Science for Saving Species

Research findings factsheet

Project 1.3.2

Threatened Species Recovery Hub

National Environmental Science Programme

Conserving Australia's threatened native mammals in predator-invaded, fire-prone landscapes

In brief

Inappropriate fire regimes and predation by introduced species each pose a major threat to Australia's native mammals. They also potentially interact, an issue that is likely to be contributing to the ongoing collapse of native mammal communities across Australia. For example, a growing number of field studies show that introduced European red foxes and feral cats are attracted to burnt areas immediately after fire, or that they prey heavily on small- and medium-sized native mammals in burnt habitats. These issues are likely to worsen under climate change, as fires become more intense and frequent. However, our understanding of how predation affects native mammal persistence after fire, or how to best manage these interactions, remains limited.

This factsheet summarises the key findings from a recent literature review on this topic (Hradsky 2020). The review evaluated the current state of knowledge on how introduced and native predators in Australia respond to fire, and their impacts on native mammals in burnt landscapes. It went on to identify strategies for reducing predation pressure on native mammals in fire-affected landscapes, and highlight key knowledge gaps for conservation researchers and land managers.

The review concluded that the most feasible management options for reducing predation pressure on native mammals post-fire are currently likely to be landscape-scale control of introduced predators, and manipulation of fire regimes to create patchy fire scars. However, the effectiveness of these methods for improving native mammal resilience to fire needs further research, as do other strategies such as targeted management of introduced predators pre- and post-fire, and providing artificial shelters as refuges for native mammal prey species in burnt landscapes.

Robust before-after-control-impact experiments are needed to assess the effectiveness of these approaches and identify any inadvertent negative outcomes for native species, particularly if introduced predator control might result in more intense predation or grazing by other species. Studies could be built around existing introduced predator management and prescribed burning programs, as well as novel experimental manipulations. Evidence-based management recommendations are urgently needed to help prevent further declines and losses of Australia's native mammals in fire-affected landscapes.

Surveys have shown that the distribution of the brush-tailed rabbit rat is strongly linked to higher shrub density and lower feral cat activity; both of these factors are in turn influenced by fire management. Image: Hugh Davies

The University of Melbourne

Victoria State Government Environment, Land, Water and Planning

Parks Victoria Healthy Parks Healthy People

Background

Nearly one-third of Australia's endemic terrestrial mammals have either become extinct or declined to 'threatened' status since European invasion. Losses and local extinctions continue to occur across northern and southern Australia. Concerningly, some of these population collapses are occurring in environments where native mammal communities have persisted in a relatively intact state until recently, such as large conservation reserves and islands.

Two key drivers of these mammal declines are thought to be predation by introduced species, especially by red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*), and inappropriate fire regimes, particularly more frequent, extensive and/or intense fires.

Feral cats and foxes were introduced by European colonists and have taken a major toll on Australia's native wildlife. They have been implicated in the extinction or decline of 97 and 58 native mammal species respectively, as well as numerous birds, reptiles and amphibians.

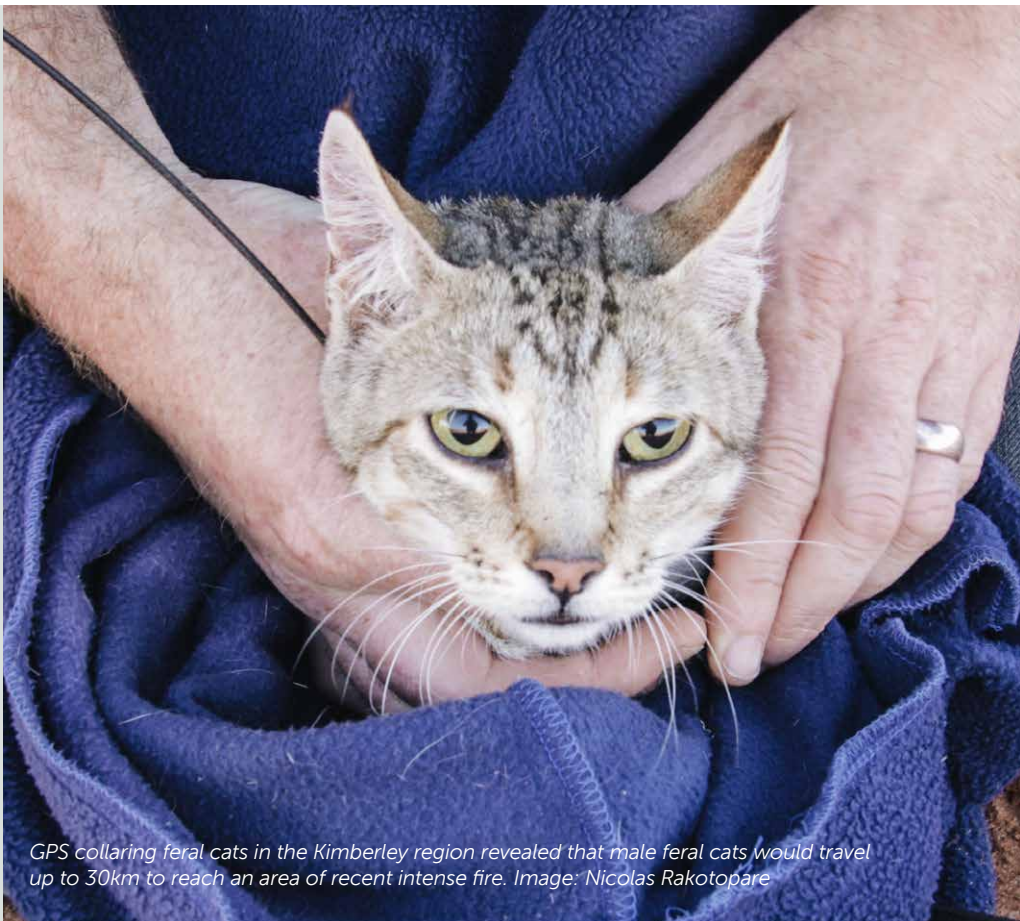
Fire is integral to many Australian ecosystems. However, current fire regimes are very different to those that occurred throughout most of the evolutionary history of our native flora and fauna. In contemporary Australia, fire is generally suppressed in urban and agricultural areas, but has become more frequent, intense and extensive across the rest of the continent, and some fire seasons have shifted. These changes in fire regimes are associated with declines in faunal species richness, abundance and survival. Furthermore, climate change is predicted to result in drier and hotter environments, which will likely promote increasingly intense and frequent fire events.

The native mammals currently extant in Australia may be able to survive either threatening process in isolation. Most native mammals have evolved adaptations to fire, and can often survive even severe fire events, seeking refuge in gullies and other areas that have been less severely burnt. Many mammals have also persisted despite the presence of feral cats and foxes for decades or even centuries, in some cases by selectively using dense vegetation or rugged habitats. There is growing concern, however, that these threats in combination could create "predation pinch points", from which mammal populations are more likely to decline than to recover.

Research aims

The review aimed to:

1. Identify how fire could alter the impacts of predators on native mammals.
2. Review the evidence on how introduced predators (feral cats, foxes) and native predators respond to fire, and the role of predation in native mammal responses to fire in natural habitats across Australia.
3. Examine potential management options for reducing the impacts of predators on native mammals after fire.
4. Highlight key uncertainties associated with these management options and priorities for future research.



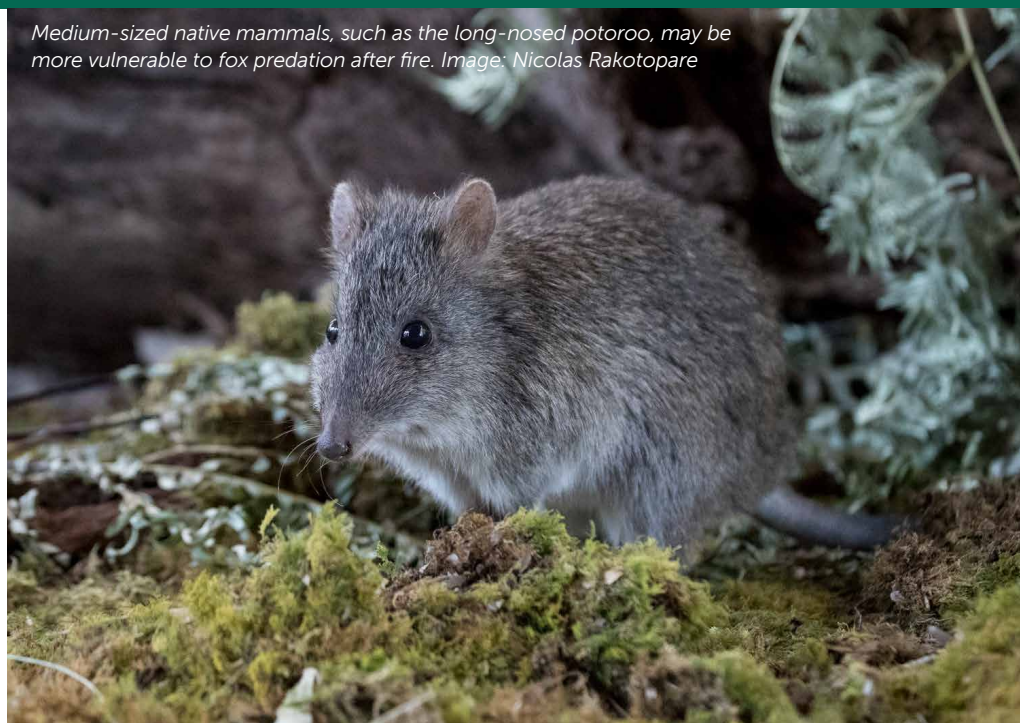
GPS collaring feral cats in the Kimberley region revealed that male feral cats would travel up to 30km to reach an area of recent intense fire. Image: Nicolas Rakotopare

Key findings

There are several potential mechanisms by which fire could exacerbate the impacts of introduced predators and native predators on their native mammalian prey. In the short term, fire removes many of the structures that provide important shelter for small to medium-sized native mammals, such as understorey vegetation, leaf litter, coarse woody debris and hollow trees. If the loss of shelter makes these species more vulnerable to predators, fire could increase the number of prey individuals that each predator could catch and kill. The increase in prey availability could also lead to predators concentrating their activity in the burnt area, further increasing the predation pressure on native mammals.

The review found that a growing number of studies in Australia have documented selection for burnt areas by introduced foxes, feral cats and native carnivores (including dingoes, northern quolls, owls, raptors and pythons) shortly after fire events, and/or that these predators feed heavily on small or medium-sized native mammals in burnt habitat. Numerous other studies have attributed observed declines in native mammal populations post-fire to increased rates of predation, although their evidence was often circumstantial. A small number of studies have tracked small or medium sized terrestrial native mammals post-fire and found that many individuals died from predation.

The inherent difficulties with conducting fire and predator research mean that many of these predator-prey studies in fire-affected environments are correlative, or lack replication of treatments or experimental controls. Nonetheless, there is sufficient evidence to suggest that reducing predation pressure on native mammals after fire is likely to improve population recovery. For examples, see the case studies on page 4.



Medium-sized native mammals, such as the long-nosed potoroo, may be more vulnerable to fox predation after fire. Image: Nicolas Rakotopare

Land managers could reduce predation pressure on native mammals in burnt habitats by reducing the abundance of introduced predators, and/or by altering the post-fire habitat to reduce the hunting success of introduced (and potentially some native) predators. The review outlines various management options within each of these approaches, and highlights their benefits and limitations. At present, the most achievable broad-scale management options for reducing post-fire predator impacts are likely to be landscape-scale control of introduced predators, and the manipulation of fire regimes to create patchy fire scars and retain more unburnt habitat. The effectiveness of other management options, such as localised management of introduced predators immediately pre- and post-fire, and provision of artificial shelters within burn scars is also worth exploring.

Any management option will only be successful if: (i) it can substantially reduce the predation pressure on native mammals in fire-affected areas, and (ii) a reduction in predation pressure after fire results in higher native mammal survival and faster population recovery. Importantly, we should not assume that conducting introduced predator control will ensure that native mammal populations are resilient to fire, even if introduced predators are the primary threat. For example, management might enable native mammals to evade predation after fire only for them to starve to death due to changes in food availability. Similarly, the successful suppression of an introduced predator could release pressure on other introduced predators, native predators or competitors, which may impact the ability of native mammal populations to recover after fire. In this respect, careful and targeted monitoring should be an essential part of integrated fire and predator management programs.

Study examples

Kimberley savannas, Western Australia

A study by the Australian Wildlife Conservancy GPS-tracked 32 cats in the Kimberley between 2010 and 2013, collecting a total of 121 tracking-months of data. They found that while cats usually stayed within their own territory, male feral cats would travel up to 30km to reach an area of recent intense fire where 43% – 96% of vegetation cover was burnt, almost 10 times their typical home range diameter. Moreover, 80% of the adult male cats that had the opportunity to travel to an intense fire scar, did so. Once they reached the burnt area, they stayed for an average of 15 days. Interestingly, no cats travelled outside their typical home territory to mild intensity fire scars. Female cats that did not travel to a fire site appeared to be lactating (i.e., had kittens). Analysis of fine-scale habitat selection showed that cats strongly selected for areas recently burnt by intense fires, but only in habitats that typically support high abundance of small mammals. Intense fires and grazing by introduced herbivores created conditions that were favoured by cats, probably due to higher hunting success (McGregor et al., 2014, 2016).

The Otway Ranges, Victoria

A study by The University of Melbourne investigated the short-term impacts of a prescribed burn on feral cats, foxes and their native mammalian prey in the Otway Ranges, south-western Victoria, in 2013. The study used habitat surveys, camera trap monitoring and fox scat collection across burnt and unburnt areas in an unreplicated before-after-control-impact experiment. They found that fire reduced understorey cover by more than 80% and resulted in a fivefold increase in the occurrence of invasive predators in burnt areas. Concurrently, relative consumption of medium-sized native mammals by foxes doubled; in particular, of long-nosed bandicoots and short-beaked echidnas (Hradsky et al., 2017).

The Top End, Northern Territory

A study by the Northern Territory Government and Charles Darwin University across more than 300 sites in the Top End found that feral cats avoided areas with higher vegetation density, unless these areas were subject to frequent, large fires (Stobo-Wilson et al., 2020a). Additionally, there were more small- and medium-sized native mammals in areas with fewer feral cats, dingoes and large feral herbivores (primarily cattle, horses and buffalo; Stobo-Wilson et al., 2020b). Overall, the findings highlighted that the most effective means to preventing further mammal declines are likely to be protecting and enhancing lower and mid-storey vegetation complexity by reducing the prevalence of frequent, large fires, and preventing overgrazing by large feral herbivores. Complex vegetation provides more shelter for small- and medium-sized mammals and reduces the prevalence of feral cats and dingoes, thereby reducing predation pressure on mammals in these areas.

Tiwi Islands, Northern Territory

Surveys for small mammals conducted at 88 sites across Melville Island in 2015 by the Tiwi Land Rangers and Charles Darwin University found that the distribution of the threatened brush-tailed rabbit-rat had contracted to areas with a low probability of feral cat detection and high shrub density. Furthermore, feral cat activity and abundance was highest in areas that had experienced frequent severe fires and heavy grazing, most likely due to the reduction in understorey vegetation density (Davies et al., 2020). This was supported by the CSIRO's Tiwi Carbon Study, which recorded an increase in shrub density in response to reduced fire frequency on Melville Island. Therefore, fire management that reduces the frequency and/or intensity of fire and enhances shrub-layer complexity could be a viable management option to reduce the impact of feral cats on Melville Island (Davies et al., 2017).

In the Otway Ranges fox and cat occurrence increased fivefold in burnt areas after a prescribed fire. Image: Bronwyn Hradsky

Implications and recommendations

Considerable knowledge gaps remain about nearly all aspects of the interactions between introduced predators, fire and native mammals in Australia. Nonetheless, we urgently need practical, evidence-based management recommendations that can be used to help improve the resilience of native mammals to current fire regimes and introduced predators. A top priority therefore needs to be experiments that improve our understanding of how to best manage post-fire predation pressure to improve native mammal survival and persistence in fire-affected landscapes.

"Natural" experiments could be built around existing introduced predator management and prescribed burning programs (which often take place on the same land already), as well as bushfire events. In addition, new experiments that manipulate existing fire regimes or predator management programs could be used to explore the effectiveness of different management tactics, such as targeted management of introduced predators immediately before and after prescribed burns, or deliberate retention of unburnt patches within the fire scar.

Field experiments will be most useful if they include experimental controls, pre- and post-management surveys, and spatial and temporal replication, although these can be difficult to achieve in the context of fire and introduced predator management. In addition, sophisticated technologies such as GPS collars, remote survey cameras, and DNA genotyping of scat and hair samples to identify individuals are increasingly affordable and practical, and so are likely to play an important role in advancing our understanding of how fire affects the interactions between predators and prey. Spatially-explicit simulation models could also be used to draw together information from different field studies, identify which mechanisms are likely to be driving observed patterns, explore hypothetical management scenarios and generate testable predictions for future field research.

A better understanding of the mechanisms that drive introduced predator and native mammal responses to fire, and improvements in our ability to manipulate them, are likely to be key to preventing further collapse of Australia's native mammal populations.

Hot fires remove ground and shrub layer vegetation, potentially leaving native animals more exposed to predators. Image: Bronwyn Hradsky

Further reading

Hradsky, B. A. (2020) Conserving Australia's threatened native mammals in predator-invaded, fire-prone landscapes. *Wildlife Research* 47: 1–15. doi.org/10.1071/WR19027

Davies H. F., Firth R. S. C., McCarthy M. A. et al. (2017) Top-down control of species distributions: feral cats driving the regional extinction of a threatened rodent in northern Australia. *Diversity Distributions*, 23: 272– 83.

Davies, H.F. , Maier, S.W. & Murphy, B.P. (2020) Feral cats are more abundant under severe disturbance regimes in an Australian tropical savanna. *Wildlife Research*, 47, 624–632.

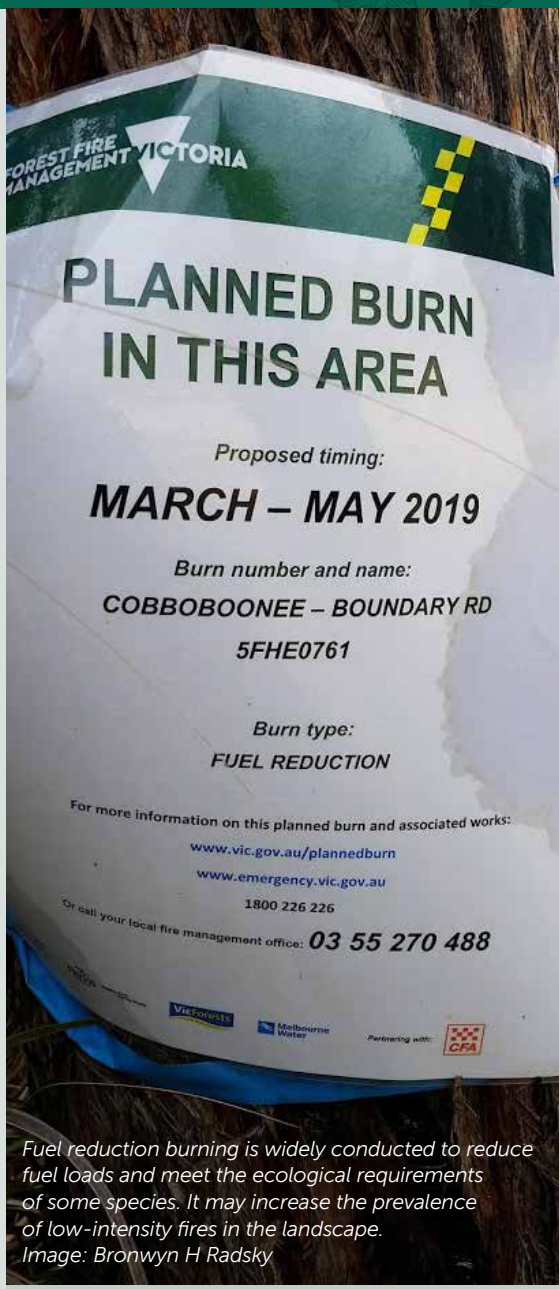
Hradsky, B. A., Mildwaters, C., Ritchie, E. G., Christie, F., Di Stefano, J. (2017) Responses of invasive predators and native prey to a prescribed forest fire. *Journal of Mammalogy*, 98:3, 29 May 2017: 835–847, https://doi.org/10.1093/jmammal/gyx010

McGregor, H. W., Legge, S., Jones, M. E., Johnson C. N. (2014) Landscape management of fire and grazing regimes alters the fine-scale habitat utilisation by feral cats. *PLoS ONE* 9:10, e109097. https://doi.org/10.1371/journal.pone.0109097

McGregor, H., Legge, S., Jones, M., Johnson, C.N. (2016) Extraterritorial hunting expeditions to intense fire scars by feral cats. *Scientific Reports* 6, 22559. https://doi.org/10.1038/srep22559

Stobo-Wilson, A. M., Stokeld, D., Einoder, L. D., Davies, H.F., Fisher, A., Hill, B.M., Mahney, T., Murphy, B.P., Stevens, A., Woinarski, J.C.Z., Bawinanga Rangers, Warddeken Rangers, Gillespie, G.R. (2020a) Habitat structural complexity explains patterns of feral cat and dingo occurrence in monsoonal Australia. *Diversity Distributions*, 26: 832–842. https://doi.org/10.1111/ddi.13065

Stobo-Wilson, A. M., Stokeld, D., Einoder, L. D., Davies, H.F., Fisher, A., Hill, B.M., Mahney, T., Murphy, B.P., Scroggie, M.P., Stevens, A., Woinarski, J.C.Z., Bawinanga Rangers, Warddeken Rangers, Gillespie, G.R. (2020b) Bottom-up and top-down processes influence contemporary patterns of mammal species richness in Australia's monsoonal tropics. *Biological Conservation* 247: 108638. https://doi.org/10.1016/j.biocon.2020.108638



Fuel reduction burning is widely conducted to reduce fuel loads and meet the ecological requirements of some species. It may increase the prevalence of low-intensity fires in the landscape.
Image: Bronwyn H Radsky

Further Information

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