BACKGROUND DOCUMENT

for the

THREAT ABATEMENT PLAN

for predation by the European red fox

2008

Department of the Environment, Water, Heritage
and the Arts

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Contents

1 Introduction

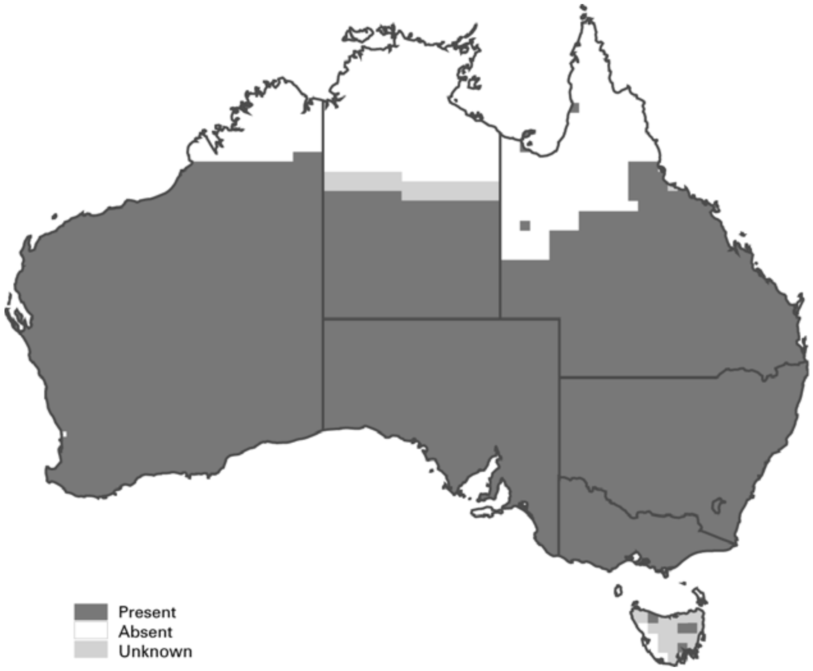
This is the background document to the *Threat abatement plan for predation by the European red fox* (DEWHA 2008). It provides information on fox characteristics, biology and distribution; impacts on environmental, economic, social and cultural values; and current management practices and measures.

The threat abatement plan (TAP) establishes a national framework to guide and coordinate Australia's response to the effects of predation by the European red fox on biodiversity. It identifies the research, management and other actions needed to ensure the long-term survival of native species and ecological communities affected by foxes. It replaces the *Threat abatement plan for predation by the European red fox* published in 1999 (EA 1999).

1.1 Fox distribution

The European red fox (*Vulpes vulpes*) has a natural distribution across the continents of Europe, Asia and North America. Hereafter in this document, a reference to 'fox' means 'European red fox' unless specifically indicated otherwise. In the Southern Hemisphere, foxes occur only in Australia, where they were introduced by English settlers in the 19th century (Rolls 1984). The fox is now one of at least 20 exotic mammals that have established a feral population (Strahan 1995). An adaptable and elusive predator and scavenger, the fox is distributed widely across the Australian mainland except for the far north (see Figure 1.1), and is now confirmed to be present in Tasmania (Saunders et al. 2006), although the extent of its distribution there is yet to be determined. Foxes in Tasmania are currently the subject of a major eradication program. The fox is creating environmental and economic impacts in Queensland (Gentle 2006); however, it has not yet colonised the tropical far north and is not established on Kangaroo Island or other offshore islands. In the light of current knowledge of control methods and ecology, the fox must be viewed as a permanent addition to the fauna of the Australian mainland.

Figure 1.1: Occurrence of the European red fox, *Vulpes vulpes*



Source: IA CRC and NLWRA (2007)

1.2 Impact of foxes

In 2004, foxes were estimated to cost the Australian environment and agricultural industries more than $227 million, of which $190 million was environmental impact (McLeod 2004). This estimate was based on two foxes per square kilometre, and a total of 7.2 million foxes in Australia. Anecdotal, circumstantial and experimental evidence shows that fox predation is a major threat to the survival of native Australian fauna (Saunders et al., in press). Terrestrial mammals at the greatest risk are those that weigh between 35 and 5500 grams (sometimes referred to as critical-weight-range species) and ground-nesting birds, many of which are endangered or vulnerable.

Given the extent of their impact on biodiversity, predation by the European red fox is listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Of the threatened species listed under the EPBC Act, foxes are considered a threat to 14 species of birds, 48 mammals, 12 reptiles and 2 amphibians, with the orange-bellied parrot, spotted quail-thrush (from Mt Lofty Ranges), herald petrel, Gilbert's potoroo and western swamp tortoise listed as critically endangered (see Appendix A of the current TAP).

For each key threatening process under the EPBC Act, the Minister must decide if a TAP is to be prepared. The Act prescribes the content of a TAP and the mechanisms by which it is to be prepared, approved and published. The relevant sections of the Act are reproduced in Appendix A.

Foxes occur on Commonwealth land such as national parks and Department of Defence properties. On a national scale, however, fox management on Commonwealth land is only a small part of the larger picture of conserving endangered or vulnerable species threatened by fox predation. State and territory wildlife agencies and their counterparts responsible for agricultural pest control have a long history of practical on-ground fox management, and it is largely through their efforts, often supported by Commonwealth programs, that major technical and strategic advances have been made.

1.3 Fox biology

A range of characteristics combine to make the fox an extremely successful invasive animal. It is listed by the World Conservation Union in its 100 worst invasive species in the world (Lowe et al. 2000). Foxes have a wide dietary range, few serious diseases and few natural enemies. They also have a high reproductive rate and a high rate of cub survival, although they only breed once a year.

Movement patterns vary during the year, depending on the breeding cycle. Sub-adult foxes are the most likely to disperse to new areas, particularly from late summer until the start of the breeding season. In one Australian study, some extreme dispersal distances were observed, the longest being a straight-line distance of 300 kilometres (Saunders et al. 2002).

2 Controlling foxes

Eradication of foxes is an attractive prospect because, once achieved, it requires no further commitment of resources; however, eradication is not currently considered a viable proposition for mainland Australia. According to Bomford and O'Brien (1995), to eradicate the fox:

- the mortality rate must be greater than the replacement rate at all population densities
- there must be no immigration
- sufficient foxes must be at risk from the control technique so that mortality from all causes results in a decrease in population
- all foxes must be detectable even at low densities
- a discounted cost–benefit analysis must favour eradication over control, and
- the socio-political environment must be suitable.

Complete removal of foxes from Australia is well beyond the capacity of available techniques and resources because the species is well established across a vast area. However, eradication from an island, or of a localised, newly introduced population, may be feasible provided a sufficiently rapid, well-funded and persistent campaign can be mounted.

Saunders and McLeod (2007) reviewed current knowledge on techniques for suppressing fox populations, including baiting, shooting, trapping, den fumigation or destruction, and exclusion fencing. The review concluded that, with the exception of broadscale baiting, the existing control methods are expensive and labour intensive, require continuing management effort and can be effective in only limited areas.

Fertility control through immunocontraception has been investigated as an alternative or supplementary means of fox control (Bradley et al. 1998), as has chemical fertility control (Marks et al. 1996). Other measures such as the use of guard animals have been promoted (Olsen 1998), but have not yet been fully evaluated in Australia.

Fox predation problems range in scale from individual foxes at a local level, to populations of foxes at the level of a national park or agricultural region (Saunders et al. 1995). The scale of the problem will determine the most appropriate and effective means of control. Large areas could be most appropriately targeted by aerial baiting or fertility control, while individual properties could make use of guard dogs. The cost-effectiveness and efficacy for each control technique, and in combination for integrated control programs, should be measured before deciding the most appropriate strategy.

Control of foxes will also be best achieved where integrated approaches target local or regional circumstances, and use the most appropriate suite of options to reduce and control population numbers and their impacts. Careful attention is needed in the selection and implementation of control methods to minimise any non-target impacts resulting from the control activities.

Control methods discussed here are baiting, biological control, barriers, habitat management, shooting and bounties.

2.1 Baiting

In most situations, poison baiting is the most effective method of reducing fox numbers and impact, although a major drawback is that it may affect native carnivores and scavengers such as dingoes, quolls, goannas and some scavenging birds, and also domestic dogs. The benefits of this control method are confined to the baited area and, unless some barrier prevents re-invasion, last only for as long as baiting is regularly applied.

Bait materials used in Australia include injected eggs, dried meat baits, fresh meat and commercial products such as Foxoff and De-Fox. The Western Australian Department of Environment and Conservation developed and manufactures its own bait, known as Pro-bait.

Aerial baiting of foxes can effectively control foxes in large areas, provided the risk of non-target bait uptake is minimal. In Western Australia — where aerial baiting is the most common form of fox control — baiting programs over areas of up to three million hectares have been shown to dramatically reduce fox numbers, to allow populations of rare species to increase and to have minimal impact on non-target species. This latter point is largely due to the native fauna having a higher resistance to the naturally occurring sodium fluoroacetate (1080) poison found in native plants.

Aerial baiting has not been implemented to the same extent in eastern Australia due to differences in landscape, land ownership, human habitation and lesser (compared to Western Australia) tolerance of native species to 1080 (Saunders and McLeod 2007), although it is used in Queensland and the Northern Territory (Sharp and Saunders 2004a). Aerial baiting is not legal on private land in New South Wales (Saunders and McLeod 2007), but the New South Wales National Parks and Wildlife Service has a special permit to aerial bait in the Yathong, Nombinnie and Round Hill nature reserves near Cobar to protect endangered mallee fowl. Further information on this program is available from their website.[1]

An example of a recent fox control program using aerial baiting is the collaboration between the Australian Wildlife Conservancy, the Invasive Animals Cooperative Research Centre and the Western Australian Government to reduce fox and cat numbers at Mt Gibson Wildlife Sanctuary. At the time of writing, sites for monitoring feral predator and prey abundance have been determined, a baseline ‘pre-baiting’ survey has been conducted and more than 70 000 aerial cat baits have been distributed on the property over a period of about six months. Early results suggest the baiting program has had a major impact on cat and fox numbers (IA CRC 2006), with foxes also taking the bait.

Where broadscale baiting is not feasible, and where the risk of bait uptake by non-target species is high, fox suppression at a local scale can be effective. With any small-scale baiting program (less than 1000 hectares), the establishment and maintenance of an effective buffer zone should be considered. Protection of prey species may require developing buffer zones of more than 15 kilometres, where foxes are held at a low density, to decrease the risk of inward migration rapidly replacing the foxes killed (Thompson et al. 2000).

Saunders and McLeod (2007) discuss the use of attractants in fox baits, a practice that has been recommended but not widely taken up. For example, a trial of bait containing synthetic fermented egg product, carried out in the southern highlands of New South Wales, found that the product significantly

1 http://www.nationalparks.nsw.gov.au/npws.nsf/content/fox_factsheet

increased visits to the site from wild dogs and foxes (Hunt et al. 2005). The product is now commercially available, as FeralMone, in an aerosol can. Saunders and McLeod (2007) suggest that the development of this readily available and user-friendly commercial product could mean an increase in the use of attractants. They also note that auditory lures were successful in attracting foxes to bait stations in arid regions of South Australia.

One of the consequences of prolonged baiting is that animals may develop bait shyness or an aversion to the poisons being used. For example, if foxes consume sublethal doses of 1080 due to a combination of bait caching and decay, they may become averse to baits. Saunders and McLeod (2007) suggest that further research is needed to determine whether this situation is important and, if so, how it can be averted.

To be effective, baiting must be intensive and cover a large area (as in the Western Shield program in Western Australia). Therefore, Saunders and McLeod (2007) suggest that research should focus on how baits are deployed rather than on developing the perfect bait.

2.2 Biological control

Some form of pathogen could conceivably affect foxes on a continental scale, but currently none is known to be sufficiently virulent, humane and specific to foxes.

Since foxes only breed once a year over a short period in early winter, fertility control could be applied over a short period of time each year. Targeting fertility may yield an effective long-term approach to reducing fox numbers. However, fertility control will not significantly reduce the danger to prey species until fox numbers have been reduced by natural attrition or by other means. Lethal control (e.g. through baiting) will therefore still be needed to rapidly reduce fox numbers. This could be followed by fertility control, used strategically to keep fox numbers low and thus provide long-term protection for threatened species.

Saunders and McLeod (2007) provide a detailed review of the state of biological control of foxes. Fertility control is still at an experimental stage of development, but the aim is to develop a safe and effective fertility control agent that may be delivered in bait. In practice, fertility control of wild vertebrates has been achieved on only a very limited scale using expensive and labour-intensive methods (Bomford 1990). It has not been successfully applied to a free-ranging population of wild vertebrates over a large area, nor has it been attempted as a method of reducing the impacts of predation on an endangered or vulnerable species.

Methods of fertility control include hormone treatment and the use of abortifacients such as cabergoline. Hormone treatment is not considered a viable option for managing populations of wild foxes as there are no practical methods of ensuring effective treatment of unrestrained animals. Saunders and McLeod (2007) state that preliminary research on the use of cabergoline is equivocal and that the technique, if proven, may be appropriate where active dens can be targeted (e.g. in peri-urban environments), but its suitability in rural settings remains unsubstantiated. The authors also note the need for economic assessment of the use of cabergoline and consideration of ethical concerns.

Much funding has gone into immunocontraception, particularly in the past 10 years. The Cooperative Research Centre for Biological Control of Vertebrate Pest Populations began a major program of research on immunocontraception in 1992 with funding provided through the Australian Government. Saunders and McLeod (2007) suggest that the most likely outcome of research into immunocontraception for foxes would be a bait-delivered, immunocontraceptive vaccine containing zona pellucida antigens, delivered as an oral vaccine through a recombinant canine herpes virus (PAC CRC 2001). However, this research has been discontinued, and the use of an immunocontraceptive vaccine as a control method is unlikely to be trialled.

2.3 Barriers

2.3.1 Fencing

Australia has a long history of fencing to control pest animals, extending over more than a hundred years. The early fences were designed to control rabbits or dingoes. More recently, fences have been proposed as a component in conservation management programs to protect prey species from predators such as foxes and cats.

Various fence designs have been developed to exclude foxes, but their relative effectiveness has not been assessed because of the lack of published information (Long and Robley 2004). A list of fence types for the exclusion of foxes, rabbits and cats, and their estimated cost, is provided in Table 2.1. Moseby and Read (2006) more recently tested fence designs for conservation purposes and found that the most effective against foxes was a 180-centimetre-high wire netting fence with a foot apron and a 60-centimetre-wide external netting overhang, curved in an arc and supported by lengths of heavy gauge wire. Steel posts were more effective than timber, as the foxes targeted the posts. Electric wires were only effective if supplemented with a physical barrier to ensure that animals received a sufficiently severe shock to be repelled.

Table 2.1: Types of fences used for fox, rabbit and feral cat exclusion

Fence type	Characteristics	Estimated cost/kilometre
Floppy top	Floppy top and electric wire to prevent scaling Mesh apron to deter digging under fence	$10 300 ($9700 without electric wire)
Overhang	Overhang to prevent scaling Wire netting barrier Mesh apron to deter digging under fence	$9900 ($8900 using 30 mm netting at base)
Electric wire overhang	Overhang and electric wire to prevent scaling Wire netting barrier Mesh apron to deter digging under fence	$11 400 with two electric wires plus an earth wire in overhang ($9800 with lighter grade posts)
Mesh/electric wire composite	Closely spaced electric wires as a barrier and a deterrent Wire netting barrier at base Mesh apron to deter digging under fence	$8000
Capped (New Zealand)	Wire mesh barrier Wire netting apron to deter digging under fence Steel roll cap to prevent climbing over Internal corner angles >120° to prevent jumping or bracing against adjacent fence panels	$50 000

Source: Long and Robley (2004)

Since little is known of the ability of targeted pest species to breach particular fence designs, it is not always possible to determine whether a fence design is going to prove inadequate or over-engineered in a given environment (Long and Robley 2004). Filling such knowledge gaps would allow optimal, cost-effective fence designs to be determined.

Frequent monitoring for the presence of foxes inside the fence is an essential precaution as considerable damage can be caused by a single fox breaching the fence. While fences may restrict movement of foxes, they may also pose a hazard to non-target wildlife, as well as placing limits on the natural ability of native animals to disperse.

The high cost of establishing predator-proof fencing and the ongoing maintenance costs involved mean that it is likely to be useful only for small areas (Aviss and Roberts 1994). However, studies at Shark Bay in Western Australia integrated fencing with baiting and trapping to reduce the frequency of challenge to the fence by incoming predators. The studies combined natural water barriers, fencing and baiting to attempt to create large predator-free reserves on peninsulas (CALM 1994).

2.3.2 Islands as natural barriers

Eradication of predators on islands and subsequent translocation of threatened species has been an important strategy for wildlife conservation. Some of the most successful examples of threatened species conservation have been on such islands or within enclosures from which feral predators are excluded.

Tasmania, Kangaroo Island and a number of small islands off the coasts of South Australia and Western Australia are the primary refuges of mammal species that are extinct or very rare on the mainland (Burbidge 1989). Given the threat that foxes pose to wildlife, it is essential that they continue to be excluded from the significant islands where they do not occur. Now that foxes have been confirmed in Tasmania (Saunders et al. 2006), the Tasmanian Government has announced its commitment to eradicating the fox, working with the Fox-free Taskforce in the state.

Preventing the introduction of foxes to islands of conservation value requires identification of potential routes of invasion, determination of the probability of such an event, and development of procedures to manage and minimise the risk. There must also be the ability to detect incursions before fox populations have a chance to become established, contingency plans that identify the most appropriate control measures and funding sources to implement the required control.

2.4 Habitat management

In environments with dense vegetation, steep topography, rocky crevices or extensive wetlands, prey are less likely to be caught by foxes (Saunders et al. 1995). The foraging efficiency of foxes seems to be maximised in open habitats where they are able to range widely and freely. They readily use roads, tracks and other cleared access ways through denser vegetation or complex topography. One option to minimise fox impacts on prey species is to remove such access points where possible and maintain bait stations along any remaining access paths.

Arboreal marsupials become vulnerable when they descend to the ground to move between trees. A continuous canopy and a thick understorey of shrubs enable them to move about in the trees where they are not at risk from fox predation. An important conservation strategy for some situations will be to minimise habitat fragmentation and to investigate options for fire, grazing or other management practices that do not destroy ground habitat.

2.5 Shooting

Shooting foxes on a contract basis is encouraged by many sectors (G Saunders, Vertebrate Pest Research Unit, NSW Department of Primary Industries, pers comm, 2007). However, the effect on fox numbers has not been documented, so research is needed into the cost-effectiveness of this approach if it continues to grow and to replace conventional control methods such as baiting. Although ground shooting of foxes may reduce local numbers or problem animals, it is labour intensive and is not effective as a broadscale fox control method.

2.6 Bounties

Reviews of the history of vertebrate pest management in general, and fox management in particular (Braysher 1993, Saunders et al., in press), conclude that subsidies and bounties have rarely been effective in reducing the damage caused by pest animals. Similarly, there is little evidence that, except occasionally and in small areas, hunting of foxes has a significant or lasting impact on fox numbers or the damage they cause.

Although there may be benefits to wildlife from widespread fox control on rural properties, it is not cost-effective, as a general policy, to seek to raise the level of recreational or professional hunting or trapping of foxes on a broad scale by payment of bounties, subsidies or other similar artificial market incentives. Where private land adjoins or contains important wildlife habitat, assistance or encouragement to landholders and the development of incentives to promote fox control on private land may be appropriate, especially if the property forms part of a buffer zone to protect threatened species populations.

3 Factors affecting fox control

This section looks at some of the factors to be considered when implementing fox control. It covers impacts on non-target species; the effects of wild rabbits, dingoes and feral cats; animal welfare concerns and cultural issues.

3.1 Impacts on non-target species

Many native birds, reptiles and marsupials are more tolerant of 1080 than foxes, especially in Western Australia where the toxin occurs naturally in certain native plant species. However, there is a risk in any fox poisoning campaign that some native carnivores and scavengers may be killed by ingesting baits intended for foxes. Among the native animals known to be most at risk from fox baiting are species of quoll (*Dasyurus*). These cat-sized marsupial carnivores are known to take fox baits under some circumstances, and some state laws do not permit baiting in areas where quolls are known to be present. In Tasmania, the abundance of two species of quoll and the Tasmanian devil (*Sarcophilus harrisii*) were reasons why fox eradication by baiting was considered not viable; however, research into possible impacts of 1080 on native species found negligible population effects (Saunders et al. 2006).

Establishing area-specific baiting protocols for foxes can minimise impacts on non-target species. Saunders et al. (1995) discuss methods for minimising the risk to non-target species, including: making the bait too big for smaller animals to swallow and too tough for them to tear apart; burying baits to make them less accessible; minimising the dose of 1080 in each bait; and conducting surveys to detect animals that may be at high risk and avoiding baiting near them. In a later publication, Saunders and McLeod (2007) discuss the possible risk to non-target species from foxes potentially regurgitating bait materials once toxic effects are experienced, and moving cached baits large distances from bait lines. Pro-bait has been shown to be potentially toxic to chuditch and brush-tailed phascogales in captive trials (Martin et al. 2002). However, no individual of either species was killed when toxic Pro-bait was made available to wild populations, and it has been endorsed for use at all Western Shield sites (N Marlow, Western Australian Department of Environment and Conservation, to G Saunders, pers comm, 2006).

Quoll populations may also be threatened by foxes competing with them for food; for example, Saunders and McLeod (2007) reported strong similarities in diet between foxes and quolls. It may be difficult at times to weigh the risk of non-target poisoning against the damage caused by an uncontrolled fox population. Further research is needed to assist decision making in these circumstances.

3.2 Effects of wild rabbits, dingoes and feral cats

The occurrence and abundance of rabbits and dingoes have been shown to influence fox numbers (Corbett 1995, Saunders et al. 1995). Rabbits and foxes are thought to have similar distributions on mainland Australia, and rabbits are one of the preferred foods for foxes. Where rabbit numbers are high, fox populations generally thrive, and when rabbit numbers drop, fox populations often decline (Williams et al. 1995). Rabbit control is therefore of critical importance to any operation aiming to achieve long-term suppression of fox numbers (Newsome 1990). However, a consequence of reducing rabbit numbers where foxes are present may be that foxes switch to preying more regularly on native species. This also needs to be taken into consideration with any fox control program.

Dingoes are common in the northern and central parts of Australia, but have been substantially controlled in the southeast and far southwest of the mainland. There is considerable evidence that in some areas where dingoes are common, foxes are excluded or their numbers are suppressed (Saunders et al. 1995, in press), and research indicates that dingoes protect a range of native species by controlling exotic predators such as foxes and cats in some areas (Pettigrew 1993). Dingoes forage in a manner similar to foxes and are susceptible to the same baiting methods. It is not feasible to selectively poison foxes in an area where dingoes are also present.

Studies investigating the control of foxes suggest that cats may be excluded or their numbers suppressed where foxes are common, and that reducing fox numbers may lead to increased cat numbers. Should these suggestions be confirmed, it will have implications for the way that fox control is applied and integrated with the management of cats.

Given the high level of interaction between foxes, cats and rabbits, activities identified in this plan must, wherever possible, be integrated with those detailed in the TAPs for the feral cat and rabbit.

3.3 Animal welfare concerns

Currently, 1080 poison is the primary method of lethal control of foxes. Wildlife and pest managers strongly support its continued use, but some animal welfare groups generally do not accept that baiting with 1080 poison is humane. Their concern relates to the possible suffering of poisoned foxes in baiting programs. These concerns could be addressed by the inclusion of an analgesic, sedative or anxiolytic (reduces muscle spasms) agent, combined with 1080 baits, and is an area that requires further research.

Consultation with animal welfare agencies, such as the Royal Society for the Prevention of Cruelty to Animals, has been facilitated through recent developments; for example, the discussion paper *A national approach towards humane vertebrate pest control* (HVPC Working Group 2004).

The Department of the Environment and Heritage (now the Department of the Environment, Water, Heritage and the Arts) commissioned the development of codes of practice and standard operating procedures (SOPs) for the humane capture, handling and destruction of feral animals. The *Model code of practice for the humane control of foxes* (Sharp and Saunders 2004b) provides information and recommendations to vertebrate pest managers responsible for the control of foxes, including advice on how to choose the most humane, target-specific, cost-effective and efficacious control techniques. Animal welfare issues related to fox management are also discussed by Saunders et al. (1995) and Saunders and McLeod (2007).

The SOPs for foxes include information about aerial baiting (Sharp and Saunders 2004a), ground baiting (Sharp and Saunders 2004c), ground shooting (Sharp and Saunders 2004d), fumigation of dens (Sharp and Saunders 2004e), trapping using padded-jaw traps (Sharp and Saunders 2004f) and trapping using cage traps (Sharp and Saunders 2004g). Each SOP provides information about the appropriate application of the method, animal welfare considerations, health and safety considerations, the equipment required and procedures to guide managers.

3.4 Cultural issues

Consideration of the differing cultural values attached to foxes must be an important component of any control program. The cultural value placed on foxes varies according to the observer’s own value system. Australia’s unique fauna is widely valued by society, and many perceive foxes to be a threat to the native fauna. Some, however, would see them as animals that have a right to a place in Australia’s environment. Some Indigenous people recognise introduced animals as part of the landscape and see them as newcomers rather than feral (Rose 1995). In some parts of Australia, foxes are still hunted for sport.

Indigenous Australians have a unique role to play in the management of natural and cultural areas, particularly in areas where traditional skills and knowledge are strong. Indigenous people can interpret the landscape and give insights into the natural history of certain species, and in some cases can track individual animals. Indigenous people can fulfil a range of other roles in feral animal control, beyond tracking; for example, by being contracted to remove, monitor and manage foxes. As the legal owners and managers of large areas of Australia, Indigenous communities are very important groups in the management of Australia’s feral animals.

4 Developing a national approach to fox management

This section looks at the different aspects involved in developing a national approach to fox management in Australia. It covers planning, strategies for allocating resources and identifying priority areas for action.

4.1 Planning for nationally coordinated action

Several recent publications have reviewed Australia's approach to fox management; these include Reddiex et al. (2004), Reddiex and Forsyth (2004), Saunders et al. (in press) and Saunders and McLeod (2007).

Total annual investment in fox control Australia wide has been estimated at about $40 million (Bomford and Hart 2002). In recent years, the Australian Government has funded fox control programs on its own lands and has also provided funding to state, territory and national organisations for fox control activities (see Table 4.1). Activities funded by the Australian Government have included projects to:

- remove foxes from Tasmania
- develop more humane toxins for use in baits
- develop an effective immunocontraceptive bait
- improve the ability to protect islands from foxes
- increase understanding of the level of control required to minimise threats to native species and ecological communities, and
- improve knowledge of the cost and effectiveness of exclusion fencing.

4.2 Strategies for allocating resources to fox management

Resources will never be sufficient to deal with all fox management problems; the TAP can, however, guide the strategic allocation of resources to give the best outcome for threatened species conservation.

Regional management is a central element of this plan; it focuses on areas where maximum benefits can be derived from reducing the impacts of fox predation on a range of species. Regional control programs are designed to protect a number of at-risk species and substantially expand available habitat. Broadscale control of foxes at this level of resolution requires a substantial investment of resources and can only be justified for species that are known to benefit from fox control. Examples of success in regional programs include Western Shield and Project Eden in Western Australia, Bounceback in South Australia and Southern Ark in Victoria.

Regional management is well suited to an adaptive management approach because it can accommodate different experimental control techniques within a broadly comparable area. The controls applied in the jarrah forests near Perth provide a particularly good example of a broadscale control program that included an experimental approach. By measuring the effectiveness of different control strategies in achieving recovery of threatened species populations, this program improved the ability of wildlife managers to successfully prepare sites for experimental reintroductions of threatened species. A focus on regional management will also provide a mechanism for integrating fox control with other biodiversity conservation actions such as Bushcare and other programs.

Table 4.1: Australian Government projects related to fox management, 2002–06

Project name	Recipient of funding

2002–03	
Development of an immunocontraceptive vaccine for the control of foxes in Australia	CSIRO Sustainable Ecosystems
A project that improves Australia's ability to protect its island habitats from feral animals — WA	WA Department of Conservation and Land Management
Development of a model code of practice and standard operating procedures for the humane capture, handling or destruction of feral animals in Australia	NSW Agriculture
Cost-effective fencing systems to exclude feral animals from areas of high conservation value in Australia	Arthur Rylah Institute for Environmental Research
A project to increase understanding of interactions between feral cats, foxes and feral rabbits in Australia	Arthur Rylah Institute for Environmental Research
A project to increase understanding of feral goat, feral cat, feral rabbit, fox and feral pig control required to minimise threats to native species and ecological communities Review of existing red fox, feral cat, feral rabbit, feral pig and feral goat control in Australia. II. Information gaps	Arthur Rylah Institute for Environmental Research
2003–04	
Development of an immunocontraceptive vaccine for the control of foxes in Australia	CSIRO Sustainable Ecosystems
2004–05	
Introduced animals on New South Wales islands: improving Australia's ability to protect its island habitats from feral animals	NSW Department of Conservation
Introduced animals on Northern Territory islands: improving Australia's ability to protect its island habitats from feral animals	NT Department of Infrastructure, Planning and Environment
Introduced animals on Tasmanian islands: improving Australia's ability to protect its island habitats from feral animals	Tasmanian Department of Primary Industries, Water and Environment
A project that reviews the Commonwealth Government's threat abatement plans for feral goats, feral rabbits, feral cats and the European red fox	Bureau of Rural Sciences
Experimental trials to determine effective feral cat and fox exclusion fence designs	Arthur Rylah Institute for Environmental Research
2005–06	

Fox Free Tasmania — Stage 3	Tasmanian Department of Primary Industries, Water and Environment
Development of PAPP (para-aminopropiophenone) based toxins as an alternative toxin for vertebrate pest control in Australia	Scientec Research Pty Ltd
Landscape-based optimisation of vertebrate pest management strategies	University of Canberra

CSIRO = Commonwealth Scientific and Industrial Research Organisation; NSW = New South Wales; NT = Northern Territory; WA = Western Australian

Recovery plans for a number of species identify the fox as a known or perceived threat. To ensure efficient and effective use of resources, an experimental approach is a suitable way forward to determine the significance of fox predation in the decline of these species, and to identify the level of control necessary for their recovery. By controlling foxes at a local level on an experimental basis, the true significance of predation by foxes as a threat to these species can be made clear. If the hypothesis that foxes are a significant threat is confirmed, this will justify expanding fox control activities to other sites where the at-risk species occur. Alternatively, if fox control is shown to be irrelevant to recovery of the species, efforts can be redirected to more effective activities.

Localised fox control in specific areas of high conservation concern, such as around populations of threatened species, may look to eradication as an appropriate response. Local eradication is an option available only for areas that meet strict criteria and where:

- the chances of reinvasion must be nil or very close to it
- all foxes must be accessible and at risk during the control operation, and
- foxes must be killed at a rate higher than their ability to replace losses through breeding.

Maintaining an area free from foxes requires a sustained control operation to prevent reinvasion from surrounding fox-infested areas. As a strategy, local eradication is applicable to small islands or small mainland sites that are surrounded by predator exclusion fences.

Where local eradication is not possible, two broad strategies can be used for localised management of foxes:

- sustained management, where control is implemented on a continuing, regular basis, or
- intermittent management, where control is implemented at critical periods of the year when damage is greatest and short-term control will reduce impacts to acceptable levels.

Sustained management is generally necessary for protecting habitats of endangered species or reintroduction sites. Intermittent management may be useful as a temporary seasonal measure at sites where predation is a seasonal threat, such as turtle nesting areas or resting sites of migratory bird species.

Buffer zones may be a necessary component of managing small areas to reduce the threat from continual reinvasion by foxes from surrounding areas. Development of such low-density buffer zones will require the active participation of surrounding landholders and a clear identification of the benefits to be obtained by all participants.

High priority must be given to monitoring the outcomes of fox control in terms of the conservation benefits derived and not simply a body count of dead foxes. Ineffective control may result in high body counts but little reduction in predation if foxes maintain a sustainably high reproductive rate, bait-shy foxes maintain predation pressure or there is immigration of foxes.

4.3 Identifying priority areas for action

The identification of those species and regions that will most benefit from coordinated fox control activities is clearly important. The development of species recovery plans will identify species that are known or perceived to be threatened by fox predation, as well as areas of habitat critical for the survival of these species. In terms of national action to abate the threat posed by foxes, implementation of recovery plans for these species must be accorded the highest priority. Local community groups and landowners should be encouraged to become involved in coordinated fox control plans for their region.

A system to weight areas according to the risk and the possibility of reducing that risk will be developed in order to allocate resources to areas where fox management is most needed. Good examples of prioritisation can be found for mammalian pests in New Zealand (Parkes and Nugent 1995), the fox (NSW NPWS 2001), feral cats (Dickman 1996) and pest animals in general (Braysher and Saunders 2003).

Parkes et al. (1996) describe a system developed in New Zealand to decide priority areas for investment in possum and feral goat control. This is a complex process that involves scoring native species in an area according to their conservation value and then weighting these scores for the threat posed to the species. Another system for identifying priority areas for work on feral cats was developed by Dickman (1996). Using the New Zealand system and that developed by Dickman as guides, procedures for prioritising areas for fox management in Australia will be refined. Accordingly, priorities for fox control for biodiversity conservation should be guided by:

- the degree of threat that foxes pose to the survival of the endangered or vulnerable species or ecological community
- the potential of the species or ecological community to recover
- the number of threatened species likely to benefit from control in that locality, and
- the cost-efficiency and likely effectiveness of fox control in each particular area, including the availability of sufficient resources for control that is sustained and logistically possible.

As recovery plans for more threatened species are finalised and adopted, it may become apparent that there are insufficient resources to fully implement all the fox control measures identified as required. Areas will then need to be ranked on a nationally consistent basis to ensure that decisions about funding for control activities maximise the conservation benefits to be derived. An agreed national methodology for ranking areas should cover protecting and facilitating the expansion of existing populations of threatened species, and preparing areas for translocation.

Appendix A: Threat abatement plans and the EPBC Act

Extracts from the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and EPBC Regulations 2000 relating to the requirements for threat abatement plans.

Section 271 Content of threat abatement plans

(1) A threat abatement plan must provide for the research, management and other actions necessary to reduce the key threatening process concerned to an acceptable level in order to maximise the chances of the long-term survival in nature of native species and ecological communities affected by the process.

(2) In particular, a threat abatement plan must:

(a) state the objectives to be achieved; and

(b) state the criteria against which achievement of the objectives is to be measured; and

(c) specify the actions needed to achieve the objectives; and

(g) meet prescribed criteria (if any) and contain provisions of a prescribed kind (if any).

(3) In making a threat abatement plan, regard must be had to:

(a) the objects of this Act; and

(b) the most efficient and effective use of resources that are allocated for the conservation of species and ecological communities; and

(c) minimising any significant adverse social and economic impacts consistently with the principles of ecologically sustainable development; and

(d) meeting Australia's obligations under international agreements between Australia and one or more countries relevant to the species or ecological community threatened by the key threatening process that is the subject of the plan; and

(e) the role and interests of indigenous people in the conservation of Australia's biodiversity.

(4) A threat abatement plan may:

(a) state the estimated duration and cost of the threat abatement process; and

(b) identify organisations or persons who will be involved in evaluating the performance of the threat abatement plan; and

(c) specify any major ecological matters (other than the species or communities threatened by the key threatening process that is the subject of the plan) that will be affected by the plan's implementation.

(5) Subsection (4) does not limit the matters that a threat abatement plan may include.

Section 274 Scientific Committee to advise on plans

(1) The Minister must obtain and consider the advice of the Scientific Committee on:

(a) the content of recovery and threat abatement plans; and

(b) the times within which, and the order in which, such plans should be made.

(2) In giving advice about a recovery plan, the Scientific Committee must take into account the following matters:

(a) the degree of threat to the survival in nature of the species or ecological community in question;

(b) the potential for the species or community to recover;

(c) the genetic distinctiveness of the species or community;

(d) the importance of the species or community to the ecosystem;

(e) the value to humanity of the species or community;

(f) the efficient and effective use of the resources allocated to the conservation of species and ecological communities.

(3) In giving advice about a threat abatement plan, the Scientific Committee must take into account the following matters:

(a) the degree of threat that the key threatening process in question poses to the survival in nature of species and ecological communities;

(b) the potential of species and ecological communities so threatened to recover;

(c) the efficient and effective use of the resources allocated to the conservation of species and ecological communities.

Section 279 Variation of plans by the Minister

(1) The Minister may, at any time, review a recovery plan or threat abatement plan that has been made or adopted under this Subdivision and consider whether a variation of it is necessary.

(2) Each plan must be reviewed by the Minister at intervals not longer than 5 years.

(3) If the Minister considers that a variation of a plan is necessary, the Minister may, subject to subsections (4), (5), (6) and (7), vary the plan.

(4) The Minister must not vary a plan, unless the plan, as so varied, continues to meet the requirements of section 270 or 271, as the case requires.

(5) Before varying a plan, the Minister must obtain and consider advice from the Scientific Committee on the content of the variation.

(6) If the Minister has made a plan jointly with, or adopted a plan that has been made by, a State or self-governing Territory, or an agency of a State or self-governing Territory, the Minister must seek the co-operation of that State or Territory, or that agency, with a view to varying the plan.

(7) Sections 275, 276 and 278 apply to the variation of a plan in the same way that those sections apply to the making of a recovery plan or threat abatement plan.

Environment Protection and Biodiversity Conservation Regulations 2000

REG 7.12 Content of threat abatement plans

For paragraph 271 (2) (g) of the Act, a threat abatement plan must state:

(a) any of the following that may be adversely affected by the key threatening process concerned:

(i) listed threatened species or listed threatened ecological communities;

(ii) areas of habitat listed in the register of critical habitat kept under section 207A of the Act;

(iii) any other native species or ecological community that is likely to become threatened if the process continues; and

(b) in what areas the actions specified in the plan most need to be taken for threat abatement.

Glossary

Abortifacient	A substance that induces abortion.
Arid	The arid and semiarid lands are those remote and sparsely populated areas of inland Australia, defined by the presence of desert vegetation and landforms as well as by low rainfall. They are bound by median annual rainfalls of about 250 mm in the south but up to 800 mm in the north and about 500 mm in the east (Beeton et al. 2006).
Biodiversity	Variability among living organisms from all sources (including terrestrial, marine and other ecosystems and ecological complexes of which they are part), which includes diversity within species and between species and diversity of ecosystems (Beeton et al. 2006).
Biodiversity conservation	The protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment (Beeton et al. 2006).
Buffer zone	An area that keeps two or more areas distant from one another.
Critically endangered	Under the EPBC Act, a native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	Under the EPBC Act, a native species is eligible to be included in the endangered category at a particular time if, at that time, (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Eradication	Application of measures to eliminate an invasive alien species from a defined area.
Feral	An introduced animal, formerly in domestication, with an established, self-supporting population in the wild.
Immunocontraception	The stimulation of the immune responses (antibody production and cell-mediated immunity) in the target animal against its own reproductive hormones, gamete proteins or another protein essential to reproduction, to induce sterility (Saunders and McLeod 2007).
Invasive species	A species occurring as a result of human activities beyond its accepted normal distribution and which threatens valued environmental, agricultural or personal resources by the damage it causes (Beeton et al. 2006).
Key threatening process	Under the EPBC Act, a process that threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.
Pest animal or species	Any non-human species of animal that causes trouble locally or over a wide area, to one or more persons, either by being a health hazard or a general nuisance, or by causing damage to agriculture, wild ecosystems or natural resources.
Recovery plan	Under the EPBC Act, a document setting out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities.

Threat abatement plan	Under the EPBC Act, a plan providing for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on impacted species and ecological communities.
Threatened species	Refers to the Australian Government list of threatened native species divided into the following categories as per the EPBC Act: critically endangered, endangered, vulnerable, conservation dependent.
Vulnerable	Under the EPBC Act, a native species is eligible to be included in the vulnerable category at a particular time if, at that time, (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Wild	Not domesticated or cultivated, but including escapees from domestication or cultivation.

Acronyms and abbreviations

EPBC Act	the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
SOP	standard operating procedure
TAP	threat abatement plan
1080	sodium fluoroacetate

References

Aviss M and Roberts A (1994). *Pest fences: notes and comments.* Threatened Species Occasional Publication 5, Department of Conservation, Wellington, New Zealand.

Beeton RJS, Buckley KI, Jones GJ, Morgan D, Reichelt RE and Trewin D (2006). *Australia state of the environment 2006,* independent report to the Australian Government Minister for the Environment and Heritage, Australian Government Department of the Environment and Heritage, Canberra.

Bomford M (1990). *A role for fertility control in wildlife management?* Bulletin 7, Bureau of Rural Resources, Canberra.

Bomford M and Hart Q (2002). Non-indigenous vertebrates in Australia. In: *Biological invasions: economic and environmental costs of alien plant, animal, and microbe species,* Pimentel D (ed), CRC Press, London, 25–44.

Bomford M and O'Brien P (1995). Eradication or control for vertebrate pests? *Wildlife Society Bulletin* 23:249–255.

Bradley MP, Hinds LA and Bird PH (1998). A bait-delivered immunocontraceptive vaccine for the European red fox (*Vulpes vulpes*) by the year 2002? *Reproduction, Fertility and Development* 9:111–116. http://www.publish.csiro.au/?act=view_file&file_id=R96066.pdf

Braysher M (1993). *Managing vertebrate pests: principles and strategies,* Bureau of Resource Sciences, Australian Government Publishing Service, Canberra.

Braysher M and Saunders G (2003). *PESTPLAN: a guide to setting priorities and developing a management plan for pest animals,* Natural Heritage Trust, Canberra. http://affashop.gov.au/product.asp?prodid=12598

Burbidge A (ed) (1989). Australian and New Zealand islands: nature conservation values and management. Occasional paper 2/89, Department of Conservation and Land Management, Perth.

CALM (Department of Conservation and Land Management) (1994). *Project Eden,* State Government of Western Australia, Perth.

Corbett L (1995). *The dingo in Australia and Asia,* the University of New South Wales Press, Sydney.

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008). *Threat abatement plan for predation by the European red fox,* DEWHA, Canberra.

Dickman CR (1996). *Overview of the impact of feral cats on Australian native fauna,* report to the Australian Nature Conservation Agency, Canberra. http://www.deh.gov.au/biodiversity/invasive/publications/cat-impacts/index.html (Accessed December 2006)

EA (Environment Australia) (1999). *Threat abatement plan for predation by the European red fox,* EA, Canberra.

Gentle M (2006). *Red fox pest status review,* Queensland Department of Natural Resources and Water. http://www.nrw.qld.gov.au/pests/pest_animals/declared/pdf/red_fox_psa.pdf

Hunt R, Dall D and Lapidge S (2005). Effect of a synthetic lure on site visitation and bait uptake by foxes *(Vulpes vulpes)* and wild dogs *(Canis lupis dingo/Canis lupis familiaris).* In: *Proceedings of the third NSW pest animal control conference,* Balogh S (ed), Coffs Harbour, NSW Department of Primary Industries, Orange, 38–40.

HVPC Working Group (Humane Vertebrate Pest Control Working Group) (2004). A national approach towards humane vertebrate pest control. Discussion paper arising from the proceedings of an RSPCA Australia/AWC/VPC joint workshop, 4–5 August, Melbourne, RSPCA Australia, Canberra.

IA CRC (Invasive Animals Cooperative Research Centre) (2006). AWC blitzes foxes and cats at Mt Gibson. *Feral Flyer* 71.

IA CRC and NLWRA (Invasive Animals Cooperative Research Centre and the National Land & Water Resources Audit) (2007). Unpublished maps produced under the National Monitoring and Evaluation Framework.

Long K and Robley A (2004). *Cost effective feral animal exclusion fencing for areas of high conservation value in Australia,* Australian Government Department of the Environment and Heritage, Canberra. http://www.deh.gov.au/biodiversity/invasive/publications/fencing/index.html (Accessed December 2006)

Lowe S, Browne M and Boudjelas S (2000). *100 of the world's worst invasive alien species: a selection from the Global Invasive Species Database,* Invasive Species Specialist Group, Auckland.

Marks CA, Nijk M, Gigliotti F, Busana F and Short RV (1996). Preliminary field assessment of a cabergoline baiting campaign for reproductive control of the red fox *(Vulpes vulpes). Wildlife Research* 23(2):161–168.

Martin GR, Twigg LE, Marlow NJ, Kirkpatrick WE, King DR and Gaikhorst G (2002). The acceptability of three types of predator baits to captive non-target animals. *Wildlife Research* 29:7489–7502.

McLeod R (2004). *Counting the cost: impact of invasive animals in Australia, 2004,* Cooperative Research Centre for Pest Animal Control, Canberra. http://www.pestanimal.crc.org.au/info/Mcleod.pdf (Accessed December 2006)

Moseby KE and Read JL (2006). The efficacy of feral cat, fox and rabbit exclusion fence designs for threatened species protection. *Biological Conservation* 127:429–437.

Newsome AE (1990). The control of vertebrate pests by vertebrate predators. *Trends in Ecology and Evolution* 5:187–191.

NSW NPWS (New South Wales National Parks and Wildlife Service) (2001). *Threat abatement plan for predation by the red fox* (Vulpes vulpes), NSW NPWS, Hurstville.http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Predation+by+the+red+fox+-+final+threat+abatement+plan (Accessed December 2006)

Olsen P (1998). *Australia's pest animals: new solutions to old problems,* Bureau of Resource Sciences, Kangaroo Press, East Roseville.

PAC CRC (Pest Animal Control CRC) (2001). *Annual Report 2000–2001,* Pest Animal Control CRC, Canberra.

Parkes JP and Nugent G (1995). *Integrating control of mammalian pests to protect conservation values in New Zealand,* Manaaki Whenua–Landcare Research, Christchurch, New Zealand, Landcare Research Contract Report LC 9495/104.

Parkes J, Henzell R and Pickles G (1996). *Managing vertebrate pests: feral goats,* Australian Government Publishing Service, Canberra.

Pettigrew JD (1993). A burst of feral cats in the Diamantina — a lesson for the management of pest species? In: *Cat management workshop,* Seipen G and Owens C (eds), Queensland Department of Environment and Heritage, Brisbane.

Reddiex B and Forsyth DM (2004). *Review of existing red fox, feral cat, feral rabbit, feral pig and feral goat control in Australia. II. Information gaps,* Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Melbourne.

http://www.deh.gov.au/biodiversity/invasive/publications/information-gaps/pubs/information-gaps-final.pdf (Accessed December 2006)

Reddiex B, Forsyth DM, McDonald-Madden E, Einoder LD, Griffioen PA, Chick RR and Robley AJ (2004). *Review of existing red fox, wild dog, feral cat, feral rabbit, feral pig, and feral goat control in Australia. I. Audit,* Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Melbourne. http://www.deh.gov.au/biodiversity/invasive/publications/feral-audit/summary.html (Accessed December 2006)

Rolls EC (1984). *They all ran wild: the animals and plants that plague Australia,* Angus and Robertson, Sydney.

Rose B (1995). *Land management issues: attitudes and perceptions amongst Aboriginal people of central Australia,* a report to the Central Land Council, Alice Springs.

Saunders G and McLeod L (2007). *Improving fox management strategies in Australia,* Bureau of Rural Sciences, Canberra.

Saunders G, Coman B, Kinnear J and Braysher M (1995). *Managing vertebrate pests: foxes,* Bureau of Resource Sciences, Australian Government Publishing Service, Canberra.

Saunders G, McIlroy J, Berghout M, Kay B, Gifford P and van de Ven R (2002). The effects of induced sterility on the territorial behaviour and survival of foxes. *Journal of Applied Ecology* 39:56–66.

Saunders G, Lane C, Harris S and Dickman C (2006). *Foxes in Tasmania: a report on an incursion of an invasive species,* Invasive Animals Cooperative Research Centre. http://www.invasiveanimals.com/images/pdfs/FoxReview_Web.pdf (Accessed December 2006)

Saunders G, Gentle M and Dickman C (in press). *The management of foxes and their impacts in Australia.*

Sharp T and Saunders G (2004a). *FOX002 Aerial baiting of foxes with 1080*, Vertebrate Pest Research Unit, Australian Government Department of the Environment and Heritage, Canberra. http://www.deh.gov.au/biodiversity/invasive/publications/humane-control/fox002-aerial-baiting-foxes-1080.pdf (Accessed December 2006)

Sharp T and Saunders G (2004b). *Model code of practice for the humane control of foxes,* Vertebrate Pest Research Unit, Australian Government Department of the Environment and Heritage, Canberra. http://www.environment.gov.au/biodiversity/invasive/publications/humane-control/cop-foxes.pdf

Sharp T and Saunders G (2004c). *FOX001 Ground baiting of foxes with 1080,* Vertebrate Pest Research Unit, Australian Government Department of the Environment and Heritage, Canberra. http://www.environment.gov.au/biodiversity/invasive/publications/humane-control/fox001-ground-baiting-foxes-1080.pdf

Sharp T and Saunders G (2004d). *FOX003 Ground shooting of foxes,* Vertebrate Pest Research Unit, Australian Government Department of the Environment and Heritage, Canberra. http://www.environment.gov.au/biodiversity/invasive/publications/humane-control/fox003-ground-shooting-foxes.pdf

Sharp T and Saunders G (2004e). *FOX004 Fumigation of fox dens with carbon monoxide,* Vertebrate Pest Research Unit, Australian Government Department of the Environment and Heritage, Canberra. http://www.environment.gov.au/biodiversity/invasive/publications/humane-control/fox004-fumigation-fox-dens-carbon-monoxide.pdf

Sharp T and Saunders G (2004f). *FOX005 Trapping of foxes using padded-jaw traps,* Vertebrate Pest Research Unit, Australian Government Department of the Environment and Heritage, Canberra. http://www.environment.gov.au/biodiversity/invasive/publications/humane-control/fox005-trapping-foxes-padded-jaw-traps.pdf

Sharp T and Saunders G (2004g). *FOX006 Trapping of foxes using cage traps,* Vertebrate Pest Research

Unit, Australian Government Department of the Environment and Heritage, Canberra. http://www.environment.gov.au/biodiversity/invasive/publications/humane-control/fox006-trapping-foxes-cage-traps.pdf

Strahan R (1995). *The mammals of Australia,* Reed Books, Chatswood.

Thomson PC, Marlow NJ, Rose K and Kok NE (2000). The effectiveness of a large-scale baiting campaign and an evaluation of a buffer zone strategy for fox control in Western Australia. *Wildlife Research* 27:65–472.

Williams K, Parer I, Coman B, Burley J and Braysher M (1995). *Managing vertebrate pests: rabbits,* Bureau of Resource Sciences and CSIRO Division of Wildlife and Ecology, Australian Government Publishing Service, Canberra.