

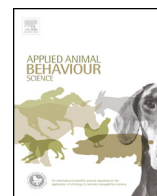


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How does cat behaviour influence the development and implementation of monitoring techniques and lethal control methods for feral cats?

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ABSTRACT

The need for lethal control of feral cats will remain in some contexts and potentially increase in others, alongside an obligation to develop and apply methods that are cost-effective, humane and target-specific as possible. Drawing on practices particularly used in Australia, New Zealand and on offshore islands we review current lethal techniques applied for feral cat removal, such as shooting, trapping and poison baiting, and how our understanding of feral cat behaviour has influenced their development and application.

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1. Introduction

The International Union for Conservation of Nature (IUCN) lists cats (*Felis catus*) among 100 of the world's worst invasive species (Lowe et al., 2000). Feral cats utilize the 'wild' end of a highly adaptive behavioural spectrum that equips them as destructive predators and disease vectors, with more subtle ecological impacts now becoming apparent (e.g. Medina et al., 2014). The ability of cats to survive either with or without dependency on humans seems intrinsic to their historical value as commensal or companion animals but is also a serious downside to their introduction, intentional or not, to naive ecosystems.

The global distribution and abundance of cats currently sit in stark contrast to the precarious conservation status of the many species of endemic mammals, birds, herpetofauna and invertebrates on which cats prey. Among various published definitions, here we focus on feral cats as those in populations that are geographically isolated from human habitation and are self-sustaining in remote areas, including offshore islands. They have no dependence on humans and many such cats may never have encountered people. In such situations managing feral cats through non-lethal approaches – such as capture–rehomeing, deterrence, exclusion or reducing fertility or recruitment (e.g. Trap–Neuter–Return (TNR) programmes) – is impractical within constraints of geographical scale, resourcing and the urgent need to prevent extirpation of some species of endemic wildlife threatened by feral cat predation. Some authors have clearly articulated the shortcomings of TNR

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in terms of the overall welfare of cats (Jessup, 2004) while others have noted dubious efficacy of TNR in protecting biodiversity values from the impacts of feral cats (Longcore et al., 2009; Lepczyk et al., 2010). For these reasons we do not further discuss non-lethal approaches. Here we review feral cat management practices mostly from Australia, New Zealand and offshore islands, as examples that have wider application in how considerations of cat behaviour must be incorporated into the development of lethal techniques and their operational implementation against criteria of efficacy, economy over broad-scale areas, target specificity and minimization of welfare impacts.

2. Why lethal techniques for feral cats?

The view of feral cats as an introduced species with harmful impacts on ecosystems has been described as a 'normative judgement' (Robertson, 2008) in some contexts. However, in Australia and New Zealand at least, the impacts of feral cats on native biodiversity values are judged severe enough to merit regulatory acknowledgement in legislation and corresponding management directives which include lethal control. Historical accounts of the European colonization of Australia and New Zealand and subsequent ecological research have provided ample evidence of ongoing adverse impacts following the arrival and spread of cats, alongside a suite of other invasive predators (e.g. Woinarski et al., 2014).

Cats were brought to New Zealand from 1769 onwards and are implicated in the extinction of at least six endemic species and some 70 local extinctions (King, 1984). They continue to contribute to the ongoing decline of a number of threatened species (Dowding and Murphy, 2001; Gillies and Fitzgerald, 2005). National conservation and biosecurity legislation and regional pest management strategies across New Zealand provide for the management of feral cats as a pest, using lethal techniques (Farnworth et al., 2010a). Defined as an animal in a 'wild state', feral cats are therefore not covered by New Zealand animal welfare legislation to the same extent as domestic cats (Farnworth et al., 2010b).

Introduction of cats to Australia possibly occurred during trade between Malay and Aboriginal people (Rolls, 1969) but was certainly accelerated with arrival of Europeans around 1800 (Dickman, 1996). Abbott (2002) suggests multiple point sources of cat arrival in Western Australia during 1824–1886. Feral cats have been linked to continental extinctions of seven species of Australian native mammals and to island and regional extinctions of native mammals and birds, and have caused the failure of reintroduction attempts aimed at re-establishing threatened species (e.g. Denny and Dickman, 2010). Feral cat management is recognized as one of the most important fauna conservation issues in Australia today, under the auspices of a national 'Threat Abatement Plan for Predation by Feral Cats' (Environment Australia, 2008). However policies across Australian states are inconsistent. Some state legislature and regulations define and regulate feral cats as a pest (Denny and Dickman, 2010) while others do not. Victorian state legislation, for example, declares it an offence for cats to attack, bite, worry or chase wildlife but currently

provides no definition of feral cats which could then be used to classify these animals as pests, as occurs with domestic and wild dogs (State of Victoria, 1975, 1994). This situation limits the tools and techniques that may be used to manage feral cat populations where they exist in Victoria on land managed for biodiversity conservation.

There is also extensive evidence that the introduction of cats to oceanic islands has been disastrous for many species of island endemics. Feral cats have contributed to at least 14% of 238 vertebrate extinctions recorded globally by the IUCN and currently threaten 8% of the 464 species listed as critically endangered (e.g. Medina et al., 2011; Nogales et al., 2013). On remote islands without human habitation, lethal methods for removing feral cats are the most feasible for urgent biodiversity protection, with affordable operational implementation and no risk of unwanted impacts on owned cats that are allowed to roam. In recent years, eradication of cats from relatively large islands (Algar et al., 2010; Campbell et al., 2011; Parkes et al., 2014) has been achieved using a combination of lethal methods.

3. How does a feral cat behave?

Some phenotypes selected in artificial breeding of pedigree domestic cats (e.g. brachycephaly, very long coats) are probably maladaptive in truly feral populations (Bradshaw et al., 1999). While coat colours in a feral population are influenced by founder genetics, they are commonly tabby, black, grey, tortoiseshell or ginger (Brothers et al., 1985; Gillies and Fitzgerald, 2005). The metabolic inability of cats to synthesize certain nutrients is overcome by their being obligatorily carnivorous (Bradshaw, 2006), and feral cats are physiologically the same as other classes of *Felis catus* in these stringent nutritional requirements and also in how they are affected by and susceptible to toxic substances. Feral cats can meet their nutritional requirements completely through predation, including survival for times without fresh water, which has allowed them to colonize and persist in arid habitats where other invasive mammals cannot. Behavioural repertoires are also considered similar across the species as a whole (e.g. all classes of cats are predatory); however, feral cats are characterized by behaviours that represent the 'wild' end of the spectrum.

3.1. Responses of feral cats to humans

Avoidance of and fear reactions to humans are highly characteristic of feral cats; described by Gosling et al. (2013) as '...unapproachable in its free-roaming environment, when trapped will display aggressive defence behaviour or cower and try to hide, when released into a confined space will not be possible to handle the cat'. Such reactions have genetic and developmental components, for example kittens with little or no contact with humans until they are two months old are likely to remain fearful of people unless remedially socialized (Bradshaw et al., 1999). In feral cat populations that rarely if ever encounter people, their innate or learned avoidance of some control methods is attributed to fearful responses to the sight, sound or

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