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Effective conservation of critical weight range mammals: reintroduction projects of the Australian Wildlife Conservancy



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Summary

The problem

1. A third of Australia's mammals are extinct, or threatened with extinction, with predation by feral cats and foxes being the most significant factor in their decline. Extensive areas, particularly of arid and semi-arid Australia, now have only a vestigial representation of their pre-European mammal assemblages
2. Such extensive losses of the native mammal fauna have also led to continental-scale ecological changes and disruption of some ecological processes

Actions taken to manage the problem

1. The Australian Wildlife Conservancy (AWC) has established a network of fenced areas (and an island) from which introduced predators have been removed and into which threatened native mammal species have been reintroduced.
2. AWC measures and reports on the population of target species, actively manages threatening processes, and conducts research related to the restoration of ecosystems through mammal reintroductions.

Markers of success

1. The risk of extinction has been significantly reduced with populations of many threatened species increasing.
2. Causes of decline have been identified and are now being managed effectively at multiple sites.
3. The ecological return from implementing a fenced area strategy is relatively high.

4. Community involvement has been substantial, with ongoing support from the community and innovative public–private partnerships.

Reasons for success

1. Reasons for initial decline were clearly identified and are now controlled.
2. Managers have been prepared to take risks, based on robust evidence produced by dedicated, science-literate staff tightly linked to management.
3. Adequate resourcing has been available for long-term and sustainable management.
4. Projects are delivered in a framework that requires accountability for outcomes (increased populations) and expenditure.

Introduction

The Australian Wildlife Conservancy (AWC) is a not-for-profit conservation organisation. Our mission is the effective conservation of Australia’s wildlife and their habitats. Currently, we manage over 3.8 million ha for conservation (Fig. 28.1). Our wildlife sanctuaries include representation of an estimated 86% of Australia’s bird species, 71% of Australia’s mammal species and over 50% of Australia’s reptile and frog species.

AWC implements a range of conservation actions on its wildlife sanctuaries, including landscape-scale management of fire, feral animals and weeds. One of the major conservation actions undertaken by AWC involves the reintroduction of threatened mammals to wildlife sanctuaries from which introduced predators have been removed. Feral cats (*Felis catus*) and foxes (*Vulpes vulpes*) are the primary threat to most small to medium-sized Australian mammals (Woinarski *et al.* 2014; Doherty *et al.* 2017). Extensive areas of southern and central Australia now have only a vestigial small to medium-sized native mammal fauna (McKenzie *et al.* 2007), disrupting a suite of ecological processes in which these mammals participate, including pollination, seed dispersal, herbivory, nutrient and water retention (Fleming *et al.* 2014). These disruptions have knock-on consequences for other components of ecosystems and human welfare.

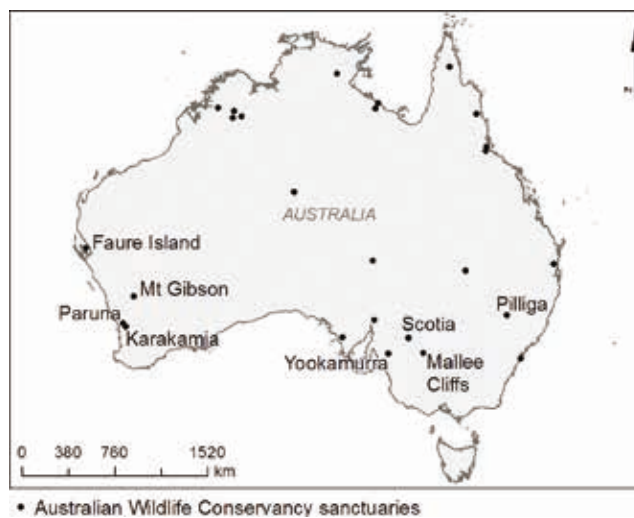


Fig. 28.1. The Australian Wildlife Conservancy has sanctuaries across the country. The named sanctuaries exclude predators to help conserve threatened mammals.

Table 28.1. Threatened mammals protected by Australian Wildlife Conservancy's reintroduction program. Global population estimates from Woinarski *et al.* (2014)

Species		EPBC status	Global population size	Number of AWC sanctuaries in which present	Population size in AWC sanctuaries	Proportion of global population, AWC
Numbat	<i>Myrmecobius fasciatus</i>	Vulnerable	1000	2	>400	40%
Western barred bandicoot	<i>Perameles bougainville</i>	Endangered	~5000	1	600	12%
Greater bilby	<i>Macrotis lagotis</i>	Vulnerable	<10 000	2	1350	15%
Western ringtail possum	<i>Pseudocheirus occidentalis</i>	Vulnerable	<8000	1	40	<1%
Burrowing bettong	<i>Bettongia lesueur</i>	Vulnerable	~15 000	3	>7500	>50%
Woylie	<i>Bettongia penicillata</i>	Endangered	<18 000	3	1000	6%
Mala	<i>Lagorchestes hirsutus</i>	Endangered	~4000	1	70	2%
Banded hare-wallaby	<i>Lagostrophus fasciatus</i>	Vulnerable	~5000	1	350	7%
Bridled nailtail wallaby	<i>Onychogalea fraenata</i>	Endangered	~2500	1	2300	90%
Greater stick-nest rat	<i>Leporillus conditor</i>	Vulnerable	>3000	1	~60	2%
Shark Bay mouse	<i>Pseudomys fieldi</i>	Vulnerable	~10 000	1	900	9%

The reintroduction of threatened mammals to feral predator-free sanctuaries is one of the standout ‘success stories’ in Australian conservation. Currently, AWC supports 11 threatened species that have been reintroduced to wildlife sanctuaries in which introduced predators have been removed (Table 28.1), including one island and four fenced ‘mainland islands’. Reintroductions have improved the conservation prognosis of these species by increasing both the number of secure populations and their global population size.

Conservation management

AWC’s reintroduction program is based on a simple premise: feral cats and foxes are the primary threat to most of Australia’s critical weight range mammals. Consequently, the removal of foxes and cats is often sufficient to re-establish viable populations of threatened mammals in areas of their former range. To date, AWC has removed introduced predators from Faure Island in Shark Bay (Western Australia, 5000 ha, predator removal completed in 2001), and four fenced ‘mainland islands’: Karakamia (Western Australia, 275 ha, 1994); Yookamurra (South Australia, 1100 ha, 2002); Scotia (New South Wales; 8000 ha, 2004); and, most recently (in 2015), Mt Gibson (Western Australia, 7832 ha). These sanctuaries support the 11 threatened mammals listed in Table 28.1.

Foxes and cats have been removed from these areas by a combination of baiting, shooting and trapping. Intensive monitoring was undertaken to determine where best to target control efforts and when control could cease. ‘Mainland islands’ are protected by a mesh fence ~2 m high, with a skirt where the fence meets the ground, a ‘floppy top’, and electrified wires to stop incursions of introduced predators and other pest animals (Fig. 28.2). Fences are patrolled every 2–3 days to maintain the integrity of the fence, and the area



Fig. 28.2. A Conservation fence, Mt Gibson wildlife sanctuary, WA.

inside the fence is also monitored regularly using sandplots, spotlighting and cameras to detect any incursions. There have only been a few incursions of introduced predators to AWC's fenced areas since establishment, mostly through human error; all incursions have been promptly eliminated.

Case studies of three species protected by AWC's reintroduction program – woylie (*Bettongia penicillata*), bridled nailtail wallaby (*Onychogalea fraenata*) and greater bilby (*Macrotis lagotis*) follow.

The woylie

The woylie or brush-tailed bettong (Fig. 28.3A) is a small (~1–2 kg) macropod, once distributed across most of southern and central Australia, from forests to semi-arid habitats. Woylies eat truffles, supplemented by tubers, bulbs, seeds, fruits and invertebrates. Woylies can produce up to three young per year (Claridge *et al.* 2007).

Woylies are highly susceptible to predation by foxes and feral cats. Populations collapsed across Australia in the late 19th and early 20th centuries; only a few populations in south-western Australia avoided extinction. Fox-baiting and a series of reintroductions helped the species recover in south-western Australia, but in the last two decades, populations in the wild have again crashed, largely due to predation by feral cats (Marlow *et al.* 2015; Wayne *et al.* 2015). The species is listed as Endangered nationally and Critically Endangered in Western Australia.

A Recovery Plan has been developed for the species (Yeatman and Groom 2012). Reintroductions are one of the main recovery actions listed in the plan.

The woylie has been subject to more reintroductions than any other Australian mammal (Short 2009). AWC has reintroduced the woylie to fenced areas at Karakamia, Scotia, Yookamurra and Mt Gibson wildlife sanctuaries. Populations in all these locations have established successfully; Karakamia has supported a stable population of around 400 woylies for over 20 years. At present, AWC sanctuaries support over 1000 woylies. Additional reintroductions are planned for Pilliga, Mallee Cliffs, Newhaven and Paruna in the next few years, with total population size predicted to exceed 10 000 individuals, which is more than 50% of the current global population size.

Bridled nailtail wallaby

The bridled nailtail wallaby (Fig. 28.3B) is a medium-sized (4–8 kg) macropod once widely distributed across inland eastern Australia from north Queensland to the Victorian mallee (Lundie-Jenkins and Lowry 2005). The species is well adapted to semi-arid conditions, capable of rapid population growth in favourable seasons. Populations of this species collapsed around the turn of the 20th century, such that, by 1937, this once common macropod was thought to be extinct. In 1973, a remnant population of bridled nailtail wallaby was discovered in central Queensland. This population, now in Taunton National Park, has been intensively managed; nevertheless, its persistence is tenuous due to predation and only 100–200 individuals remain (Woinarski *et al.* 2014).

A semi-wild population of the bridled nailtail wallaby was established at Scotia in 1998 by Earth Sanctuaries Ltd when 12 animals sourced from Queensland were released to a 250 ha breeding compound. Animals were provided with food and water and the population quickly expanded. Upon acquiring Scotia in 2004, AWC established a feral predator-free area of 8000 ha using conservation fencing. In 2004–2005, 162 bridled nailtail wallabies were released from the breeding population into Stage 1 (4000 ha). In 2008, an additional 267 individuals were released to Stage 2. By the end of 2011, following 2 years of good

rainfall, Stages 1 and 2 supported more than 2000 animals; the population peaked at ~3600 animals in late 2012. The population subsequently declined to ~2300 following a run of dry years and is currently stable.

AWC's investment at Scotia has been critical in securing the future of the bridled nail-tail wallaby. The reintroduction to Idalia NP in Queensland has failed (Bridled Nailtail Recovery Team *pers. comm.*) and the remnant population at Taunton has declined over the last 20 years. AWC also plans to reintroduce the species to fenced feral predator-free areas at Mallee Cliffs and Pilliga in NSW; the combined population size across these populations and Scotia is predicted to reach 6000. This is consistent with the Recovery Plan (Lundie-Jenkins and Lowry 2005), which identifies reintroductions as one of the main recovery actions. It remains difficult to re-establish the species outside fenced areas. Animals released outside the fence at Scotia in 2010 did not persist more than a few months (Hayward *et al.* 2012). Nonetheless, because of their moderately large size, the bridled nailtail wallaby remains a candidate for translocations 'outside the fence' if more effective strategies for feral predator control can be developed. AWC is currently conducting research on the ecology of feral cats and foxes at Scotia as part of a long-term strategy to establish a bridled nailtail wallaby population in the broader landscape.

Greater bilby

The greater bilby (Fig. 28.3C) is a small (1–2.5 kg) burrowing mammal once widely distributed across Australia (Pavey 2006). Bilbies are omnivorous, feeding on insects, bulbs and fungi dug from the ground. Like other small mammals, bilbies are susceptible to predation by foxes and feral cats. The lesser bilby (*Macrotis leucura*) is extinct, while the distribution of the greater bilby has contracted to south-west Queensland and part of the Northern Territory and Western Australia, with a population size estimated at 10 000 (Woinarski *et al.* 2014). An interim conservation plan recently developed for bilbies mostly dealt with the management of remnant populations (Bradley *et al.* 2015); nevertheless, reintroductions were recognised as one of the actions contributing to the species' conservation.

Bilbies have been reintroduced to AWC's Scotia, Yookamurra and Mt Gibson sanctuaries, as well as Arid Recovery (South Australia), Lorna Glen (Western Australia) and Thistle Island (WA). The total population size on AWC sanctuaries is currently 1350. The population at Scotia has increased from 400 in 2010 to around 1200 in 2016 (Fig. 28.4). AWC plans to reintroduce bilbies to feral predator-free areas at Pilliga, Mallee Cliffs and Newhaven in the next few years. The total population of bilbies on AWC sanctuaries is predicted to approach 8000 individuals, or 40% of the current global population size.

Research, biology, identification of key threats

The small to medium-sized mammals that are the focus of AWC's reintroduction program are primarily threatened by introduced predators. The re-establishment of reintroduced populations on islands and fenced 'mainland islands' free of cats and foxes has demonstrated that removal of introduced predators is often sufficient for the recovery of these species.

AWC conducts intensive research on various aspects of the ecology of reintroduced species (e.g. Hayward *et al.* 2015). At present, we are conducting research to better understand the ecology of feral predators, with the goal of suppressing cats and foxes sufficiently to allow reintroduction of at least some threatened mammals outside fenced areas. A technical challenge faced by all AWC's reintroduction programs is the need to optimise and maintain the genetic integrity of reintroduced populations; this is also the subject of active research by AWC.

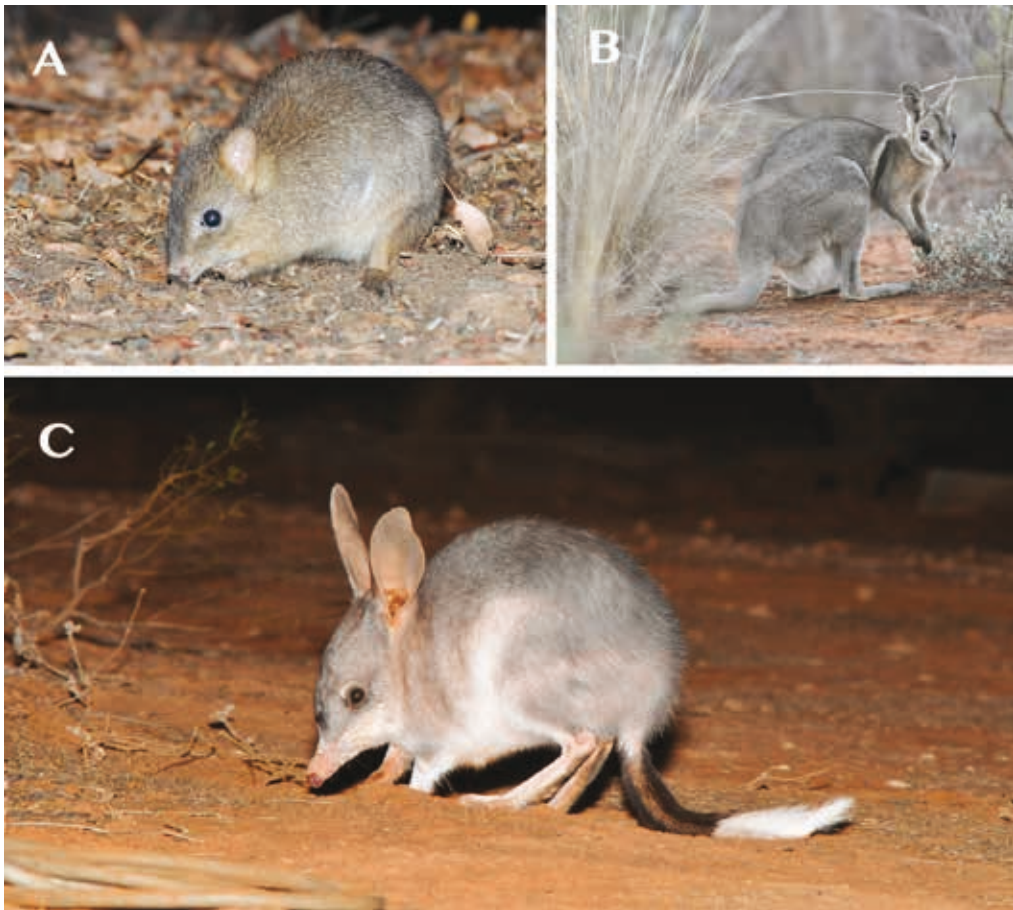


Fig. 28.3. (A) Woylie, Karakamia wildlife sanctuary. (B) Bridled naitail wallaby, Scotia wildlife sanctuary. (C) Greater bilby, Scotia wildlife sanctuary (photos: Wayne Lawler, AWC).

Planning and policy

AWC is one of the pioneers of reintroductions of threatened mammals to fenced feral predator-free areas in Australia. Our experience is that, where threatened species occur in jurisdictions where reintroductions are a well-established conservation measure (e.g. Western Australia, South Australia), recovery plans and government agencies are supportive of reintroduction programs.

Reintroductions to feral predator-free areas were identified in the Mammal Action Plan 2012 (Woinarski *et al.* 2014) as one of the few effective conservation actions undertaken for threatened mammals in Australia. This recognition, along with failure of many conservation programs reliant on management of feral predators in extensive landscapes, has helped in the broader acceptance of reintroductions as a conservation tool. This acceptance is demonstrated by the recent initiative of the New South Wales Government, where AWC has been contracted to establish feral predator-free areas and reintroduce regionally extinct mammals into two national parks. Reintroductions are currently one of the areas of research in the Threatened Species Recovery Hub: an initiative of the Australian Government.

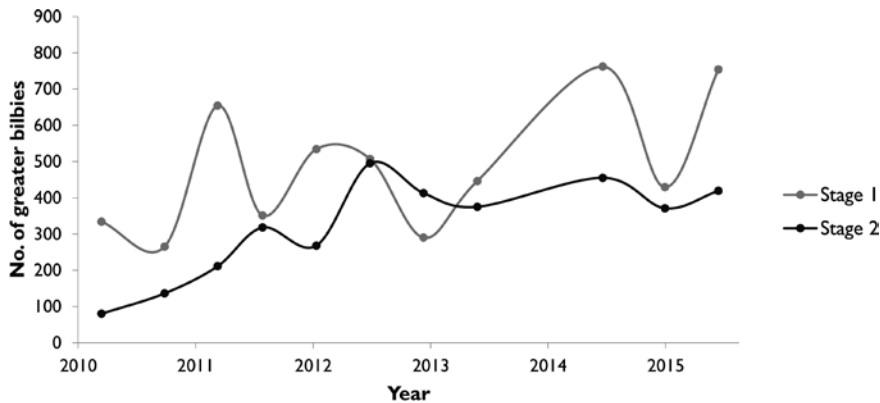


Fig. 28.4. Trends in numbers of Greater Bilby at AWC's Scotia Wildlife Sanctuary.

People, agencies, governance and accountability

As well as dealing directly with the primary threat to small to medium-sized mammals, the success of AWC's reintroduction program is due to several organisational factors. Most importantly, AWC is focused on delivering the highest possible ecological returns with available resources. Our reintroduction projects are delivered within a framework of accountability for outcomes (e.g. mammal populations) and expenditure. This promotes investor confidence, helping to secure resources. It also promotes innovation in relation to the establishment of large fenced areas and the removal of feral predators. Second, AWC invests substantially in 'in-house' scientific expertise. Currently, we have a staff of over 40 professional ecologists, who contribute to the design, implementation and monitoring of reintroduction projects. Third, our managers and many of our scientists are located on wildlife sanctuaries: an essential pre-requisite for successful execution of reintroduction programs. For example, our on-site managers are available to respond immediately to threats to the integrity of the fence.

AWC's reintroduction program has been supported by government agencies. For example, we have a good working relationship with the WA Department of Parks and Wildlife, which manages remnant populations of many threatened mammals and has substantial expertise in reintroductions; we are currently delivering two reintroduction projects in partnership with the New South Wales Government. Partner organisations such as Perth Zoo have assisted with captive breeding of source animals. Our experience is that organisations are generally willing to work together for the benefit of threatened species, although greater accountability within our sector for outcomes and costs would enhance the quality and productivity of collaborations.

Management

AWC is a not-for-profit organisation overseen by a board and accountable to supporters for conservation outcomes and expenditure. Our conservation priorities are informed by our expertise in ecology and land management, our scientific advisory network, and by extensive collaboration with external researchers and research organisations. Our reintroduction programs are informed by a structured decision-making prioritisation process.

Monitoring

Consistent with the need for accountability and adaptive management, AWC has devoted considerable resources to monitoring the outcomes of reintroduction projects. Typically,

animals translocated to a new site are studied intensively, using telemetry and trapping, to determine survival, movement patterns and habitat preferences. For example, half the woylies reintroduced to Mt Gibson in 2015 and 2016 were fitted with radio-collars with a mortality sensor; the survival and location of collared animals was determined for a period of months. This information has been used to calculate home range, dispersal and habitat preferences and will, in turn, allow AWC to refine release protocols for future reintroductions of woylies to semi-arid habitats.

Once animals have established at a site, AWC ecologists use a variety of methods to estimate population size. Mark-recapture methodology, based on trapping animals, is used to estimate population size of readily trapped species such as burrowing bettong (*Bettongia lesueur*) and woylie. Spotlight transects, where animals are counted and their distance from a transect measured, are used to estimate population size of less readily trapped species such as bilby and bridled nailtail wallaby, using a strip-transect approach. A similar approach, based on diurnal counts, is used to estimate population size of the numbat.

In some cases, it is difficult to estimate population size robustly. For example, burrowing bettongs have become very common on AWC's Faure Island Wildlife Sanctuary, with an estimated 5000–10 000 individuals. The burrowing bettong readily enters traps, so that capturing sufficient individuals of other reintroduced species has become a challenge. AWC ecologists have trialled a range of alternative methods to estimate population size of these species, including spotlight transects, arrays of camera traps, ink-pads and scat counts. Genetic analysis of scats offers another potential solution.

Infrastructure

AWC's reintroduction programs to sites on mainland Australia are all dependent on a key piece of infrastructure: namely a feral predator-proof fence. The design of the fence has been refined over time and incorporates passive (high mesh fence with floppy top) and active (hot-wire) deterrents to incursions by feral predators. The ongoing success of reintroduction programs relies on maintenance of the integrity of the fence. AWC staff conduct fence patrols every 2–3 days to check for and fix potential problems, such as areas where animals have tried to burrow under the fence. The consequences of inadequate fence maintenance are demonstrated by the collapse of the bilby population at Currawinya National Park, Queensland, after a fence was breached by feral cats (Woinarski *et al.* 2014).

A second critical piece of infrastructure is accommodation for staff that allows ready access to the reintroduction site and fence. AWC has located workshops, office buildings and science laboratories at or near mainland reintroduction sites to facilitate staff working on site.

Money

AWC reintroduction projects have delivered an exceptional return on investment relative to other strategies: see, for example, the bridled nailtail wallaby case study. Establishing a feral predator-free fence involves a significant capital investment. Major reintroduction projects, such as AWC's Mt Gibson project – which involved construction of 43 km of fence and will entail reintroduction of 10 regionally extinct mammals – cost more than A\$2 million to establish, with reintroductions costing in the order of A\$100 000 per species, depending on complexity of sourcing, transporting and monitoring animals. However, running costs are modest (mainly staff time for checking the fence and monitoring reintroduced species) and the returns for many threatened mammal species have proven to be higher than alternative strategies. The Western Australian Government's 'Western Shield' Program, noting its objectives extend beyond threatened mammal recovery, costs

several million dollars a year (Possingham *et al.* 2004). In some cases, reintroductions to areas from which feral predators have been eradicated are at present the only proven means of securing populations of small to medium-sized mammals susceptible to feral cats and foxes (Woinarski *et al.* 2014; Doherty *et al.* 2017).

AWC is primarily funded by donations from supporters, supplemented by government investment in some key projects. AWC also receives considerable in-kind support from volunteers – typically, several hundred people volunteer a year across AWC sanctuaries, from a few hours to several weeks at a time. Volunteers help in a variety of ways with reintroduction projects, from contributing to general sanctuary management to assisting with monitoring surveys.

The future

AWC's reintroduction program has substantially improved the conservation of 11 threatened mammals in a cost-effective manner. Expansion of the program in the next few years will increase the scope of the program, the number of species protected, the number of secure populations and global population sizes of protected species.

Conclusions

Reintroductions of threatened mammals to areas from which introduced predators have been eradicated has proven to be one of the few effective conservation measures available for small to medium-sized Australian mammals. The success of AWC's reintroduction program is due to several factors, including:

- Our approach deals effectively with the primary threat to small to medium-sized mammals.
- Projects are delivered in a framework that requires accountability for outcomes (increased mammal populations) and expenditure.
- AWC invests in 'in-house' scientific expertise, with tight integration of science and management.
- Staff are based on-site to manage the reintroduction program reliably.
- AWC is supported by a well-established funding model and sound governance structure.

Acknowledgements

AWC's founder, Martin Copley, had the vision to establish a mammal reintroduction project at Karakamia, WA. The success of this project led to AWC developing its current network of reintroduction projects. AWC thanks supporters for meeting the financial costs of these projects, the large number of AWC staff (present and past) and volunteers whose hard work made the projects a reality, and the numerous other stakeholders including government agencies, zoos and other private nature conservation organisations for providing source animals, expertise, approvals and other support. Thanks also to John Woinarski, Stephen Garnett and David Lindenmayer for reviewing the manuscript.

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