Hattah–Kulkyne Lakes Ramsar Protection Project: predator control and monitoring program

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Hattah–Kulkyne Lakes Ramsar Protection Project: predator control and monitoring program

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Summary

The Hattah–Kulkyne Lakes Predator Management Strategy forms part of the larger Mallee Catchment Management Authority (MCMA) 'Building Reconnected, Resilient Landscapes and Communities across the Murray Mallee' program to be delivered 2013–2018. Within the broader program are a series of subprojects, with one specifically addressing the issue of systematically and strategically reducing pest plant and animal infestations in order to protect key ecological attributes of the Hattah–Kulkyne Lakes Ramsar site.

In order to achieve this the Mallee Catchment Management Authority engaged the Arthur Rylah Research Institute (ARI) of the Department of Environment and Primary Industries to prepare a Predator Management Strategy.

The Predator Management Strategy identifies a range of control techniques for Red Foxes (*Vulpes vulpes*), with an appraisal of the predicted benefits and limitations of the various techniques. The strategy also discusses the potential for innovative control techniques to be employed within the site.

In order to accurately determine whether the predator control program is meeting its objectives, a monitoring program must measure the responses of both predator populations (i.e. operational monitoring) and prey populations (i.e. performance monitoring).

The recommended fox control strategy is a two-stage approach. Stage one is the initial knockdown of the local fox population, and stage two is the sustained management of the lowered fox population. To assess the effectiveness of the initial knockdown, the strategy recommends a before-and-after poison baiting comparison in a proportion of the area occupied by foxes. This approach will also be implemented for the longer-term monitoring of the fox population.

Suggested approaches to monitoring are provided for the monitoring of waterbirds and reptiles (including freshwater turtles), which are likely to increase in abundance following control of foxes to low abundance. A detailed monitoring and evaluation plan will be developed to assess the performance of the fox control program under a separate project.

Increasing water flows into the Hattah–Kulkyne Lake system is likely to result in increased European Rabbit (*Oryctolagus cuniculus*)abundance, with increased and sustained vegetation growth through spring and early summer. With fox control, and thus reduced predation on rabbits, it is expected that rabbit densities will increase in the Hattah–Kulkyne Lakes study area, with the potential for subsequent increases in feral cat (*Felis catus*) populations. It is recommended that a rabbit control operation be implemented to complement the fox control program.

As there is no legal definition for 'feral cats' in Victoria, and no legal large-scale cost-effective control tools, the strategy recommends the collection of information on the impact that feral cats are having in the Lakes system so as to inform the use of broad-scale management programs in the future.

1 Background

The Hattah–Kulkyne Lakes Ramsar protection project forms part of the larger Mallee Catchment Management Authority (MCMA) ‘Building Reconnected, Resilient Landscapes and Communities across the Murray Mallee’ program to be delivered between 2013–2018. This will continue to protect and improve the ecological character of the Ramsar-listed Hattah–Kulkyne Lakes through the implementation of riparian and waterway pest plant and animal control works and activities. Delivered over five years it will help secure the environmental benefits obtainable from the complementary ‘The Living Murray’ project which is restoring natural water flows to the lakes system.

Mallee Catchment Management Authority engaged the Arthur Rylah Institute (ARI) of the Department of Environment and Primary Industries to prepare a Predator Management Strategy as part of the larger subproject. The strategy aims to systematically and strategically reduce introduced predators in order to protect key ecological attributes of the Hattah–Kulkyne Lakes Ramsar site as invasive species present a major threat to the response of native species to favourable conditions brought about by the restoration of appropriate water regimes.

1.1 Assumptions and rationale

The MCMA Hattah–Kulkyne Lakes predator control subproject brief outlines the assumptions and rationale for the control of predators. The two main assumptions identified in that document are that:

1. Foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) pose a critical threat to the ecological character of the Hattah–Kulkyne Lakes Ramsar site.

   This assumption is based on the following rationale:

   - Foxes and feral cats are widespread throughout the Hattah–Kulkyne Lakes site, with the following categories of native fauna considered to be at risk from predation: arboreal mammals; bird species that spend much of their time at or near the ground (nesting and/or feeding), including the threatened Freckled Duck (*Stictonetta naevosa*), Bluebilled Duck (*Oxyura australis*), Apostlebird (*Struthidea cinerea*), Spotted Bowerbird (*Chlamydera maculata*) and Mallee Emu-wren (*Stipiturus mallee*); reptiles, including the threatened Carpet Python (*Morelia spilota*); and amphibians, including the threatened Barking Marsh frog (*Limnodynastes fletcheri*).
   - While there are limited quantitative data available on the impact of feral cats on native fauna in the Hattah–Kulkyne Lakes Ramsar site, they are listed under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act 1999) as a key threatening process, with the potential to kill vertebrates weighing as much as 3 kg, while preferring to kill mammals weighing less than 220 g and birds weighing less than 200 g. Feral cats also kill and eat reptiles, amphibians and invertebrates. Cats can also have indirect effects on native fauna by carrying and transmitting infectious diseases, such as toxoplasmosis.

2. The proposed control methods and additional resources provided by the MCMA subproject can eradicate foxes and cats from littoral and nesting zones while favourable conditions following restoration of natural water flows are being experienced.

This assumption is based on the following rationale:

- An experimental fox management project undertaken from 2002–2006 in Hattah–Kulkyne National Park documented that intensive fox baiting over a large area resulted in an estimated 89% reduction in fox activity in the treated area, but also an estimated 74% reduction in the non-treated area. Hence the treatments were not independent, and foxes were moving from the non-baited area into the baited area and taking baits (Robley et al. 2004). There is also evidence that fox abundance can be significantly reduced through prolonged maintenance of low rabbit abundance (Sandell 2011), indicating that the delivery of integrated management programs (for rabbits and foxes) can achieve the targets detailed by the subproject brief.
- Limited information is available on the relative effectiveness of feral cat control programs in this environment, and as such they will be considered a 'secondary' target of the fox-baiting program while alternative methodologies are being identified and validated. Once these initial trials have been completed, best management practice will be implemented for the specific control of cats.

In reality not all of the assumptions outlined above from the MCMA Hattah–Kulkyne Lakes predator control subproject are likely to be met, especially the ability to completely eradicate foxes and cats. Despite numerous large-scale attempts, no eradication campaign against any well-established introduced vertebrate pest has been successful on any continent (Bomford and O'Brien 1995). In the Predator Management Strategy that follows, the focus instead is on the effective management of introduced predators so as to allow affected native species to increase and persist at the Hattah–Kulkyne Lakes, rather than on the eradication of foxes or feral cats.

1.2 Project objectives/outcomes

The Hattah–Kulkyne Lakes Ramsar protection subproject brief identified a set of strategies for achieving the overarching goal. These are:

- A targeted fox-baiting program in the Ramsar Lakes littoral and nesting zones (600 ha) over the five years of project delivery.
- Trialling of various cat control methodologies, with the most effective to be employed for the remainder of project delivery.
- Opportunistic shooting of both foxes and cats over the life of the project so as to enhance outcomes.

The subproject brief also prescribes assessing the success of the predator control program by monitoring:

- Annual change in fox and cat abundance (number per spotlight km) within the littoral zone (600 ha), as determined by long-term transect monitoring to be conducted in autumn and spring (Parks Victoria-funded program).
- Annual presence/absence of foxes and feral cats within the littoral and nesting zones, as determined by sand pads and remote sensor cameras (a combination of those established under the previous Caring for our Country (CFOC) 2009–13 investment and additional cameras established under the current 2013–18 funding).

1.3 Project area

The Hattah–Kulkyne Lakes Ramsar system is located within the Hattah–Kulkyne National Park and forms part of the Murray River floodplain, consisting mainly of shallow lakes, anabranches and temporary swamps. Twelve of the lakes are included in the Ramsar site, and these cover an area of approximately 1155 ha. The twelve lakes are: Arawak (40 ha), Bitterang (73 ha), Brockie (28 ha), Bulla (40 ha), Cantala (101 ha), Hattah (61 ha), Konardin (121 ha), Kramen (161 ha), Lockie (141 ha), Mournpall (243 ha), Yelwell (81 ha) and Yerang (65 ha) (Figure 1).

Black Box (*Eucalyptus largiflorens*) woodland is widespread and found on the drainage areas and flood plains, while the margins of the river, creeks and lakes support stands of River Red Gum (*E. camaldulensis*). Large areas of mallee are present throughout the Park, and there are lesser stands of Moonah (*Melaleuca pubescens*), scattered Belar (*Casuarina cristata*) and Buloke (*Allocasuarina leuhmannii*).

The predator control strategy will cover an area larger than the specified subproject area of 600 ha, encompassing areas that will be inundated during complete flooding (some several thousand hectares of mainly open grassland, but includes all the habitat types described above, including small areas of Mallee (Figure 1)) in order to suppression the local fox population and reduce predation pressure of native species.

The Hattah–Kulkyne Lakes have been identified as an icon site under The Living Murray (TLM) initiative. The aim of this river restoration initiative is to restore natural flow regimes to the river and its floodplain wetlands. Two primary watering actions have been developed to achieve the ecological objectives that have been set for the Hattah Lakes:

- Inundation to 43.5 m Australian height datum (AHD) 3-in-10 years to flood lakes, waterways and fringing vegetation; and
- Inundation of the surrounding floodplain to 45 m AHD 1-in-8 years.

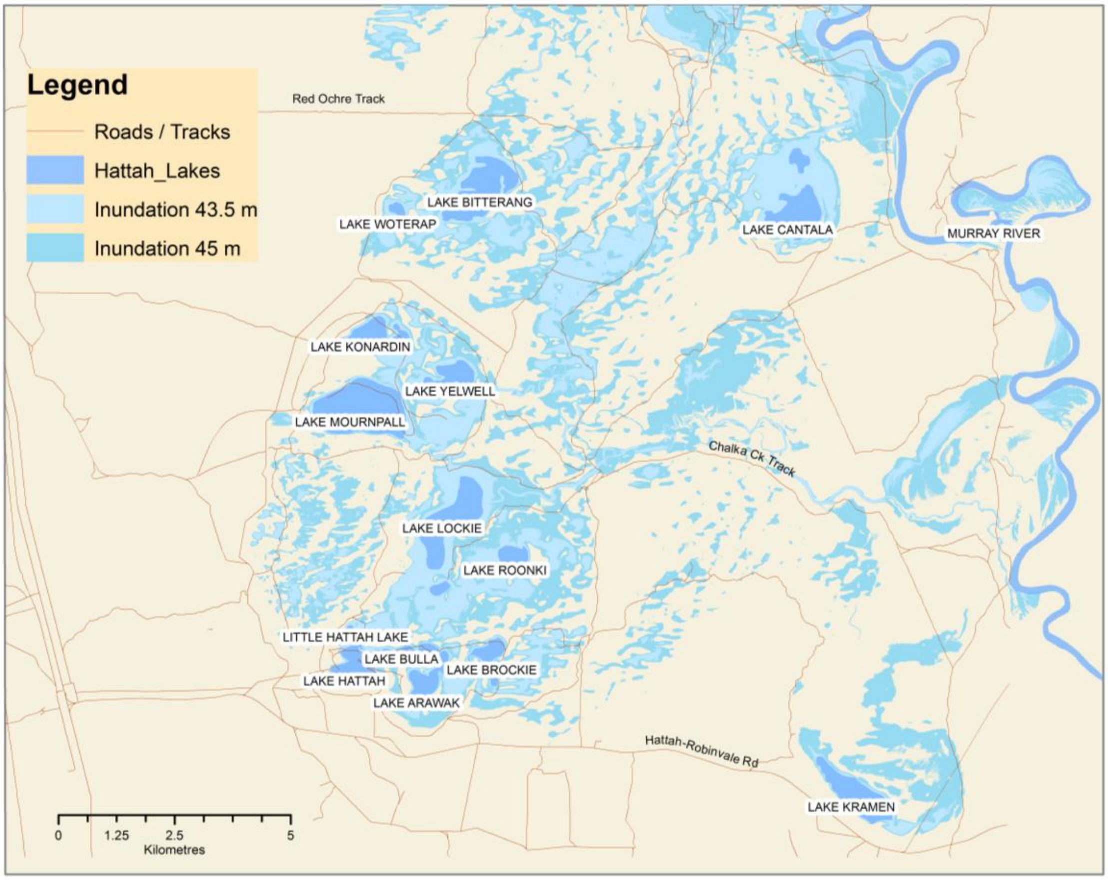

Figure 1. Location of the project area for the Hattah–Kulkyne Lakes Predator Management Strategy. Inundation levels of 43.5 m and 45 m (AHD) to be achieved in 3-in-10 and 1-in-8 years, respectively.

2 Predator control

There are a range of predator control options available for reducing predation pressures at the Hattah–Kulkyne Lakes Ramsar site. Control techniques are identified and described for foxes and feral cats, with an appraisal of the advantages and limitations of the various techniques, including innovative control techniques that could be used within the site, either at present, or in the near future.

2.1 Foxes

The most commonly used fox control techniques in Australia include poison baiting, trapping, shooting, breeding den fumigation and destruction, and harbour removal, as well as *in situ* protection measures for target fauna, such as exclusion fencing (Saunders et al. 1995). The most appropriate of these control measures are considered below, in terms of their feasibility and likely efficacy within the Hattah–Kulkyne Lakes Ramsar site, based on reviews of previous research into fox control programs in Australia.

2.1.1 Poison baiting

Poison baiting is the most widely used fox control technique in Australia, and is considered to be the single most effective method for controlling foxes (Saunders and McLeod 2007). There are two primary methods of poison baiting: ground baiting and aerial baiting.

Baiting is undertaken with sodium monofluoroacetate (1080) impregnated baits, either manufactured or fresh-meat (e.g. liver). However, there are other toxicants that are available or being developed, and these, along with a range of delivery methods, are discussed further below.

2.1.1.1 Intensity of application

Baiting intensity is dependent on four factors: the current size of the fox population and the abundance of competitors for baits; the size of the area to be baited; the resources available for undertaking baiting; and the number of baits used. Most areas will require frequent baiting, due to rapid recolonisation by foxes. Algar and Kinnear (1991) demonstrated that juvenile foxes were able to recolonise a 44,512 ha area within 6 months of a control program that had removed 86–91% of the resident population.

The availability of baits to targeted animals is best expressed as the number of baits available to targeted animals in relation to the density of the targeted animal, however it is not usually possible to estimate the density of foxes (e.g. Ramsey et al. 2014 unpublished) making this approach impractical and bait density has more often been used. Algar and Kinnear (1992) recommended a baiting density of 5–6 baits per square kilometre for aerial baiting in semi-arid Western Australia. Thomson and Algar (2000) found 5 baits per square kilometre was as effective as 10 baits for fox densities from 0.5–1.0 adult per square kilometre in arid parts of Australia. Saunders et al. (1997) recommended a procedure for placing baits on trails at one every 400–500 m, which they report was roughly equivalent to 9–12.5 baits per square km in central NSW. Murray et al. (2006) used non-toxic baits impregnated with coloured beads to assess the distance at which fox scats with beads were found from bait stations. In forests in East Gippsland, Victoria, they recorded a mean distance of recovery of 1600 m from a bait station, and suggested that 1 km intervals would be sufficient to expose most foxes in a large forest block to poison baits. Fleming (1997) found that a density of poisoned baits at 4.4 per square kilometre was inadequate for effective control in temperate forest in NSW. Based on the current best available information and the label requirement to bury baits in Victoria it is recommend baits be spaced at 500 m intervals along roads and tracks throughout the broader Hattah-Kulkyne study area.

2.1.1.2 Timing of baiting programs

Currently, a variety of factors determine the timing of baiting programs. These variations are based around the susceptibility of the fox, e.g. breeding or dispersal times, the susceptibility of the prey species being protected, e.g. nesting and/or fledgling time, and the available resources, e.g. summer-time casual employment. An adaptive management research program investigated the effectiveness and efficiency of a variety of intensities and timings of baiting for the control of foxes in Victoria (Robley et al. 2008). The most effective control strategy was for continuous year-round baiting; however, only slightly lower levels of reduction were gained using a pulsed baiting program where baiting was undertaken in four, 8 weeks pulses of baiting.

2.1.1.3 Replacement baiting

During a baiting program, bait stations must be checked on a regular basis, and baits that have been taken replaced. By holding the number of baits constant through daily replacement, Fleming (1996) achieved a 90.8% reduction in foxes over a 2-week period in temperate rangeland in north-eastern New South Wales (NSW). By replacing baits frequently, the problem of non-target removal, which can often limit the success of baiting programs, is reduced. Also, replacing baits until bait-take is zero, or nearly so, allows for the removal of all bait-susceptible individuals in the shortest amount of time.

The 1080 content of meat baits usually declines with time, due to water leaching and to microbial and insect attack (McIlroy et al. 1988); cached and uneaten baits will inevitably contain sublethal doses of 1080 for some time (Saunders et al. 1999), and such doses may nonetheless elicit symptoms of 1080 toxicosis in the fox if consumed. The consumption of such baits by foxes immigrating to previously baited areas may produce aversion to baits, although this hypothesis is untested. However, the chance of this occurring can be minimised by a combination of frequent replacement and the use of a highly palatable bait type that increases the chances of immediate consumption and reduces the incidence of caching. Label conditions for the use of 1080 baits specifies that all baits that remain at the completion of the baiting program must be collected and destroyed, also reducing the chances of foxes obtaining a sublethal does.

2.1.1.4 Free feeding

Free feeding can be used to (a) determine the degree to which non-target species visit bait stations in areas where these species are thought be present; (b) ‘attract’ foxes to bait stations, the idea being that foxes learn where there is a free feed; and (c) determine a relative index of abundance before and immediately following the implementation of a poison-baiting program (Saunders et al. 1995). However, free feeding can have a counterproductive effect in that foxes may learn to cache the poisoned baits. There are no non-target species in the Hattah-Kulkyne area that are of concern, we will use digital cameras to assess pre- and post-baiting index of abundance of foxes, therefore free-feeding is not recommended for the Hattah-Kulkyne Lakes predator management strategy.

2.1.1.5 Bait material

A number of bait products containing 1080 have been, or are being, developed for the control of foxes around Australia. These include fresh and dried meat baits, hen eggs, and a number of commercially manufactured meat-based products. FOXOFF® is a commercially manufactured bait consisting of a soft meat-like substitute based on meat meal and containing animal fat, preservatives, binding agents and proprietary flavour enhancers. This bait is widely used in fox control programs in Australia.

van Polanen Petel et al. (2004) compared the palatability of FOXOFF® and fresh and dried deep-fried liver baits. They found that, while there was no difference in the rate at which these baits were cached, liver baits were eaten the most often. Other bait material includes dried kangaroo meat or horsemeat. The meat is cut into 120-g chunks and injected with a dose of 1080 dissolved in water. The meat is then dried to a weight of 40–50 g before being used or frozen for storage.

2.1.1.6 Toxicants

1080

Sodium monofluoroacetate (1080) is the synthetic sodium salt of the naturally occurring monofluoroacetic acid. It is odourless, tasteless, highly soluble in water and readily broken down by bacteria and fungi in the soil (Saunders and McLeod 2007). 1080 is toxic to all aerobic species, but in particular to mammals. Toxicity varies between species, with canids and felids being among the most susceptible (Saunders et al. 1995; Saunders and McLeod 2007).

The risks of 1080 poisoning to native non-target species are generally low. Good baiting practices like burying baits, regular and frequent replacement of baits can effectively reduce these risks, and a number of regulations and restrictions surrounding the use and deployment of 1080 have been put in place for this reason. Used properly, 1080 remains the most suitable toxin currently available for broad-scale fox control (Saunders et al. 1995; Saunders and McLeod 2007).

PAPP

Para-aminopropiophenone (PAPP) is a toxin that induces methaemoglobinaemia, causing death through a lethal oxygen deficit in the heart and brain (Vandenbelt et al. 1944). Canids and felids are highly susceptible to this toxin, whereas many native species (although not all) are relatively resistant (Savarie et al. 1983; Fisher et al. 2008).

There are three advantages to the use of PAPP over 1080, namely:

- The availability of an antidote, BlueHealer®, effective if delivered within approximately 20 min of poisoning (S. Humphrys, Invasive Species CRC, pers. comm. 2012);
- Reduced non-target impacts for some native species (Fleming et al. 2006); and
- Improved welfare outcomes for foxes, namely a more rapid death (approximately seven times faster than 1080) and the appearance of fewer distress symptoms prior to death (Marks et al. 2004).

The use of PAPP in the 'Curiosity®' cat bait for use on the surface, is currently being assessed for registration by the Australian Pesticides and Veterinary Medicines Authority (APVMA); however, it is unknown when registration may be completed.

One disadvantage of using PAPP in place of 1080 is the high susceptibility of goannas (*Varanus* spp.). This genus appears to have an even higher sensitivity to PAPP than canids (Southwell et al. 2011), which indicates PAPP baits could be highly lethal to goannas.

Goannas can unearth and consume buried baits (Woodford et al. 2012), and hence the use of PAPP in standard buried baiting or aerially deployed baiting requires careful consideration. The overall risks to goannas of baiting with PAPP have not been fully assessed, but are likely to be influenced by the time of year at which baiting with PAPP occurs and its accessibility when deployed. The M-44 ejector (see below) is a bait delivery device that has been designed to restrict the access of non-target species to bait. M-44 ejectors could enable the use of PAPP at the Hattah–Kulkyne Lakes Ramsar site, conferring all the advantages of PAPP bait and virtually eliminating risks to goannas. Until the risks of using PAPP in buried or aerial baits have been fully assessed, 1080 is the recommended toxicant when using standard delivery mechanisms.

2.1.1.7 Delivery mechanisms

Buried baits

Ground baiting is generally undertaken using bait stations; these usually consist of a sand plot or raised mound of sand or soil. Directions for the use of fox baits published by the Department of Environment and Primary Industries (DPI 2012) recommend baits are buried 8–10 cm below the surface. Burying bait at bait stations is considered to significantly reduce the potential impact on non-target species (i.e. native fauna) (Dexter and Meek 1998; Murray et al. 2006; Robley 2011), although this has not been experimentally verified (see Saunders and McLeod 2007).

Various native and exotic non-target species have been observed excavating buried baits. These include the Black Rat (*Rattus rattus*) and the Bush Rat (*R. fuscipes*) (Fairbridge et al. 2000). Evidence of goannas and Common Brushtail Possums unearthing and consuming manufactured fox baits from bait stations has also been recorded (Woodford et al. 2012; Robley pers. obs.). Despite these occasional occurrences, buried 1080 baits are considered to present minimal risk to native species, and at the population level, most species have been found to benefit from the reduction in predation pressure resulting from baiting programs. The risks to goannas and possums from buried 1080 baits are considered very low.

It is important to record the location of bait stations, the number of baits laid, the number of baits taken, the species that are thought to have taken the baits, and the dates baits have been laid, replaced and collected. This information can be used to assess the effectiveness of the control program.

Another consideration is the time it takes 1080 baits to become sublethal. A study in Orange (NSW) concluded that, under overall average rainfall conditions from September to November (81 mm ± 4.7 mm), FOXOFF® baits were non-lethal to foxes after 2.8 weeks (Saunders and Harris 2000). Factors that contribute to the defluorinating of 1080 include soil microorganisms, soil moisture, the wash-through effect of rainfall, and the amount of rainfall (Saunders et al. 1995). Saunders and Harris (2000) also found that baits exposed to no rainfall were lethal to foxes up to 11 weeks after being laid. In separate trials, Staples and McPhee (1995) showed that the toxic content of FOXOFF® was reduced to 18–23% of the initial toxic load after being exposed to 56.4 mm of rain over 2 weeks. They do not provide an indication of the toxicity of these baits, but an 80% reduction in 3.3 mg of 1080 would result in approximately 0.66 mg remaining in the bait. The minimum lethal dose of 1080 for foxes is 0.15 mg kg^{-1} (McIlroy and King, 1990). Thus, these baits would not be lethal to the average fox (lethality at 0.15 × 6 kg = 0.90 mg).

Aerial application

Within Australia, aerial baiting is recommended for large, sparsely populated areas that are remotely located and inaccessible by vehicles. Aerial application is the most commonly used method of baiting in remote parts of Western Australia, the Northern Territory and Queensland, and is also used in the Northern Territory. In NSW and South Australia, aerial baiting for foxes is used, but only under a special permit where endangered species are being protected on Crown land. The use of aerial baiting in Victoria is currently only available for the control of wild dogs and is limited to eastern Victoria.

M-44 ejectors

M-44 ejectors are tube-like, spring-loaded devices and are partially buried in the ground. The above-ground component is baited with an attractant and, when pulled, propels a toxicant into the animal's mouth (Saunders and McLeod 2007). A number of trials using M-44 ejectors (containing 1080, PAPP or cyanide) have been undertaken in Victoria (Busana et al. 1998; van Polanen Petel et al. 2004; Marks and Wilson 2005; Nicholson and Gigliotti 2005).

M-44 ejectors are designed to significantly increase the target specificity of poison baiting, and reduce non-target impacts. The device is only triggered by an upward-pulling motion, and activates when a threshold pull-force is reached. The pull-force required to activate the ejector can be set to specifically target canids and felids. M-44 ejectors can be ordered at the unit price of approximately $35.00 AUD (S. Humphrys, Invasive Animals CRC, pers. comm. 2012; B. Hall, pers. comm.) from Animal Control Technologies Australia.

A multi-shot ejector is currently being researched and developed; if successful, it may be commercially available in the future (S. Humphrys, Invasive Animals CRC, pers. comm. 2012). This could offer the significant advantage of multiple fox kills per deployment. It is recommended that if these become commercially available their use be considered where spatially specific and seasonal native prey species are of particular concern, and that a strategy for the use of the multi-dose ejector be developed.

2.1.2 Other control methods

The control of foxes in any particular area should not be reliant on a single method. A range of control techniques can be applied in addition to a baiting program. In situations where bait-take decreases but fox signs or activity levels remain high, the use of alternative techniques may remove individual animals that are not taking baits.

2.1.2.1 Shooting

Shooting is commonly undertaken from a vehicle at night with the aid of spotlights; tin whistle lures, which mimic the distress call of a rabbit, are sometimes used. Daylight drives or 'battues' can also be used, in which unarmed beaters and dogs are used to drive foxes into a line of waiting shooters. Both techniques are resource intensive (McPhee and Bloomfield 2012). If shooting is to be undertaken, it needs to be carried out systematically (covering the entire area), and use call-up devices. The shooting program should be random (i.e. carried out at different times each night and different times of the month or year) and backtrack to cover the entire site (Saunders et al. 1995).

Shooting has been shown to alter the age-structure and demographics of a population, but does not necessarily lead to a decline in fox abundance, or a reduction in the impact of fox predation (Saunders and McLeod 2007). Shooting typically removes young, inexperienced foxes from the population and tends to quickly educate foxes to the spotlight and vehicle noise (Coman 1988; Kay et al. 2000). Foxes also become spotlight shy, making it difficult to come within shooting range, and often less than a third of the number of foxes seen are shot (Fleming 1997; van Polanen Petel et al. 2004).

Shooting is, therefore, ineffective at significantly reducing and sustaining low fox populations in large, unenclosed areas. Shooting within the study area is not recommended for broad application across the site. The technique is best suited for localised control or to collect specimens for demographic or diet analysis.

2.1.2.2 Trapping

Trapping typically involves the use of 'soft-jaw' (i.e. rubber) leg-hold or foot-hold traps. Cage traps are generally considered to be ineffective for the capture of foxes (Saunders and McLeod 2007). Soft-jaw traps are often deployed in conjunction with scent lures and set along access tracks, animal tracks, or in areas where there are signs of fox presence (e.g. scats, tracks). This technique has been used in circumstances where other methods, such as lethal baiting, pose too high a risk to non-target animals. However, it is not a cost-effective control technique for large-scale predator control programs (Saunders et al. 1995).

Trapping is labour intensive and costly. Traps must be monitored at least daily for captured animals throughout their deployment, and trapping success is generally low. Because of the low capture rates and poor efficiency, trapping is best used as a supplementary method integrated with other control techniques.

2.1.2.3 Den fumigation and destruction

The fumigation of fox dens with carbon monoxide (CO) gas is used during the fox-breeding season, to destroy the fox cubs in the den. Carbon monoxide causes death by depriving the brain of oxygen, rendering the animals unconscious before death. It is currently the only registered fumigant in Australia, and is more humane than alternative fumigants, such as chloropicrin or phosphine (Saunders and McLeod 2007).

Den fumigation is best undertaken while cubs are still confined to the den, between October and November. The success of this technique is related to the high fidelity foxes show to dens year after year. Den fumigation also has the potential to remove the next generation of foxes. As a control technique, however, den fumigation and/or destruction offers only localised control. On a broad spatial scale, it is only effective when used in conjunction with baiting.

The time required to locate dens can be managed by engaging sectors of the community to assist with locating and recording dens. These activities can be undertaken as part of a community program, such as the 'Dob in a den' program adopted at Phillip Island (McPhee and Bloomfield 2012), and are a useful way of encouraging community participation and fostering ownership. Fox dens could then be mapped on a Global Information System (GIS) layer, which would help to target fox control efforts. This approach is not recommended for use at the Hattah Lakes site unless a system of volunteers that could make it cost-effective.

2.2 Feral cats

There is no legal definition of 'feral cat' in Victoria, and the only legislative mechanism available to public land managers is the *Domestic Animals Act 1994*, which allows authorised officers to seize and remove cats known to be threatening wildlife. This Act and its regulations do not prescribe methods of seizure or destruction, and 'authorised officers' are restricted to those contracted to a local government.

Feral cats are managed in other States of Australia, and the sections below review methods used to manage their impact.

2.2.1 Poison baiting

Poison baiting is generally the most cost-effective control strategy for feral cats, and can result in substantial reductions in feral cat populations (Denny and Dickman 2010). Baiting for feral cats, using surface laid meat-based chipolata-style bait impregnated with 1080 (ERADICAT®), has been successfully undertaken on a number of islands, in National Parks, and in other relatively remote areas in central and Western Australia where there are large feral cat populations.

A new bait-delivery approach with the toxicant encased in a hard pellet embedded in the bait that cats swallow whole (Curiosity®), using PAPP as the toxicant, is being developed and trialled. However, as previously discussed, goannas are highly susceptible to PAPP, and field trials have shown that they will consume ground-laid cat baits containing pellets similar to those that would be used to contain a toxicant (Forster 2009). Therefore, poison baiting in semi-arid environments with PAPP may be best restricted to cooler months when goannas are not actively hunting.

2.2.2 Shooting

Shooting of feral cats is not a permitted activity in Victoria. The same issues relating to the shooting of foxes (see section 2.1.2.1) apply to the shooting of feral cats.

2.2.3 Trapping

Within incorporated localities (e.g. Shires), stray domestic cats can be collected using cage traps; if found to be unowned, they can be euthanised by an authorised officer or an agent, usually a veterinarian. The restrictions that apply to the trapping of foxes (see section 2.1.2.2) also apply to the trapping of feral cats. Trapping is labour intensive, expensive and time consuming, but it may be a useful means of removing or controlling cats inside important habitats, or as a supplementary control measure.

The *Prevention of Cruelty to Animals (POCTA) Act 1986* allows for the use of leg-hold traps; however, exemption under this Act for the use of these devices explicitly states that they can only be applied to pest animals listed under the *Catchment and Land Protection Act* 1994 (CaLP Act) (foxes, wild dogs, rabbits). The CaLP Act does not make reference to feral cats, and therefore the use of leg-hold traps for the capture of feral cats is not allowed in Victoria.

3 Integrated pest control

In predator–prey studies in semi-arid eastern Australia, Pech et al. (1992) demonstrated that populations of European Rabbits (*Oryctolagus cuniculus*) can be regulated by foxes. They found that the size of the fox population in summer was dependent on the availability of rabbits over the immediately preceding rabbit-breeding season (spring). When rabbit densities were low, foxes could regulate rabbit populations, and when rabbits ‘escaped’ predator regulation, rabbit populations increased to high densities. The boundary between regulation and non-regulation by predators was demonstrated by a predator-removal experiment (Pech et al. 1992). In the treated areas, predators were initially culled; rabbits then increased to higher densities than in an untreated area where predators were always present. When predators were allowed back into the treated areas, rabbit populations continued to increase, and they did not decline to the density present in the untreated area. When predators were present, rabbits could be maintained at low densities. Exceptionally high rabbit recruitment, or artificially reduced predation, can result in rabbits escaping predator regulation.

Increasing water flows into the Hattah–Kulkyne Lake system will benefit rabbit populations through increased and sustained vegetation growth in spring and early summer. With the addition of fox control lowering predation pressure on rabbits, it is expected that rabbit densities will increase in the Hattah–Kulkyne Lakes study area. There is similar evidence of feral cats responding to increases in rabbit populations in New Zealand (Cruz et al. 2013).

It is recommended that rabbit control be undertaken in conjunction with fox control to maximise gains in biodiversity and to reduce the magnitude of increases in rabbit populations.

4 Monitoring success

Monitoring is an essential component of a predator control program. It not only allows evaluation of control techniques, but also enables ongoing improvements to management. Monitoring can be divided into two categories: operational monitoring and performance monitoring. Operational monitoring estimates the proportional change in the target pest animal population as a result of the control activities (i.e. the efficiency of the control program) (Reddiex and Forsyth 2006). Performance monitoring assesses whether or not the objectives of the program have been achieved as a result of the control activities (e.g. protection or enhancement of Ramsar biodiversity values).

In order to accurately determine whether the predator control program is meeting its objectives, the monitoring program must measure both the responses of predator populations (i.e. operational monitoring) and the responses of prey populations (i.e. performance monitoring).

4.1 Operational monitoring

Operational monitoring uses data collected throughout the operation of the program to assess the cost-effectiveness of management. There are various types of monitoring techniques for assessing fluctuations in predator populations, including measurement of bait-take, active den counts, examining sand plots, genetic sampling and spotlight counts. The relative suitability and accuracy of such techniques for estimating predator abundance has been the subject of much research. Monitoring programs within the Hattah–Kulkyne Lakes Ramsar study area should use a combination of operational monitoring techniques. Further details of these operational monitoring techniques are provided below. These sections summarise standard operating approaches as outlined by Mitchell and Balogh (2007).

4.1.1 Bait-take

The uptake of toxic baits is a widely used measure for assessing the efficiency of fox-baiting programs and can provide an estimate of the reduction in fox populations by measuring the decline in bait-take over time. It is especially useful for assessing the initial reduction in the fox population following the introduction in lethal baiting; it is assumed that the reduction in bait-take is approximately proportional to the reduction in the population. This can involve the use of free-feed baits before and immediately following the initial use of poison baits to obtain a pre- and post-poison baiting index of fox abundance.

However, there are several issues with the use of bait-take for monitoring population changes. Firstly, foxes sometimes cache baits, i.e. one fox may remove more than one bait. Secondly, sublethal dosing, in which the toxicant degrades and does not kill an individual, may lead to behavioural changes, such as bait aversion. Bait aversion in some foxes means that bait-take indices may underestimate the density of foxes. Lastly, bait-take by non-target species, where this cannot be distinguished, may inflate estimates of fox abundance.

For these reasons, bait-take is not considered a suitable operational monitoring technique in isolation. It is included as a matter of course in all baiting programs, as this is recorded when baits are checked and replaced; however, other operational monitoring techniques must be undertaken in tandem in order to have sufficient confidence in the outcomes of baiting programs.

4.1.2 Spotlight counts

Spotlight counts, whereby foxes are counted from slow-moving vehicles, along fixed transects with the aid of spotlights, are a common method of monitoring fox abundance. Multiple counts, over time, can provide a reliable population index that can help determine the long-term population trend, although the statistical trend may still be biased as a consequence of seasonal variability in foxes not related to the impact of the control operation or observer differences (McLeod et al. 2007). It has been suggested that between five and nine repeat counts per monitoring period, i.e., the period when undertaking the survey may be required in order to obtain a reliable population estimate, due to the cryptic behaviour and low detectability of foxes (McLeod et al. 2007). Advantages of this method are that it is relatively quick and easy, and that large areas and a range of habitats can be covered.

Disadvantages of spotlight counts include the following:

- Propensity for high variability as a result of low detectability, changes in fox behaviour due to weather, season or prey availability, and the use of roads producing uneven sampling;
- A tendency to underestimate abundance due to low detectability;
- Detectability is influenced by fox behaviour, population age structure and abundance;
- Long-term monitoring is required before trends can be reliably detected; and
- The sensitivity to population change is relatively low (i.e. only large fluctuations are detected).

It is important that spotlight surveys are standardised as far as possible, both spatially (between sites) and temporally (between nights).

Distance sampling

Distance sampling provides density estimates from spotlight counts that correct for visibility biases by measuring the distance and angle of the animal from the observer. This sampling method has been shown to produce results consistent with other types of counts, provided that measurements are made accurately. This method also assumes that individuals do not move from their initial location before they are detected, and that they are not recorded twice (Mitchell and Balogh 2007). Estimating density provides additional information and the added advantage of being able to inform future control efforts, and it may assist with research to determine fox densities in the region. While this approach has its advantages, it needs a high degree of skill to accurately and consistently record distance and angle to a sighted animal.

4.1.3 Sand plots

Observation of footprints (tracks) left on raked sand pads is commonly used for monitoring purposes in two ways: to indicate the presence of an animal in a particular area, or to provide an index of abundance, based on the number of tracks counted per unit distance. One of the main constraints of this technique is that it is more likely to monitor fox activity, which may vary seasonally, and which may not be related to abundance (Robley et al. 2008). As such, it can more accurately be considered to be an activity index. It is also time consuming, labour intensive, and affected by weather, and requires a high level of skill to identify tracks, particularly to differentiate between fox and dog tracks (Robley et al. 2008). Furthermore, a very high investment in terms of the number of plots (and hence time and resources) is likely to be required to implement sand plot monitoring in order to reliably detect changes in fox activity (Robley et al. 2008). Sand plots are not recommended for assessing changes in the fox population for this program.

4.1.4 Occupancy estimation

An alternative to measuring changes in a populations size is to measure changes in the proportion of sites in an area that are occupied by the species in question. The simplest approach is to derive a naïve estimate, i.e. the number of sites where the species has been detected at least once divided by the total number of sites in the study area. This assumes that if a species is present on a site, then it will be detected, i.e. the probability of detection (p) is one. This method will likely result in a negatively biased estimate of site occupancy, as it is possible that sites that are considered unoccupied could in fact have the species present but go undetected. MacKenzie and Kendall (2002) proposed that by repeated surveying of sites, the probability of detecting a species that is present can be estimated, which then enables unbiased estimation of occupancy.

Remote cameras are an efficient means of collecting presence data over long periods of time (e.g. weeks) with minimal input of labour and minimal stress to the animals being surveyed. For remote camera data, each day of a camera's deployment at a survey site can be treated as a repeated survey, during which the target species was or was not detected. The resulting sequence of detections/non-detections at each site is referred to as the 'detection history'. The set of detection histories collected during a remote camera survey can then be analysed using a statistical modelling framework developed by MacKenzie et al. (2005) to infer the probability of detection associated with each survey (i.e. the likelihood that the target species will be detected by remote cameras at occupied sites). The probability of detecting the target species is then incorporated into the final occupancy estimate to account for sites where the target species may have been present but was not detected during the survey.

Camera trapping was found to be the most efficient method for detecting foxes compared with hair-traps (DNA identification), spotlighting and sand plots (Vine et al. 2009) and Robley et al. (2010, 2012) evaluated camera-sampling designs for feral cats and foxes and found this method provided robust estimates of occupancy rates. It is recommended that this monitoring approach be adopted to assess the difference between the pre- and post-poison baiting fox population.

4.1.5 Genetic sampling

Genetic sampling can provide the best and most comprehensive population-level data, both for foxes and for other introduced species. Berry et al. (2012) recently evaluated the long-term effects of 1080 poison baiting on the abundance and extent of movement of foxes using non-invasive DNA sampling of fox hairs in semi-arid Western Australia. The fox population was subject to two episodes of aerially delivered 1080 poison baits within 12 months. Individual foxes were identified by genotyping eight microsatellite DNA markers and a gender-specific marker. Berry et al.(2012) found that baiting significantly reduced the density of foxes, and that the low density was sustained for more than 6 months. A detailed cost-benefit analysis comparing this method and the one above would be useful in deciding which to implement. Genetic sampling can provide information on actual abundance and density as well as relatedness of individuals within the population. If genetic sampling is more cost-effective than occupancy estimation procedures, it is recommended that this approach be used to quantify the changes in the Hattah–Kulkyne fox population.

4.2 Performance monitoring

To directly assess the benefits of predator control for native prey species, a monitoring program that measures the impact of predation (kill rates) on prey species over time (survival rates) is desirable. As this is generally costly in terms of resources and time, and often impractical (Thompson and Fleming 1994), fox abundance is usually used as an approximate indicator, where fox abundance is assumed to be proportional to the impact (Saunders and McLeod 2007). However, this assumes that the predator population size is directly related to the impact of predation and this is unlikely to be the case in most situations. Therefore, it is desirable to monitor the responses of target prey populations to predator control. A program that monitors both predator and prey will be far more valuable than one that monitors pest abundance alone. Monitoring should ideally be undertaken prior to, as well as during, control activities. This allows regular assessment of the program outcomes, measured against pre-control benchmarks. If pre-poison-baiting assessment is not possible, then a comparative approach can be used to assess the benefits of fox control. This approach requires monitoring of areas that receive no fox control treatment as well as of treatment areas; all other things being equal, a positive response in native prey species indicates that fox control has had a positive impact in the treatment areas.

In the section that follows, two native animal groups are identified that are present in the Hattah–Kulkyne Lakes Ramsar study area that are at risk from predation, and a brief outline of possible monitoring approaches is provided. Some or all of these could be monitored to assess prey responses, and a more detailed monitoring program will be commissioned by the MCMA once species have been selected for monitoring.

4.2.1 Ground-nesting water and shore birds

Of particular concern for the project are waterbirds, e.g. the endangered Freckled Duck and Blue-billed Duck. Non-native predators pose a significant threat to many bird populations worldwide and are currently ranked the third most significant threat to birds by the International Union for the Conservation of Nature (BirdLife International 2008). Controlling non-native predators has, in some cases, led to dramatic increases in native species numbers (e.g. Donlan et al. 2007; Rayner et al. 2007). Suppression by non-native predators of bird recovery following the more natural flooding to the Hattah–Kulkyne Lakes is possible. In a review of the demographic response of birds resulting from predator-removal programs, Lavers et al. (2010) found that nesting location (surface versus non-surface), body mass and egg mass best predict increases in bird population. However, collection of nest and /or chick survival and adult survival rates is difficult and labour intensive, resulting in a potentially high risk and expensive monitoring program. It would be possible to experimentally determine the impact of predation by foxes and feral cats on the nest success of ground-nesting waterbirds within the 600-ha littoral zone of the Hattah–Kulkyne Lakes.

Consideration needs to be given to several issues related to the use of artificial nests. Nest predation risk can differ between artificial and natural nests because they might be preyed upon by different species (Thompson and Burhans 2004). Differences in construction of the artificial nests and eggs must be consistent and resemble the natural nests and eggs as closely as possible (Haskell 1995; Rangen et al. 2000). Nest density needs to be not higher than natural density, or the surplus of artificial nests might lead to higher predation rates (Martin 1988). Investigator activity might affect the predation intensity on artificial nests (Major 1990, Rotella et al. 2000).

4.2.2 Reptiles

The Hattah–Kulkyne Lakes system supports a diverse range of reptiles, including the endangered Carpet Python. Numerous diet studies have shown that foxes prey upon a wide range of reptiles in the semi-arid and arid parts of Australia (Catling 1988). In a recent review of fox diet across Victoria, (N. Davis pers. comm.) found that reptiles were the commonest item in the fox’s diet in the Mallee region. However, there have been few studies investigating the impact of predator removal on the occurrence or abundance of reptiles. Olsson et al. (2005), in a replicated baited versus non-baited study in semi-arid NSW, found that fox-baited areas showed more than five times higher density of Sand Goannas (*Varanus gouldii*), a species that strongly overlaps the fox in food niche breadth and is itself a direct target of fox predation. They also found that exclusion of non-native predators from a natural habitat led to significant increases in the density of small lizards, suggesting that predation can drive lizard population dynamics in this ecosystem.

Increases in the proportion of an area occupied by a range of small or medium-sized reptiles likely to be at risk from fox predation could be used as a measure of the success of the fox control program. Monitoring approaches for assessing reptiles have been developed using digital cameras (Welbourne 2013) and could be applied to the response of reptiles in the Hattah–Kulkyne Lakes project. A small pilot study would be required prior to commencing the monitoring, to determine the sampling effort (number of sites) required to detect changes of different magnitudes (e.g. a doubling in the proportion of area occupied) with varying degrees of certainty. Monitoring within the greater inundation area of the Hattah–Kulkyne Lakes area would occur at two locations within the baited area and at one location outside (not baited). The unbaited area location would act as a control for comparison with the treated (baited) areas.

The nests of freshwater turtles are known to suffer from predation by foxes (Spencer and Thompson 2002), with up to 95% of eggs being removed by foxes in some cases (Thompson 1983). The Eastern Long-necked Turtle (*Chelodina longicollis*) is known to periodically occur in the Hattah–Kulkyne Lakes system and is likely to benefit from longer periods of water being retained in Lake Hattah and Lake Mournpall which retain water for the longest time of all the lakes. The Eastern Long-necked Turtle is commonly found in shallow, ephemeral wetlands, often remote from permanent rivers. It is capable of long-distance overland migration, has a low rate of desiccation and the ability to aestivate on land, enabling it to exploit productive ephemeral habitats, particularly in the absence of competition from fish and other turtle species. Such habitats provide optimal conditions for growth and reproduction. In drier periods, however, turtles may need to seek refuge in permanent water. This species lays between 6 and 23 hard-shelled eggs from spring to late summer which coincides with the beginning of the outflow phase of the Hattah Lakes watering regime. Although currently considered common and not under major threat, the most widespread conservation concern is high nest predation from foxes (Kennett et al. 2009).

Pre- and post-poison-baiting assessment of the rate at which foxes raid nests and consume artificial turtle eggs could be used to measure the performance of the predator strategy in a similar approach described in section 4.2.1 for nesting water and shore birds. Turtle nests are well concealed and identifying natural nests is not practical. An alternative approach would be to undertake a comparative assessment of the rate at which turtle nests are being attacked by foxes in areas with and without fox control. All other factors being equal or accounted for, the difference can be attributed to the predator control strategy.

5 Recommended predator control and monitoring program

5.1 Initial knockdown of local fox population

In order to demonstrate the impact of the initial poisoning phase a Before–After–Impact monitoring design is recommended. This approach involves the collection of information on the status of the fox population before implementing the initial control strategy to establish a baseline index of fox abundance, undertaking a period of poison baiting, and then assessing the status of the fox population after the initial knockdown. Sustained control (section 5.2) then commences.

5.1.1 Outcome

The outcome sought is an operational strategy that records an immediate reduction in the fox population and that is integrated into the performance monitoring program (section 4.2).

5.1.2 Recommended approach

- Deploy 75 camera traps (Reconyx PC500 or PC900) over a 30-day period to establish a pre-poison assessment of the proportion of the area occupied. Details of camera set-up and programming are provided in Appendix 1, and an example camera set-up data sheet is provided in Appendix 2. Figure 2 shows the proposed location of camera traps in the study area.

- Undertake 3 weeks of poison baiting as the initial knockdown period (with daily replacement of baits). Bait type and placement is described in section 5.2.

- Deploy 75 camera traps following the 3 week poisoning operation for 30-days. Use the same camera locations as for the pre-baiting period (Figure 2).

- Analysis and reporting of results (including information on all species detected by camera traps) within 3 months to be presented to MCMA and Parks Victoria and used to assess the effectiveness of the initial knockdown of the local fox populations.

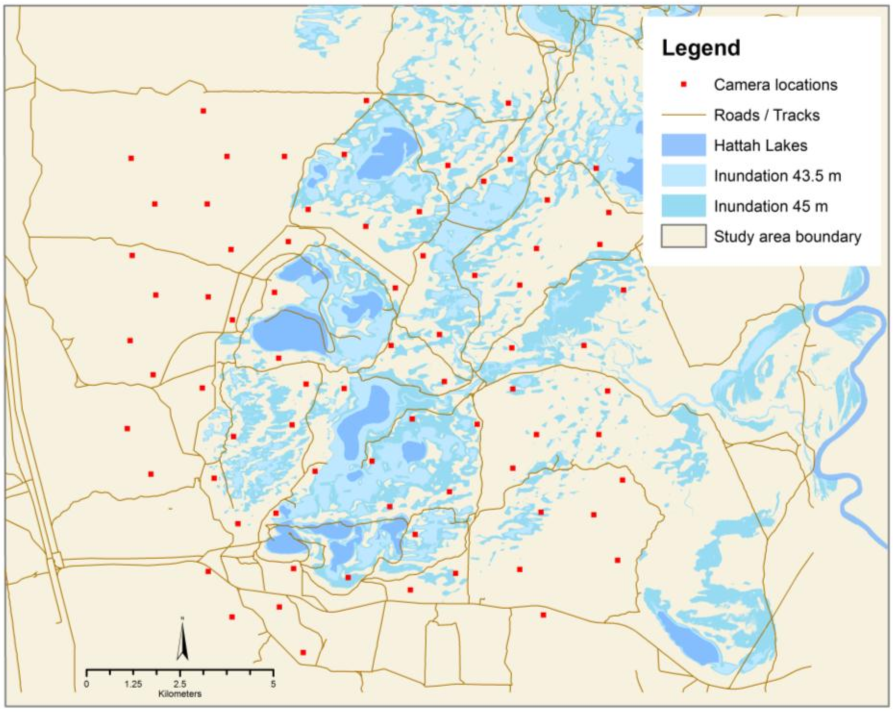

Figure 2. Proposed layout of camera-monitoring sites for assessing the long-term trends in the local fox population based on inundation levels of 43.5 m AHD. Inundation levels of 43.5 m AHD to be achieved in 3-in-10 years.

5.2 Sustained fox control program

5.2.1 Outcome

The outcome sought is a baiting strategy that demonstrably reduces the fox population within an operationally efficient framework over the longer-term.

5.2.2 Recommended approach

The following is the recommended approach for the sustained control of foxes at the Hattah–Kulkyne Lakes Ramsar protection site:

- Bait type should be managed to suit local conditions. During drier months the use of manufactured baits is recommended. During wetter periods either dried or fresh deep-fried liver baits should be used.
- Baits containing 1080 are to be used as the risk to goanna species from PAPP is high.
- Baits to be buried to a depth of 8-12 cm as per label conditions.
- Bait stations are to be placed at intervals to achieve the highest practical bait density per km^2, i.e. a spacing of approximately one bait station every 500 m along roads and tracks. This is a trade-off between cost and inducing caching behaviour in foxes (baits to close together). Also, as baits are required to be buried placing baits by hand off tracks would significantly increase the cost. The proposed locations of roads and tracks for bait stations are illustrated in Figure 3.
- Bait stations are to be located on all accessible tracks. Tracks with bait stations that are inundated as a result of flooding must be identified when unavailable for baiting. When a track or road becomes inaccessible due to inundation, consideration should be given to the construction of alternative bait stations to maintain as high a density of baits in the landscape as practical.
- Bait replacement and recording of bait-take should occur every 14 days following the initial knockdown period (see ‘Operational monitoring program’ below).

Additional recommendations for fox control

- Supplementary fox control using leg-hold traps could be used to target specific stages in the fox’s life cycle each year, i.e. breeding (July, or prior to extensive inundation) and dispersal (January). Trapping should be focused around the 600-ha littoral zone of the Hattah–Kulkyne Lakes.
- Incidental shooting may occur as part of Parks Victoria’s rabbit control operations. This may have the benefit of removing bait-shy foxes from the population.
- Investigate options for undertaking seasonal aerial baiting operations, including a desktop review of potential non-target impacts, and the development of a draft operational plan to undertake aerial baiting.
- Develop a strategic plan for the use of multi-dose M44 ejectors when they become available, including cost-benefit analysis of using this tool versus aerial baiting and traditional ground based baiting.

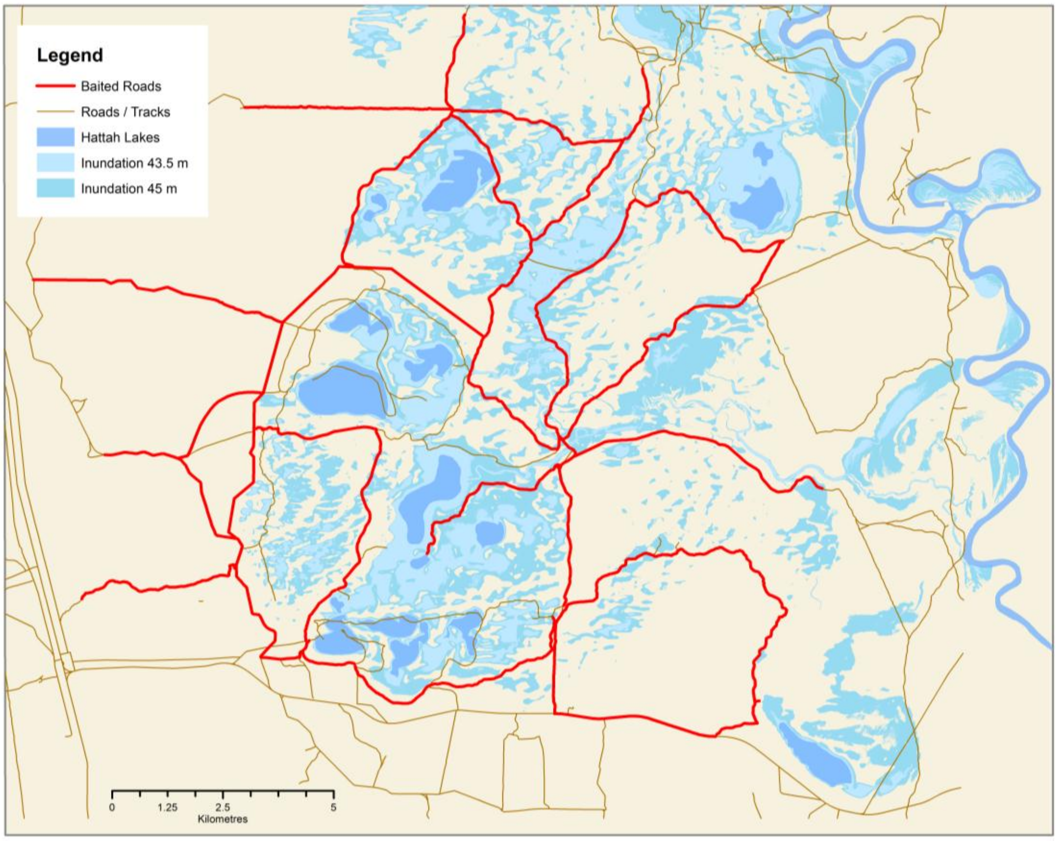

Figure 3. Tracks and roads proposed to be baited as part of the Hattah–Kulkyne Lakes protection project. Inundation levels of 43.5 m and 45 m (AHD) to be achieved in 3-in-10 and 1-in-8 years, respectively.

Longer-term trends in the local fox population also need to be monitored to ensure fox populations remain at lowered levels. It is recommended that two independent indexes of the fox population be used;

- Proportion of area occupied - Repeat the camera trap monitoring annually at the same locations and for the same length of time in October each year as described above.
- Index of fox abundance - Record the proportion of baits taken each fortnight.

Analysis and reporting of results from the annual predator and native species monitoring to be used to assess the ongoing effectiveness of the baiting operation.

5.3 Feral cats

When feral cats are nutritionally stressed, there is an increased likelihood of them taking a bait (Algar et al. 2007; Campbell et al. 2011). Currently, there is little information as to when feral cats are food stressed in any environment within Victoria. Determining when feral cats are most susceptible to baiting will involve assessing feral cat body condition; however, it is most likely in late autumn (when prey abundance is most likely to be at its lowest). In order to build a business case for the use of control tools that are not currently registered in Victoria for feral cat control (e.g. Eradicate (1080), Curiosity (PAPP) and leg-hold traps), and to provide background information to support legislative changes in relation to the status of free-living cats, a two-stage approach is recommended.

First, in year one, demonstrate that feral cats are consuming threatened species, and determine if and when they are nutritionally stressed by assessing the gut contents collected in each season. This will require a scientific research permit and exemption under the CALP Act to capture and destroy feral cats to collect gut samples and body condition data. Second, in year two, undertake a series of non-toxic, surface-laid bait-uptake trials.

5.4 Supplementary data

It is recommended that fox scats be collected when baits are checked and replaced for three years (the current life of the strategy). The location of each scat (GPS co-ordinates) and the date of collection need to be recorded for each scat. Scats are to be stored in labelled paper bags and scats dried in a warm dry place. Once dried, scats can be stored in a cool dry place until sufficient samples (~50 scats) have been collected. Data that can be extracted includes seasonal and long-term changes in fox diet. Foxes are opportunistic, generalist predators, and changes in their diet reflect the underlying availability of native prey. This information can be used to refine control operations around specific locations or times of year to better protect the ecological character of the Hattah–Kulkyne Lakes system.

5.5 Data storage

We recommend the development of a project database to store all relevant information and data to facilitate timely analysis and reporting. All species records should be entered into the Victoria Biodiversity Atlas.

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Appendix 1. Reconyx (camera traps) set-up guide

- Program cameras
  - Motion sensor ‘on’.
  - 3 shots per trigger.
  - 1-s interval time.
  - 15-s quiet period time.
  - Set sensitivity on ‘high’.
- Set-up
  - Go to grid reference.
  - Set camera facing in a southerly direction.
  - Attach camera to a tree with a diameter at breast height (BDH) ≥ 20 cm Do not attach onto spindly trees that may move in the breeze.
  - Set camera so top of camera is just below knee height and 3 m from bait.
  - If required, wedge sticks behind to get perpendicular to ground.
  - Place fox lure (commercially available) inside bait holder and secure to ground with steel peg. Place bait holder 2-3 m in front of camera.
  - Remove a strip of vegetation and logs 1 m wide between the camera and to 1 metre behind the bait holder to the ground. Background vegetation more than 1 metre behind the bait holder is useful in reflecting IR light.
- Ensure set-up shot is taken be triggering camera **and viewed**.
  - Is the bait centred correctly?
  - Is the field of view level?
  - Is there vegetation in the way?
  - Are there logs etc. in the way?
- Take picture of data sheet using the camera with site number, memory card number and date **clearly in view**.
- Ensure data sheet is complete.
- **Ensure you switch camera on before leaving site!**

Camera Pick-up

- Ensure a pick-up photo is recorded to test if camera is still operational and to record collection data (used later in data analysis).
- Turn off camera, remove card and record card number, camera number and location and site name / number on small sealable envelope and place SD card inside.
- Pack camera in bubble wrap to protect lens etc from scratches/damage.

Appendix 2. Camera site data sheet

Project name: HK Lakes Predator Survey

Site ID: ....

Installed by: .... **Date set:** ....

Camera No: ....

Memory card number: .... **Camera Type:** ....

GPS coordinates (GDA): ....

Bait type……………………………………………………………………….

TAKE A PHOTO OF THIS SHEET

Date retrieved: ....

Was the camera operating on retrieval? ....

Notes:...

....

....

....

....

....

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....

Appendix 3. Data for each bait station

Data collection

Standardised data collection and systemised storage will enable the analysis required to formally assess the outcomes of the fox control program in order to enhance future management programs.

Data that should be recorded for each bait station include:

Bait station data

- its location (clearly mapped with a unique identifier, GPS location)
- type of bait
- date bait was laid
- dates on which bait stations were checked
- dates on which baits were replaced
- fate of bait (taken, exposed, or not taken)
- an indication of what took the bait (including unknown)
- presence of fox signs (tracks/scats) on bait stations where baits were not taken
- signs of any other species on bait station
- the time taken to operate the baiting program and the number of people involved
- date program finished.

Fox scat data

- Check for fox scats at every bait station every time.
- Collect scat into a small brown paper bag/envelope.
- Record the date the scat was collected.
- Record the bait station it was collected from.
- Store in warm, dry location.
- If scat moist on collection, dry in warm (<40°C) oven overnight.

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