A PLAN TO PROTECT A DECLINING POPULATION OF ROSENBERG'S GOANNA IN CANBERRA NATURE PARK

This document is a draft plan with comprehensive explanations for its proposed actions.

written by the

National Parks Association (ACT)

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Cover photo: Goanna Rambo in Mt Ainslie Nature Reserve. The white ‘down arrow’ mark in front of his left eye makes him uniquely identifiable.

ACKNOWLEDGMENTS

Many people contributed to this document, among whom I wish to particularly thank John Brickhill, Isobel Crawford, Sandy Clugston, Ani Gruber and Rosemary Hollow for their comments on early drafts. Responsibility for remaining errors remains entirely with me, Don Fletcher.

This plan is a by-product of the NPA Goanna Project (https://www.npaact.org.au/goanna-project) which is about conservation-related research on Rosenberg’s Goanna. Details of the project, including more acknowledgments, are available elsewhere, including in the annual Project Plan and occasional issues of ‘Goanna News’ also available at the same location.

For financially supporting the project and helping in many other ways I thank the National Parks Association (ACT), and for essential Environment Grant funding I thank successive ACT Ministers for the Environment, and the Environment Planning and Sustainable Development Directorate. I am immensely grateful to our many individual public donors who also provide financial support, some of it anonymously. All funds go to equipment; there are no payments to individuals.

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SUMMARY

Two species of large goannas were still present in the Canberra hills until the earliest days of Canberra Nature Park (CNP). In the 1970s the Lace Monitor was the species most frequently seen by residents (Higgins 2016) but no populations of that species remain in the ACT, only vagrant individuals reported every few years, often outside the city area. Rosenberg's Goanna was also present in multiple hill reserves but now the only peri-urban population of either species is the small one in Mt Ainslie Nature Reserve and the contiguous Mt Majura Nature Reserve (Ainslie-Majura). This population will also disappear unless something is done to change the factors leading to the decline of goannas in CNP.

For reasons explained in the plan, it seems very likely that baiting of foxes and restriction of dogs to marginal areas of reserves could reverse the trajectory of goannas in Canberra Nature Park.

This plan proposes a Goanna Zone in Ainslie-Majura, from which dogs would be excluded, except along certain roads, where a 40m wide strip would be left free of fox baits or ejectors to enable retention of dog walking along those roads. Also a wide strip on the eastern and southern margins of the reserve would be free of fox control devices to enable dog walking. The goanna zone would be treated with buried 1080 baits, and canid pest ejectors in parts of the goanna zone closer to houses. These are both potentially lethal for any domestic dogs which take them.

The plan strongly recommends community consultation and education. It also strongly recommends engagement with neighbouring rural landholders.

There is increasing recognition of the need for ecological restoration and recovery action, and there is increasing action too in this area, including in Australia. Urban areas are a particular focus for such activity. The possibility of protecting the Rosenberg's Goanna population at Ainslie Majura is a fine opportunity for the ACT to show it too makes worthwhile achievements in this space.

A summary of the actions proposed is to:

1. Decide what consultation and public education is appropriate, and commence it, preferably involving all stakeholder groups (rural neighbours, dog walkers, etc) and using a variety of communication methods;
2. Commence an ongoing trickle of public communication about goannas;
3. Meanwhile complete necessary preparation, including:
    a. Finalise an Ainslie-Majura Goanna Conservation Plan (involving Fox control), to government satisfaction;
    b. Obtain ministerial approval for the plan;
    c. Identify funds;
    d. Liaise again with rural landholders in the AMFMA about Fox control.
4. Implement dog restrictions, including the no-dogs Goanna Zone and whatever other restrictions are decided;
5. Deploy signage;
6. Conduct one or more non-toxic baiting/ejector trials to evaluate the risk to recalcitrant pet dogs;
7. Commence Fox control;
8. Provide occasional public updates on progress and to maintain social licence;
9. Monitor effectiveness with occasional goanna surveys; and
10. Review progress biennially for at least the first 6 years.

It is recognised that opposition to this plan is likely from

- People who want to retain their traditional dog walking activity;
- The campaign against the use of 1080; and
- The campaign against the killing of sentient animals such as foxes.

Some special precautions are advocated, additional to those normally applying to fox baiting, namely:

- Conduct an initial baiting trial using dye instead of toxin, as a final warning to any dog owners still allowing their pet to roam off-leash in the Goanna Zone;
- Use extra large fox baits at this site, the same as the normal PCS dingo baits (~250 g of semi-dried kangaroo) but containing the amount of toxin used for foxes (3 mg 1080), in order to reduce the potential for non-target animals to consume one bait, or multiple baits; and
- In the first two years, place a camera to monitor every bait and ejector in case of claims or uncertainty about who/what may have taken the bait.

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CONTENTS

INTRODUCTION

To save an existing natural population of a keystone species is immensely better than to reintroduce one later, both from a conservation perspective and a cost perspective. If action is taken soon enough to save the remaining population of Rosenberg's Goannas at Ainslie-Majura, neither reintroduction nor rewilding will be needed later for this species in these two reserves, and the conservation benefits from this small predator will be maintained continuously.

We are living in the biodiversity crisis (Ripple *et al*. 2017). The most extensive biodiversity losses are occurring at the margins of our cities (IPBES 2019). That is because cities are expanding rapidly and because cities occupy highly productive land which tend to be biodiverse areas (Ives *et al*. 2016).

Consequently, a revolution is commencing, in both thought and action, on the restoration and rewilding of urban natural areas. For example, a number of eminent Sydney-based authors (Finnerty *et al*. 2025) have this year published a major paper on the topic, including this statement:

> *Despite the challenges faced within an urban context, the potential benefits of urban rewilding are substantial. When undertaking species reintroductions close to people, these benefits may extend beyond ecological restoration and species recovery, fostering community engagement, enhancing cultural connections, and providing measurable health and well-being advantages to city dwellers.*

The authors give international examples of numerous fauna reintroductions in urban areas, including four species in Sydney: Platypus, Brown Antechinus, Eastern Pygmy Possum and Bush Rat; also Quenda in Perth.

Large predators, such as dingoes, cannot be reintroduced in urban areas, so their value for ecosystem regulation must be forgone. Smaller predators, such as Goannas, are among the highest priority species for reintroduction or rewilding in urban areas due to the role they play in ecosystem regulation. Fortunately, Ainslie-Majura may need only restoration, not reintroduction, of its Rosenberg's Goanna population, if management action is effective enough, and early enough.

Accordingly, this is a plan to protect and increase the existing natural population of Rosenberg's Goanna, (also called the Heath Goanna, *Varanus rosenbergi*) which is resident in the Mt Ainslie Nature Reserve and Mt Majura Nature Reserve. These reserves are contiguous. Their combined area is referred to here as 'Ainslie-Majura Nature Reserve' or simply 'Ainslie-Majura'.

Ainslie-Majura is part of Canberra Nature Park (CNP), which consists of 39 urban and peri-urban Nature Reserves. This plan, if enacted, would directly contribute to the achievement of the primary goal of CNP, which is protection of native plants, animals and ecosystems (ACT Government 2021, p 14).

This plan, prepared by the National Parks Association of the ACT Inc (NPAACT), is intended as a potential resource which the City and Environment Directorate of the ACT Government (C&E) may choose to draw from in preparing its own plan for the actions proposed here. Responsibility for preparation of the government plan, and for its implementation, if it goes ahead, is likely to rest mainly with the ACT Parks and Conservation Service (PCS) within C&E, and with the relevant ACT Minister, Tara Cheyne MLA.

AIMS OF THE PROJECT TO PROTECT GOANNAS

The aims for this plan are to:

1 Increase community awareness for Rosenberg's Goannas in the Canberra region and develop and maintain community support for goanna protection;

2 Restore, then maintain, the viability of the population of Rosenberg's Goannas in Ainslie Majura Nature Reserve, by reducing the population limiting effect of Foxes and dogs;

3 Retain dog walking opportunities in the Ainslie-Majura vicinity to maintain the social benefits and human health benefits that are associated with dog ownership and nature-based exercise.

4 Use the experience gained in this site to support goanna conservation elsewhere, including possible reintroduction and conservation of the Lace Monitor (*Varanus varius*) which disappeared from CNP in recent decades and is now rare in the ACT.

BACKGROUND INFORMATION

Conservation status of ACT goanna species

National Status

Rosenberg's Goanna occurs in Australia as two well-separated meta-populations (populations comprising multiple component populations) (Figure 1). The main meta-population is found from southern Western Australia across the southern coastline through South Australia to the western edge of Victoria. Its most abundant population is on Kangaroo Island, where there are no Foxes.

A well-separated eastern meta-population is scattered from the Hunter Valley southward to the Victorian border and westward to the ACT region. Its most abundant population is in Naas Valley, within Namadgi National Park, ACT, another site with a low density of Foxes.

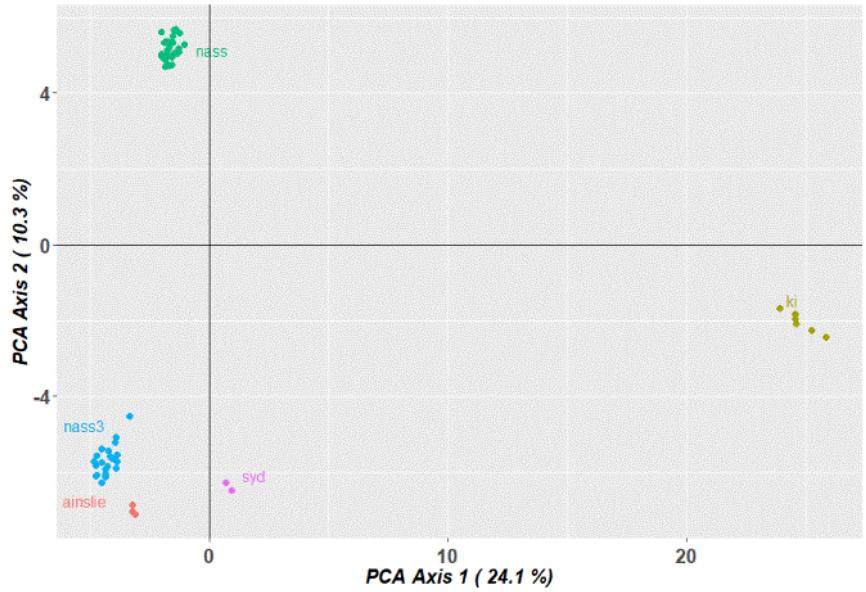
Figure 1: National distribution of Rosenberg's Goanna; from Atlas of Living Australia

Rosenberg's Goanna is listed as 'Vulnerable' by the South Australian, Victorian and NSW governments. Its status in the ACT has not been considered by the relevant committee. The species is not listed nationally because the populations in south western Australia and on Kangaroo Island are secure. The assumption is that these western populations are the same taxon as the eastern populations, based on a genetics investigation carried out in the 1990s and published eighteen years ago (Smith *et al*. 2007).

The result of that investigation, that Rosenberg's Goanna comprised only one taxon, surprised those who conducted it, because local animals are larger, dig more extensive burrows, behave differently and are coloured differently. However that investigation was limited to using mitochondrial DNA (only ~1% of the genome), mostly from museum specimens, and was based on the DNA technology of the time.

Research recently commenced, uses nuclear DNA from fresh tissue, and modern methods which evaluate hundreds of thousands times more genomic information. Preliminary results suggest the possibility that the eastern and western meta-populations may be two taxonomic entities (Figure 2). If that was found to be the case, the populations of the eastern mainland, which have declined substantially, are likely to attract greater concern than any of the current threat classifications indicate. Figure 2 also indicates the likelihood of a second kind of Rosenberg's Goanna in the ACT (green dots). This also warrants further investigation.

Figure 2: Preliminary Principal Components Analysis of DNA from Rosenberg's Goannas. In this preliminary result, the main western occurrence is represented by only the six brown dots to the right. Naas Valley samples are represented by blue dots from animals in the lower valley, which the analysis reveals to be similar to samples from Mt Ainslie and northern Sydney. The green dots represent animals from the upper Nass Valley, i.e. more than 900 m above sea level.



ACT Status

Until the 1970s, two species of goanna were being reported by residents living near bushland areas around Canberra. There are numerous records of this, including photographs published in *The Canberra Times* (Higgins 2016). Some photos show the narrow tail banding of Rosenberg's Goanna, but the majority of photos feature the broad bands and climbing habit of the Tree Goanna, aka Lace

Monitor, *Varanus varius*. It was not recognised initially that more than one goanna species was involved, so records before 1990 were all labelled as Lace Monitor.

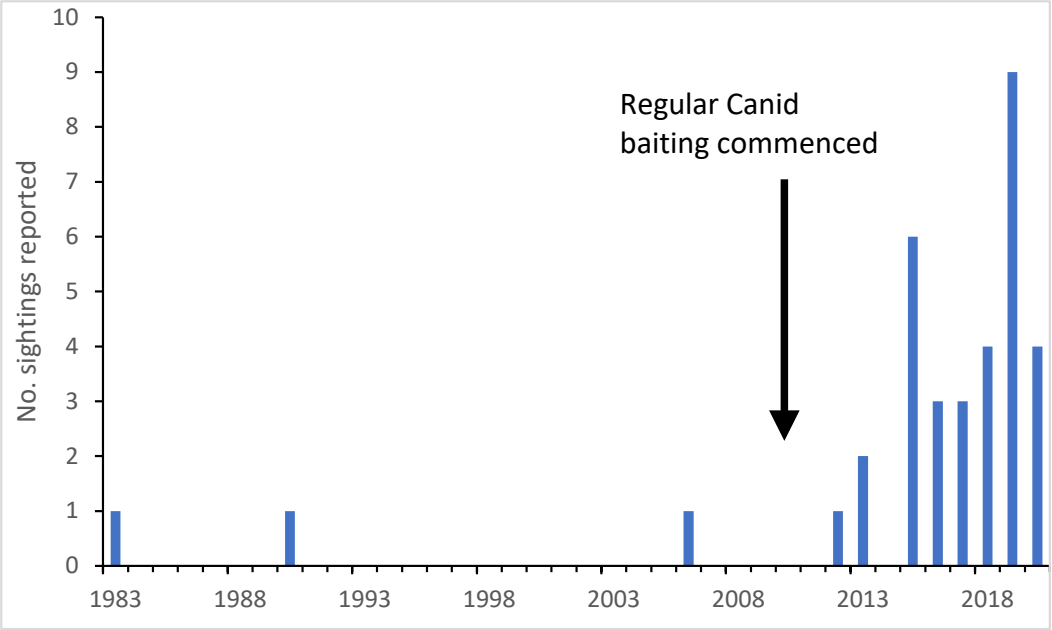
The larger, and initially more abundant, Lace Monitor, is no longer present in Canberra Nature Park, and it is now rare in the ACT.

The ground dwelling Rosenberg's Goanna has also disappeared from most of Canberra Nature Park but is still present in Ainslie-Majura Nature Reserve and Rob Roy Nature Reserve. It is reasonable to infer from the history of the populations of the two ACT goanna species, that the remaining CNP populations will follow the ones that disappeared earlier. In other words, the Ainslie-Majura population should be expected to disappear too, unless something changes which prevents the extinction process from continuing.

The threat is not limited to Ainslie Majura. The apparent stronghold of Rosenberg's Goanna in the Naas Valley is not the bastion against extinction which it may appear to be. For reasons given later, the explanation for the high abundance of Rosenberg's Goanna in the Naas Valley is almost certain to be that abundance of the introduced European Red Fox (*Vulpes vulpes*, hereafter simply 'Fox') has been kept low in that valley for more than a decade. The knowledge of low Fox abundance is based on evidence from baited camera traps and the near-absence of Fox sign prior to the 2020 bushfire. Low abundance of Foxes is due to a permanent dingo-baiting program that began in about 2010.

During the period while the Naas Valley goannas were increasing (Figure 3), Rosenberg's Goanna populations declined in nature reserves along the Murrumbidgee River Corridor where there is no Fox control. From reported low density in the early 1990s, they now are either rarely seen (e.g. Stony Creek Nature Reserve – two reported sightings in thirty years - Nature Mapper) or have become completely undetectable (e.g. Gigerline Nature Reserve, D Roso pers comm. and Nature Mapper).

Figure 3: Number of records of goannas in Namadgi National Park, from Canberra Nature Map.



The recently increased abundance of Rosenberg's Goanna in the Naas Valley (Figure 3) depends on continued suppression of Foxes. This cannot be guaranteed. For example, baiting ceased for almost

two years after heavy rainfalls following the 2020 fire-caused erosion that cut the Naas Valley Fire Trail. Foxes and cats became more common following the bushfire and the cessation of baiting. They were increasingly recorded on goanna camera traps. Records of other known post-fire invaders also increased, i.e. two deer species and Long Nosed Bandicoots. Such events, and worse ones, can easily be repeated, or the Dingo baiting program could be changed for other reasons Thus, the Naas Valley goanna population should not be relied on as a sole basis for saying the status of Rosenberg's Goanna in the ACT is secure. For security of any species, at least five populations must be maintained long term. This has been achieved nationally but not in the ACT region alone.

Status in Ainslie-Majura Nature Reserve

With only a veritable handful of goannas remaining, it is apparent that the status of the Rosenberg's Goanna population in the Ainslie-Majura Nature Reserve is poor. Attempts to estimate the population size using Mark-Resight analysis mostly have failed due to inadequate numbers of goanna recorded in the surveys – i.e. three individuals with no resightings in 2021, zero in 2022, and three individuals with three resightings in 2022/23. However, by combining data from all surveys and all public sources, the population has been estimated to be five to ten goannas, most likely seven or eight (Fletcher, Kravis and Brickhill, in prep).

What are the threats to Rosenberg's Goanna?

For most declining species, no ecological experiments have been conducted which would enable the relative importance of potential threats to be ranked. Large goannas are a rare partial exception, in that three ecological experiments have recorded increased activity and abundance of large goannas in response to Fox control (Olsson *et al*. 2005; Sutherland *et al.* 2011; Hu *et al.* 2019). Additional threats can be inferred, as follows:

- Rosenberg's Goannas favour woodlands. Clearing of woodlands reduces goanna habitat and therefore reduces or eliminates goanna populations, as does woodland modification, particularly the removal of fallen trees and branches, e.g. by insensitive bush fire fuel management;
- Habitat fragmentation and roading. Goannas travelling between remaining habitat islands must negotiate hostile environments, where they are vulnerable to 'predators' of many kinds, especially motor vehicles, dogs, and those humans who still regard goannas as a threat or a pest. Therefore the size of habitat islands is likely to be important, to reduce the contact rate between goannas and hostile factors such as cars on high speed roads;
- Unfriendly Road Design for Wildlife. GPS tracking shows that mature goannas at Ainslie Majura are successfully crossing the Mt Ainslie summit road unharmed, so there is potential for goannas to learn to use structures such as culvert pipes (a kind of pipe installed under roads to channel surface water beneath the roadway), or to cross at less risky times of day. However wildlife-friendly culvert pipes (ones lacking vertical drop structures, and preferably supported by fences that funnel wildlife toward the pipes and away from the road surface) are less common than necessary to enable safe wildlife movement.
- Presence of Lace Monitors appears to restrict the distribution of Rosenberg's Goannas at local scale and Lace Monitors excavate and consume the eggs of the smaller species when they can. Competition for food is a possibility also.
- Presence of Dingoes has an unknown effect, which is likely to be both negative (through direct predation of goannas) and positive (through suppression of Foxes) but the sustained co-existence of dingoes and goannas over thousands of years suggests that the nett effect of dingoes is often positive, and that dingoes do not drive large goanna species to extinction;

- Disturbance by domestic dogs, on lead or off lead, probably acts in a similar way to Fox predation;
- Reduced genetic heterogeneity, causing reduced fitness, is a possible effect of historic population bottlenecks due to habit fragmentation and small population size but there is little evidence either way whether this is an important factor;
- Extensive loss of *Nasutitermes exitiosus* termite mounds could be a threat if it removed all mounds within a habitat island. However the Naas Valley research has shown that goannas are capable of moving large distances through continuous suitable habitat to reach breeding sites with termites, and returning to termite-free feeding areas where they may remain for most of the year; and
- Intense bushfires kill some Rosenberg's Goannas, but because this species of goanna habitually retreats to burrows, many survive. At least half the Naas Valley population survived the intense 2020 bush fire, which is much more than most other terrestrial vertebrate species. Lace Monitors are probably more vulnerable to wildfires because they habitually retreat to trees with hollow branches.

Extinction events mostly involve multiple causes, but based on local and national research, the activity of Foxes appears to be by far the greatest threat to Rosenberg's Goanna. It appears that managing that threat alone may prove sufficient to maintain or increase the current population of Rosenberg's Goanna in the Ainslie-Majura Nature Reserve.

Indigenous perspective

Across the Australian continent, goannas are highly significant animals to Indigenous communities and feature strongly in their art and in traditional diets. As soon as possible, consultation with local Indigenous communities is highly recommended to aid in further development of this proposal.

Also it is worth considering using Indigenous names. The Ngarigo and Ngunnawal word for the Tree Goanna or Lace Monitor was 'Wirria' (https://www.forkword.com/plog/?p=694). According to local aboriginal people, other local words for 'goanna' were 'Weereewa' and 'Girriwah'. 'Weereewa' is also a name for Lake George.

Side effects of changed abundance of Foxes and Rosenberg's Goanna

Multiple effects, involving multiple species, result from any ecological management intervention such as weed control, pest control, bush fire fuel reduction or grazing management. For example, reducing Fox abundance would not only increase goanna abundance. Several other species are likely to be affected noticeably. Altering the status of top predators (in this case both the Fox and Rosenberg's Goanna can be considered a top predator) is especially well known for resulting in ecosystem effects. The most powerful type of effect is a 'trophic cascade'. A trophic cascade arising from removal of predators, causes reciprocal change at successive lower trophic levels, with biomass reducing in the odd numbered trophic levels, and increasing at the others. A commonly cited example is the suppression of brown bears and wolves in the lower 48 states of the USA, causing herbivore species to increase and shrubby vegetation to reduce. See Ripple *et al*. (2001) and Newsome and Ripple (2015) for examples. A trophic cascade of that magnitude is unlikely to arise from Fox control at Ainslie Majura, especially in the context that the management of kangaroos at Ainslie Majura is still developing and its vegetation effect is likely to be in the opposite direction. Rather, trophic cascades are mentioned here as support for the idea that 'side effects' are to be expected from predator manipulation, and to indicate likely directions of change.

General principles have emerged from Australian and international research on the complex interaction of predator and prey populations. An excellent summary of Australian investigations involving Foxes, cats and Rosenberg's Goannas is provided by Johnston and Menz (undated). Its relevance to Ainslie-Majura is so great that it is copied here as Appendix 2. Some key points follow:

- Goannas have been interpreted as the nearest ecological equivalent to Foxes in Australia;
- However dietary overlap is higher between goannas and cats than goannas and Foxes;
- Both cats and Foxes are predators of goannas;
- Reduction of Fox abundance has resulted in increased goannas in multiple investigations in widely differing environments;
- In and around Innes National Park at the tip of Yorke Peninsula, SA, where the Johnson and Menz review was mainly focussed, the combined effect of reduced Foxes and increased Rosenberg's Goannas was:
    - increased abundance of Hooded Plover and Mallefowl;
    - re-appearance of Bush Stone Curlews after an absence of sightings for 40 years;
    - re-appearance of Echidnas after an absence of sightings for 20 years; and
    - 30% increase in lamb survival on a participating rural property.

Goannas can regulate prey populations, and they have been used for pest control, mainly in India but also on Pacific islands, where the Mangrove Monitor (*Varanus indicus* – a slightly smaller species than Rosenberg's Goanna) is known to regulate populations of *Rattus exulans* and several beetle species. In Australia, predation by the Lace Monitor (*Varanus varius*) has prevented post-fire recovery of a population of Ring Tailed Possums, a favoured prey. And finally, Rosenberg's Goannas were introduced to Reevsby Island (SA) to control snakes but the effect was not evaluated.

Ecology is still at an early stage, and research on Fox management is limited, so although Foxes are widely controlled, the following predictions of collateral effects of Fox control at Ainslie Majura, must be somewhat tentative:

Abundance may increase	
Species	**Confidence**
Brush Tailed Possum	High
Red Necked Wallaby	High
Echidna (after 5-8 years)	High
Ground nesting birds	High
Rosenberg's Goanna	High
Rabbit	Medium
Krefft's (Sugar) Glider	Medium
Blue Tongued Skink	Low
Long Necked Turtle	Low

Abundance may decrease	
Species	**Confidence**
Dogs off-lead (due to increased care by owners)	High
Fox	Med-High
Small skinks and dragons	Medium
Large species of snakes	Medium

Goannas at Ainslie-Majura

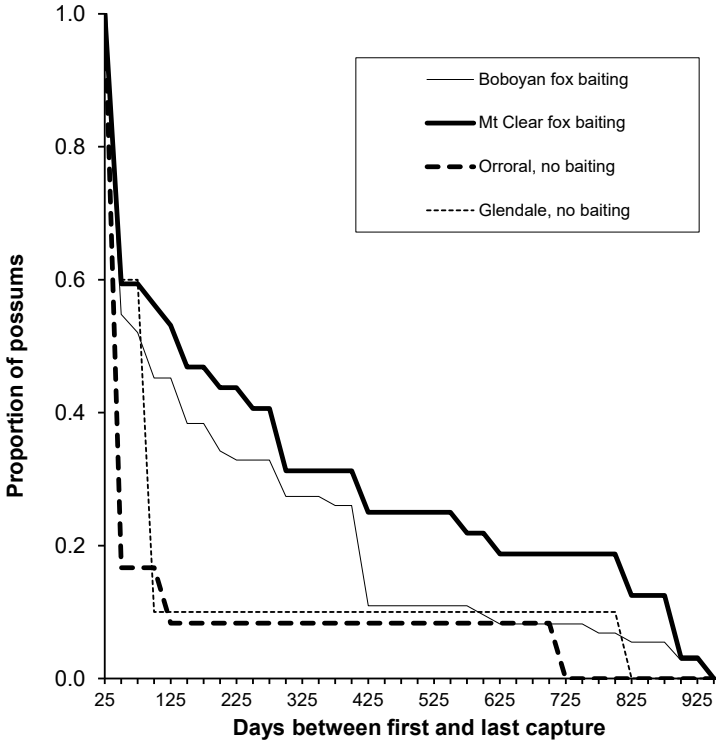
Since 2015, members of the NPAACT have collected photos of the faces of Rosenberg's Goannas in Ainslie-Majura Nature Reserve, including copies of photos taken by members of the public and ones recorded on camera traps. As a result, seven individual goannas are known (4 M, 3 F), of which four were seen to be alive during the 2022/23 season i.e., Rex, Rum, Robyn Small and Rambo; two were last seen in 2021 i.e., Rosy and Robin Large, and one was last seen in 2019 i.e., Roxy. Goannas live for decades, so it is possible that all seven are still alive.

Uncertainty whether the population could be smaller or larger than seven is largely due to blurry images of two goannas named 'Robyn Small' and 'Robin Large', which are known only from low quality photos, so it is possible that they are really the same animal. In conclusion, in 2025 the population of Rosenberg's Goannas remaining in Ainslie-Majura appears almost certain to be at least five (unless some have died since their last sighting in 2022/23) but is unlikely to be more than ten. This is a very small population in conservation terms.

Unfortunately there is still no way to ascertain the age structure of a goanna population because a method has not been published to determine the age of a goanna in years. However goannas continue to grow throughout life, so the larger individuals in a population should tend to be the older ones. One of the Rosenberg's Goannas at Ainslie-Majura is the largest of all 168 Rosenberg's Goannas measured by researchers in the ACT region and at least two of the others are also relatively large. This suggests the possibility of a high proportion of older animals, which is a concerning pattern.

A bias toward older animals is a pattern associated with populations limited by predation. A few older individuals persist (survive) for a long time, presumably because they either possess protective behaviours that are less common among juveniles, or they occupy 'refuge' locations. These few individuals are responsible for most of the breeding, and because of them, the species is not exterminated from the site, but their offspring do not last for long. Figure 4 demonstrates this pattern with Brush Tailed Possums in two Namadgi valleys where Foxes were baited, compared to two unbaited valleys (Fletcher, unpublished). The Fox baiting resulted in a higher density of possums. Figure 4 shows that the baiting also resulted in a more even age structure in the possum populations.,

Figure 4: Mean persistence times of Brush Tailed Possums, from a 2.5 year trapping survey in unbaited valleys (dashed lines) and Fox-baited valleys (continuous lines). The age distributions are more even where Foxes are baited.

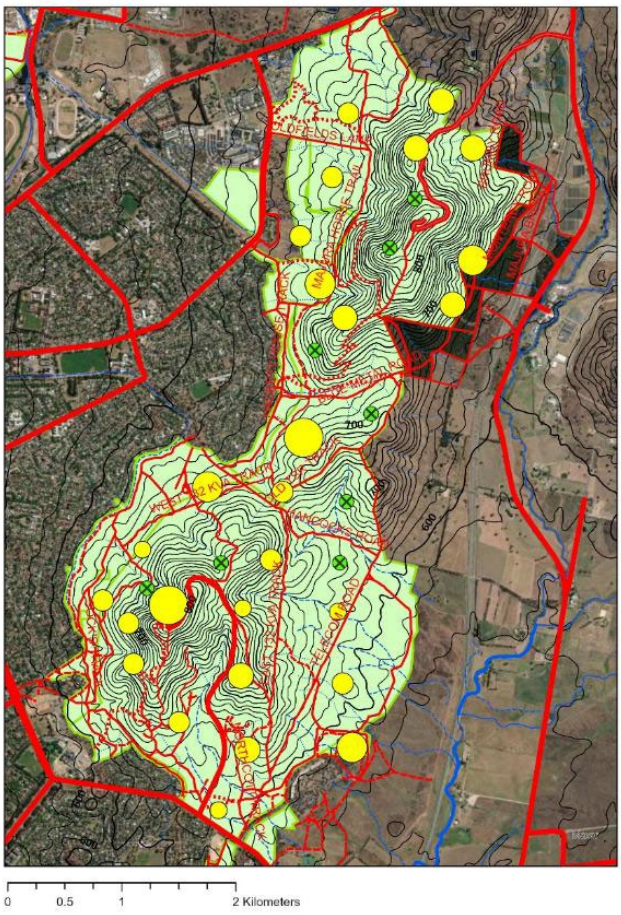


Foxes at Ainslie Majura

Foxes are common and widespread in Ainslie-Majura Nature Reserve. A four week survey at Mt Ainslie in 2021, using 20 baited camera traps, found Foxes visited 14 of the camera sites (70%), which was seven times as many sites as visited by goannas (Fletcher and Jokinen 2021). A 10-week survey in 2022/23 using 35 baited camera traps, confirmed the pattern. Foxes visited 27 sites (77%) which was also seven times as many sites as visited by goannas (Figure 5; Fletcher *et al*. in prep). Native species strongly dominated the results, such as Black (Swamp) Wallabies and Shingleback Skinks, but Foxes were among the ten most common species recorded. Foxes were recorded every week of the survey, goannas in only three of the ten weeks.

The longer running 2022/23 survey (late November to early March) revealed more about Foxes than their distribution and relative abundance. Early in the survey it was common to see up to three sub-adult Foxes at one bait at the same time. These younger Foxes conspicuously lacked the wariness that was displayed by the adults, regarding the bait. The older juvenile and sub-adult stages are crucial times of life for Foxes, when the great majority are lost to starvation (Saunders *et al*. 1995, 2010). As the summer progressed, these young animals became less numerous in photos. Presumably most died and a smaller number would have grown into adults, replacing natural adult mortality.

Figure 5: In the 2022/23 camera trapping survey, Foxes were photographed at 27 of 35 baited camera traps in Ainslie Majura (Size of symbols is proportional to number of Fox detection events).



During the 2022/23 goanna survey, two of the four goanna individuals that we observed directly, had recently been seriously injured, possibly due to attacks by Foxes or dogs. Parallel deep gashes appeared on the neck of one and the tail base of another. The former goanna also had had the end of its tail chewed off. We suspected that Foxes may have been responsible. Starving sub-adult Foxes are likely to attempt to attack any potential prey they encounter. These two large adult goannas may have been able to defend themselves sufficiently to escape being eaten by an inexperienced young Fox, but both were left with wounds which could potentially have proven fatal due to blood loss or infection. The goanna with the neck injury could make barely an effort to escape us. We took it for veterinary attention, including a course of antibiotics administered over the next few weeks. Since then it has been seen repeatedly, and is easily recognised by its scars and shortened tail.

A good question is whether starving sub-adult Foxes attack the much smaller female goannas when they are laying. When laying, the female is in a torpor-like state and will tolerate close approach. While laying, her head may protrude from the burrow that she has dug into a termite mound. Thus the female appears extremely vulnerable to attack (Figure 6). The Fox in the inserted image in Figure 6 visited the site just after the eggs had been laid and before the goanna returned to finish backfilling her nest hole by sweeping soil up from below using her legs and tail. She completed the final backfilling the next morning (Figure 6) then remained on site constantly for three weeks, to guard her eggs until the termites had cemented them into place (Figure 7). She could remain well hidden among fallen branches, and when dogs or noisy people approached, she could take refuge in an abandoned rabbit warren a few metres away.

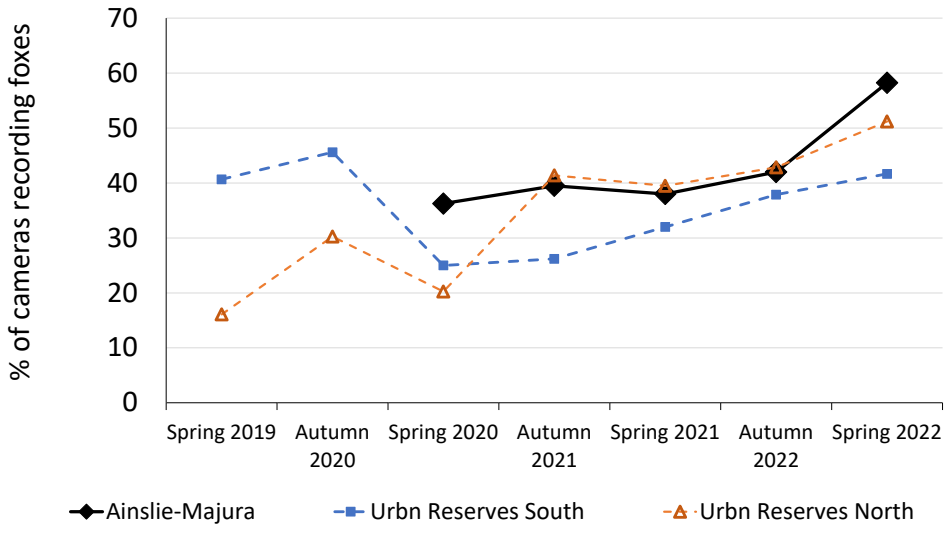
Figure 6: In the late afternoon and evening when they are laying, female Rosenberg's Goannas appear vulnerable to Fox attack. The main illustration shows Goanna Rosie laying a clutch of eggs one afternoon in 2016. The left inset shows a Fox visiting later that evening. The right inset shows Goanna Rosie early next morning when she finished backfilling the hole.

Figure 7: Goanna Rosie guarding the termite mound containing her eggs in 2016. Mostly she was hidden among the fallen branches and in a nearby burrow but here she is more obvious in the open.

Fox monitoring by PCS

A different type of camera-trapping survey is being run biennially by PCS. Foxes are the primary species of interest for this survey (rather than goannas) but thirteen other CNP mammal species have also been monitored, using unbaited cameras to record animals passing along roads. Thirteen cameras are allocated to each of three groups of reserves for a fortnight each Spring and Autumn (Figure 8).

Figure 8: PCS data from seven separate surveys showing the percent of camera-nights in which Foxes were photographed on roads in Canberra Nature Park.



In Figure 8 there is a statistically significant increase in Fox detections from 2019 to 2022 in Ainslie-Majura. There is no statistically significant change in the other groups. It seems likely that the increase is partly due to use of better cameras and better camera management in later years, as well as to real change in Fox abundance due to more favourable weather conditions in later years.

In the latest survey data to have been collated (Spring 2022), Foxes were the species recorded most often in the Northern Woodland group (58% of camera days); second most often in the Urban South reserves group (42% of camera days). and third most often in the Urban North group / Ainslie-Majura, after Humans (98% of camera days) and Dogs (66% of camera days). Foxes are detected approximately as often in all groups, but there are more humans and dogs at Ainslie Majura.

In the photos collected by the survey, Foxes of different ages are seen and some are carrying prey including Brush Tailed Possums, Rabbits, and a Black (Swamp) Wallaby (Figures 9, 10).

Figure 9: Fox carrying a portion of Brush Tailed Possum along a road

Figure 10: An adult Fox with four cubs suckling on a road in front of a monitoring camera

Compared to typical Fox abundance data, the results from the PCS camera survey are impressively consistent for all three groups of reserves (Figure 8). In the section on monitoring we recommend using this survey to evaluate effectiveness of Fox control.

Effect of dogs on wildlife at Ainslie Majura

Our observations of unleashed dogs on Mt Ainslie indicate a high likelihood that goannas are being encountered by unsupervised dogs. This would increase the loss rate of juvenile goannas and result in the occasional loss of adult goannas. If the Mt Ainslie goanna population is as small as it appears at this stage, the loss of even one individual adult female goanna every five years may have a significant effect on whether goannas persist at Mt Ainslie. But that is only the tip of the iceberg regarding dogs.

Most vertebrate prey species, and some invertebrates, avoid feeding in places, times or circumstances that they perceive to be associated with greater risk of being attacked (Ludwig and Rowe 1990; Sinclair and Arcese 1995; Brown *et al*. 1999; Laundre *et al*. 2010, 2014; Tuft *et al*. 2011; Atkins 2017). It is thought that this so-called 'landscape of fear' effect (or 'predation sensitive foraging' effect) causes greater reduction in the abundance of prey populations than the number of prey killed by the predators (Laundre *et al*. 2010) including when the predator is the domestic dog (Silva-Rodriguez and Sieving 2012). Whatever the mechanism, numerous examples are known of dog impacts, through disturbance, not killing, of wildlife (Bateman and Gilson 2025). This applies even with bush birds and dogs on-leash; dog walking in woodland brought about a 35% reduction in bird diversity and 41% reduction in abundance (Banks and Bryant 2007).

It is very likely that goannas too are subject to the 'landscape of fear' effect caused by dogs on-lead, as well as off-lead. And it is not only foraging locations that are influenced by predators. The same kind of behaviour applies in relation to social groupings, light phases (e.g. rabbits reduce their time above ground on bright moonlit nights) and times of day when prey are willing to venture forth. Therefore, dogs (and Foxes) almost certainly affect goannas in additional ways, as well as limiting where they forage.

Thus the activity of leashed and unleashed dogs at Mt Ainslie is not merely a threat to the effectiveness of the camera survey. Dog activity can reasonably be regarded as a threat to the goanna population, even in the unlikely case that no goanna was ever killed by a dog. Because of the power of the 'Landscape of Fear' effect (see text), the non-lethal activity of dogs is equivalent, in its effect on the goanna population, to a certain goanna mortality rate. And the mortality rate of these 'equivalent goanna kills' is likely to be greater than the rate of 'actual goanna kills' by dogs.

Policy on dog walking at Ainslie Majura

The policy considerations relating to the approval to take dogs into reserve areas are clearly explained in Section 7.4.3 of the Management Plan for CNP (ACT Government 2021), copied here as Appendix 1. Dogs are prohibited in 16 of the 39 CNP reserves. The two reserves at Ainslie-Majura are among the 23 CNP reserves where domestic dogs may be walked on-lead (ACT Government 2021).

For decades there was little to no enforcement of the on-lead rule at Ainslie-Majura, until 2024, and even following the 'blitz' commenced that year, the rule is still ignored by a concerning proportion of dog owners. In both the 2021 goanna survey at Mt Ainslie, and the 2022/23 survey of Ainslie-Majura, all dogs (100%) that were recorded by our camera traps were off-lead. These dogs either consumed the goanna bait or urinated on it. This disturbance occurred in spite of the fact that the

camera traps had been positioned out of sight of any walking path. If a dog attacked a goanna at these places, the owner back on the path would rarely have known.

Along the walking paths, the proportion of off-lead dogs is lower, but even here the majority of owners (65%), flout the rules, based on records from a camera used in 2024/25 to monitor a goanna burrow dug into the side of the Lower Beacon Fire Trail.

Majority contempt for the rules is not due solely to the inadequate enforcement history of Ainslie-Majura because it also applies in more recently reserved areas. For example, a worse result was recorded from five camera traps placed on roads at the Pinnacle Nature Reserve (another on-lead reserve) in 2021 to monitor Fox baiting devices (ejectors), with 75% (21 of 28) of dogs off-leash (Pulsford pers comm 2022). This appears to be the norm judging by Victorian experience. Over a seven year period, rules posted on beaches to prevent disturbance to nesting Hooded Plovers, an endangered species, were mostly ignored, with 78 to 88% of dogs roaming unleashed (Dowling and Weston 1999).

At Ainslie-Majura, during the surveys in 2021 and 2022-23, almost every owner of off-lead dogs was observed carrying a lead to which they attached their dog(s) when a ranger vehicle appeared. This suggests that ranger presence is a very influential factor in achieving environmentally sound public behaviour. However it is not possible to have a ranger present all day every day, on every road, in every reserve.

Compliance with 'no dogs' areas seems much greater than compliance with the 'on-lead' requirement, judging by our much lower encounter rate with dogs in no-dog reserves than with off-leash dogs in on-lead areas. (This has not been checked with camera surveys, as far as we know).

In future, if Fox baiting is attempted, the notification of Fox baits being present in the reserve, with warnings about the toxicity of Fox baits to dogs, seems likely to be a powerful additional factor in improving the compliance behaviour of dog walkers.

The social and health benefits of domestic dogs

The keeping of dogs is widely believed to provide their owners with health and social benefits. Additional benefits may arise from the vicarious exercise carried out while exercising the dog. The actual medical evidence is more equivocal. For example, controlled experiments by Australian researchers did not detect an effect of dog ownership on any health parameters evaluated, except that reported loneliness was reduced, especially if the dog owner interacted with other dog owners while walking (Powell *et al*. 2019). However many less rigorous studies have reported health benefits. A review paper acknowledged the equivocal nature of results from different studies but concluded that '*dog ownership is associated with lower risk of death over the long term, which is possibly driven by a reduction in cardiovascular mortality*' (Kramer and Mehmood 2019).

Aside from their presumed health and social benefits, dog walking appears to be an important element in the recreation spectrum at Ainslie Majura. Although both reserves would probably have been designated as 'no' dogs' if they had been a new reserve created in recent years (because of the presence of Rosenberg's Goannas), the volume of dog walking is so high there and the activity so well entrenched, it seems possible that Ainslie-Majura may not be able to be transitioned entirely to a no dogs area in the immediate future.

The health and social benefits of wildlife encounters

A Fox control program is likely to have some of the same health benefits as dog walking if the expected increase in abundance of native species results in more public encounters with native animals, because similar health benefits apply to encounters with wildlife as to dog ownership (Shoesmith and Ratschen 2023). Some people value such encounters so highly that there is speculation that wildlife are more beneficial than pet animals in terms of human health. Thus the total effect of restricting dog walking areas in order to conduct Fox control could be a nett positive effect, or at least not severely negative, depending on the relevant numbers involved.

Potential for harm to domestic dogs and the value of zoning

Foxes and dogs are so similar biologically that most Fox control methods (except shooting) have the potential to also harm dogs, e.g., if dogs consume baits set for Foxes. Thus, among other methods, a zoning strategy is important to minimise the risk to dogs from Fox control methods. It would also have the important benefit of protecting goannas from the presence of dogs.

That is, an area is needed for goannas, where dogs are not allowed and where a range of lethal Fox control methods can be used, some of which would pose a risk to any domestic dogs which stray into the area, or are allowed there by their owners.

Potential Fox control methods

The ACT Parks and Conservation (PCS) is proficient in the use of a wide range of Fox control methods. Fox control measures used in Australia include baiting, trapping, shooting, den fumigation and exclusion fencing, with baiting being the most cost-effective and most commonly employed method.

Thermal assisted shooting for Fox control

An animal or person seen in visible light, e.g. with ‘night vision’ equipment, may blend with its background or be hidden behind screening vegetation or camouflage. But mammals are almost always hotter than their background, or screening vegetation. Thermal cameras and thermal telescopes convert heat to light, so in a thermal viewer the hidden animals or people can provide a high contrast image, especially at night and in the early morning when the surroundings are cooler.

The use of this technology is still developing (e.g. Pulsford *et al*. 2023) but so far it has greatly increased both the safety and the effectiveness of shooting as a potential control method for vertebrate pests. ACT Parks and Conservation, and its contractors, have been among the leading Australian adoptees. As well as efficacy, there is also a safety dividend. For example, together with other safety measures, thermal technology has enabled kangaroo shooting to be done safely in CNP reserves, even though some of the kangaroo management areas are small and surrounded by residential suburbs.

Whistling for Fox control

Fox whistling refers to a commonly used shooting method to encounter Foxes at a greater rate than occurs when shooters go searching for Foxes. Foxes are attracted to noises played either with an electronic device or with a wind instrument such as the traditional whistle shown in Figure 11. There is plenty of advice on the internet about how to do it, but as with most hunting, even experienced and skilled practitioners may fail more often than they succeed.

Figure 11: A Fox whistle of traditional style. Diameter is about 3 cm.

Limitations of shooting for Fox control

Fox shooting has often been used to harvest Fox populations to sell their skins or obtain bounty payments. The numbers of skins sold or bounties paid often sound impressive, leading lay people to falsely conclude that Fox impact has been reduced. However the Fox removal rate per square kilometer is generally lower than the rate required to reduce the population and control Fox impacts. The number of Foxes remaining is the important metric, but it is almost never measured. Shooting is not a suitable method to reduce an abundant Fox population at landcscape scale (and no bounty scheme has ever changed that). The main value of shooting is that it can be applied to a particular site after baiting, to remove Foxes that have not succumbed to the primary control method.

Baiting for Fox control

As stated previously, baiting is the most cost-effective and most commonly employed method for Fox control.

In principle, the control of vertebrate pests with baits while protecting humans and non-target species, is achieved by combining three ways of distinguishing target animals from non-target animals. These are:

a) bait type (e.g., birds dislike bait that has been dyed green, and most herbivores dislike smells of rotting meat);
b) toxin type and dose rate (e.g., pigs are more sensitive than other species to the bacon preservative Sodium Nitrite, and many introduced species are more sensitive to 1080 than most native species because of the presence of fluoroacetate compounds in Australian plants); and
c) bait deployment method (e.g., use of fences, bait cages, feed hoppers or other means of limiting access to the bait for non-target species; also maximising bait size and spacing, so small animals would have to travel impossibly far, or eat impossibly much of the bait, to be at risk).

All three methods apply to Fox baiting. Fox baits mostly are smelly pieces of decomposing fat and meat, which makes them unattractive to humans and some herbivores, but highly attractive to Foxes and dogs. The usual deployment method is to bury the bait 10 cm deep because burial deters a large number of non-target species, but not Foxes. Goannas and domestic dogs are exceptions, i.e. they are non-target species that will readily excavate and eat buried smelly meat-based baits that are unattractive to humans and the majority of other wildlife. However goannas are relatively insensitive to the 1080, as mentioned below.

For more than half a century, the toxin used in Australia for Fox baiting has been Sodium Fluoroacetate, generally known as '1080', pronounced 'ten eighty'. Foxes are acutely sensitive to 1080 while goannas are highly tolerant of it (a goanna would need to find and eat an implausible number of baits before it was at risk) therefore baiting programs for Foxes or dingoes are frequently run where goannas are present.

However domestic dogs are sensitive to 1080, the same as Foxes. And dogs are like Foxes in their willingness to dig up buried Fox baits and eat them, therefore it is essential to prevent pet dogs from accessing baits containing 1080.

Most other Australian native species are somewhat tolerant of the small dose of 1080 that makes a bait lethal to a Fox (usually 3 mg) but are not as tolerant of it as goannas are, and some may be killed if they consume baits. However most are prevented from doing so to any significant degree by the nature of the bait material and by burial of the bait. In that regard, we recommend using Dingo-size baits (generally ~ 250 g) containing a Fox-dose amount of 1080 (3 mg) and burying the baits 500m apart. The increased bait size, compared to the typical 30-50 g Fox bait, is expected to significantly minimise the risk of non-target impact.

Government should be aware in advance that to use 1080 baiting at Ainslie-Majura will attract ill-informed criticism. A disadvantage of 1080 arises from the fact that it has been in use for decades. So, like most chemicals used for a long time in the control of plant or animal pests, it now evokes strong opposition from small but vocal groups. The same groups display much less reaction in social media to the newer vertebrate toxins although some have been proven to pose great risk to non-target native species, for example the risk to owls and other predatory birds from widely used rodenticides such as Brodifacoum, and in spite of greater animal welfare concerns also.

As occurred with the Glyphosate herbicide, social media and political factors are increasingly influencing public opinion about the use of 1080. A vast amount of incorrect information has been disseminated about 1080, which exacerbates the criticisms and aggravates the distrust between the opposing groups.

In modern times, even beneficial or innocuous substances attract substantial criticism, in spite of common sense or evidence, such as vapour trails from high-flying aircraft, vaccines, and fluoride in drinking water. And such sentiment sometimes results in government action, e.g., legislation has been passed to ban the use of fluoride in large parts of Australia and the USA. It is therefore not surprising that a powerful toxin such as 1080 attracts even stronger criticism, and over time, generates even more myths, and that in the last three decades there have been incessant calls for 1080 to be banned. Notably, the campaign for a Tasmanian ban succeeded in 2001 under a Labor-Greens government, until the ban was reversed in 2014 under a Liberal government which stated that the search for an alternative to 1080 had been unsuccessful.

Wildlife controversy is nothing new and knowledge about how to deal with it has been learned in Australia and internationally. See 'Communication and public education' below.

There is some interest in an alternative to 1080 known as PAPP (i.e. 4- aminopropiophenone, also known as para-aminopropiophenone).

Is PAPP a replacement for 1080 for Fox control?

In case of accidental bait consumption, PAPP is less toxic to domestic dogs than 1080 if the dog is treated within 20-30 minutes of ingesting the bait. And if the poisoning is fatal, PAPP results in what appears to be a much more humane death. However PAPP is far more toxic to native animals than

1080. And goannas are acutely sensitive. Only 3% of the PAPP in a single Fox bait ('Foxecute' Applied Animal Biotechnologies) would be sufficient to kill half the Rosenberg's Goannas that consumed it (APVMA 2015). It would be easy for goannas to consume much more than 3% of the toxin in a bait because even a whole Foxecute bait would be only ~ 10% of the average daily food intake of a typical Rosenberg's Goanna. Goannas are well accustomed to digging for food, and to eating carrion, so they readily find and consume the types of baits used against Foxes.

Our conclusion about PAPP as a possible alternative to 1080, is that although the goanna population could benefit greatly from Fox population reduction, if this was achieved mainly using PAPP, there is a risk that direct poisoning of goannas by the baits might do more harm to the goannas than the benefit from Fox reduction.

Are ejectors better than buried baits for Fox control?

All dog and Fox species habitually cache food, exemplified by pet dogs burying bones in the garden. And they habitually raid the caches of other dogs and Foxes. Thus, in areas near the boundary between baited and unbaited land, Foxes can potentially move Fox baits into the unbaited area where they may be eaten by domestic dogs. To prevent caching of Fox baits, a device called a 'Canid Pest Ejector' (hereafter 'ejector') has been developed.

When a Fox pulls up on a bait attached to the top of the ejector, toxin is propelled upward into the mouth of the Fox by the action of a spring. So bait caching is almost impossible with ejectors. Exceptions have been reported to occur occasionally because some Brush Tailed Possums and some Rosenberg's Goannas manage to dismantle and carry off part of the ejector apparatus to eat the bait elsewhere. In a remote area trial, Corvids disabled 6 of 10 ejectors in 3 months, including one in which the apparatus was dismantled (Kreplins *et al*. 2018). It appears likely that a modification would make it difficult or impossible for animals to dismantle ejectors.

A trial of ejectors is currently being carried out under a contract issued by Office of Nature Conservation. It is evaluating whether modified ejectors can be used to target Foxes with minimal risk to the larger dingo or the smaller Rosenberg's Goanna.

Disadvantages of ejectors are that (a) Fox populations have not commonly been controlled with ejectors alone, rather than buried baits, presumably because the experienced adult Foxes are wary of the devices; (b) a higher level of maintenance is needed; and (c) ejectors cost more. However ejectors are safer for use closer to residential areas than buried baits because they prevent Foxes moving baits into the residential area. This suggests the potential value of using modified ejectors near the boundary of the control area and in the zone which normally separates suburbs from areas treated with buried baits.

Seasonal factors - a) colder months

Observations in the local region suggest that shorter and cooler days in autumn cause Rosenberg's Goannas to stop eating, and a few weeks later to enter a winter burrow where they commence brumation, a physiological state that is approximately equivalent to hibernation in mammals. It is suspected that with most individuals, food consumption does not resume until a few weeks after they emerge in spring from the winter burrow. This may mean that the winter season is one in which most goannas are probably safe from both dogs and any use of PAPP.

Winter is also the season when warren-directed rabbit control methods are employed at Ainslie Majura. Rosenberg's Goannas often occupy rabbit burrows in the warmer months (after they have

eaten some of the occupants of the warren) but their winter burrows are always self dug, are distinctive, and are mostly located well away from rabbit warrens.

Seasonal factors - b) warmer months

In the local region, from late January to early March, female Rosenberg's Goannas construct their nests in the mounds of one of the Gluegun Termite species, *Nasutitermes exitiosus* (Figure 6). They lay a clutch of around 12 eggs (2–16) in the core of the nest, below ground level, generally starting in the late afternoon and continuing through the evening. As described above under '*Foxes at Ainslie-Majura'* and illustrated in Figure 6, at this time they are in a trance-like state and tolerate close approach. They appear to be acutely vulnerable to predation by Foxes, which appear from camera monitoring to have a habit of regularly checking the *Nasutitermes* mounds.

Summer is also an important season for Foxes, a time of high mortality of sub-adults, probably due mainly to starvation and accidental deaths. Most of the sub-adult Foxes do not survive for long, yet they are capable of harming wildlife significantly.

Therefore one of the most important roles of Fox control to protect goannas in the ACT region, should be to prevent the production of a large cohort of these hungry sub-adults, or reduce their abundance, prior to the time in late January and February when female Rosenberg's Goannas are vulnerable. Fortunately, sub-adults are the easiest cohort to kill, whether by baiting or shooting.

It is possible that the required level of Fox control which will benefit goannas may not be high. The explanation for so many studies reporting that Fox baiting benefits goannas may be that only a limited degree of Fox population control is sufficient to reduce the risk to breeding female goannas.

Potential for Fox immigration to offset Fox control

Suburban areas are considered likely to hold the highest density of Foxes of any habitat type in Australia, followed by sheep growing areas with some tree cover (Saunders *et al*. 1995). Ainslie-Majura Nature Reserve is bordered to the west by the former and to the north east by the latter. It seems likely that the Fox population within the reserve will be elevated by the proximity to the surrounding habitats and that immigration from the surroundings would enable the Fox population to recover more rapidly from a single episode of control.

Therefore the Fox control strategy at Ainslie-Majura should (a) adopt the tenure blind approach described under the next heading; and (b) embrace the dynamic nature of populations. Using ecological terms, the goal should be to make the Ainslie-Majura Fox population a 'sink population', with the surrounding areas being 'source populations'. The usual tendency to see the goal in terms of 'zero Foxes' should be resisted. The goal is to reduce Fox impact, not to eradicate Foxes.

In ideal circumstances, after a few years of successfully applying such a strategy (and allowing time for older resident adult Foxes to die of natural causes), the Ainslie-Majura Fox population would comprise mainly sub-adults and young adults recently arrived from the surrounding areas. These are the easiest demographic groups to control.

The size of the Fox control area is widely recognised to be an important factor for successful Fox control, so it is helpful that with an area of 11 sq km (1,139 ha), Ainslie-Majura Nature Reserve is an order of magnitude larger than the majority of CNP units, and is the second largest unit of CNP, after Rob Roy Nature Reserve at 20 sq km. However it is still a challenging area for successful Fox control due to the lack of barriers at its edge, the 'Fox friendly' neighbouring land-use types, the high levels

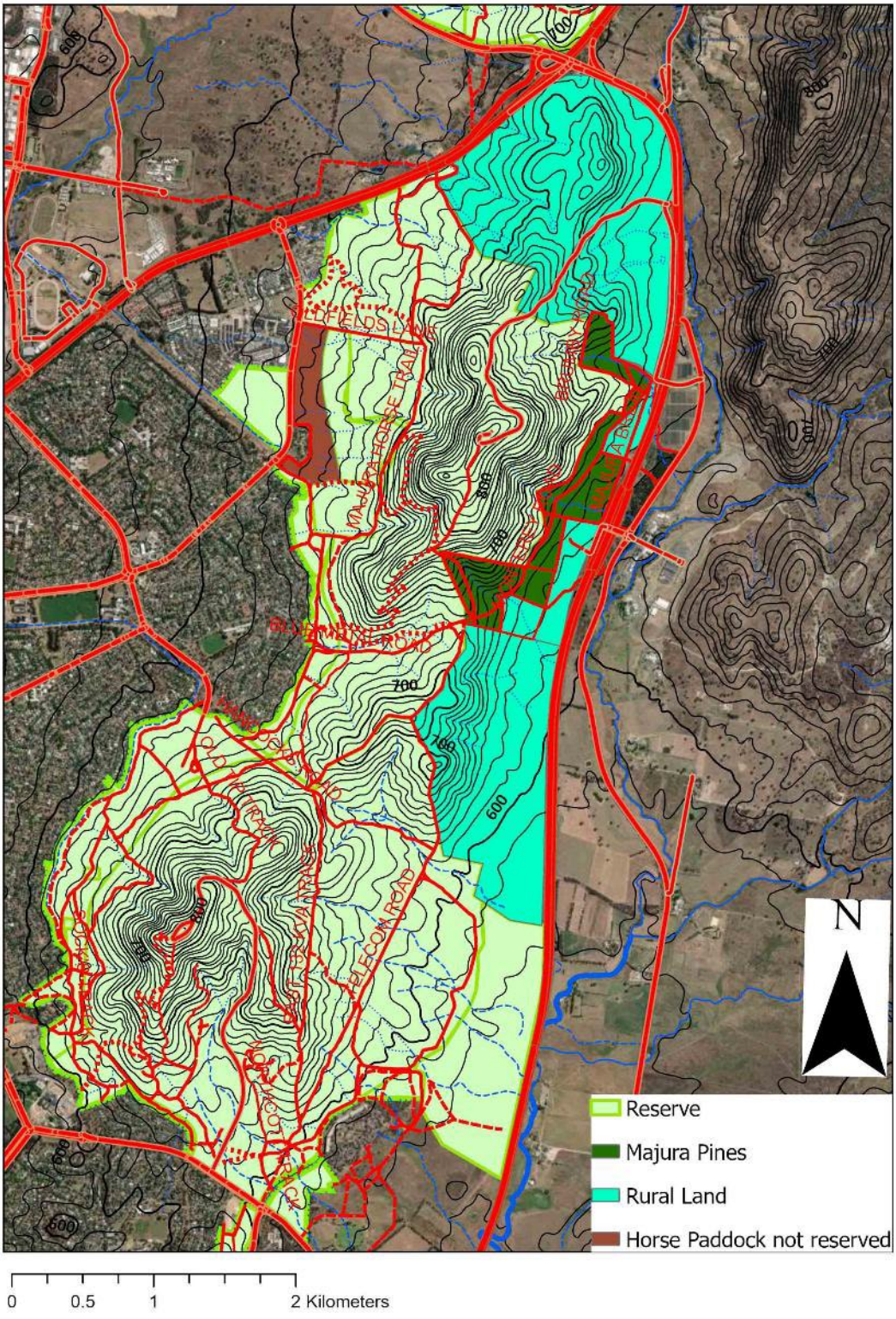
of public scrutiny that apply in peri-urban situations, and the existence of social media campaigns against the use of 1080.

Tenure blind management

It is generally more efficient for management of wild populations to be planned in a 'tenure-blind' manner, also known as the 'nil-tenure approach'. This is particularly applicable for mobile species such as the Fox.

To use the 'tenure blind' method would mean that Fox management at Ainslie-Majura would be planned within boundaries that, as far as possible, are either legal limits to Fox control technology, or natural inhibitors to Fox movement, such as the suburban edge and main roads, rather than to land tenure boundaries such as nature reserve boundaries. Thus the rural properties adjoining the reserve would be included in the control program. Implementation of a tenure-blind plan depends on willingness of the affected landholders, which is expected to vary between individuals, between enterprises (e.g. sheep growing V grape growing), and between years and seasons.

Figure 12: The proposed 'Ainslie Majura Fox Management Area', showing main land tenures. Numerous small inholdings are not shown, such as water reservoirs, electricity sub-stations, air navigation facilities and the National Pistol Club.



Therefore, although the primary concern of this proposal is within the Nature Reserve, a plan for Fox control should refer to a larger area, i.e. the Ainslie-Majura Fox Management Area (AMFMA) (Figure 12). It is to this larger area that actions such as Fox control activities should be applied, as far as possible, subject to the wishes of individual landholders.

The success of a co-operative tenure-blind approach obviously depends greatly on liaison between the landholders. Typically there is much variation in levels of support for such programs. Consultation with adjacent landholders should take place as soon as possible in the development of this plan.

PROPOSED ACTIONS

Integrating Fox control methods and using zoning to optimise goanna conservation and safety of domestic pets

Buried Fox baits using 1080 have proved remarkably safe, if correct protocols are followed, and are the single most effective Fox control method. Correct use includes setting an offset between suburbs and the baiting area. The offset is generally 500 m because Foxes are unlikely to carry baits 500 m for caching. To treat areas of preferred goanna habitat which are within 500m of the suburb, modified ejectors should be used.

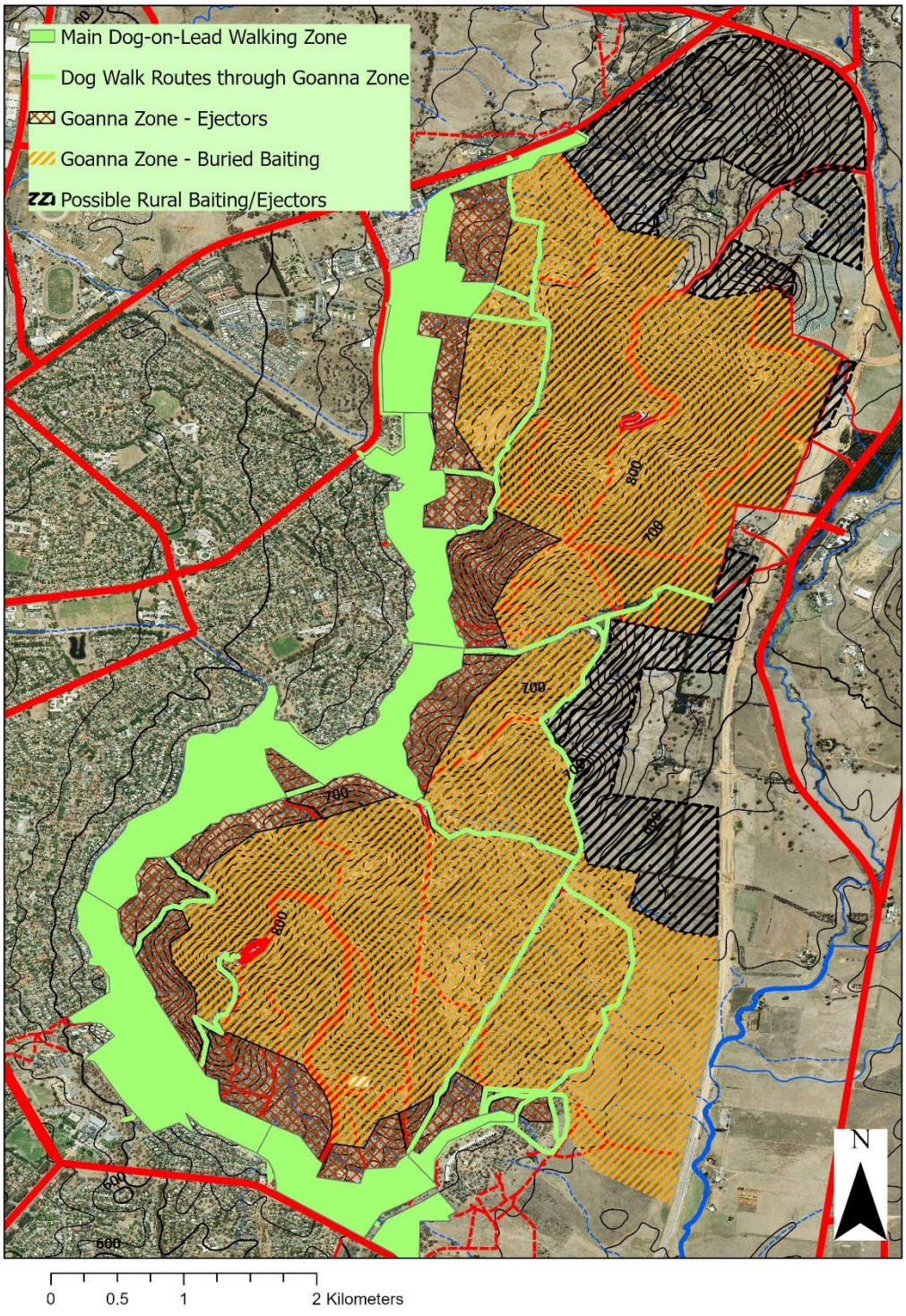
Buried 1080 baiting should be the mainstay of the control program, with whistling and shooting to reduce the number of Foxes which were not removed by baiting. Ejectors could be used in a more limited area to take the program into places where buried baiting is inapplicable.

Shooting is relatively ineffective and costly at the population level and animals learn ways to avoid shooting methods. Therefore shooting should be used after baiting has been carried out, not the reverse. When Foxes are scarce, a shooter my spend much time without sighting one. Whistling is a way of attracting Foxes to the shooter by imitating the distress cry of an injured rabbit. Even so, not all shooting sessions should succeed in killing a Fox, if the program is successful. In vertebrate pest control it is a strategic mistake to use the number of animals killed as the measure of success.

Thus, with this plan the protection of pet dogs depends on zoning. The proposed zones are shown in Figure 13, with a more detailed view in Figures 14 to 16. The zones are:

1. A Dogs-on-Lead Zone where no Fox baiting or trapping would be conducted and people are free to take dogs, providing they are on lead.
2. A Goanna Zone comprising most of the two reserves, where no dogs are permitted and lethal Fox control methods are deployed. For internal purposes the Goanna Zone is is broken into two parts for treatment:
    a. one where only ejectors are used, 200-500 m from suburb, (or non-lethal buried baits to evaluate dog-owner compliance); and
    b. another where buried baits are used >500m from suburb and >200m from rural dwellings and other assembly points on rural leases.
3. Alert Dog Strips. These are strips 10m either side of roads through the Goanna Zone, which are managed the same as Dogs-on-Lead Zone, i.e. no Fox baiting or trapping would be conducted in the strip and people are free to take dogs, providing they are on lead. The owners need to be vigilant to keep their pets from going outside the strip.

Figure 13: Proposed No-dog zone (Goanna zone) divided into areas for buried baiting and areas for ejectors only. Possible rural Fox baiting areas are also shown. To increase dog walking opportunities, baiting would not be undertaken within 10m of roads and tracks marked green.



For zoning to work, clear signage is vital. It is also recommended to conduct an initial messaging blitz using all possible media (including social and news media, snail mailouts, communication through local schools and local community groups, and ranger presence) to warn dog owners that their pet is at extreme risk if it enters a treated area.

An initial non-lethal baiting trial is recommended, using trail cameras on buried baits to evaluate the effectiveness of the messaging and signage before switching to lethal baits. (At ejector sites, for convenience, buried non-lethal baits could be used). The possibility could be investigated of placing dye capsules in the non-lethal baits, to help communicate the risk to those dog owners who let their pet stray into the baited areas.

Foxes are exceptionally wary. Baited wildlife cameras show that most adult Foxes approach the baits for several nights before attempting to bite them, and some adults never take baits. This type of wariness has been labelled ‘neophobia’, meaning ‘fear of the new’. To deal with neophobia, it is important to replace baits for a period long enough that the baits are no longer perceived as ‘new’, i.e. at least six weeks. Following one or more successful sessions of baiting, independent control methods should be deployed, i.e., Fox whistling and shooting with thermal viewing equipment, to target the individuals that survive the baiting, i.e. the wariest and most experienced Foxes, which are the ones least dependent on provided food. These Foxes are likely to be responsible for the most breeding. It will take several years to remove them.

Winter baiting and fox control is important. This is a strategic time when goannas are less active and less likely to remove buried baits, when food demands by Foxes may be higher and when the removal of females will prevent the production of litters of several starving sub-adults the following summer. All action programs have to be integrated with other work loads but an ideal timing for an annual fox program might be achieved with a six week baiting in winter to target wary adult females and another program around the end of the year in December-January to target the sub-adults which were not prevented by the previous winter program.

Figure 14: Detail of Fox control zones - North

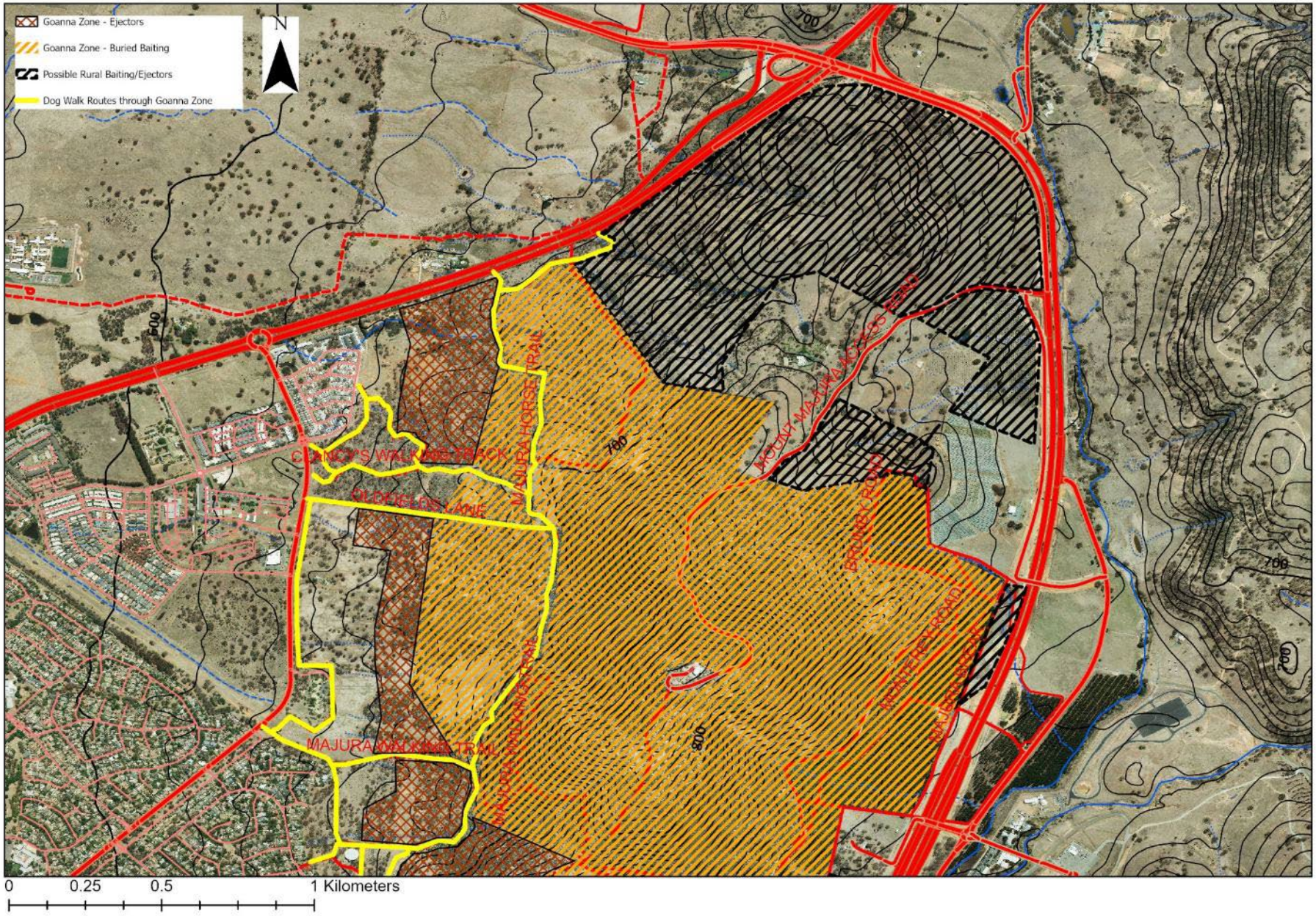


Figure 15: Detail of Fox control zones - Middle

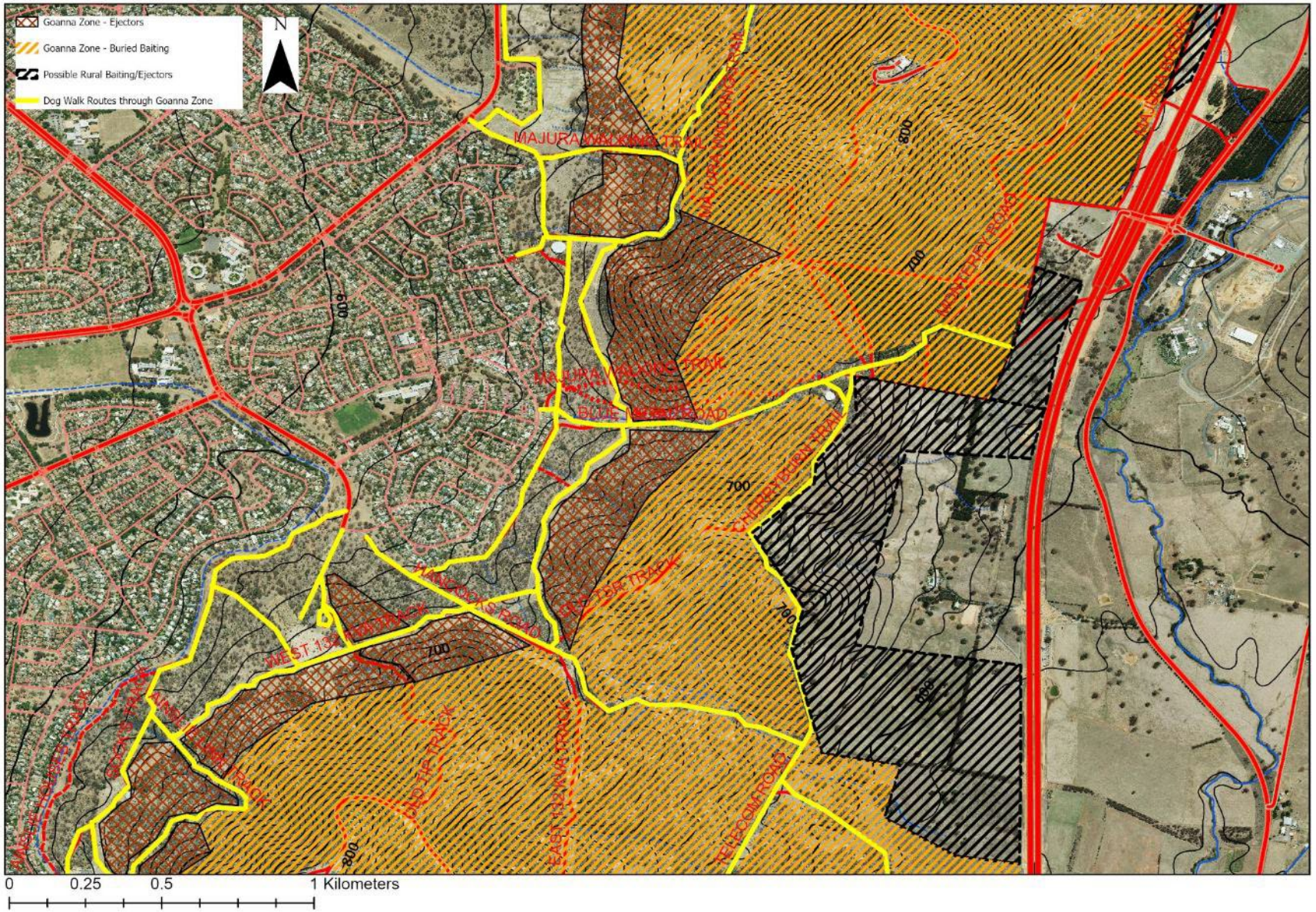
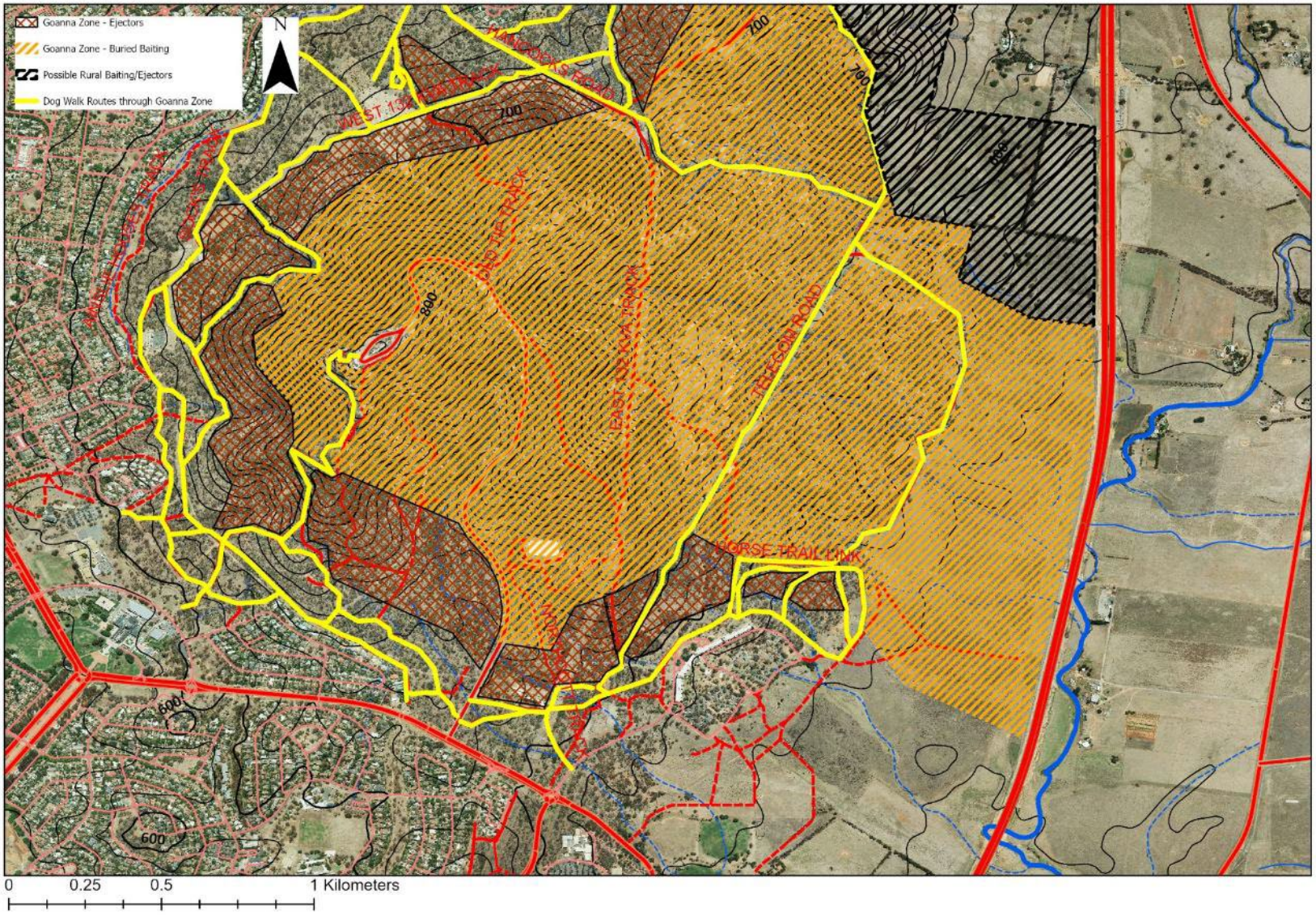


Figure 16: Detail of Fox control zones - South



Goanna genetics and possible need for genetic rescue

The small size of the remaining population of Rosenberg's Goannas at Ainslie Majura has prompted questions about genetic viability. This could be extremely important, although the retention of parthenogenesis in the Varanidae family, over evolutionary time, indicates that varanid species can persist even when their genetic diversity is extremely low. (In Varanid parthenogenesis, a lone female produces a small clutch of male offspring (so they are not clones of the female). One of the parthenogenetic offspring must mate with the female to enable a mixed sex breeding population to commence).

To evaluate the risk that low genetic diversity is affecting goanna population growth rate at Ainslie-Majura it is necessary to rely as much as possible on genetic evidence from reptile populations, and not so much on guesses based on experience with mammalian genetics. Knowledge of the genetics of Rosenberg's Goanna is increasing rapidly, including the contributions of Jason Dobry (Dobry *et al*. 2023a, 2023b, 2025) who is a member of the NPA Goanna Project (https://www.npaact.org.au/goanna-project). The discovery by the project, of two genetically distinct forms of Rosenberg's Goanna in the ACT also needs to be taken into account in any translocation or other 'genetic rescue' activity.

To progress this issue, we need DNA samples from more of the Ainslie-Majura goannas, preferably including females, to add to the three male samples collected in 2022/23.

MONITORING AND CRITERIA FOR MEASURING SUCCESS

A Fox control program using 1080 at Ainslie-Majura is clearly one which it is necessary to monitor. Monitoring is probably essential to the social and political credibility of the program and necessary to defend it from criticisms of the use of 1080.

The first requirement is monitoring of Rosenberg's Goannas and Foxes to evaluate how well the program has succeeded, or whether it has failed, but monitoring of additional ecosystem elements is also desirable, e.g., abundance of Red Necked Wallabies, Rabbits and Cats, to detect possible 'side effects' of Fox reduction. Effects viewed as positive and ones seen as negative are both possible.

Generally, successful monitoring will be more difficult and expensive than expected by inexperienced people. It is always challenging to conduct ecological monitoring that provides reliable results, and a large number of inadequately planned efforts have failed (Robinson *et al*. 2018; Lindenmeyer and Likens 2018). Some problems arise from inadequate appreciation of the long term nature of the undertaking. Much of the existing long term monitoring was not initiated in the expectation that it would continue for long (Lindenmeyer and Likens 2018).

Robinson *et al*. (2018) identify five principles for successful monitoring:

(i) Integrate monitoring with management;
(ii) Design fit-for-purpose monitoring programs;
(iii) Engage people and organisations;
(iv) Ensure good data management; and
(v) Communicate the value of monitoring.

In the following remarks about what monitoring should be done, we are guided by these five principles as well as pragmatism borne from experience, and the edict 'keep it simple'.

Monitoring of vertebrate pest control programs is often done using methods which are closely linked to the control action, e.g. the decline in the rate of Fox bait take is often used as an indication of success in reducing a Fox population. Bait take is worth monitoring because it is simple and cheap, improves operator effectiveness and provides other benefits, but it overestimates program effectiveness because Foxes that never eat baits are not included.

However there is one existing PCS program that monitors Foxes and some other fauna, independently of the control method. It was described above under 'Fox monitoring by PCS'. The program should be a sound basis for evaluating the Fox control program.

We suggest an *inhouse* review of the unbaited camera program. For example there appears to be an important gap in camera coverage on the west side of Mt Ainslie. Considering the long-term nature of monitoring, it is also recommended to review, and if necessary, revise, arrangements for what is recorded, for storage of records and storage of images and to prepare detailed documentation of the survey method so future operators follow the same procedure.

Also, the survey photos show large numbers of dogs on-lead and off-lead. Previous surveys could be re-visited to determine whether the ratio of on-lead to off-lead dog owners is improving in response to the increased effort that EPSDD is putting into messaging.

To monitor goanna abundance, a separate survey using baited cameras is proposed because in this case the cameras need to be close enough to the bait to recognise individual goannas, which could deter many Foxes. Also, special cameras of shorter focal length should be used in future to record goanna markings. The low number of goannas remaining at Ainslie-Majura precludes normal Mark Resight analysis of data from individual surveys. Rather it is a matter of combining data from all sources including public sightings. Each survey is a significant workload, but it is not necessary to do it every year.

In summary the monitoring we propose is:

1. Normal PCS practice of recording bait placement and bait take.
2. Cameras placed on baits and ejectors to provide assurance about safety and to aid operators to achieve good species identification from dig marks, etc
3. Continue the current program with unbaited cameras on roads as the primary index of Fox abundance, and also for indexes for other species;
4. Conduct occasional goanna surveys with baited camera traps using new cameras of short focal length, but otherwise the same as used for surveys in 2022/23 and 2025 (described in Fletcher, Kravis and Brickhill *in prep*). This survey too provides supplementary indexes for other fauna;
5. Occasional opinion polls of reserve users.

The following criteria are indicators of a successful program

- Decline in camera survey detections of Foxes
- Decline in Fox bait take (Foxes are expected to continually reinvade, so bait take should not be expected to reach zero)
- Decline in camera survey detections, and ranger observations, of dogs in the no-dogs area
- Decline in camera survey detections of unleashed dogs
- Increase in the % of dogs on lead
- Increase in the number of goannas known to be alive

- Cameras on baits do not record much interference by humans or domestic dogs
- Most users of the reserve are supportive of goanna conservation.

PUBLIC EDUCATION AND COMMUNICATION

Fox baiting using 1080 is potentially controversial. (See above - Baiting for Fox control). Wildlife controversies are commonplace, and the first rule for their management is that it is better to prevent a controversy if possible by adequate consultation, public education and provision of verifiable information, and by fostering stakeholders who will provide accurate independent commentary at strategic times.

Thus the second rule should surely be to never rely on prevention, but remain eternally vigilant, and head off any problem before it grows. It clearly works better to provide factual information, than to succumb to ill-informed but passionate criticism. (The NSW government has repeatedly provided evidence for the value of this advice).

Therefore it is important for ACT Government to 'own' any debate about 1080 and rapidly provide factual content to counteract any myths that are propagated. Regarding Ainslie-Majura, any potential for misinformation about 1080 should be pre-empted by public communications activity, and counteracted whenever it arises.

The success of this plan is heavily dependent on public support. It is necessary to communicate the positive messages and also to combat the negativity of small but vocal elements of the community about elements of the plan, such as use of 1080 and killing of Foxes.

We advocate the need for a constant trickle of information with surges of information occasionally, especially if this can be done at key times, e.g., at the changes in season, especially if dog walking rules change seasonally. This could involve:

- Semi-permanent corflute signage about the presence of goannas in the area in relation to dog rules (e.g. Figure 17) with simple changes made ~annually (e.g. different background colour or alternative photos) to overcome 'sign weariness' (trickle);
- Manage a Facebook group and other social media presence for goanna photos and observations and comments about the program (trickle);
- Presentations to key community groups in the Ainslie-Majura area (surge);
- Media releases at strategic times (surge);
- Social media advertisements at strategic times such as the start of the goanna season (surge);
- Goanna 'interpretation' by volunteers equipped with the freeze dried goannas owned by PCS, at pedestrian entrances to A-M. This is a powerful way to engage dog walkers and to raise the profile of goannas in the area (surge); and
- Short-term (eg 2 month) bus - back advertisements (surge).

Consideration should be given to contracting out elements of the public education program, given the tight controls that apply to communication in government, and the overly long reaction times when news-media communication is required. Finally we advocate consideration of media other than news media and social media. Books, movies, poetry and song all potentially have a role to play in managing public opinion.

Figure 17: Design of signs scheduled for installation in 2025 at entrances to Ainslie Majura. The intended background colour is brown. Changing the background colour each year is recommended.

We note that, compared to Australia generally, the Canberra public is exceptional in its level of support for lethal wildlife conservation measures such as Fox control, once they have understood what the program is attempting and that there is evidence to justify it. Extra-ordinarily strong community support now even extends to the shooting of kangaroos in urban areas (Micromex Research 2009, 2012, 2015, 2019, 2023). Similarly, the on-line response to the annual announcement of ACT park closures for heli-shooting of deer, pigs, goats, and horses, has become more accepting e.g https://region.com.au/government-resumes-annual-animal-cull-as-quite-a-diverse-landscape-faces-threat/866781/ .

However there have been some notable exceptions now largely forgotten, i.e. wildlife management projects influenced by deteriorating PR situations which ended in unwanted outcomes, such as:

- a court case for defamation (ground shooting of feral horses in 1987);
- a Ministerial stay on action, pending a 3-year independent inquiry (ACT rural kangaroo licencing in 1995); or
- total abandonment of the project (commercial harvesting of kangaroos at Googong in 2004).

These provided the following valuable lessons:

Preparation stage

1 Ensure in-house subject experts have had time and opportunity to sharpen their knowledge by reading papers, doing research, attending conferences, or contacting interstate colleagues.

2 Ensure the proposed action is in line with all relevant legislation, plans, codes of practice, etc. and has the appropriate government approvals.

3 Prepare a Communications Plan which is thoroughly vetted by subject experts as well as by expert PR. Within it, list a wide variety of possible PR questions. Prepare both brief answers (for e.g. the media) and more detailed technical answers with references to scientific publications (for e.g. responding to self-appointed experts and community opinion-leaders who burrow deep into whatever subject material is most readily available on-line).

4 Formally set up rules which enable exceptionally free and open communication between the Communications Team, the Ministers Media Adviser and the subject experts (within limits).

Consultation, Implementation and Ongoing stages

5 Officials (or groups of officials) who front the media, or meet with community group representatives, must have excellent subject knowledge, including of peripheral matters which could be raised by critics. [If there is already some suspicion or distrust of government officials, even just one instance of supplying incorrect information can be the turning point between a PR situation that is recoverable and one that is a disaster in spite of strenuous effort to correct the information later].

6 Keep all internal staff well briefed on what is being said and done officially. And if there is ever a PR crisis do more frequent briefing. [Everyone identified with the responsible agency is a communicator, whether they are well informed or not. If people involved in the program are asked about 1080 by friends they will reply. It is much better if the replies support the official line. Those individual staff members who disagree with elements of the program (there are always some who do) will be more respectful of the 'company line' if they were consulted than if they were sidelined or forgotten].

7 Cultivate, empower and brief a non-government expert group willing to speak up about the project with an independent voice, so that the media have external supporters of the program to turn to for comment as well as external critics of the program. [For example 'The Limestone Group' provided invaluable commentary on kangaroo management in the early years when culling in urban reserves was commencing].

8 Conduct prior consultation with stakeholders. In this case, local indigenous groups, the two Parkcare Groups and the Community Associations in the area all are obviously important, as well as dog owner groups. ACT Herpsoc and the Conservation Council are potential allies who should also be briefed.

9 Revise the Communications Plan in the light of the consultation.

10 Minimise delays in getting approval to speak to media. On matters of established policy, delegate freedom for media response from the ministers office to the Government Service, and delegate within the Government Service. [News cycles are rapid. Tomorrow may be too late].

PROJECT OUTLINE

1 Decide what consultation and public education is appropriate, and commence it, preferably involving all stakeholder groups (rural neighbours, dog walkers, etc) and using a variety of communication methods;
2 Commence an ongoing trickle of public communication about goannas;
3 Meanwhile complete necessary preparation, including:
   a. Finalise an Ainslie-Majura Goanna Conservation Plan (involving Fox control), to government satisfaction;
   b. Obtain ministerial approval for the plan;
   c. Identify funds;
   d. Liaise again with rural landholders in the AMFMA about Fox control.
4 Implement dog restrictions, including the no-dogs Goanna Zone and whatever other restrictions are decided;
5 Deploy signage;
6 Conduct one or more non-toxic baiting/ejector trials to evaluate the risk to recalcitrant pet dogs;
7 Commence Fox control;
8 Provide occasional public updates on progress and to maintain social licence;
9 Monitor effectiveness with occasional goanna surveys; and
10 Review progress biennially for at least the first 6 years.

ASSOCIATED RESEARCH ON FOX CONTROL METHODS

Answers to the following research questions would be of use in supporting and informing the tactics mentioned in this plan.

- What is the movement behaviour of Foxes in Ainslie Majura? In particular, to what extent are reserve Foxes also suburban Foxes and rural Foxes?
- To what extent are buried meat baits excavated by Rosenberg's Goannas in each month?
- Can ejectors be modified so that goannas, possums and corvids cannot either discharge them or dismantle them?
- To what extent are collared ejectors accessed by Foxes while excluding larger canids? This research has been contracted to Sydney University by Office of Nature Conservation in EPSDD.
- What winter burrows are Rosenberg's Goannas using in Ainslie Majura and are these at any risk of being treated in rabbit control operations?

APPENDIX 1: Extract from the Canberra Nature Park Reserve Management Plan (2021).

7.4.3 Dog walking

Dog walking is a popular activity in Canberra Nature Park. Limiting access for dogs to some areas of Canberra Nature Park is important in order to protect sensitive environmental areas and species as dogs can have a significant impact on reserve values. For example, dogs may: » harass, chase, maim, kill and/or orphan wildlife (both diurnal and nocturnal wildlife) » disturb wildlife feeding or breeding patterns through their scent, presence and defecation/urination » introduce diseases, such as distemper virus, parvovirus or Murray Valley Encephalitis virus, and transport parasites, such as hydatids, into wildlife habitats » conflict with other reserve visitors. Dogs are prohibited in reserves unless an Activities Declaration (see Glossary) under the Nature Conservation Act indicates that dogs are permitted in the reserve subject to certain conditions, such as a requirement that the dog must be on a leash and on a formal track or trail. Penalties apply for breaches of these conditions. Dog access is also subject to Domestic Animals Act 2000 declarations, and dogs off leash or harassing wildlife can be impounded or destroyed under the Act. The Domestic Animals Act requires: » dogs in public places to be on a leash and under the control of the carer » the carer of a dog in a public place to carry equipment suitable for the hygienic disposal of faeces dropped by the dog » the carer of a dog in a public place to hygienically dispose of any faeces dropped by the dog. Dogs are permitted in 23 of the 39 Canberra Nature Park reserves (see Table 7.1) and must be on leash, on a formal track or trail, and under control at all times. The ACT Government's Canberra Dog Model (ACT Government 2019d) recommends a leash length no longer than two metres https://www.cityservices.act.gov.au/pets-and-wildlife/ domestic-animals/dogs/recreation-with-my-dog/the-canberra-dog-model.

Allowing dogs into these nature reserves is a continuation of past practice and acknowledges the significant value many people in neighbouring suburbs place on the activity. If the presence of dogs is found to be having an unacceptable adverse impact on reserve values, the approval for dog walking in some locations will be reviewed. Visitors with dogs should follow best practice as outlined in Box 3. Callum Brae and Mulligans Flat–Goorooyarroo nature reserves, and the mid- to lower slopes on the eastern side of Mount Ainslie are important breeding habitat for threatened woodland birds. Dogs are prohibited in these reserves, with the exception of Mount Ainslie. Reserve users walking dogs should avoid the eastern areas of Mt Ainslie during the bird breeding season. These areas may be closed during this period. When considering access for dogs in new Canberra Nature Park reserves, the Parks and Conservation Service takes account of: » likely disturbance to rare or threatened species » possible impacts on other species (such as nesting birds), mobility of kangaroos near roads and access to dams » potential conflict with other reserve users. Access restrictions do not apply to assistance animals or dogs otherwise exempted under the Domestic Animals Act. The Conservator may issue a Nature Conservation Licence for specialist dog trainers, for example, the Australian Customs Service and Australian Federal Police.

BOX 3 Dog walking—best practice » Always keep your dog on leash, preferably no longer than two metres, and only on a formal track or trail. » Ensure that you are able to physically restrain the dog on the leash. » You must stay on a track or trail to reduce the area influenced by the dog's smell and behaviour. » Avoid disturbing kangaroos and other wildlife. » Keep dogs out of dams and waterways. » Do not lead your dog when riding a horse or bicycle. » Ensure your dog does not harass or conflict with other visitors. » Remove dog droppings.

APPENDIX 2: Extract from 'An independent review of the evidence under-pinning the "Rewilding of Southern Yorke Peninsula" '

The document from which the following material was copied, by Greg Johnston and Clementine Menz (undated), is available from https://cdn.environment.sa.gov.au/landscape/docs/ny/gsa-review-johnson-menz.pdf

1.6.2 'Baiting for Biodiversity'

Reducing the threat of Fox predation was an important precondition to reintroducing tammar wallabies to Yorke Peninsula (Department for Environment and Heritage 2004). An intensive Fox control program began on Innes National Park in 2003 and continues to date. Passive tracking stations (Engeman and Allen 2000) demonstrated a significant reduction in Fox abundance on the park between 2003 and 2007 (Sharp et al. 2010). In 2006, a community-based Fox control program was initiated on lands surrounding Innes National Park, to reduce the immigration rate of Foxes into the park and thereby lower the intensity of predator control required on the park. By 2008-2009, 24 landholders were participating in the program, covering approximately 60,000 ha (Sharp et al. 2010). The Northern and York Natural Resources Management Board has been supporting a community-driven Fox control program (called 'Baiting for Biodiversity') across 170,000 Ha on southern Yorke Peninsula since 2012. These baiting programs have been followed by the re-appearance of bush stone curlew (*Burhinus grallarius*) after 40 years of no sightings, and echidnas after 20 years. They have also resulted in stable or increasing populations of malleefowl, hooded plovers and Rosenberg's goannas (Andy Sharp, pers comm 2018). Baiting for Biodiversity program resulted in a 30% increase in lamb survival (Max Barr - personal communication, 2018).

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2.3.3 Goanna responses to invasive predator control

Reptiles are rarely considered in the context of predator management programs (Bryant 2012, Sutherland and Bryant 2014). Foxes and cats show considerable dietary overlap with medium-sized and large goannas (Sutherland et al. 2011a) and goannas have been interpreted as the nearest ecological equivalent to Foxes in Australia (Pianka 1986, Pianka 1989). Small to medium-sized goannas are also preyed upon by Foxes (Catling 1988, Paltridge 2002, Olsson et al. 2005, Woinarski et al. 2018a). Therefore, controlling Foxes may lead to an increase in the population density of the medium-sized Rosenberg's goanna (*Varanus rosenbergii*) on Yorke Peninsula, due to decreased predation and/or competitive release.

This possibility is supported by a doubling of lace monitor (*Varanus varius*) abundance in areas were Foxes had been controlled (Hu et al. 2019), and a five-fold increase in sand goannas (V. gouldii) following Fox removal at two different sites (Olsson et al. 2005, Read and Scoleri 2015), though it is not clear whether reduced predation or competitive release explain these responses. Rosenberg's and sand goannas are closely related species (Pianka et al. 2004), both medium-sized and similar in many aspects of their biology, including body size and diet (King and Green 1999, Sutherland 2011). Therefore, it is possible that Rosenberg's goannas would show a similar response to that of sand goannas to decreased Fox density on southern Yorke Peninsula.

Dietary overlap is higher between medium-sized goannas and cats than it is to Foxes (Sutherland et al. 2011a). Cats are also known predators of goannas in general (Catling 1988, Dickman 1996a,

Molsher et al. 1999, Read and Bowen 2001, Paltridge 2002, Doherty et al. 2015, Woinarski et al. 2018a), and of Rosenberg's goannas in particular (Rismiller and McKelvey 2003). Eradication of feral cats from Faure Island in Shark Bay, Western Australia, caused a large increase in sightings of sand goannas (Rowles 2008).

Goannas can limit or regulate prey populations and have been used for pest control. In India, goannas are protected because they eat crabs that plague rice paddy dykes (Greer 1989). On some Pacific islands mangrove monitors (Varanus indicus) regulate populations of polynesian rats (*Rattus exulans*) and some beetles (Uchida 1967, Cota 2008). More locally, Rosenberg's goannas were reportedly introduced to Reevesby Island in Spencer Gulf to reduce the number of snakes (Mirtschin 1982, Robinson et al. 1985).

Should the population density of Rosenberg's goannas increase on Yorke Peninsula following control of cats and Foxes, it is likely to result in top-down changes in the abundance of the species preyed upon by goannas. Small lizard captures increased in a Fox, cat, rabbit and goanna-free exclosure compared to control sites in New South Wales (Olsson et al., 2005), though it is not clear which individual or combination of predator species was responsible for this change. In contrast, small lizard captures declined in a similar exclosure at the Arid Recovery Reserve, but where goannas had not been excluded (Moseby et al. 2009a).

The increased abundance of goannas inside the Arid Recovery Reserve may, at least partially, explain the decline in small reptile captures there (Read and Scoleri 2015). Goannas can also influence mammal and insect populations. On the Marshall and Palau islands Mangrove monitors (*Varanus indicus*) were considered a nuisance and cane toads were introduced to control their numbers (Dryden 1965, Uchida 1967, Cota 2008). Following the decline in mangrove monitors, Polynesian rats increased, and the numbers of beetles that harm coconuts also rose (Uchida 1967, Cota 2008). Predation by the arboreal lace goanna (*V. varius*) prevented population recovery of ringtail possums (*Pseudocheirus peregrinus*) following a bushfire (Russell et al. 2003).

Rosenberg's goannas are ectotherms, relying on environmental heat and solar radiation to maintain their preferred body temperature (King 1980, Green et al. 1991, King and Green 1999). They emerge from burrows after dawn to bask and commence activity when their body temperature approaches 35oC and return to their burrow in the evening, when they can no longer maintain their preferred body temperature. Their diurnal activity is strongly influenced by ambient temperature and solar radiation across the year. Consequently, goanna diel activity is longest in summer (King 1980, King and Green 1999, Sutherland and Predavec 2010). In contrast endothermic predators, such as cats and Foxes, are not restricted by ambient temperature and solar radiation. They can hunt for prey over a wider range of times. Cats and Foxes are generally crepuscular or nocturnal (Sutherland and Predavec 2010, Brook et al. 2012), although they can be active at any time of the day. Ectothermic predators have resting metabolic rates 10-20 times less than endotherms (Pough 1980). The rates at which ectotherms take prey, and their populations can respond to changes in prey abundance are lower than endotherms. However the relatively low energy demands of ectotherms mean they may occur at higher densities than mammalian or avian predators occupying similar niches (Sutherland and Bryant 2014). We are not aware of any empirical data allowing comparison of the relative impact of ecologically equivalent reptilian and mammalian predators, but reptilian predators such as Rosenberg's goanna, should pose a smaller potential impact on their prey than mammalian predators due to their lower energetic requirements and greater restriction by ambient temperatres.

Rosenberg's goannas may consume Fox and cat baits laid during baiting programs on Yorke Peninsula (Short et al. 1997, de Tores et al. 2011, Jessop et al. 2013). However goannas show a high tolerance for sodium monofluoroacetate ('1080'; Mcilroy et al. 1985), suggesting that consumption of 1080 baits is unlikely to harm them. This is supported by a five-fold increase in the density of sand

goannas in areas that had been subjected to 1080 baiting over ten years (Olsson et al. 2005). In contrast to 1080, goannas are susceptible to para-aminopropiophenone (PAPP; de Tores et al. 2011).The ectothermic physiology of Rosenberg's goannas could be used to mitigate any potential for Rosenberg's goannas to take baits laid to control Foxes and/or cats. Laying baits in cold weather, when goanna activity is low, should minimise the risk of goannas taking PAPP-based baits (Jessop et al. 2013).

In the absence of other predators, island populations of Rosenberg's goanna are larger than their mainland counterparts (Case and Schwaner 1993). The reasons for these differences are unclear, but may reflect competitive release in the absence of predators with whom they co-occur on the mainland (Sutherland et al. 2011a). Equally it could be due to other differences between islands and the mainland (e.g. food availability due to seabird colonies) that allow goannas to live longer and reach larger sizes on islands (e.g. Johnston 2011). For whatever reason, we may see changes in goanna body size in response to control of non-native predators and re-introduction of native predators on Yorke Peninsula.

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