.

The rate of visitation and removal of baits were significantly higher for KPBG and Bold Park compared to Whiteman Park (Visitation: $\chi^2_{5,\ 0.05,}$=17.8; removal: $\chi^2_{5,\ 0.05,}$=20.4) (Fig. 13). There were no seasonal differences in the number of baits removed from each park ($\chi^2_{2,\ 0.05,}$=1.65), therefore seasonal data was not considered in further analyses. Despite differences between parks in terms of rates of visitation and removal of baits, this was not considered to affect the results from other treatments. To ensure that subsequent tests had valid expected values (>5) data from the three parks was subsequently pooled and analysed together.

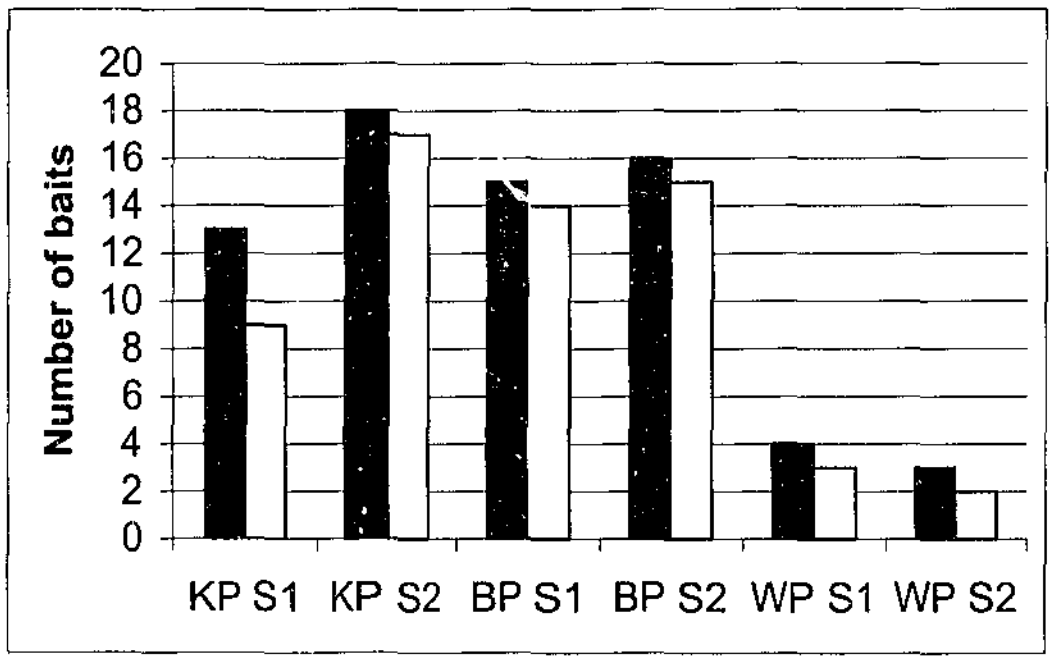

Figure 13. Graph showing the total baits visited (closed bars) and taken (open bars) by foxes within each park (BP= Bold Park, KP= Kings Park and Botanic Garden, WP= Whiteman Park) during each season (S1= season 1, S2= season 2).

Statistical analysis could not be carried out on each bait presentation method as expected frequencies were less than five. However, of the type of meat presented, foxes showed a slight preference for Probaits, taking 27 out of 31 visited (87%), compared to 33 out of 41 (80%) dried meat baits visited during the baiting trials. Of the presentation methods, foxes seemed to prefer untethered baits over tethered (38:22), and covered over uncovered (35:25). Considering bait presentation methods combined, the untethered and covered was a preferred choice for foxes, with this method popular as both a dried meat bait and Probait. Tethered and covered was popular as dried meat bait, but was least popular as Probait. The untethered and uncovered method also showed considerable preference by foxes (Fig. 14).

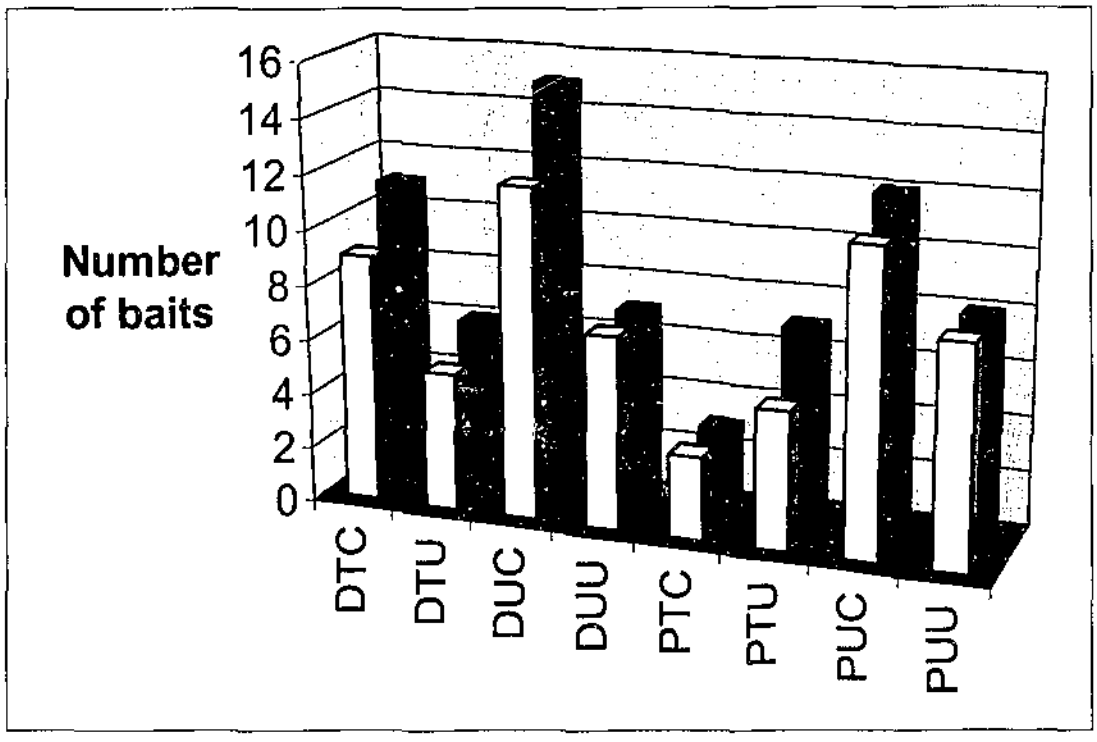

Figure 14. Graph showing rate of visitation (closed bars) and removal (open bars) of the eight different bait presentation techniques tested (DTC=dried, tethered, covered; DTU=dried, tethered, uncovered; DUC=dried, untethered, covered; DUU=dried, untethered, uncovered; P=Probait), by foxes during a baiting trial over two seasons and three parks combined.

Foxes removed 26 baits from all three parks combined during Season 1 and 34 baits from all three parks combined during Season 2. Although there appeared to be some seasonal variation in the removal of baits by foxes, the result was not significant ($\chi^2_{1,0.05,} = 0.82$). This result further supports the result that there were not seasonal differences in the number of baits removed from each park, therefore justifying the pooling of data and analysing it together.

Fate of baits taken by foxes

Of a total 60 baits taken by foxes, 34 (57%) were cached. Of those baits cached, 13 (38%) had been removed and presumably eaten when checked one week later; but most, 62% (n=21) remained where they were originally cached. None of the cached baits were removed and re-cached.

Caching varied with season. Twelve baits were cached during Season 1, and 22 were cached during Season 2, however this result was not significant ($\chi^2_{1, 0.05,} = 0.457$).

Foxes showed no preference for caching a particular bait type, with 18 (54.5%) of the 33 dried meat baits taken by foxes cached, and 16 (59%) of the 27 Probaits taken by foxes cached. Tethering as a presentation method showed a difference in the rate of caching; untethered baits were cached preferentially (n=22) over tethered baits (n=12). The same amounts of covered baits were cached as uncovered. Statistical analysis could not be carried out on each bait presentation method as expected frequencies were less than five.

Cached baits were found 0.5 m to 155 m from where they were taken (median distance for 34 caches = 30 m, mean 47.7±44 m). All cached baits were found buried close to the surface in shallow depressions covered by sand (Fig. 15). Foxes used no consistent type of vegetative cover to conceal the cache; one bait was cached 0.5 m from the sand plot it was removed from, in bare sand not covered by vegetation. There was also no

consistency as to the location that foxes cached baits, i.e. near or away from walk paths, but commonly they were cached more than 5 m away from paths.

The remaining baits that were taken but not cached (n=26), were all suspected to be eaten, apart from one bait that was found intact, and another two baits that were found half eaten. It was not possible to confirm that the baits had been eaten at the location where the transmitter was found.

Figure 15. Photograph showing a Probait that had been cached by a fox during Season 1 of the baiting trials at Whiteman Park. The bait was buried no more than 100 mm below the surface.

Analysis of bait visitation and removal by non-target species

Birds were the most common non-target species to visit baits. However, dogs were the most common non-target species to remove baits, removing 26 of 28 baits visited (or 3.4% of 762 baits presented). Interestingly rodents (probably rats based on print and scat size, D. Moro, pers. observ.) removed 35% of baits visited. Rabbits and kangaroos visited but did not remove baits. Of 114 baits visited by non-target animals, 50% were removed (Table 2).

Table 2. Total numbers of visits to baits and total number of baits removed by non-target species during baiting trials over two seasons and three parks. Results of the target species have been presented at the bottom of the table in italics.

Species	***Number of visits (% of baits presented)***	***Number of takes (% of baits visited)***
Dog	28 (5.5)	26 (93)
Bird	42 (5.5)	24 (57)
Rodent	20 (2.6)	7 (35)
Kangaroo	17 (2.2)	0
Rabbit	7 (0.9)	0
Total	114 (15)	57 (50)
Fox	*69 (9)*	*60 (87)*

Analysis of bait visitation and removal by dogs

Dogs visited and removed baits in Bold Park and Kings Park Bushland, but not at Whiteman Park. In total 28 (5.5%) of the 506 baits presented in these two parks were visited and 26 (5%) of those presented were removed over the two seasons.

Presentation methods trialed had no effect on bait uptake by dogs. Tethering of baits did not lower rate of take, with 15 tethered baits removed and 11 untethered baits removed over the two seasons. Ten baits were removed that were covered, and 16 were removed that were not covered. Dogs showed no preference for dried meat bait or Probait, with 14 of each visited and 13 of each removed over the two seasons and from two parks. Statistical analysis could not be carried out on each bait presentation method as expected frequencies were less than five.

Of the 26 baits taken by dogs, transmitters were found at distances ranging from 1 m to 133 m (median 30 m, mean 33±45 m). Dogs had eaten 18 (69%) of the baits taken, with three only partially eaten and five found not eaten at all. Six transmitters in baits taken by dogs could not be located.

Analysis of bait visitation and removal by birds

Birds removed baits from all three Parks, with bird activity most common at Whiteman Park. Of the birds to visit or remove baits, the prints were consistent with corvids, in particular ravens, and magpies (*Gymnorhina tibicen).* The prints of a raven are similar in shape to those of a magpie, but are slightly larger (P. Mawson, pers. comm.). Forty two baits were visited by birds, with 24 (57%) of these removed, 14 of these were removed at Whiteman Park.

Tethering of baits did reduce the rate of take by birds, with four tethered baits removed of 16 visited (25%), and 20 untethered baits removed of 26 visited (77%). Covering the

baits did deter birds visiting baits. Birds visited 26 baits that were not covered, compared with 16 that were covered. Birds showed a preference for dried meat baits, removing 15 of the 23 visited (65%), but only removing eight of the 19 Probaits visited (47%). Statistical analysis could not be carried out on each bait presentation method as expected frequencies were less than five.

Of the 24 baits taken by birds, they were found at distances ranging from 1 m to 573 m (median 10 m, mean 108±167 m). Birds had eaten 11 of the baits taken, with five only partially eaten and eight not eaten at all.

Analysis of bait visitation and removal by rodents

Rodents only visited and removed baits in Bold Park and Kings Park Bushland. It is suspected that the black rat (*Rattus rattus)* removed the baits as the house mouse *(Mus domesticus)* would visit but probably not remove baits due to its small size and inability to remove the weight of the bait. In total rodents visited 20 baits and removed seven. Statistical analysis could not be conducted due to expected frequencies being less than five.

Tethering of baits did lower the rate of take by rodents. In total 8.3% of the tethered baits visited were removed, and 75% of the untethered baits visited were removed. Rodents showed a preference for dried meat baits, removing 40% of those visited, but only removing 33% of the Probaits visited. Five baits were removed of 13 visited that were covered, and two were removed of seven visited that were not covered.

Of the seven baits taken by rodents, they were found at distances ranging from 0.5 m to 12 m (median 3 m, mean 4 m ±3.7 m). Rodents had eaten all of the baits taken; of the other 13 baits visited they were all partially eaten.

Analysis of bait visitation by other non-target species

Western grey kangaroos (*Macropus fuliginosus*) visited 17 baits at Whiteman Park, but did not remove any. Rabbits visited seven baits in total, one of these was at Kings Park Bushland, and the other six were at Bold Park. None of these baits were removed.

3.4 Discussion

The results of the pilot study were consistent with Thomson and Kok (2002) and Saunders *et al.* (1999), suggesting that transmitters do not affect the rate of take of Probaits by foxes.

The results of the bait analysis showed that there was a significant difference between the bait uptake by foxes at Whiteman Park, KPBG or Bold Park. Since management actions at Whiteman Park already include fox control, the result indicates the fox control program is effective at controlling foxes in an urban area. The result also indicates that fox numbers at KPBG and Bold Park are higher than at Whiteman Park, and therefore would need to be controlled for faunal re-introduction to take place. The presence of foxes at Whiteman Park is not an indication that the fox control program

there is not effective. The realistic aim of any predator control program among mainland environments is to control and not to eradicate (Simberloff, 2002). Foxes are going to continually re-invade the park from outer areas where they are not controlled. Another consideration is that Whiteman Park delayed baiting for one month prior to the commencement of this study, and for the duration of this study taking place there, this could also have assisted the re-invasion of the park from foxes outside.

This study has established that foxes are present and will take baits in (at least) three Perth urban conservation reserves. Total visitation to all baits presented by foxes was low (9%), but the rate of take of those visited was high compared to other studies (87%). For example, Thomson and Kok (2002) reported foxes visiting 23% of baits and taking 64% in rural Western Australia. Van Polanen Petel *et al.* (2001) found foxes visited 79% of baits presented, and taking 96% on semi-urban Phillip Island. In urban Melbourne, Marks and Bloomfield (1999a) recorded a 100% removal of baits presented for foxes, although other species were known to take a number of these baits. These comparative studies imply that bait take by foxes vary with location, but the takes in this study are comparable (though higher) with those in rural Western Australia.

Availability of alternate food sources may influence bait removal. At KPBG, rubbish from bins is likely to be an alternate food source for the foxes (P. Mawson, *pers. comm.*). At Bold Park, rabbits are abundant throughout the bushland (M. Buist, *pers. comm.*), and would provide a suitable alternate food source. These alternate food sources could also have influenced the high rate of cached baits observed in this study.

Caching rates were high in this study, with 57% of the baits taken by foxes being cached, (cf. 25% Thomson & Kok, 2002; 10% Saunders *et al.* 1999; 18% van Polanen Petel *et al.* 2001). Saunders *et al.* (1993) suggested that caching may be influenced by bait abundance, as the strategy is undertaken when an abundant source of food is available. Only 38% of baits cached in this study had been eaten one week later. In the present study there was no significant difference shown in the frequency of caching between seasons, or between the two bait types offered. Maximum distances to cached baits from where they were taken was lower in this study (155m), compared to maximum caching distances reported elsewhere (eg. 380m Thomson & Kok, 2002; 800m Saunders *et al.* 1999; 485m van Polanen Petel *et al.* 2001). The distances baits are cached from their source location may reflect the higher density of foxes in an urban area, and which correlates with a smaller home range for each fox (Saunders *et al.* 1995).

There was no significant difference in the rate of bait removal between the two seasons tested, therefore this would suggest that any baiting program implemented at KPBG, Bold Park or possibly any other Perth urban reserve, is likely to be just as effective in early Winter as it would be in late Winter/ early Spring. Further studies would need to be undertaken to test the efficacy of baiting during other times of the year. However, baiting in early winter would result in a reduction in the adult fox population immediately prior to cubbing and should result in a significant reduction in the fox population during the summer months (assuming baiting is conducted throughout the year).

This study is unique in several areas as it reflected a methodology that would be realistic and easily implemented by managers in urban areas. Therefore some aspects of this methodology need to be considered when comparing this study to others that are similar. For example, this study was undertaken in an urban area, studies by Thomson and Kok (2002) and Saunders *et al.* (1999) were both undertaken in rural areas, where fox diet, activity and dispersal differs from urban foxes (Harris 1981; Lloyd, 1980; Saunders *et al.* 1995). The methodology of this study was also different to other studies, eg. Saunders *et al.* (1999) presented baits for 10 day periods. Van Polanen Petel *et al.* (2001), whose study was undertaken in a semi-urban area, free fed for one week to habituate foxes to the presence of food. Saunders *et al.* (1999) also targeted specific areas where fox activity was high. Similarly, the bait uptake trial by foxes conducted in urban Melbourne by Marks and Bloomfield (1999a) was undertaken in areas where previous studies by the same authors (1999b) had established that foxes were present. Had these methods been utilised in this study, a higher bait uptake may have been achieved.

Because foxes showed no strong preference for any bait presentation, the key in maximising uptake of baits by foxes lies in reducing bait uptake by non-target species. Birds were the most common non-target species to visit baits, while dogs and rodents were the most common non-target species to remove baits. Rabbits and kangaroos visited but did not remove baits.

Dogs were not deterred by the tethering of baits, with more tethered baits removed than untethered. Dogs removed more uncovered baits than those left covered under some vegetation. A food lure that elicits an olfactory response in dogs is considered the most likely of odours to attract a dog to something (Allen *et al.* 1989), so that a dog's sense of smell would allow it to find a bait regardless of its placement. Therefore, covering baits with vegetation is unlikely to affect bait uptake by dogs. No baits were removed by dogs in Whiteman Park, indicating that public education is an effective medium to limit bait uptake by dogs and thus reduce the risks of poisoning associated with these non-target species.

Tethering reduced the rate of bait removal by birds and rodents. Covering baits with vegetation could also be an effective method to reduce birds visiting baits which could lead to a reduction of birds taking baits. Another strategy to prevent birds visiting baits would be to change the location of baiting sites. At Whiteman Park alone, birds visited 62% of the total number of baits visited at three parks, with most of the prints consistent with ravens. At Whiteman Park the same positions are used for bait placement, indicating that the ravens have habituated to these areas as a provisioner of food.

In conclusion, this study found that foxes showed no strong preference for bait type or presentation method, therefore will accept either a dried kangaroo meat bait or a Probait regardless of presentation method. Reducing alternative food sources (such as rabbits, or clearing bins before dusk) may reduce caching at KPBG and Bold Park. Tethering

and covering of baits have proven effective methods to reduce visitation to, and removal of, baits by non target species such as rodents and birds. An effective public awareness campaign appears to show promise if bait uptake by dogs is to be reduced, and is the focus of the study in the next chapter.

CHAPTER 4

PUBLIC PERCEPTIONS

4.1 Introduction

Baiting for feral predators is strongly accepted throughout rural areas with many landowners asking CALM to extend baiting to include their properties (CALM, 2003a). This reflects the economic impact that feral predators have on livestock (Saunders *et al.*, 1995). Yet in an urban area, most feral predators do minimal harm to humans, and the need to destroy or control them could be questioned, given the risks associated with control options such as baiting with 1080, which is now the accepted practice in rural WA.

CALM aims to create a high level of awareness of, and support for, Western Shield in areas where the project is undertaken, and in areas where the project is intended. They also aim to gain public acceptance of the use of poison, and the aerial distribution of poison baits (CALM, 2003a).

Ways of informing the public about Western Shield include extensive signage throughout the targeted areas. Leaflets are prepared for regional shires to send out with dog licence renewals. Advertisements are also placed in regional and metropolitan newspapers four times a year to inform the public about the Program. This advertising

is also part of CALM's obligations under the Health Act in relation to the use of toxic baiting (CALM, 2003a).

The director of the Strategic Development and Corporate Affairs Division within CALM commissioned three community awareness surveys for Western Shield, carried out in 1996, 1998 and 2000. The surveys were focused on landowners whose properties are next to baited areas and are therefore more likely to be aware of the Program. The survey conducted in 2000 involved telephone interviews of 368 people living in the Perth Hills, Albany, Pemberton, Manjimup, and Collie areas. Of the 368 people surveyed, 88% were aware of the fox control program, but only 44% were aware of the term Western Shield (CALM, 2003).

A survey has never been undertaken in the Perth Metropolitan Region to assess the level of awareness that Perth people have for Western Shield, its aims and the potential risks to domestic animals. This public acceptance will be an important component of any baiting program in urban reserves.

This chapter aims to

- evaluate the level of awareness Perth people have regarding Western Shield and the use of 1080 baits, and
- investigate whether nearby residents and users of two Perth urban bushland reserves would support fox control in those reserves.

4.2 Methods

Questionnaire construction and administration

A short questionnaire was prepared and distributed to park residents (those within two blocks of each park) and users (those using the park at any time of the day; these people requested or were given a questionnaire whilst using the park) (Appendix 1). The questionnaire included an information sheet about the project, prepared by CALM and enclosed (Appendix 2).

The questionnaire was constructed so that it was easy to answer. The questions were clear, and clear instructions were given on how to answer a question, for example, tick one box only. Closed questions (those where the respondent is given a number of alternative answers, and they must select only one) were used, as these were an effective approach for determining the respondent's awareness of an issue (de Vaus, 1995). For the first two questions, the respondent's level of understanding was assessed by using semantic differential formats, similar to a rating scale (de Vaus, 1995). Three levels of understanding were presented, and the respondent had to mark which level of understanding best presented their view.

The first question aimed to establish a respondent's awareness of Western Shield, and then to rate their level of understanding of the Program.

The second question aimed to establish the level of awareness that a respondent had regarding the 1080 baits used in Western Shield. The question assessed whether respondents were aware that the poison baits used to control foxes in the Western Shield Program pose a risk to domestic animals, if so they were asked to rate their level of understanding.

Question 3 assessed whether a respondent would support fox control in Perth urban conservation reserves, taking into consideration the information they received, and given the risks to non-target species but also the benefits of a fox control program.

Respondents were then asked to indicate how often they use a Park, and to supply their postcode. A section was given for respondents to write down any other comments or concerns. The park used was indicated on the back of the questionnaire before distribution, by marking KPBG or Bold Park.

A total of 1015 were distributed to residents living in the Park vicinty (579 Kings Park, 436 Bold Park). Distribution involved hand delivery to residents no further than two blocks from each Park. A further 157 were distributed to users of each Park (96 Kings Park, 61 Bold Park). Respondents were requested to return the questionnaire to the administration of Kings Park or Bold Park, or mail it to Edith Cowan University.

De Vaus (1995) presents a common method of calculating the response rate of a questionnaire as:

RR = NR/ND – ineligible + unreachable.

Where RR is the response rate (expressed as a percentage), NR is the number returned, and ND is the number distributed.

Because of the methodology used to distribute the questionnaire, ineligible and unreachable was difficult to identify, as a mail out survey relies on those respondents to contact the researcher (de Vaus, 1995).

Data analysis

Data were entered into the Statistical Package for Social Sciences (SPSS). Univariate analysis was used to obtain descriptive statistics such as the frequencies and percentages of the respondent's park usage data. Cross-tabulation compared the results of the descriptive statistics with the level of awareness for Western Shield and risks associated with 1080 baiting, and support for fox control. Chi square analysis was used to test for significant differences within the data.

4.3 Results

Response rate

In total 108 questionnaires were returned in the mail, equating to a response rate of 9.2%. A well conducted mail survey should generate a response rate of between 60% and 75%, but this would include using incentives such as a prize, or including postage

paid envelopes for the questionnaires to be returned (de Vaus, 1995). These were all unavailable for this study.

Awareness of Western Shield

A total of 53.7% (n=58) of respondents were aware of the Western Shield program in Western Australia. However there are no significant differences ($\chi^2_{1,0.05,}$ =0.454) in the frequency of awareness of this program between the users and the residents of two urban parks of Perth.

Of the 58 respondents who were aware of Western Shield, 57 continued on to rate their level of understanding of the program. Of these, 54.4% (n=31) of respondents perceived they had a good knowledge of the Program, and were aware that it has been successful in controlling feral animals and re-introducing fauna to some areas in Western Australia. Only 7% (n=4) had "heard of it", but had no idea of the Program's aims or outcomes. A total of 38.6% (n=22) perceived they had a reasonable level of understanding of the Program and knew that the Program aimed to reduce feral animals from Western Australia.

Awareness of the risks associated with 1080 baiting

A significant difference ($\chi^2_{1,0.05,}$ =65.05) was observed in the frequency of awareness of the risks associated with 1080 baiting for the questionnaire respondents surveyed in this

study. A total of 77% (n=83) of respondents were aware of the risks associated with 1080 baiting.

Of 78 respondents for question 2a, 67% (n=52) had a good understanding of the risks associated with 1080 baiting, and were aware that native animals had a natural tolerance to 1080 baits, and that domestic animals did not. Only 13% (n=10) had assumed that 1080 baits would poison all animals including native, with 20% (n=16) having seen the information regarding Western Shield and the use of 1080 baits, and had therefore realised they posed a threat to domestic animals.

Support of fox control

The results showed there is a significant difference ($\chi^2_{2,0.05}$, =65.96) in the frequency of support for fox control between the users and residents of two urban parks surveyed in Perth. In total, 69.4% (n=75) of respondents would support a fox control program in Perth urban conservation reserves. However, a total of 18.5% (n=20) felt they would need more information to make an informed decision (Fig. 16).

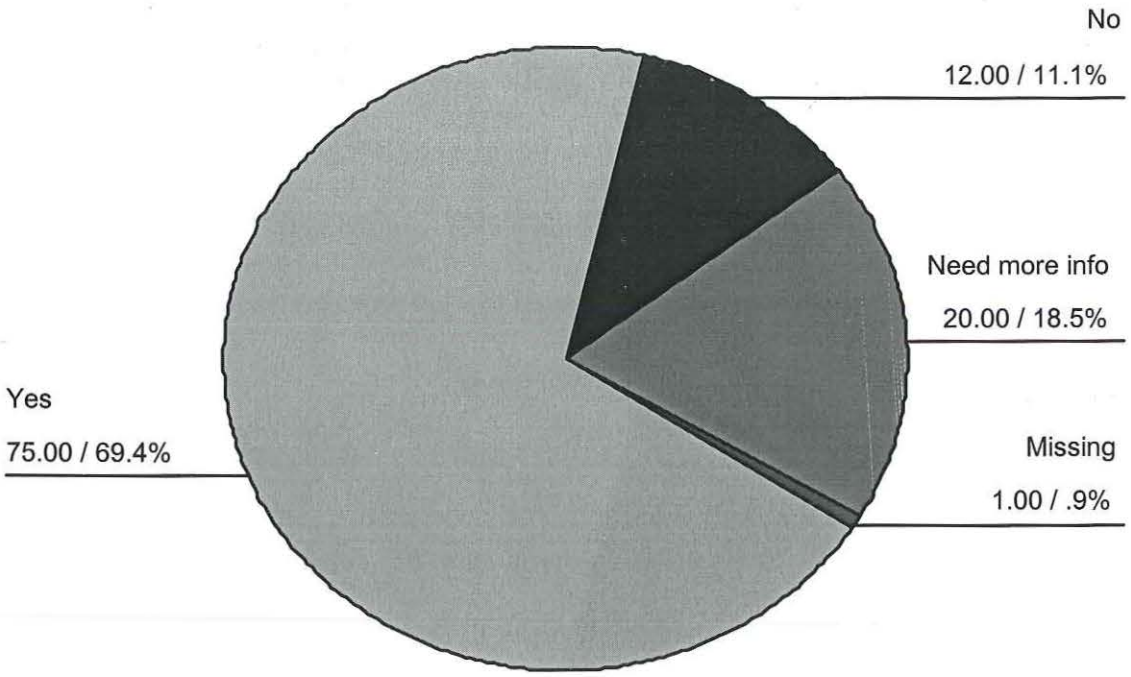

Figure 16. Graph illustrating the numbers / percentages of 108 respondents to their support of fox control using baiting in the Perth Metropolitan Area.

Support of fox control was cross-tabulated with awareness of the Western Shield program, and awareness of the risks associated with 1080 baiting. The results showed there was no significant difference ($\chi^2_{2,0.05}$, =4.07) in the frequency of support for fox control between the respondents who were aware of Western Shield, and those who were not aware of Western Shield: a total of 77% of those who were aware of the Western Shield program would support a fox control program in Perth urban conservation reserves, and 61% of those who were not aware of the Program were supportive.

Similarly there was no significant difference ($\chi^2_{2,0.05}$, =2.51) in the frequency of support for fox control between the respondents who were aware of the risks associated with 1080 baiting, and those who were not aware. Of those with an awareness of the risks associated with 1080 baiting, 73% would support a fox control program in Perth urban conservation reserves, with 61% of those who were not aware of the risks supportive.

Park usage

Of the 108 respondents, 36 were users or residents of Bold Park, 72 were users or residents of KPBG. A total of 33 respondents had been given the questionnaire as park users, 75 respondents were park residents. Only one of the residents never used the parks, the remaining 74 residents were also park users.

Results showed there was a significant difference ($\chi^2_{2,0.05}$, =7.86) in the frequency of support for fox control between the users and residents of KPBG, and between the users and residents of Bold Park. KPBG users and residents were overall more supportive of fox control in an urban area than the users and residents of Bold Park (55:20). A total of 45.5% of Bold Park users and residents were divided equally between needing more information, and not supporting fox control in an urban area.

There was also a significant difference ($\chi^2_{2,0.05}$, =7.15) in the frequency of support for fox control between the users of both parks and the residents of both parks. The results showed there was a higher support for fox control in an urban area from park users than residents. Of the 33 park users, 85% (n=28) would support a fox control program in

Perth urban conservation reserves, but 15% would need more information. Of the 75 park residents, 63.5% (n=47) would support a fox control program in Perth urban conservation reserves, and 20% would need more information.

Twenty-one of the respondents used a park daily (5 or more times per week), 29 respondents used the parks weekly (one to four times per week), 21 respondents used the parks monthly (less than once per week, but at least once per month), 36 respondents used the Parks on a yearly basis (less than once per month, but at least once per year). One respondent never used the Parks.

Results showed there was a significant difference ($\chi^2_{8,0.05}$, =25.65) in the frequency of support for fox control between the daily, monthly, weekly and yearly users, and those who never used KPBG and Bold Park. The yearly users of parks were the most supportive for fox control at 86%, but only 47.6% (n=10) of the daily users would support a fox control program in Perth urban conservation reserves. 76% of the weekly users, and 62% of the monthly users would support a fox control program in Perth urban conservation reserves.

Postcode

Because this survey aimed to gather the awareness of people living in close proximity of KPBG and Bold Park, it was necessary to ask this question, so that any respondents who did not live near these parks were disregarded. All of the respondents were therefore deemed living in close proximity to either of the parks.

Comments or concerns

Respondents were given the chance to write down any comments, or concerns that they may have with fox control in an urban area. This was an open question, with respondents required to formulate their own responses. Open questions are difficult to analyse, as they are difficult to interpret (de Vaus, 1995). In total 52% (n=56) of respondents chose to make comments (Appendix 3). Taking into account the difficulties with analysing open questions, a total of 19 comments appeared positive, with seven clearly negative. Some respondents (n=7) were concerned about the ethics (humaneness) of using 1080, and suggested using alternative methods to control foxes, such as trapping or biological control. Others (n=2) were concerned about birds taking baits and succumbing to the 1080, or dropping them in places where they shouldn't. A few (n= 2) respondents were concerned about the populations of rabbits in Bold Park if foxes were removed. Access to each park was a concern if baiting was to proceed. A further nine respondents mentioned that cats in each park also need to be controlled, but did not suggest how.

4.4 Discussion

Results obtained from the questionnaire found that Park users and residents of KPBG and Bold Park are largely in support of fox control in Perth urban bushland reserves. Only 12.1% of respondents would not support fox control in urban Perth. Park usage was a significant factor relating to respondents being supportive of fox control, KPBG

users and residents were more supportive than Bold Park users and residents, and park users were more supportive than park residents.

The awareness of Western Shield was low (53.7%) compared to the 80% of respondents in rural areas, and these results suggest that an education program will be required equivalent to rural areas if the level of awareness is to be improved in urban areas. CALM and possibly BGPA would therefore need to undertake a high profile public awareness campaign to notify more Perth residents of the Western Shield program if fox baiting was on the management agenda for urban parks.

Awareness of the poison risks associated with 1080 baiting was high. As for support of the Program, those who were aware of the risks were more supportive of fox control. This indicates that people are largely prepared to accept the risks associated with 1080 baiting, given the benefits gained for conservation.

Foxes in urban reserves are a public concern. During the course of this study, a resident of the KPBG area wrote a letter to the editor of The West Australian (16/07/2003) concerned about the presence of foxes in the Park (Appendix 4). In reply to this letter, a story was published in The West Australian (19/07/2003), reporting on the bait trials being undertaken (Appendix 5). This media attention indicates that the public cannot be omitted from any program to control foxes but must be integrated into the management of these parks.

CHAPTER 5

DISCUSSION

As the world's population becomes increasingly urbanised, the need for people to see nature on their doorstep is becoming more appealing. The management of urban areas to support native flora and fauna is becoming increasingly important. Perth has the potential to lead the way in urban ecology, still retaining areas of bushland that are large and sufficiently productive to provide suitable refuge for various species of native fauna that once lived throughout the south west of Australia.

Biodiversity incorporates fauna as well as flora, and this is recognised by The Botanic Gardens and Parks Authority. Recommendation 80 of the Kings Park Bushland Management Plan (KPBG, 1995) proposes to implement and monitor feral animal control programs. Similarly, the Bold Park Environmental Management Plan (BGPA, 2000) recognises introduced pests as processes that can be actively managed. The Bold Park management plan also considerers the possibility of fauna re-introductions, but highlights that predator control will be essential if this is to occur.

For the successful re-introduction of native animals to these, and possibly, other regional parks in the Perth Metropolitan Region, predator control will need to be implemented. Previous studies have found the removal of the fox from an area will benefit populations of native fauna (Friend, 1990; Kinnear *et al.* 1988). Kinnear *et al.*

(2002) found that removing foxes from an area using baiting methods will produce significant population recoveries of prey species. Risbey *et al.* (2000) studied the small vertebrate fauna of Heirisson Prong, Western Australia, and found the captures of small mammals were higher where only foxes were controlled, compared to lower rates where foxes and cats were controlled. But, in an urban area, effective fox control encounters different management decisions.

Implementing fox control using 1080 baits in an urban area poses a difficult decision for any management authority. Potential risks of poison baiting to target and non-target animals leads to social concerns for the people who live near or use the areas where baiting would take place.

This study has illustrated that foxes will accept baits presented in (at least) two parks within the Perth Metropolitan Region (KPBG and Bold Park). The study has also found that the residents and users of these two parks are largely supportive of fox control in an urban area, given that most of these people are aware of the risks associated with baiting using 1080. Perhaps the most important aspect gained from this study is the knowledge of methods that can be implemented to reduce the likelihood of non-target animals taking or moving baits. Baits that are tethered will prevent rodents and birds removing them. Covering baits will also prevent birds from seeing the baits from above.

Whiteman Park managers currently tether toxic baits presented there to control foxes and to prevent removal of these baits by non-target species. An additional presentation strategy that could further minimise poison risks, the metal poles that poison baits are tethered to could be moved to different locations around the park as it appears that ravens have become habituated to the presence of the bait presentation stations. During this study, ravens removed some tethered baits, suggesting that the removal of toxic baits by ravens at Whiteman Park is likely.

Another important aspect to consider if baiting was to proceed in the Perth urban area, is that foxes in KPBG and Bold Park are feeding on alternative food sources. Consequently, one way to maximise bait uptake by foxes, (and decrease fox numbers), may be to minimise alternative food sources such as rabbits. Predator-prey models such as the Lotka-Volterra model assumes that the numbers of a predator depend on the prey population (Brewer, 1994). This is the case in the boreal region of Canada where the lynx (*Lynx Canadensis*) is a specialist predator of snowshoe hares (*Lepus americanus*), and the rise and fall in lynx numbers mirrors the rise and fall of snowshoe hares (Krebs *et al.* 2001). Therefore by controlling rabbits in these two parks, in particular Bold Park, fox numbers may decline as a response to the decline in rabbit numbers. A decrease in rabbit numbers may also reduce the rate that foxes cache baits at KPBG and Bold Park, an important factor that will further reduce impacts to non-target animals, especially dogs.

The results obtained by using Whiteman Park as a reference site in this study have indicated two things. Firstly, that a significant difference exists between the removal of baits by foxes between Whiteman Park and the foxes at KPBG and Bold Park, therefore indicating that reduced fox numbers can be achieved with fox control in an urban area. Secondly, given that dogs are allowed into Whiteman Park and no baits were removed by dogs there during this study, responsible pet ownership of dogs appears to occur if people are notified appropriately that 1080 baits are used in the park.

The baits presented at KPBG and Bold Park in this study were typically more than 10 m from walk trails. Of those baits removed by dogs, the dog was presumably either on an unusually long lead, or it was not on a lead at all. The Bold Park Management Plan (2000) stipulates that dogs must be on a lead no-more-than 2 m in length whilst in Bold Park. There seems to be no excuse to have dogs off a lead within the park: there are also two areas directly adjacent to Bold Park that allow dogs to be exercised off a lead.

For the Sydney North Regional Fox Baiting Program, dogs are prohibited from all reserves while baits are presented for fox control. Public communication is a key driver of this and other baiting programs. For example, the Warringah Council erects warning signs at the main entrances and along the boundaries of their reserves, a notification letter is distributed, and public notices are placed in local newspapers (Warringah Council, 2002). To date, no dog deaths have been reported to agencies involved in the program (Warringah Council, 2002). These would be effective methods for

management authorities here in Perth to implement if fox control using 1080 baits were to proceed.

As well as informing users and residents of parks about the dangers faced while baits are presented, it is also important to make those people aware of the risks and benefits of fox control prior to commencing any baiting. The Warringah Council undertook a two year public awareness campaign prior to commencing the fox control program in North Sydney (Warringah Council, 2002). The Council also addressed concerns about the humaneness of using 1080 baits to eliminate foxes by meeting with animal welfare committees.

The results from the social survey undertaken in this study indicate that public education relating to fox control, Western Shield, and the benefits obtained from it is required in urban Perth. More than 45% of respondents were not aware of the Western Shield Program run by CALM. The Sydney North Regional Fox Baiting Program may be a good example for Perth urban bushland management authorities to consider as an example if a fox control program in Perth urban reserves is implemented.

In 2005 the BGPA is due to release a new management plan for both Kings Park and Botanic Garden and Bold Park. Perhaps a component in these management plans should involve a long-term plan to control foxes (and rabbits) in the parks, with the goal of re-introducing some native animals. If this plan were to be successful, they

would be recognised as leaders not only in their conservation work for flora, but also fauna.

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CONTRIBUTORS

Personal communications and observations mentioned in-text.

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Dr. Peter Mawson	Senior Zoologist, DCLM
Dr. Dorian Moro	Post Doctoral Research Fellow, Edith Cowan University
Peter Thomson	Research Scientist, Department of Agriculture
Joanne Wallace	Environmental Officer, Whiteman Park

APPENDICES

6. Any other comments or concerns?

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Please return this form to the person that handed it to you, to the address shown below, or to the Administration of Bold Park, Kings Park and Botanic Gardens or Whiteman Park.

Jennifer Jackson
School of Natural Sciences
Edith Cowan University
100 Joondalup Drive
Joondalup WA 6027

Thankyou

*Office use only: park **user** or resident*

BOTANIC GARDENS
& PARKS AUTHORITY

ECU
EDITH COWAN

DEPARTMENT OF
Conservation
AND LAND MANAGEMENT
Conserving the nature of WA

A Project to Determine Whether Native Mammals Could be Re-introduced to Urban Bushland

In rural Western Australia Western Shield has been successful at controlling exotic predators and re-introducing native fauna to conservation reserves. The Department of Conservation and Land Management and the Botanic Gardens and Parks Authority hope introduce predator control in the Perth urban area, and achieve similar positive results.

A research project is currently being undertaken to examine bait take by target species, in particular foxes. Part of this research project involves identifying the level of public understanding and any concerns towards fox baiting in urban areas. This short questionnaire has been produced to achieve this. Please take a few minutes to answer the following questions. Your time is very much appreciated.

1a. Before reading the information page attached, were you aware of the Western Shield program in Western Australia? *(Tick one box only)*

- ☐ Yes *(Go to question 1b)*
- ☐ No *(Go to question 2a)*

1b. If you answered yes, what was your level of understanding? *(Circle one number only)*

1. Had just "heard of it", but have no idea of the Program's aims or outcomes.

2. Reasonable level of understanding; have heard of the Program and know that the Program aims to reduce feral animals from Western Australia.

3. Good knowledge of the Program, and am aware that it has been successful in controlling feral animals AND re-introducing fauna to some areas in Western Australia.

2a. The poison baits used to control foxes in the Western Shield Program pose risks to domestic animals (dogs and cats will die if they ingest a bait), were you aware of this? *(Tick one box only)*

- ☐ Yes *(Go to question 2b)*
- ☐ No *(Go to question 3)*

2b. If you answered yes, what was your level of understanding? *(Circle one number only)*

1. I assumed that 1080 baits would poison all animals including natives.

2. I have seen the information regarding Western Shield and the use of 1080 baits, and had therefore realised they posed a threat to domestic animals.

3. I have a good understanding, and I knew that native animals had a natural tolerance to 1080 baits, and that domestic animals did not.

3. Given the information you received, and taking into consideration the risks and benefits of fox control, would you support a fox control program in Perth urban conservation reserves? *(Tick one box only)*

- ☐ Yes
- ☐ No
- ☐ Would need more information to make an informed decision

4. How often would you use Kings Park? *(Mark one box only)*

- ☐ Times a week
- ☐ Times a month
- ☐ Times a year

Other.....
.....

5. What is your postcode?
.....
.....

Appendix 2. Information sheet

A Project to Determine Whether Native Mammals Could be Re-introduced to Urban Bushland

Our native fauna, particularly our small mammals and some of the ground nesting birds have not fared well in the past 200 years due to clearing of native vegetation, altered fire regimes and the introduction of predators such as the fox. Eleven species of mammal that once occurred in Western Australia are now extinct and several more are under considerable threat of extinction.

Research conducted over the past 30 years in Western Australia has shown that predation by foxes is the single most important threat to some species, and that if this introduced predator can be controlled then the native species can recover. In 1996 the Department of Conservation and Land Management commenced a major fox control program called Western Shield that is focused in the southwest of the State. Dried meat baits containing the poison 1080 or sodium monofluroacetate are laid over nearly 3.5 million hectares of conservation estate at least four times per year. After a short period of baiting it has been possible to re-introduce some of our native mammal species back into these protected areas, and many new populations have now been established.

Species such as Woylies, Numbats, Bilbies, Western Ringtail Possums, Dibblers, Chuditch, Shark Bay Mice, Boodies or Burrowing bettongs and Malleefowl have been successfully released into sites on the mainland and on some islands off the coast.

The Swan Coastal Plain upon which Perth sits once supported a large mammal population, but most species have now become locally extinct due to the combination of reasons mentioned above. Perth is fortunate in that it still retains some relatively large areas of remnant vegetation within the urban areas. Kings Park, Bold Park and the various Regional Parks north and south of the Swan River can still provide suitable habitat for many native species, but not while foxes are living in those sites.

Fox baiting has taken place at Whiteman Park for more than 10 years. Whiteman Park is a 4,200 hectare recreation and conservation reserve located in the northeast corridor of the Perth Metropolitan Region. It contains over 1,500 hectares of bushland in good condition. As a result of fox baiting and a diverse range of vegetation and habitat types, the Park sustains a wide range of native mammal fauna that are rare on the Swan Coastal Plain including the Black-gloved Wallaby, Honey Possum and Quenda.

The Department of Conservation and Land Management, Whiteman Park, Edith Cowan University and the Kings Park and Botanic Gardens (that manages both Kings Park and Bold Park) are keen to find out whether it would be possible to use 1080 baits in other urban areas to control foxes. In order to do this we need to know what species other than foxes might take poison baits, and what steps can be taken to reduce the risk of this happening.

Ms Jennifer Jackson is conducting an Honours research project in Environmental Management at Edith Cowan University to examine how readily foxes take non-poisoned meat baits that are presented in different ways (laid on the ground, buried, tied to a post), and to determine what other species like domestic dogs or ravens might take or move baits.

Because of the risk to pets ALL of the baits used in this research project contain no poison whatsoever - there is no risk to any animals. The project also does not involve any trapping or handling of animals. The only methods used to monitor bait consumption are sand pads to help in identifying footprints, and miniature radio transmitters to help monitor bait movement.

If this project does indicate 1080 baits could be used to control foxes, no baiting will begin and no animals will be re-introduced without significant public consultation and education.

Ms Jackson's time is precious in the field, so if you have any detailed questions that she is unable to answer to your satisfaction please feel free to contact either of her supervisors:

Dr Dorian Moro, Edith Cowan University Ph. 9400 5143, or
Dr Peter Mawson, Department of Conservation and Land Management
Ph. 9334 0421

Appendix 3. Questionnaire Comments or Concerns

Kings Park

- I think re-introducing native fauna to Perth urban area is wonderful. Planting local plants in private gardens is a good step that I am trying to implement.

- I hear loud complaints about feral cats in parks. Domestic animals are not encouraged in the parklands. It would be good to see evidence of more small animals in Kings Park.

- The main concern is that eventually people would not be able to take their dogs through Kings Park and areas of the Park may become excluded to visitors. Although we support the protection of native species and habitats. A difficult balance of people, pets and natural habitats.

- I congratulate you on your research in this field. It should have been done ages ago.

- We hope your research is successful and that these results could then be used in the Gingin Brook to reduce fox numbers. At the present time, Ag WA officers have not wanted to use 1080 because of residents concerns of the effect on their domestic animals.

- You don't say HOW the baits kill- if they suffer at all, then I do not support it.

- While I support the control of foxes, I would want to be sure that they were killed humanely.

- What about feral and domestic cats? Plus the removal of trees in areas adjacent to Kings Park?

- Very supportive of this. Would it also destroy the feral cats? It would help control the practice of letting dogs loose in the Park. How about Pelican Point? Foxes have been seen there.

- Though I recognise the possible benefits of a baiting program in urban bushland, I have reservations about the danger 1080 baits would pose to dogs in particular.

- Any methods used to re-introduce native animals to parks supported by me. Look forward to fauna in Kings Park. As a frequent user would love to see any improvements in this jewel in the State's treasures.

- We are very fortunate to have such a beautiful Park next to the centre of Perth.

- If a cat or dog is loose and feral in the Park, nail them.
- I have seen warning signs on Canning River foreshore (Sth Perth/ Manning) re fox baits- is this an isolated occurrence?
- Stop the cane toad.
- Size of urban reserve and probability of success of re-introduction.
- Please go ahead with this project, it is urgently needed in Perth bushland. Domestic animals should be kept at home or restrained, if not then the owners can only blame themselves.
- Need to stop stray cats! Especially near edges of bushland.
- In conjunction to fox baiting we need to address the issue of domestic cats attacking native wildlife.
- I hope this goes ahead, if domestic pet owners cannot or will not control their pets, particularly cats, and they are poisoned, that's their problem.
- Prospect of re-introducing native species to Kings Park is very exciting- would be even better if it included kangaroos and koalas. Good luck with the project.
- I am a supporter of animal rights but something has to be done about CATS! Particularly in parks and reserves, but also in the suburbs. I know it poses an almost insurmountable problem at present.
- I presume that if areas are baited there will be clear (and often) signs to warn people walking dogs- even on leads and at unsealed paths.
- If there are only possums in Bold Park, why is it a rule to have my small dog on a lead?
- I would support an urban wild cat control program also, I would support the release of a fox specific virus or pathogen. I would also support the same for all cats- then cats wanted by owners could be vaccinated and we would have widespread cat control.
- Presumably baits can be positioned well away from walkways and bush tracks? Then signage indicating these no-go areas should be sufficient to alert dog walkers that they must keep to authorised areas. Are all native species immune? What about migrating birds?
- Sooner the better.

- I don't feel you can justify the risks to domestic pets whilst trying to poison foxes- which are not the only predators of our native fauna. I don't believe re-introducing these natives into such a built up area as Kings and Bold Park will be successful- its unfair to the natives that will become cat food!

- Having seen a demonstration of fox baiting I wonder if you have consulted someone like Ray Kerslake of Dept. of Agriculture who is very knowledgeable about foxes and fox baiting.

- It is wrong to kill foxes, making them suffer because we don't want the here. Just sterilise.

- I hope this goes ahead, if domestic pet owners cannot or will not control their pets particularly cats and they are poisoned, that's their problem!

- Great idea! I am concerned about:
- Numbers of introduced species in metro area- galahs, rainbow lorikeets, Geraldton wax etc.
- Large numbers of large trees being cut down housing and increased development.
- Large numbers of introduced species being planted (tress, maple etc) for streetscaping, where will magpies, owls, larks etc nest in the future?
- Degradation of our remaining 'natural' parks etc. Need to plant Jarrah, Marri, Wandoo trees in parks.
- Like to see introduction of laws to prevent cats from being outdoors at night.
- Most natives sold are not suitable for nectar feeding birds.
- Lifestyle TV programs that encourage people to plant non-native plants, chop down trees and go fishing!

Bold Park

- As noted on previous page, I would not support any program involving the deliberate poisoning of any animal. Also, I have 2 dogs, and I would object strongly to their being put at risk by 1080 baits.

- Given the demise of the fox- and assumed feral cats- what control of the rabbit population is proposed? I would hope not myxomatosis- used last time- blinded rabbits are a distressing sight.

- As I am with a problem of arthritis my walking on rough terrain is limited. Very good to have the seats to take a rest.

- Rather than poison, which is cruel (and poisoned carcasses may pose a threat to raptorial birds), why not have an old fashioned dogger with an appropriate firearm (.22 short shouldn't pose a major safety hazard?).

- I would not be supportive if birds were affected. They can be picked up later by domestic pets. Is there some method in which dead animals can be located and picked up quickly for disposal before eaten again by domestic pets or birds?

- Is it wise to introduce native fauna into Bold Park and Kings Park where traffic (heavy and high speed) is a worse hazard than live foxes? Many birds and small animals lay dead squashed on the road. Also remember cane toads, rabbits, foxes and their disastrous effects from ecological point of view.

- Bold Park extends to area of bush opposite my home. As an owner of pets, I am strongly opposed to baiting the area. As a user of the beach beyond Bold Park at different hours of the day I have seen a fox on only three times in the last 10 years. More domestic pets would be killed than foxes.

- The beach in front of Bold Park in the south City Beach area is an '"off the lead"" area. With an easterly breeze, dogs could smell a bait and run into Bold Park before an owner could stop it, (they have no incentive to do so at the moment). I am strongly opposed to baiting here, dogs from many western suburbs are brought here- in summer especially. This area of Bold Park is only a minute part of the whole bush area (compared with land, rifle range, Cottesloe Golf Course land, Perry Lakes, bush around Superdrome area), so baiting would probably have minimal effect on feral animals anyway.

- As a resident, frequent Bold Park user and pet owner, I would be most interested to know more of any proposed action.

- Controlling the risk to domestic pets whilst still permitting free access to the areas.

- How bad is the fox problem in Bold Park? Are there rabbits in Bold Park? What other native animals would return to Bold Park?

- Although domestic dogs are currently only allowed in Bold Park on leads some people still choose to recreate with their dogs not on a lead. These and even dogs on leads, if 1080 baits are near pathways, could result in devastating deaths for peoples pets. The relative worth/value to our community of our pets versus what native mammals remain in Bold Park is worthy of debate itself. If trapping of foxes is a viable alternative, I'd prefer it. Also, domestic cats, like dogs, should be licensed and confined especially at night to their owner's properties. Cats, feral and domestic pose a much greater threat to out native fauna than dogs.

- Cats are so badly controlled by owners (including me) that I would risk losing cats to eliminate foxes! Is a fox not an animal? (ref your highlighted paragraph on Dr Moro's report).

- Provided baits are placed some distance from paths- no problems.

- I a totally opposed to the use of 1080 anywhere, and the use in Bold Park is too silly to contemplate. If as a consequence of this study (which I cannot believe has not been done before) baiting is considered I will initiate a public campaign against it. This is a totally ludicrous idea. Native animals become extinct due to habitat loss. Do something about this instead of poisoning defenceless animals.

- We would be happy to see elimination of feral animals from native reserves, and to volunteer assistance. There would need to be full protection for pets visiting the areas with owners.

- Despite the difficulties and cost associated with humane trapping and euthanasia it is the only method of removal I would condone. I am against poisoning. Apart from the distress the animals suffer I am concerned that birds may remove the baits from the designated areas also and deposit them in the neighbourhood. We live opposite Bold Park and have a number of pets.

- Live next to Bold Park. Encourage dugites and bobtails etc in my backyard. Agree crows will move baits-based on observation. Would love to have native mammals in my back yard. Three cats in our street have decimated the skinks in my backyard.

- It seems obvious to me that feral control, and re-introduction of species should be in Metropolitan areas as there is a ready supply of volunteers. There is also much greater awareness generating potential in the city.

- Feral cats appear to be in Bold Park.

- As I do walk my dog in Bold Park area, my concern is how long would we have to stay out of there until it is considered safe for domestic animals to venture there?

- As a concern, how close to paths would the 1080 be placed? Dogs on leashes can still enter the edges of the bush. Aerial drops are a little too random, could the baited meat be dragged into areas accessible by domestic animals?

- Will the introduced rodent population increase as a result of the loss of foxes?

- Dogs and cats and horses should not be permitted in Bold Park. All cats and dogs should be sterilised except those of registered breeders. Good luck with your important work, may you succeed for all our sakes.

Appendix 4. Letter to *The West Australian*

16th July 2003

Eradicating foxes?

EARLY this morning, while cycling to work through Kings Park, I spied a fox hesitate as it crossed my path. I wondered, is the Kings Park authority's primary objective in its widespread elimination of the overgrown peppermints and other majestic gums to eradicate such feral animals from the park? If so, aren't there other more sensible and effective alternatives whereby the eucalypts might be preserved?

KEITH GALE, Nedlands.

Appendix 5. *Urban fox plague sparks bait trials*

4 The West Australian Saturday July 19 2003

Urban fox plague sparks bait trials

Litter bin in parks an easy target for feral menace

■ By Leith Paganoni

FOXES are thriving so well in Perth's suburbs that authorities are testing non-toxic baits in Kings Park and Bold Park.

Vermin controller Mark Read said he shot up to 10 foxes annually, but they were a small fraction of the number spotted around Perth.

"Everyone knows they're out there, the hard part is to find out where they hang out," he said.

CALM senior zoologist Peter Mawson said it was impossible to guess how many foxes lived in the metropolitan area.

Foxes were at home in an urban environment and liked waterside suburbs and older suburbs.

While Perth's foxes tend to live in parks and reserves, they happily travel through residential streets to isolated pockets of bush such as the Mt Lawley Golf Club.

Golf club general manager Lindsay Stade said about five were usually spotted on the course each year.

The club called in an exterminator after fox sightings because they were a threat to native fauna and their faeces littered fairways.

Dr Mawson said Perth's foxes would have had a field day with the fish kill from the recent algal bloom in the Swan River.

"Kings Park is a natural attraction for foxes with abundant food scraps left in rubbish bins," he said. "Water fowl at the freeway interchange get a hammering."

Foxes ate rubbish, pet food, road kill, domestic animals such as chickens, the young of native animals and even insects.

Supporters of the urban bush trials of baits believe eradicating foxes and feral cats from urban parks would restore Perth's biodiversity and is worth the risk to pets.

An Edith Cowan University student started the trials in March and will continue recording which animals — foxes, feral cats, dogs, birds or native animals — take the baits until October.

CALM carries out aerial and ground fox-baiting in national parks using 1080, a natural poison which does not harm native animals. It has been unable to use the poison in parks near domestic animals and where people take their pets.

Botanic Gardens and Parks Authority chief executive Steve Hopper said the only methods to control feral predators in Kings Park and Bold Park were trapping feral cats and gassing fox dens.

In CALM's experience, baiting was the most effective method of control but in inner urban areas there were additional considerations such as domestic pets.

WA Canine Association president Anne Rushby said fox baiting in the parks was not a problem because dogs had to be leashed in public places apart from dog exercise areas.