

Recovery Plan for the
Greater Bilby (*Macrotis lagotis*)
DRAFT



March 2019

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Front Cover: Ninu nyinanyi ngurrangka talingka (Bilby living in sandhill country) © Jodie and Nolia Ward

The Species Profile and Threats Database pages linked to this recovery plan is obtainable from:
http://apps.internal.environment.gov.au/cgi-bin/sprat/intranet/showspecies.pl?taxon_id=282

Recovery Plan for the Greater Bilby (*Macrotis lagotis*) DRAFT



Australian Government

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Environment and Energy



Department of Biodiversity,
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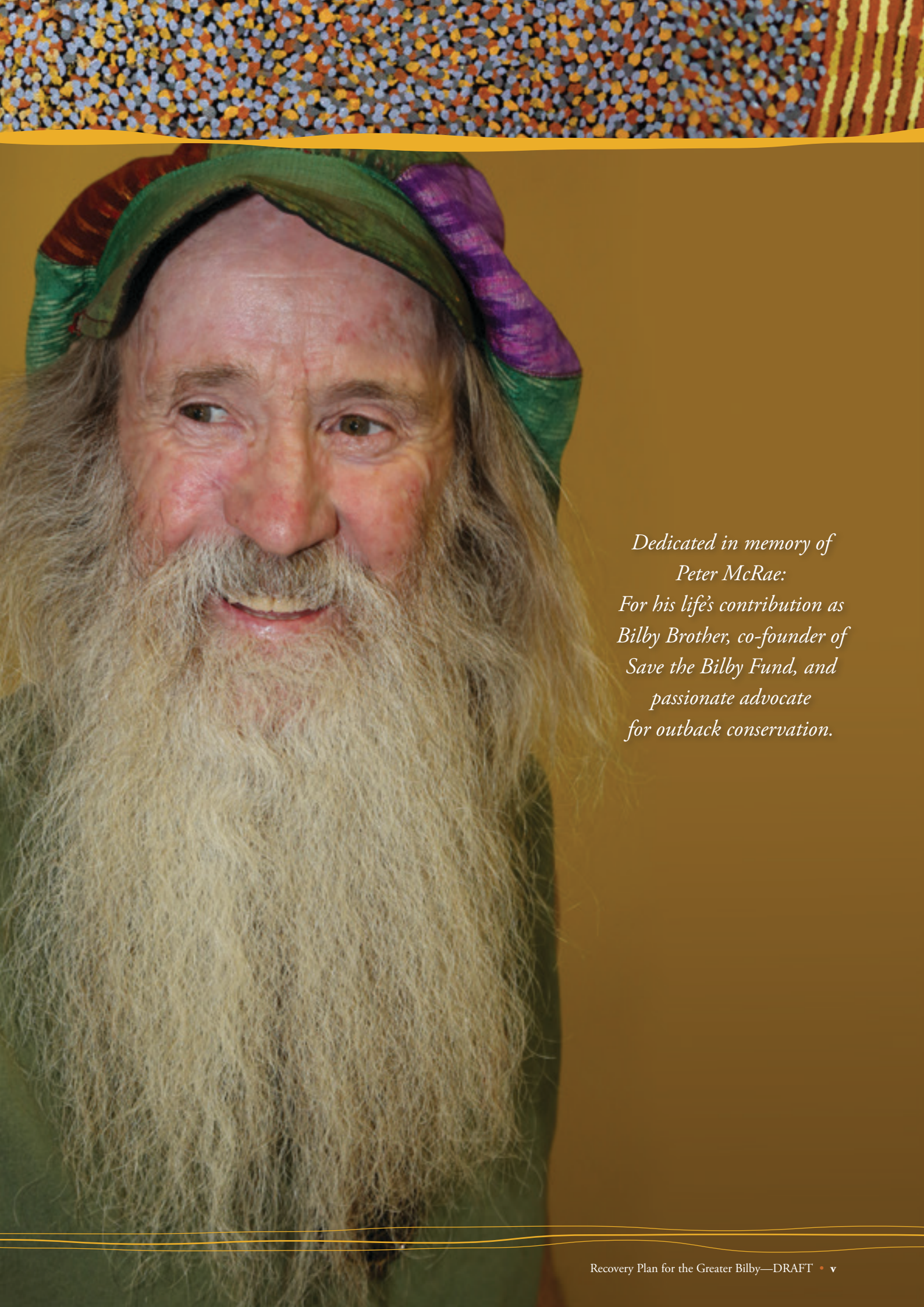
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Photo: Bilby tracks—roadside tracks at Birdsville. © Save the Bilby Fund Kevin Bradley 2018



*Dedicated in memory of
Peter McRae:*

*For his life's contribution as
Bilby Brother, co-founder of
Save the Bilby Fund, and
passionate advocate
for outback conservation.*

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Due to the vast number of individual contributors who have provided inputs to this plan representing the interests of a diverse range of stakeholder groups including Traditional Custodians, land managers, land owners, NGOs, and government agencies, to list them would be impractical and risk missing someone unintentionally.

We extend our sincerest thanks to each and every individual and organisation that has contributed, and invested effort to support the recovery of this iconic and culturally significant marsupial to remain in the Australian landscape for future generations.

Acronyms

AR	Arid Recovery
AWC	Australian Wildlife Conservancy
BHA	Bush Heritage Australia
CPSG	Conservation Planning Specialist Group (International Union for the Conservation of Nature)
CLC	Central Land Council
DAFF	Department of Agriculture, Forestry and Fisheries (Queensland)
DBCA	Department of Biodiversity, Conservation and Attractions (Western Australia)
DoEE	Department of the Environment and Energy (Australian Government)
EHP	Department of Environment and Heritage Protection (Queensland)
DENR	Department of Environment and Natural Resources (Northern Territory)
DEW	Department for Environment and Water (South Australia)
NPSR	Department of National Parks, Sport and Racing (Queensland)
KLC	Kimberley Land Council
NPWS	National Parks and Wildlife Service, New South Wales
NLC	Northern Land Council
WWF	World Wide Fund for Nature
SCA	State Conservation Area
STBF	Save the Bilby Fund
ZAA	Zoo and Aquarium Association

1. Summary

This document constitutes the national Draft Recovery Plan for the Greater Bilby (*Macrotis lagotis*), made under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The plan aims to halt decline and support recovery of the Greater Bilby and provides for the research and management actions necessary to maximise the Greater Bilby's chances of long-term survival in nature.

The objectives of this plan are that by 2029:

- the size of the Greater Bilby population has grown
- the area occupied by the Greater Bilby has been maintained or increased
- the genetic diversity of the Greater Bilby has been maintained, and retains the potential for evolutionary change through adaptation and selection
- Aboriginal people have a greater role in bilby conservation.

The plan includes on-ground actions for; introduced predator and introduced species management to promote bilby population growth, habitat management to maintain, or preferably, improve habitat condition, and to manage the Greater Bilby as a single, interconnected meta-population to maintain genetic variability and provide insurance against loss. These activities are planned to occur within a monitoring framework that measures the impact of management.

The plan includes supporting actions to promote the role of Aboriginal people and land managers in bilby conservation, provide governance and coordination, establish and maintain monitoring and survey, and undertake research to inform management.



Photo: Greater Bilby (*Macrotis lagotis*). © Copyright Wells, Babs & Bert (CALM) and the Department of the Environment and Energy



2. Introduction

The Greater Bilby, *Macrotis lagotis* (Reid, 1837), is the only remaining member of the Genus *Macrotis* and sole extant representative of the Family Thylacomyidae (Jackson and Groves, 2015) and will be hereafter referred to as ‘the Greater Bilby’ when referring to the species, or as bilbies or bilby when referring to individual animals. The Greater Bilby is of high spiritual importance to Aboriginal people across its present and former its range. This plan acknowledges this importance and the significant role Aboriginal people play in the conservation of the Greater Bilby.

The Greater Bilby once occupied more than three quarters of Australia - almost all the drier areas. By 2019 the range of the Greater Bilby had been reduced by more than 80 per cent and naturally wild bilbies are now only found in the Northern Territory (NT), central and north-eastern Western Australia (WA), and in small isolated populations in Queensland (Qld). Bilbies have been reintroduced to islands and enclosures, and are managed in zoos and wildlife parks.

More than 70 per cent of the distribution of naturally-occurring wild bilbies is found on Aboriginal lands managed by Aboriginal people, including Traditional Owners and Indigenous Rangers. Training and employment opportunities for Aboriginal people, improved access to traditional lands, and maintenance of culture and traditional ecological knowledge are critical for bilby conservation.

Predation by and competition from introduced species, habitat loss and degradation, population reduction and fragmentation, and changed fire regimes, all continue to threaten the Greater Bilby’s long-term chances of survival in nature.

An adaptable and flexible management approach is required to deal with the interdependence and variability of threats across the species’ range and the uncertainty about the effectiveness of individual management actions. The potential for incremental loss of traditional ecological knowledge and management in these sparsely populated, harsh and isolated locations, places emphasis on the need to support local communities to implement and coordinate actions locally, whilst exchanging knowledge at regional and national scales.

The objectives of this plan are that by 2029:

- the size of the Greater Bilby population has grown
- the area occupied by the Greater Bilby has been maintained or increased
- the genetic diversity of the Greater Bilby has been maintained, and retains the potential for evolutionary change through adaption and selection
- Aboriginal people have a greater role in bilby conservation.

To achieve these objectives, this plan identifies both on-ground and supporting strategies, with both the research and management actions believed to be necessary to maximise the Greater Bilby’s long-term chances of survival in nature.

The on-ground strategies include predator and introduced species management to promote bilby population growth, habitat management to maintain, or preferably, improve habitat condition, and to manage the Greater Bilby as a single, interconnected meta-population to maintain genetic variability and provide insurance against loss. These activities are to occur within a monitoring framework that measures the impact of management.



Photo: Napurula with bilby—Sally Napurula Butler with a bilby at the Alice Springs Desert Park, 2016, © Kiwirrkura IPA

The supporting strategies focus on supporting Aboriginal groups and land managers, improving governance and coordination, improving monitoring and survey methods, and undertaking research to inform management.

This recovery plan is based on two key documents:

- the *‘Greater Bilby recovery summit 2015 report and interim conservation management plan’* prepared by the Save the Bilby Fund and the Conservation Breeding Specialist Group of the IUCN. This report was a product of a four-day workshop in 2015, consisting of thirty-nine experts representing twenty-nine organisations involved in recovery of the Greater Bilby. This workshop reviewed the conservation activities that had been undertaken since the publication of the Recovery Plan for the Greater Bilby 2006–2011 (Pavey 2006).
- *‘What did we learn from the 2016 Ninu Festival?’* prepared by Rachel Paltridge. This report was informed by a three-day workshop in 2016, of 125 Indigenous Rangers from 10 Indigenous land management organisations and 22 other experts representing 18 partner organisations. A second complementary report, *‘Bilby is part of this country and for everybody, cultural report about bilbies and the Ninu Festival, Kiwirrkura, 2016’* was produced by Fiona Walsh and Custodians of the Greater Bilby and focused on more of the cultural aspects of the Ninu Festival and explored the significance of bilbies to Traditional Owners.



3. Background

3.1 Purpose

A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) aims to halt the decline and to support the recovery of species listed as threatened so that its chances of long-term survival in nature are maximised.

3.2 Cultural significance

The number of Indigenous names for the Greater Bilby highlights its importance for Aboriginal people across Australia. The name Bilby is derived from the Ullaroi language name – Bilba (Paltridge 2016). There are at least another twenty names used across Australia. Having a name for an animal indicates that Aboriginal people recognise it as distinct and means they have an understanding of its ecology, undertake management for the species, and incorporate it into their cultural stories, beliefs, and law. This knowledge, and a strong connection to the species, continues for Aboriginal people, even in areas where bilbies are now locally extinct.

In 2016 the Kiwirrkurra Community (WA), on behalf of the Indigenous Desert Alliance, hosted a Ninu (bilby) Festival, recognising the importance of the knowledge and support from Indigenous Rangers and Traditional Owners across the Greater Bilby's range. The Ninu festival harnessed traditional and contemporary knowledge about the Greater Bilby and processes which threaten it to produce a framework for effective and collaborative management of wild bilby populations across Australia (Paltridge 2016).

This recovery plan contains many on-ground actions for implementation in Indigenous Protected Areas and other Aboriginal-managed lands. In order to maximise their effectiveness, this plan embraces the themes of:

- keeping the cultural knowledge of the Greater Bilby alive and strong
- increasing community awareness of the Greater Bilby – locally and more broadly
- strengthening and expanding Indigenous Ranger support and activities
- increasing management efforts
- mapping and monitoring bilbies, threats, and management effectiveness

Ninu helps to connect people. Across Aboriginal Australia, people connect through family, language, country and Dreamings. 'Relatedness' is a central and valued concept amongst Aboriginal groups. This relatedness includes people's relationships to each other, to animals and their songlines (Walsh 2016).

Tjukurpa has many deep, complex meanings. Tjukurpa refers to the creation period when indigenous ancestral beings created the world. Tjukurpa tells of the relationships between people, plants, animals and the physical features of the land. It is the past, present and future – all at the same time. Through the Tjukurpa, bilbies of one place are related by Tjukurpa to bilbies in another place and another place and so on along lines that cross the country. So custodians in one place can make connections to custodians in other places. They do this through their responsibilities to look after the sites, songs and stories for the animals. Sharing these animals and their stories helps to connect people over thousands of kilometres (Walsh 2016).

3.3 Conservation status

The Greater Bilby is listed as vulnerable under the EPBC Act. The main factors that are the cause of the species being eligible for listing in the vulnerable category are that it is patchily distributed and has a small area of occupancy (reduced to 20 per cent of its former range (Southgate 1990)); the population size is estimated to be fewer than 10,000 mature individuals and it is undergoing continual decline (Woinarski et al. 2014).

Table 1: International, national and state conservation status of the Greater Bilby

Legislation	Conservation Status
<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	vulnerable
<i>Biodiversity Act 2016 (New South Wales)</i>	extinct
<i>Nature Conservation Act 1992 (Queensland)</i>	endangered
<i>National Parks and Wildlife Act 1972 (South Australia)</i>	Vulnerable
<i>Territory Parks and Wildlife Conservation Act 2006 (Northern Territory)</i>	threatened
<i>Wildlife Conservation Act 1950 (Western Australia)</i>	vulnerable
<i>IUCN Red List of Threatened Species (2013)</i>	Endangered

3.4 The Greater Bilby Recovery Team

Recovery teams provide advice and assistance in coordinating actions described in recovery plans. They include representatives from organisations with a direct interest in the recovery of the species, including those involved in funding and those participating in actions that support the recovery of the species. Members are committed to the conservation of the species and the achievement of recovery objectives and implementation of recovery strategies.

The Greater Bilby Recovery Team (GBRT) has the responsibility of providing advice and coordinating the implementation of the recovery actions outlined in this recovery plan. The membership of this recovery team and associated subcommittees draws from a wide variety of individuals and organisations relevant to the conservation of the Greater Bilby, such as: the Department of the Environment and Energy (DoEE), the Department of Biodiversity Conservation and Attractions (WA) (DBCA), the Department for Environment and Water (SA) (DEW), the Department of Environment and Science (Qld) (DES), the Office of Environment and Heritage (NSW) (OEH), The Department of Environment and Natural Resources (NT) (DENR), Save the Bilby Fund (STBF), Indigenous Rangers, Northern Land Council (NLC), Central Land Council (CLC), Kimberly Land Council (KLC) Desert Wildlife Services (DWS), Rangelands NRM, South West NRM, Territory NRM, Australian Wildlife Conservancy (AWC), Bush Heritage Australia (BHA), independent researchers, community groups and landholders. Membership of the recovery team changes over time to reflect its changing role and tasks as conservation progresses.



3.5 Species description and ecology

The Greater Bilby is endemic to Australia and is an iconic species to many Australians. With the extinction of the Lesser Bilby (*Macrotis leucura*) in the 1960s, it is the only surviving member of the family Thylacomyidae (Jackson and Groves 2015).

The Greater Bilby is a medium-sized burrowing marsupial with long, soft, blue-grey fur over most of the body but white to cream fur on its underside. It has large ears, a long pointed snout with slit like nostrils and a mostly black tail with a white tip. The forelimbs have three stoutly clawed toes that enable bilbies to burrow effectively, and two un-clawed toes. The hind limbs are slender and each has four toes.

Male bilbies can grow to 550 mm long, with a tail up to 290 mm, and can reach a weight of 2500 g. Females are smaller and can grow to 390 mm with a tail of 278 mm and can reach a weight of 1100 g (Johnson 2008). Breeding varies depending on seasonal conditions and food availability, with litters mostly of one or two, but sometimes three (McCracken 1990). Pouch life is about 75–80 days, with females tending their young in a burrow for another two weeks (Woinarski et al. 2014). Bilbies can live up to 11 years in captivity, however, in the wild, most animals are unlikely to survive that long (Southgate et al. 2005). Females start breeding at five months and males at eight months. Generation time is assumed to be four years (Woinarski et al. 2014).

Bilbies are omnivores that primarily dig for food creating holes often approximately 250 mm in depth, but sometimes more than one metre in depth. Diet consists of invertebrates such as butterfly and moth larvae, termites, ants, grasshoppers, spiders and beetles, and other items such as seeds, bulbs, and fungi (Burbidge et al. 1988; Gibson 2001; Southgate and Carthew 2006). Some of the key food resources (including food plants) are promoted by fire (Southgate 1990b, Southgate and Carthew 2006, Southgate and Carthew 2007; Southgate et al. 2007). They dig to access termite mounds, expose bulbs, and expose the roots of wattle and other shrubs that have root-dwelling invertebrate larvae (Pavey 2006). *Senna notabilis* (Cockroach bush), and a wide variety of wattle species (including *Acacia doreta* (a curly-barked or minni richi tree) are sources of witchetty grubs (moth and beetle larvae) favoured by bilbies (Paltridge 2016).

Bilbies are highly mobile and can have large foraging ranges. Adult females have been known to move up to 1.5 km between burrows on consecutive days; while adult males regularly move 2–3 km and up to 5 km between burrows on consecutive days. Movements of these distances are far greater than other medium-sized mammals, like bandicoots, indicating that bilbies are well adapted to the variability of resources in the arid regions (Southgate et al. 2007).

Males range more widely than females from their home burrows and home ranges can vary considerably in size in different locations. Bilbies have been recorded using up to 18 burrows concurrently over several months, and construct a new burrow on average every two and a half weeks (Moseby and O'Donnell 2003). The mean female home range at Arid Recovery was 0.18 km² and the mean male home range was 3.16 km² (Moseby and O'Donnell 2003). There are many active and disused burrows within the home range. The nightly home range movements of the bilby generally total less than 4 km (Southgate et al. 2007). The home ranges of movements of bilbies in other areas such as the Kimberley and Queensland is not known.

Bilby burrows appear to be important refuges for a range of other fauna (Read et al. 2008; Hofstede and Dziminski 2017).



Photo: Greater Bilby © Dept of Environment and Heritage – Qld.

3.6 Distribution

Before European settlement, bilbies occurred over 70 per cent of the Australian mainland. Since the late 1800s, bilbies have disappeared from at least 80 per cent of their former range (Southgate 1990).

The majority of remnant, naturally occurring populations of bilbies occur on Aboriginal lands managed for a variety of purposes (Bradley et al. 2015). Due to threatening processes, the range of the Greater Bilby has contracted northwards and this contraction is continuing. Wild populations are restricted predominantly to current distribution in Figure 1 or identified as sites in this plan (Johnson 2008, Greater Bilby Recovery Team pers comm 2015).

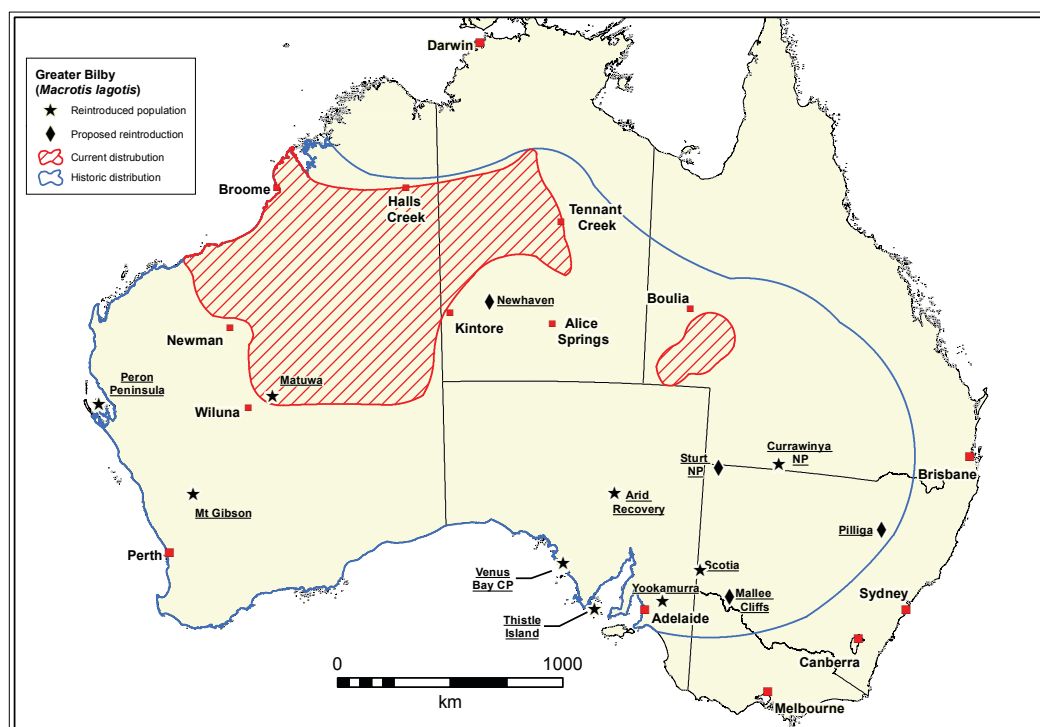


Figure 1: Distribution of the Greater Bilby (*Macrotis lagotis*). Historic distribution has been adapted from Southgate (1990a)

The estimated current distribution of bilbies was developed using information from mapping undertaken by Indigenous Rangers at the Ninu Festival in 2016, database records, and expert opinion elicited at the 2015 Bilby Summit. Future mapping of bilby distribution, particularly in the NT and WA, will incorporate Indigenous knowledge arising from on-ground management and monitoring works and records from other sources.

3.7 Reintroduced populations

Bilbies have been reintroduced at Matuwa (WA) into a 250,000 hectare intensively managed area. This area has been collaboratively managed by DBCA and Martu rangers for fire, for feral cats (annual Eradicat baiting and trapping since 2004) and has been fenced to exclude domestic stock and camels (since 2000). Between 2007 and 2009, 128 bilbies were reintroduced and have since expanded throughout most of the 250,000 hectare managed area and have also colonised adjacent areas outside this managed area.



3.8 Fenced wild populations

Bilbies have been reintroduced to a number of introduced predator-free ‘safe havens’ (islands and large fenced enclosures) across their former range. These populations are free-ranging and protected from introduced predators but generally are otherwise exposed to a range of natural selection pressures. Bilbies were reintroduced to Thistle Island (39 km²) in South Australia (SA) in 1998, and reintroduced to five fenced mainland islands: Arid Recovery Reserve near Roxby Downs (SA), Peron Peninsula near Shark Bay (WA), Dryandra Woodland near Narrogin (WA) (now extinct), Scotia Sanctuary in western New South Wales (NSW) and Yookamurra Sanctuary, SA (Woinarski et al. 2014). Between 2005 and 2010, and again in 2018 bilbies were released into the bilby enclosure at Currawinya National Park, Qld, and Mt Gibson Sanctuary, WA in 2016.

The combined population size of reintroduced populations is estimated at 2500 individuals (Greater Bilby Recovery Team, 2018). These reintroductions are important for a number of other reasons: they help restore ecological processes, such as soil-turnover, in which the bilby participates (e.g. James et al. 2009); they ensure the bilby genome is exposed to selection pressures from a suite of environments across its former range (e.g. Weeks et al. 2015); and they are important culturally, both for Aboriginal people within the former range of the Greater Bilby, for whom the species retains cultural importance, and for the broader Australian public, for whom the Greater Bilby is an iconic native species (e.g. Save the Bilby Fund).

At the time of writing this plan, in addition to re-releasing bilbies at Currawinya National Park there were proposals to reintroduce bilbies to additional fenced areas including Newhaven, NT, the Pilliga State Conservation Area (NSW), Mallee Cliffs National Park (NSW) and Sturt National Park (NSW). The long-term objective at many of these locations is reintroduction ‘outside the fence’, provided threatening processes (in particular, introduced predators) can be sufficiently reduced, and provided that antipredator behaviours can be maintained in fenced wild populations (Jolly et al. 2018).

Bilbies are also held for captive breeding in a number of enclosures and zoos. These populations are provided with supplementary food and often managed as individuals, rather than as independent populations. Monarto Zoo (SA) and Dreamworld (Qld) coordinate bilby captive breeding under the guidance of the Zoo and Aquarium Association, which sets standards and practices for bilby husbandry, biosecurity, and breeding.

3.9 Important populations and populations under particular pressure

The former distribution of the Greater Bilby was more or less continuous across its former range (Abbott 2001, Woinarski et al. 2014), and molecular DNA analysis does not show strong genetic structure indicating that there is a single ‘evolutionary significant unit’ (Moritz et al. 1997). The Greater Bilby is considered a single population even though fragmentation and isolation may have resulted in local adaptation. Managing the Greater Bilby as a single genetic unit is likely to maximise conservation outcomes for the Greater Bilby (Bradley et al. 2015). The Greater Bilby largely now occurs as small groups which are fragments of the former near continuous distribution. Each of these groups is important and under pressure.

As the bilby is intended to be managed as a meta-population, the local cultural significance of each occurrence, and the lack of information of population structure, the concept of ‘important populations’ (where one occurrence of the Greater Bilby is deemed to be of more value than another) is not relevant to the conservation of the Greater Bilby.

A meta-population is a group of populations that are separated by space but consist of the same species. These spatially separated populations interact as individual members move from one population to another.

3.10 Habitat

Historically, bilbies used a wide range of climatic zones, soil, vegetation types, and land forms across much of Australia. Vegetation types used by bilbies included eucalypt open forest and woodland in south-western Western Australia, the South Western Slopes bioregion and the Southern Tablelands of NSW (M Fleming pers. comm.) and around Adelaide, SA; tall shrublands and open woodlands in semi-arid regions; and hummock grasslands across arid Australia (Abbott 2001; Pavey 2006; Southgate 1990b). The habitats used by the remaining wild bilbies vary between both sites and regions in which bilbies persist, so there is no simple universal description of habitat. They now occupy a range of habitats including: open tussock grassland on uplands and hills; *Acacia aneura* (mulga) woodland/shrubland growing on ridges and rises; and hummock grassland in plains and alluvial areas (Woinarski et al. 2014).



Photo: Bilby Diggings and habitat at Diamantina National Park, Qld © Simon Nally 2018

Habitats in the central desert area include salt lake margins (especially those supporting *Cyperus bulbosus* (Bush onion), areas with laterite (concreted, iron-rich rock layers), areas of rock features, and sandplains dominated by spinifex or mulga (Paltridge 2016). In the Tanami Desert, Bilby occurrence is strongly associated with substrate type (less abundant on dune and sand substrates than on laterite/rock features or drainage/calcrete substrates), mean annual rainfall, and the presence of *Canus lupis dingo* (the dingo) (Paltridge 2016, Southgate et al. 2007).

These habitats support shrub species such as *Acacia kempeana*, *A. hilliana* and *A. rhodophylla*, which have root-dwelling larvae (Latz 1995, cited in Southgate et al. 2007) that provide a relatively reliable food source for bilbies. They also contain patchy spinifex (*Triodia* spp) hummocks that provide runways between hummocks, enabling easier movement and foraging (Southgate et al. 2007).

In the northern part of its range, bilbies persist in areas of habitat that have higher levels of plant and therefore food production. Habitat types in these areas comprise closed coastal tussock grasslands and *Acacia bivenosa* shrublands, *Acacia* dominated woodland, shrubland and thickets on pindan sandplain, comprising species such as *A. eriopoda*, *A. monticola*, *A. stellaticeps* and *A. tumida*. Bilbies may also have persisted in the most northern parts of these areas because of fewer foxes (*Vulpes vulpes*) (Southgate et al. 2007). Bilby distribution is limited by the availability of soils suitable for burrowing, such as sandy areas, where burrow excavation is easier (Moseby and O'Donnell 2003).

Across the Greater Bilby's range, fire is likely to be affecting the suitability of habitat by influencing the type and availability of food resources, the visibility of bilbies to predators, and shelter from predators. In parts of the Tanami Desert, the occurrence of the Greater Bilby is associated with close proximity to recently burnt (< 1 year) habitat (Southgate et al. 2007). A post-fire ephemeral grass, *Yakirra (Panicum) australiense*, is an important part of the Greater Bilby's diet in spinifex habitats (Southgate and Carthew 2006).

3.11 Habitat critical to survival

As noted above, the habitat, or biophysical environment, of the Greater Bilby varies across its range, so it is not possible to generate one description or definition of habitat critical to survival. The habitat critical to the survival of the Greater Bilby may be more usefully defined at a bioregional scale that takes into account the combination of plants, animals, geology, landforms, and climate that is relevant to a geographical unit. However, any categorisation of habitat critical to survival must acknowledge that it exists as a continuum, with carrying capacity fluctuating with seasonal or episodic food availability and effects of threats. A set of comprehensive habitat descriptions to define habitat critical to survival was unavailable at the time of drafting this plan.

As an interim guide, habitat critical to the survival of the Greater Bilby can be considered to include:

- any area where the species is known or likely to occur as shown on the Distribution Map on the Greater Bilby SPRAT Profile found at https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=282. Figure 2 is indicative of these areas at the time of publication, but should not be relied upon.
- any location outside the above area where bilbies are found to occur
- any area, between the areas noted above, that may be periodically occupied by bilbies
- any area which bilbies may naturally colonise or may feasibly be reintroduced.

Habitat critical to the survival of the species occurs in a wide range of tenures and land ownership arrangements, including on Aboriginal owned or managed land, private land and leaseholds, travelling stock routes, unallocated crown land, national parks and nature conservation reserves, and other lands managed for conservation.

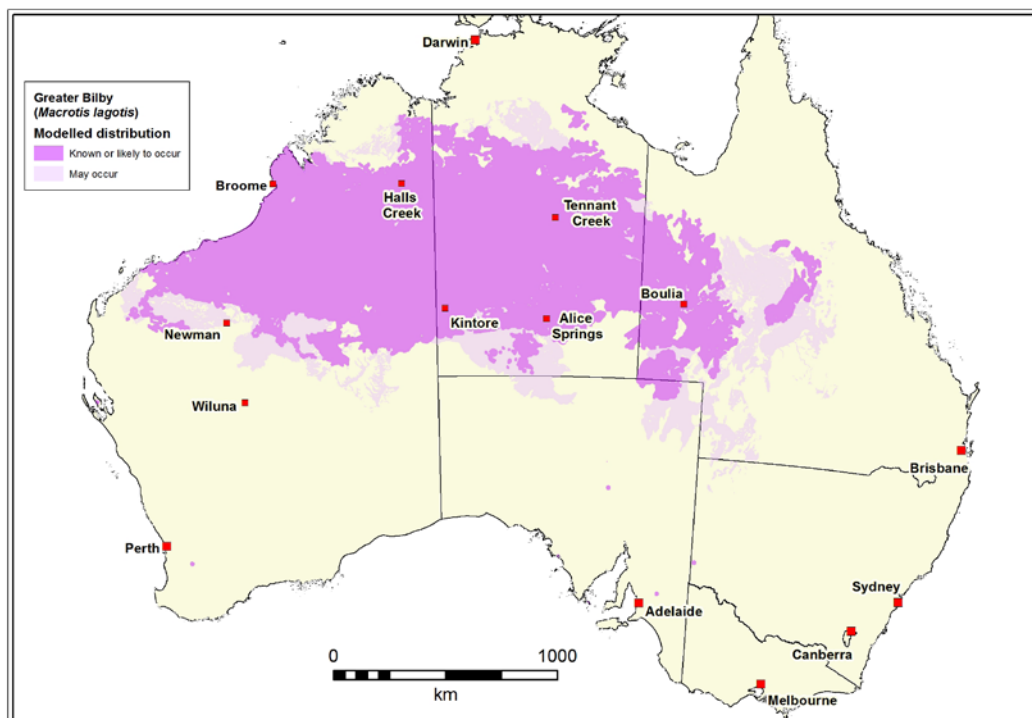


Figure 2: The modelled distribution of the Greater Bilby (*Macrotis lagotis*). The distribution shown is generalised from the Department's *Species of National Environmental Significance* dataset. This is an indicative map of the present distribution at time of publication and is currently under review.

4. Recovery objectives

The ‘*Greater Bilby recovery summit 2015 report and interim conservation management plan*’ (the interim plan) (Bradley et al 2015) included the following vision:

VISION

‘In 2040, the Greater Bilby and its cultural and spiritual significance to Traditional Owners is valued and embraced by all Australians and by the global community. Together we engage through effective partnerships providing legislative, management and stewardship frameworks that support a secure, viable and self-sustaining population of bilbies in the wild, across an extended range.’

This vision, and the goals and outcomes of the interim plan and the findings of the 2016 Ninu Festival (Paltridge 2016) have been used to frame the objectives, strategies and actions in this recovery plan. The objectives and actions included in this plan also represent a continuation and extension of the conservation framework laid out in the preceding recovery plan (Pavey 2006).

More than 70 per cent of the distribution of naturally-occurring wild bilbies are found on Aboriginal-managed lands. Training and employment opportunities for Aboriginal people, access to traditional lands, and maintenance of culture and ecological knowledge are critical for the conservation of wild bilby populations.

Objectives and performance criteria

The EPBC Act requires a recovery plan to provide for the research and management actions necessary to stop the decline and support the recovery of the Greater Bilby so that its chances of long-term survival in nature are maximised. The chances of long-term survival in nature are affected by:


- the levels of mortality; longevity, and rate of reproduction
- the extent and quality of habitat, and
- the size of and connectivity between populations.

These factors affect (both negatively and positively) the Greater Bilby’s ability to be resilient to stochastic events and threatening processes.



Photo: Birdsville Bilby survey site sand dune. © Save the Bilby Fund Kevin Bradley 2018

This plan is designed to operate for ten years. The ecological priorities within this period are to increase the population size and extent, prevent local extinction, and to maintain genetic diversity. The social priority is to increase the involvement of Aboriginal people in bilby conservation.



The objectives describe the state of the species and the level of involvement of Aboriginal people in 2029.

Objective 1: The size of the Greater Bilby population has grown

Performance criterion 1: In 2029, indices of abundance at a sample of sites show growth compared to 2019. The sample sites are to be identified by the recovery team within 12 months.

Objective 2: The area occupied by the Greater Bilby has been maintained or increased

Performance criterion 2(a): In 2029, the bilby continues to occupy key sites that were occupied in 2019. These sites include Sangsters Bore (NT), Matuwa (WA), Warburton (WA), Kiwirrkurra (WA), Astrebla Downs (Qld), and any other site identified by the recovery team.

Performance criterion 2(b): In 2029, the distribution of the Greater Bilby has been maintained or increased since 2019. To be calculated using extent of occurrence methods based on presence-only data.

Objective 3: The genetic diversity of the Greater Bilby has been maintained and retains the potential for evolutionary change through adaption and selection

Performance criterion 3: In 2029, genetic diversity is estimated to be equivalent to that present in 2019. The measure is to be defined by the meta-population management plan.

Objective 4: Aboriginal organisations, communities, and individuals have a greater role in bilby conservation.

Performance criterion 4: In 2029, there has been an increase in the number and locations of Aboriginal people who are actively engaged in bilby recovery, from leadership and agenda setting to on-ground works.

Performance criterion 1 focuses on reversing the suspected recent trend of decline, by showing growth. This also increases the Greater Bilby population, so that it becomes larger and therefore more resilient.

Performance criteria 2(a) and 2(b) focus on halting the existing trend of progressive local extinction from south to north, and the incremental reduction in the extent of habitat occupied, both of which reduces resilience and increases the chances of extinction.

Performance criterion 3 focuses on maintaining the evolutionary potential and resilience of the Greater Bilby population.

Performance criterion 4 acknowledges the critical role of Aboriginal people and their land in the conservation of the Greater Bilby at many locations.



Photo: Bilby Diggings and habitat at Diamantina National Park, Qld © Simon Nally 2018



Photo: Bilby Diggings and habitat at Astrebla Downs National Park, Qld © Simon Nally 2018



5. Threats

The known and potential threats that affect the achievement of the recovery objectives are listed below. Threat prevalence and intensity vary across the range of the Greater Bilby. Members of the Greater Bilby Recovery Team (pers comm 2015) have identified some of these variations:

- In the absence of traditional burning practices, fires in the Kimberley occur as frequent summer or late dry season wildfires, compared to the Pilbara and deserts of WA and NT where episodic summer wildfires risk burning extensive areas of habitat, and both represent threats. Fire size, frequency, intensity, and extent varies according to climate and biogeography, and these parameters affect predation rates.
- Highest risk of predation occurs where foxes are well established in the landscape, regardless of feral cat (*Felis catus*) presence. In areas where foxes are not well established, predation by cats remains a significant risk. The effect of introduced species varies with historical and current land-use, water availability, climate, and biogeography.
- The risk of habitat loss or fragmentation from activities such as agriculture or mining related land use, varies with development pressure, land use, weed and pest species, geology, biogeography, and climate.

There is significant interaction between threats. For example, fire reduces the height and size of vegetation allowing predators to more easily see and catch bilbies. Extensive fires may not leave sufficient cover for bilbies to shelter from predators.

This plan includes governance and monitoring actions that aim to minimise inappropriate management actions. A consideration of any possible perverse outcomes from management actions is outside the scope of this plan, but may be considered by the recovery team, governments and land managers when planning actions.

5.1 Predation by foxes, cats, and wild dogs

Foxes have had the single largest negative effect on the conservation of the Greater Bilby (Abbott 2001). Fox predation is a major cause of mammal extinction and decline in Australia (Kinnear et al. 2002), and the presence of foxes is negatively correlated with the presence of bilbies (Southgate 1990). Foxes are more common in the southern part of the Greater Bilby's range, and so may exert more predation pressure than in the northern part of the species' range. An abundance of rabbits leads to elevated predator densities, and rabbits are largely restricted to the southern part of the Greater Bilby's current distribution (Cox et al. 2013).

It is likely that the range of the fox continues to expand and adversely affect the range of the Greater Bilby. Foxes are expanding north and west in the NT and WA, and surveys indicate that the range of the Greater Bilby has contracted from the south in the NT over the same period (Paltridge pers comm. 2016).

Cat predation is another major factor associated with the decline of bilbies. With less than 200 years evolutionary exposure to cats, bilbies do not seem to have developed innate antipredator behaviours in response to the threat of cat predation (Steindler et al 2018). The range of the cat overlaps with that of the current range of the Greater Bilby and has done for some time, so it is unlikely that the cats alone are responsible for the decline of the Greater Bilby across its range (Southgate 1990a). However, it is assumed that cat predation is occurring at most locations.



At some locations and following particular seasonal conditions, cats can significantly limit, and at times, eliminate, local bilby populations. Predation by cats has been recorded at Dryandra, Arid Recovery, Matuwa (Lorna Glen) (K. Morris pers. comm., cited in Woinarski et al. 2014), Venus Bay and in the Tanami Desert (Tennant Creek and Kintore) (Paltridge 2002). Predation by cats can be severe in Qld (Woinarski et al. 2014). Cats have led to the failure of bilby reintroductions outside fenced enclosures (Moseby et al. 2011) and within the enclosure at Currawinya (Qld) when the perimeter fence deteriorated and cats entered the enclosure. Accordingly it is assumed that cat predation is likely at most locations, and may be the primary impediment to reintroduction at many sites.

Dingo and bilby distributions have overlapped for thousands of years. Dingoes are also known to take the bilby as prey, but have not been substantially linked with the decline of the species (Southgate 1990a; Southgate et al. 2007). In contrast to their response to the threat of cat predation, bilbies show an innate antipredator response to the threat of dingo predation (Steindler et al. 2018) - noting that this may be lost without continued exposure to predators (Jolly et al. 2018). Bilbies and dingoes occur in similar environmental conditions, and the presence of dingoes may in fact improve habitat suitability for bilbies by preying upon or displacing more effective predators such as the foxes and cats. The dingo is known as an important predator of cats and can possibly displace foxes (Southgate et al. 2007). In arid areas dingoes have been found to have positive effects on small mammals and negative effects on foxes (Letnic et al. 2009b, cited in Letnic et al. 2012). Dingoes appear to suppress cat numbers in northern Australia (Kennedy et al. 2011). However, correlations between dingo and cat activity in the arid zone are less clear.

In western Queensland wild dogs (dingoes, domestic dogs that have become feral, and hybrids) have been recorded as a consistent predator of bilbies. In 2013, of 32 dogs shot, 12 had identifiable bilby remains in their stomach. This was during a boom-bust cat plague that followed a rat plague, and the numbers of wild dogs had also significantly increased, and were believed to present a significant additional predation pressure on bilby populations. Analysis of 150 dog scats collected from Astrebla Downs National Park in 2018 showed that 70 per cent had recently eaten bilby.

Stocking rates of domestic herbivores (cattle, sheep, and goats) rely on water availability. Increased water availability (usually more water points) can promote the wider spread and elevated densities of introduced predators. There are anecdotal reports of fox expansion associated with increases in water points, for example, in the Pilbara (NatureMap, 2016).

5.2 Habitat loss and fragmentation

Land clearing leads to loss of habitat, degradation of surrounding habitat, increased predation and fragmentation effects (Bradley et al. 2015).

Roads, fences, dams, mines and associated camps, pipelines and other industrial structures, agriculture, and settlement may threaten bilbies through vegetation clearance, increased risk of road kill, creating barriers to dispersal and gene flow, and elevated predator densities resulting from increases in food and water resources (Bradley et al. 2015). The development of large scale pivot irrigation agriculture in the Pilbara and Kimberley may contribute to these effects.

The construction of and upgrading of roads in areas where road access has previously been limited is likely to increase the threat of mortality or injury of bilbies on roads. There are areas in the north Pilbara and Kimberly where numerous road mortalities of bilbies have been reported over the last decade, with medium to longer term impacts on local populations unknown.

Buffel grass and couch grass have both been recorded in bilby habitat, and the former is expected to present a significant threat to habitat by changing fire intensity and regimes, and by competing with bilby food plants. Other, unspecified weeds have also been reported from Bilby sites in WA and the NT.



5.3 Domestic and other introduced species

Bilby distribution is associated with an absence or low density of rabbits and low domestic herbivore stocking rates (Southgate 1990a; Woinarski et al. 2014). Introduced herbivores remove vegetation cover and cause soil compaction and loss, effects that are greater closer to water points. Herbivores also congregate along drainage lines, which are often prime bilby habitat in the Pilbara and Tanami (Bradley et al. 2015). Rabbits and bilbies share important food plants, such as bush onion (*Cyperus bulbosus*), and rabbits support higher densities of cats and foxes. It is also assumed that rabbits take over and exclude bilbies from burrows (Paltridge 2016).

At NT and WA locations, trampling and herbivory from donkeys, horses, and camels is assumed to be degrading habitat. While there is no published information on the adverse impacts caused by these species on the Greater Bilby, the earliest decline of the Greater Bilby in Qld occurred in the more intensively grazed landscapes. Cattle trampling also affects bilby burrows, sometimes causing their collapse (K Bradley pers comm. 2016). Trampling and grazing is particularly damaging in areas where vegetation is regenerating in the first year after fire and there is naturally low vegetation cover and fragile soils.

Domestic cattle stocking rates have increased in recent decades, with more watering points and different cattle breeds more suitable to this area introduced. Between 2009–10 and 2011–12 cattle stocking rates on farms producing beef in northern Australia were the highest in 20 years (Thompson and Martin 2014). The expansion of agriculture and cattle grazing within the Kimberly, where there is a trend for clearing of land for irrigated agriculture and irrigated cattle fodder production, is likely to affect bilbies.


As the cane toad (*Rhinella marina*) progressively invades the Kimberley from the east, it may invade some areas used by bilbies. If this occurs, there is the potential that bilbies will consume toadlets and/or toads. Although not identified as a specific threat, actions are included to detect and monitor adverse effects from the presence of the cane toad.

5.4 Unmanaged fire

The relationship between the Greater Bilby and fire is complex, and the prevailing fire regime of an area can determine its suitability as habitat for bilbies.

Large hot fires remove vegetation cover from significant areas, and frequent fires may prevent the vegetation from re-establishing its former structure. This increases predation pressure on bilbies as predators focus effort on burnt areas that have less protective cover (McGregor et al 2014) and are more effective in the resultant simpler habitats (McGregor et al 2015, Leahy et al. 2016). Regrowth in these intensively burnt areas can become increasingly impenetrable and unsuitable for medium-sized species like the Greater Bilby (Southgate pers comm. 2016). Intensive fires may also reduce the availability of some bilby food resources, such as shrubs that harbour root-dwelling larvae (Southgate pers comm. 2016).

Fire can promote the growth of bilby food plants and can influence vegetation density by making it more, or less, suitable for bilbies. Bilbies responded well to fires in the central and northern Tanami, where fire is frequent, due to regeneration of major food plants (Southgate and Carthew 2006; Southgate and Carthew 2007). Bilbies have persisted in areas around Aboriginal communities where a traditional fine-scale mosaic of smaller and less intense fires prevails (Paltridge 2016, pers comm). Smaller and less intense fires can promote the growth of bilby food plants and influence vegetation density, making the habitat more suitable for bilbies (Southgate and Carthew 2006; Southgate and Carthew 2007).



Fire size, intensity, and frequency may increase in the north of the Greater Bilby's range due to a changing climate (Bradley et al. 2015). Hence, the threat of unmanaged fire is likely to increase with time. Climate change is likely to affect the survival of bilbies in some areas in the future. Predicted future weather conditions in Australia may include more frequent and severe bushfires, longer heatwaves, reduced rainfall in southern and eastern areas of Australia and an increase in the extremity and frequency of intense rainfall events causing local flooding (State of the Environment Committee, 2011).

Planting and invasion of habitat by Buffel grass is believed to be a significant threat to habitat by changing fire intensity and regimes, and compounding the factors noted above.

5.5 Loss of Traditional Owner knowledge and land management

The majority of wild bilbies occur on Aboriginal-managed lands in the NT and WA (Walsh and Custodians of the Bilby 2016; Bradley et al. 2015) and, as noted above, the application of traditional ecological knowledge by Aboriginal people managing their country may influence the local persistence of bilbies. Loss of this knowledge, or reduction in traditional management, may therefore contribute to the local extinction of bilbies and management actions have the potential to be less effective if this local and traditional knowledge is not incorporated.

Aboriginal people who have both experience of local environmental conditions and ecological knowledge of bilbies also have capacity for research and management, and can inform management actions to make them more locally effective. It is therefore critical to the conservation of the Greater Bilby that plans, policies, and programs encourage the inter-generational retention of traditional ecological knowledge and facilitate increased land management by Aboriginal people.

5.6 Reduction in population resilience and genetic fitness in wild and intensively managed populations

A species whose population is small and fragmented is more susceptible to extinction than a species whose population is large and inter-connected. This elevated extinction risk is the result of several different factors:

- Small populations are more susceptible to chance events that can cause local extinction, which cumulatively can result in species extinction. They are also less resilient to fluctuation in death and reproduction rates.
- Small populations can have low genetic diversity and are subject to progressive loss of genetic diversity. Less genetic diversity reduces opportunities for evolutionary adaptation and ability to adapt to changes in the environment.
- A large population that consists of small isolated sub-populations that do not exchange genes is similarly subject to the loss of genetic diversity and its potential consequences.

The factors can combine or operate in isolation to result in an extinction vortex, where the factors reinforce themselves and accelerate a spiral into extinction.

Human-mediated threats have combined to eliminate bilbies from some areas and, in other areas to create fragmented or isolated sub-populations, sometimes of unviable size, and likely to contain only a subset of previous genetic diversity. Such sub-populations are less resilient to threats and have a low capacity to adapt and respond to change.

The factors identified above apply to both remnant and reintroduced sub-populations, but their effect is influenced by the specific circumstances and the nature of management actions. There are a substantial number of bilbies in reintroduced sub-populations and in captive-breeding facilities. These sub-populations vary in their exposure to the pressures of natural selection.

Sub-populations on islands or in large fenced areas are protected from feral cats and foxes, but are otherwise free-living (i.e. reliant on their own foraging for survival, exposed to a range of native predators and other environmental stresses); sub-populations in captive breeding facilities are usually protected from predators and environmental extremes, and provided with food and water. Management of these sub-populations includes maintenance of genetic diversity and adaptive potential (Hayward et al. 2014).



Photo: Zecharia Spencer conducting traditional burning on the Kiwirrkurra IPA © Kiwirrkurra IPA



6. Strategies and actions

The recovery of the Greater Bilby requires on-ground (or direct) strategies to minimise or compensate for the threats to the objectives listed above. Supporting strategies provide for governance to coordinate actions and make the best use of available resources, including assistance to Aboriginal and other land managers, such as graziers, pastoralists and mining companies. Supporting strategies also provide for research to improve the effectiveness of actions, monitoring and survey methods, data analysis and reporting, so that progress can be measured consistently and management actions adapted.

A strategy outlines the way a threat to the objectives, or set of related threats, will be eliminated, reduced, or compensated for. A strategy can also be considered a sub-plan that groups related actions together. Actions describe what will be done, and to the extent practicable, where it will be done and by whom.

Strategies and actions in this plan have been identified on the basis of:

- Effect on objectives – it is believed that if an action is implemented, it will cause the target threat to be reduced and/or the objective closer to being achieved.
- Feasibility – it is believed that partners are willing to act, have the skills and experience to act, and have existing capacity or capacity that can be improved with additional resources.

Bilbies mainly persist in areas that have a sparse human population where it is difficult and expensive to implement works without using the experience and capacity of local communities and local land managers. Local communities, landholders and land managers are likely to have the best understanding of local constraints, and can adapt activities to respond to local conditions. In particular, the skills, expertise, experience, connection to Country and capacity of Traditional Owners and Aboriginal land managers are likely to be critical to the protection and recovery of the Greater Bilby.

For these reasons, in the least-populated areas, on-ground actions are more feasible when targeted to local communities, using the locally effective techniques and practices most familiar to the community. It is further recognised that, given that over 70 per cent of the distribution of naturally-occurring wild populations of bilbies occur on lands managed by Aboriginal people and organisations, the continued survival of the species is likely to be intrinsically linked to healthy and resilient Aboriginal communities managing and exercising their traditional custodianship of the land.

To allow local communities and land managers to influence how, where, and when actions are implemented, actions in this plan are framed to allow a flexible approach to implementation that will suit the local conditions, resources and skill base.



On-ground and supporting strategies

All strategies identified in this plan are necessary for the conservation of the Greater Bilby. On-ground strategies directly tackle biological threats to the objectives for the conservation of the Greater Bilby, while the supporting strategies establish the systems needed to ensure effective on-ground action. Generally, on-ground strategies relate to the specific actions needed at different sites, while supporting strategies will be implemented across many sites, or are not directly spatial in nature.

The threats relate to three key biological factors – the effect of predators, the extent and condition of habitat (including habitat loss, and habitat degradation arising from fire, weeds, grazing, fragmentation, etc.), and population resilience. Accordingly, the on-ground strategies focus on these factors:

- manage introduced predators
- improve and maintain habitat
- establish and maintain a Greater Bilby meta-population that maintains genetic diversity and insures against extinction in nature.

These on-ground strategies are complemented by supporting strategies aimed at ensuring successful implementation of this recovery plan. Supporting strategies are:

- research strategy – to ensure management actions are underpinned by rigorous research
- recovery governance – to ensure efficient, effective, and timely implementation of recovery actions
- monitoring, survey and information management – to measure management impact and report on progress; and
- Traditional Owner research and management – to provide for Aboriginal land managers, including Traditional Owners and Indigenous Rangers, to plan and implement research and management actions.

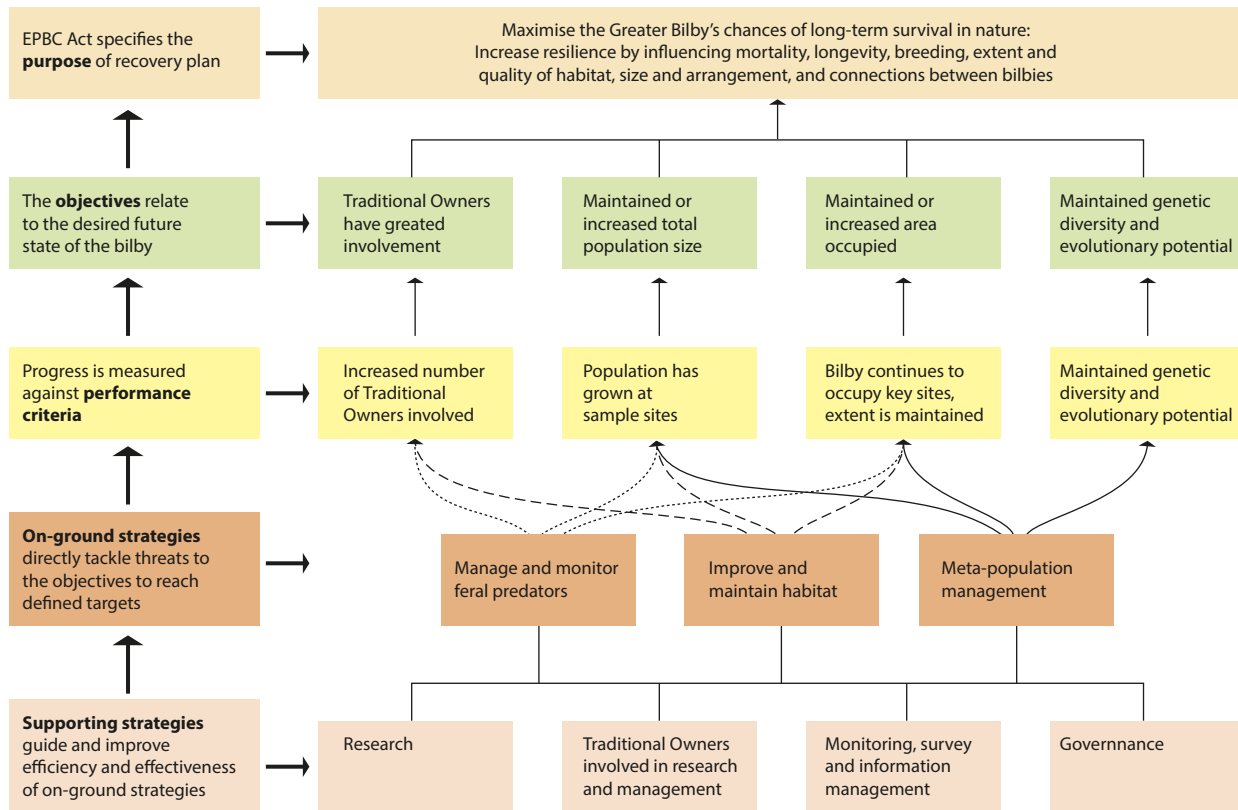
Priority setting and costs

Actions are not prioritised in this recovery plan, for the following reasons:

- It is necessary to implement all actions in this plan to maximise the Greater Bilby's chances of long-term survival in nature. All actions are important.
- Maximum investment in local, on-ground action is likely to be achieved where communities and land managers can choose and tailor actions to respond to local conditions, resources and capacity.
- The risk presented by each threat varies across the distribution of the Greater Bilby and between locations where bilbies persist, hence the priority for actions varies for each location.
- Priorities at some locations are likely to change within the life of this plan and over-prescribing priorities may reduce plan effectiveness.

Costs are not identified in this plan. Although the additional cost of some actions can be calculated, the cost of most actions is dependent on local priorities for action, the feasibility of actions, whether it is a new or a modification of an existing activity, and the existing capacity that is available to undertake the action. The plan aims to avoid being prescriptive and inflexible, and aims to encourage local adaptation and autonomy by land managers when implementing actions.

Recovery plan purpose, objectives, and strategies



Actions

This plan aims to ensure that lack of scientific certainty is not used as a reason to delay on-ground action. It is acknowledged that the effect of each action will not be known without monitoring and analysis, and the combined effectiveness of actions requires research and governance through an adaptive management framework. It is also acknowledged that negative effects may occur and may remain undetected where such systems are not in place. However, unless the action is not time-critical, and there are sufficient resources available to undertake the necessary research, these actions should not be delayed until the associated research is completed.

Actions have been framed at a high level to allow an adaptive and flexible approach to implementation that responds to variation in conservation needs across the range, as well as new information as it becomes available.

The term 'bilby sites' and 'sites' includes all locations where it is possible that bilbies may persist, either naturally or as a result of being reintroduced. This includes locations or areas of Indigenous Ranger activity named in this plan, locations of recent records, and locations where there is evidence of suitable habitat or bilby presence.

Note: As bilbies are mobile and move within the landscape according to resource availability, the term 'site' is intended to encompass the area within which a sub-population or group of bilbies may range over generations.



Bilby sites and partners have only been identified to the extent practicable during the development of this plan. It is expected that further bilby sites will be identified during the life of this plan, and the land manager, with assistance from the recovery team, will identify relevant recovery actions for those sites. Ongoing consultation with Traditional Owners, Indigenous Rangers, state and territory conservation agencies, and other land managers is necessary to identify further sites relevant to this plan.

Sites identified in the plan are shown on maps available with this plan. The recovery team may revise these maps during the life of the plan, to reflect new information about the need for the implementation of actions at identified or additional sites.

Supporting Strategy: Monitoring, survey and information management

The actions required to conserve the Greater Bilby vary at each site according to local conditions and the way the threats interact. The effectiveness of actions at a local scale may be reliant on adapting actions to those circumstances. Monitoring provides the ability to test the impact of management actions, and modify or change actions if required. Monitoring is also required to measure performance against the objectives of the plan.

Action	Description	Partners
1a	Continue or start bilby population monitoring and bilby surveys to establish baseline and measure management impact: <ul style="list-style-type: none">• Facilitate and coordinate monitoring and survey, including through initiatives such as the Bilby Blitz Programme• Promote regular (annual and five-yearly) surveys of bilby sites by local communities using methods that generate comparable data• Include sites necessary to measure against recovery plan performance criteria• Use methods relevant to the circumstances and conditions, such as sign or track plots, burrow visits, cameras, thermal imaging etc.• Collate, analyse and report on data generated from monitoring and surveys.	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, Save the Bilby Fund, other land managers, State and Territory conservation agencies, Australian Wildlife Conservancy and species experts.
1b	Identify sample sites at which growth of bilby population will be measured (see performance criterion 1) within 12 months.	Recovery Team, Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, other land managers, State and Territory conservation agencies, Australian Wildlife Conservancy
1c	Identify any other sites for occupancy survey necessary for reporting against performance criterion 2(a).	
1d	Develop and publish monitoring and survey protocols	
1e	Standardise and implement occupancy/habitat survey methods for bilbies, predators and herbivores across the range of the bilby	
1f	Investigate and establish, if feasible, a 'national database' or 'national map', combining existing data (mapping etc.) to enable on-ground recovery actions. Include layers/data on climate, vegetation, geology and fire frequency mapping etc.	Recovery Team, DoEE, State and Territory conservation agencies

Supporting Strategy: Traditional Owner research and management

The majority of wild bilbies occur on Aboriginal-managed land in WA and the NT, yet until recently the development of bilby conservation plans and strategies did not usually involve effective consultation with Aboriginal people. The future of the Greater Bilby relies on the skills, expertise, experience, connection to Country, and capacity of Aboriginal land managers, including Traditional Owners and Indigenous Rangers.

The Greater Bilby persists in areas where Indigenous Rangers can implement management and monitoring activities, and where some traditional land management activities are still carried out. Increased capacity and support for local communities reduces the expense of management activities in otherwise remote and sparsely populated areas. The harsh environments and substantial distances make the use of non-local workers and resources inefficient, as transport and accommodation costs reduce the proportion of resources invested in on-ground actions. In addition, local people, landholders and land managers are likely to have the best understanding of local constraints, and can adapt activities to respond to local conditions.

In 2016, the Kiwirrkurra Community (WA), on behalf of the Indigenous Desert Alliance, hosted a Ninu (Bilby) Festival, recognising the importance of the knowledge and support from Indigenous Rangers, Traditional Owners, and other Aboriginal groups, communities, and individuals operating in areas where bilbies are or used to be. The Ninu Festival harnessed traditional and contemporary knowledge about the Greater Bilby, threats to its persistence and produced a framework for effective, collaborative management of wild bilby populations. It was emphasised that the motivation to protect the Greater Bilby is based on the cultural connection, and that it is essential to maintain this connection (Paltridge 2016).

Loss of traditional ecological knowledge and Aboriginal land management activities are a significant risk to the conservation of the Greater Bilby. The following actions are designed to ensure that this traditional ecological knowledge and land management capabilities are supported and celebrated.

Action	Description	Partners
2a	<p>Continue to facilitate awareness-raising activities in order to maintain focus on both the cultural significance of the bilby, and Indigenous ecological knowledge and skills in bilby management:</p> <ul style="list-style-type: none">• Conduct events to celebrate and share knowledge about bilby significance and conservation• Provide opportunities to exchange knowledge and experience on cat control techniques between Traditional Owners, land managers and species management experts <p>Share stories, reports, and knowledge about the Greater Bilby, and information about ranger and Indigenous organisation conservation activities, through school activities, traditional media and social media</p>	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, Save the Bilby Fund, State and Territory conservation agencies, relevant NRM organisations
2b	<p>Facilitate Indigenous leadership and involvement in the Recovery Team through the Indigenous sub-committee, and professional development opportunities in recovery team policy and governance. This will ensure extant populations are managed, and maintain a focus on the cultural significance, traditional ecological knowledge and Aboriginal land management skills in bilby conservation.</p>	Recovery Team and Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, State and Territory conservation agencies

Action	Description	Partners
2c	Build the knowledge, awareness and passion for bilbies in the younger generation, e.g. through junior Indigenous Ranger activities, that facilitates both intergenerational knowledge transfer and training in management	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, State and Territory conservation agencies, relevant NRM organisations
2d	For each site, develop a spatially explicit and plain language annual action plan tailored to the needs of the land manager based on the recovery plan, suitable for use in the field by land managers	Indigenous Rangers, Traditional Owners and Indigenous land managers, Save the Bilby Fund, relevant NRM organisations
2e	Based on annual action plan, consider revising Indigenous Ranger work plans to include relevant bilby recovery actions	Indigenous Rangers, Save the Bilby fund, Traditional Owners and Indigenous land managers, relevant NRM organisations
2f	Provide training and support for Indigenous Rangers to accurately and systematically monitor bilbies, e.g. data collection and management, for example, through Bilby Blitz Programme	State and Territory conservation agencies, relevant NRM organisations, key independent experts

Supporting Strategy: Recovery governance

Bilby conservation activities are undertaken by individuals, communities and organisations such as Aboriginal land managers and organisations, (including Indigenous Rangers and Traditional Owners, and remote Aboriginal communities), pastoralists and other landholders/managers, government agencies, NGOs and researchers. Combined, this represents a significant investment in the conservation of a species.

Governance can help connect and establish a common purpose between partners, learning from each other's experience and efforts, sharing resources and capacity, and coordinating bilby management and research actions that are being, and/or need to be, undertaken. Governance can also assist in establishing systems to communicate between partners and to collate information that can be used for reporting at different scales.

Action	Description	Partners
3a	Recovery Team to establish governance arrangements including: <ul style="list-style-type: none"> Indigenous subcommittee (responsible for communicating with Traditional Owners and Indigenous Rangers, and advising Indigenous issues) science subcommittee (responsible for identifying, advising of priorities and coordinating research) meta-population subcommittee (responsible for planning for bilby genetic integrity, insurance, and meta-population management) 	All
3b	Establish a bilby recovery coordinator	Recovery Team
3c	Provide annual reporting on progress against recovery actions	Recovery Team
3d	Review the recovery plan five and ten years after making.	Recovery Team, State and Territory conservation agencies, DoEE



Photo: Greater Bilby in captivity © Dept of Environment and Heritage Qld.

On-ground strategy: Manage and monitor predators

Predation by foxes, cats and possibly wild dogs has the potential to prevent population growth and to cause local extinction, preventing the plan's objectives from being achieved. Directly controlling cats, foxes and wild dogs is necessary at many bilby sites under some circumstances. However, predation levels and the impact of cats is often dependent on population resilience, fire regimes, water availability, and the condition of habitat.

Action	Description	Relevant site/s	Partners
4a	<p>Implement cat control measures:</p> <ul style="list-style-type: none"> Undertake cat control using techniques applicable to the circumstances and local conditions, e.g., baiting, trapping, hunting, shooting, grooming traps, etc. Ensure that potential impacts on non-target species are considered and managed. Schedule control activities to account for bilby and cat breeding cycles, prey availability, potential interactions with dingoes, etc. Provide information, advice and training to landowners and managers to conduct localised cat management at known sites, using the right methods. Continue refining and trialling new baits, attractants and other methods to develop effective cat control techniques for arid areas. Provide opportunities to exchange knowledge and experience on cat control techniques between Traditional Owners, land managers and species management experts. Ensure monitoring is established to determine the baseline and measure management impact. 	<p>All sites. Key sites include Diamantina NP (Qld), Astrebla Downs NP (Qld), Currawinya (Qld), Haasts Bluff (NT), Hanson River (NT), Illeuweru (NT), Munglawurru (NT), NTIPA1-NTIP4, Kurrawarra Nyura Mala (NT), Kalumpurpa (NT), Karlantjipa North (NT), Kintore (NT), Kurrara Kurrara (WA), Peron Peninsula (WA), Marruwa (WA), Ngururpa (WA), Nyangumarta (WA), Waylarta (WA), Mina Mina (NT), Matuwa (WA), Gooniyandi (WA), Kiwirrkurra (WA), Yawuru (WA), Katjarra (WA), Nyirripi (NT), Railway South TCK, STIPA Central (NT), Purta and Mt Frederick ALT (NT), STIPA Lander River (NT), Sangsters Bore (NT), Tanami Downs (NT), The Granites (NT).</p>	<p>Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, Save the Bilby Fund, State and Territory conservation agencies, WWF, AWC, local NRM organisations</p>
4b	<p>Reduce predator impacts on bilbies at the southern edge of bilby range:</p> <ul style="list-style-type: none"> Conduct localised cat and fox control at bilby sites on edges of the range, including trialling of new techniques and utilising existing control activities e.g. shooting, baiting. Ensure that potential impacts on non-target species are considered and managed. Implement and test control techniques (primarily baiting, grooming trap, shooting, training rangers and neighbouring pastoralists to trap (Qld) traditional hunting, fox and cat-specific baiting, trapping, grooming trap, shooting (NT and WA)). Encourage existing shooting activities (e.g. for kangaroos) to include cats and foxes as targets, and to record and report sightings. 	<p>Key sites include Mina Mina (NT), The Granites (NT), Sangsters Bore (NT), Tanami Downs (NT), STIPA Central (NT), STIPA Lander River (NT), Matuwa (WA), Warburton (WA), Kiwirrkurra (WA), Marruwa (WA), Haasts Bluff (NT), Hanson River (NT), Kintore (NT), Illeuweru (NT), Astrebla Downs NP (Qld), Kurrara Kurrara (WA), Nyirripi (NT), Railway South TCK (NT), and other sites identified by the recovery team</p> <p>Sites in Qld (trapping) and in NT and WA (trap, grooming trap, shoot)</p>	<p>Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, Save the Bilby Fund, State and Territory conservation agencies, Rangelands NRM, South West NRM, Australian Wildlife Conservancy</p>

Action	Description	Relevant site/s	Partners
4c	<p>Proactively control cats and wild dogs during boom-bust prey events:</p> <ul style="list-style-type: none"> • Undertake cat control where there is likely to be a boom in cat prey species. Integrate with rabbit control where cat predation may control rabbit numbers. • Undertake rabbit control to prevent fluctuations in rabbit numbers. Test isolated rabbit populations in bilby areas for RHDV and release new strains, if necessary • Monitor indicators of prey density (such as small mammals and rabbits) • Monitor indicators of immigration likely to increase cat and wild dog density • Monitor indicators of prey-switch timing (eg. when prey such as small mammals or rabbits decline in availability), and establish threshold triggers that ensure cat and wild dog control actions are implemented before prey-switching escalates. 	<p>At identified key sites. Key sites include Astrebla Downs NP (Qld), Peron Peninsula (WA), Diamantina NP (Qld), Illeuweru (NT), Kalumpurlpa (NT), Haasts Bluff (NT), Hanson River (NT), Karlantjpa North (NT), Kintore (NT), Kiwirrkurra (WA), Kurrawarra Nyura Mala (NT), Marruwa (WA), Mina Mina (NT), Nyirripi (NT), Munglawurru (NT), NTIPA1-NTIP4, Purta and Mt Frederick ALT (NT), Railway South TCK, Sangsters Bore (NT), STIPA Central (NT), STIPA Lander River (NT), The Granites (NT), Yawuru (WA), Tanami Downs (NT), Gooniyandi (WA),</p>	<p>Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, other land managers, Save the Bilby Fund, State and Territory conservation agencies, AWC</p>
4d	<p>Establish baseline monitoring of bilbies and predators using agreed monitoring techniques:</p> <ul style="list-style-type: none"> • Monitor factors/circumstances of predation that results in local extinctions • Establish arrangements for data sharing and intellectual property management • Establish local and centralised data management, analysis and reporting systems 	<p>All sites</p>	<p>Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, Save the Bilby Fund, State and Territory conservation agencies, AWC.</p>
4e	<p>Train Aboriginal land managers, including Traditional Owners and Indigenous Rangers to establish or improve predator control and management activities, including:</p> <ul style="list-style-type: none"> • Standardised methods • Data management and reporting systems 	<p>Where identified as a need.</p>	<p>Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners</p>
4f	<p>Investigate and, if feasible, develop and make available baseline distribution data and maps of threats (cats, foxes, cattle, horse/donkey, camel, key weeds and fire histories) that can be used at a national scale for a general overview, and at a local site scale, so Indigenous Rangers can check and update the veracity of available data.</p>	<p>All sites, especially sites subject to active management</p>	<p>DoEE, data set owners</p>
4g	<p>Use results from above to develop regional predator management strategies (e.g. Tanami, southern WA, northern WA, SW Qld)</p>	<p>All sites</p>	<p>State and Territory conservation agencies, relevant NRM organisations</p>

Action	Description	Relevant site/s	Partners
4h	Determine tolerable levels of cat and wild dog occupancy relevant to key sites by monitoring locations where bilby colonies persist and compare to localities (with similar conditions) where bilbies are absent. Identify thresholds that require the commencement of cat and wild dog control/management to prevent extinction or maintain population condition.	Currawinya (Qld), Newhaven (NT), Pilliga (NSW), Mallee Cliffs (NSW), Sturt NP (NSW), Nyul Nyul (WA), Yawuru (WA), Gooniyandi (WA), Mt Gibson (WA), Peron Peninsula (WA), Matuwa (WA), Kurrara Kurrara (WA), Kiwikurra (WA), Katajarri (WA), Astrebla Downs NP (Qld), Diamantina NP (Qld)	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, State and Territory conservation agencies, Save the Bilby Fund, WWF, AWC, local NRM organisations Wild Deserts (UNSW)
4i	Determine the climatic conditions, weather conditions, and key habitat and prey resources that affect fox extent of occurrence and levels of occupancy.	Gooniyandi (WA), Yawuru (WA), other sites as identified by recovery team	State and Territory conservation agencies, relevant NRM organisations
4j	Determine if foxes are extending their range in WA	At identified key sites. Currently identified key sites including Matuwa (WA), Warburton (WA), Kiwirrkurra (WA), Gooniyandi (WA), Jarntinti and Karlamilyi (WA), Karajarri (WA), Yawuru (WA), Barumba Track (WA), Copper Hill Road (WA), Nyul Nyul (WA), Karajarri (WA), Mankarr mulga place (WA), Nyikina Mangala (WA), Paruku (WA), Ngurrara (WA), Marruwa (WA), Near Jiwal Jiwal and Jurrar (WA), Near Yulpu (WA), North East Jigalong (WA), Nyangumarta (WA), Nyikina Mangala ((WA), Pinpi Road (WA), Punmu, Punmu and Lakeside (WA), Puntawarri (WA), Road to Ruddal River (WA), Talawana Track (WA), Telfer Road North Section (WA), Walpet Track (WA), Walyarta (WA), Warburton (WA), Warntili (WA), Yawinya (WA), South of 33 (WA), Jenkins Track (WA), East of 33 (WA), Pangkapirni and east (WA)	WA Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, State and Territory conservation agencies, relevant WA NRM organisations, KLC
4k	Determine where and under what conditions bilbies are co-existing with predators	Karajarri (WA), Yawuru (WA), Nyul Nyul (WA), Nyikina Mangala (WA), Paruku (WA), Ngurrara (WA), South of 33 (WA), Jenkins Track (WA), East of 33 (WA), Pangkapirni and east (WA)	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, State and Territory conservation agencies, relevant NRM organisations, WWF, KLC, CLC

Action	Description	Relevant site/s	Partners
4l	Improve understanding of immigration corridors, source populations and cat movement during boom and bust events in SW Qld, to enable effective scale and timing of control activities.	Qld bilby sites with key site being Astrebla Downs NP	AWC, DAFF, University of Queensland (UQ), Save the Bilby Fund
4m	Investigate the interaction between cats and dingoes, including determining whether dingoes suppress cats and foxes and if so, under what conditions.	All sites where dingoes are present	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, State and Territory conservation agencies, relevant NRM organisations

On-ground strategy: Improve and maintain habitat

For the Greater Bilby population to grow, and for the species to persist at sites it currently occurs, bilbies need food, shelter, protection from predators, and the opportunity to connect with other bilbies. The ability for habitat to provide for bilbies is often related to fire regimes, land uses that fragment or reduce the amount of habitat present, and habitat degradation resulting from introduced species. Climatic conditions also influence habitat quality, but addressing this threat is not within the scope of this plan.

Manage Fire

Action	Description	Relevant site/s	Partners
5a	<p>Define, promote and implement region-specific fire management to minimise large-scale fires and promote mosaics, using traditional ecological burning and traditional Indigenous knowledge:</p> <ul style="list-style-type: none"> • Undertake burning (including patch burning, traditional burning, linear fire breaks) at each known site. • Undertake landscape-scale fire management, and limit the extent and spread of wildfires to protect sites and bilby habitat from unmanaged fire following high rainfall events. Consider aerial burning after extensive rainfall events that are likely to create conditions that result in widespread fires • Develop fire management guidelines that protect specific habitat elements, such as key food resources (e.g. witchetty grubs) • Develop fire management guidelines for the following areas: Qld bilby sites, the Pilbara, Lancewood (NT) and Dampierland (IBRA) 	All sites with active management	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, researchers, State and Territory conservation agencies, WWF, relevant NRM

Action	Description	Relevant site/s	Partners
5b	<p>Undertake the above burns at selected sites across sand-plain habitat:</p> <ul style="list-style-type: none"> • Monitor and analyse effects on the availability of key bilby plant food, to test and refine the fire-rainfall-Yakirra model • Determine whether fire plays a role in promoting key food resources in the Pindan and savannah areas of the Kimberley / Dampierland (IBRA). <p>Test response of bilbies (plus habitat quality, food availability, predators, dingoes) to experimental fire manipulation in five different bilby sub-population fragments in sand plain habitat.</p>	<p>Sites to be selected by Recovery Team across sand-plain, Pindan and savannah areas. Consider:</p> <p>Newhaven (NT), Pilliga SCA (NSW), Mallee Cliffs NP (NSW), Sturt NP (NSW), Nyul Nyul (WA), Karajarri (WA), Nyikina Mangala (WA), Kintore (WA), Kiwirrkurra (WA), Marruwa (WA), Katjarra (WA), Mungarlu (WA), Matuwa (WA), Kurrara Kurarra (WA), Yawinya (WA)</p>	<p>Recovery Team Science subcommittee, relevant Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, researchers, State and Territory conservation agencies, WWF, relevant NRM organisations</p>

Improve habitat connectivity and maintain habitat extent

Action	Description	Relevant site/s	Partners
5c	<p>Compile traditional ecological knowledge about links between habitat, fire patterns and key bilby food availability</p>	All sites	<p>Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners</p>
5d	<p>Ground-truth and refine bilby habitat model within the separate regions (e.g., using 2ha plot and occurrence data, remote sensing data and vegetation mapping):</p> <p>Investigate relationship between modelled bilby habitat and fire history (e.g., area of habitat to area burnt), and development and climate</p>	<p>Sites to be selected by Recovery Team</p>	<p>Recovery Team Science subcommittee, Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, researchers, State and Territory conservation agencies, WWF, relevant NRM organisations</p>
5e	<p>Enlarge and reconnect small wild sub-populations. Improve connectivity by managing habitat quality between bilby sub-populations in south-west Qld:</p> <ul style="list-style-type: none"> • Improve habitat condition and reduce predators in the strip of land between Astrebla and Diamantina NPs by undertaking joint strategic introduced predator controls, implementing strategic or ecological burns, and reduction or better management of water points and grazing regimes • Provide information, advice, and support to land managers to ensure land condition remains suitable to enable bilbies to persist at existing and periodically occupied bilby sites <p>Manage predators in buffer zones around bilby sites to enable bilby numbers to expand in good seasons, and facilitate dispersal between bilby sites</p>	<p>Astrebla Downs and Diamantina National Parks, Pullen Pullen reserve</p>	<p>DES, Bush Heritage Australia, Save the Bilby Fund</p>

Action	Description	Relevant site/s	Partners
5f	<p>Maximise the retention of bilby habitat, and enhance retained habitat:</p> <ul style="list-style-type: none"> • Avoid habitat alteration, fragmentation, and loss, where possible <p>Where habitat is unavoidably affected, implement predator, fire, and habitat management to increase the chances of long-term persistence at the site, and to expand the population into an adjoining or nearby area.</p>	All sites	State and Territory governments, Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, and other land managers
5g	<p>Develop guidelines on minimising impacts on bilbies from agriculture and other development. Include information to identify how to maintain and enhance sufficient extent and connectivity of habitat, maintenance or restriction of any associated subsurface and surface waters, undertake fire management, and manage predators to promote resilient bilby populations.</p>	N/A	State and Territory governments; land managers
5h	<p>Identify sufficiently large areas to support sub-populations of up to 10,000 individuals (target a lower limit of 3000):</p> <ul style="list-style-type: none"> • Determine bilby densities at low and high points in cycle, in different habitats. Sites: SW Qld, Kiwirrkurra IPA, Ngaanyatjarra IPA, Punmu area and western Tanami Desert <p>Determine size of areas required to support high bilby numbers.</p>	To be identified in meta-population plan	Recovery Team science and meta-population subcommittees
5i	<p>Define how bilbies/predators use roads/rail relative to dispersal, road kill and mitigation, and promote effective management</p> <ul style="list-style-type: none"> • Determine if disturbance around roads attract bilbies, e.g., regrowth or ease of burrowing • Determine if road kill a significant cause of mortality for bilbies in different areas and, if so, investigate mitigation/management measures <p>Determine if rail/roads are barriers to bilby dispersal/ gene flow.</p>	Nyul Nyul (WA), Yawuru (WA), Illeuwurru (NT), Gooniyandi (WA). Railway South TCK, The Granites (NT) Other sites as identified by Recovery Team.	Relevant Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, Recovery Team Science subcommittee
5j	<p>Trial the treatment of weeds to determine the effects of weed reduction on the suitability of habitat for the bilby; including:</p> <ul style="list-style-type: none"> • Buffel grass • Couch grass growing along drainage lines. 	Illeuwurru (NT), Newhaven (NT), STIPA Lander River (NT), Hanson River (NT), Munglawurru (NT), Gooniyandi (WA), Karlumpurla (NT), The Granites (NT), Nyul Nyul (WA), Yawuru (WA), NTIPA1, Mungarlu (WA), Katjarra (WA), Mankarr mulga place (WA). Other sites identified by Recovery Team	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, Recovery Team Science subcommittee

Managing impacts of herbivore grazing

Action	Description	Relevant site/s	Partners
5k	Continue to exclude cattle from currently ungrazed habitat at bilby sites.	All WA/NT sites where relevant, including: Lander River (NT), Hanson River (NT), Gooniyandi (WA), Karlumpurla (NT), Sangsters Bore (NT), STIPA Central (NT), STIPA Lander River (NT), Mungarlu (NT), Illeuwurru (NT), Karajarri (NT), Kurrara Kurrara (WA), Mina mina (WA), Matuwa (WA), Nyirripi (NT), NTIPA 1–4, Nyul Nyul (WA), Yawuru (WA)	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, and other land managers
5l	Trial the effectiveness of reducing the number of feral herbivores on improving persistence or population growth at known sites.	Illeuwurru (NT), Gooniyandi (WA), Newhaven (NT), Kiwirrkurra (WA), Yawuru (WA), Katjarra (WA), Kurrara Kurrara (WA), Marruwa (WA), Matuwa (WA), NTIPA 1, Nyul Nyul (WA), Other sites identified by Recovery Team	Aboriginal land managers and organisations, including Indigenous Rangers and Traditional Owners, and other land managers
5m	Reduce water point density in habitat at bilby sites and in adjacent habitat to 1970s level by 2025: Investigate potential for stewardship payments to reduce water points or water availability to compensate for associated stocking reductions	All sites	State and Territory conservation agencies
5n	Develop guidelines for stocking levels based on stocking levels at grazed sites where the bilby has persisted	N/A	State and Territory conservation agencies
5o	Trial reduction in stock grazing intensity in areas of potential habitat adjacent to bilby sites, to encourage bilby expansion	Sites to be determined by land managers in consultation with Recovery Team Science subcommittee	State and Territory conservation agencies
5p	Provide information and advice to pastoral companies about opportunities to increase bilby population size and resilience on pastoral lands.	N/A	State and Territory conservation agencies, relevant NRM organisations
5q	Define and promote tolerable grazing levels of feral herbivores, relative to suitable habitat, fire, predators and water points.	N/A	Recovery Team Science subcommittee, State and Territory conservation agencies
5r	Quantify the effect of grazing on bilby populations and persistence. Compare bilby abundance near and remote from grazing pressure under different grazing intensities (to determine thresholds of acceptable grazing)	N/A	Recovery Team Science subcommittee

On-ground strategy: Meta-population management

This strategy includes actions to manage the Greater Bilby meta-population that maintains genetic diversity, maintains evolutionary potential, reintroduces the species to sites within its former range, and insures against extinction in the wild. Significantly growing the size of the Greater Bilby population is likely to be required to effectively recover the Greater Bilby in the longer term. Accordingly, opportunities to grow the population, whilst meeting other objectives should not be discounted on the basis of this plan.

A meta-population is a group of populations that are separated by space but consist of the same species. These spatially separated populations interact as individual members move from one population to another.

Action	Description	Relevant site/s	Partners
6a	Develop and implement a single overarching adaptive meta-population management plan, acknowledging one national genetic management unit. The plan is to identify the number, quality and arrangement of bilbies that are necessary to be resilient to stochastic losses; provides insurance against loss, retain evolutionary potential, provide for supplementation and reintroduction and foster cultural and community involvement in bilby conservation.	Entire population of bilby	Recovery Team, CPSG, ZAA, State and Territory conservation agencies
6b	Implement meta-population management plan including reintroducing the Greater Bilby to sites within its former range as required, including in introduced predator-free areas, and maintain and enhance such populations.	Entire population of bilby	AWC, Save the Bilby Fund, Arid Recovery, Wild Deserts (UNSW), State and Territory conservation agencies, ZAA
6c	Implement meta-population management plan including: <ul style="list-style-type: none">• Consolidate or establish new holdings of bilbies as required• further founder collection, as required;• movement of genetic resources between facilities and wild bilby sites;• amalgamate holdings of bilbies as required;• breeding for release, as required;• maintaining selective pressures and evolutionary potential,• providing for population growth, where opportunities exist	Entire population of bilby	AWC, BHA, State and Territory conservation agencies, Wild Deserts (UNSW), ZAA, Save the Bilby Fund
6d	Develop and implement a Captive Management Plan for the captive population to implement the meta-population and recovery plans.	Captive, fenced and island sites	ZAA, AWC, Arid Recovery, Save the Bilby Fund, State and Territory conservation agencies
6e	Undertake trial reintroductions to test responses to varying levels of predators, stock grazing, and other disturbance factors.	As identified by state and territory conservation agencies. AWC, Save the Bilby Fund, Arid recovery, Wild Deserts (UNSW).	ZAA, AWC, Arid Recovery, Wild Deserts (UNSW), Save the Bilby Fund, State and Territory Conservation Agencies

Supporting strategy: Research strategy

The on-ground management actions listed above incorporate or identify related monitoring and research actions that inform and measure the impact of on-ground actions. Beyond these, there is much to learn about bilbies, their habitat, and the effects and inter-dependencies of factors that threaten the conservation of the Greater Bilby. Research questions not tied to management actions that may reveal information are general research actions that will support the overall recovery of the Greater Bilby and may inform future action. Research that is planned to be conducted on Aboriginal land should have its plans developed in conjunction with the relevant Aboriginal, group, community, and individuals.

Action	Description	Partners
7a	Collate and report on the findings of research and revise actions where necessary	Recovery Team Science subcommittee; Recovery Team State and Territory conservation agencies
7b	Establish systems to promote the integration of monitoring and management activities, so that management impact can be measured.	Recovery Team Science subcommittee, State and Territory conservation agencies
7c	Facilitate the integration of management and associated research so that research findings influence management practice.	Recovery Team, State and Territory conservation agencies
7d	Develop a research plan that identifies priority areas for additional research. Research topics include: <ul style="list-style-type: none">• Bilby biology, ecology, population dynamics and genetic diversity• Predator biology, ecology, interdependencies, control methods and effects on the bilby• Habitat quality, extent, processes and threats, such as fire and grazing• Factors that influence the spread of fire, and its effects on habitat and food availability• The effects of, and opportunities associated with, a changing climate• Interdependencies between predators (including the dingo), fire, water availability and introduced species	Recovery Team Science subcommittee, State and Territory conservation agencies, research providers



Photo: Tjirururr bilby dreaming site—The Ninu Festival opened with a visit to a bilby dreaming site on the Kiwirrkurra IPA, Tjirururr. © Kiwirrkurra IPA

7. Social and economic considerations

The key social impact of this plan is expected to be positive and arise from the acknowledgement of the critical role that Aboriginal land managers, including Traditional Owners and Indigenous Rangers, and Aboriginal organisations and communities play in the future conservation of the Greater Bilby across much of its current distribution. The plan acknowledges the value of traditional ecological knowledge, traditional management practices, maintenance of culture and connection to country, and the understanding local communities have of threats and local conditions.

Economic impact may occur to those who require approval to remove or modify bilby habitat and are prevented from doing so, or are required to modify their proposal by a consent authority as a result of this plan. Although this plan indicates the need to understand how agricultural practices (such as grazing) affect bilbies and to consider modifying practices in consultation with land managers if necessary, the economic costs of any such voluntary changes may be significant at the station level but are not expected to be significant at an industry level.

The investments of conservation organisations such as the Australian Wildlife Conservancy, Bush Heritage Australia, World Wildlife Fund, and the Save the Bilby Fund in on-ground actions identified in this plan are considered significant economic benefits.

Another social benefit of this plan is that it deals with community concerns about the loss or local extinction of charismatic fauna.



Photo: Demonstrating cat trapping at the Ninu Festival, June 2016 © Kiwirrkurra IPA.

8. Partners and affected persons

Persons likely to be affected by the actions proposed in this plan include Traditional Owners, Indigenous Rangers, and Aboriginal organisations; Australian, state, and territory governments; land owners and managers; researchers; tourism operators; conservation groups; and wildlife interest groups. This list, however, should not be considered exhaustive, as there may be other interest groups that would like to be included in the future or need to be considered when specialised tasks are required in the recovery process.

In addition to the organisations, institutions, and groups identified below, the conservation of the bilby has relied on (and continues to rely upon) the dedication, skills, and insights of individual champions and researchers who each have worked on the bilby for more than a decade. These key individuals include: Rick Southgate (Envisage Environmental Services), Katherine Moseby (Ecological Horizons), Rachel Paltridge (Desert Wildlife Services), and Peter McCrae and Frank Manthey of Save the Bilby Fund.


Partner	Shortened form
Arid Recovery	AR
Australian Wildlife Conservancy	AWC
Bush Heritage Australia	BHA
Conservation Planning Specialist Group (International Union for the Conservation of Nature)	CPSG
Central Land Council	CLC
Department of Agriculture, Forestry and Fisheries (Queensland)	DAFF
Department of Biodiversity, Conservation and Attractions (Western Australia)	DBCA
Department of the Environment and Energy (Australian Government)	DoEE
Department of Environment and Heritage Protection (Queensland)	EHP
Department of Environment and Natural Resources (Northern Territory)	DENR
Department for Environment and Water (South Australia)	DEW
Department of National Parks, Sport and Racing (Queensland)	NPSR
Kimberley Land Council	KLC
Mulan Aboriginal Corporation	
National Parks and Wildlife Service, New South Wales	NPWS
Northern Land Council	NLC
Rangelands NRM	
Save the Bilby Fund	STBF
South West NRM	
Territory NRM	
World Wide Fund for Nature Kimberley	WWF
Wild Deserts Partnership (University of New South Wales Centre for Ecosystem Science and Ecological Horizons)	Wild Deserts (UNSW)
Zoo and Aquarium Association	ZAA


Indigenous Rangers and groups

Ranger team	IPA/Ranger Group Organisation
Anangu Luritjiku Rangers	Central Land Council
Anmatyerr Rangers	Central Land Council
Bardi Jawi Rangers	Bardi Jawi IPA
Birriliburu Rangers – Birriliburu IPA	Birriliburu IPA, Bardi and Jawi Niimidiman Aboriginal Corporation, Desert Support Services
Gooniyandi Rangers	Kimberley Land Council
Jigalong Rangers	Kanyirninpa Jukurrpa
Karajarri Rangers	Karajarri IPA, Karajarri Traditional Lands Association, Kimberley Land Council
Kiwirrkurra Rangers	Kiwirrkurra Indigenous Protected Area (IPA), Tjamui Tjamu , Desert Support Services
Kunawaritji Rangers	Kanyirninpa Jukurrpa (KJ)
Martu Rangers	Kanyirninpa Jukurrpa (KJ)
Murnkurumurnkurru Gurindji Rangers	Central Land Council
Muru-Warinyi Ankkul Rangers	Central Land Council
Ngurrara Rangers	Ngurrara IPA, Yanunijarra Aboriginal Corporation
North Tanami Rangers	Northern Tanami IPA, Central Land Council,
Nyangumarta Rangers	Nyangumarta IPA, Nyangumarta Warrarn Aboriginal Corporation
Nyikina Mangala	Walalakoo AC, Kimberley Land Council
Nyul Nyul Rangers	Kimberley Land Council
Paruku Rangers	Parurku IPA, Tjurabalan Aboriginal Corporation, Kimberley Land Council
Parngurr Rangers	Kanyirninpa Jukurrpa (KJ)
Punmu men	Kanyirninpa Jukurrpa (KJ)
Punmu women	Kanyirninpa Jukurrpa (KJ)
Walpiri Rangers	Southern Tanami IPA, Central Land Council
Wiluna Rangers	Matuwa Kurarra Kurarra IPA, Tarlka Matuwa Piarku AC, Desert Support Services
Yawuru Country Managers	Yawuru Native Title Holders Aboriginal Corporation

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