

**Reversing the decline of native mammals in
northern Australia**

**– prospectus for a research and management
program.**

v2. October 2008

The context

Since European settlement, 18 species of native mammal have become extinct in Australia. This set of extinctions rates as Australia's most profound biodiversity loss, and one of the world's worst.

These extinctions particularly affected bandicoots, smaller macropods, larger rodents and larger dasyurids (quolls and their allies). Although other factors contributed, much of the decline and loss was due to predation by cats and/or foxes.

Mostly, the extinctions happened between the 1890s and 1950s, a time when there was little awareness of the problem, limited acceptance of environmental responsibility, and meagre scope for reducing the impacts of the threats.

These historic declines and extinctions were not limited to uncommon, restricted or specialised species. Many of the now extinct species were previously extraordinarily successful, occurring commonly across a wide range of habitats and had flourished for hundreds of thousands of years.

The loss of these species has diminished our environmental legacy and tarnished the reputation of our nation. In some cases, the species lost were pivotal to Aboriginal culture.



Examples of now extinct mammals from central Australia: pig-footed bandicoot (left); crescent nail-tail wallaby (right)

Here, we show that the losses have not stopped; that they are not simply a blight on our past, but rather a continuing feature, particularly in northern Australia, a major region of Australia previously considered to provide a refuge and stronghold.

Here, we argue that we should recognise the problem, and our obligation to attempt to resolve it.

The problem

Northern Australia includes some of the World's most intact and extensive natural environments. It may seem paradoxical that there could be serious biodiversity conservation issues within it.

But evidence for ongoing and escalating decline in the mammal fauna of northern Australia is now compelling.

This decline was first recognised for the inland semi-arid fringe of northern Australia, in the south-east and south-west Kimberley and the Gulf of Carpentaria hinterland, with evidence of decline or regional loss based on comparison of current status with accounts of early naturalists, sub-fossil material and information from Aboriginal residents¹.

Recent evidence suggests that the decline is spreading to higher rainfall, coastal and more rugged areas across much of northern Australia.

The brush-tailed rabbit-rat *Conilurus penicillatus* in the Northern Territory provides an example of the pattern of decline. This example is also representative in that the closest relative of this species, the white-footed rabbit-rat *C. albipes*, lived in southern Australia, but is now extinct: northern Australia retains some of the legacy lost from elsewhere in Australia, but appears now to be following the same pathway of decline.

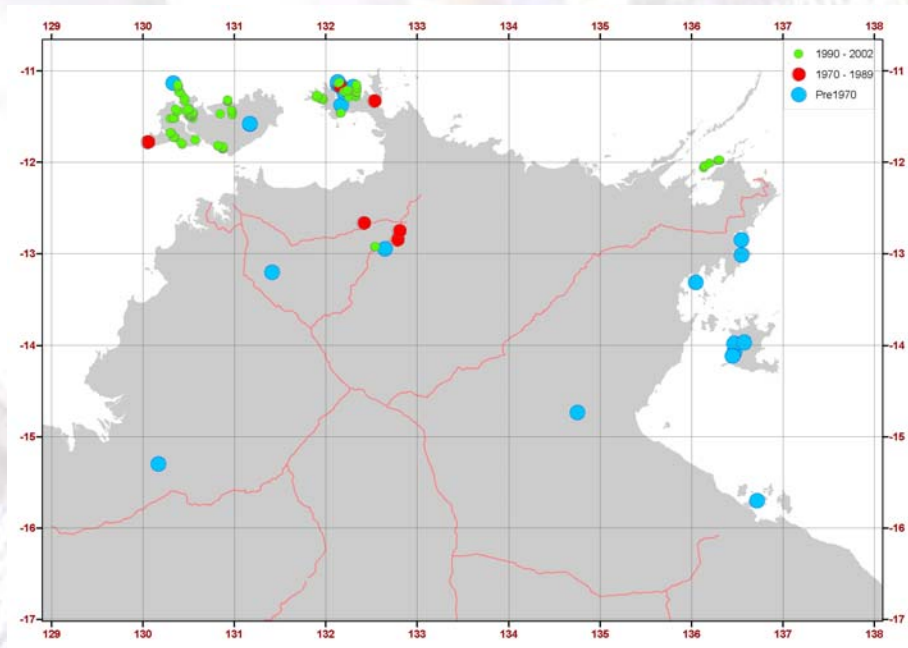
Decline of the brush-tailed rabbit-rat in the Northern Territory

Early naturalist accounts attest to the former abundance of this species. For example, in 1897, Knut Dahl noted that "*in Arnhem Land (it) is everywhere common in the vicinity of water*"²; and the collector Collett noted that it was then "*Numerous all over Arnhem Land, and in great numbers on the rivers on the lowlands*"³.

There were no detailed accounts of its abundance again in this region until the 1960s, when CSIRO undertook systematic wildlife surveys in and around the area that is now Kakadu National Park. They reported that it was "*a reasonably common species, found chiefly in woodland with suitable hollow tree shelters*"⁴.

At the next round of CSIRO surveys of the Kakadu area in the early 1980s, it was reported "*This beautiful uncommon species is likely to be widespread in open forest and woodland*"⁵, being recorded in three of 18 sampled woodland sites.

Much more extensive surveys of the Kakadu area in the late 1980s, 1990s and 2000s have reported its continued presence at only one site (from more than 500 sites sampled), and confirmed its absence from the three sites from which it was recorded in the early 1980s. Thus, in the Kakadu region, this species has gone from being “everywhere common” in the 1890s, to “reasonably common” in the 1960s, to “uncommon” in the 1980s to diminishingly rare now.



Changing distribution of the brush-tailed rabbit-rat in the Northern Territory

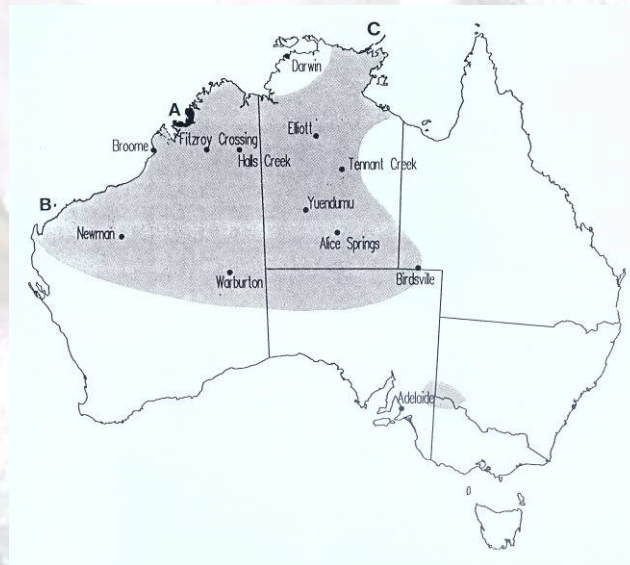
More broadly across the Top End of the Northern Territory, it has shown a pattern of decline from inland mainland areas to restriction in coastal areas, and particularly to islands.

Beyond the Northern Territory, this species persists in part of the North Kimberley, and is known from one island in the Gulf of Carpentaria, Queensland.



brush-tailed rabbit-rat

A similar pattern of decline (to islands and other coastal areas, higher rainfall areas, and more rugged areas) is also evident for the golden bandicoot *Isoodon auratus*. This species formerly occurred across much of Australia, but is now restricted to a few Western Australian islands, a small section of the north Kimberley mainland and one remote island off Arnhem Land.



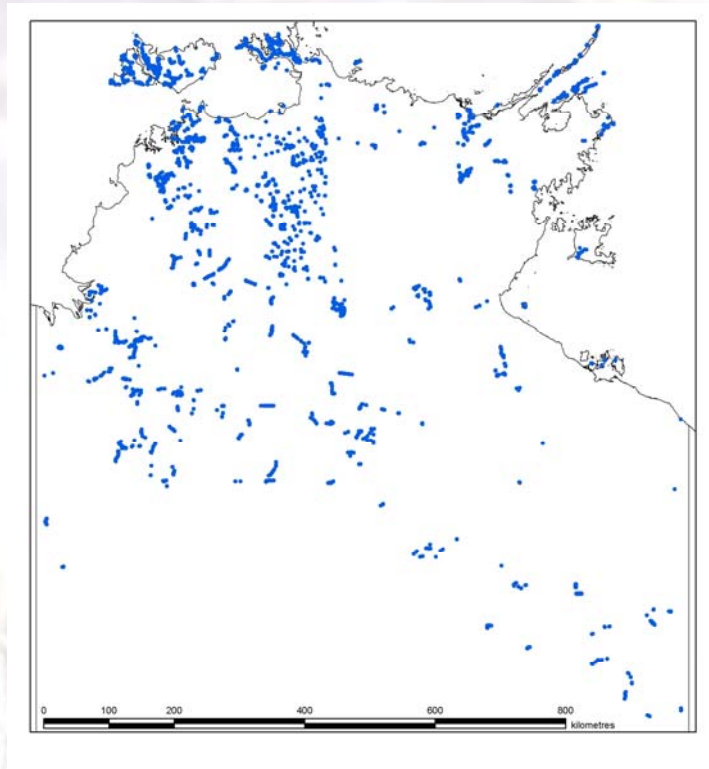
Former range (grey shading) and current range (A, B, C) of the golden bandicoot.

Over the last 10-20 years, we have attempted to assess the status and trends in the mammal fauna of the Top End, through comparison with historic accounts, through intensive survey, through documentation of Indigenous knowledge and through monitoring.

As an illustration of the contrast between historic accounts and present status, Dahl reported for the northern brush-tailed phascogale *Phascogale pirata* that:

*"on the rivers Mary and Katherine it was frequently observed. In fact, nearly everywhere inland it was very constant, and on a moonlight walk one would generally expect to see this little marsupial"*⁶

This species is now very seldom recorded in the Northern Territory. For example, we have conducted intensive wildlife surveys at around 5000 sites in the Top End of the Northern Territory (with each site trapped for a 3-night period, and with intensive spotlighting), and recorded a tally of fewer than 10 phascogales.



Location of sites subjected to intensive wildlife survey, Northern Territory 1990-2008

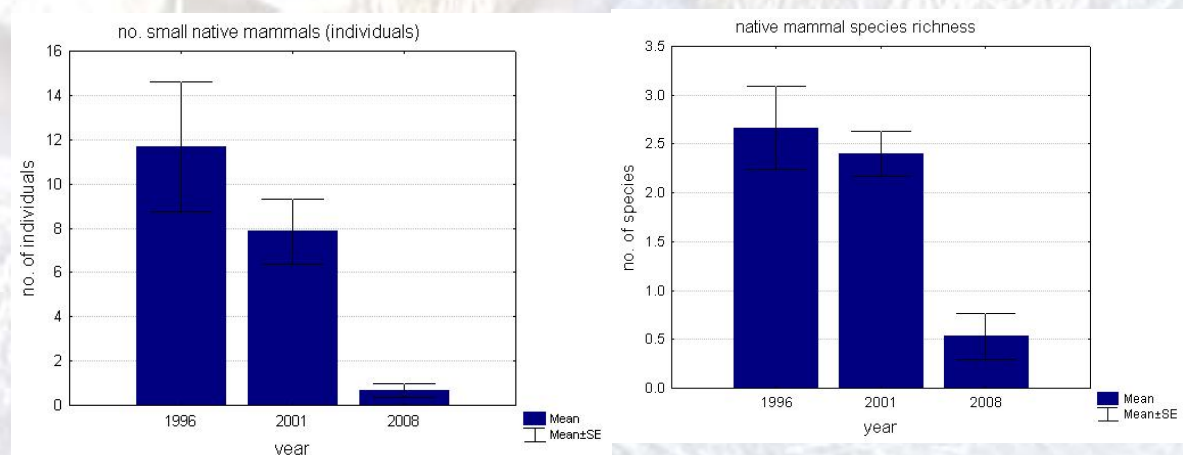
Aboriginal people across much of the Top End report a consistent pattern of decline for some mammal species, although the quality of this information is increasingly faltering as the most knowledgeable older men and women pass away, and the pattern of intricate knowledge of environments derived from management of the land becomes lost.



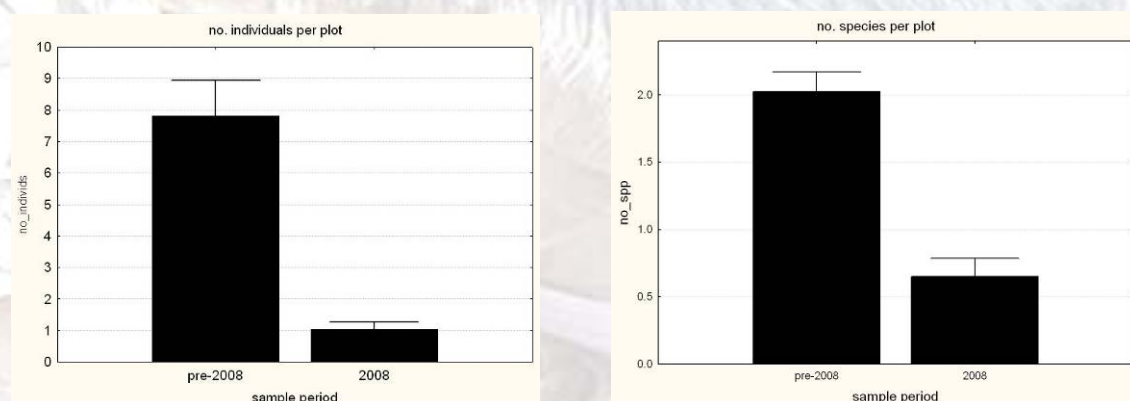
Indigenous knowledge of mammal status has been documented across many communities in the Top End of the Northern Territory

Systematic monitoring provides the most robust and precise information on trends in the mammal fauna of northern Australia. Over the last 10 years, we have established large series of monitoring plots across a range of sites in the Top End of the Northern Territory, with the most extensive of these in Kakadu National Park, Litchfield National Park and Nitmiluk National Park. These permanent plots sample all environments and include many sites remote from any infrastructure. They are monitored at intervals of about five years, at the same time of year and using a consistent methodology.

As at 2008, 15 plots have been sampled on three occasions at Kakadu, and 63 plots have been monitored on at least two occasions. The results demonstrate a very marked decline. This decline is unrelated to variation between years in rainfall or other weather patterns.



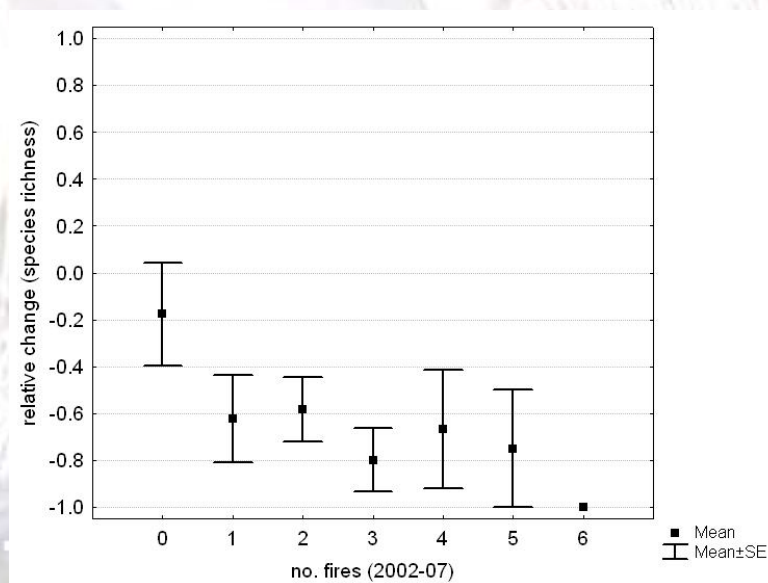
Change in abundance (left) and richness (right) of native mammals (small and medium-sized species only), at Kakadu, 1996-2008 (15 plots)



Change in abundance (left) and richness (right) of native mammals (small and medium-sized species only), at Kakadu, 2001-2008 (63 plots)

The decline in small native mammals in Kakadu over this period affected upland and lowland plots (although the decline was more marked in lowland plots). A portion of the decline is attributable to loss of northern quolls because of the invasion by cane toads, but even with carnivorous (toad-eating) native mammals excluded, there remains a highly significant and substantial decline.

The extent of change in mammals at individual plots at Kakadu was related to the fire history of those plots, with far more severe decline in plots that were exposed to the most frequent fire.



Change in native mammal richness at individual monitoring plots in Kakadu, 2002-2007, in relationship to the number of times the plot was burned over this period. Any score below 0 indicates decline (to a minimum possible score of -1, which indicates disappearance of all mammals from a plot that previously held mammals).

The pattern of decline in Kakadu revealed by these monitoring plots is consistent with declines observed in an entirely independent data set for Kakadu lowlands from 1986 to 2001⁷. The available evidence suggests that this declining trend is by no means restricted to Kakadu. For example, over the period 2002-07, native mammal richness per plot declined by more than 50% across 47 monitoring plots sampled at Litchfield National Park. We use Kakadu here as an example, largely because the historical record and extent of monitoring is the best available; and because it is a reasonable assumption that species may be most likely to retained in a large well-resourced National Park.

Notably, the trend of decline is most evident in large rodents, dasyurids, bandicoots and possums, amongst the groups that have proven the most extinction-prone elsewhere in Australia.



Examples of species in decline in Kakadu (and elsewhere in the Top End): northern quoll (left); black-footed tree-rat (right)

The cause(s)

There is increasingly good experimental, ecological, and modelling evidence that fire regimes affect the status of mammals in northern Australia⁸. Many mammal species known to be in decline are dependent upon hollow logs, perennial grasses and shrubby understories (with fruit-producing plants), all attributes that are diminished by the prevailing regime of frequent fire.

Extensive fires also increase the susceptibility of native mammals to predation, especially by feral cats.



Feral cat captured at remote outstation in Arnhem Land (photo: P. Cooke)

Evidence to suggest a role of feral cats in the decline of native mammals comes especially from the relatively good persistence of many native mammal species on cat-free islands, largely regardless of the fire regimes on those islands. There is anecdotal evidence to indicate recent increase in cat numbers, possibly due in part to the outstation movement (many Aboriginal people returning to country in the 1960s and 1970s outstation movement took cats with them) and/or through broad-scale control of dingos/wild dogs. The introduction of cats to the Sir Edward Pellew Islands (Gulf of Carpentaria) in the 1970s appears to have since led to the local extinction of significant populations of native mammals known to be present a decade previously.

Feral cats may also be associated with the spread of exotic diseases, such as toxoplasmosis, elsewhere linked to decline of native mammals.

There is no direct evidence of a role of exotic disease in the decline of native mammals in northern Australia. But the current rapid and severe decline of Tasmanian devils elsewhere in Australia attests to the capability of disease to cause local extinctions of native mammals. In northern Australia, the relatively good persistence of native mammals on islands is consistent with a role of disease in causing declines in mainland populations. Other supporting evidence is the increasing incidence of the non-native black rat *Rattus rattus* across many remote and undisturbed areas of northern Australia: this species may spread diseases novel to the native mammal fauna.

Cane toads have spread rapidly across much of northern Australia over the last few decades and are undoubtedly the principal cause of the decline of northern quolls (although this species was in decline even before the advent of toads). However, the impact of toads by no means explains the decline of most native mammal species: indeed, most non-carnivorous native mammal species may be expected to increase because of toads (through reduction in predator pressure), and this is not observed.

There is some evidence, from cross-fence studies and suggestions in the historical record, that environmental change associated with pastoralism is disadvantageous to at least some native mammals⁹, but many declines have occurred in areas remote from the influence of pastoralism.

Overall, the data suggest that the main factors contributing to the decline of native mammals in northern Australia are inappropriate fire regimes (too frequent, intense and extensive fires) and predation by feral cats. It is feasible that disease may also be implicated; and cane toads have particular damaging impacts on at least one native mammal species.

The solution(s)

No single action will halt the decline. Rather, we here propose an integrated and collaborative program of research and management, with distinct components.

1. *Safeguard the islands*

Islands have long been recognised to have special significance for the conservation of Australian biodiversity. Islands offer the opportunity of refuge from cats and from exotic diseases. In the Northern Territory, there are 233 islands > 20 ha¹⁰. Most are Aboriginal owned; many have not been surveyed for biodiversity; of those that have been surveyed, many have outstanding conservation values.



A collaborative management program for translocated northern quolls on islands off Arnhem Land has had outstanding conservation outcomes.

With due care for existing conservation values, islands also offer the opportunity for short- to medium- term refuge for translocations of mammals that are otherwise largely doomed in their mainland range¹¹.

The ownership of Northern Territory islands by Aboriginal people offers a special opportunity and obligation to provide collaborative wildlife management programs, that involve two-way training and the development of Indigenous Protected Areas.

Individual actions:

- 1.1. undertake strategic and collaborative surveys of poorly-known islands;

- 1.2 work with Aboriginal landowners and Indigenous ranger groups to establish or enhance quarantine programs that reduce the likelihood of spread to islands of unwanted exotic organisms; and/or to attempt to eliminate unwanted exotic organisms that are already present;
- 1.3. for island groups of conservation significance, establish and fund Indigenous Protected Areas;
- 1.4. where appropriate, undertake translocations of mammals that are under most threat in their mainland range.

2. Identify the relative impact of different threats; and the ecological requirements of particular native mammal species

There has been a substantial body of research undertaken on the ecology of many mammal species in north Australia, mostly over the last two decades. From these research programs, we know the ecological requirements of many species, their status and their response to many management factors. This is adequate to provide management advice for many species and many situations; but some strategic further research is required to specifically target management priorities and to ensure that management is evidence-based.

The most significant research requirements are to clarify the relative detriment of cats and fire (and the compounding influence of fire on predation); to identify whether exotic disease has any role; to identify the requirements of selected poorly-known native mammal species; and to translate this knowledge to practical and cost-effective management guidelines.

Individual actions:

- 2.1. establish cat exclosures to more precisely determine the relative impacts of predation and to provide models of cat-free management;
- 2.2. assess the responses of native mammal species to a range of fire regimes and changes in fire management (e.g. such as in the Western Arnhem Land Fire Abatement project);
- 2.3. assess the incidence of disease in black rats around Darwin suburbs and in remote bushland populations;
- 2.4. where possible, assess the disease status in native mammals;
- 2.5. investigate the status, habitat requirements, and responses to threats for selected poorly-known native mammal species (e.g. northern brush-tailed phascogale);
- 2.6. evaluate the responses of small mammals to a range of pastoral practices and regimes;

- 2.7. conduct a comprehensive regional analysis of mammal survey data to identify localities where mammal richness may have been retained, and the factors that may be associated with that retention;
- 2.8. translate this and previous research to practical management recommendations.

3. Reduce threats

Axiomatically, native mammals are in decline across much of northern Australia because of the impact of particular threat(s). These species will recover where and when these threats can be moderated to a necessary degree. In most cases, these management actions should be undertaken by or in collaboration with landholders, such as through Indigenous ranger groups on Aboriginal lands; as offsets to large development proposals; or as part of covenants of significant biodiversity areas on pastoral lands.

Individual actions:

- 3.1. reduce fire frequency across significant areas of the Top End;
- 3.2. develop and implement broad-scale control programs for feral cats across significant areas of the Top End (initially including some large exclosures);
- 3.3. develop and implement control programs for black rats at source areas and in isolated populations across significant areas of the Top End;
- 3.4. where necessary, establish and maintain captive breeding populations of species at perilous risk.

4. Maintain and enhance monitoring programs

The demonstration of significant decline in native mammals across northern Australia has largely been because of the existence of robust and extensive (ambient) monitoring programs. These existing programs are largely funded on an ad hoc and short term basis.

A more long-term and extensive monitoring program with more secure funding is required to continue to assess trends in this native mammal fauna, to measure the success of (a range of different possible) interventionist management actions, and hence to demonstrate cost-effectiveness of investments.

Individual actions:

- 4.1. maintain and extend existing monitoring programs that measure general trends in the status of native mammals;

4.2. develop and implement monitoring programs that specifically measure the efficacy of management interventions.

5. Communicate the challenge and involve the community

For many residents of northern Australia, native mammals are largely invisible, and their plight unnoticed. This program will not succeed without greater community awareness and participation.

Individual actions:

5.1. develop and implement a communication program that allows the community to appreciate this component of our natural legacy;

5.2. develop or enhance programs that help pass Indigenous knowledge of wildlife to younger generations;

5.3. provide opportunities for the community to play a meaningful role in management solutions.

Governance

This initial draft of this proposal has been prepared by the Northern Territory Department of Natural Resources Environment, the Arts and Sports.

To be effective, the program will have to work across tenures, agencies and jurisdictions. Over the last 10-20 years, there has been a fertile collaboration between many of these interested parties, including – in the Northern Territory - the Tropical Savannas Cooperative Research Centre, Parks Australia, the Threatened Species Network (WWF), a range of Indigenous ranger groups, Charles Darwin University and CSIRO. Complementary research and management programs have been undertaken by Western Australian Department of Environment and Conservation, the Australian Wildlife Conservancy and Kimberley Land Council; by Queensland Environment Protection Agency; and by scientists from several Universities.

The mechanics and detail of this program and its management will be further developed collaboratively with relevant and interested stakeholders.

Costs

An indicative 5-year costing for this program is presented in the Table below. A range of funding sources may contribute to components of this program. Note that this Table relates to date only to actions in the Northern Territory, rather than northern Australia as a whole.

Some funding has been sought for 2008-09 through the Caring for Our Country program.

(\$000)

item		2009	2010	2011	2012	2013	total
1.1	survey islands	50	50				100
1.2	quarantine islands	50	50	50	25	25	200
1.3	island IPAs		200	200	200	200	800*
1.4	island translocations		50	50	25	25	150
2.1	cat enclosures (experimental management)	250	250	50	50	50	650
2.2	assess fire impacts	50	50	50	50	50	250
2.3	assess disease	200	200	100			500
2.4							
2.5	study of poorly-known mammals	200	200	200			600
2.6	study pastoral impacts	150	150	100	100		500
2.7	broad-scale survey analysis	50	100	50			200
2.8	develop management priorities		30	30	30		90
3.1	improve fire management	200	200	200	200	200	1000*
3.2	control cats		100	200	200	100	600
3.3	control rats			200	100	100	400
3.4	captive breeding		50	50	50	50	200
4.1	monitoring trends	100	100	100	100	100	500
4.2	monitoring management effectiveness	100	100	100	100	100	500
5.1	communication program	50	50	50	50	50	250
5.2	Indigenous knowledge transfer	100	150	150	150		550*
5.3	community involvement		50	50	50	50	200
	total	1550	2130	1805	1480	1100	8240

* indicates funding likely to be covered by other existing processes

¹ Johnson, K.A., and Southgate, R.I. (1990). Present and former status of bandicoots in the Northern Territory. In *Bandicoots and bilbies* (eds J.H. Seebeck, P.R. Brown, R.L. Wallis and C.M. Kemper.) pp. 85-92. (Surrey Beatty and Sons: Sydney.)

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² Dahl K (1897). Biological notes on north-Australian mammalia. *Zoologist*, Series 4, 1, 189-216.

³ Collett R (1897). On a collection of mammals from North and North-west Australia. *Proceedings of the Zoological Society, London*, 1897, 317-336.

⁴ Calaby JH (1973). Mammals. In *Alligator Rivers region environmental fact-finding study*. CSIRO Division of Wildlife Research, Canberra.

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⁶ Dahl K (1897). Biological notes on north-Australian mammalia. *Zoologist*, Series 4, 1, 189-216.

⁷ Woinarski, J.C.Z., Milne, D.J., and Wanganeen, G. (2001). Changes in mammal populations in relatively intact landscapes of Kakadu National Park, Northern Territory, Australia. *Austral Ecology* **26**, 360-370.

⁸ Pardon, L.G., Brook, B.W., Griffiths, A.D. and Braithwaite, R.W. (2003). Determinants of survival for the northern brown bandicoot under a landscape-scale fire experiment. *Journal of Animal Ecology* **72**, 106-115.

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⁹ Woinarski, J.C.Z., and Ash, A.J. (2002). Responses of vertebrates to pastoralism, military land use and landscape position in an Australian tropical savanna. *Austral Ecology* **27**, 311-323.

¹⁰ Woinarski, J., Rankmore, B., Fisher, A., Brennan, K., and Milne, D. (2007). *The natural occurrence of northern quolls *Dasyurus hallucatus* on islands of the Northern Territory: assessment of refuges from the threat posed by cane toads *Bufo marinus**. Report to the Natural Heritage Trust. (Department of Natural Resources, Environment and The Arts, Darwin.)

¹¹ Rankmore, R.P., Griffiths, A.D., Woinarski, J.C.Z., Ganambarr, B.L., Taylor, R., Brennan, K., Firestone, K., and Cardoso, M. (2008). *Island translocation of the northern quoll *Dasyurus hallucatus* as a conservation response to the spread of the cane toad *Chaunus (Bufo) marinus* in the Northern Territory, Australia*. Report to the Natural Heritage Trust. (Department of Natural Resources, Environment and The Arts, Darwin.)