

Science for Saving Species

Research findings factsheet

Project 3.2.2.1



National Environmental Science Programme

What 15 years of monitoring is telling us about mammals in Booderee National Park

Booderee National Park: An iconic Australian reserve

Booderee National Park is located in Jervis Bay in south-eastern Australia, around 200 km south of Sydney on the New South Wales coast between Nowra and Ulladulla.

First established as a national park in 1992, it is a 6600 ha reserve that supports more than 200 terrestrial vertebrate species including threatened species and threatened ecological communities. The key vegetation communities for mammals encompass heathlands, warm temperate rainforests, forests, woodlands, shrublands, swamps and sedgeland.

Booderee National Park represents a critically important science-manager partnership across Parks Australia, the Wreck Bay Aboriginal Community and the Threatened Species Recovery Hub. It was ranked as one of Australia's best-managed protected areas by WWF Australia in 2008.

Fifteen years of monitoring shows mammal collapse

A major monitoring program began in Booderee National Park in 2003, which encompassed a range of vertebrate groups including mammals, birds, reptiles and frogs, as well as native vegetation.

Fifteen-years of monitoring has now revealed a major ecological surprise: localised collapses of populations of some of the park's mammal species and the dramatic rise in abundance of others.

The number of different native mammal species in the park almost halved between 2003 and 2016 and there have been major declines in the populations of many mammal species that remain. While areas outside Booderee National Park continue

to support populations of species lost or declining in the park.

Declines and local extinctions within the park have included both terrestrial and arboreal (tree dwelling) mammals, with the latter group very hard hit. Monitoring has also been able to clearly establish that it is mammal species only that have been affected by these site-level losses.

Within the park the greater glider (*Petauroides volans*) has declined very significantly and has not been observed in Booderee since 2006. It is now presumed locally extinct.

The common ringtail possum (*Pseudocheirus peregrinus*) has also declined significantly, with



Radio tracking reintroduced mammals. Photo: Natasha Robinson

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Fifteen years of monitoring shows mammal collapse (cont)

none observed in the long-term monitoring sites since 2014.

Major declines have also been observed for other mammals in the park.

The long-nosed bandicoot (*Perameles nasuta*), which initially increased substantially following fox control but then declined before reaching a low stable abundance, the bush rat (*Rattus fuscipes*), and the tree-climbing micro-predator the brown antechinus (*Antechinus stuartii*), have all exhibited significant declines between 2003 and 2016. They are now found in around one eighth, one half and 60% of their 2003 sites, respectively. Declines in bush rat abundance following intensive fox control have also been observed in Western Australia.

Two species of macropod, the black wallaby (*Wallabia bicolor*) and the eastern grey kangaroo increased in abundance but have

more recently declined. The brush-tailed possum (*Trichosurus vulpecula*) has increased in abundance during the course of the study.

At the same time as these mammals have declined, owls that were once relatively common in Booderee National Park (the powerful owl, sooty owl and masked owl) appear from the continuing monitoring to have also significantly declined. Severe reductions in key species of prey is the most likely explanation.

While mammal declines are being observed over many parts of Australia, the declines in Booderee National Park are more surprising because many of the declining and locally extinct mammals remain in surrounding areas outside of the park. Furthermore, the park was ranked as one of Australia's best-managed protected areas by WWF Australia in 2008.

Park management for mammals

Fox baiting, fire management and weed control have been three key activities of park management. The biodiversity monitoring program has been used to measure the effectiveness of management activities and to refine them. Other than for mammals, the effects have been positive. The park activity with the greatest impact on fauna is an intensive poison-baiting program for foxes.

Fox control

The establishment of fox control slightly preceeded the establishment of the park's biodiversity monitoring program. It was first implemented in 1999, with 120 stations in all seven of the key vegetation types baited every six months. Control efforts were greatly intensified in 2003 (the year biodiversity monitoring began), with baits laid monthly through to 2014, and fortnightly since then. In addition, a network of sand plots was established throughout the park,

and footprints, tracks and scats were recorded every month. Since 2015, remote cameras have been deployed for 14 nights per site in each of 50 sites distributed widely across the eastern and south-eastern parts of the park.

The control program has been highly successful, resulting in a very significant decline in bait take and sand plot records, although some foxes still occur. When evidence of a fox is detected (e.g. scat, tracks or sighting), a professional marksman is immediately engaged. The baiting program greatly reduced the numbers of foxes in the park. It was expected that reduced foxes would lead to the recovery of native fauna and there have been increases in the populations of many native species, such as the eastern bristlebird.

A feature of the Booderee mammal declines is that not only were they unexpected but counter-intuitive with respect to fox control.



Eastern quolls have been reintroduced to the park. Photo: Rewilding Australia

The common ringtail possum, for example, was expected to benefit from fox control as they are a major prey item of foxes, but has instead apparently declined drastically, almost to local extinction. However, declines in terrestrial mammal abundance following initial increases have been observed in a wide range of other fox control sites in Australia.

Identifying the causes of mammal declines

In light of the unexpected and deeply concerning mammal declines and extinctions, many hypotheses have been put forward and tested. Analysis of monitoring data within the park, comparisons with data from studies outside the park and additional research has eliminated many potential factors, but after many years of careful study the cause is still not apparent.

The three key management activities in the park, fox baiting, fire management and weed control, have been eliminated as independent causes of the losses and extinctions.

Along with fox baiting, foxes have been ruled out as the cause. Similarly, increased competition from native animals following reduced fox numbers has been ruled out. Furthermore, blame cannot be assigned to cats. Feral cats are a common cause of mammal declines Australia-wide, but they are rare in Booderee National Park, with just 21 records between 1999 and 2013. There has been no evidence of an increase in cat numbers in Booderee with the decline in population of foxes.

Fire has also been eliminated as a cause. A large wildfire burnt half the park in 2003, the same year the fox-baiting program was intensified and species monitoring program began. Analysis has shown that the majority of fauna were either minimally affected by this fire event or have since recovered from it.

Additional potential causes that have been tested and not supported by recent modelling and other ongoing work by ANU and Parks Australia, include:

- Competition among hollow-using species - there is no evidence of competition by common brushtail possums.
- Native herbivore release and over-browsing – there is no evidence of an association with increases in numbers of kangaroos and wallabies.
- Exotic herbivore release - there is no evidence of significant increases in rabbits.
- Consumption of poison baits - the now-extinct greater glider does not descend to the ground, where the baits are laid.
- Climate change - areas immediately outside Booderee National Park support populations of all the species lost or declining in the park.
- Invasive plant species – there is no evidence to support weed invasion as a cause of the declines and losses.
- Irruptive population dynamics - the now locally extinct species, the greater glider and the common ringtail possum, are not species with populations characterized by explosions and crashes (called irruptive dynamics), although this may be plausible in the case of the long-nosed bandicoot's dramatic increase and decrease and the increase and decrease of macopods.

Although a wide range of potential drivers or mechanism of the declines have been ruled out as independent causes, it cannot yet be ruled out that multiple causes are interacting to cause the declines and this should be further investigated.



Radio tracking.
Photo: Natasha Robinson

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Booderee National Park.
Photo: Keir Smith Flickr CC BY-SA 2.0

As the declines and losses recorded were unexpected and rapid, they indicate a critical need for early alerts to conservation managers about impending problems, allowing them to alter management regimes before major declines occur.

Challenges presented by the Booderee mammal declines and extinctions

The drivers of the unexpected and unexplained declines and extinctions of native mammals in Booderee National Park remain unclear, and could not have been predicted by current ecological knowledge or theory. Further, it is concerning that these declines and extinctions took place in a well-managed protected reserve.

Although intensive sampling was done over a considerable period of time, the possibility that insufficient data were gathered to establish the causes of decline should also be considered.

Isolation is a possible stressor that was not tested but which may have influenced the results. Booderee National Park occupies a peninsula surrounded by considerable adjacent urbanisation. This may mean that population declines and losses may not be able to be reversed by

immigration. Isolation impacts may explain past mammal extinctions in the park, such as the losses of the spotted-tail quoll and the yellow-bellied glider in the 1980s, and could also go some way to explaining the losses of the greater glider and common ringtail possum observed in the current research.

While the lack of a clear cause of the chaotic dynamics including increases, declines and local extinctions after 15 years of monitoring may be concerning, it does not undermine the value of the past monitoring. Much has been learned in this period and many causes have been ruled out.

The evidence does suggest that the declines and losses may ultimately be due to a combination of stressors, which may include both those tested and some that have not yet been identified.

Eastern bristlebird numbers have increased following intensive fox control within the park.
Photo: David Cook CC BY-NC 2.0 Flickr



The role of reintroductions

The mammal losses in Booderee National Park have left depleted assemblages and vacant niches, meaning that some ecological roles may now be unfilled. The apex mammal predator niche in Booderee is unfilled with the loss of the spotted-tailed quoll in the 1980s and the arboreal marsupial assemblage is hugely depleted with the recent losses of greater glider and common ringtail possum.

The Threatened Species Recovery Hub is working in partnership with Booderee National Park with the aim of both solving the mystery of why the declines have happened and conducting reintroductions to help replenish ecological niches and restore the depleted assemblages.

Parks Australia is already undertaking mammal reintroductions. Southern Brown bandicoot (*Isodon obesulus obesulus*) and long nosed potoroo

(*Potorous tridactylus*) reintroductions and translocations have been conducted and a pilot reintroduction of the mesopredator, the eastern quoll (*Dasyurus viverrinus*) occurred in March 2018. Reintroductions of other lost fauna, especially arboreal marsupials, are being considered with the particular aim of experimentally identifying the cause of the decline of the greater glider. Together these reintroductions may restore some of the mammal species to the park.

Conducted as rigorous scientific experiments, the reintroductions are also an important opportunity to test more potential causes for the mammal declines and losses, and to ensure the effectiveness of management actions. An important need in taking these actions, due to the risk potential for perverse outcomes, is to maintain reference areas with no management interventions.

Detailed ongoing monitoring is critical

Monitoring has been a vital part of work since 2002 in Booderee National Park, and must continue at least at its current level of intensity. Given the vulnerability of many mammal species in the park, detailed monitoring is important to alert park managers to declines as they emerge, and to provide feedback on the effectiveness of different management approaches.

More sensitive early warning signals are needed. As the declines and losses recorded were unexpected and rapid, they indicate a critical need for early alerts to conservation managers about impending problems, allowing them to alter management regimes before major declines occur. The example of the local extinction of the greater glider is sobering. No early warning signs were detected before rapidly declining from being detected at a quarter of monitoring sites, to not being detected at any sites in only two years.

A southern brown bandicoot within Booderee National Park. Photo: Natasha Robinson



The pathway to recovery is complex

The research suggests that (even subtle) changes in the whole community need to be tracked rather than just those of individual species to avoid detecting critical changes too late.

The pathway to recovery may also be much more complex than simply removing an apparent initial threat, such as foxes. When threats have operated for a long time, they may have damaged ecological webs to a point that they do not simply recover when the threat is removed.



Long-nosed potoroo at Booderee National Park. Photo: Natasha Robinson



Booderee National Park. Photo: Kate Bunker Flickr CC BY-NC 2.0

Further Information

For full details of the research see:

Lindenmayer, D., et al., 2018. Conservation conundrums and the challenges of managing unexplained declines of multiple species, *Biological Conservation* 221, 279-292