Society for Conservation Biology
Oceania Section

28 July 2020

Re: Inquiry into the problem of feral and domestic cats in Australia

To the Committee Secretariat,

Thank you for this opportunity to make a submission to the Inquiry into the problem of feral and domestic cats in Australia.

The Society for Conservation Biology Oceania Section is the peak professional group for conservation biology in Australia, with 400 members that include conservation scientists, policy-makers and managers. Our role is to provide scientific information for management and policy decisions about the long term sustainability and future of ecosystems and their dependent organisms, recognising the importance of ecosystem services for humanity and based on the best available science.

Feral and domestic cats have had severe impacts on Australian wildlife since their introduction by Europeans and will continue to do so into the foreseeable future. Feral cats threaten a large number of mammal, bird and reptile species and reducing the impacts of cats is critical to the conservation of Australia's biodiversity. Reducing the impacts of cats is challenging and while there have been many advances in this space over the past 40 or so years, an effective, broadscale control tool remains elusive. As described in this submission, effectively reducing the impacts of cats on vulnerable fauna populations requires approaches that are tailored to the specifics of each management context, consider both lethal and non-lethal approaches, and take a whole-of-ecosystem approach, including accounting for other threats such as fire and grazing, and interactions with foxes, dingoes, rabbits and other species.

We address terms of reference a, b, e, f and h in detail below. The key messages and recommendations contained therein are:

1) All management interventions should be well supported by evidence and monitoring to ensure that they meet their intended objectives and provide good return on investment.

2) Management actions should focus on reducing the *impacts* of cats on native fauna populations, rather than on reducing the number of cats alone.

3) We recommend increased research investment and effort into improving bait uptake by cats and reducing non-target consumption of baits.

4) We recommend greater integration of prey population monitoring into cat baiting programs and publication of results in order to evaluate the biodiversity benefits of such programs.

5) We recommended that future establishment of predator-free islands and fenced sanctuaries, and the associated reintroductions of threatened species, follow a systematic planning approach to optimise conservation benefits.

6) We recommend increased research investment and effort into the post-fire impacts of cats (and foxes) in both arid and mesic ecosystems to inform appropriate management practices.

7) We recommend increased research investment and effort to assess whether artificial refuges improve the survival and abundance of small, terrestrial fauna after fire.

8) We recommend increased research investment and effort into methods that improve the ability of native fauna to recognise and respond appropriately to cats as predators.

9) We recommend that strong regulatory controls that prevent the import of high risk domestic cat varieties be maintained.

10) We recommend that regulations around pet cat containment, registration and desexing be strengthened in all local government areas across Australia.

The SCBO welcomes the opportunity to provide further information or to discuss our submission in more detail.

Yours sincerely,

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Responses to terms of reference

a. the prevalence of feral and domestic cats in Australia.

Cats (*Felis catus*) occur in all Australian terrestrial habitats, covering 99.9% of mainland Australia and 92% of Australia's total island area (Woinarski et al. 2019b). In Australia, it is estimated that there are between 0.7 million feral cats in towns and 2.1 million feral cats in the bush (which can fluctuate between 1.4 and 5.6 million), as well as 3.9 million pet cats (Woinarski et al. 2019b).

b. the impact of feral and domestic cats including on native wildlife and habitats.

Australia has the world's worst mammal extinction record and many of these extinctions have been attributed to predation by feral and domestic cats (Woinarski et al. 2015). Since their introduction to Australia in 1788, cats have been implicated in at least 22 native mammal extinctions and continue to endanger an estimated 75 threatened or near-threatened mammal species (Woinarski *et al.* 2015). These extinctions have resulted not only in species loss, but also the loss of the ecological functions those species performed, including soil turnover, nutrient cycling, aiding plant recruitment, and mediation of fire regimes (Fleming *et al.* 2014; Halstead *et al.* 2020). It is estimated that more than one billion mammals, 649 million reptiles and 377 million birds are killed by cats each year (Woinarski et al. 2019b; Woinarski et al. 2018; Woinarski et al. 2017).

e. the efficacy (in terms of reducing the impact of cats), cost effectiveness and use of current and emerging methods and tools for controlling feral cats, including baiting, the establishment of feral cat-free areas using conservation fencing, gene drive technology.

A range of options exist for managing feral cat populations. We use the word 'management' rather than the more commonly used 'control' because the former is more inclusive of the full range of options available, particularly non-lethal methods. There is no silver bullet for reducing the impacts of cats and the best approach, or combination of approaches, is context specific. Effectively reducing the impacts of cats across Australia, including on islands, requires a broad suite of techniques that include both lethal and non-lethal approaches, as well as direct interventions for some threatened species, such as translocations and captive breeding. Further, cat management should be designed and conducted within an ecosystem framework, rather than focussing on a single species or threat, which can be ineffective and sometimes result in unexpected negative consequences (Didham et al. 2007; Doherty et al. 2015).

We note that the efficacy of cat management can be measured in multiple ways. The efficacy of lethal measures is often reported based on the number of individuals killed, or the change in cat activity, abundance or occupancy. However, it is important to note that the relationship between these measures and the impact of cats on prey populations is not necessarily linear (Dick et al. 2017; Norbury et al. 2015). Removing 30% of cats from a population may not lead to a 30% reduction in predation rates, either because neighbouring cats could quickly reinvade from the surrounding area (Lazenby et al. 2014), or because certain 'problem' individuals responsible for a disproportionate amount of predation are not removed (Moseby et al. 2015). Even so, a 30% reduction may not be sufficient to enable recovery of a prey population (Dick et al. 2017; Norbury et al. 2015).

For these reasons, any pest control program should involve monitoring of not only the pest species, but also the target asset (e.g. species richness, threatened species abundance), in order to properly quantify the impact of the program (Doherty & Ritchie 2017; Reddiex & Forsyth 2006). All management interventions should be well supported by evidence and monitoring to ensure that they meet their intended objectives and provide good return on investment. Management actions should focus on reducing the *impacts* of cats on native fauna populations, rather than on reducing the number of cats alone.

Here we focus on the following approaches: trapping and shooting, poison baiting, grooming traps, exclusion fencing, islands, management of fire and grazing, artificial refuges, and predator avoidance training, but also recognise that other approaches include gene drive, guardian animals and rabbit biocontrol, amongst others.

Lethal methods

Trapping and shooting

Cat management has traditionally focussed on lethal methods, including trapping, shooting and poison baiting. Such approaches focus on removing individual predators from a system to reduce or eliminate predation pressure on prey species. Because of the high reproductive rate and reinvasion potential of cats, lethal control in open landscapes (i.e. not within fenced areas or on islands) requires sustained and intensive efforts to effectively suppress cat populations. Demographic studies indicate that typically >50% of a cat population must be removed each year to limit population growth (Hone et al. 2010). Shooting and trapping are very labour intensive and there is little to no documented evidence that these approaches in isolation are effective at suppressing cat populations.

In fact, Robely et al. (2019) recently tested cage trapping of feral cats across Victoria and found it to be highly unsuccessful at three of the four locations, and at the fourth location, less than <50% of the population was trapped. Leg-hold trapping is more effective than cage trapping for cats, but it is still labour intensive and thus limited by the spatial scale over which it can be conducted. Recreational hunting has also been suggested as a possible management approach. Bengsen and Sparkes (2016) found insufficient evidence to determine whether recreational hunting can effectively control mammal populations on public land, although this seems unlikely for cats, given the limitations detailed above. Nonetheless, trapping and shooting can be particularly valuable in the final stages of eradicating cats from islands or within fenced reserves.

Poison baiting

Poison baiting differs from hunting and shooting in that it can be deployed over much larger areas more quickly. However, baiting of cats is notoriously difficult due to their preference for live prey and general aversion to scavenging. Further, cats typically only eat when they are hungry, so encountering a bait does not mean it will be consumed. Eradicat and Curiosity baits are small sausage style baits composed of kangaroo meat, chicken fat, and digest and flavour enhancers (Algar et al. 2007; Algar & Burrows 2004; Johnston et al. 2012, 2013, 2014). Eradicat contains 1080 poison injected directly into the bait, whereas Curiosity contains a hard capsule of para-aminopropiophenone (PAPP).

Eradicat baiting in Western Australia is targeted at times of the year when alternative prey availability is lower, thus increasing the likelihood that cats will consume the baits. In arid and semi-arid areas, this timeframe is late autumn and early winter when the availability of rabbits, small mammals and particularly reptiles is lower (Algar et al. 2007; Algar & Burrows 2004). However, because prey availability also varies with inter-annual rainfall, the efficacy of baiting is reduced if there has been heavy rainfall in the preceding year (Christensen et al. 2013).

Due to these factors, the consumption of baits by cats is unreliable and thus cat baiting programs are less consistently effective than similar programs targeted at foxes or dingoes (e.g. Algar et al. 2011; Algar et al. 2013; Doherty and Algar 2015; Moseby & Hill 2011; Palmer et al. 2020; Richards & Algar 2010). Further, because foxes and dingoes are less selective in their bait consumption, baiting campaigns with low uptake by cats may have the unintended consequence of removing these larger canid predators, thus releasing cats from competitive suppression (Marlow et al., 2015; Molsher et al. 2017; Wang and Fisher, 2012).

Additionally, repeated cat baiting can alter population demographics by selectively removing young, bait-naive cats, leading to a population bias towards adult male cats that are bait averse, thus decreasing baiting efficacy over time (Lohr & Algar 2020; Palmer et al. 2020). Intensive leg-hold trapping was needed to address this issue at Matuwa in Western Australia and it was recommended that intensive trapping programs be conducted at least every 10 years, in concert with annual baiting (Lohr & Algar 2020).

Aerial Eradicat baiting is conducted at 50 baits per km^2, which is much higher than baiting densities used for foxes and dingoes (usually around 5 baits per km^2). A much higher baiting density is used for cats in order to increase the likelihood that cats encounter a bait when they are hungry. However, because cat baits are distributed on the ground surface and are not buried, they are readily consumed by non-target species. Multiple studies have shown that the majority of baits, sometimes >90%, are consumed by non-target native fauna (Algar et al. 2007; Doherty & Algar 2015; Hohnen et al 2020; Moseby et al. 2011). Goannas (*Varanus* spp.) and corvids (*Corvus* spp.) are frequent consumers of baits, but other species recorded eating cat baits include brushtail possums, bush rats, bandicoots, skinks and various birds. **We recommend increased research investment and effort into improving bait uptake by cats and reducing non-target consumption of baits.**

Despite the adoption and promotion of cat baiting as a management tool, there is little, or perhaps no, published evidence of it having positive outcomes for threatened species or native fauna more generally. **We recommend greater integration of prey population monitoring into cat baiting programs and publication of results in order to evaluate the biodiversity benefits of such programs.** Ideally, this should involve fauna population monitoring in unbaited areas so that any impacts of baiting can be distinguished from that of unrelated factors, such as inter-annual rainfall.

Felixer grooming traps

Felixer grooming traps are a recent innovation that delivers 1080 poison to cats in a more targeted and localised way compared to broad-scale baiting. Felixers are stationary box-like devices equipped with sensors, a motion-sensing camera, a poison-delivery mechanism, and a cat-recognising algorithm (Read et al., 2014). When a cat is detected by the device the animal is automatically squirted with a measured and lethal dose of 1080, which is subsequently ingested through oral grooming (Read et al. 2014). Felixers record data on detections of both target and non-target species, and two recent trials suggest they have a low rate of false-positives (i.e. non-target species squirted; 8.53% and 0.00%, respectively), and a high rate of correctly identifying as cats as targets (82% and 77%, respectively; Moseby et al., 2020; Read et al., 2019).

The device can be loaded with 20 dischargeable doses of 1080 and are powered by batteries with solar rechargers (Read et al., 2019). Therefore, they can be left *in situ* for months, making them a less labour-intensive management option compared to trapping, shooting and poison baiting. The devices still require regulatory approval before being commercially available. Further, the current cost of the device (reported as $15,000 per unit) prohibits their deployment at large spatial scales or at high densities. As such, it is likely that Felixers will initially be most useful for removing cats from closed environments such as islands and fenced areas, or at very local scales, such as to protect small populations of threatened species.

Exclusion

Predator-free islands and fenced sanctuaries (i.e. havens) are effective management options for protecting native species from cat predation. Following invasive predator eradication, threatened native species can be protected and/or reintroduced, resulting in secure populations and improvements in ecological function (Hayward et al., 2016; Mills et al., 2018). For those native species

most susceptible to cat predation (e.g. the eastern barred bandicoot, *Perameles gunnii gunnii*), fenced and islands havens are currently the only reliable approach for securing populations in the wild.

Predator-exclusion fencing

Fenced havens are created by erecting specially-designed fences that exclude cats and foxes and then eradicating predators from inside the fenced area. Presently, there are 21 fenced areas with functional, predator-exclusion fencing on the Australian mainland, ranging in size from 0.5 km^2 to 123 km^2 and covering a total area of 520 km^2 (Legge et al., 2018). Of these 21 fenced areas, 17 currently contain one or multiple populations of threatened mammals that are susceptible to cat predation, totalling 49 populations of 25 species (Legge et al., 2018; Woinarski et al., 2019a). There are at least eight new fenced havens planned for construction over the next 10 years, providing an additional 918 km^2.

However, fenced havens are not suitable for all threatened species; birds can fly over fences and possums, quolls, and rodents can climb over or squeeze through the fence (Woinarski et al., 2019a). Exclosure fencing also requires a considerable upfront cost, including feral eradication, fence construction, and ongoing maintenance and repairs, resulting in an estimated cost of $120,000 for 1 km^2 and $400,000 for 10 km^2 (Woinarski et al., 2019a). Additionally, not all environments are suitable for enclosure fencing, such as areas with rugged topography, tall forest, frequent fire and watercourses (Woinarski et al., 2019a), and the relatively small spatial area over which they are established may facilitate a risk of overabundance and genetic decline for enclosed populations (Hayward and Kerley 2009; Moseby et al. 2018).

Islands

Island havens are one of the most successful approaches for protecting native species that are susceptible to cat predation. There are currently 590 Australian islands (5,539 km^2) known to be cat and/or fox free, of which nearly 30 are the result of eradication programs (Legge et al., 2018; Woinarski et al., 2019a). The translocation of threatened species to cat-free islands has proven to be a successful management tool, with the majority (90%) of fauna translocations resulting in self-sustaining populations (Short 2009; Legge et al., 2018). Compared to fenced havens, islands havens have a greater capacity to protect threatened species *in situ*, due to their larger size and, in some cases, historical absence of cats (Legge et al., 2018). Additional cat eradication programs underway on several large islands (totalling 5,184 km^2; Legge et al., 2018). Like fenced havens, islands require intensive effort and cost to initially eradicate cats, ranging from $600-26,000/$km^2$ depending on island size and other factors (Algar et al., 2010; Campbell et al., 2011). Where islands support other invasive species (e.g. the black rat *Rattus rattus* or European rabbit *Oryctolagus cuniculus*), the removal of cats can result in population increases of these species, creating unintended negative consequences for native wildlife (Rayner et al., 2007; Springer et al., 2018). Once cats are eradicated, island havens require strict biosecurity regulations to prevent cat introduction or re-establishment, particularly for those islands supporting a human population (Legge et al., 2018).

While fenced reserves and predator-free islands have played an essential role in protecting many threatened species, the cumulative benefit over time has been suboptimal. Ringma et al. (2018) showed that 11 new safe havens were created from 2010-17, but they only increased protection of species already present in existing havens, and did not improve protection of the 29 predator-susceptible species not present in the haven network. **We recommended that future establishment of predator-free islands and fenced sanctuaries, and the associated reintroductions of threatened species, follow a systematic planning approach to optimise the conservation benefits (e.g. Ringma et al. 2019).**

Promoting coexistence

Because eradicating cats from Australia is not currently possible and the efficacy and benefits of lethal control is limited in many situations, it is also important to consider what alternative approaches can be used to increase the ability of native fauna to coexist with cats in the environment. We discuss three relevant approaches, namely landscape management of fire and grazing, provision of artificial refuges, and predator avoidance training and natural selection.

Landscape management (fire and grazing)

A series of studies from northern Australia have shown that: i) feral cats show positive habitat selection for intensely burnt or grazed habitats with high prey densities, ii) they can travel long distances to recent fire scars, iii) they have greater hunting success in open microhabitats, and iv) small mammals experience higher predation rates in recently burnt compared to unburnt areas (Leahy et al. 2016; McGregor et al. 2014, 2015, 2016a, 2016b). Legge et al. (2019) also showed that appropriate fire management in the Kimberley increased small mammal abundance and richness, but this effect was only present in areas where livestock had been removed, probably because grazing removes ground cover and exacerbates the impacts of cats. Taken together, these studies suggest that reducing livestock grazing pressure and reducing fire frequency and intensity can indirectly reduce the impacts of cats by conserving habitat complexity that provides prey species with protection from predators. It is also possible that grazing by overabundant herbivores (both native and exotic) could exacerbate the impacts of cats by removing ground cover, although this is yet to be tested.

It is currently unclear how the results from northern Australia transfer to the mesic ecosystems of southern Australia, particularly the degree to which cats (and foxes) travel to or target recently burnt areas. One study showed increased fox and cat activity, and increased occurrence of medium-sized mammals in fox diets following a prescribed burn in the Otway Ranges (Hradsky et al. 2017a). However, GPS tracking showed that foxes did not travel long distances to access the burnt area (Hradsky et al. 2017b). If it is shown that predation by cats and foxes negatively impacts prey survival and population recovery post-fire, approaches that might be used to mitigate these impacts include targeted lethal control of predators in burnt areas, or provision of artificial refuges (discussed below). **We recommend increased research investment and effort into the post-fire impacts of cats (and foxes) in both arid and mesic ecosystems to inform appropriate management practices.**

Artificial refuges

Artificial refuges are one method currently being trialled to provide small mammals with movement pathways and protection from cats and foxes in fire-affected areas, in an attempt to reduce the risk of predation and improve population persistence (Dickman 2015; Watchorn et al., 2019; Bleicher & Dickman 2020). The artificial refuges are wire mesh tunnels that allow small mammals to enter and exit from any point, whilst physically excluding cats and foxes and obscuring their prey search image. To ensure the refuges exclude cats of all sizes, the openings in the tunnel are small (50 mm), therefore, larger cat-susceptible species, such as bandicoots and potoroos, cannot benefit from this design.

Research in arid environments suggests that small mammals and reptiles recognise the refuges as sites with reduced predation risk (Dickman 2015), and foraging experiments have demonstrated that the refuges act as safe corridors for dunnarts (Bleicher & Dickman 2020). However, the effects of the shelters were localised and not evident at the landscape scale (Bleicher & Dickman 2020). The refuges are also being trialled in post-fire mesic environments, and whilst there is evidence that they are used by threatened species, such as the swamp antechinus (*Antechinus minimus*) (Watchorn et al., 2019) and the Kangaroo Island dunnart (*Sminthopsis aitkeni*) (WWF 2020), experiments determining their efficacy are still underway. Notably, whilst artificial refuge provision is unlikely to be a feasible method of reducing post-fire predation rates at large spatial scales, the approach could provide a valuable, targeted management tool for protecting key populations of small threatened

species *in situ*. **We recommend increased research investment and effort to assess whether artificial refuges improve the survival and abundance of small, terrestrial fauna after fire.**

Predator avoidance training

Inappropriate anti-predator responses (naiveté) towards cats is a key factor contributing to the extinction and endangerment of many native species. An approach currently being trialled is to train susceptible animals to recognise invasive predators and respond appropriately (e.g. by fleeing or hiding). Almost all releases of threatened mammals outside of fenced reserves have been unsuccessful due to predation (e.g. Bannister et al. 2016; Moseby et al. 2011b). Mammal populations within fenced reserves and on islands can lose their predator awareness, thus making them more susceptible to predation. Moreover, Australian mammals share less than 200 years of coexistence with cats, and may fail to recognise them as threats (Steindler et al., 2018).

Research currently underway is applying principles of behaviour change and natural selection to determine whether exposing native mammals to low densities of cats in a controlled environment can improve their anti-predator behaviours (Moseby et al. 2016).This type of exposure has improved the anti-predator responses in species such as the burrowing bettong (*Bettongia lesueur*) (West et al. 2017), greater bilby (*Macrotis lagotis*) (Moseby et al., 2012; Ross et al., 2019), and brushtail possum (*Trichosurus vulpecula*) (Bannister et al., 2019). Improved survival of predator-exposed animals post-translocation was demonstrated for some (Ross et al., 2019), but not all of these studies (Moseby et al., 2012; Bannister et al., 2019), suggesting that improved predator awareness does not necessarily translate into improved reintroduction success in the wild. **We recommend increased research investment and effort into methods that improve the ability of native fauna to recognise and respond appropriately to cats as predators.**

f. the efficacy of import controls for high risk domestic cat varieties to prevent the impacts of feral and domestic cats, including on native wildlife and habitats.

Hybrid cat breeds, which are the result of crossing domestic cats (*Felis catus*) with other species in the family Felidae can seriously impact Australia's already vulnerable fauna. For example, if the the hybrid Savannah cat, which is the result of crossing the domestic cat with the African serval (*Leptailurus serval*), was introduced to Australia, it would likely threaten at least 28 native mammal species on top of the 168 already susceptible to predation by domestic cats (Dickman et al. 2019). This combined, poses a risk to 91% of Australia's strictly terrestrial mammal species and to 93% of threatened mammal species (Dickman et al. 2019). **We recommend that strong regulatory controls that prevent the import of high risk domestic cat varieties be maintained.**

h. the interaction between domestic cat ownership and the feral cat problem, and best practice approaches to the keeping of domestic cats in this regard.

Feral cats have been the primary focus of most management practices and on average an individual feral cat kills more animals than an individual pet cat. However, pet cats occur at concentrated high densities in residential areas and collectively, in comparison to feral cats, kill 28–52 times more animals per km^2 in natural environments and 1.3–2.3 more animals per km^2 in urban environments (Legge et al. 2020). Predation by pet cats on introduced rodents has led to the assumption that pet cats may benefit the environment by reducing pest numbers, however the evidence for this is contentious, and the toll on native wildlife that are being killed by pet cats per km^2 is still much higher than that of feral cats in residential areas (Legge et al. 2020). Further to this, one of the most common causes of injury to wildlife brought into rescue centres is attacks by pet cats (e.g. Shine and Koenig 2001).

Aside from direct predation, pet cats can also negatively impact local wildlife populations by changing the feeding and breeding behaviour of wild animals, and by spreading diseases (Beckerman et al. 2017; Day et al. 2012). The most commonly documented disease spread by cats is toxoplasmosis.

This parasite (*Toxoplasma gondii*) reproduces in the cat gut and is extramented in cat faeces in the form of eggs (oocysts). In residential areas, oocyst densities found in the environment can be astronomical as a result of the high density of cats and therefore high prevalence of *Toxoplasma* (Dubey 2002).

It is important that cat owners are educated on the threat of pet cats to Australian wildlife. While feral cats continue to be challenging and costly to manage, the impacts of pet cats can be reduced much more effectively and humanely. Cats are opportunistic hunters and even well-fed cats can kill wildlife. Keeping cats indoors at night can shift their predation to daytime hours and bells often do little to limit their hunting success (Legge et al. 2020). Therefore, it is important to keep cats indoors and limit their outdoor activities to contained areas such as cat runs. Further to this, it is important that all owned cats are desexed to limit unwanted strays. In areas where there is wildlife that is particularly susceptible to cat predation, mandatory cat containment or the prohibition of cat ownership should be considered. Regulations for cat containment should be strengthened. For example, in New South Wales under the Companion Animal Act 1998, pet cats that are microchipped, registered and wearing a collar are not restricted on where they can roam, except in prohibited places such as protected wildlife areas and where food is prepared or consumed. This legislation makes it very difficult for Local Councils to seize stray cats, and further aggravates the toll pet and stray cats are having on local wildlife. **We recommend that regulations around pet cat containment, registration and desexing be strengthened in all local government areas across Australia.**

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