BACKGROUND DOCUMENT

for the

THREAT ABATEMENT PLAN

for predation by feral cats

2008

Department of the Environment, Water, Heritage
and the Arts

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1 Introduction

This is the background document to the *Threat abatement plan for predation by feral cats* (DEWHA 2008). It provides information on feral cat 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 feral cats 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 feral cats. It replaces the *Threat abatement plan for predation by feral cats* published in 1999 (EA 1999).

1.1 Feral cat distribution and abundance

Cats (*Felis catus*) have a history of association with humankind dating back thousands of years. They accompanied seafarers for vermin control, companionship and food (Jones 1989, Dickman 1996), and in this way the species has spread to all inhabited parts of the globe and many uninhabited islands. The feral cat is now the most widely distributed of all the world's felids.

The first recorded instance of cats being brought to Australia is by English settlers in the 18th century, although cats may have arrived with much earlier visitors to the continent (Baldwin 1980). Cats were deliberately released into the wild during the 19th century to control rabbits and mice (Rolls 1984). With the exception of some of the wettest rainforests, feral cats are now found in mainland Australia, Tasmania and many offshore islands (Figure 1.1).

Figure 1.1: Occurrence of feral cats, *Felis catus*

Source: IA CRC and NLWRA (2007)

The feral cat population is continually boosted as domestic cats are recruited (SoE SA 2003). There are approximately 3 million domestic cats and 18 million feral cats in Australia (McLeod 2004).

1.2 Impact of feral cats

Predation by feral cats has caused the decline and extinction of native animals on islands (van Rensburg and Bester 1988, Copley 1991, Burbidge and Manly 2002). In addition, evidence from the tabulation of bird population responses to the eradication or control of feral cats shows that most bird populations do increase in size. Modelling has also shown an association between cat presence and native mammal extinctions on Australian islands (Burbidge and Manly 2002).

The clearest evidence of the effects of cat predation on native animals comes from island data; however, cat predation has also had a major effect in mainland Australia. According to Van de Kuyt (2001), species at risk from cat predation:

- have very localised or fragmented distributions
- occur in low densities
- have low reproductive rates and slow growth rates
- have behavioural characteristics that make them more vulnerable (e.g. inappropriate avoidance behaviour)
- occur in colonies or are colonial breeders
- occur in areas where cat numbers are high, and
- occur in specific habitats that have been largely destroyed or modified by humans.

On the mainland, predation by feral cats (and foxes) threatens the continued survival of native species such as the eastern barred bandicoot in Victoria, which currently persists in low numbers in the wild (Dickman 1996) and in several captive colonies. Feral cats have thwarted reintroduction programs for threatened species such as the numbat, golden bandicoot, burrowing bettong, mala and bilby in the arid and semiarid zones of Western Australia and the Northern Territory (Johnson 1991, Gibson et al. 1994, Dickman 1996). Cats were recently eradicated, using aerial baiting and trapping, from the Montobello Islands Conservation Park in Western Australia (Algar et al. 2002, Burbidge 2004) and Faure Island in Western Australia (Algar et al. 2001), with the aim of reintroducing threatened native mammals. A similar reintroduction program is under way on the Peron Peninsula in Western Australia.

Predation by feral cats is listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Of those species on the EPBC Act threatened species list, feral cats are considered a threat to 35 species of birds, 36 mammals, 7 reptiles and 3 amphibians, with 4 of those, the orange-bellied parrot, spotted quail-thrush (Mt Lofty Ranges), herald petrel and Gilbert's potoroo, being critically endangered (see Appendix A of the 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.

1.3 Cat biology

Australia and Antarctica are the only continents without a native member of the cat family, Felidae. Felids have a body form, musculature, nervous coordination and senses that are highly specialised for stalking and capturing prey. All species of wild cats prefer live prey and will rarely consume carrion, except during droughts or when they are debilitated.

The adult feral cat weighs 4 kilograms on average but can weigh up to 9 kilograms. Feral cats are carnivores and can survive with limited access to drinking water because they consume adequate moisture from their prey: small mammals, birds, reptiles, amphibians, fish and insects (DEH 2004). They are solitary and predominantly nocturnal, spending most of the day in burrows, logs or rock piles. Male feral cats may occupy a home range of 10 square kilometres, or larger if food is scarce. The home ranges of female feral cats are smaller.

Mature (one year or older) feral cats can breed in any season and produce up to two litters, each of about four kittens, every year. Few kittens survive. Dingoes and foxes prey on feral cats and compete for food, as do wedge-tailed eagles. Feral cats also carry infectious diseases that can be transmitted to native animals, domestic livestock and humans (DEH 2004).

1.4 Categories of cats

In recent years, the impact of cat predation on native Australian wildlife has become a prominent public issue with strongly polarised opinions, especially where domestic cats are implicated. Cats can be grouped into categories according to how and where they live. The definitions and categories used vary widely, so the following terms are used for the purposes of this plan:

- *feral cats* are those that live and reproduce in the wild (e.g. forests, woodlands, grasslands, wetlands) and survive by hunting or scavenging; none of their needs are satisfied intentionally by humans
- *stray cats* are those found in and around cities, towns and rural properties; they may depend on some resources provided by humans but are not owned, and
- *domestic cats* are those owned by an individual, a household, a business or corporation; most of their needs are supplied by their owners.

These categories of cats reflect a continuum, and individuals may move from one category to another (Newsome 1991, Moodie 1995). In any given situation, the category causing the most damage to wildlife needs to be identified because management actions will depend on the type of cat causing the damage. Where domestic cats are the primary cause, management is likely to concentrate on owners and consist of promoting responsible ownership through education and legislation. For feral cats, the focus is on reducing numbers or inhibiting predation through the use of mechanical, chemical or biological methods. Control of stray cats often requires a combination of technical and social approaches.

1.4.1 Domestic cats

Concern about predation on wildlife by domestic cats developed in Victoria during investigations into the decline of the eastern barred bandicoot (Brown 1989). Cat predation has since become a national issue among cat owners, veterinarians, conservationists and wildlife managers. A study published in 1990 suggested that domestic cats in South Australia killed an average of 26 animals per year, many of them native birds (Paton 1990). Subsequent surveys have both supported (Trueman 1991) and contradicted (Reark 1994) Paton's conclusions. In urban areas of Victoria, traumatised small mammals are usually reported as victims of cat attack (Dowling et al. 1994).

The data on predation by domestic cats is poor and does not provide information about the impact on populations of most prey species. Data obtained by written or telephone questionnaire have a number of areas of potential bias (Manly 1992). Too much reliance is placed upon the memory of cat owners, their ability to identify prey animals and their willingness to participate fully in a survey. Also, animals brought home may not have been caught or injured by the cat.

Management of cats in cities may not be seen as an issue of wildlife conservation because animals that live in cities, whether native or introduced, are generally common, adaptable species. With few exceptions, threatened species do not occur in or near cities and may not be directly at risk from domestic cats. Nevertheless, domestic cats in cities occur in very high densities and, even if each individual cat is taking only a small number of prey, the sum of that predation will reduce urban wildlife populations.

Although the responsibility for managing domestic cats ultimately rests with their owners, consideration must be given to mechanisms to limit the impact of domestic cats on native fauna. State, territory and local governments already support initiatives aimed at encouraging responsible pet ownership, including the development of appropriate legislation, education and awareness programs, and management plans to address local problems and prevent the transition of cats from domestic to stray to feral. Victoria has

enacted legislation that requires cat owners to register their animals and gives councils the power to set fees and take remedial action. New South Wales has initiated the development of legislation to promote responsible ownership and improved welfare of companion animals.

Moves by governments to control cats present a range of opportunities to measure the conservation benefits to be derived from managing urban cats (Tidemann 1994). Rigorous monitoring and analysis of various management regimes and suitably designed experiments could determine whether laws to control domestic cats lead to desirable outcomes for urban and peri-urban wildlife.

1.4.2 Stray cats

Irresponsible cat owners and those who feed stray cats play a major role in maintaining populations of stray cats in urban and rural areas. Encouraging changes in the behaviour of these people will significantly reduce the numbers of free-ranging stray cats where these are causing damage. Control of stray cats is promoted by groups such as the Royal Society for the Prevention of Cruelty to Animals (RSPCA) to address significant animal welfare concerns.

Capturing, sterilising and releasing are seen as an effective approach to managing colonies of stray cats in urban Europe (Hammond 1981) and have been used in parts of Adelaide (Pierson 1994). This approach improves cat welfare and enhances urban amenity, but no benefits to wildlife are derived as the number of predators remains unchanged. Any programs to manage stray cats in urban and peri-urban areas should be reviewed to determine their effectiveness in achieving wildlife conservation goals.

1.4.3 Feral cats

The nature and extent of the threat posed to native wildlife by feral cats are poorly understood, and the evidence relating to their impacts on the mainland is largely inferred. Feral cats are mobile, especially during periods of food shortage (Newsome 1991), and can disperse widely. The feral cat population is self-sustaining and may breed at any time of the year under favourable conditions. Feral cats occupy virtually all Australian environments, and the damage they cause to wildlife is likely to vary widely across this spectrum of habitats.

This plan focuses primarily on managing the impact of feral cats. In general, species listed as threatened that are susceptible to cat predation are located in areas where domestic and stray cats are absent. It is generally accepted that improvements in the management of domestic and stray cats are necessary to reduce recruitment to the feral cat population (Copley 1991), but there is little research demonstrating that populations of feral cats are significantly bolstered by such recruitment. However, for eradication and control efforts to be sustained, the transition of cats from domestic to stray to feral must be prevented so that new feral cat populations are not established.

Feral cats occur on Commonwealth land, such as Department of Defence properties and Commonwealth-managed national parks. On a national scale, however, management of feral cats on Commonwealth land is only a small part of the larger picture of conserving threatened species affected by cat predation. State and territory wildlife agencies have a long history of practical on-ground management of feral cats, and it is largely through their efforts, often supported by Commonwealth programs, that major technical and strategic advances have been made. More recently, private sector and community initiatives have also contributed to feral cat control activities.

2 Controlling feral cats

Eradication of feral cats is an attractive option because, once achieved, it requires no further commitment of resources other than for monitoring. Bomford and O'Brien (1995) argue that the following conditions must apply to achieve eradication:

- the rate of removal exceeds the rate of increase at all population densities
- there is no immigration, and
- all reproductive animals are at risk (e.g. all females in the population are eliminated).

They further state that eradication is the preferred option only when:

- all animals can be detected at low densities
- discounted cost–benefit analysis favours eradication, and
- there is a suitable sociopolitical environment.

These conditions cannot be met for feral cats on mainland Australia or in Tasmania at present. The eradication of feral cats is well beyond the capacity of available techniques and resources because the species is so well established across such a vast area. Feral cats are found in very low densities over large home ranges, making them difficult to locate. They can reproduce quickly under favourable conditions in self-sustaining populations.

In contrast, eradication of populations of feral cats from islands is feasible and has been achieved on Macquarie Island (Tasmania) and on the Montobello Islands and Faure Island (Western Australia). Flinders Island and Bruny Island (Tasmania) also have active cat management programs, but many other similar Tasmanian islands have no control or eradication programs for feral cats or other vertebrate pests (RPDC 2003). According to Nogales et al. (2004), feral cats have been removed from at least 48 islands globally.

The main techniques currently used for the control of feral cats are trapping, shooting and exclosures. The Department of the Environment, Water, Heritage and the Arts currently supports research into felid-specific baits and toxins (with the Western Australian Department of Environment and Conservation and the Victorian departments of Sustainability and Environment, and Primary Industries). There has been some use of fumigation, sodium fluoroacetate (1080) and secondary poisoning from rat-baiting campaigns in the past, although these methods are not common or mainstream (Q Hart, National Feral Animal Control Program, pers comm, June 2007).

The control of cats will be best achieved where an integrated approach targeting the local or regional circumstances uses the most appropriate suite of available 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 techniques, both those currently available and those being developed, are briefly discussed below. Available methods are generally expensive and labour intensive, require continuing management effort and can be effective only in limited areas. The techniques discussed here are shooting, trapping, exclusion fencing, baiting, fumigants, biological control, fertility control, commercial harvesting, financial incentives and habitat management.

2.1 Shooting

As a control technique, shooting is most appropriate if applied for an extended period or timed opportunistically. Feral cats are killed by recreational shooters, but the magnitude of the impact on feral cat or prey populations is unknown. The South Australian Department for Environment and Heritage uses recreational hunters for controlling feral goats and to complement other methods of fox and feral cat control in some areas (T Naismith, Parks and Wildlife Manager, Flinders Ranges National Park, pers comm).

Shooting is humane if the shooters are experienced, skilled and responsible (Sharp and Saunders 2004a). If cats are wounded, they must be located and killed as soon as possible, as should dependent kittens of lactating female cats. Shooting is expensive, labour intensive and time consuming and can only be done on a relatively small scale.

2.2 Trapping

Although steel-jawed and neck-snare traps have been used in trapping feral cats in the past, it is now widely recognised that traps that contain animals are more humane than traps that restrain animals. Soft-catch traps can be set to prevent lighter non-target species from being caught, or non-target species can be released with minimal harm. Treadle snares are another humane alternative to steel-jawed traps, but they are difficult to set and must be checked every four to six hours (Sharp and Saunders 2004a).

Trapped animals are vulnerable to exposure, thirst, starvation, shock, capture myopathy (malfunction of muscle fibre) and predation, so traps must be sheltered from extreme weather and checked at least daily. Trapped feral cats must be killed quickly and humanely, along with dependent kittens, and non-target animals should be released if unharmed, or treated or killed humanely if wounded (Sharp and Saunders 2004a).

Cage traps are generally ineffective for trapping feral cats, but can be used for trapping stray and domestic cats around rubbish dumps and in nature reserves close to urban development. To successfully trap feral cats, the lure or attractant chosen is most important. Research on a number of lure types is currently being undertaken (see Section 2.4). Trapping as a control method is expensive, labour intensive and time consuming, and is only recommended on a small scale or where eradication is the objective.

2.3 Exclusion fencing

At present, the most effective management technique for wildlife vulnerable to terrestrial predators, such as feral cats, relies on barriers. In many cases, these are natural barriers — stretches of water surrounding islands — but a number of small reserves have been enclosed with predator-proof fencing (Aviss and Roberts 1994, Coman and McCutchan 1994).

A review of predator-proof fencing in Australia has found that, although most fences are a significant barrier to foxes and feral cats, even the most elaborate can be breached (Coman and McCutchan 1994). If breached, fences increase the vulnerability of threatened species by preventing their escape from predators. To minimise this risk, fencing should be combined with an integrated baiting and trapping program to reduce the frequency of challenge to the fence by incoming predators. The combination of fencing with a baiting and trapping program is an expensive option that is likely to be useful only for small areas or areas with specific characteristics, such as peninsulas. Fencing also affects the movement of other wildlife, preventing their dispersal and interbreeding with other populations. Projects in Shark Bay, Western Australia, have sought to use a combination of conventional control methods, natural water barriers and fencing to create large

predator-free reserves on peninsulas (CALM 1994).

Exclusion fences are often erected for the purpose of excluding more than one type of vertebrate pest. Five types of fences are used for fox, rabbit and cat exclusion; the characteristics and estimated costs of these are shown in Table 2.1.

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)

Particular aspects of cat behaviour determine the type of fence necessary for their exclusion (Long and Robley 2004). Small mesh sizes at the base of fences are necessary to exclude kittens. Cats can jump higher than 1.8 metres, and can land and jump again on vertical netting. Some cats can withstand many electric shocks in order to cross a fence. However, cats do not like unstable surfaces.

Exclusion fencing is considered to be the most humane non-lethal feral cat control method, but the cost of establishing and maintaining fences can be prohibitive. Their use tends to be limited to the management of highly valued threatened species that live in relatively small areas from which cats can be eradicated (e.g. bilby colonies). Any fencing can increase the vulnerability of non-target species by changing dispersion and foraging patterns, increasing the risk of entanglement and electrocution, and posing a bushfire hazard (Sharp and Saunders 2004a).

2.4 Baiting

Baiting is usually the cheapest and most effective broadscale technique for controlling the numbers of inconspicuous small and medium-sized pest animals. Baiting techniques for feral cats tend to be much less effective than techniques for baiting dogs and foxes.

Baiting feral cats is difficult because they are often found in low densities, can have large home ranges, may only feed on carrion when live food is scarce and are naturally wary. For a bait to be successful, feral cats must be able to detect it; also, it must be attractive to them, particularly where they occur at low densities. The timing of a baiting program is a critical element in the successful baiting of feral cats (Short et al. 1997, Algar et al. 2007). Aerial baiting may be the only option for broadscale control of feral cats.

The Department of Environment and Conservation in Western Australia has developed a sausage-like bait that is proving effective in experimental and operational baiting programs (Burrows et al. 2003, Algar and Burrows 2004) under different conditions. Even though native species have evolved a degree of tolerance to 1080, a number of non-target species are potentially at risk from cat baiting programs because of their size and ability to consume the relatively small, moist bait. Methods to reduce the exposure and risk to non-target species are being pursued.

Baits that use 1080 must be buried when used in eastern states, which severely restricts their use in targeting feral cats. Lures to attract cats at low densities need to be developed, together with new toxins for cat baits that are target specific and humane.

2.4.1 Toxins

The use of cyanide in Australia for pest control is currently illegal, except under permit for research. Algar and Kinnear (1992) developed the use of cyanide as a research tool for studies of fox ecology. The technique has also been used to assess bait preferences of feral cats (Friend and Algar 1995, Algar and Sinagra 1996). The use of cyanide as a control technique was also evaluated by Marks and Gigliotti (1996), who found that there was some benefit in using it as a means of taking foxes to measure population parameters, develop indices of abundance, verify impact on target and non-target species, and monitor rates of reinvasion. This was a consequence of the speed with which the poison acted and was seen as being humane. An ejector system to deliver the poison was also developed, but this remains a tool for research and has not been licensed for general use. The capacity to use this technique on feral cats has not been evaluated.

Development of a felid-specific toxin has been identified as a priority for feral cat control. It must be humane and specific, have a delivery system that minimises non-target exposure, and be cheap, safe and easy to deploy. The application of such a system will need to be complemented by an education and awareness program.

2.4.2 Lures

Feral cats' hunting skills rely on audio and visual stimuli rather than an acute sense of smell. Researchers within Australia are currently examining audio and visual attractants that will lure feral cats to baits (Algar et al. 2007). Bait additives that enhance smell and taste are also being evaluated (Algar and Burrows 2004). Certain lures being examined may also be used to trap cats and monitor cat abundance.

2.5 Fumigants

Feral cats and foxes are known to use rabbit warrens as dens or shelter, making them vulnerable to techniques such as fumigation. However, native reptiles and small mammals also use rabbit warrens and may be at risk of exposure if fumigants are used. Thus, any use of fumigants would have to take into account the risk to native species.

Aside from the risk to native species, there are serious concerns about the animal welfare implications of using certain fumigants. Williams et al. (1995) regard chloropicrin as inhumane. The risk to people using fumigants such as chloropicrin is also recognised in occupational health and safety guidelines, which contain stringent handling requirements. The *Model code of practice for the humane control of feral cats* (Sharp and Saunders 2004a) does not mention the use of fumigants; this method is not commonly used and is not regarded as a humane and effective control technique for these animals.

2.6 Biological control

In 1977, the viral disease feline panleucopenia*,* also known as feline parvovirus and feline enteritis, was introduced to sub-Antarctic Marion Island by South African wildlife authorities to control feral cats (van Rensburg et al. 1987). The disease significantly reduced the cat population on the island, but feral cats were not fully eradicated until 1992 after an integrated campaign of trapping, baiting and shooting (Bester 1993). The initial success of the biological control agent was due to a lack of immunity to the disease.

Feline panleucopenia occurs in feral cat populations on all large land masses, including mainland Australia and Tasmania. This disease causes high mortality in non-immune populations, but survivors are immune, and screening of blood samples in Australian feral cats indicates widespread immunity to the disease (Moodie 1995). This suggests that the disease is already circulating through feral cat populations and any control effect is already operating. For mainland situations, this disease has little tactical value, and its deliberate introduction to susceptible populations may be questioned as inhumane (Copley 1991, Moodie 1995), as well as being of concern to the legitimate pet trade and domestic cat owners.

For Australia, it seems unlikely that there are any felid-specific pathogens that may be suitable as biological control agents; that is, any that are sufficiently virulent and humane and from which domestic cats can be protected (Moodie 1995).

2.7 Fertility control

Fertility control is an attractive form of pest animal management, being more humane than using lethal control measures to reduce pest population numbers. If an immunocontraceptive vaccine were developed for cats, its broadscale use would depend on the development of a suitable delivery mechanism for the vaccine and appropriate approvals to release the vaccine into the wild.

The development of immunocontraceptive vaccines is both high cost and high risk, and no effective fertility control agents are currently available for broadscale use against any carnivore in the world (Saunders and McLeod 2007). Therefore, fertility control is not a feasible option for cat control at this time.

2.8 Commercial harvesting

Feral cats may be hunted for their fur for export, but no skins or furs have been exported from Australia since 1989 (Ramsay 1994). Commercial hunting will only harvest a target species as long as it is commercially viable to do so, and the export of cat fur and skins was low volume and subject to price fluctuations (Ramsay 1994). Social considerations also strongly influence such activities, even when commercially viable. Where the desired benefit of commercial harvesting is the protection of threatened species from predation, market variability is unlikely to result in controls being applied in a consistent manner.

2.9 Financial incentives

Reviews of the history of pest management conclude that, in general, subsidies and bounties have rarely been effective in reducing damage by pest animals (Braysher 1993, Saunders et al. 1995, Saunders et al., in press). As a general policy, it is not cost-effective to seek to raise the level of recreational or professional hunting or trapping of feral cats 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 landowners and the development of incentives to promote feral cat control on private land may be appropriate, especially if the property forms part of a buffer zone to protect threatened species.

2.10 Habitat management

Although habitat fragmentation can deplete species richness (Bennett 1990) and increase the incursions of invasive species, the magnitude of the impact of this invasion is not well quantified (May and Norton 1996). Feral predators such as foxes and dingoes use roads and other easements to travel through or gain access to areas where they hunt (Catling and Burt 1995, 1997; Mahon et al. 1998), but cats tend to move directly across roads or travel only short distances along them. This behavioural difference has direct implications for the study and control of cats.

Weed incursions and human activities (e.g. tree removal) alter the floristics and complexity of the vegetation (Bennett 1990). Claridge et al. (1991) suggested that, as a consequence of social interactions, female and juvenile bandicoots were affected by logging activities and subsequent incursions by foxes and wild dogs. Roads, in particular, affect small forest mammals, depending on the traffic volume, road surface, and activity and foraging patterns of the mammals (Oxley et al. 1973).

Components of the environment may potentially be manipulated or managed to reduce the damage done by feral cats. Native animals may be more secure in structurally complex habitats (Dickman 1996), so habitat management to reduce fragmentation (rehabilitation of fire trails, roads and clearings) and increase the density of vegetation may be effective in reducing the level of feral cat predation. Research is required on the effect of habitat management on feral cats and their prey.

3 Factors affecting feral cat control

In developing an approach to manage the impacts of feral cats on native species and ecological communities, the extent and nature of the threat and the interactions of feral cats with other species must be understood, as must amensal impacts[1] and sociopolitical and animal welfare issues.

3.1 Understanding the extent and nature of the threat

Strong empirical evidence of the extent of the impact feral cats exert on native wildlife on the mainland is scarce. However, compelling evidence is available on the effect of feral cats on native fauna on Australian offshore islands, and from population counts and modelling (e.g. Burbidge and Manly 2002).

The situation is complicated by land-use changes since European settlement, in particular the spread of pastoralism, land clearing and alteration of fire regimes for arid and semiarid desert, grasslands, shrublands and woodlands. Paltridge et al. (1997) observed that watering points were used as daytime shelter for feral cats as a consequence of the taller vegetation behind fenced-off bores. The authors also noted that many species of birds taken by feral cats in central Australia were those that regularly required free water, and that during drought feral cats consumed carrion from dingo kills near watering points (Paltridge et al. 1997). Little is known of the effects of feral cats on native animals that require free water (Landsberg et al. 1997). There is anecdotal information that predation occurs, but the impact on species or faunal assemblages has not been quantified.

Other introduced feral animals have also had significant impacts, both on habitats and on native animals. As an example of the complexity of these interactions, the spread of rabbits has provided a ready food source for introduced predators such as feral cats and foxes, although some native species such as wedge-tailed eagles have also benefited.

Predation is a feature of virtually all ecological systems. Raw estimates of the total number of prey animals taken by cats and studies of diet are of limited value in determining the ecological impact of predation. Cat predation becomes a significant threat to native species only when the level of predation exceeds the capacity of individual populations to replace themselves. Australia's pre-European fauna included a suite of native predators, including large reptiles, raptorial birds, quolls and dingoes. The degree of threat posed by cat predation is associated with:

- behavioural, morphological and physiological characteristics of cats that make them more efficient predators than native predators
- factors that make cats more abundant or persistent than native predators
- the small size and isolation of populations of some threatened species, and
- the vulnerability of native prey to cat predation.

From a wildlife management point of view, the key question is whether the removal of feral cats will result in significant increases in the population or distribution of particular native species. A significant impediment to answering this question is the technical difficulty of measuring and manipulating the numbers of feral cats, both before and after control actions. Currently, track and spotlight counts are used to estimate feral cat

[1] An amensal impact is one in which a species adversely affects another species, but is not itself adversely affected.

abundance, and an identification system using DNA from hair or faeces is under development (Forsyth et al. 2005). Forsyth et al. (2005) suggest that the best estimate of kill rates from control can be made by attaching mortality-sensing radio collars to a random sample of feral cats before the control action.

3.2 Interactions with other introduced species

3.2.1 Rabbits

In areas where rabbits occur, rabbits tend to be the main prey item for feral cats. In these areas, cats will prey upon native animals opportunistically, particularly when rabbit numbers decline (Williams et al. 1995, Newsome et al. 1996). In areas where rabbits are absent, native species form the staple diet of feral cats.

There is good evidence that environments are made more suitable for feral cats by the presence of rabbits (Taylor 1979, Newsome 1990), as they are a preferred food item and their burrows provide shelter for feral cats. Feral cat numbers have been observed to rise and fall with fluctuations in rabbit numbers (Williams et al. 1995), and control of rabbits, particularly in rangelands and on islands, is important in lowering feral cat numbers and reducing their effect on native species (Newsome 1990).

Feral cats prefer young rabbits, but can survive on a range of prey (Catling 1988). Impacts on alternative prey can be particularly severe in island situations where, for example, winter nesting birds may be preyed upon when rabbit numbers are low (Brothers 1984).

In semiarid New South Wales, Newsome et al. (1989) found that rabbit numbers increased significantly in areas where feral cats and foxes were systematically removed, compared with areas where the predators were left alone. The response was most marked after approximately 14 months of continual predator removal. The study showed that, in semiarid habitats, shooting predators can effectively release an introduced prey population from the suppressive effects of introduced predators. There are no comparable studies showing such a response in native prey populations.

3.2.2 Dingoes

Dingoes have influenced the abundance of feral cats (Corbett 1995, Williams et al. 1995). Dingoes are common in the northern and central parts of Australia, but have been effectively controlled in the southeast and far southwest of the mainland (Corbett 1995). Dingo predation of exotic predators like feral cats may protect a range of native species by reducing cat numbers (Palmer 1996ab) and, indirectly, by excluding cats from carrion during droughts (Pettigrew 1993, Corbett 1995). The deliberate introduction of dingoes to control exotic predators is unlikely because they also affect agricultural interests and other human activities.

3.2.3 Foxes

A review of the interactions between feral cats and other introduced animals (Robley et al. 2004) found that feral cats and foxes overlap in distribution and diet. There is evidence of interspecific competition, with foxes competitively excluding feral cats from food resources, and of direct predation of foxes upon feral cats. Several studies describe increases in cat abundance following reductions in fox numbers resulting from control operations. However, the evidence is inconsistent between studies. Mesopredator release of feral cats following fox control remains a concern.

3.2.4 Rodents

Smith and Quin (1996) modelled the decline and extinction of a diverse range of native rodents, finding that introduced predators and the presence of rabbits and house mice explained much of the decline. In particular, the presence of foxes and rabbits led to the most severe declines, but declines were less severe where dingoes were present. The abundance of feral cats explained the loss of native (conilurine) rodents weighing less than 35 g. Where all predators were sustained by mice and rabbits, the declines in native

species were uniformly severe (Smith and Quin 1996). In temperate habitats, house mice may play an important role in supporting feral cat abundance, acting as staple prey (Robley et al. 2004). What is not fully understood is the relationship between feral cats and raptors or wild dogs.

3.3 Amensal impacts

Although amensal impacts are not listed as a key threatening process, native species may also be deleteriously affected through parasites and diseases transmitted from cats. *Toxoplasmosis gondii* is able to infect a range of marsupial and other mammalian hosts, including humans (Jones 1989). Exposure to this disease may be detectable through disease symptoms or blood tests, but significant or sustained damage to the faunal assemblage from *Toxoplasmosis* may have already occurred historically, and the impact can only be guessed at (Dickman 1996). It may be necessary to examine the possibility for control or management of the impact of disease on vulnerable populations of threatened species.

3.4 Animal welfare concerns

Most animal welfare organisations accept that there is a need to control feral cats to protect environmental values and wildlife (Carter 1994); however, they also stress that control methods must be humane. Animal welfare organisations do not support the use of mechanical hold-fast traps, such as steel-jawed leg-hold traps (Sharp and Saunders 2004a). Exclusion fencing is the most humane, non-lethal method of control of feral cats, but effects on non-target animals need to be assessed. Generally, fertility control is considered to be the most humane technique for the overall control of feral cats, but there are issues surrounding potential effects on domestic cats, and such a control mechanism is not available at present.

Consultation with animal welfare agencies, such as the RSPCA, 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 feral cats* (Sharp and Saunders 2004a) provides information and recommendations to vertebrate pest managers responsible for the control of feral cats, including advice on how to choose the most humane, target-specific, cost-effective and efficacious control techniques.

The SOPs for feral cats include information about ground shooting (Sharp and Saunders 2004b), and trapping with cage traps (Sharp and Saunders 2004c) and padded-jaw traps (Sharp and Saunders 2004d). Each SOP provides information about the appropriate application of the method, animal welfare considerations, health and safety considerations, equipment required and procedures to guide managers.

3.5 Cultural issues

The cultural value placed on feral cats varies according to the observer's own value system. Australia's unique fauna is widely valued by society, and many perceive feral cats to be a threat to the native fauna. Nevertheless, there are concerns that domestic cats may be threatened by actions taken to control the impacts of feral cats.

Some Indigenous people recognise introduced animals as part of the landscape and see them as newcomers rather than feral; others argue that the feral cat pre-dated European settlement and has been incorporated into Aboriginal law (Rose 1995). With the decline and extinction of many arid zone mammals with a mean adult body mass of between 35 and 4200 g (defined by Burbidge and McKenzie [1989] as

‘critical-weight-range mammals’), introduced mammals are viewed by some Indigenous people as a welcome addition to their diet.

Consideration of the differing cultural values attached to domestic and feral cats must be an important component of any control program.

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. By employing such skilled people, problem predators can be tracked, resulting in the animals’ capture or destruction.

Tracking is a labour-intensive technique, but the time and expense may be offset by the benefit of removing particular problem animals from the predator population. By selectively removing a few individual cats, such as large, experienced males specialising in hunting particular rare species, the primary agents of damage may be eliminated, allowing wildlife colonies to survive even though there are other feral cats around (Gibson et al. 1994).

Indigenous people can fulfil a range of other roles in feral cat control; for example, by being contracted to remove, monitor and manage feral cats. 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 feral cat management

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

4.1 Planning for nationally coordinated action

State and territory wildlife agencies have a long history of practical feral cat management, and it is largely through their efforts, often supported by Australian Government programs, that major technical and strategic advances have been made. An important function of this TAP is to ensure the most effective application of national resources to gain the best outcome for nature conservation.

The economic impact of feral cats has been estimated at $2 million per year, divided equally between management costs and research costs (McLeod 2004). Environmental impacts of feral cats, based on 18 million feral cats in Australia, each killing eight native birds per year at a value of each bird to the community of $1, are estimated to cost $144 million per year (McLeod 2004). No attempt has been made to estimate private landholder expenditure on feral cat control as it is considered to be limited and ad hoc (Hart 2005).

In recent years, in addition to funding programs to control feral cats on its own lands, the Australian Government has provided funding to state, territory and community organisations for feral cat control activities, including development of a felid-specific toxin, eradication of feral cats from Macquarie Island and trials of a cat-attractive bait (Table 4.1).

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

Project name	Recipient of funding
2002–03	
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
A project to increase understanding of interactions between feral cats, foxes and feral rabbits in Australia	Arthur Rylah Institute for Environmental Research
Cost effective fencing systems to exclude feral animals from areas of high conservation value in Australia	Arthur Rylah Institute for Environmental Research
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
A project that improves Australia's ability to protect its island habitats from feral animals — Western Australia	WA Department of Conservation and Land Management
2003–04	
A project that develops an agreed code of practice and standard operating procedures for the humane care and use of pest animals in Australia for the purposes of scientific research	NSW Agriculture
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
Experimental trials to determine effective feral cat and fox exclusion fence designs	Arthur Rylah Institute for Environmental Research
A report outlining Australia's past performance in invasive species prevention, detection, eradication and management	Agtrans Research
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
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
Review the methods used to determine the abundance of feral cats	Arthur Rylah Institute for Environmental Research
Kaye Kessing ‘That Feral Cat’ and ‘The Feral Map of Australia’ posters	Kaye Kessing Productions
2005–06	
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

NSW = New South Wales; NT = Northern Territory; WA = Western Australian

4.2 Strategies for allocating resources to feral cat management

Abating the threat posed by feral cats and securing threatened species is a long-term process requiring careful planning, research, frequent review, the adoption of new knowledge and an adaptive management framework. As has been stated previously, the total eradication of feral cats throughout Australia is impossible with the control techniques currently available. In addition, resources will never be sufficient to deal with all feral cat management problems, so this plan must ensure the strategic allocation of resources to give the best outcome for threatened species conservation.

There are two main approaches that can be taken, with current techniques, to reduce feral cat damage. The first is to eradicate or suppress feral cats in manageable areas of high conservation value, while the second approach is preventative:

- ensure that feral cats do not become established on islands of high conservation value where they do not presently occur, and
- prevent the transition of cats from domestic to stray to feral using education and domestic cat control techniques.

Development of more effective and humane techniques to control feral cats must be actively encouraged and supported.

As a strategy, local eradication of feral cats is applicable only to small islands or small mainland sites that are surrounded by predator exclusion fences. Maintaining an area free from feral cats requires a sustained control operation to prevent reinvasion from surrounding areas. Buffer zones may be a necessary component of managing small areas, to reduce the threat from continual reinvasion by cats from surrounding areas. Development of such buffer zones will require the active participation of surrounding land managers and a clear identification of the benefits to be obtained by all participants. Significant benefits can be obtained through cooperative implementation of plans across different land tenures.

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

- sustained management, where control is implemented on a continuing, regular basis, or
- intermittent management, where control is applied 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 threatened species or reintroduction sites. Intermittent management may be effective as a temporary seasonal measure to protect areas such as nesting or resting sites of migratory bird species. It may also be useful when transient feral cats are moving into an area where threatened species have been reintroduced, and during periods of drought, prey shortage, disease or other stress when the feral cat population is vulnerable and more likely to crash.

Recovery plans for some threatened species identify feral cats as a perceived threat. To ensure efficient and effective use of resources, an experimental approach must be used to determine the significance of feral cat predation in the decline of these species. By approaching local control on an experimental basis, the true significance of predation by feral cats will be better understood. If the hypothesis that feral cats are a significant threat is confirmed, the expansion of control activities to other sites where the species occurs is justified. However, if cat control is shown to be irrelevant to recovery of a species, efforts can be redirected to other activities.

Programs to control feral cats must be integrated with other pest control activities whenever possible. The pest species management series published by the Bureau of Rural Sciences provides guidelines for the application of an integrated approach to pest management (Braysher 1993, Saunders et al. 1995, Williams et al. 1995).

The steps used by Braysher (1993) for planning and evaluating integrated pest management programs are as follows:

- define the problem, including a measure of the deleterious impact
- develop well-defined objectives, performance criteria and criteria for failure
- identify and evaluate management options
- implement the plan, and
- monitor and evaluate the plan against its objectives.

A focus on integrated pest management and local action will provide a good mechanism for integrating feral cat control with other biodiversity conservation actions.

High priority must be given to monitoring the outcomes of feral cat control in terms of conservation benefits derived, not simply the feral cat kill rate. Ineffective control may result in high body counts but little reduction in predation if feral cats maintain a sustainably high reproductive rate, are bait-shy and trap-shy, or if populations are maintained through immigration.

4.3 Identifying priority areas for action

Total eradication of feral cats throughout Australia is impossible with the control techniques currently available (see Section 2). The identification of native species and populations that will benefit most from feral cat control is therefore particularly important. A nationally agreed methodology for ranking areas on a consistent basis is required to maximise the conservation benefits derived from expenditure on feral cat control. Such a methodology needs to take account of protecting existing populations of threatened species, facilitating their expansion and preparing areas for translocation. 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 and Nugent (1995) offer a weighted or ranked system that measures risk from pest species and the

ability to manage it. This ‘worst pest–priority places’ model maximises action against the pest animal for the benefit of conservation in the affected place. Parkes (1993) noted that, for this to happen, the response of the affected resources to pest densities must be known to determine the optimal point where the benefits are maximised and when control should cease. The level of variation in the system must also be known, to enable the effects of management actions to be separated from the effects of environmental changes.

The knowledge gap about the impacts of feral cats on the biota of mainland Australia (Dickman 1996) precludes an accurate estimation of the benefits to be derived by their control. Increasing resolution of the deficiencies in our knowledge will allow a better assessment of the value of control activities. A discounted cost–benefit analysis can then be used to indicate the future value of different management options (Bomford and O’Brien 1995, Bomford et al. 1996).

Dickman (1996) identified areas where extant native species are most at risk from predation by feral cats, and the ecosystems where this impact is likely, or known, to be greatest. The analysis did not include areas where the reintroduction of species into their former range may occur. Priority regions, with the corresponding bioregions in brackets (Thackway and Creswell 1995), are ranked as:

- Southwest Western Australia (Warren, Jarrah Forest, Swan Coastal Plain, Esperance Plains, Mallee and Avon Wheatbelt)
- Channel Country of Queensland/South Australia (Channel Country)
- Top End of the Northern Territory (Top End Coastal, Pine Creek–Arnhem, Central Arnhem)
- the Kimberley (North Kimberley, Central Kimberley)
- Tasmania (Woolnorth, West and Southwest, Central Highlands, Tasmanian Midlands, D’Entrecasteaux, Freycinet, Ben Lomond, Furneaux)
- Norfolk Island
- Victoria (Southeast Corner, Southeast Coastal Plain, Victorian Volcanic Plain), and
- the Pilbara (Pilbara).

The priorities identified by Dickman (1996) are not universally accepted, with some state conservation agencies identifying other areas as higher priority. In addition, the continuing development of recovery plans is likely to identify further species that are threatened by feral cat predation, and the areas of habitat critical for the species’, survival. Priorities must evolve with new information and experience to ensure an efficient national approach to the management of feral cats.

Implementation of such recovery plans must be accorded the highest priority in terms of action in order to abate the threat created by feral cats nationally. Landholders and managers, local community groups and the private sector should be encouraged to become involved in coordinated feral cat control programs in their area.

The tasks ahead are to greatly increase our knowledge of feral cat impacts on wildlife and to develop better tactical methods for reducing those effects. It is a long-term process, and this TAP offers a framework for undertaking these tasks.

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 longterm 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

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.
Commercial harvesting	The taking of animals from the wild for a commercial purpose.
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.
Eradication	Application of measures to eliminate an invasive alien species from a defined area.
Exclosure	Area fenced to keep out unwanted animals.
Felid	A member of the cat family.
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.
Mesopredator	A middle-rank predator in a food web (Saunders and McLeod 2007).
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.
Semiarid	Lands where rainfall is so low and unreliable that crops cannot be grown

	with any reliability (Beeton et al. 2006). *See* Arid zone
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.
Wild	Not domesticated or cultivated, but including escapees from domestication or cultivation.

Acronyms and abbreviations

DNA	deoxyribonucleic acid
EPBC Act	the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SOP	standard operating procedure
TAP	threat abatement plan
1080	sodium fluoroacetate

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