Submission to the House of Representatives Standing Committee on the Environment and Energy:

***Inquiry into the problem of feral and domestic cats in Australia*.**

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Summary

Term of reference *a*: the prevalence of cats in Australia.

- based on collation and analysis of ca. 100 local studies of cat density, we estimate the population of feral cats in Australia's natural environments is ca. 2.1 million;
- this population size varies temporally, with increases following good rainfall in inland Australia (to c. 5.6 million) and decreases during drought years (to c. 1.4 million);
- the density of feral cats varies spatially, typically being higher on islands, and in inland Australia following rainfall, and being lower in some extremely rugged rocky areas;
- there are a further 0.7 million feral cats in highly modified environments, such as unowned 'strays' in urban areas, so the total population of feral cats in Australia is ca. 2.8 million;
- there are 3.8 million pet cats in Australia;
- cats were introduced to Australia in 1788, and have subsequently spread across the entire continent and to about 100 islands;
- with the exception of reserves on some cat-uninhabited islands, cats occur pervasively across Australia's conservation reserve system – subverting, for cat-susceptible native wildlife, the conservation benefit intended from such a network;
- the only Australian areas currently without cats comprise a network of fenced areas (predator exclosures) established on the mainland to protect threatened native mammals (total area ca. 594 km^2) and some islands (with total area 5,539 km^2 to 8,074 km^2): hence, cats occur across more than 99.8% of the Australian land mass.

Term of reference *b*: the impacts of cats on wildlife.

- globally, cats have caused or contributed to 26% of all extinctions of reptile, bird and mammal species over the last 400 years;
- the extinction rate of Australian mammals since 1788 has been exceptional – far higher than for any other continent. Cats were a main cause of 25 of these 34 extinctions;
- cats continue to cause the decline of many Australian wildlife species;
- some native species, especially mammals, have proven highly susceptible to predation by cats (and the other introduced predator, the red fox), and occur now only in areas without these predators (such as islands and fenced exclosures);
- as a consequence of extinctions and severe population losses in the Australian mammal fauna, due to the impacts of feral cats, much of Australia now supports only an insecure vestige of the mammal fauna it supported 200 years ago;
- based on collations that we have undertaken, cats are known to kill at least 30 Australian frog, 260 Australian reptile, 340 Australian bird and 150 Australian mammal species, including at least 132 Australian threatened species;
- based on analysis of many thousands of cat dietary samples, we determined that, on average, a single feral cat in the bush kills about 370 invertebrates, 44 frogs, 225 reptiles, 130 birds and 390 mammals per year; and the collective toll of Australian animals killed per year by all feral cats (including unowned stray cats, but excluding pet cats) in Australia is ca. 1.1 billion invertebrates, 90 million frogs, 600 million reptiles, 320 million birds and 960 million mammals (i.e., 1.6 million reptiles, 0.9 million birds and 2.6 million mammals per day);
- most of the animals killed by feral cats in Australia are native species;
- most Australian pet cats are allowed to roam for at least part of the day or night. The average roaming pet cat kills 186 reptiles, birds and mammals per year, and an unknown number of frogs and invertebrates. The high density of pet cats in urban settings results in

high kill rates per unit area (7,190 to 13,100 mammals, birds and reptiles killed by pet cats per km^2 per year, within the area occupied by pet cats). Collectively pet cats in Australia kill 390 million mammals, birds and reptiles per year (i.e., more than one million animals per day);

- the impacts of cats on Australian wildlife compound, and are compounded by, the impacts of other factors, including fire, over-grazing and habitat fragmentation;
- cats are the definitive host of the protozoan parasite *Toxoplasma gondii* (i.e., the parasite would not exist in Australia without the presence of cats). From its source in cats, *T. gondii* infection is now known to occur in many Australian bird and mammal species, with many consequences including spontaneous abortions, changed and aberrant behaviours and increased mortality. However, the population level impacts on Australian wildlife species of such infection are not yet well resolved;
- many of the Australian wildlife species rendered extinct or much depleted by cats had important ecological functions. As a result of the loss or decline of these species, Australian ecosystems are less productive, less healthy and less diverse.

Term of Reference *c*: The effectiveness of current legislative and regulatory approaches

- Australia's three-tiered government system makes managing broad-scale environmental issues a complex challenge;
- legislation interacts with social, political, economic, and cultural factors to affect implementation;
- cats are represented in law as both companion animals as well as an invasive pest, making effective legislative and regulatory approaches to management potentially conflicting and inconsistent;
- some technological and policy advances (backed by legislative/regulatory change) in the past decade have led to some successes, such as eradications of cats from some islands, and new cat poison delivery systems;
- predation by feral cats is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*, and a national Threat Abatement Plan exists to guide coordinated action on cats. However, the efficacy of this plan is limited because there is no requirement under the Act to implement it;
- cat management is a responsibility of the states and territories, each having their own laws that relate with varying focus and effectiveness to the management of feral cats;
- local governments have a significant role in the management of pet cats and feral cats in urban areas (strays), but management practices are highly variable, partly because of weak or restrictive legislative settings at the state/territory level.

Term of Reference *d*: The effectiveness of Commonwealth action and cooperation with states and territories on this issue, including progress made under the Threat Abatement Plan, national framework and national declaration relating to feral and domestic cats in Australia

- the national declaration at the meeting of Environment Ministers 2015 encouraged reform of legislation to remove barriers to feral cat management; included a commitment to improving pet cat management; and acknowledged that managing feral cats was important for threatened species recovery. The commitments have only partially been achieved;
- managing feral cats is listed as a key component of the 2015 national Threatened Species Strategy;
- the Feral Cat Taskforce is a forum for policy-makers, government and non-government managers and researchers to share information, enhance opportunities for cooperation, and build a community of practice;

- feral cat management is highly variable among by states and territories, but can be nationally coordinated through the Intergovernmental Environment and Invasives Committee;
- the Threat Abatement Plan, the Threatened Species Strategy, the national declaration, and coordinating mechanisms such as the Feral Cat Taskforce and the Environment and Invasives Committee are positive steps towards nationally coordinated management of feral and pet cats. However, across most of Australia, feral cats remain unmanaged. Where management occurs, it is inconsistent, constrained by a range of factors at each tier of government, poorly resourced and, overall, ad-hoc and ineffective.

Term of Reference 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 management options are available for controlling feral cats, which vary in efficacy, cost, applicability and risks, depending on the local context;
- control options have increased in recent years due to innovation (e.g., novel toxins and toxin delivery systems), and new cat control methods are being trialled or developed;
- generally, the most effective cat control options (cat exclusion in fenced areas or eradication from islands) can only be applied over relatively small (although with increasing technical capacity, gradually increasing) areas, but these approaches are essential for preventing extinctions in our most cat-susceptible native species. Management options that can be applied at larger scales are important for recovering native species that can co-exist with a reduced level of cat predation;
- new technologies that may enhance cat management in the future include new traps, new toxins, engineered disease and gene drives;
- options for managing feral cats living near or in towns and cities differ from those available for feral cats in the bush;
- the most effective way to reduce the urban feral cat population is to remove their access to human food subsidies, by managing refuse bins carefully, fencing off rubbish sites, intensive farms, and any other potential area of super-abundant food;
- Trap-Neuter-Release (TNR) is not an effective way to reduce the size of urban feral cats, nor their impacts on wildlife.

Term of Reference 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.

- breeds of the domestic cat (*Felis catus*) can be imported into Australia under current legislation, but must meet quarantine conditions and veterinary health checks before release to owners;
- high risk varieties of cat, under this term of reference, are hybrids between *Felis catus* and other cat species that introduce novel traits, behaviours or appearance for the pet trade;
- the importation of hybrids is regulated by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Biosecurity Act 2015. Hybrids can be imported into the country only if they are on the Live Import List of the EPBC Act or if they satisfy other requirements, although application can be made to the Minister for the Environment to include new taxa;
- an application to import the savannah cat (a hybrid of the domestic cat and serval *Leptailurus serval*) was blocked by the Minister for the Environment in 2008, after a specific amendment to the EPBC Act, and based on assessment of the increased risks to Australian

biodiversity. This example shows that current legislation can effectively preclude importation of high risk (hybrid) varieties of domestic cat.

Term of Reference g: Public awareness and education in relation to the feral and domestic cat problem.

- Relative to the public in most other countries, Australians are generally more aware of and concerned about the impacts of cats on native wildlife, more likely to change their behaviour if given appropriate guidance, and more likely to accept regulatory and legislative changes to reduce the impacts of cats;
- there is considerable public support for lethal control of feral cats. However, there is less support for lethal control of roaming cats in urban areas, in case these cats are pets;
- some groups in the broader community contribute to feral cat control. The extent of the beneficial impact of such efforts is unclear, but these groups are concerned about the constraints on their efficacy imposed by confusing and spatially-variable rules about where feral cat control is permitted, and uncertainty about the effectiveness of different lethal control methods and subsequent impacts on native wildlife;
- trap-neuter-release (TNR) is sometimes advocated as a way to reduce the numbers of feral cats in urban and suburban areas, but numerous studies have shown that TNR is an ineffective and expensive approach to the problem of reducing cat numbers, it perpetuates the killing of wildlife by unowned cats, and is likely to encourage dumping of unwanted pets;
- cat containment is an increasingly used husbandry strategy for pet cats. Most cat owners in Australia agree that pet cats should be contained indoors or in a run at night; 24-hr containment is less preferred by owners because some owners perceive cat containment as a constraint on their cat's natural hunting behaviours;
- cat owners understand that allowing their pets to roam increases threats to the health and safety of their cats;
- cat owners list veterinarians as the people they are most likely to take advice about cat care and management.

Term of reference *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.

- the extent of interaction between pet cats and the feral cat population (and the consequences of such interaction) is poorly known;
- the most consequential impact would be in cases where pet cats are introduced to settings without an existing feral cat population (such as many islands);
- in other cases, wandering or abandoned pet cats may bolster the feral cat population, thereby compounding impacts on wildlife and subverting existing local or regional control programs;
- high densities of pet or stray cats that exist near populations of cat-susceptible native species could cause local population declines and extirpations;
- there is a set of best practice mechanisms that reduce the interaction of pet and feral cats, and the associated risks: (i) ensure pet cats do not roam; (ii) ensure that all pet cats are neutered prior to reproductive age; (iii) prohibit the importation of pet cats to locations not currently inhabited by cats (notably some islands); (iv) constrain the ownership of pet cats in or adjacent to areas of significant conservation value; (v) ensure all pet cats are registered; (vi) cap the number of pet cats per household; (vii) provide ongoing education and awareness-raising materials about cat impacts and responsible pet cat management to the public; and (viii) ensure that the authorities responsible for these mechanisms have

adequate will, regulatory basis, appropriate mix of incentives and disincentives, and dedicated resources to implement and police them.

Other issues

- cats carry many bacterial, viral, fungal and parasitic pathogens that can inflict health impacts on people and livestock. Some pathogens need cats to complete their life cycle – these pathogens would not exist in Australia if cats had not been introduced here;
- people are affected by the cat-dependent pathogens *Toxoplasma gondii* (which causes toxoplasmosis), *Bartonella henselae* (which causes cat scratch disease) and *Toxocara cati* (cat roundworm). Livestock are affected by *T. gondi, T. cati* and two species of *Sarcocystis* (which cause large cysts to develop in sheep meat);
- we estimate the *annual* economic costs (to human health and livestock production) of these cat-dependent pathogens in Australia at $6.1 billion;
- most of the costs are due to the associations between *Toxoplasma* and higher rates of traffic accidents and mental health illnesses in people. Although causality remains uncertain, *Toxoplasma* is associated with reduced reflex times and higher rates of accidents; increased incidence of depression, schizophrenia and suicidal behaviour;
- cat predation of wildlife inflicts costs to ecotourism, and the provision of food for pet cats places a burden on agricultural production;
- Australian pet owners spend about $3.6 billion per year on care of pet cats – at least an order of magnitude higher than targeted spending by the Australian government across all of Australia's ca. 1800 threatened species;
- the costs of managing stray and feral cats by councils and conservation agencies are considerable.

Recommendations

Term of Reference (a)

1. Australia has one of the most robust estimates for the cat population size of any country in the world. However, data on feral cat densities in towns and cities are relatively scarce; data on the numerical responses of cats to a range of control measures are also limited. These deficiencies should be redressed by the establishment of programs that include commitments to:

- ongoing monitoring of the size of the cat population in Australia and its response to local- and regional-scale management;
- improve estimates of the numbers of feral cats in urban environments, as well as the extent to which cats move between the pet, urban feral, and bush feral fractions.

Term of Reference (b)

2. Predation by cats is the major factor causing the imperilment of many of Australia's threatened animal species, and driving the decline of many species not yet listed as threatened. Recovery Plans and conservation advices for these species need to more explicitly provide the justification, mechanism and resourcing for more effective and sustained control programs that effectively reduce the abundance and impacts of feral and pet cats.

3. Australian islands are critical for the conservation of many Australian animal species that are susceptible to introduced predators (cats and foxes); and many also have significant breeding colonies for seabirds and marine turtles that are also readily depleted or destroyed by introduced predators.

- Biosecurity is suboptimal for many of the islands currently uninhabited by cats, and this deficiency should be remedied such that the likelihood of inadvertent or deliberate introduction of cats to such islands is rendered negligible.
- Eradication of cats from islands also offers extraordinary opportunities for conservation safeguarding and the recovery of threatened species, and a long-term program should be established to reduce the number of Australian islands occupied by cats.

4. Australia's conservation reserve system is purposed largely to protect and recover biodiversity, but most reserves in that system offer no succour for cat-susceptible native animals. Management plans for key reserves should provide clear commitments to reducing the impacts of cats, such plans should be fully implemented, and the outcomes for biodiversity monitored.

5. Pet owners who allow their cats to roam are responsible for inflicting a substantial toll on Australian wildlife and reducing the biodiversity in urban and peri-urban environments. The toll should, and can readily be, reduced through the consistent development, imposition and policing of a package of legislative and regulatory provisions described below (under Term of Reference c).

6. The impacts of the cat-borne parasite *Toxoplasma gondii* on the population viability of Australian animal species is poorly resolved, and further research is warranted on its incidence and impact, and on options to remediate significant impacts.

Term of Reference (c)

7. Increase the obligation to implement, and report on the progress of, Threat Abatement Plans, Recovery Plans and Conservation Advices, for example in the current review of the EPBC Act.

8. The EPBC Act's provisions for offsetting and strategic assessments have the largely unrealised potential to foster the development and implementation of broad-scale programs for the control of cats, in order to deliver substantial benefits to biodiversity conservation. Consider opportunities to develop this potential further, for example in the forthcoming review of the Act.

9. Review processes for trials and registration of new cat toxins and toxin delivery systems, and consider opportunities to streamline.

10. Set a consistent foundation for feral and pet cat management at the national (or state/territory) level, with consistent coordinated actions then implemented and enforced at the local government level. For example, feral cats should be declared pests across all states and territories (including external territories).

11. Regional cat management officers may be a useful mechanism for working across local government areas on consistent pet and stray cat management approaches.

12. Key components for an improved legislative and regulatory national framework for the management of pet cats comprise:

a. **Mandatory pet cat registration**, with fee structures that incentivise desexing of cats, and de-incentivise non-desexed cats. Registration fees can be used towards the management of cats, and the system should allow local governments to keep track of registered cat breeders.
b. **Mandatory desexing** of pet cats before they reach sexual maturity. The current rates of cat desexing in local government areas is highly variable, ranging from 5% to 99%. Low rates of desexing may be related to large urban feral cat (stray) populations.
c. **Limit the number of cats per household.** Currently, only some local governments specify a limit on the number of cats per household, with permits required to keep more than the specified limit. We suggest that a limit of two cats per household (with the exception of licenced cat breeders) is an appropriate limit.
d. **Cat-free or cat containment areas.** New residential developments provide an opportunity to prohibit cats from areas adjoining bushland and other areas with high environmental values.
e. **24 hour containment or curfews, with corresponding resourcing for compliance and enforcement.** For example, the ACT now has 17 cat containment suburbs, and out of 34 Victorian local governments surveyed, 10 have a dusk to dawn curfew and 7 have 24 hour containment.

f. **do not allow Trap-Neuter-Release programs**, nor stray cat feeding sites, that could encourage dumping of pet cats.

Term of Reference (d)

13. The national *Threatened Species Strategy*, operating over the period 2015-2020, provided a major national focus on the problem posed to Australian biodiversity by feral cats, developed a series of priority and coordinated actions for cat control and prompted substantial additional funding for some key cat management actions. Future iterations of that Strategy should build from this important foundation to maintain its momentum and enhance its achievements.

Term of Reference (e)

14. Enhance biosecurity arrangements for cat-free islands, including public education and awareness programs to prevent introductions to uninhabited and inhabited islands (see also Recommendation 3 above).

15. Expand the national network of cat-free islands and fenced areas, with a national strategic perspective to complement more local priorities. For example, Commonwealth investment could be directed to projects that focus on unprotected, or poorly protected cat-susceptible species at the national scale. Mechanisms to support national coordination and collaboration would be helpful.

16. Without compromising on appropriate levels of scrutiny and risk assessment, improve the efficiency of processing applications to trial new cat toxins and toxin delivery systems, and to expand the use of existing toxins and methods.

17. Support research and management programs that quantify co-benefits of fire and grazing management for cat control over more biomes.

18. Design a spatially-explicit and costed 'map' for optimal cat control across Australia, that integrates the conservation values and susceptibilities of local species (and thus the level of cat control required), the feasibility of control options, and the employment opportunities for local people.

19. Invest in research and development of novel approaches to cat control.

Feral cats in towns

20. Support local governments to review regulations on refuse management, tighten if needed, then implement and police compliance.

21. Support local governments and industry to exclude cats from sites of food subsidy (including rubbish dumps and intensive farms).

Term of Reference (f)

22. The legislative and regulatory framework that now precludes high risk (hybrid) cats from being imported should be maintained.

23. The EPBC Act, as a key legislative instrument that provides protection from the importation of hybrid cats, should continue to serve this function.

24. As documented under other terms of reference in this submission, owned domestic cats can have major negative effects on native wildlife and habitats. Strong quarantine and veterinary control over all imported domestic pet cats thus should be maintained.

Term of reference (g):

25. Effective management of feral cats is likely to have broad support from the public and should need relatively low levels of engagement for management programs to be initiated and implemented.

26. Some segments of the community are already engaged in feral cat control. Working with these groups to guide strategic and targeted feral cat control may help to improve the efficacy of this contribution towards improving outcomes for wildlife.

27. Domestic cats are perceived by the public to be less problematic for wildlife, but levels of awareness of the potential problems of domestic cats are nonetheless high. Attitudes towards domestic cat management practices amongst cat owners are positive, but compliance rates are low. Changes in legislation and practice to better manage domestic cats should be readily achievable provided that appropriate levels of education and engagement with the public are undertaken prior to, and during, the implementation of such changes. Messages framed around cat health and well-being and delivered through trusted messengers such as veterinarians may be most effective. Building and/or appealing to a social norm around cat containment would also be useful.

28. Stray cats are perceived by many people to be a problem, and reduction in their numbers can be achieved by integrated programs of preventing cats from accessing superabundant food sources along with public education and engagement, followed by cat trapping, re-homing (of pets) and euthanasia (of unowned cats).

29. Attitudes towards control of feral and domestic cats are different, and difficulties discerning between ‘feral’ and ‘owned‘ or ‘unowned’ domestic cats drives some opposition to lethal control of feral cats. Working with key stakeholders to resolve identification of feral from domestic cats may go some way to resolving this potential area of conflict in attitudes.

Term of Reference (h)

30. The risks and consequences of infiltration of pet cats to the feral cat problem (and hence the impacts on wildlife) can be readily minimised by:

- ensuring pet cats do not roam;

- ensuring that all pet cats are neutered prior to reproductive age;
- prohibiting the importation of pet cats to locations not currently inhabited by cats (notably some islands);
- constraining the keeping of pet cats in or adjacent to areas of significant conservation value;
- ensuring all pet cats are registered;
- capping the number of pet cats per household; and
- ensuring that the authorities responsible for these mechanisms have adequate will, regulatory basis, appropriate mix of incentives and disincentives, and dedicated resources to implement and police them.

Other issues

31. Disease rates and thus the costs of disease in people and livestock can be reduced by reducing exposure to cats and by interrupting transmission pathways:

- Reduce the population of feral cats, especially around farms, gardens, parks and playgrounds.
- Reduce the rates of pet cat ownership.
- Keep pet cats contained, which reduces the chance that the pet will contract pathogens.
- Adhere to cooking habits (washing vegetables before eating them, cooking meat thoroughly) and hygiene practices (washing hands after gardening, handling kitty litter) that reduce risk of contracting *Toxoplasma* and *Toxocara.* (see also Recommendation 12 above.)

32. Improve reporting systems for tracking the occurrence of cat-borne (including cat-dependent) disease; this will involve improvements in the levels of public awareness of these illnesses, enhanced diagnosis, and public health recording.

Who we are

This submission is coordinated by Professors Sarah Legge, Chris Dickman and John Woinarski, Tida Nou and Drs Georgia Garrard and Hugh McGregor for the Threatened Species Recovery Hub of the National Environmental Science Program. Collectively, we have many decades of experience in ecological research and management, including many studies of feral and pet cats and many studies of threatened species, in all biomes across Australia. We also have substantial experience in conservation policy in Australia and globally, including through membership of the Australian Threatened Species Scientific Committee and as current and previous chairs of the IUCN Australasian Marsupials and Monotremes Specialist Group. Professors Legge and Woinarski are also members of the Australian government's Feral Cat Taskforce.

Our submission builds from a major body of research conducted by us over the period 2015 to 2020, supported by the Australian Government's National Environmental Science Program (NESP) through the Threatened Species Recovery Hub. This submission is a distillation of the outcomes of some of that research and we will readily provide copies of those research publications on request. Information relevant to almost all of the Inquiry's Terms of Reference is also described in our recent book, *Cats in Australia: companion and killer* (Woinarski *et al.* 2019b), and we commend that publication to you.

However, our concern about the impacts of cats on the conservation of Australian biodiversity also precedes the program of work we conducted through NESP. For example, Professor Dickman compiled the report *Overview of the Impacts of Feral Cats on Australian Native Fauna* for the Australian Nature Conservation Agency in 1996. The problem has been little resolved in the more than 20 years since that assessment.

Introductory remarks

We welcome this Inquiry. Observers of Australian nature have been concerned about the impact of cats for more than a century. For example,

> "*Undoubtedly, if many of our highly interesting and beautiful birds, especially ground-loving species, are to be preserved from total extinction, we must … at no distant date face squarely a wild-cat destruction scheme*" (Campbell 1906);
>
> "*If we are in earnest about the proper protection of our native birds – some of them the wonders of the world – we should face the wild cat pest now, ere it be too late, and before unique species, like the Night Parrot, Scrub-bird, and other ground-loving birds, have passed out forever*" (Campbell 1924).

However, the impact of cats on Australian biodiversity has continued and accumulated largely unabated ever since, at least in part because those impacts have been difficult to quantify, because the impacts of cats fall more on biodiversity than economic prosperity, because many in our community love cats, and because the challenge of remedying the problem (i.e., effectively controlling cats) is daunting. These issues can be resolved, and this Inquiry is ideally positioned to chart a pathway to that resolution.

Term of Reference a.
The prevalence of feral and domestic cats in Australia

We recently collated available information on the distribution and abundance of feral cats in Australia to derive the first robust estimate of their total population size (Legge *et al.* 2017). Although there are major challenges involved in estimating the density of feral cats (with best practice involving analysis of images of individually recognisable cats obtained from arrays of remote cameras), there are now more available site-based estimates of feral cat density from Australia than from any other country. We used about 100 such local estimates, spaced widely across Australia, then modelled the variation in these estimates to derive maps of cat densities and an overall estimate of the total population size of feral cats in largely natural environments. The average density is 0.27 feral cats per square kilometre, with typically higher densities on islands than on mainland Australia. Densities vary in inland Australia with decrease during drought periods and rapid increase (aided by the cat's high potential reproductive output and capability for long-distance movement) after widespread rains, so the total feral cat population varies among years. Overall, **we estimate the average population size of feral cats in natural landscapes of Australia is 2.1 million,** fluctuating between 1.4 million in dry conditions up to 5.6 million after widespread rain through inland Australia (Fig 1.).

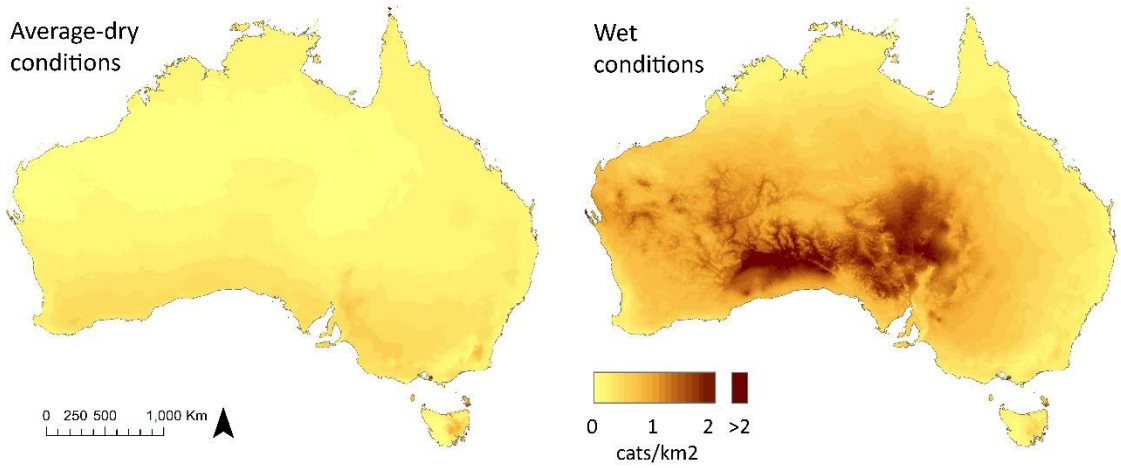

Fig. 1. Cat densities across Australia fluctuate in response to widespread rainfall patterns. After extended rain, cats increase in density markedly in inland Australia.

There are fewer estimates available of the numbers of feral cats in highly modified Australian environments (such as 'stray' cats in urban areas). Because feral cats in such settings may benefit from food sources intentionally or unintentionally provided by humans, their density is typically higher than in natural landscapes. **We estimated that the total number of feral cats in modified environments at 0.7 million** (Legge *et al.* 2017); hence, **the total population of feral cats in Australia is about 2.8 million**.

We also collated information on the occurrence of feral cats on Australian islands (i.e., those smaller than Tasmania). This is not a straightforward exercise as many islands have not been sampled for cats – or indeed for biodiversity in general. We concluded that feral cats are now present on about 100 Australian islands, representing about 2% of the number of Australian islands larger than one hectare (ca. 5500 islands); however, cats are present on most larger islands, so their island occurrence represents about 80% of the total area of Australian islands (ca. 33,000 km^2). **The total area of islands known, or likely, to be unoccupied by cats is** between 5,539 km^2 to 8,074 km^2 (**about 0.1% of the Australian land mass**). Occurrence on islands is an important consideration, as eradication of cats from (or prevention of their assisted migration to) islands is much more achievable than for mainland settings, and many islands support (or supported) important biodiversity assets such as endemic species and seabird breeding colonies. A list of islands occupied by feral cats is provided in Legge *et al.* (2017). For conservation objectives, cats have been eradicated from about 24 Australian islands (Woinarski *et al.* 2019b), including recently from Macquarie and Dirk Hartog Islands, with the latter representing the largest island in the world (628 km^2) from which cats have been eradicated.

Our results indicated that cats are present across all Australian habitats, and almost the entire mainland area. The exception on mainland Australia is the network of predator exclosures. These constitute a major and highly successful conservation initiative in Australia, established as havens for

native mammal species known to be susceptible to introduced predators. Through the establishment of exclosure fencing and subsequent eradication of feral cats (and foxes) from inside such fenced areas, cats are now absent from 28 such conservation havens, with a total area of 594 km^2. Although this predator exclosure network is a substantial conservation achievement, it represents less than 0.008% of Australia. **Hence, cats are absent in Australia only from a set of mostly small islands and a network of relatively small mainland exclosures: i.e., cats are present over 99.9% of the Australian land mass**.

With the exception of the small proportional area of predator exclosures, feral cats are present in all conservation reserves other than those on some islands, typically at the same density (and with the same impact) as in adjacent unreserved lands (Legge *et al.* 2017). This means that **the primary foundation of conservation efforts in Australia – the national reserve system – is ineffective for the conservation of the large component of Australian biodiversity that is susceptible to feral cats**.

For obvious reasons, the population of pet cats in Australia is much easier to tally than for feral cats. Substantial surveys of pet ownership indicate that there are pet cats in 27% of Australian households, with an average of 1.4 cats per cat-owning household, for a **total population of 3.8 million pet cats in Australia** (Animal Medicines Australia 2019). This number has shown little overall change in recent decades (Legge *et al.* 2020), although there is evidence that the number of pet cats in some remote Indigenous communities is rising (Kennedy *et al.* 2018).

Recommendations:

- Australia has one of the most robust estimates for the cat population size of any country in the world. However, data on feral cat densities in towns and cities are relatively scarce; data on the numerical responses of cats to a range of control measures are also limited. These deficiencies should be redressed by the establishment of programs that include commitments to:
    - ongoing monitoring of the size of the cat population in Australia and its response to local- and regional-scale management;
    - improve estimates of the numbers of feral cats in urban environments, as well as the extent to which cats move between the pet, urban feral, and bush feral fractions.

Term of Reference b.
The impact of feral and domestic cats including on native wildlife and habitats

In this section of our submission we describe the impacts of cats on Australian wildlife and habitats; we describe impacts of cats on human health and agricultural productivity in the 'other issues' section below.

Cats have detrimental impacts on wildlife directly through predation, and indirectly through spread of disease, competition and (in many parts of the world but not Australia) hybridisation. In turn, cat-induced loss and decline of some wildlife species may lead to broader ecological ramifications, including losses of the ecological function that those native wildlife species formerly provided.

A recent global review concluded that cats have caused or contributed to the extinction of two reptile, 40 bird and 21 mammal species, collectively about 26% of the total number of extinctions in these animal groups over the last ca. 400 years (Doherty *et al.* 2016). Many of these losses have been of species restricted to islands, where impacts of introduced species are often magnified.

The impacts of cats on Australian fauna are more pronounced than for any other continent, probably because Australian species have had a long evolutionary history without cat-like predators, and because many Australian animals have slow life histories (including relatively low reproductive output) such that their populations cannot readily sustain increased losses due to predation pressure (Edwards *et al.* 2020). Evidence of the impacts of cats on Australian fauna derive from many sources including: strong spatial and temporal patterns of decline of native species mirroring the cat's spread across the Australian continent and to islands; persistence of many Australian animal (particularly mammal) species on islands to which cats have not been introduced contrasting with extensive losses of these species across the mainland component of their range; successful reintroductions of many threatened Australian mammal species to fenced areas from which cats have been excluded; assisted or natural recovery of populations of native species from areas (especially islands) from which cats have been eradicated; failures of many reintroduction attempts to areas in which cats have not been controlled; and many studies demonstrating high and unsustainable rates of predation of native animals by cats (Woinarski *et al.* 2019b).

In some cases, the introduced red fox has had a comparable and compounding impact on Australian animals, and it is not always straightforward to disentangle the separate impacts of these two invasive predator species (Radford *et al.* 2018). However, cat impacts are more pervasive, as they occur across the entire mainland, and on far more islands than foxes.

Based on review of all relevant information, we concluded that **cats were a major cause of the extinctions of 25 of the 34 Australian mammal species lost since 1788**, and a likely contributing factor for a further three of those species; and a likely contributing factor to three of the nine extinctions of Australian bird species since 1788 (Woinarski *et al.* 2019a; Woinarski *et al.* 2019b). **The rate of loss of Australian mammal species over this period is exceptional at global level**: far higher than for any other continent, and cats have been the most significant contributor to these exceptional losses of the Australian mammal fauna (Woinarski *et al.* 2015). **Many mammal species had or have such high susceptibility to predation by cats that they are highly unlikely to persist at sites with even very low densities of cats**: examples include the threatened rufous hare-wallaby (mala) and golden bandicoot (Radford *et al.* 2018). Furthermore, cats are highly efficient at finding and hunting favoured wildlife species, even if these become diminishingly rare in the environment: rarity is no protection from cat predation (Stokeld *et al.* 2018).

But extinction is the extreme endpoint of a long gradient of biodiversity loss. **Cats also have caused and continue to cause marked decreases in the population size and distributional extents for many still extant species, and are a main driver of the ongoing decline and imperilment in many of Australia's threatened species**. Hence, more effective management of cats is a priority for the recovery of many threatened species, across much of the continent and on many islands. As a consequence of extinctions and severe population losses in the Australian mammal fauna, due to

the impacts of feral cats, many areas of Australia now support only an insecure vestige of the mammal fauna they supported 200 years ago.

Based on collation of very large datasets from ca. 100 cat dietary studies, we compiled records of cat predation on Australian fauna species, with records of such predation on: ca. 30 frog species; ca. 260 Australian reptile species, including 11 threatened species; ca. 340 native bird species, including 71 threatened bird species (ca. 60% of the total); and ca. 150 native mammal species, including 50 threatened species (ca. 60% of the total) (Woinarski *et al.* 2017b; Woinarski *et al.* 2018; Woolley *et al.* 2019; Woinarski *et al.* 2020). **Hence, cats are known to kill at least 780 Australian vertebrate species, including at least 132 threatened species**. Cats probably eat many more Australian animal species than these tallies, as most of the animal species for which there have been no records of cat predation occur in areas in which there have been few or no cat dietary studies. Across bird species, cat predation is most likely for medium-sized (60-300 grams) birds that nest and forage on the ground. Across mammals, cat predation is most likely for medium-sized (ca. 400 grams) species and least likely for species associated with rocky habitats. Notwithstanding such preferences, cats can kill animals as large as themselves, such as wallabies weighing about 4 kg (Woinarski *et al.* 2019b).

We have also recently collated quantitative information from many cat dietary studies across Australia, and analysed the resulting dataset to estimate the annual toll of Australian animals killed by cats. In essence, this calculation is based on the density of feral cats multiplied by the number of individual animals in an average cat's digestive system at any instant (with this latter figure assumed to comprise what that cat has eaten in the preceding 24 hours). These analyses indicate that **on average a single feral cat in the bush kills about 370 invertebrates, 44 frogs, 225 reptiles, 130 birds and 390 mammals per year**; and **the collective toll of Australian animals killed per year by all feral cats (including unowned stray cats, but excluding pet cats) in Australia is ca. 1.1 billion invertebrates, 90 million frogs, 600 million reptiles, 320 million birds and 960 million mammals** (i.e., 1.6 million reptiles, 0.9 million birds and 2.6 million mammals per day) (Woinarski *et al.* 2017a; Woinarski *et al.* 2018; Murphy *et al.* 2019; Woinarski *et al.* 2020; Woolley *et al.* 2020).

These tallies fall unevenly across species and regions. Predation rates of birds are particularly high on islands, where cats may consume large numbers of nesting seabirds: for example, prior to their eradication on Macquarie Island, a population of ca. 375 feral cats killed at least 58,000 breeding seabirds per year (Jones 1977). The number of reptiles killed by cats is much higher in inland Australia than in higher rainfall areas, probably reflecting spatial variation in reptile abundance.

It is challenging to contextualise, and infer impact from, the tolls of animals killed by cats, in part because there are no estimates of the total population sizes for most Australian animal species. We estimated that the Australian land bird population is about 11 billion; hence, feral cats kill about 3% of the total Australian bird population every year (Woinarski *et al.* 2017a). This rate of take may be sustainable for some bird species, but prey selectivity by cats means that the proportional take will vary markedly across species and many bird species will be unlikely to maintain populations when faced with the continual losses due to cat predation.

The toll of animals taken by cats every year can also be contextualised by comparison with losses associated with other major threats to Australian biodiversity. With due interpretational caveats,

and recognising the invidiousness of comparing threats that both have significant impacts, the annual toll of reptiles, birds and mammals killed by cats is much higher than corresponding figures for Australian animal losses due to land clearing: 600 million reptiles killed per year by feral cats cf. ca. 90 million lost annually to land clearing; 320 million birds killed per year by feral cats cf. ca. 9 million birds lost annually to clearing; 960 million mammals killed per year by feral cats cf. ca. 2 million lost annually to clearing (Cogger *et al.* 2003; Woinarski *et al.* 2017a; Woinarski *et al.* 2018; Murphy *et al.* 2019).

Most of the animals killed by feral cats in the bush are native (100% of all frog individuals killed, >99% of reptiles, 99% of birds, 56% of mammals). There is a marked geographic variation in the proportion of native to introduced mammals killed by feral cats, with introduced rodents and rabbits making up most of the mammalian diet of feral cats in much of temperate and southern Australia, but native mammals comprising the bulk of mammal items consumed by feral cats elsewhere (see Figure 2).

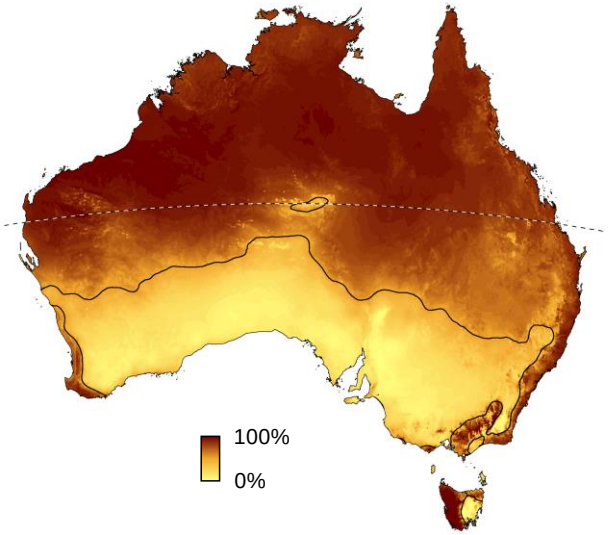

Figure 2. The percentage of native mammals relative to all mammals taken in the diet of feral cats (from Murphy *et al.* 2019).

Our assessments of the tallies of Australian wildlife species and individuals killed by cats may be inflated marginally by the inclusion within our dietary analyses of some items taken by scavenging on animals killed through other causes, although the proportional take of carrion is typically relatively low for feral cats. Conversely, our tallies do not include animals killed by cats but not eaten, or animals that are wounded by cats and escape but subsequently die due to their wounds.

The impacts of cats on biodiversity compound, and are compounded by, the impacts of other factors. Cats occur at higher density and/or hunt more efficiently in recently burnt areas, in fragmented landscapes, and in heavily grazed landscapes, mostly because these factors lead to reduction in ground cover and hence shelter for many native animals (Woinarski *et al.* 2019b). For example, it is likely that in the aftermath of the 2019-2020 wildfires, any surviving wildlife in burnt areas will be much more susceptible to cat predation than they were before the fires, and cats are

also likely to focus their hunting around unburnt patches that would otherwise provide some refuge for surviving wildlife in largely burnt landscapes. Collectively, this likely increased predation pressure post-fire will compound the impacts of the fires on wildlife and reduce the rate and likelihood of post-fire recovery.

Introduced mammals (particularly rabbits) may also influence the impacts of cat predation on native wildlife because they can sustain very high densities of cats, such that even if native species form a minor component of cat diet, that consumption rate may become a significant impact across a large population of cats. Some evidence suggests that reduction in the abundance of introduced prey species (notably rabbits) results in reduced abundance of cats, and consequently increases in native mammals (Pedler *et al.* 2016; McGregor *et al.* 2020). Likewise, management that improves ground cover vegetation and habitat quality, such as through improved fire regimes or reduction in livestock grazing intensity, can lead to recovery of native wildlife, at least in part because it reduces the population density or hunting efficacy of cats (Legge *et al.* 2019).

Cats eat, and deplete, many of the same species that form the prey of native carnivores, such as quolls, goannas, snakes, owls and raptors (Glen 2014). However, the population level impacts on native predators of such competition with cats are not yet well determined.

Humans introduced cats to Australia; in the process cats introduced a set of parasites and diseases that were not formerly present in this continent, and these have subsequently spread to infect many native animals. The most noteworthy of these novel introductions is the protozoan parasite *Toxoplasma gondii* which has a life history that cycles between cats and other warm-blooded animals. Cats are the definitive host, so this parasite would disappear from Australia in the absence of cats (or other felines). **Toxoplasmosis infection is now known to occur in many Australian bird and mammal species, with many consequences including spontaneous abortions, changed and aberrant behaviours and increased mortality**. Notwithstanding some high rates of infection in some native animal species and in some regions, the population level consequences to native wildlife of such infection remain poorly resolved (Fancourt *et al.* 2014).

The impact of cats extends across ecological food webs to ecological functioning and the structure and health of ecosystems and habitats. This is mainly because many of the Australian mammal species that have become extinct or declined most severely because of cats performed important ecological functions. Many of the now cat-reduced native animals were (or are) critically important for the dispersal of seeds and fungi (Fleming *et al.* 2014), germination of seeds (Valentine *et al.* 2018), reduction in fuel loads (and hence moderation of fire intensity) (Ryan *et al.* 2020), maintenance of soil fertility (Eldridge and James 2009) and provision of shelters (such as deep burrows) used by many other species. **Australian ecosystems are less productive, healthy and diverse because cats have reduced the population sizes of many native animals that played important ecological roles**.

We have recently reviewed the impacts of pet cats on Australian wildlife and we refer you to that publication (Legge *et al.* 2020) for a detailed account. In summary, even well-fed pet cats will kill. Most pet cats are allowed to roam, for at least part of the day or night. Because of the high density of pet-owners, and the amount of food deliberately or inadvertently provided by humans, pet cats

occur at far higher densities (39-70 pet cats per km^2 in urban settings) than feral cats in natural landscapes (1 cat every 3-4 km^2). Hence, even though the average roaming pet cat kills fewer animals (the average roaming pet cat kills 186 reptiles, birds and mammals per year) than is the case for feral cats (748 reptiles, birds and mammals per year), the number of animals killed per unit area by pet cats (7,190 to 13,100 animals killed by pet cats per km^2 per year) far exceeds the comparable toll per area from feral cats in natural landscapes (204 animals per km^2 per year).

We calculated that collectively **pet cats in Australia kill 390 million animals per year (i.e. more than one million animals per day)**, with most of these being native animals. Whereas feral cats in natural landscapes have their populations regulated in part by prey availability (such that when native wildlife become rare, cat population density also tends to decline, providing some relief to the wildlife), this is not the case for pet cats because so much of their food is provided by humans. Hence, if a native animal becomes rarer in urban settings, the predation pressure exerted by pet cats does not decline. Based on an intensive study that estimated the average density of birds in Australian urban and suburban areas, and the average rate of predation by pet cats in those areas, Paton (1991) concluded that 'this (take by cats) is equivalent to … taking all of the young being hatched … or at least 50% of the standing crop of birds' (p.68).

Native wildlife would be more abundant in Australia's towns, gardens and parks if the current rate of predation by pet cats can be reduced. Pet cats that are allowed to roam at any time kill nocturnal and diurnal animals; **pet cats that are securely contained during the night kill animals during the day; pet cats that are securely contained during the day kill animals at night; pet cats that are securely contained 24 hours a day do not kill wildlife**.

Recommendations

- Predation by cats is the major factor causing the imperilment of many of Australia's threatened animal species, and driving the decline of many species not yet listed as threatened. Recovery Plans and conservation advices for these species need to more explicitly provide the justification, mechanism and resourcing for more effective and sustained control programs that effectively reduce the abundance and impacts of feral and pet cats.
- Australian islands are critical for the conservation of many Australian animal species that are susceptible to introduced predators (cats and foxes); and many also have significant breeding colonies for seabirds and marine turtles that are also readily depleted or destroyed by introduced predators.
    - Biosecurity is suboptimal for many of the islands currently uninhabited by cats, and this deficiency should be remedied such that the likelihood of inadvertent or deliberate introduction of cats to such islands is rendered negligible.
    - Eradication of cats from islands also offers extraordinary opportunities for conservation safeguarding and the recovery of threatened species, and a long-term program should be established to reduce the number of Australian islands occupied by cats.
- Australia's conservation reserve system is purposed largely to protect and recover biodiversity, but most reserves in that system offer no succour for cat-susceptible native

animals. Management plans for key reserves should provide clear commitments to reducing the impacts of cats, such plans should be fully implemented, and the outcomes for biodiversity monitored.

- Pet owners who allow their cats to roam are responsible for inflicting a substantial toll on Australian wildlife and reducing the biodiversity in urban and peri-urban environments. The toll should, and can readily be, reduced through the consistent development, imposition and policing of a package of legislative and regulatory provisions described below (under Term of Reference c).
- The impacts of the cat-borne parasite *Toxoplasma gondii* on the population viability of Australian animal species is poorly resolved, and further research is warranted on its incidence and impact, and on options to remediate significant impacts.

Term of Reference c.
The effectiveness of current legislative and regulatory approaches

The management of environmental issues is a complex challenge for Australia's three-tiered government system. Environmental issues frequently span state and territory boundaries and are inherently complex. There are interactions with social, political, economic, and cultural factors which affect legislation and how it is implemented and enforced. The status of cats as both valued companion animals as well as one of Australia's most invasive pests creates a range of challenges in the development of an effective legislative and regulatory approach to management.

Assessing the effectiveness of the current sets of legislation and regulations relating to feral and pet cats is challenging. At a coarse level, **the current settings can be considered ineffective, given the problems they are designed to resolve remain unabated: feral cats still occur in undiminished numbers across almost all of Australia, most pet cats roam, and most wildlife species susceptible to cat predation continue to decline**. However, there has been some progress over the last decade, and some governance settings have improved. **The most notable of these successes have been the eradication of feral cats from some islands and increase in the number and extent of mainland predator exclosures** (Legge et al 2018), **with both of these advances leading to some recovery of some threatened species for which cats are a primary threat**. Other advances include some increases in the menu and effectiveness of poison baits and other options for cat control and a more collaborative inter-governmental approach to the problem posed by feral cats. Legislative and regulatory settings have contributed to this progress.

National

Predation by feral cats was one of the first threats listed (in 2000) **as a Key Threatening Process for Australian biodiversity under the *Environment Protection and Biodiversity Conservation Act* 1999** (EPBC Act). The Act allows for the development and implementation of a Threat Abatement Plan, if the Minister considers that such a plan is a feasible, effective and efficient way to abate the threatening process (s. 270A). To date, there have been three successive iterations of Threat Abatement Plans for feral cats. The Threat Abatement Plans have been focused on attempting to

reduce the impacts of cats in high biodiversity areas, improving control mechanisms, and maintaining and enhancing collaboration and public support (Woinarski *et al.* 2019b).

However, **the EPBC Act imposes little obligation to implement (other than on Commonwealth lands), and no obligation to fund, actions in Threat Abatement Plans**. **As a consequence, although the Threat Abatement Plan for feral cats provides a good schematic foundation for improving the control of feral cats, its potential is largely unrealised**. Its effectiveness and implementation have been especially constrained in the majority of Australia that is not Commonwealth lands (s. 269). Even on Commonwealth lands, such as Kakadu National Park, there has been little resourcing or implementation of the feral cat Threat Abatement Plan, notwithstanding the Act's requirement that the 'Commonwealth must implement a … threat abatement plan to the extent to which it applies in Commonwealth areas' (s. 269(1)).

The EPBC Act is the foundation legislation for the protection of Australian biodiversity, with particular importance for the conservation of threatened species. The EPBC Act provides for the establishment of Conservation Advices and/or Recovery Plans for listed threatened species, developed as the national basis to ameliorate the threats to the species and guide their recovery 'so that (their) chances of long-term survival in nature are maximised' (s 270(1)). As noted under our response above to Term of Reference *b*, at least 132 of Australia's threatened wildlife species are known to be killed by cats. **Most of these EPBCA-listed species do not have Recovery Plans. However, even for those threatened species that do have Recovery Plans, the EPBC Act provides no obligation to implement the actions within Recovery Plans or to fund them** (s. 269). Conservation Advices typically have much less detail on the actions required, and in any case have even less clout than Recovery Plans (s 266B). Hence, although many Recovery Plans and Conservation Advices made under the EPBC Act provide a clear recognition that more effective management of cats is a priority means for the recovery of threatened species, **the lack of obligation within the Act to implement these plans often means that such actions are not undertaken, rendering the plans entirely ineffective, and their desired outcomes illusionary**.

Toxins used for feral cat management are regulated by the Australian Pesticides and Veterinary Medicines Authority (under the *Agricultural and Veterinary Chemicals Act 1994* and *Agricultural and Veterinary Chemicals Code Act 1994*). Currently, sodium fluoroacetate (1080) and para-amino propiophenone (PAPP) are registered for use under certain conditions. These toxins can be presented in trials via research and minor use permits (e.g. for the Felixer grooming trap), and then eventually via registered products (e.g. Eradicat; Curiosity). The processes for obtaining minor use permits and/or registration involves thorough risk assessments, and are very lengthy.

The EPBC Act also currently provides the Commonwealth government's basis for evaluating and approving applications for developments that may have impacts on threatened species and other environmental values. In some cases, development applications are approved under sections 130(1) and 133 of the Act with conditions that provide for some offsets to the potential impacts of the development on threatened species and other matters. As an example, an application in 2011 to mine iron ore at Yandicoogina in the Pilbara was approved by the Commonwealth government (with complementary approval by the Western Australian government) on condition that the proponents develop, fund and implement an offset plan that would provide benefit to two threatened species

present at the proposed mine site, northern quoll and Pilbara olive python (Department of Sustainability Environment Water Populations and Communities 2012). The resulting offset plan mostly constituted a broader-scale program to reduce the population size of feral cats at a large property in the region, with the expectation that this program would result in increases in population size of northern quoll. This example indicates that **there may be far more substantial potential to use the Act's offset provisioning strategically to increase the duration, extent and intensity of control programs for feral cats, especially across regions of high biodiversity value**. The Act's current provisions for strategic assessment (Part 10) also have the – largely unrealised – potential, to support, plan and implement regional-scale programs for the benefit of biodiversity, and this capability could readily be used to develop more strategic, enduring and broad-scale efforts to control feral cats.

State and territory governments

Most environmental management is the responsibility of states and territories. **Each Australian jurisdiction has its own laws that relate with varying focus and effectiveness to the management of feral cats** (Woinarski *et al.* 2019b). Feral cats are declared as pests in some jurisdictions (Queensland, Northern Territory, South Australia, on public lands of Victoria, and on an 'unassigned control' basis in Western Australia, meaning that there is no obligation on individuals or agencies to undertake management). Feral cats are not declared as a pest in the ACT, New South Wales, or Tasmania. One significant complication in the management of cats in Australia is that pet cats, exactly the same species as feral cats, are managed through companion animal legislation. **How cats can be managed therefore depends on where they live (which jurisdiction, and what tenure) and whether they are owned (pet) or not**.

Local governments

Local governments have a significant role in the management of pet and stray cats, yet management practices are highly variable, ranging from the 'do nothing' approach, to the implementation of by-laws requiring desexing, registration and 24/7 containment.

We have recently surveyed local governments in Australia to assess their involvement in, success with, and problems encountered in, cat management. The survey shows that cat management is a major challenge for local governments in Australia. A range of contributing factors were identified by respondents, including social, behavioural, cultural, funding constraints and knowledge gaps. Common responses regarding legislative and regulatory settings in the survey included:

- Lack of a coordinated approach between local, state and federal governments: some local governments view cat management on a local scale as a low priority in the absence of regional management.
- In some jurisdictions, feral cats are not declared as established pest animals, preventing effective action by local government.
- Efforts to establish cat management by-laws can be overridden or disallowed by the state government (e.g., in South Australia).
- Legislation is typically weaker for domestic cats than it is for dogs, limiting local government ability to act.

- Legislation may not include registration or desexing requirements for domestic cats, and may not confer the ability for local governments to establish local by-laws.
- There is a lengthy process and substantial costs associated with establishing and implementing local by-laws for domestic cats: accordingly, there may be a preference to 'do nothing'. Participants stated that the process for an individual local government to develop and implement by-laws on cat containment takes approximately 5 years or longer. If this process needs to be repeated for every local government area in Australia, it equates to a significant amount of time and effort.

Recommendations

- Increase the obligation to implement and report on the progress of Threat Abatement Plans, Recovery Plans and Conservation Advices, for example in the current review of the EPBC Act. the EPBC Act's provisions for offsetting and strategic assessments have the largely unrealised potential to foster the development and implementation of broad-scale programs for the control of cats, in order to deliver substantial benefits to biodiversity conservation. Consider opportunities to develop this potential further, for example in the forthcoming review of the Act.
- review processes for trials and registration of new cat toxins and toxin delivery systems, and consider opportunities to streamline.
- set a consistent foundation for feral and pet cat management at the national (or state/territory) level, with consistent coordinated actions then implemented and enforced at the local government level. For example, feral cats should be declared pests across all states and territories (including external territories).
- regional cat management officers may be a useful mechanism for working across local government areas on consistent pet and stray cat management approaches.
- key components for an improved legislative and regulatory national framework for the management of pet cats comprise:
    a. **Mandatory pet cat registration**, with fee structures that incentivise desexing of cats, and de-incentivise non-desexed cats. Registration fees can be used towards the management of cats, and the system should allow local governments to keep track of registered cat breeders.
    b. **Mandatory desexing** of pet cats before they reach sexual maturity. The current rates of cat desexing in local government areas is highly variable, ranging from 5% to 99%. Low rates of desexing may be related to large urban feral cat (stray) populations.
    c. **Limit the number of cats per household.** Currently, only some local governments specify a limit on the number of cats per household, with permits required to keep more than the specified limit. We suggest that a limit of two cats per household (with the exception of licenced cat breeders) is an appropriate limit.
    d. **Cat-free or cat containment areas.** New **r**esidential developments provide an opportunity to prohibit cats from areas adjoining bushland and other areas with high environmental values.
    e. **24 hour containment or curfews, with corresponding resourcing for compliance and enforcement.** For example, the ACT now has 17 cat containment suburbs, and out of 34

Victorian local governments surveyed, 10 have a dusk to dawn curfew and 7 have 24 hour containment.

f. **do not allow Trap-Neuter-Release programs**, nor stray cat feeding sites, that could encourage dumping of pet cats.

Term of Reference d.
The effectiveness of Commonwealth action and cooperation with states and territories on this issue, including progress made under the Threat Abatement Plan, national framework and national declaration relating to feral and domestic cats in Australia

In July 2015, Commonwealth, State and Territory Ministers endorsed a national declaration of feral cats as pests that threaten wildlife, and recognised that pet cats can have detrimental impacts on native animals. The declaration encouraged reform of legislation to remove barriers to feral cat management in some jurisdictions; included a commitment to improving pet cat management; and acknowledged that managing feral cats was important for threatened species recovery.

Around the same time, the management of feral cats was listed as a key component of the national Threatened Species Strategy (Commonwealth of Australia 2015). **The Threatened Species Strategy contains explicit quantitative targets for feral cats, including increasing predator-free areas, eradicating feral cats from five islands, establishing the Feral Cat Taskforce, dedicating funding for research, monitoring and management, and culling 2 million cats over the period 2015-2020** (Woinarski *et al.* 2019b).

The Feral Cat Taskforce is a forum for policy-makers, government and non-government managers and researchers to share information, find opportunities for cooperation, and build a community of practice. It is chaired by the Threatened Species Commissioner. The Taskforce has been a useful mechanism for coalescing and focussing cat research, management and communication activities around the Australian Government's Threat Abatement Plan and its Threatened Species Strategy. **The Feral Cat Taskforce is a model that could be usefully applied to help coordinate actions for other nationally listed threats. However, its operation would be much enhanced if it were able to fund substantial component of the Threat Abatement Plan**.

Feral cat management is carried out by states and territories, with these activities nationally coordinated through the intergovernmental Environment and Invasives Committee, which implements the Australian Pest Animal Strategy. In reality, feral cats are subject to highly variable levels of management among jurisdictions. This ranges from efforts to eradicate cats on offshore islands, targeted baiting, trapping and exclusion fencing programs (notably in Western Australia) to very little management at all in some other jurisdictions.

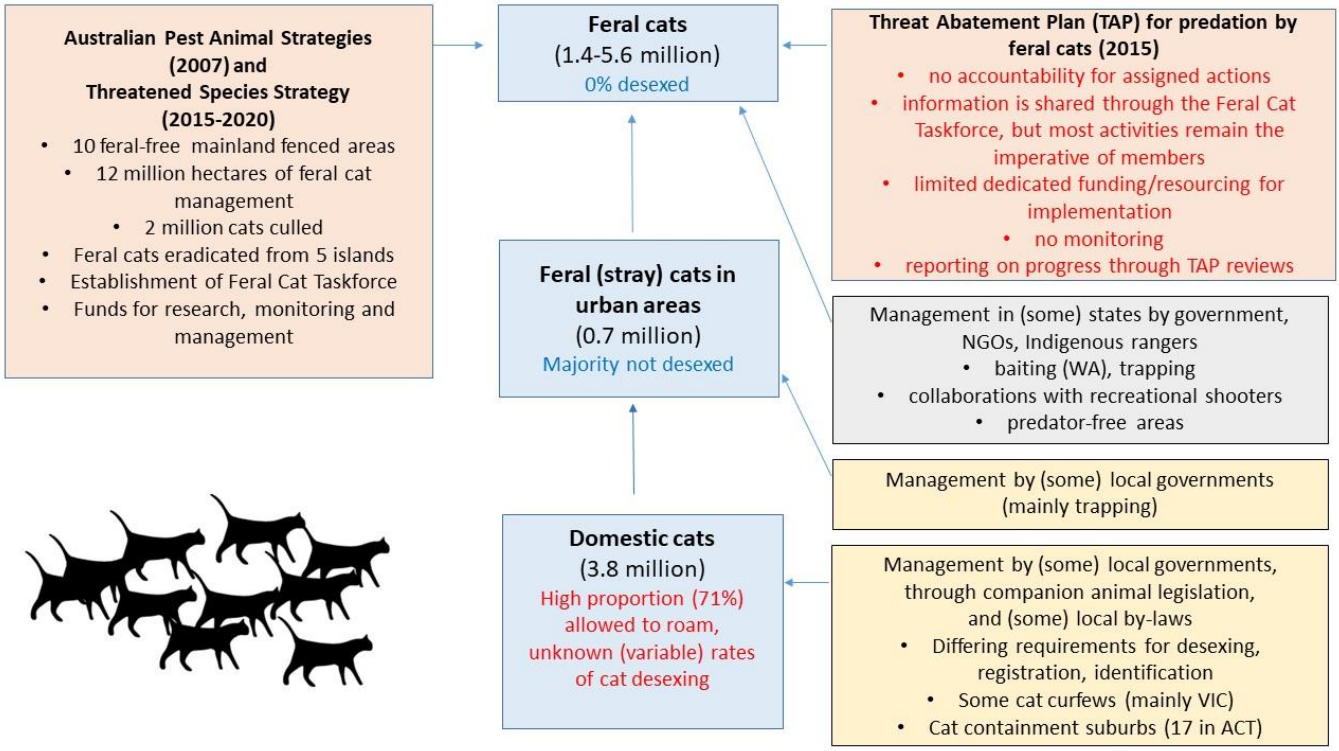

Figure 3: Overview of current national policy, and management inputs from various levels of government, in Australia. While there has been some progress with cat management on some islands and states (particularly WA), there are still major shortcomings (noted in red text) in the management of cats.

In summary, the Threat Abatement Plan, the Threatened Species Strategy, the national declaration, and coordinating mechanisms such as the Feral Cat Taskforce and the Environment and Invasives Committee are all positive steps towards the management of feral and pet cats. However, in the majority of the Australian mainland and on Tasmania, feral cats are largely unmanaged. Where it does exist, much of the feral and pet cat management on the Australian mainland is inconsistently applied and resourced, constrained by a range of factors at each tier of government, and overall, ad-hoc and ineffective.

Recommendations

- The national *Threatened Species Strategy*, operating over the period 2015-2020, provided a major national focus on the problem posed to Australian biodiversity by feral cats, developed a series of priority and coordinated actions for cat control and prompted substantial additional funding for some key cat management actions. Future iterations of that Strategy should build from this important foundation to maintain its momentum and enhance its achievements.

Term of Reference 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

There is no single, best approach for controlling feral cats. Instead, there are a range of management options for controlling feral cats, which vary in efficacy, costs, applicability and risks, depending on the local context. The menu of control options has expanded in recent years due to innovation (e.g., novel toxins and toxin delivery systems), and work is underway to develop new cat control methods. Recent work has also helped to test the efficacy of some of the control alternatives.

To some extent, the effectiveness of feral cat control in the bush trades off with the area over which it can be applied. For example, physical exclusion of cats from an area using barriers (predator-proof fencing, or stretches of sea for islands) are the most effective way to reduce cat density to zero. However, the operational challenges and costs of fencing and eradicating cats from within fenced areas or from islands limits the areas over which this option can be used. Hence, much less than 1% of Australia is cat-free. At the other extreme, managing grazing and fire in order to maintain ground cover that reduces cat hunting success can be applied over very large areas (McGregor *et al.* 2014; Davies *et al.* 2020; Stobo-Wilson *et al.* 2020; Stobo-Wilson *et al.* 2020), but cats will continue to live in these areas, and will continue to hunt, albeit it at reduced efficiency and impact.

Given the complexity of considerations, one way to frame the selection of feral cat control options is in terms of the native species of conservation concern.

- For those species that are most susceptible to the impacts of cats, such as bettongs, hare-wallabies, stick-nest rats, physical exclusion of cats is essential for avoiding extinction in the near term. For example, our work has identified that 12 mammal species require complete separation from cats to persist, and that a further 40 mammal species should have a portion of their populations living free from cats, to reduce the risk of extinction (Legge *et al.* 2018).
- For species that can persist in the open landscape if cat predation impacts are strongly reduced, control options include poison baiting, shooting, trapping, and hunting (by tracking, or using trained dogs). Of these, only poison-baiting can be applied at large scales, and only in the southwest of WA (currently). Some of the 40 mammal species mentioned above can persist if supported by this management, as can over 30 mammal species that are moderately impacted by cats, as well as some bird species (e.g. western ground parrot).
- For species that can persist in the open landscape if cat impacts are moderately reduced, options include large reductions in rabbit densities, managing fire and grazing to promote ground cover, and possibly, in some situations, relaxing dingo control. These actions will help many native species of mammal, bird, reptile and frog.

The options for managing feral cats living on the fringes, and within, towns and cities differ from those available for feral cats in the bush. For example, poison baiting and shooting are much less feasible options, for obvious reasons. The most effective way to reduce the urban feral cat population is to remove their access to human food subsidies, by managing refuse bins carefully,

fencing off rubbish sites, intensive farms, and any other potential area of super-abundant food. This action will prevent the formation of cat colonies, where cats live at extremely high densities around a food source.

Trap-Neuter-Release (TNR) is advocated by some groups and individuals who are distressed at management actions that involve killing cats. It involves capturing cats living in colonies, having them desexed by a vet, and releasing them back to the colony. The colony cats are often supported by feeding. In most areas, release of unowned cats contravenes local or state/territory laws, rendering TNR illegal. The evidence from numerous trials carried out in a range of countries show that TNR does not reduce the overall population size of urban ferals (owned, stray) cats because of continual immigration from outside the colony. **Desexed cats that are returned to the area where they were caught continue to hunt, so their impacts on wildlife are unabated**. There is an argument that capturing and carrying out an invasive surgical procedure on a feral (wild) cat is inhumane, and **the net welfare benefit of TNR (compared to reducing the density of cats) is negative given the released cat continues to inflict pain and suffering on other animals**. Cats living in high density colonies also have higher prevalence of diseases that can affect people and livestock, such as cat scratch disease and toxoplasmosis. **A concerted, sustained, strategic and adequately resourced program of removal (for adoption or euthanasia) of unowned cats is likely to reduce cat colonies and their impacts on wildlife more rapidly and effectively than a program that returns cats to their colonies after sterilisation**.

The current management options for feral cats living in the bush, and those living in towns, are listed in Table 1. The table also summarises, for each option, the extent of its current use, the potential for expansion, its efficacy, the area over which the option can be applied, the cost, constraints and risks associated with the action, and its humaneness. The last section of the table presents potential future options for cat control that are being trialled or developed.

Table 1. Summary of management options for cats, particularly feral cats, in Australia. (Modified version of Table 9.3 in Woinarski et al 2019b).

Management option	Current use	Potential for expansion	Efficacy	Area	Costs	Constraints/risks	Humaneness
Feral cats in the bush							
Cat exclusion – island refuges	Including Dirk Hartog Island, 593 islands known to be cat-free, covering 5539 km^2 with many of the 4758 (covering 2535 km^2) unsurveyed islands probably also cat-free. Variable levels of biosecurity to prohibit introduction of cats to islands on which they are not currently present.	Eradication of cats from islands technically possible, and the size of islands subject to cat eradication is growing Translocations of native species to islands is a very successful conservation tool	Very high	Small relative to animal distributions, but size of individual islands targeted for eradication is growing	For cat eradication - single large investment, but then ongoing costs are much more modest For biosecurity to prevent cat introductions – very low cost relative to benefit	• Represents a small proportion of former distributions of many species • Does not address ecological degradation caused by cats on mainland • Issues of genetic connectivity, loss of genetic diversity, overabundance, loss of predator awareness, are all emerging issues • May require ongoing biosecurity and regulation to prevent cat introductions or re-establishment • Some risk that threatened species translocated to cat-free islands may have impacts on native species present there; • Not all cat-susceptible native species will have habitat that is found on cat-free islands	Requires a one-off cull of cats only rather than a continuing need for killing
Cat exclusion – mainland fenced enclosures	28 exist, covering 594 km^2; more under construction	Increasingly large areas are being constructed. Fenced areas in northern Australia a higher priority now, to promote representation of those predator-susceptible	High Greater biosecurity and longevity risks than islands	Very small relative to animal distributions, but size of individual sites is growing	Upfront large capital investment, then substantial ongoing costs for maintenance,	• Represents a very small proportion of former distributions of many species • Does not address ecological degradation caused by cats on the balance of the mainland • Issues of genetic connectivity, loss of genetic diversity,	Requires a one-off cull of cats only rather than a continuing need for killing

Management option	Current use	Potential for expansion	Efficacy	Area	Costs	Constraints/risks	Humaneness
		native species that are currently unrepresented in the exclosure network			infrastructure replacement	overabundance, loss of predator awareness, are all emerging issues • Decentralised management (of fences and islands) may lead to uneven representation of native species in need of this level of protection • May not be effective for some predator-susceptible animals (e.g. birds)	
Poison baiting	Eradicat (most successful bait system) used in south-west WA over 15 000 km^2 of conservation land annually, and in trial sites in eastern Australia. New toxins and toxin presentation being trialled	Eradicat could be used more broadly in the south-west of WA, limitation is cost. Elsewhere, non-target impacts become more limiting New formulations (Hisstory) and toxins (PAPP) should expand the potential for using poison baiting	Medium–high	Medium	High annual costs	• Non-target impacts, and risk of unwanted consequences, become more substantial away from the south-west • Over time, bait resistance in cats likely • Animal welfare concerns • May not reduce cat density and predation pressure sufficiently to allow persistence of the most predator-susceptible native species • Ongoing application of poisons needed to maintain enduring results • Some legal constraints • Obtaining permits to use cat toxins is subject to very long lead times, delays, and restrictions	Variable pain and suffering associated with poisons, for target and non-target species

Management option	Current use	Potential for expansion	Efficacy	Area	Costs	Constraints/risks	Humaneness
Rabbit and introduced rodent management	Rabbits are being controlled by releases of disease	Scope to increase the frequency of new disease releases, including forms with cumulatively broader geographical impacts	Medium	Very large	Costs to date have been borne by agricultural sector, who seek to reduce rabbit impacts	• Risks from cat prey-switching in initial population knock-down need to be assessed and managed • Limited current scope for control of invasive rodents; and, if controlled by poisons, likelihood of direct and indirect non-target impacts (e.g. native predators of rabbits) • May not reduce cat density and predation pressure sufficiently to allow persistence of the most predator-susceptible native species • Animal welfare concerns with spread of disease and or poisoning • Not applicable across large parts of Australia without rabbits	Some applied diseases may cause suffering and pain before death
Dingo management	Some current research Parts of Australia without dingo persecution	Some potential for reintroduction of dingoes to parts of Australia, and relaxation of dingo control in other parts	Low–medium	Very large	May involve compensation costs to pastoralists	• Risks to livestock industry need to be evaluated and managed • May not reduce cat density and predation pressure sufficiently to allow persistence of the most predator-susceptible native species • Small, highly vulnerable populations of threatened	May reduce need for poison baiting of dingoes

Management option	Current use	Potential for expansion	Efficacy	Area	Costs	Constraints/risks	Humaneness
						fauna may be at risk from dingo predation • Some legal constraints	
Habitat management	Growing evidence for benefits to fauna in tropical savannas down to south-eastern forested areas	Could be used over large landscapes, especially in northern Australia, where fire and feral herbivores are managed for multiple purposes	Low–medium	Very large	Co-benefit of management for other purposes, so costs potentially relatively low, unless land owners are incentivised to manage conservatively	• May not reduce cat density and predation pressure sufficiently to allow persistence of the most predator-susceptible native species • In many pastoral areas, options for reducing stock density and impacts are limited	No significant animal welfare concerns
Trapping/shooting/hunting (including using dogs, new traps, as well as Indigenous hunting)	Used in targeted cat control projects, and in the western deserts by some Indigenous Rangers and Traditional Owners	Could be expanded with funding; use of dogs and new traps (Felixer) will help reduce labour. Indigenous cat tracking and hunting could be more broadly supported	Low–medium	Very small	Moderate costs relative to area, but excellent employment opportunities in regional and remote Australia	• Efficacy is variable; • Some animal welfare concerns (e.g. leghold traps) • Some legal constraints	Some trap techniques may cause stress or pain
2. Feral cats in towns							
Fence off dumps, intensive farm sites, any other source of super-abundant food that promotes the formation of cat colonies	Limited	Much scope for expansion	Very high	Medium (around towns)	Moderate upfront capital costs, some ongoing maintenance costs	Sustained management of fences required	No significant animal welfare concerns
Enhanced management of garbage systems, e.g. no	Limited	Much scope for expansion	Very high	Medium (around towns)	Costs of informing public, and	Will require ingoing policing for compliance	No significant animal

Management option	Current use	Potential for expansion	Efficacy	Area	Costs	Constraints/risks	Humaneness
accessible skips with food scraps					policing regulatory systems by local government		welfare concerns
Trapping (usually cage traps)	Patchy: some local governments have trapping programs, or supply traps for residents to use	Much scope for expansion	Low–medium	Very small	Moderate costs relative to area	Efficacy is variable, and needs ongoing intensive effort to be useful	Usually cage traps, so limited welfare concerns
Trap-Neuter-Release	Limited, and except for a small number of research trials, the practice is illegal in most states	Do not expand	Not effective	Can only be used in tiny areas	High, but to date has been borne by community	• Does not reduce population size of feral cats in towns because of immigration • Desexing does not stop cats from hunting in local areas • Can encourage 'cat dumping' by owners of unwanted pets • Cat colonies can be disease hotspots	Procedures very stressful for feral cats Net welfare to cat and its prey is negative
Enhanced management of pet cats to stop leakage into the feral cat population	Patchy implementation of a range of pet management options (see ToR c)	Much scope for improvement, by aligning national, state and local government legislation and regulation, and resourcing local governments to manage pet cats and urban feral cats more effectively	Very high with adequate investment	Medium (around towns	Moderate costs, shared by government and pet cat owners	• Legislative and management changes must be accompanied by extensive and ongoing public education programs for uptake and compliance • Pet cat populations may be increasing in remote communities; their management may require collaboration between cat owners, rangers, and groups such as Animal Management in Rural and Remote Communities, to deliver	Improved welfare outcomes from management

Management option	Current use	Potential for expansion	Efficacy	Area	Costs	Constraints/risks	Humaneness
						integrated education and cat care services.	
3. Future options							
Guardian dogs (that repel cats from defined areas)	Being trialled; highly effective at repelling foxes and dingoes/dogs. If they are shown to be effective at repelling cats, guardian dogs could be used to protect sites with cat-susceptible species		Unknown (highly effective with canids)	Small	Lower than trapping, shooting because of low labour costs	• Dogs need training and supervision • Dogs need to be imprinted on any native species they are likely to encounter	No significant animal welfare concerns
Accelerated selection for predator awareness	Being trialled; will take some years before assessment is possible		Unknown	Potentially very large	Unknown	• Whether selection could ever produce an individual that can evade cats (rather than survive for an extra couple of weeks) is unknown • Feasibility of going from research trials to operationalising in open landscapes is unknown	Ongoing predation trials may invoke public concern
Immunocontraception	Approaches are being trialled, especially by vet industry because of potential application for pet cats and stray cat management		Presently not effective; may become effective	Medium (around towns) to large (in open landscapes)	Development costs high	Feasibility of being a viable option in open landscape, with feral cats, is low.	
Cat disease	Has been used for eradicating cats from islands overseas, but not used in Australia. Little active research in this area		Presently not effective; may become effective	Potentially very large	High development and ongoing technical support and monitoring	• Public concern over engineered diseases that could affect pet cats • Conservationists concern over engineering diseases that could affect highly threatened felid species overseas	Some applied diseases may cause pain and suffering
Gene drives	Potential for gene drives to control invasive species is being developed first in rodents		Presently not effective;	Small-medium (island	Very high development and ongoing	• Social licence may be challenging	

Management option	Current use	Potential for expansion	Efficacy	Area	Costs	Constraints/risks	Humaneness
			may become effective	eradication) to very large (if feasible)	technical support and monitoring	• Technical challenges associated with moving from invertebrate to vertebrate systems	

Recommendations:

- Enhance biosecurity arrangements for cat-free islands, including public education and awareness programs to prevent introductions to uninhabited and inhabited islands (see also Recommendation 3 above).
- Expand the national network of cat-free islands and fenced areas, with a national strategic perspective to complement more local priorities. For example, Commonwealth investment could be directed to projects that focus on unprotected, or poorly protected cat-susceptible species at the national scale. Mechanisms to support national coordination and collaboration would be helpful.
- Without compromising on appropriate levels of scrutiny and risk assessment, improve the efficiency of processing applications to trial new cat toxins and toxin delivery systems, and to expand the use of existing toxins and methods.
- Support research and management programs that quantify co-benefits of fire and grazing management for cat control over more biomes.
- Design a spatially-explicit and costed 'map' for optimal cat control across Australia, that integrates the conservation values and susceptibilities of local species (and thus the level of cat control required), the feasibility of control options, and the employment opportunities for local people.
- Invest in research and development of novel approaches to cat control.

Feral cats in towns

- Support local governments to review regulations on refuse management, tighten if needed, then implement and police compliance.
- Support local governments and industry to exclude cats from sites of food subsidy (including rubbish dumps and intensive farms).

Term of Reference 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.

Different breeds of the domestic cat (*Felis catus*) can be imported into Australia under current legislation, but must meet quarantine conditions and veterinary health checks before release to owners. **High risk varieties of cat, under this term of reference, are hybrids: crosses between *Felis catus* and other cat species that introduce novel traits, behaviours or appearance for the pet trade**. Examples of such hybrids include the Punjabi, Bristol, Marlot, Chausi, Jambi, Savannah and Bengal. In Australia the importation of hybrids is tightly regulated by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Biosecurity Act 2015. Hybrids can be imported into the country only if they are on the Live Import List of the EPBC Act or if they satisfy other requirements, although application can be made to the Minister for the Environment to include new taxa. Currently, as an historical exception, Bengal cats are allowed to be imported if individual animals can be shown by official pedigree papers to be removed by five generations or more from

their leopard cat ancestor. **The Live Import List specifically excludes only one hybrid: the savannah cat (a hybrid of the domestic cat and serval *Leptailurus serval*)**. **Concern about the potential impacts on wildlife of this hybrid cat led the Minister for the Environment to ban its importation in 2008** (Dickman *et al*. 2019). Subsequent analyses showed that, if the savannah cat had been allowed into Australia and subsequently become established in the wild, it would have threatened 28 native mammal species in addition to the 168 species that already face some degree of risk from domestic cats, placing 91% of the country's terrestrial mammals (and 93% of threatened native mammals) at risk (Dickman *et al.* 2019). The ministerial decision to ban importation of the savanna cat was made by a specific amendment to the EPBC Act, and showed that current legislation can effectively preclude importation of high risk (hybrid) varieties of domestic cat.

Recommendations:

- The legislative and regulatory framework that now precludes high risk (hybrid) cats from being imported should be maintained.
- The EPBC Act, as a key legislative instrument that provides protection from the importation of hybrid cats, should continue to serve this function.
- As documented under other terms of reference in this submission, owned domestic cats can have major negative effects on native wildlife and habitats. Strong quarantine and veterinary control over all imported domestic pet cats thus should be maintained.

Term of Reference g.
Public awareness and education in relation to the feral and domestic cat problem.

Concern about the impacts of feral cats on Australian wildlife has been long-standing, at least among keen observers of Australian nature. The impacts of feral and domestic cats on wildlife began to be more broadly realised in the public arena in the early 1990s, and since that time public concern and awareness of the problems posed by cats has grown. **International surveys show that Australians are generally more aware and concerned about the impacts of cats on native wildlife than in other countries, more likely to change their behaviour if given appropriate guidance, and more likely to accept regulatory and legislative changes to reduce the impacts of cats** (Hall *et al.* 2016). **Recent Australian research indicates a very high level of public awareness of the impacts of feral cats on native wildlife and suggests that the public consider that feral cats do not enjoy an intrinsic right to exist** (Garrard *et al.* 2020). While there is considerable support for lethal control of feral cats where this is deemed to be warranted, there is less support for lethal control of roaming pet cats (Travaglia and Miller 2018), and the difficulty of discerning 'feral' from 'unowned-' or 'owned' cats is a key concern for those who are opposed to feral cat control (Garrard *et al.* 2020).

There is evidence of a significant contribution to feral cat control made by some groups in the broader community (Garrard *et al.* 2020); however, there is little information about the beneficial impact of this contribution for native wildlife. Nonetheless, these groups and individuals report that their contribution to feral cat control is currently constrained by confusing and spatially-variable rules about where feral cat control is permitted, and uncertainty about the effectiveness of different lethal control methods and subsequent impacts on native wildlife. A targeted information and education campaign in collaboration with key industry groups, such as the Sporting Shooters

Association of Australia may help to strategically align the efforts of individuals with national objectives.

The practice of trap-neuter-release (TNR) is sometimes advocated as an ethical and publicly acceptable way to reduce the numbers of unowned cats in urban and suburban areas, but we strongly reject this here. **Numerous studies have shown that TNR is an ineffective and expensive approach to the problem of reducing cat numbers, and more likely to encourage dumping of unwanted pets and hence perpetuate the problem**. Recent management implemented by Brisbane City Council has shown instead that the numbers of stray cats can be reduced using a some simple steps: an education program for residents living near (and sometimes contributing resources to) colonies of cats, then a cat-trapping program followed by re-homing of micro-chipped pets or euthanasia of non-owned cats. To reduce the problem of people continuing to dump cats and to provide supplementary food, Brisbane City Council carried out a program of compliance and enforcement action to improve their legislated biosecurity risk management of cats. Between 2014 and 2020 the Council's actions removed several hundred stray cats so that, by early July 2020, no stray cat colonies were known in the Brisbane City Council area (Read *et al.* submitted). **Two aspects of this highly successful program stand out: 1) local residents and business owners perceived stray cats to be a problem in the first place and prompted the city council to take action, and 2) the council's engagement with the public at all stages ensured that the program has run successfully for six years and achieved its objective of reducing, indeed removing, urban stray cats**.

Cat containment is an increasingly used management strategy for domestic cats, particularly in urban and suburban areas. There are now numerous examples of 24-hr cat containment policies, including in multiple regions of the ACT. Research illustrates that most cat owners in Australia agree that domestic cats should be contained indoors or in a run at night time (89%), but that 24-hr containment is less preferred (47% agree) (Elliott *et al.* 2019). However, the proportions of cat owners actually containing their cats is lower than this, particularly for night-only containment (24%). A challenge to increasing compliance with cat containment is that owners perceive it to be a constraint on their cat's natural hunting behaviours; yet, when prompted, most agree that a well-cared for cat has no need to hunt (Elliott *et al.* 2019). **Many cat owners understand that an outdoor lifestyle brings with it threats to the health and safety of their cats, and list veterinarians as the people they are most likely to take advice from about cat care and management**, indicating that messages framed around the wellbeing of their pet, delivered by a trusted messenger such as a veterinarian, may help to improve compliance with cat containment and other key management actions such as desexing and micro-chipping. In addition, because attitudes towards cat containment are generally stronger amongst non-cat owners, and that some cat owners get advice from friends and family, sensitive messaging that seeks to build a social norm around cat containment would also be useful.

Recommendations:

- Effective management of feral cats is likely to have broad support from the public and should need relatively low levels of engagement for management programs to be initiated and implemented.

- Some segments of the community are already engaged in feral cat control. Working with these groups to guide strategic and targeted feral cat control may help to improve the efficacy of this contribution towards improving outcomes for wildlife.
- Domestic cats are perceived by the public to be less problematic for wildlife, but levels of awareness of the potential problems of domestic cats are nonetheless high. Attitudes towards domestic cat management practices amongst cat owners are positive, but compliance rates are low. Changes in legislation and practice to better manage domestic cats should be readily achievable provided that appropriate levels of education and engagement with the public are undertaken prior to, and during, the implementation of such changes. Messages framed around cat health and well-being and delivered through trusted messengers such as veterinarians may be most effective. Building and/or appealing to a social norm around cat containment would also be useful.
- Stray cats are perceived by many people to be a problem, and reduction in their numbers can be achieved by integrated programs of preventing cats from accessing superabundant food sources along with public education and engagement, followed by cat trapping, re-homing (of pets) and euthanasia (of unowned cats).
- Attitudes towards control of feral and domestic cats are different, and difficulties discerning between 'feral' and 'owned' or 'unowned' domestic cats drives some opposition to lethal control of feral cats. Working with key stakeholders to resolve identification of feral from domestic cats may go some way to resolving this potential area of conflict in attitudes.

Term of Reference 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.

Pet cats have their own direct impacts on wildlife and disease transmission (see response to Term of Reference *b* above). However, the pet cat population may also have some indirect impact through its linkage to the stray and feral cat populations. Wandering and abandoned pet cats (and their kittens) may help to maintain or increase the population of feral cats (in the process potentially subverting local and regional management efforts seeking to reduce feral and stray cat populations), further spread disease (in both directions) and compound the impacts of feral cats. **The extent of recruitment to the feral cat population from pet cats is poorly known, and merits further research**. It may be low if the feral cat population is already at carrying capacity, as is generally likely. But this will not be the case in some situations, notably if pet cats are taken to island communities that currently do not have feral cats.

There is also a risk, not readily quantifiable, that pet cats with behavioural traits likely to enhance hunting capability (such as Bengal cats, a large and active breed arising from hybridisation of domestic cats with the Asian leopard cat *Prionailurus bengalensis bengalensis*) escape or mate into the feral cat population, with consequent increase in the predation effectiveness of feral cats (see ToR f)

In rural areas, notably in some farm homesteads and in some Indigenous communities, cats are kept as semi-pets with limited constraints on their reproduction and often under circumstances where

they are expected to hunt for much of their own food. In such situations, these semi-owned cats may be major sources for additions to the feral cat population, and many such situations may occur in or adjacent to areas of significant value for biodiversity conservation (e.g., Meek 1998).

There are also obvious risks to pet cats in their interaction with feral cats, with such risks including injury from fights, unwanted pregnancies and disease transmission.

Recommendations:
The risks and consequences of infiltration of pet cats to the feral cat problem (and hence the impacts on wildlife) can be readily minimised by:

- ensuring pet cats do not roam;
- ensuring that all pet cats are neutered prior to reproductive age;
- prohibiting the importation of pet cats to locations not currently inhabited by cats (notably some islands);
- constraining the keeping of pet cats in or adjacent to areas of significant conservation value;
- ensuring all pet cats are registered;
- capping the number of pet cats per household; and
- ensuring that the authorities responsible for these mechanisms have adequate will, regulatory basis, appropriate mix of incentives and disincentives, and dedicated resources to implement and police them.

Other issues

Health and agricultural impacts of cat-dependent disease

Domestic cats carry many bacterial, viral, fungal and parasitic pathogens that can inflict health impacts on people and livestock. The close association between pet cats and people mean that cats are significant reservoirs for diseases such as methicillin-resistant *Staphylococcus aureus*, gastrointestinal pathogens like *Cryptosporidium* spp. and *Giardia* spp., as well as ringworm and scabies. **Some of these pathogens, including those with significant consequences, need cats to complete their life cycle: they would not exist in Australia if cats had not been introduced here**.

Five cat-dependent pathogens with substantial impacts on human health and livestock are:

- *Toxoplasma gondii*, a protozoan parasite that cycles between cats and any other warm-blooded animals. People who contract *T. gondii* may appear asymptomatic, or have a mild illness, or experience severe, potentially lethal symptoms, especially if the parasite passes from mother to foetus. *Toxoplasma* has effects on behaviour and can impact mental health. It is also a major contributor to spontaneous abortion in sheep and goats.
- Two species of *Sarcocystis*, also protozoan parasites, that cycle through cats and sheep. They cause macroscopic cysts to form in sheep tissues that reduce meat saleability.
- *Bartonella henselae*, a bacterium that causes cat scratch disease, which is an infection that can be contracted by people when scratched or bitten by cats.
- *Toxocara cati*, the cat roundworm, causes minor illnesses in humans and livestock.

We have recently collated national and global data on infection rates, health and production consequences, to estimate the *annual* economic costs of four of these cat-dependent pathogens in Australia at $6.1 billion (Legge *et al.* in press). We estimated that:

- Toxoplasmosis in people costs AUS$6.06 billion (plausible range $2.90-10.7 billion).
- Toxoplasmosis in livestock costs production $9.97 million (range 5.9-16.5) annually.
- Cat scratch disease in people costs $3.2 million (range 2.74-3.66).
- Sarcocystosis in livestock costs AUS$1.77 million annually.

Most of the human health costs are due to the associations between *Toxoplasma* and higher rates of traffic accidents and mental health illness in people. Although causality remains uncertain, *Toxoplasma* is associated with reduced reflex times and higher rates of accidents; increased incidence of mental health issues including depression, schizophrenia, and suicidal behaviour.

Our estimates of health and production costs may be under-estimates of the actual values, because we were unable to cost all the impacts from cat-dependent pathogens, infections and illness are under-reported or misdiagnosed, and our understanding of disease outcomes is still imperfect. Nevertheless, our analysis suggests that substantial benefits to public health and livestock production could be realised by reducing exposure to cats and breaking parasite transmission cycles.

Recommendations

- Disease rates and thus the costs of disease in people and livestock can be reduced by reducing exposure to cats and by interrupting transmission pathways:
    - Reduce the population of feral cats, especially around farms, gardens, parks and playgrounds.
    - Reduce the rates of pet cat ownership.
    - Keep pet cats contained, which reduces the chance that the pet will contract pathogens
    - Adhere to cooking habits (washing vegetables before eating them, cooking meat thoroughly) and hygiene practices (washing hands after gardening, handling kitty litter) that reduce risk of contracting *Toxoplasma* and *Toxocara.*
- Improve reporting systems for tracking the occurrence of cat-borne (including cat-dependent) disease; this will involve improvements levels of public awareness of these illnesses, enhanced diagnosis, and public health recording.

Other economic considerations

As well as the impacts of cat-borne disease summarised above, other costs of cats to the Australian economy are diffuse and have not been comprehensively catalogued. An American study indicated that loss of birds due to predation by feral cats cost the US economy US$17 billion per year, with this estimate based on spending by bird-watchers and recreational hunters, but with the estimate not including the loss of birds killed by pet cats (a comparable magnitude of loss) or other contributions made by birds to the economy, such as their beneficial impact to horticultural productivity through

consumption of destructive insects (Pimentel *et al.* 2005). No comparable estimate is available for costs associated with the losses caused by cats to wildlife other than birds.

Australian pet owners spend about $3.6 billion per year on care of pet cats (Animal Medicines Australia 2019), **at least an order of magnitude higher than targeted spending by the Australian government across all of Australia's ca. 1800 threatened species** (Wintle *et al.* 2019). In addition, a portion of our agricultural production is diverted to producing pet cat food: a recent study estimated that each cat needs the equivalent of 0.4-0.6 ha of agricultural land to produce its food each year (Su *et al.* 2018). For the 3.8 million pet cats in Australia, this equates to setting aside about 19,000 km^2 of land to meet the needs for annual food production for pet cats, an area about the size of Kakadu National Park.

Ongoing costs associated with management of stray and feral cats by councils and conservation agencies and NGOs have not been estimated, but must be considerable.

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