

# Research and management to reverse the decline of native mammal fauna | Final report

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## Summary of project and achievements

This project sought to characterise the conservation status of the mammal fauna in northern Australia, investigate factors that may be implicated in the decline of this fauna, and identify effective management responses.

Study components demonstrated that predation by feral cats caused extirpation of an experimentally reintroduced population of a native mammal species (Frank *et al.* 2014), and that feral cat impacts were much more severe in areas that had been extensively burnt (McGregor *et al.* 2014; Leahy *et al.* in review); but a cat enclosure fencing study in Kakadu (see photo below) failed to demonstrate beneficial response by native mammals, possibly because the study period was too brief and mammal populations in the area were too depleted. Mammal surveys across combinations of fire and grazing treatments in the Kimberley showed that the benefits of improving fire patterns to mammal richness and abundance were significantly muted if introduced herbivores were present.

The first substantial assessment of the incidence of disease in mammal assemblages of northern Australia indicates the presence of some pathogens that may have lethal or sub-lethal impacts on native mammals, but there is uncertainty around their role in the current decline.



This cat enclosure fence was completed in Kakadu in late 2013.

## Principal focus and significance

There has been a very severe loss in the Australian mammal fauna in the period since European settlement, with the most recent assessment (Woinarski *et al.* 2014) concluding that 30 mammal species have become extinct in Australia over that period. This extinction tally includes 29 species endemic to Australia, more than 10% of the endemic mammal fauna present in 1788. Earlier extinctions occurred mainly in central Australia and temperate Australia, but recent declines have mostly been in northern Australia (Woinarski *et al.* 2014). In at least parts of northern Australia, these recent declines have been severe and rapid, and have involved many species (Woinarski *et al.* 2001; Firth *et al.* 2010; Woinarski *et al.* 2010; Woinarski *et al.* 2011). This project sought to clarify the pattern of this decline, investigate the factors responsible for its cause, and determine management responses that will most effectively remediate the problem.

## Distinctiveness of issue to this landscape

The current rate and severity of decline of the mammal fauna in at least parts of northern Australia is exceptional, with analysis indicating that it exceeds that elsewhere in Australia (Woinarski *et al.* 2014). This is of considerable conservation concern because northern Australia has previously experienced relatively little loss of biodiversity (since European settlement) and has acted as a refuge for many species and species-groups that have exhibited substantial declines elsewhere in Australia (Woinarski and Braithwaite 1990; Woinarski *et al.* 2007). The current declines in the mammal fauna in northern Australia are also exceptional in a global context, because most declines and extinctions elsewhere in the world have occurred in areas affected by substantial land clearing, habitat modification or hunting (Hoffmann *et al.* 2010; Hoffmann *et al.* 2011), issues that are not (yet) major concerns in northern Australia. A notable feature of the decline of mammals in northern Australia is that declines have been reported from some large and relatively well-resourced conservation reserves (Woinarski *et al.* 2010; Russell-Smith *et al.* 2014), indicating that reservation alone has been insufficient to maintain biodiversity and that the intensity, scope or approach of management in reserves may need substantial refinement.

This project focuses particularly on the conservation of the mammal fauna, because although there have been some marked declines in other plant and animal groups in northern Australia (Franklin 1999; Woinarski and Catterall 2004; Franklin *et al.* 2005), the extent of this decline is appreciably less than for mammals (Woinarski *et al.* 2012).

## Knowledge status and constraints

Prior to the instigation of this project, previous studies had identified the extent of recent mammal decline, mostly through monitoring studies in a relatively small number of areas (Woinarski *et al.* 2001; Woinarski *et al.* 2010; Russell-Smith *et al.* 2014), complemented with broader-scale qualitative assessments garnered from traditional Indigenous knowledge (Ziembicki *et al.* 2013). Some previous studies have indicated a role of changed fire regimes (Yibarbuk *et al.* 2001; Kutt and Woinarski 2007; Legge *et al.* 2008; Firth *et al.* 2010; Woinarski *et al.* 2010) and of pastoralism (Woinarski and Ash 2002; Kutt and Woinarski 2007; Legge *et al.* 2011) in the general pattern of decline, and of poisoning by cane toads for the decline of one mammal species (O'Donnell *et al.* 2010). These studies have not been definitive and there remains much uncertainty about the relative impacts of different causes and of the extent of interactions among threat factors (Woinarski *et al.* 2011). Without clearer resolution of causality, managers are likely to be unable to implement tightly focused and effective management responses.

Furthermore, the geographic extent of decline in the north Australian mammal fauna, and the characteristics of declining species, are not yet well resolved (Fisher *et al.* 2014; Murphy and Davies 2014; Woinarski 2015).

Collectively these information gaps represent major constraints on management responses: accordingly addressing these main gaps formed a major focus for this project. However, addressing these key information gaps is not straightforward, given the potential range of threat factors and their interactions, the number and diversity of mammal species involved, and the extent and environmental variability of northern Australia. Furthermore, for one potential major threat – predation by feral cats – landscape-scale experimentation is difficult and expensive. Likewise, it is also difficult to search for a disease factor that may be causing decline across a wide range of mammal species, especially in a region where there is very little existing information on the incidence and impacts of almost all parasites and diseases.

There are constraints not only on research but also on the subsequent application of research outcomes to develop effective management responses. There may be few options for the cost-efficient control of feral cats, disease or cane toads; and a preferred fire regime (such as a significant increase in the extent of long-unburnt habitat) for at least some declining mammal species may now be almost impossible to establish.



Researchers conduct a health check on a northern brown bandicoot.

## Methodological approaches

This project comprised multiple components, including:

- A Before-After-Control-Impact experimental trial of the effects of cat predation through the establishment of two 64 ha fenced cat exclosures in Kakadu National Park, with subsequent monitoring of the response of the native mammal fauna
- Experimental trial of impacts of cat predation through survival analysis of introduced mammal population in small-scale cat exclosures and matched sites that were cat-accessible
- Ongoing monitoring of mammal fauna at a large series of sites at Kakadu, Litchfield, Nitmiluk and Garig Gunak Barlu National Parks, plus AWC's Mornington, Marion Downs, Tableland, and Wongalara Wildlife Sanctuaries, with correlative analysis of trends for sites of differing fire histories, introduced herbivore densities and environmental settings
- Systematic inventories of the incidence of diseases among selected mammal species at sites known to be experiencing mammal decline and sites at which the mammal fauna is stable or undergoing relatively little decline
- Comprehensive overview of the conservation status of all Australian mammal species
- Broad-scale assessment of the abundance of feral cats through extensive remote camera surveys, and of diet through stomach content analysis
- Detailed study of the behaviour (including response to fire and grazing intensity) and abundance of feral cats through radio-tracking
- Detailed study of the survival (and causes of mortality) of selected mammal species, at sites with varying fire regimes
- Detailed study of survival of reintroduced 'toad smart' northern quolls in Kakadu to determine whether reintroduction could facilitate recovery of quoll populations
- Assessment of the effectiveness of taste-aversion training for northern quolls in response to cane toad invasion of the Kimberley.

Additionally, we used expert assessments and management prioritisation to develop, collaboratively with Parks Australia, a conservation strategy for threatened species in Kakadu (Woinarski and Winderlich 2014b, 2014a). Most priority threatened species in Kakadu are mammals, and this document applied our research findings to resolve complex management challenges.

A recent comprehensive synthesis (Ziembicki *et al.* 2015) has collated results from these components of this project and other studies to review the status of mammals across northern Australia, the evidence implicating putative threats, and priority management responses. A specific symposium at the 2014 Ecological Society of Australia conference also brought together individual project components, and identified key findings and research and management priorities, and provided considerable publicity about the issues.

## Lessons learnt for this landscape

There is a series of lessons for this landscape arising from this project. It is now evident that biodiversity in this landscape cannot be presumed to be secure simply because of the environments' relative intactness and the relatively extensive conservation reserve network. More intensive, active and focused management of key threats will be required. Our results suggest that the two main concerns are with predation, principally by feral cats, and fire, but also that introduced herbivores interact with both of these threats. Prior to this project and other recent studies, feral cats were generally regarded as not a significant concern in northern Australia. With results widely disseminated from our studies, there is now much greater awareness and appreciation of the potential threat posed by feral cats. Our results also suggest that the current frequent fire regime in most parts of northern Australia is likely to be detrimental (directly and through enhanced impacts of predation) to at least some components of the mammal fauna; and particularly so in the presence of introduced herbivores. There are clearly major challenges in attempting to implement broad-scale control of feral cats, and to reduce fire frequency and introduced herbivore densities in this landscape generally, and specifically in areas managed primarily for conservation.

## National implications of lessons learnt

There are two major national implications arising from this project. The first is that there is a conservation imperative to develop effective broad-scale control of feral cats, or at least localised control in a series of areas of conservation significance; however, measures to mitigate feral cats need to be implemented in conjunction with addressing other threats operating in the landscape. The second implication is that the establishment of conservation reserves is necessary but not sufficient for the maintenance of biodiversity: those reserves must also be managed actively and purposefully to control key threats.

## Problems addressing the focus and how overcome

It is not straightforward to clarify the direct and interactive impacts of a range of putative threats across many species in many areas within a relatively short timeframe. We sought to address this challenge through strategic prioritisation of research to address major information gaps that currently impede management. We also adopted a wide range of research approaches – including robust experiments, focused study of individual native mammal species and individual threats, monitoring, modelling, and comprehensive reviews – and undertook studies across many different areas.

## Towards implementation

This project helped shape and implement major changes in the management of threatened species, particularly mammals, in Kakadu National Park, one of the most significant conservation reserves in northern Australia.

This project has provided further evidence of the important role of feral cats, fire and introduced herbivores in the decline of native mammals in northern Australia, and consequently of the need for better broad-scale management of these factors. However, these factors are challenging to manage. A high frequency and extent of fire is typical of much of northern Australia, including in many conservation reserves. For example, about 60% of the woodlands in the lowlands of Kakadu is burnt every year (Russell-Smith and Edwards 2014), a fire regime that is clearly dissonant with the conservation needs of many native mammal species. Large-scale, proactive, strategic and systematic fire management in the Kimberley demonstrates that purposeful management can achieve substantial beneficial changes in fire regime, most notably with increase in the extent of longer-unburnt vegetation (Legge and Fleming 2012), and sets an example that can be trialled across many other areas in northern Australia to enhance biodiversity management.

There are significant opportunities to enhance the control of feral cats in northern Australia. These include: (i) the development and implementation of better biosecurity for islands in which cats are not currently present; (ii) eradication of cats from selected islands with high conservation values; (iii) the more strategic use of cat-free islands for translocation of threatened mammals that are declining on the mainland; (iv) purposeful manipulation of fire regimes, grazing regimes and dingoes to reduce the abundance and impacts of feral cats; (v) strategic establishment of large-scale cat exclosures at sites that are significant for conservation; (vi) further research into baiting or other mechanisms to reduce the abundance of cats (without detrimental impacts on non-target species) at broader scale.



Improving fire regimes which more closely reflect the traditional Indigenous fire management practices is expected to lead to improved outcomes for biodiversity.

## Looking ahead – future needs

This project has made substantial progress towards more effective conservation of the mammal fauna of northern Australia; however, it has also highlighted its complexity, notably the role of predation more broadly and its interactions with fire and productivity. There is therefore still substantial need for further research and enhanced management.

Our assessment of disease remains relatively preliminary, and much more detailed study is a high priority. In particular, further investigation of the epidemiology of *Toxoplasma gondii* to evaluate its lethal and sublethal effects on native mammals, and prevalence relationships with cat densities across northern Australia would be useful (this work would complement other research elsewhere in Australia).

The invasion of cane toads is a significant threat to populations of northern quolls in the Kimberley. Cane toad aversion baits could be used to reduce this threat, but further field studies are necessary. Establishing insurance captive populations of quolls prior to toad invasion may also warrant consideration.

The factors controlling the abundance and impacts of feral cats across northern Australia remain poorly resolved, and we have provided only preliminary evidence of the likely effects of fire and grazing pressure in influencing this predation impact. As the manipulation of fire and grazing may be one of the few relatively cost-effective mechanisms available to manage the impacts of feral cats, there is considerable value in attempting to further resolve this interaction.

In other parts of Australia, dingo populations may influence the abundance or impacts of feral cats (Kennedy *et al.* 2011; Brook *et al.* 2012), but may also have some detrimental impacts on a range of native species. Further research on this issue may be useful in northern Australia to help derive practical approaches to the management of feral cats and predator regimes more generally, particularly in relation to interactions with fire and grazing regimes, and productivity.

A major component of this project, the experimental use of cat exclosures in Kakadu, did not produce a marked positive response in the native mammal fauna. We suspect that this is because of the relative brevity of the study period (12 months) and the very low abundance of mammals in the study area. We consider that there is merit in continuing the study for a longer period.

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