

# Yookamurra Wildlife Sanctuary Ecohealth Report 2020



## Summary

Australian Wildlife Conservancy (AWC) has implemented an Ecological Health Monitoring Program (Ecohealth) to measure the changes in ecological health on Yookamurra Wildlife Sanctuary (Yookamurra). This report provides information on the Ecohealth indicators monitored at Yookamurra; including a brief rationale for indicator selection, the methods used for their survey, the calculation of metrics, and the status of those indicators in 2020 and trends in their values over time (where possible). Values of metrics derived in this report were based on data collected from 2009 to 2020 for some key conservation assets, and 2017 to 2020 for surveillance monitoring of some species. The metrics and their values are summarised in the accompanying Ecohealth Scorecard.

In 2020, surveys were conducted of the four species of locally-extinct mammals and two species of threatened plants reintroduced to Yookamurra, as well as of extant assemblages of birds, small mammals and reptiles. The first targeted survey of the Southern Hairy-nosed Wombat was also conducted on Yookamurra, with the aim of estimating population size based on a census of burrow activity.

Total survey effort in 2020 comprised 108 bird surveys, 864 pitfall trap nights, 1,296 funnel trap nights, 597 cage trap nights, 384 spotlight surveys, 128 diurnal transect surveys, and 1,499 warren surveys. Overall, a total of 67 species of native birds, 17 species of reptile and seven native mammals were recorded from the 2020 surveys. Two native vertebrate species were confirmed (i.e., detected for the first time at this site) at Yookamurra in 2020: the Little Buttonquail and Pied Butcherbird.

Although rainfall was near to average in 2020, the effects of the preceding record drought were still evident in survey results. Birds, reptiles and small mammals were all less abundant than when surveyed before the drought, and populations of three of four species of reintroduced mammals, and both reintroduced plants, continued to decline into 2020. Nevertheless, there were signs of recovery in some assemblages, with a recovery in the population size of Burrowing Bettongs, and an increased abundance of small mammals and birds in 2020 than at the height of the drought in 2019.

The Southern Hairy-nosed Wombat survey successfully identified 1,169 warrens, of which 72% of these were active. The survey results indicate that Yookamurra supports over 2,000 Southern Hairy-nosed Wombats and the property is likely a stronghold for the species in the Murraylands region.

# Contents

Introduction.....	1
Yookamurra Wildlife Sanctuary.....	1
Conservation values .....	1
Threats.....	3
Climate and weather summary .....	4
Methods .....	4
Indicators and metrics .....	4
Survey types and history .....	7
Survey design and methods .....	7
Standard Trapping Survey .....	7
Diurnal Bird Survey .....	9
Bettong Survey - Burrowing and Brush-tailed Bettongs .....	9
Greater Bilby and Common Brushtail Possums Spotlight Surveys .....	10
Numbat Survey .....	11
Malleefowl Mound Survey .....	12
Southern Hairy-nosed Wombat Survey.....	12
Threatened Plants Survey.....	13
Analysis methods.....	14
Standard Trapping - Small terrestrial vertebrate fauna .....	14
Diurnal Birds .....	14
Burrowing and Brush-tailed Bettongs .....	14
Bilbies, Common Brushtail Possums, Numbats .....	14
Southern Hairy-nosed Wombats .....	14
Threatened plants .....	14
Results .....	15
Biodiversity indicators .....	15
Reintroduced mammals .....	15
Extant small-medium mammals .....	17
Small-medium sized mammals (reintroduced species).....	18
Southern Hairy-nosed Wombat.....	18
Small-medium reptiles.....	18
Birds .....	20
Malleefowl.....	20
Vegetation – threatened plants .....	20
Discussion .....	21
Acknowledgments .....	21
References .....	21
Appendix 1. Native vertebrate species list, Yookamurra Wildlife Sanctuary.....	23

*Document citation:* Crisp H, Wauchope M, Joseph L, Kanowski J (2021) *Yookamurra Wildlife Sanctuary Ecohealth Report 2020*. Australian Wildlife Conservancy, Perth, WA.

*Cover photograph:* Southern Hairy-nosed Wombats on warren system. AWC/Helen Crisp; Common Brushtail Possum. AWC/Susie Stockwell; Murray-Darling Carpet Python. AWC/Susie Stockwell.

## Introduction

Australian Wildlife Conservancy (AWC) owns, manages, or works in partnerships across 30 properties in Australia, covering more than 6.5 million hectares, to implement our mission: *the effective conservation of Australian wildlife and their habitats*. AWC relies on information provided by an integrated program of monitoring and research to measure progress in meeting its mission and to improve conservation management.

AWC's Ecohealth Monitoring Program has been designed to measure and report on the status and trends of species, ecological processes and threats on each of these properties (Kanowski et al. 2018). The program focuses on selected indicator species, guilds, processes and threats using metrics that are derived from data collected through a series of purpose-designed surveys. The structure of the Ecohealth Program on each AWC property is as follows: based on the guidance provided by AWC's over-arching program framework, Ecohealth Monitoring Plans are developed describing the conservation values or assets of each property, and threats to these assets. In addition, the Ecohealth Plans set out the monitoring program that will be used to track the status and trend of selected indicators of these conservation assets and threats. Annual survey plans and schedules are developed to implement these plans. The outcomes of these surveys are presented in annual Ecohealth Reports and summary Ecohealth Scorecards.

This document is the first in the series of annual Ecohealth Reports for Yookamurra Wildlife Sanctuary (referred to here as Yookamurra). The companion Ecohealth Scorecard presents the indicators and their metrics in a summary format.

## Yookamurra Wildlife Sanctuary

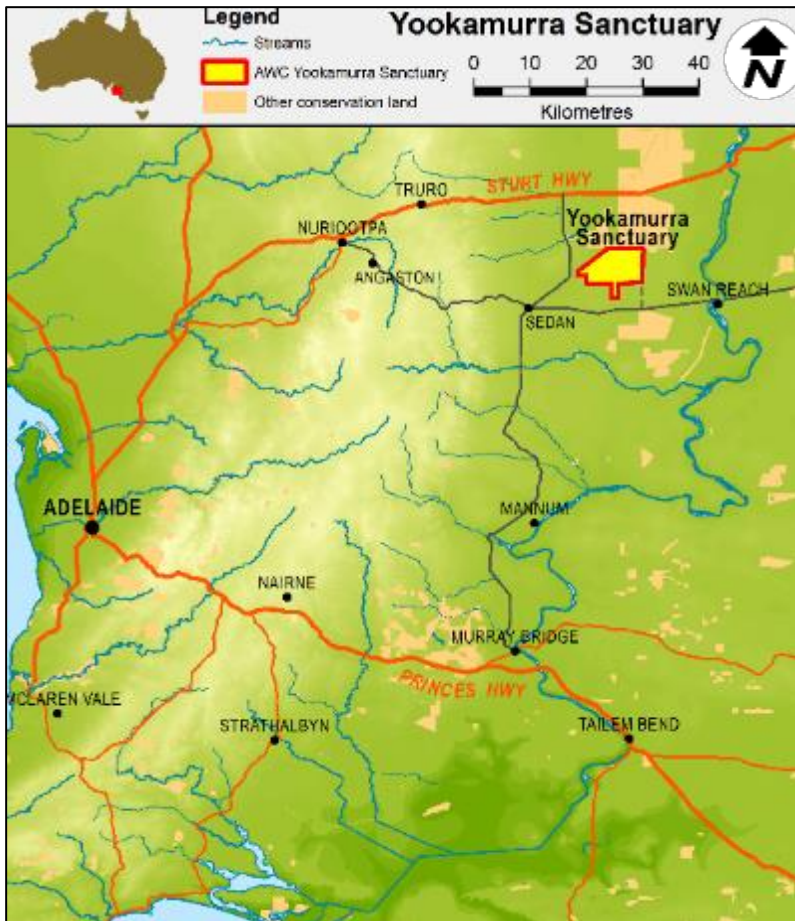
### Conservation values

Yookamurra is located in south-eastern South Australia and is 5,027 ha in extent (Figure 1). The property is located on the western edge of the Murray Darling Depression Bioregion in the northern section of the Murraylands region, between the Mt Lofty Ranges and the River Murray known as the Western Murray Plains.

At the time of European arrival, the Ngaiawang People occupied an area of approximately 388,000 hectares on the Western Murray Plains, in which Yookamurra is situated (South Australian Museum 1977). This land was often shared with the Nganguraku People, part of the Ngarrindjeri Nation. Within this area the main focus of activity was the River Murray, located less than 10 km from Yookamurra's eastern boundary. The river provided a permanent water source and a continuous food supply. No material evidence of Aboriginal settlement or management has been found on Yookamurra itself, however there is no doubt that the plains away from the river were regularly utilised by Indigenous people (Tindale 1974; South Australian Museum 1977; Clarke 2009). More generally, the structure and composition of Australian ecosystems, including those in the mallee, reflect a very long history of Indigenous interactions with the landscape and its resources (Flannery 1994; Gammage 2011; Rule et al. 2012; Clarke et al. 2021).

Charles Sturt and his expedition were the first Europeans to explore this part of the continent in early 1830. Leaseholds close to the river were quickly developed, land occupied by Yookamurra was 'Unallocated Crown Lands'. In 1861, land shortages in the more fertile districts led to the opening up of the marginal 'Hundreds', west of the River Murray; the 'Hundreds' were divided into Sections from approximately 120 to 200 hectares. Yookamurra falls within the 'Hundred of Fisher' and the 'Hundred of Bagot'; the property is made up of 21 separate land titles.

Throughout the property there is evidence of early pastoral settlement, including several ruins and 'woodcutter camps'. Some areas of the property were cleared for sheep (*Ovis aries*) grazing, as early as the late 1800's, to as recent as the 1940's, and some sections were cut for mallee wood to fuel paddle steamers. However, given the 'marginal' location and no permanent water sources on Yookamurra, establishment of pastoral pursuits were short-lived.



**Figure 1. Location and regional context of Yookamurra Wildlife Sanctuary in south-eastern South Australia**

Yookamurra was established in 1989 by Earth Sanctuaries Ltd (ESL). In 1990, ESL built one of Australia's first large feral predator-proof fences on the property to facilitate the reintroduction of locally-extinct mammals to a 1,100 ha fenced area (referred to here as Stage 1). Feral herbivores were eradicated from the fenced area in 1991.

AWC acquired Yookamurra from ESL in 2002. The fence was upgraded in 2006-7, permitting the eradication of feral predators, which to that point had threatened populations of species reintroduced to the fenced area.

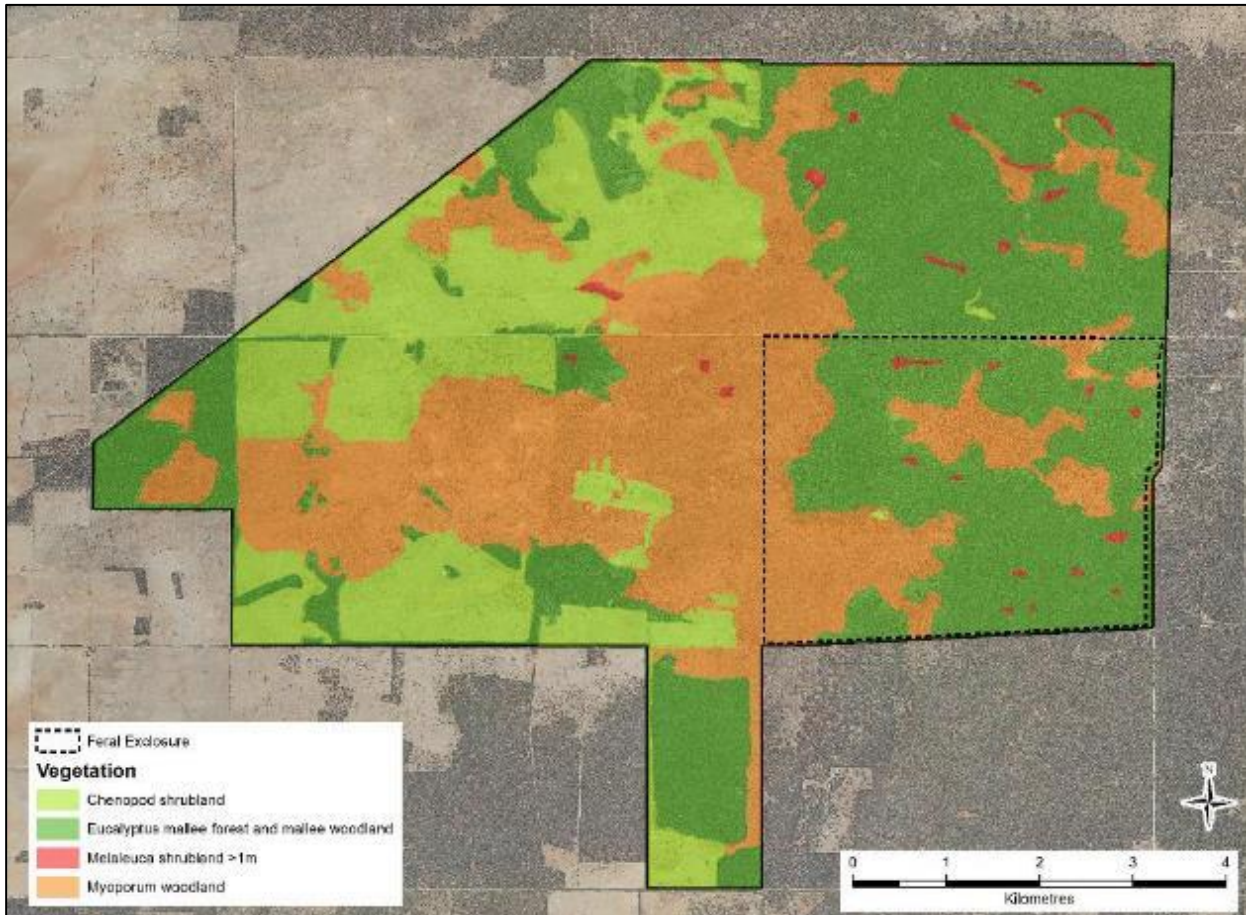
Yookamurra protects three major vegetation communities (Figure 2): the most common being Eucalyptus Mallee Forest and Mallee Woodland, which occupies 42.2% of the total sanctuary area, followed by Myoporum Woodland (35.3%) and chenopod shrubland (18.3%). Inside Stage 1, Eucalyptus Mallee Forest and Mallee Woodland, and Myoporum Woodland, are the dominant broad vegetation communities, which occupy 63.6% and 35.2%, respectively. The old-growth mallee on Yookamurra has significant conservation values from a regional perspective.

Yookamurra protects 164 native plant species, from 41 families. Of these, Peep Hill Hopbush (*Dodonaea subglandulifera*) is listed as Endangered nationally; while Desert Phebalium (*Phebalium glandulosum* spp. *macrocalyx*) is listed as Endangered in South Australia. Both these threatened plants were reintroduced to Yookamurra in 1991, and persist on the property.

Over 200 species of native vertebrates are currently known or considered likely to occur on Yookamurra. These include 21 mammals (including four reintroduced species, as below), 122 birds, 65 reptiles, and four frogs. Seven of these species are listed as threatened nationally or in South Australia; another 20 species, predominantly birds, are listed as 'rare' in South Australia.

Very little information is available about the historical mammal assemblage of the area around Yookamurra. South Australian Museum records from the Murray Mallee date back to 1863, but those from 1889-1899 were mainly from the Riverland area, to the east of Yookamurra, while most records are in the database are relatively recent - post the 1960s (Foulkes and Gillen 2000). Consequently, the historical mammal assemblage (prior to European occupation) must be extrapolated from records outside of the region and from the known

habitat requirements of likely species. It is thought that at least 16 mammal species from the historical assemblage have been lost from Yookamurra. Four of the lost species are globally-extinct, and 12 are regionally-extinct. Four of the regionally-extinct mammals have been successfully reintroduced to the fenced area on Yookamurra: the Burrowing Bettong (*Bettongia lesueur*), Brush-tailed Bettong (*Bettongia penicillata*), Greater Bilby (*Macrotis lagotis*) and Numbat (*Myrmecobius fasciatus*). Attempted reintroductions of two other threatened mammals, the Greater Stick-nest Rat (*Leporillus conditor*) and Plains Mouse (*Pseudomys australis*), have not persisted on the property.



**Figure 2. Map showing extent and distribution of broad vegetation types of Yookamurra Wildlife Sanctuary**

## Threats

### Feral animals

Yookamurra, like much of southern Australia, has been invaded by a range of feral animals, including sheep, goats (*Capra hircus*), house mice (*Mus musculus*), black rats (*Rattus rattus*), foxes (*Vulpes vulpes*), cats (*Felis catus*), rabbits (*Oryctolagus cuniculus*) and hares (*Lepus europaeus*). The feral predators and large feral herbivores have been eradicated from the fenced area, and are subject to ongoing control on the remainder of the property.

### Weeds

A total of 31 exotic plant species have been identified on Yookamurra, one of which is of national significance, African boxthorn (*Lycium ferocissimum*), and another two are declared species, horehound (*Marrubium vulgare*) and salvation Jane (*Echium plantagineum*; Biosecurity SA 2015).

### Changed fire regimes

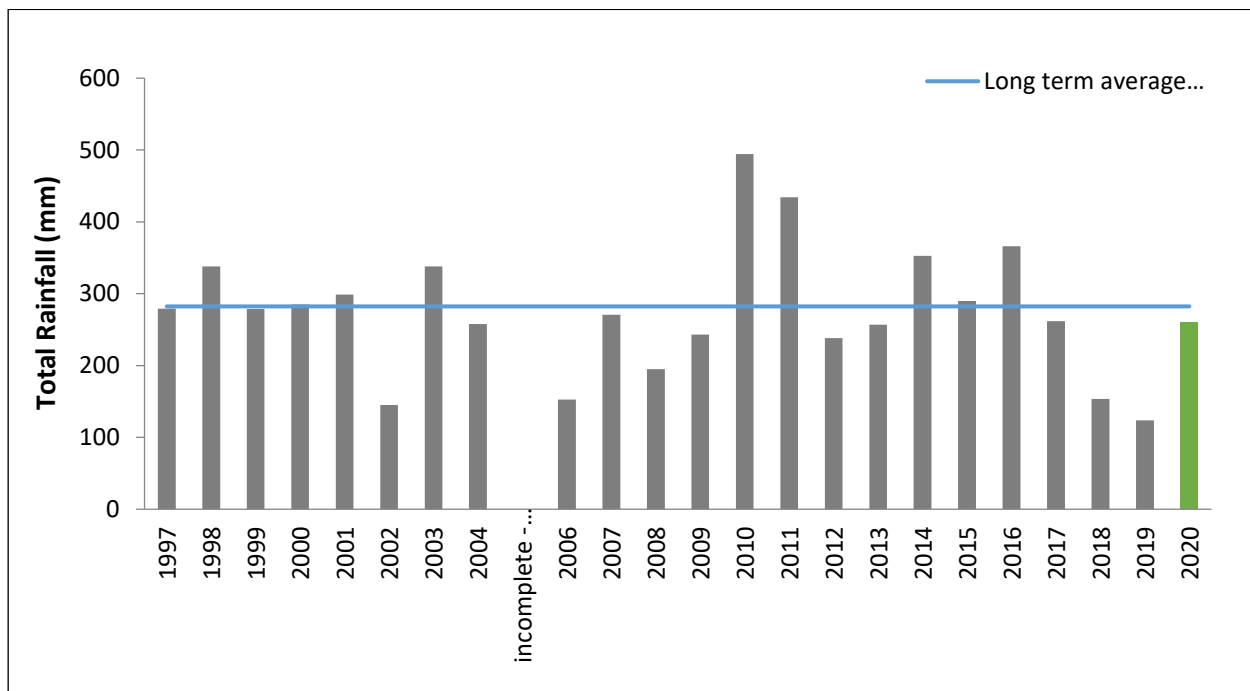
Pre-European fire regimes in the mallee are poorly documented (Clarke et al. 2021). Since European settlement, the mallee has been prone to occasional wildfires. The last wildfire on Yookamurra was recorded in 2014, burning only 55 ha outside the fenced area. Aside from this isolated incident, there have been no notable wildfires recorded on Yookamurra or surrounding properties since 1931. From time to time, AWC implements small prescribed burns to reduce fuel loads around infrastructure on the property.

## Climate and weather summary

Yookamurra is located in the semi-arid zone, where rainfall is sporadic. Rainfall data has been collected on a daily basis since 1997 at Yookamurra using a standard Bureau of Meteorology (BOM) rain gauge. Other weather data including temperatures and wind speed are collected sporadically on-site using a handheld weather station (Kestrel) particularly during surveys. The closest weather stations are located in the Barossa Valley (60 km to the west) and the Riverland (145 km to the east).

Based on the locally-collected data, long-term annual average rainfall on Yookamurra is 282 mm. The highest recorded annual rainfall was 494 mm in 2010. The lowest recorded annual rainfall was 124 mm in 2019. The two previous years (2017 and 2018) also received below average rainfall (Figure 3), such that the period 2017-19 represents the driest conditions on record on Yookamurra.

In 2020, a total of 260 mm was recorded, nearing the long-term average and providing some reprieve from the preceding dry years. August 2020 was the wettest month in 10 years with 53 mm falling.



**Figure 3. Annual rainfall at Yookamurra Sanctuary since 1997 compared to the long-term average (1997-2020) (blue horizontal line)**

## Methods

### Indicators and metrics

Yookamurra's Ecohealth Monitoring Program has been designed to measure and report on the status and trends of species, ecological processes and threats on the sanctuary. The program focuses on selected biodiversity and threat indicators, using metrics derived from data collected through a series of purpose-designed surveys. A selection of species or guilds were chosen as biodiversity indicators which fit into one or more of the following categories: (1) declining and/or threatened species or guilds, (2) strong drivers of ecosystem function, or (3) are a member of the full range of taxa (to enable ongoing surveillance monitoring of a range of taxonomic groups to provide early warning of any unexpected declines).

There are 30 biodiversity indicators (species and guilds) the rationale for their selection is recorded for each indicator in Table 1. In this report, the methods and results are presented for all of these indicators for which surveys were carried out in 2020. Threat indicators are selected to ensure monitoring the status and trends of introduced weeds, predators and herbivores and changed fire regimes (where appropriate). There are four threat indicators (Table 2); none of which are reported on in this report based upon 2020 surveys.

**Table 1. The biodiversity indicators for Ecohealth Monitoring Program on Yookamurra Sanctuary in 2020.**

Rationale for selection: T = threatened or declining; D = strong driver of ecosystem function; S = surveillance monitoring.

Metric definitions: Population estimate = number of individuals on Yookamurra; Abundance = number of individuals/100 trap nights (small mammals, reptiles) [or mean count per one survey (birds)]; Activity = number of records/survey; Mean activity = mean number of records/site; Occupancy = proportion of sites recorded; Richness = mean number of species/site [or mean number of species per one survey (birds)].

Indicator	Rationale			Survey method	Metric/s (in order of preference)
	T	D	S		
<b>Mammals</b>					
<b>Reintroduced mammals</b>					
Numbat ( <i>Myrmecobius fasciatus</i> )	*	*		Diurnal transects	Population estimate
Greater Bilby ( <i>Macrotis lagotis</i> )	*	*		Spotlighting transects	Population estimate
Burrowing Bettong ( <i>Bettongia lesueur</i> )	*	*		Cage traps	Population estimate
Brush-tailed Bettong ( <i>Bettongia penicillata</i> )	*	*		Cage traps	Population estimate
Common Brushtail Possum ( <i>Trichosurus vulpecula</i> )	*	*		Spotlighting transects	Population estimate
<b>Small-medium mammals</b>					
Small-medium mammals – all (trappable)	*		*	Pitfall traps	Abundance, Occupancy
Dasyurids - guild	*		*	Pitfall traps	Abundance, Occupancy
Western Pygmy Possum ( <i>Cercartetus concinnus</i> )			*	Pitfall traps	Abundance, Occupancy
Common Dunnart ( <i>Sminthopsis murina</i> )			*	Pitfall traps	Abundance, Occupancy
<b>Large herbivores</b>					
Southern Hairy-nosed Wombat ( <i>Lasiorhinus latifrons</i> )	*	*		Burrow census and occupancy	Population estimate
<b>Arboreal mammals</b>					
<b>Reptiles</b>					
<b>Small-medium reptiles</b>					
Reptiles – (less large varanids and snakes)			*	Pitfall traps, funnel traps	Abundance, Richness
Reptiles – agamids (guild)			*	Pitfall traps, funnel traps	Abundance, Richness
Reptiles – pygopodids (guild)			*	Pitfall traps, funnel traps	Abundance, Richness
Reptiles – skinks (guild)			*	Pitfall traps, funnel traps	Abundance, Richness

Indicator	Rationale			Survey method	Metric/s (in order of preference)
	T	D	S		
Reptiles – geckos (guild)			*	Pitfall traps, funnel traps	Abundance, Richness
Oriental Skink ( <i>Ctenotus orientalis</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
Shrubland Morethia Skink ( <i>Morethia obscura</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
Southern Slider ( <i>Lerista dorsalis</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
Nobbi Dragon ( <i>Diporiphora nobbi</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
Painted Dragon ( <i>Ctenophorus pictus</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
Bynoe's Prickly Gecko ( <i>Heteronotia binoei</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
Southern Rock Dtella ( <i>Geyhra lazelli</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
Eastern Stone Gecko ( <i>Diplodactylus vittatus</i> )			*	Pitfall traps, funnel traps	Abundance, Occupancy
<b>Birds</b>					
All birds (diurnal)			*	Standard bird survey: 20-min counts	Mean abundance, Richness
Honeyeaters - guild			*	Standard bird survey: 20-min counts	Mean abundance, Richness
Ground active birds - guild	*		*	Standard bird survey: 20-min counts	Mean abundance, Richness
Southern Scrub-robin ( <i>Drymodes brunneopygia</i> )			*	Standard bird survey: 20-min counts	Abundance, Occupancy
Malleefowl ( <i>Leipoa ocellata</i> )	*			Mound survey	Number of mounds, Activity
<b>Vegetation: threatened plants</b>					
Desert Phebalium ( <i>Phebalium glandulosum</i> )	*			Count	Population count
Peep Hill Hopbush ( <i>Dodonaea subglandulifera</i> )	*			Count	Population count

Table 2. Threat indicators for Ecohealth monitoring program for Yookamurra Sanctuary.

Indicator	Rationale	Survey method	Metric/s
<b>Feral predators</b>			
Fox ( <i>Vulpes vulpes</i> )	Major threat to wildlife	Targeted Predator Surveys – Methods under development.	TBD
<b>Weeds</b>			
Weeds (Significant and WONS): Horehound ( <i>Marrubium vulgare</i> ) and salvation Jane ( <i>Echium plantagineum</i> )	Threat to vegetation	Targeted searches – Methods under development.	TBD
<b>Fire</b>			
Extent of wildfire	Major threat to wildlife	Fire scar analysis	% of property

## Survey types and history

To report on the Biodiversity and Threat Indicators, our survey teams conduct a variety of surveys over a period of 1-5 years. AWC established the Malleefowl surveys in 2008, shortly followed by Bettong Surveys in 2009, with Standard Trapping Surveys commencing in 2014. Other components of the Yookamurra Ecohealth monitoring and threat monitoring program have been added in subsequent years. The surveys conducted in 2020 and associated effort and history are outlined in Table 3. The methodology is described, and results of these surveys are reported on in this document.

**Table 3. Survey history and effort for Ecohealth surveys on Yookamurra Wildlife Sanctuary in 2020**

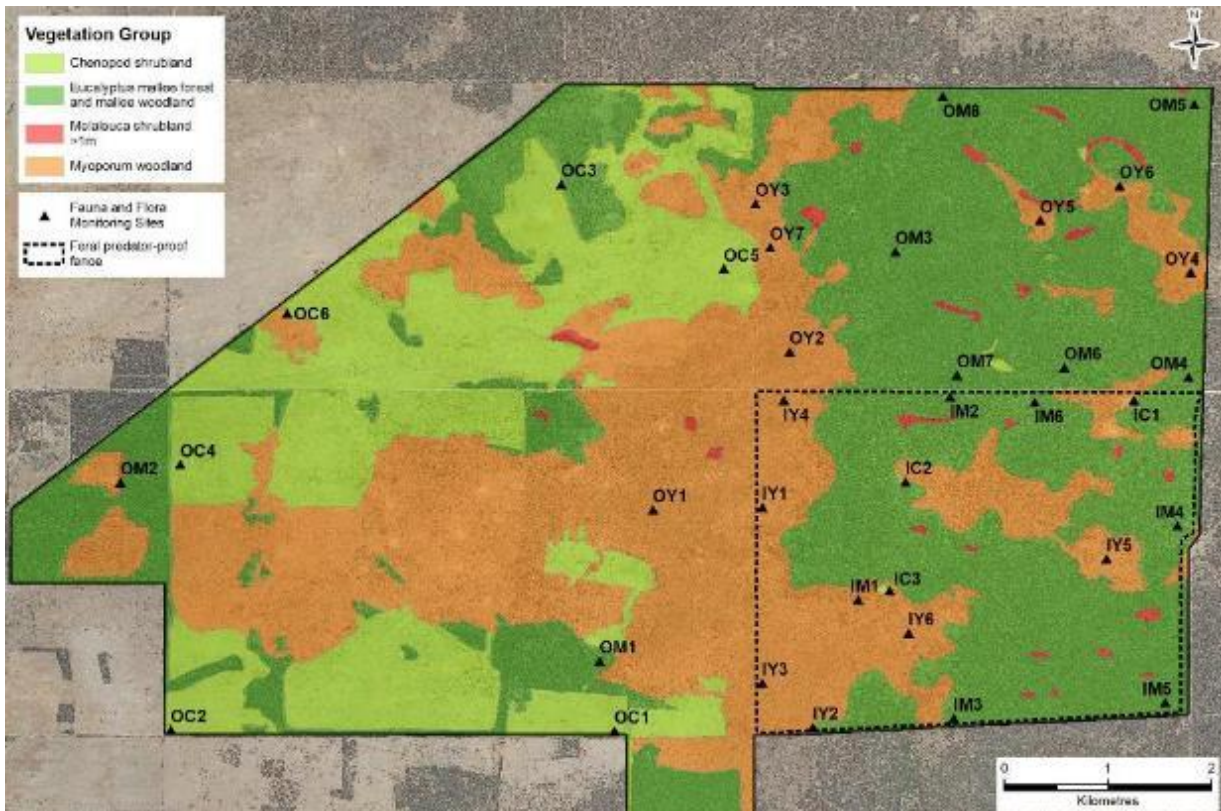
Survey name	2020 Effort	Description/Comment	Previous Surveys
Standard Trapping Survey	1,440 trap-nights	24 sites surveyed, each site with 8 pitfall traps and 12 funnel trap, repeated over three days (checked twice daily); sites stratified by major vegetation type.	2020: 24 sites, 1,440 trap nights 2019: 36 sites, 2160 trap nights 2018: 24 sites, 1440 trap nights 2017: 24 sites, 1440 trap nights 2014: 18 sites, 1080 trap nights
Diurnal Bird Survey	108 surveys	20 minute – 2 ha survey. Completed at all 36 Standard Trapping Survey sites, repeated over three mornings.	2020: 108 surveys 2019: 108 surveys 2015: 54 surveys
Bettong Survey	597 trap-nights	50 sites inside Stage 1, 3 traps at each site, set for 4 nights (note in 2020, one site was closed for one night).	2020: 50 sites, 597 trap nights 2019: 50 sites, 600 trap nights 2018: 50 sites, 600 trap nights 2017: 50 sites, 600 trap nights 2016: 50 sites, 600 trap nights 2015: 450 trap nights 2014: 300 trap nights 2013: 300 trap nights 2012: 400 trap nights 2011: 300 trap nights 2010: 200 trap nights 2009: 200 trap nights
Bilby Spotlight Survey	256 spotlight surveys	8 transects inside Stage 1, surveyed twice per night for 8 nights, twice per year (April and Sept)	2015-20: 256 surveys annually (except 2016, no survey)
Brush-tailed Possum Spotlight Survey	128 spotlight surveys	8 transects inside Stage 1, surveyed twice per night for 8 nights, once per year (April)	2020: 128 surveys
Numbat Survey	128 transect surveys	8 transects inside Stage 1, surveyed twice per day for 8 days, once per year (Nov)	2015-20: 128 surveys annually
Malleefowl Mound Survey	3 mounds checked	Each Malleefowl mound checked and assessed for activity	2020: 3 mounds checked 2019: 2 mounds checked 2018: 2 mounds checked 2017: 2 mounds checked 2016: 2 mounds checked 2008-2015: 1 mound checked
Southern Hairy-nosed Wombat Survey	1,499 warrens surveyed	Warrens identified via Google Earth were surveyed for evidence of activity.	2020: 1,499 warrens surveyed
Threatened Plants Survey	3 sites checked	Population count	2016-20: 3 sites checked annually

## Survey design and methods

### Standard Trapping Survey

There are 36 Standard Trapping Survey sites on Yookamurra (Figure 4) stratified by broad vegetation type. Half of these (n=18) sites were established in 2016-17 to increase the number of replicates in each of the three broad vegetation types. Replicates in each habitat type are located at least 500 m apart. At present, a subset of 24 monitoring sites representative of the two dominant broad habitat types found within the fenced

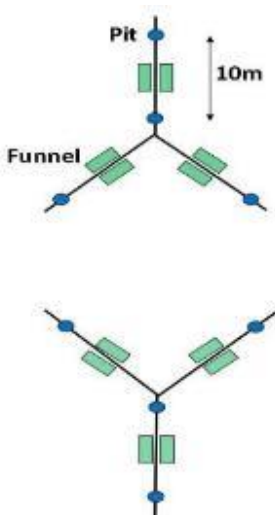
enclosure (Stage 1) have been surveyed annually since 2017. Future surveys will be conducted every third year, or more frequently after extreme weather.



**Figure 4. Location of Standard Trapping Survey and Diurnal Bird Survey sites on Yookamurra**

The Standard Trapping Survey for small terrestrial vertebrate fauna used a combination of live-trapping techniques (i.e. pitfall and funnel traps) and were centred at each of the 36 permanently established sites. Each survey site consisted of two back-to-back 'Y' shapes (each with three 10 m 'wings', joined at the middle) separated by about 10 m (Figures 5 and 6) which included eight pitfall and 12 funnel traps at each site. Each pair of funnel traps was covered with a sheet of air-cell insulation and nesting material was placed in the bottom of each pitfall to provide protection for trapped animals.

Each trap site was operated for three nights. All traps were checked in the morning and the evening. Small mammals were identified and weighed, the sex and breeding condition was determined, and native species were measured and given a temporary mark before release. Reptiles and amphibians were identified, snout-vent length was measured, sex was determined where possible and given a temporary mark (not amphibians) before release. Surveys were carried out in Spring.



**Figure 5. Schematic layout of small terrestrial vertebrate monitoring site indicating trap type and placement**



**Figure 6. A completed 'Y' showing pitfalls (bucket), drift fence and funnel traps.** Photo: AWC/Helen Sharp

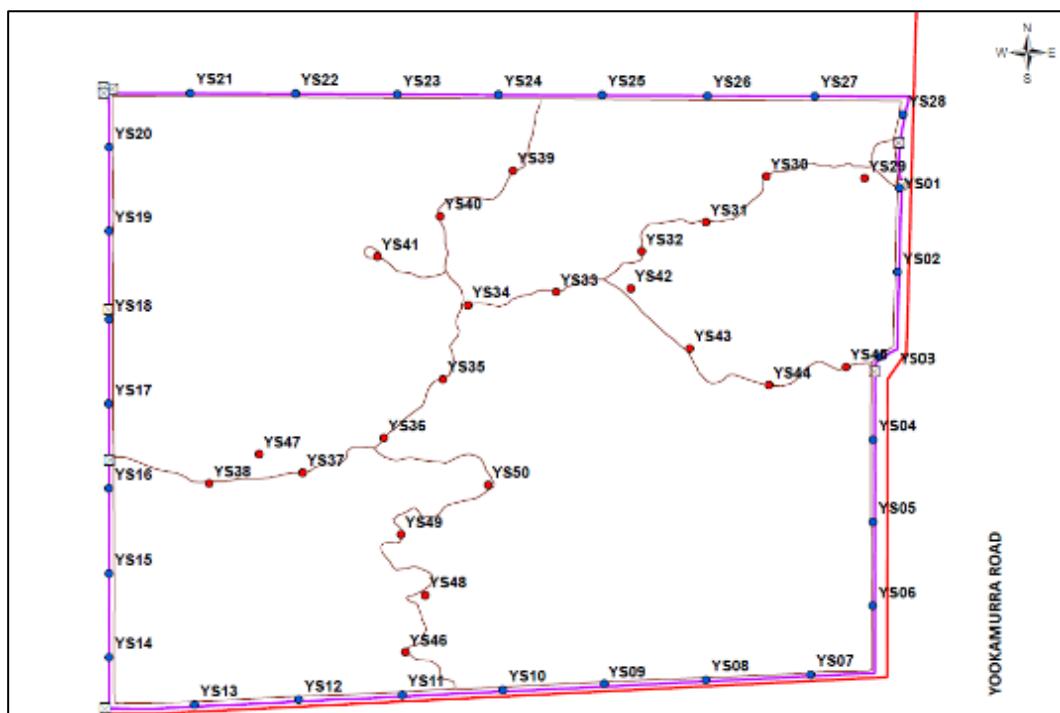
### Diurnal Bird Survey

Diurnal Bird Surveys sites are conducted at the 36 Standard Trapping Survey sites (Figure 4). Surveys have been conducted annually since 2019; prior to this the bird surveys were opportunistic and sporadic.

Surveys were carried out using the standard Birdlife Australian Atlas (Blakers et al. 1984) 20-minute, 2 ha observational survey at all 36 monitoring sites. The observer spent 20 minutes actively searching two hectares centred on the survey site (Figure 4) identifying and recording any sightings or vocalisations. When more than one individual of the same species was noted, it was recorded only if the observer was certain that it was not an individual recorded previously. Surveys were repeated on each of three mornings. Surveys were carried out in Spring.

### Bettong Survey - Burrowing and Brush-tailed Bettongs

Reintroduced populations of Burrowing and Brush-tailed Bettongs were surveyed with cage traps, with data analysed by a capture-mark-recapture model to estimate population size. The survey utilised 50 permanent monitoring sites spaced 400 - 500 m apart established along road networks within Stage 1 (Figure 7).



**Figure 7. Location of the 50 permanent cage trapping sites used for Bettong surveys at Yookamurra**

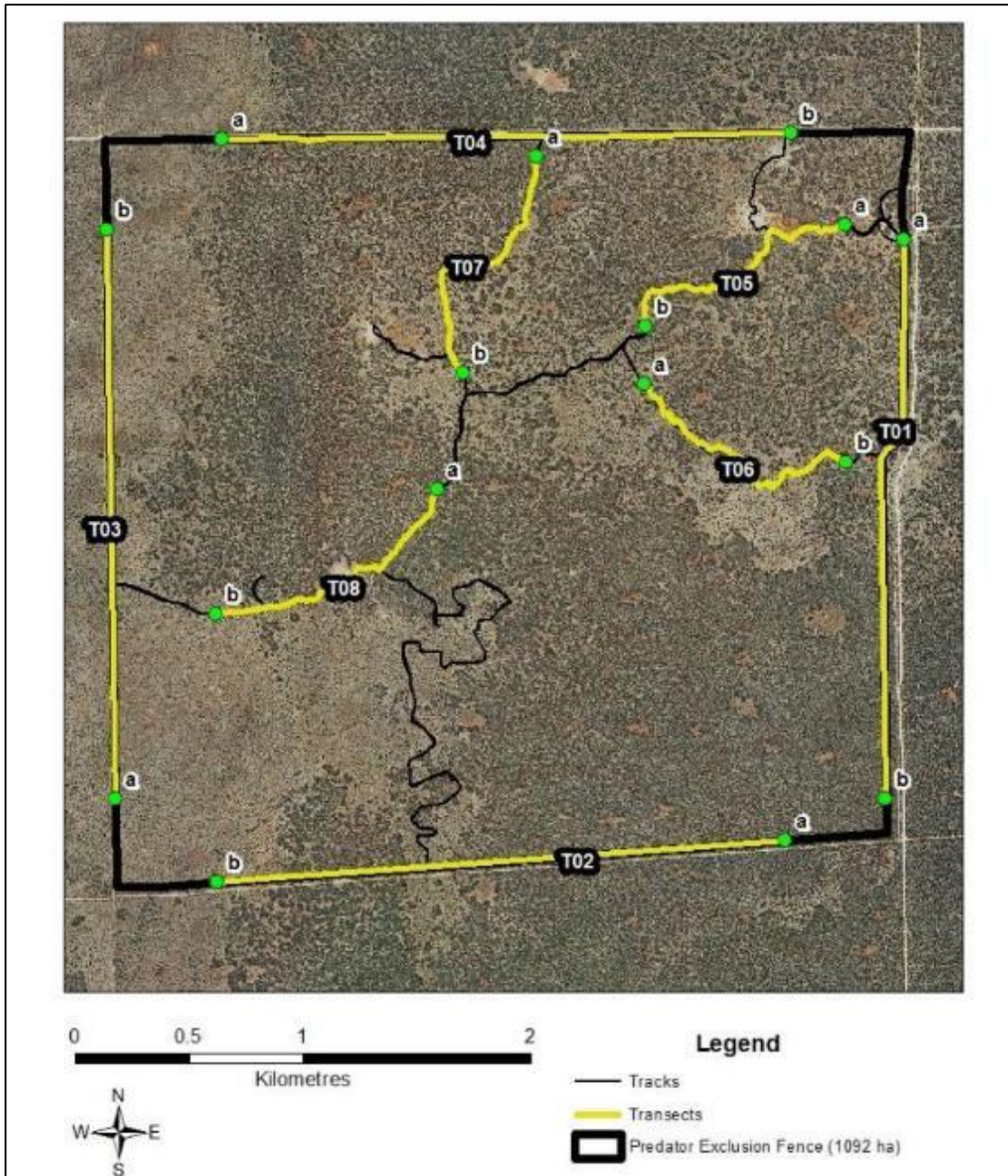
At each site, three standard sized (220 x 220 x 550 mm), treadle-operated wire cage traps were deployed. Cage traps were opened in the late afternoon, baited with peanut paste and rolled oat balls, checked from two hours after sunset and then closed until the following afternoon. Any bettong individuals captured were 'processed', meaning they were checked for a unique microchip number, weighed, and a variety of morphometric measurements obtained such as pes (hind foot) length and breeding status to assess the health and condition of the individual and then released at site of capture (Figure 8). Each site was opened for four nights. The unique microchip number is critical for the capture-mark-recapture model to estimate population size and assessing the frequency at which an individual has been encountered. This survey, normally carried out in Autumn (April), was postponed due to Covid-restrictions in 2020, and was carried out in Spring (September).



**Figure 8. A bettong survey volunteer releasing a Brush-tailed Bettong (Woylie) at Yookamurra Wildlife Sanctuary.** Photo: AWC/Wayne Lawler

### **Greater Bilby and Common Brushtail Possums Spotlight Surveys**

Reintroduced populations of Bilbies and Common Brushtail Possums were monitored using spotlight surveys along eight road-based transects inside Stage 1 (Figure 9) over 8 nights. Each species was surveyed separately to ensure focused effort. Transects located along the Stage 1 perimeter fence were 2,500 m in length, the internal transects were 1,250 m. Each transect was surveyed twice per night. The technique involved driving (10-12 km/hr) with two observers situated on the vehicle tray spotlighting for the target species. When an individual was observed the distance and angle from the observer to the animal was recorded, in addition to the angle to the middle of the transect (the road) using a high precision rangefinder (TruPulse 360R). A GPS was used to record location details and a Kestrel (portable weather station) was used to record weather data. Surveys were carried out in Autumn (March) and Spring (September).



**Figure 9. Location of the 8 driving strip plot transects inside Stage 1 of Yookamurra used to monitor Bilby, Numbat and Common Brushtail Possum populations**

### Numbat Survey

The reintroduced population of Numbats was monitored in November 2020 using diurnal surveys along eight road-based transects inside Stage 1 (Figure 9), over eight days. November is the optimal time of year to survey for Numbats as this is the time when juveniles are foraging independently and when they disperse from their natal home range to establish their own territories (Friend 1995). Each transect was surveyed twice per day; once in the morning and once in the early evening. The technique involved driving (10-12 km/h) with two observers situated on the vehicle tray. When a Numbat was observed (Figure 10), the distance and angle from the observer to the Numbat was recorded, in addition to the angle to the middle of the transect (the road) using a high precision rangefinder (TruPulse 360R). A GPS was used to record location details and a Kestrel (portable weather station) was used to record weather data.



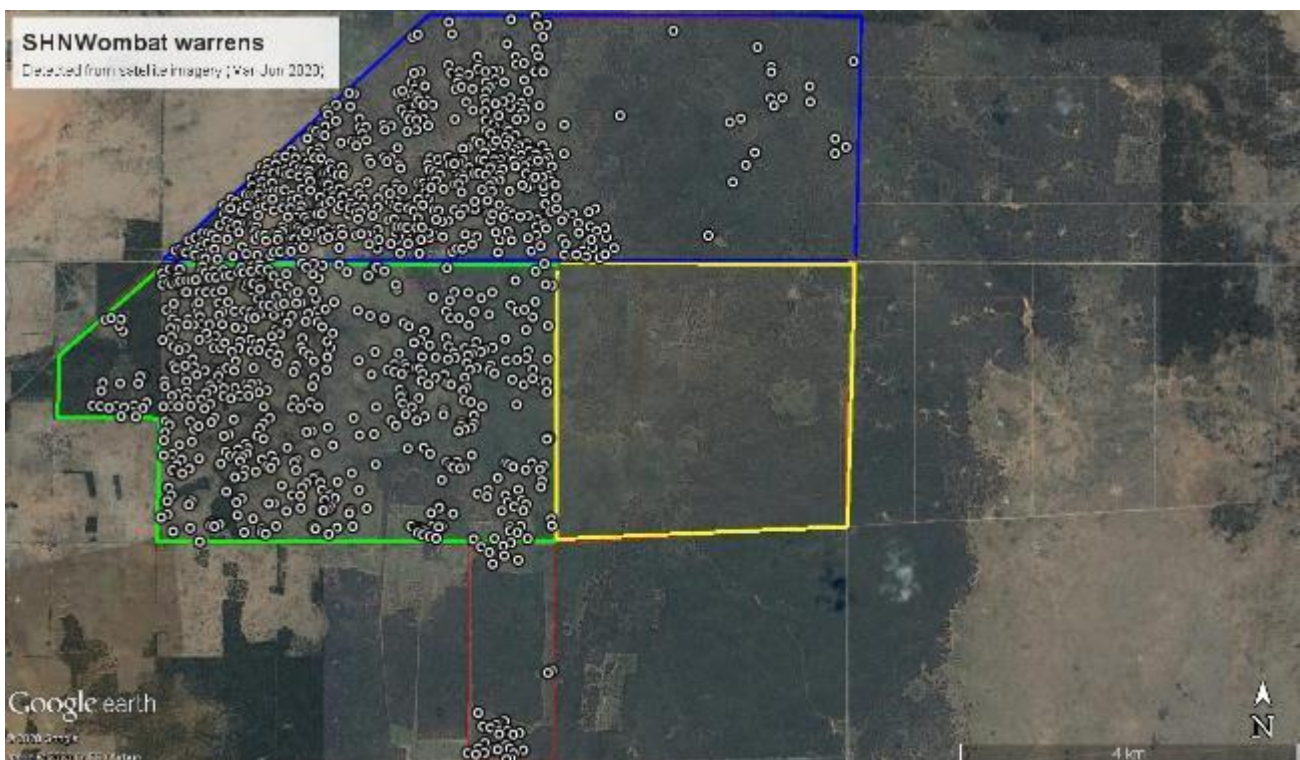
**Figure 10. Numbat in the mallee habitat.** Photo: AWC/Peter Crighton

### **Malleefowl Mound Survey**

All known Malleefowl mounds on Yookamurra were visited in October and breeding activity was assessed based on criteria outlined by the National Malleefowl Recovery Team (2016), noting features such as the mound profile, presence of leaf litter and eggshells. Disturbance to mounds by feral herbivores and predators, which threaten the Malleefowl (Wheeler and Priddel 2009; Harrington 1979, 1986), was also recorded.

### **Southern Hairy-nosed Wombat Survey**

Yookamurra supports a sizeable population of the Southern Hairy-nosed Wombat. The first targeted Ecohealth survey for this species was carried out in Autumn 2020 to estimate population size. Warrens (or potential warrens) were first identified using Google Earth at a scale of <100 m to systematically search the whole property outside Stage 1. All potential 1,169 warrens (sites) were ground-truthed (Figure 11).



**Figure 11. Location of the 1,169 warrens outside of Stage 1 of Yookamurra used to monitor Southern Hairy-nosed Wombat population.** Image: Google Earth.

Where a warren was present, the activity status of each burrow was assessed and the number of burrows (both inactive and active) were counted. Any opportunistic sightings of Southern Hairy-nosed Wombats were also recorded.

### Threatened Plants Survey

Surveys of the two threatened species of plants reintroduced to Yookamurra: Peep Hill Hopbush and Desert Phebalium were conducted at the 3 reintroduction sites to assess population size (Figures 12 and 13).

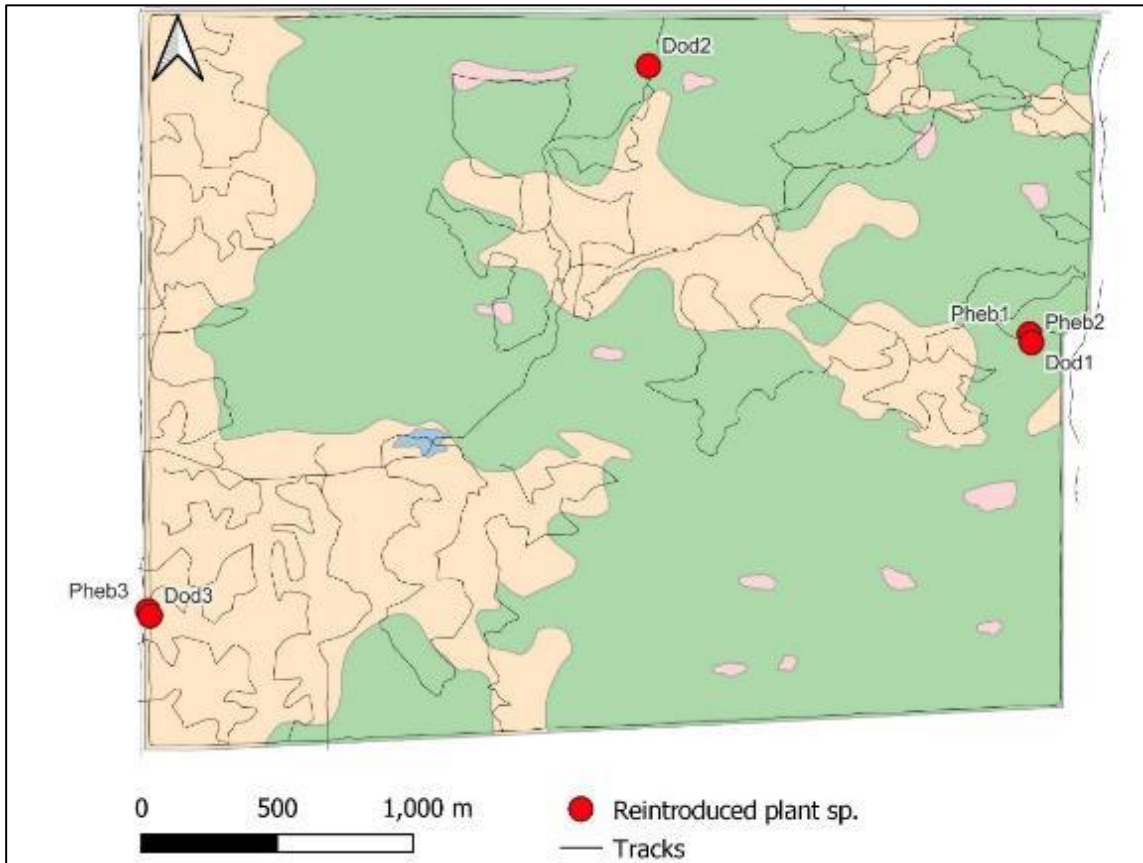


Figure 12. Location of the 3 sites inside Stage 1 of Yookamurra Wildlife Sanctuary used to monitor the two reintroduced plant species, Desert Phebalium and Peep Hill Hopbush



Figure 13. The endangered Peep Hill Hopbush, *Dodonia subglandulifera*. Photo: Helen Crisp/AWC.

## Analysis methods

### Standard Trapping - Small terrestrial vertebrate fauna

Abundance (number of individuals/100 trap nights) and occupancy (% of sites individuals were detected) were calculated for the guild of small-medium mammals as a whole, as well as for dasyurids (as a guild), and for each of two indicator species for small mammals: Western Pygmy Possum and Common Dunnart.

Abundance (number of individuals of all species in the guild/100 trap nights) and richness (mean number of species in the guild captured per site) were calculated for the guild of all reptiles as a whole, as well as for taxonomic guilds of: agamids, pygopodids, skinks and geckos. Abundance (number of individuals/100 trap nights) and occupancy (% of sites indicator species was detected) were calculated for each of the indicator species. Large snakes and/ or large varanids were excluded from analyses.

### Diurnal Birds

An index of abundance was calculated for the three guilds (all birds, honeyeaters and ground-active birds) as follows: first, by taking the average of the total (raw) bird counts across three survey mornings for each site to obtain a 'site average'; and second, by summing all 'site averages', then dividing this result by the number of sites. Species richness for the three bird guilds was calculated by taking the average species richness for each site across three survey mornings, then averaging this across all sites. Abundance and occupancy (% of sites indicator species was detected) were calculated for one indicator species, Southern Scrub-robin. Migratory birds were not included in analyses.

### Burrowing and Brush-tailed Bettongs

Population estimates were derived from encounter frequencies of each individual (determined by their unique microchip number) encountered during the survey. These data were analysed using a closed capture model with full likelihood  $p$  and  $c$  (where  $p$  = the encounter probability, or probability of first capture, and  $c$  = the probability of recapture). Breeding was calculated as the proportion of females with pouch young (PY).

### Bilbies, Common Brushtail Possums, Numbats

Population estimates for the Bilby, Common Brushtail Possum and Numbat were generated using 'strip-plot' (or belt transect) analyses. The strip width was determined by reviewing the median perpendicular distance from the transect line that the target species was detected across multiple surveys. The strip width was the same for Bilby and Numbat, and slightly greater for Common Brushtail Possums. Observations within the strip width were tallied and divided by the area surveyed to estimate population density, which was then used to estimate total population size by extrapolating across the entire fenced area.

### Southern Hairy-nosed Wombats

The number of active burrows was multiplied by a burrow occupancy rate (0.43) to estimate population size, drawing on research by Swinbourne et al. (2018).

### Threatened plants

All plants were counted at the three reintroduction sites inside Stage 1 to provide a population count for both reintroduced plant species.

## Results

### Biodiversity indicators

#### Reintroduced mammals

Broadly, results for 2020 show ongoing impacts from record dry conditions in 2018-19 on populations of reintroduced mammals on Yookamurra. Declines were observed in populations of Numbats, Bilbies and Brush-tailed Bettongs; however, the Burrowing Bettong population showed some signs of recovery in response to good rainfall in August 2020. More details on each species are presented below.

#### Numbat

The Numbat population has remained relatively stable over the last five years, however there was a decline observed in 2020 with a population estimate of c. 20 (Figure 14), noting that the results of transect surveys are not robust when population sizes are low. Nevertheless, a decline would be consistent with the expected impact of record dry conditions. Given the return of average rainfall in 2020, it is expected that the Numbat population will increase in response.

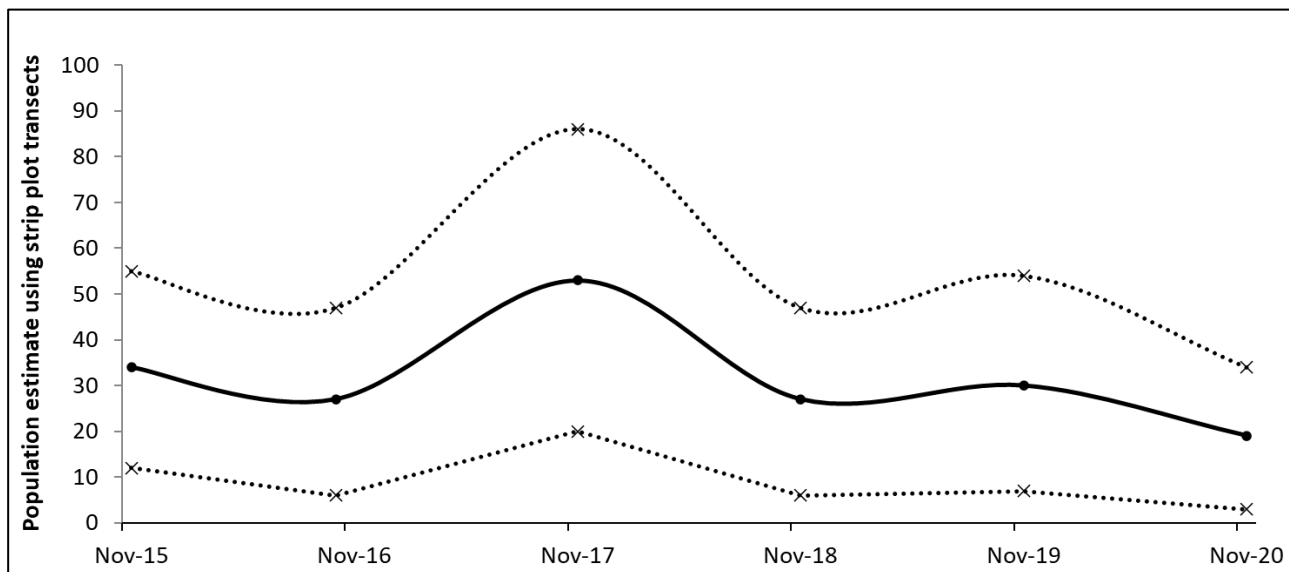


Figure 14. Numbat population estimate at Yookamurra. Dashed line = 95% confidence intervals.

#### Greater Bilby

Population estimates of Greater Bilbies on Yookamurra are presented in Figure 15.

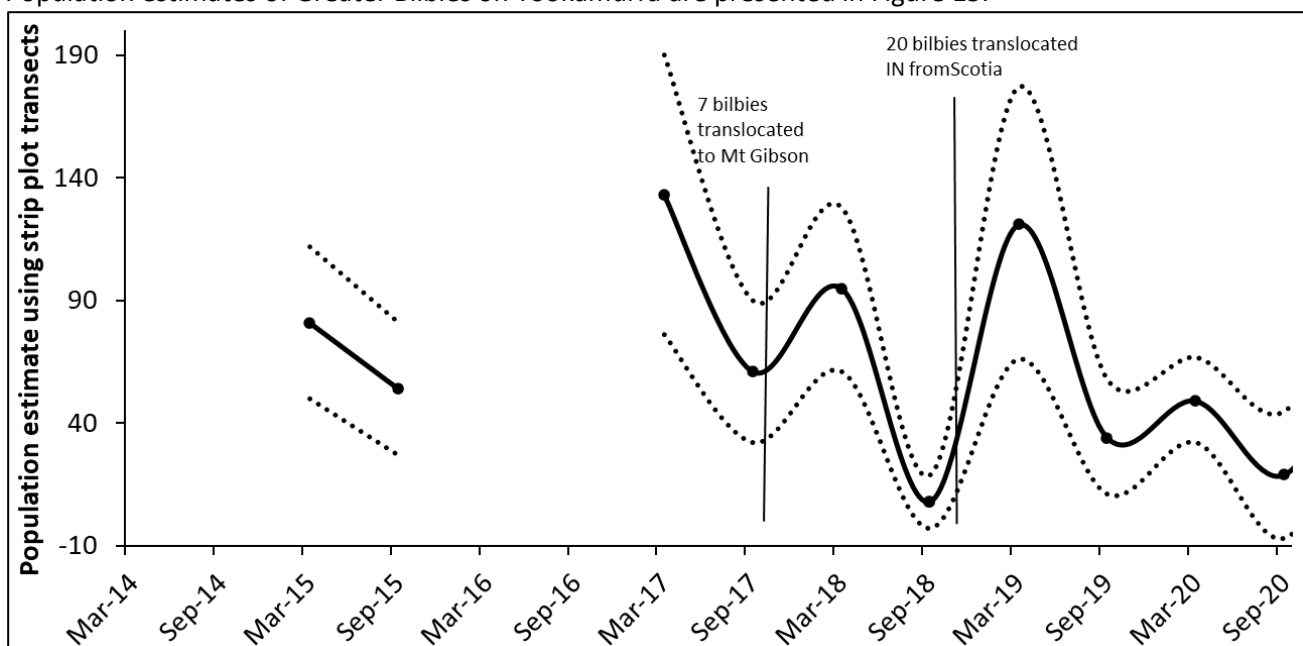
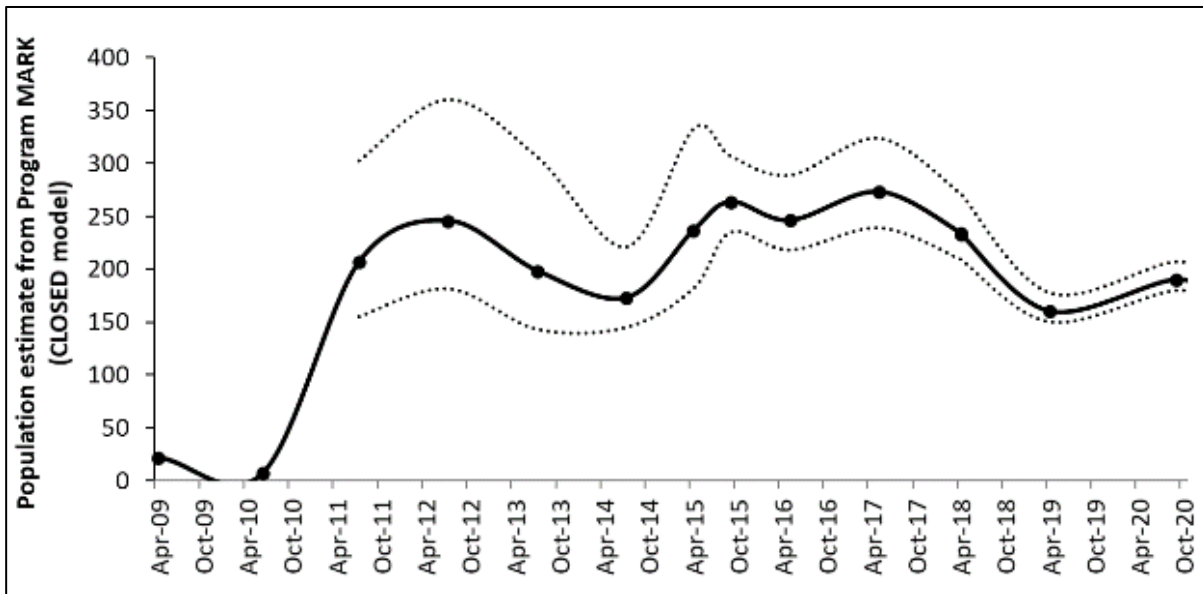


Figure 15. Bilby population estimates at Yookamurra. Dashed line = 95% confidence intervals.

The autumn survey is typically inflated by juvenile Bilbies entering the population following summer rains. Based on data from each season, it is clear the Bilby population has declined on Yookamurra in the last two years. As for the Numbat, the reported decline is plausibly explained as a response to record dry conditions (fluctuations in population size are reported for remnant Bilby populations: Southgate et al. 2007), and it is expected that the population will recover with the return of average rainfall conditions.

### **Burrowing Bettong**

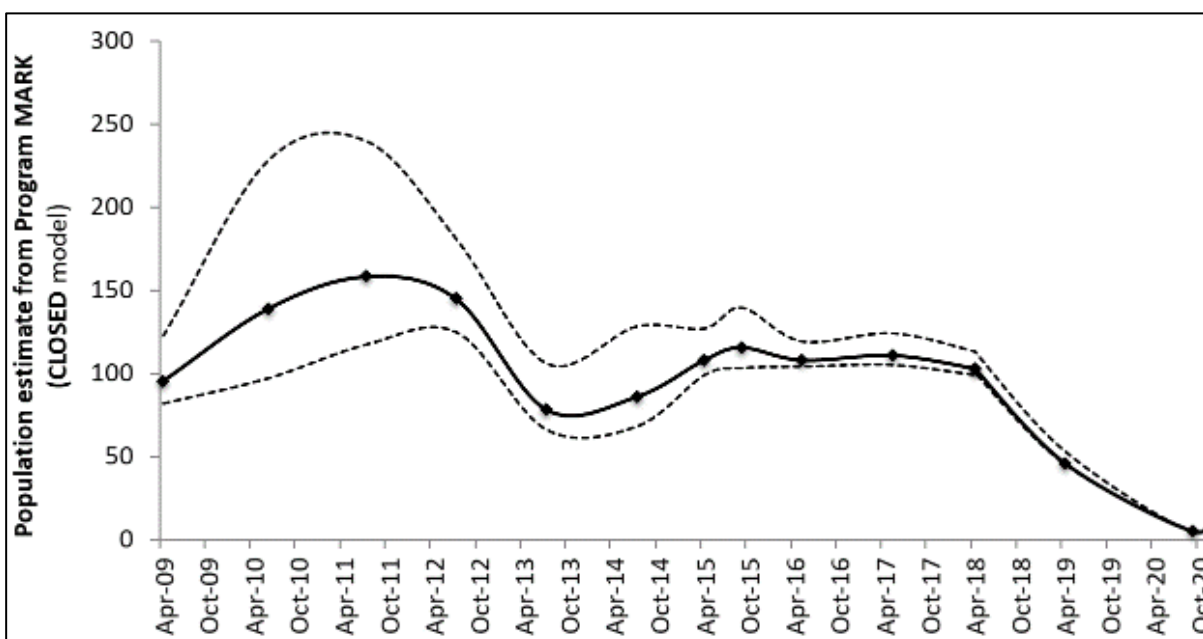
The Burrowing Bettong population on Yookamurra has remained relatively stable over the last eight years with around 200-250 individuals (Figure 16). Surveys show a decline in the population from 2017-2019, coinciding with the record drought. In 2020, the population was estimated at 190 (range 180-207), an increase from the previous year. Over 50% of females trapped in the 2020 survey were carrying pouch young. These results were encouraging, suggesting a recovery in the population in response to higher rainfall in 2020. A similar recovery has been observed in the Burrowing Bettong population on Scotia Wildlife Sanctuary.



**Figure 16. Burrowing Bettong population estimates at Yookamurra.** Dashed line = 95% confidence intervals.

### **Brush-tailed Bettong**

Unlike Burrowing Bettongs, populations of the Brush-tailed Bettong on Yookamurra (and Scotia) have not recovered from major declines incurred during the 2018-19 drought (Figure 17).



**Figure 17. Brush-tailed Bettong population estimates at Yookamurra.** Dashed line = 95% confidence intervals.

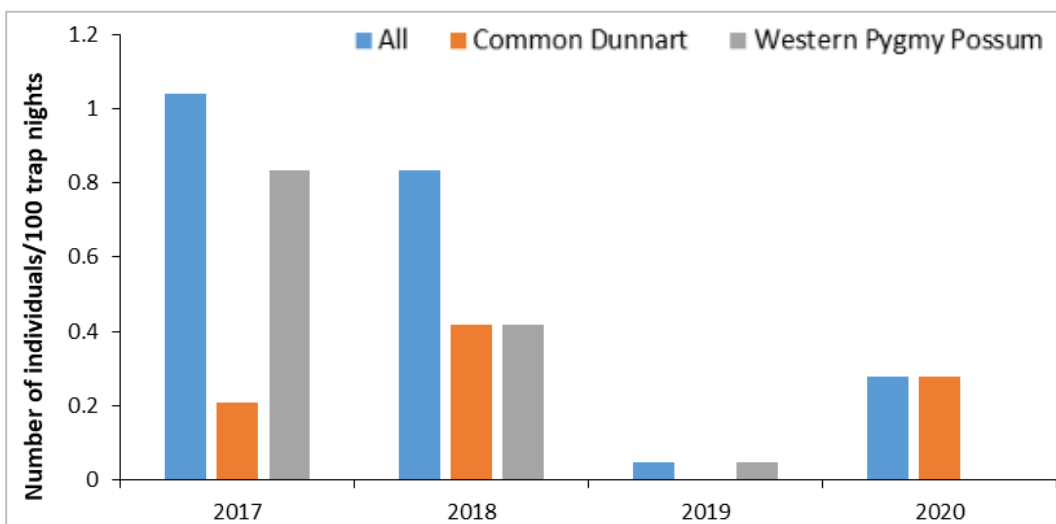
At Yookamurra, numbers of Brush-tailed Bettongs have fallen from a long-term size of around 100 individuals to less than 20 individuals in 2020 (noting that survey methods are not robust for small populations). Given these results, AWC decided to translocate Brush-tailed Bettongs from Scotia to Yookamurra at the end of 2020, pooling populations to limit inbreeding. AWC is currently developing a plan to guide long-term management of Brush-tailed Bettongs at Yookamurra and inform their reintroduction to Scotia.

### **Common Brushtail Possum**

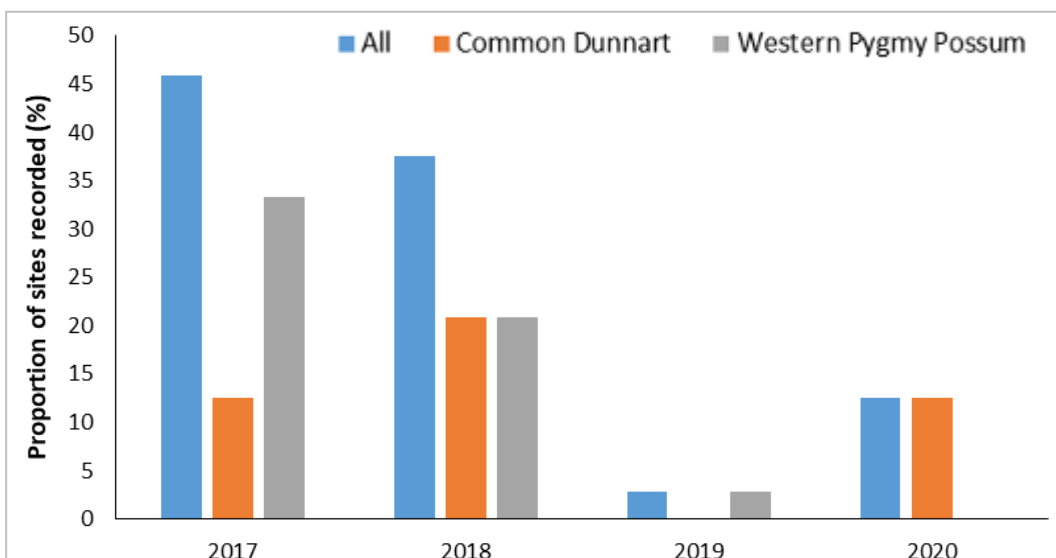
Spotlight surveys have been conducted for the Common Brushtail Possum on Yookamurra for several years, although different survey methods preclude direct comparison of results. In 2020, a total of 90 possums were observed during the 8 nights (16 sessions) of survey, all within the fenced area. No possums were observed outside Stage 1. Within the fenced area, possum observations were distributed across all transects and habitat types. Population was estimated at 91 (range 60 – 122). Previous surveys have estimated around 200-300 possums in the fenced area at Yookamurra, sufficient to allow the harvest of 80 possums for a translocation to the Flinders Ranges in 2015. A decline in population size in 2020 was expected, given the record dry conditions in 2018-19.

### **Extant small-medium mammals**

In 2020, only the Common Dunnart was detected during surveys. In 2019, at the height of the drought, no dunnarts were detected, and the abundance of Western Pygmy Possums was very low (Figure 18). Western Pygmy Possums were more commonly detected prior to the drought, while the abundance of Common Dunnarts varied between years. Values for occupancy followed the same trends as for abundance, with a decline to low numbers at the height of the drought, and a partial recovery in 2020 (Figure 19).



**Figure 18. Abundance of all small mammals (guild) and species compared across years at Yookamurra**

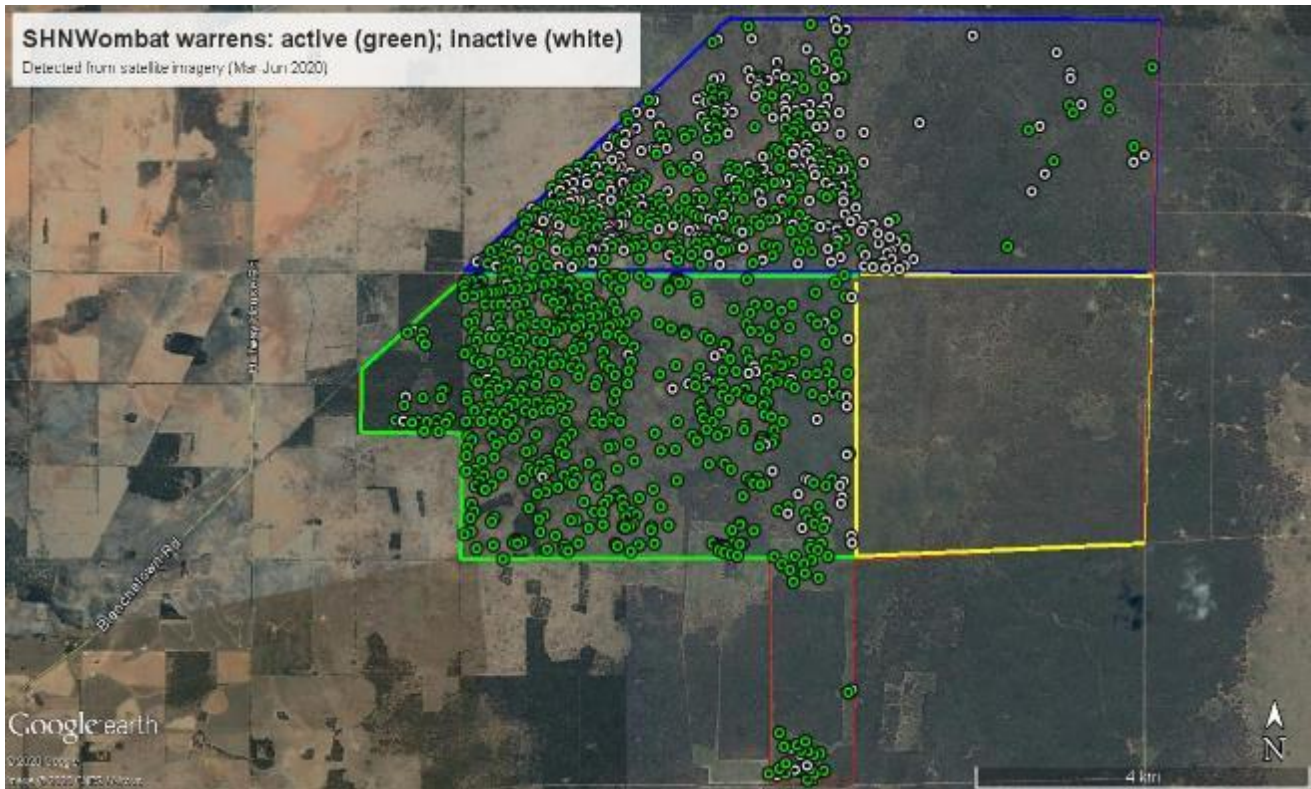


**Figure 19. Occupancy of all small mammals (guild) and species compared across years at Yookamurra**

## Small-medium sized mammals (reintroduced species)

### Southern Hairy-nosed Wombat

In 2020, a targeted survey was carried out to estimate the population of Southern Hairy-nosed Wombats at Yookamurra. A total of 1,499 potential warren sites were mapped and visited, of which 1,169 were actually warrens, and 72% of actual warrens were active (Figure 20). In total, there were 4,928 active burrows (each warren typically has multiple burrows), which equates to a conservative population of over 2,100 Southern Hairy-nosed Wombats on Yookamurra (a population density of 0.54 wombats/ha), with over half of this population (n=1,279) located on the west block (Figure 20).



**Figure 20. Active and inactive wombat warrens at Yookamurra Wildlife Sanctuary**

The estimate of a large number of wombats on Yookamurra is consistent with field observations, including the number of wombats observed on warrens and during opportunistic spotlighting, the extent of suitable habitat (particularly to the west of Stage 1), and the number of warrens that evident in satellite imagery and old aerial photographs.

There were marked differences in the distribution of active warrens across the property, primarily driven by habitat-type. In the west block, which is dominated by chenopod shrubland, 93% of warrens were active. In contrast, in the northern block, which is dominated by large tracts of mallee, only 29% of warrens were active.

A total of 83 wombats were seen during the survey and none had visual evidence of mange. All but a couple of older individuals appeared in good condition.

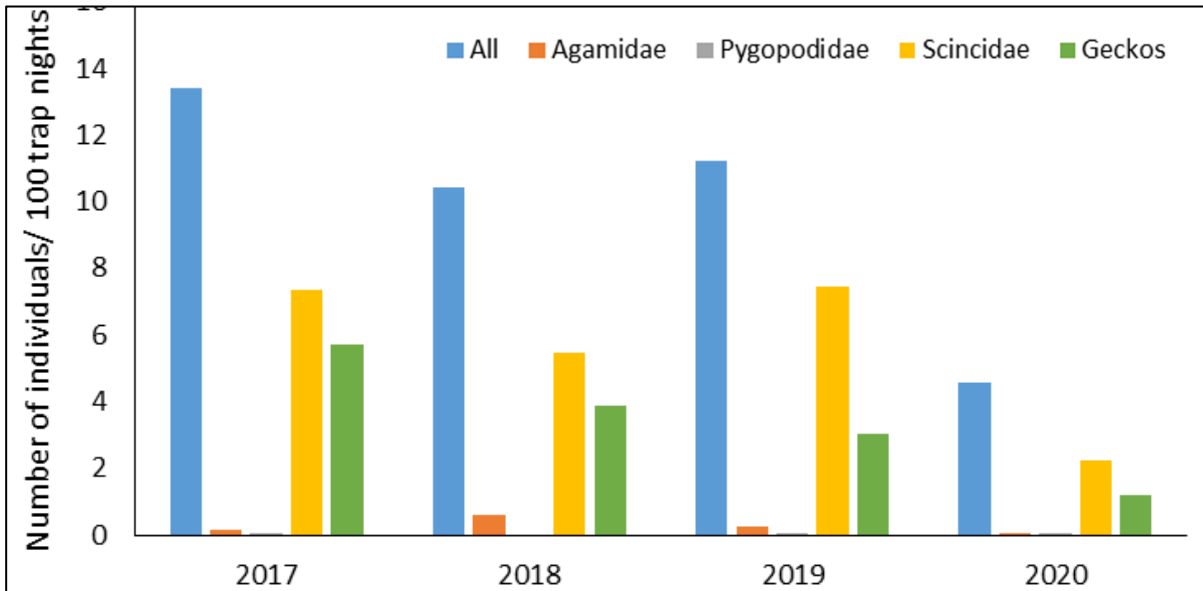
This was the first time the survey had been conducted, providing a baseline for future years. This result is extremely encouraging given the below-average rainfall for the last three consecutive years, although Southern Hairy-nosed Wombats are known to be tolerant of drought conditions, with an extremely efficient water-use physiology (Wells 1973).

### Small-medium reptiles

Reptiles are notably diverse component of the vertebrate fauna of Yookamurra. Fifty-one species of small-medium reptiles (skinks, dragons, geckos, blind snakes, pygopodids), 12 snakes, and one species of goanna are known or likely to inhabit Yookamurra (see Appendix 1). Three reptiles (all snakes) are listed as rare in South Australia; the Bardick (*Echiopsis curta*), Murray Darling Carpet Python (*Morelia spilota metcalfei*) and Eastern Bandy Bandy (*Vermicella annulata*), the two latter species confirmed on the property. The presence of the Carpet Python on Yookamurra is particularly significant as existing records are largely from along the edges of

the Murray River and not in mallee vegetation. Although not captured during a formal survey, Carpet Pythons were detected opportunistically during other surveys and land management activities in 2020.

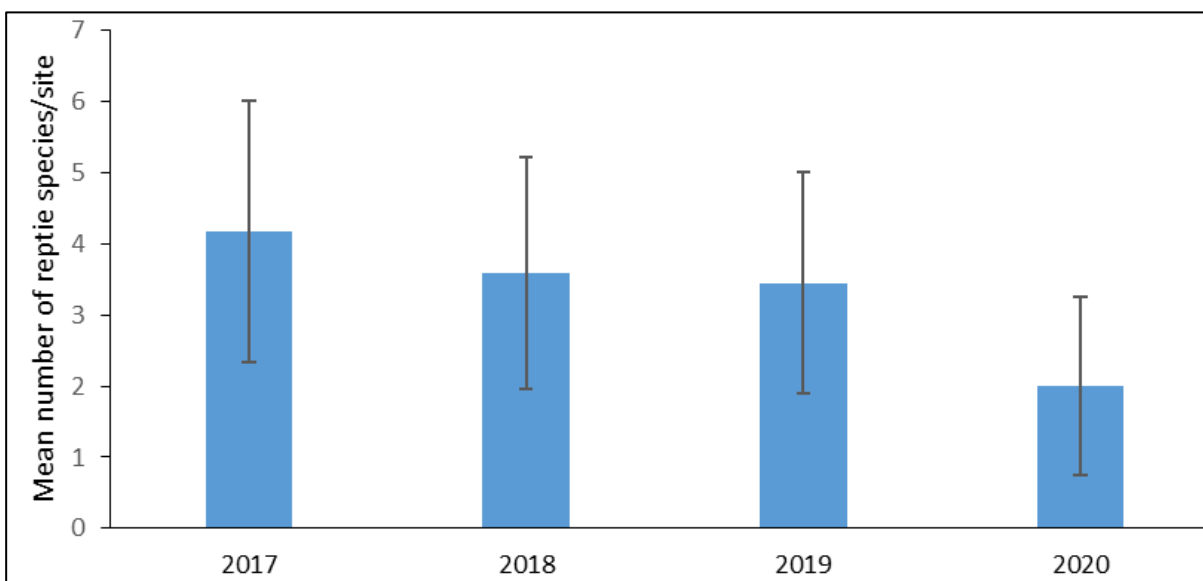
A total of 66 individual captures across 17 reptile species were recorded during surveys in 2020. All metrics were lower in 2020 compared to previous years. Abundance was well down from previous years across reptiles as a whole (4.6 individuals/100TN) and also across all four indicator guilds, most likely due to preceding dry conditions but also likely due to unseasonably low diurnal and overnight temperatures during the October survey (Figure 21). The Oriental Skink was the most frequently caught reptile species (17 individuals captured), followed by Bynoe's Prickly Gecko (14 individuals captured), then the Barking Gecko (7 individuals).



**Figure 21. Abundance of all reptile species (guild) and indicator guilds at Yookamurra, 2017-20.**

Reptiles occupied 88% of all sites during the survey. This was a decline from the previous year where 100% sites were occupied. Species richness for all reptiles was lower compared to previous years with an average of 2 species recorded per site (+/-0.3 se) (Figure 22).

Very low numbers of the 8 reptile indicator species were captured during 2020, with only one species, Bynoe's Prickly Gecko found to have a slight increase in abundance (2020: 1 individual/100TN; 2019: 0.8) and occupancy (2020 46%; 2019 36%).



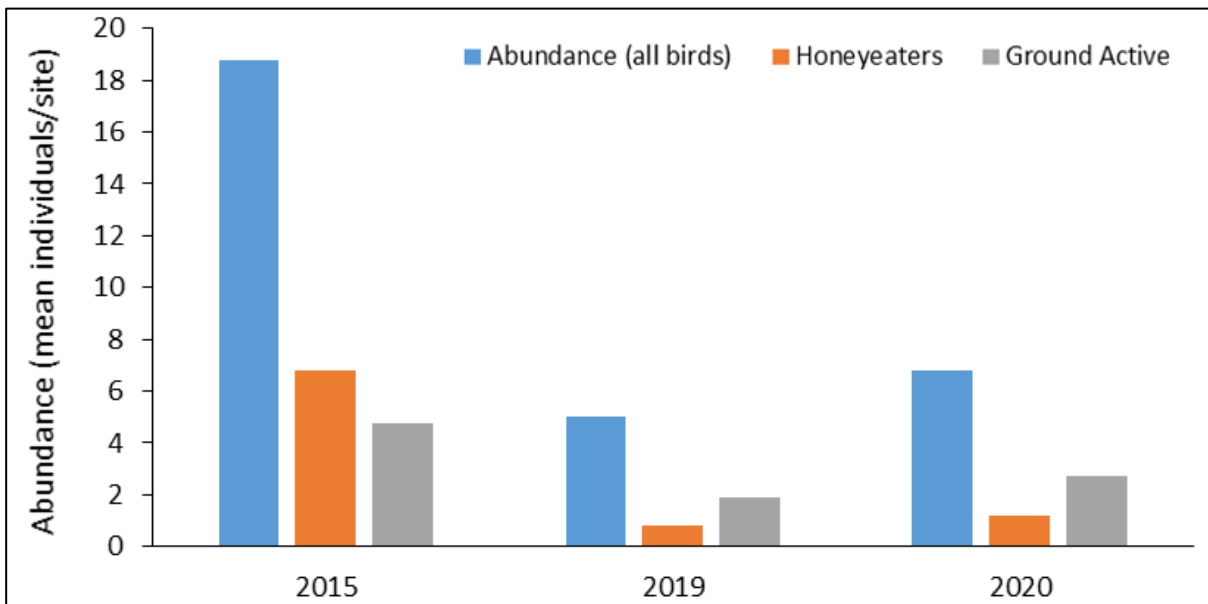
**Figure 22. Mean species richness per site (+/- SD) of all reptile species at Yookamurra, 2017-20.**

## Birds

Bird surveys were conducted in early spring 2020. While Yookamurra experienced record drought in 2019, rainfall returned to average in 2020, with a very wet August prior to the survey. As a result, during the bird survey, 94% of survey sites had some form of vegetation in flower, compared to 44% the previous year.

A total of 67 native bird species were recorded during the survey, slightly higher than in the previous year, with an average of 6.8 birds ( $\pm 0.8$  se) recorded per survey across all sites, and an average of 2.4 ( $\pm 0.2$  se) species recorded per survey across all sites. Ground-active birds were the most abundant and widespread guild, followed by honeyeaters (Figure 23).

Bird abundance and richness were higher in 2020 than 2019, but still well below results from 2015, prior to the drought (Figure 23).



**Figure 23. Mean abundance of honeyeaters, ground-active birds and all birds, at Yookamurra, 2015, 2019 and 2020.**

Two bird species recorded during this survey had not previously been detected on Yookamurra: the Little Buttonquail (*Turnix velox*) and Pied Butcherbird (*Cracticus nigrogularis*). The Galah (*Eolophus roseicapilla*) was the most frequently sighted species across all habitats. Budgerigars (*Melopsittacus undulatus*; only confirmed last year) were recorded at multiple sites across Yookamurra this year, along with White-fronted Chats (*Epthianura albifrons*) in response to the recent rain. A single Brown Quail (*Coturnix ypsilophora*; listed as Rare in SA) was also observed during the survey.

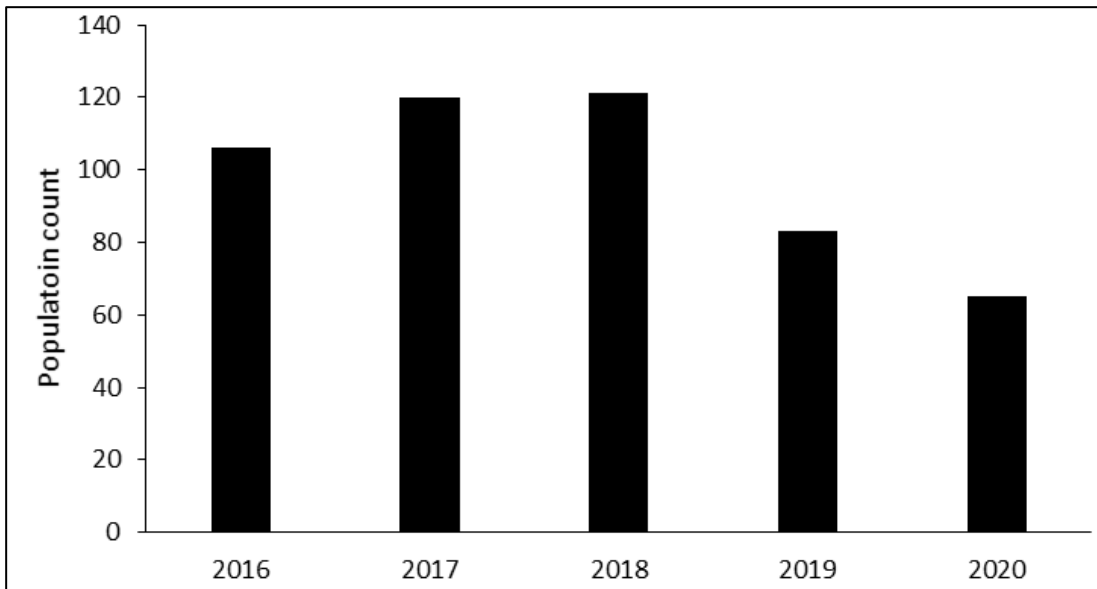
The Southern Scrub-robin was detected at 47% sites during the survey in 2020, much higher than 2019 (28%), and also higher than 2015 (39%).

## Malleefowl

The Malleefowl is a threatened ground-active bird, susceptible to predation by feral predators. Malleefowl are difficult to detect using standard bird survey techniques. Instead, Malleefowl breeding activity can be monitored by inspection of their distinctive mounds. On Yookamurra, Malleefowl mounds have been located through ground searches, all outside the fenced area. From 2008-15, one active Malleefowl mound was known on Yookamurra; this increased to two from 2016-18. At the height of the drought, in 2019, both known mounds were inactive. In 2020, a third mound was discovered during wombat surveys. Surveys found two of the three mounds were active in 2020, with Malleefowl observed at both the active mounds.

## Vegetation – threatened plants

Impacts of the severe drought on the reintroduced Desert Phebalium have continued into 2020, despite the return of higher rainfall. In 2019, the number of live plants declined from 121 to 83 plants. Declines continued into 2020, despite supplementary watering, with a total of 65 individuals recorded (Figure 24).



**Figure 24. Population count of the reintroduced Desert Phebalium plant at Yookamurra.**

The reintroduced population of Peep Hill Hopbush has also continued to decline, with three plants alive in 2020, down from seven in 2019. Yookamurra likely provides only marginal habitat for this species.

## Discussion

The survey results reported here show that most wildlife and their habitats on Yookamurra continue to be adversely affected by the record drought experienced in 2018-19. Populations of three of the four species of reintroduced mammals and both species of reintroduced threatened plants have continued to decline into 2020, and small mammals, reptiles and birds were all less abundant in 2020 than prior to the drought. Nevertheless, there were signs of recovery in some assemblages, following a return of average rainfall conditions during 2020, with an increased number of Burrowing Bettongs, small mammals and birds than at the height of the drought in 2019. The surveys showed that Yookamurra supports a substantial number of Southern Hairy-nosed Wombats, and is likely an important stronghold for this species in the wider Murraylands region.

## Acknowledgments

AWC acknowledges the Nganguraku people from the Ngarrindjeri Nation as the Traditional Custodians of the country on which Yookamurra resides. We also acknowledge their continuing connection to land, culture and community. We pay our respects to Nganguraku people from the Ngarrindjeri Nation Elders past present and emerging.

AWC's Ecohealth Program is only possible because of the generosity of AWC's supporters. Ecohealth surveys at Yookamurra would not be possible without the input from amazing volunteers and interns. In 2020, special thanks go to Johanna Kuhne (AWC intern), Susie Stockwell and Bart Peek (Spike).

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## Appendix 1. Native vertebrate species list, Yookamurra Wildlife Sanctuary.

**Bold** = Ground Active bird species

Class	Order	Family	Scientific Name	Common Name	Likelihood	EPBC Species	State Species and Subspecies
Amphibia	Anura	Limnodynastidae	<i>Limnodynastes dumerilii</i>	Eastern Banjo Frog	Confirmed		
Amphibia	Anura	Limnodynastidae	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog	Confirmed		
Amphibia	Anura	Limnodynastidae	<i>Neobatrachus pictus</i>	Painted Frog	Confirmed		
Amphibia	Anura	Limnodynastidae	<i>Neobatrachus sudellae</i>	Sudell's Frog	Confirmed		
Aves	Accipitriformes	Accipitridae	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk	Confirmed		
Aves	Accipitriformes	Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk	Confirmed		
Aves	Accipitriformes	Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle	Confirmed		
Aves	Accipitriformes	Accipitridae	<i>Circus assimilis</i>	Spotted Harrier	Confirmed		
Aves	Accipitriformes	Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite	Confirmed		
Aves	Accipitriformes	Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite	Confirmed		
Aves	Accipitriformes	Accipitridae	<i>Hieraaetus morphnoides</i>	Little Eagle	Confirmed		Vulnerable
Aves	Accipitriformes	Accipitridae	<i>Milvus migrans</i>	Black Kite	Confirmed		
Aves	Anseriformes	Anatidae	<i>Anas gracilis</i>	Grey Teal	Confirmed		
Aves	Anseriformes	Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck	Confirmed		
Aves	Apodiformes	Aegothelidae	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar	Confirmed		
Aves	Caprimulgiformes	Caprimulgidae	<i>Eurostopodus argus</i>	Spotted Nightjar	Confirmed		
Aves	Caprimulgiformes	Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth	Confirmed		
<b>Aves</b>	<b>Casuariiformes</b>	<b>Casuariidae</b>	<b><i>Dromaius novaehollandiae</i></b>	<b>Emu</b>	<b>Confirmed</b>		
Aves	Charadriiformes	Burhinidae	<i>Burhinus grallarius</i>	Bush Stone-curlew	Very Likely		Rare
Aves	Charadriiformes	Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	Very Likely		
Aves	Charadriiformes	Charadriidae	<i>Vanellus tricolor</i>	Banded Lapwing	Very Likely		
<b>Aves</b>	<b>Charadriiformes</b>	<b>Turnicidae</b>	<b><i>Turnix varius varius</i></b>	<b>Painted Buttonquail</b>	<b>Confirmed</b>		<b>Rare</b>
<b>Aves</b>	<b>Columbiformes</b>	<b>Columbidae</b>	<b><i>Geopelia placida</i></b>	<b>Peaceful Dove</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Columbiformes</b>	<b>Columbidae</b>	<b><i>Ocyphaps lophotes</i></b>	<b>Crested Pigeon</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Columbiformes</b>	<b>Columbidae</b>	<b><i>Phaps chalcoptera</i></b>	<b>Common Bronzewing</b>	<b>Confirmed</b>		

Class	Order	Family	Scientific Name	Common Name	Likelihood	EPBC Species	State Species and Subspecies
<b>Aves</b>	<b>Columbiformes</b>	<b>Columbidae</b>	<i>Phaps elegans</i>	<b>Brush Bronzewing</b>	<b>Confirmed</b>		
Aves	Coraciiformes	Alcedinidae	<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher	Confirmed		
Aves	Coraciiformes	Alcedinidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher	Possible		
Aves	Coraciiformes	Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	Confirmed		
Aves	Cuculiformes	Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	Confirmed		
Aves	Cuculiformes	Cuculidae	<i>Cacomantis pallidus</i>	Pallid Cuckoo	Confirmed		
Aves	Cuculiformes	Cuculidae	<i>Chrysococcyx basalis</i>	Horsfield's Bronze Cuckoo	Confirmed		
Aves	Cuculiformes	Cuculidae	<i>Chrysococcyx osculans</i>	Black-eared Cuckoo	Confirmed		
Aves	Falconiformes	Falconidae	<i>Falco berigora</i>	Brown Falcon	Confirmed		
Aves	Falconiformes	Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel	Confirmed		
Aves	Falconiformes	Falconidae	<i>Falco longipennis</i>	Australian Hobby	Confirmed		
Aves	Falconiformes	Falconidae	<i>Falco peregrinus</i>	Peregrine Falcon	Confirmed		Rare
Aves	Falconiformes	Falconidae	<i>Falco subniger</i>	Black Falcon	Likely		Rare
<b>Aves</b>	<b>Galliformes</b>	<b>Megapodiidae</b>	<i>Leipoa ocellata</i>	<b>Malleefowl</b>	<b>Confirmed</b>	<b>Vulnerable</b>	<b>Vulnerable</b>
<b>Aves</b>	<b>Galliformes</b>	<b>Phasianidae</b>	<i>Coturnix ypsilophora</i>	<b>Brown Quail</b>	<b>Confirmed</b>		
Aves	Passeriformes	Acanthizidae	<i>Acanthiza apicalis</i>	Inland Thornbill	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Acanthizidae</b>	<i>Acanthiza chrysorrhoa</i>	<b>Yellow-rumped Thornbill</b>	<b>Confirmed</b>		
Aves	Passeriformes	Acanthizidae	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill	Confirmed		
Aves	Passeriformes	Acanthizidae	<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Acanthizidae</b>	<i>Aphelocephala leucopsis</i>	<b>Southern Whiteface</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Passeriformes</b>	<b>Acanthizidae</b>	<i>Hylacola cauta cauta</i>	<b>Shy Heathwren</b>	<b>Confirmed</b>		<b>Rare</b>
Aves	Passeriformes	Acanthizidae	<i>Smicrornis brevirostris</i>	Weebill	Confirmed		
Aves	Passeriformes	Artamidae	<i>Artamus cinereus</i>	Black-faced Woodswallow	Confirmed		
Aves	Passeriformes	Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow	Confirmed		
Aves	Passeriformes	Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	Likely		
Aves	Passeriformes	Artamidae	<i>Artamus personatus</i>	Masked Woodswallow	Confirmed		
Aves	Passeriformes	Artamidae	<i>Artamus superciliosus</i>	White-browed Woodswallow	Confirmed		
Aves	Passeriformes	Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	Confirmed		

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<b>Aves</b>	<b>Passeriformes</b>	<b>Artamidae</b>	<b><i>Gymnorhina tibicen</i></b>	<b>Australian Magpie</b>	<b>Confirmed</b>		
Aves	Passeriformes	Artamidae	<i>Strepera versicolor</i>	Grey Currawong	Confirmed		
Aves	Passeriformes	Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckooshrike	Confirmed		
Aves	Passeriformes	Campephagidae	<i>Lalage tricolor</i>	White-winged Triller	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Cinclosomatidae</b>	<b><i>Cinclosoma castanotum</i></b>	<b>Chestnut Quail-thrush</b>	<b>Confirmed</b>		<b>Rare</b>
<b>Aves</b>	<b>Passeriformes</b>	<b>Climacteridae</b>	<b><i>Climacteris picumnus</i></b>	<b>Brown Treecreeper</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Passeriformes</b>	<b>Corcoracidae</b>	<b><i>Corcorax melanorhamphos</i></b>	<b>White-winged Chough</b>	<b>Confirmed</b>		<b>Rare</b>
Aves	Passeriformes	Corvidae	<i>Corvus bennetti</i>	Little Crow	Confirmed		
Aves	Passeriformes	Corvidae	<i>Corvus coronoides</i>	Australian Raven	Confirmed		
Aves	Passeriformes	Corvidae	<i>Corvus mellori</i>	Little Raven	Confirmed		
Aves	Passeriformes	Dicaeidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird	Confirmed		
Aves	Passeriformes	Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	Confirmed		
Aves	Passeriformes	Hirundinidae	<i>Petrochelidon nigricans</i>	Tree Martin	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Maluridae</b>	<b><i>Malurus assimilis</i></b>	<b>Purple-backed Fairywren</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Passeriformes</b>	<b>Maluridae</b>	<b><i>Malurus leucopterus</i></b>	<b>White-winged Fairywren</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Passeriformes</b>	<b>Maluridae</b>	<b><i>Malurus splendens</i></b>	<b>Splendid Fairywren</b>	<b>Confirmed</b>		
Aves	Passeriformes	Meliphagidae	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Anthochaera carunculata</i>	Red Wattlebird	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Caligavis chrysops</i>	Yellow-faced Honeyeater	Very Likely		
Aves	Passeriformes	Meliphagidae	<i>Epthianura albifrons</i>	White-fronted Chat	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Meliphagidae</b>	<b><i>Epthianura aurifrons</i></b>	<b>Orange Chat</b>	<b>Confirmed</b>		
Aves	Passeriformes	Meliphagidae	<i>Gavicalis virescens</i>	Singing Honeyeater	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Gliciphila melanops</i>	Tawny-crowned Honeyeater	Likely		
Aves	Passeriformes	Meliphagidae	<i>Lichenostomus cratitius occidentalis</i>	Mainland Purple-gaped Honeyeater	Very Likely		Rare
Aves	Passeriformes	Meliphagidae	<i>Manorina flavigula</i>	Yellow-throated Miner	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	Confirmed		

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Aves	Passeriformes	Meliphagidae	<i>Melithreptus lunatus</i>	White-naped Honeyeater	Likely		
Aves	Passeriformes	Meliphagidae	<i>Nesoptilotis leucotis</i>	White-eared Honeyeater	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater	Confirmed		Rare
Aves	Passeriformes	Meliphagidae	<i>Ptilotula ornata</i>	Yellow-plumed Honeyeater	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Ptilotula penicillata</i>	White-plumed Honeyeater	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Purnella albifrons</i>	White-fronted Honeyeater	Confirmed		
Aves	Passeriformes	Meliphagidae	<i>Sugomel niger</i>	Black Honeyeater	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Monarchidae</b>	<b><i>Grallina cyanoleuca</i></b>	<b>Magpie-lark</b>	<b>Confirmed</b>		
Aves	Passeriformes	Monarchidae	<i>Myiagra inquieta</i>	Restless Flycatcher	Confirmed		Rare
<b>Aves</b>	<b>Passeriformes</b>	<b>Motacillidae</b>	<b><i>Anthus australis</i></b>	<b>Australian Pipit</b>	<b>Confirmed</b>		
Aves	Passeriformes	Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella	Confirmed		
Aves	Passeriformes	Oreoicidae	<i>Oreoica gutturalis</i>	Crested Bellbird	Confirmed		
Aves	Passeriformes	Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrikethrush	Confirmed		
Aves	Passeriformes	Pachycephalidae	<i>Pachycephala inornata</i>	Gilbert's Whistler	Confirmed		Rare
Aves	Passeriformes	Pachycephalidae	<i>Pachycephala pectoralis</i>	Australian Golden Whistler	Confirmed		
Aves	Passeriformes	Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler	Confirmed		
Aves	Passeriformes	Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	Confirmed		
Aves	Passeriformes	Pardalotidae	<i>Pardalotus striatus</i>	Striated Pardalote	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Petroicidae</b>	<b><i>Drymodes brunneopygia</i></b>	<b>Southern Scrub Robin</b>	<b>Confirmed</b>		
Aves	Passeriformes	Petroicidae	<i>Melanodryas cucullata cucullata</i>	South-eastern Hooded Robin	Confirmed		Rare
Aves	Passeriformes	Petroicidae	<i>Microeca fascians fascians</i>	Eastern Jacky Winter	Confirmed		Rare
Aves	Passeriformes	Petroicidae	<i>Petroica boodang boodang</i>	Eastern Scarlet Robin	Very Likely		Rare
Aves	Passeriformes	Petroicidae	<i>Petroica goodenovii</i>	Red-capped Robin	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Pomatostomidae</b>	<b><i>Pomatostomus ruficeps</i></b>	<b>Chestnut-crowned Babbler</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Passeriformes</b>	<b>Pomatostomidae</b>	<b><i>Pomatostomus superciliosus</i></b>	<b>White-browed Babbler</b>	<b>Confirmed</b>		

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Aves	Passeriformes	Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail	Confirmed		
<b>Aves</b>	<b>Passeriformes</b>	<b>Rhipiduridae</b>	<b><i>Rhipidura leucophrys</i></b>	<b>Willie Wagtail</b>	<b>Confirmed</b>		
Aves	Passeriformes	Zosteropidae	<i>Zosterops lateralis</i>	Silvereye	Confirmed		
Aves	Pelecaniformes	Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican	Confirmed		
Aves	Podicipediformes	Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	Confirmed		
Aves	Psittaciformes	Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	Confirmed		
<b>Aves</b>	<b>Psittaciformes</b>	<b>Cacatuidae</b>	<b><i>Cacatua sanguinea</i></b>	<b>Little Corella</b>	<b>Confirmed</b>		
<b>Aves</b>	<b>Psittaciformes</b>	<b>Cacatuidae</b>	<b><i>Eolophus roseicapilla</i></b>	<b>Galah</b>	<b>Confirmed</b>		
Aves	Psittaciformes	Cacatuidae	<i>Lophochroa leadbeateri leadbeateri</i>	Eastern Major Mitchell's Cockatoo	Likely		Rare
Aves	Psittaciformes	Cacatuidae	<i>Nymphicus hollandicus</i>	Cockatiel	Very Likely		
Aves	Psittaciformes	Psittaculidae	<i>Barnardius zonarius</i>	Australian Ringneck	Confirmed		
Aves	Psittaciformes	Psittaculidae	<i>Glossopsitta concinna</i>	Musk Lorikeet	Confirmed		
Aves	Psittaciformes	Psittaculidae	<i>Melopsittacus undulatus</i>	Budgerigar	Confirmed		
Aves	Psittaciformes	Psittaculidae	<i>Neophema chrysostoma</i>	Blue-winged Parrot	Possible		Vulnerable
<b>Aves</b>	<b>Psittaciformes</b>	<b>Psittaculidae</b>	<b><i>Neophema elegans elegans</i></b>	<b>Elegant Parrot</b>	<b>Confirmed</b>		<b>Rare</b>
Aves	Psittaciformes	Psittaculidae	<i>Northiella haematogaster</i>	Eastern Blue Bonnet	Confirmed		
Aves	Psittaciformes	Psittaculidae	<i>Parvipsitta porphyrocephala</i>	Purple-crowned Lorikeet	Confirmed		
Aves	Psittaciformes	Psittaculidae	<i>Polytelis anthopeplus monarchoides</i>	Eastern Regent Parrot	Confirmed	Vulnerable	Vulnerable
<b>Aves</b>	<b>Psittaciformes</b>	<b>Psittaculidae</b>	<b><i>Psephotellus varius</i></b>	<b>Mulga Parrot</b>	<b>Confirmed</b>		
Aves	Psittaciformes	Psittaculidae	<i>Psephotus haematonotus</i>	Red-rumped Parrot	Confirmed		
Aves	Strigiformes	Strigidae	<i>Ninox boobook</i>	Australian Boobook	Confirmed		
Aves	Strigiformes	Tytonidae	<i>Tyto javanica</i>	Eastern Barn Owl	Confirmed		
Mammalia	Chiroptera	Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tailed Bat	Possible		Rare
Mammalia	Chiroptera	Molossidae	<i>Austronomus australis</i>	White-striped Free-tailed Bat	Confirmed		
Mammalia	Chiroptera	Molossidae	<i>Ozimops petersi</i>	Inland Free-tailed Bat	Possible		

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Mammalia	Chiroptera	Molossidae	<i>Ozimops planiceps</i>	Southern Free-tailed Bat	Confirmed		
Mammalia	Chiroptera	Molossidae	<i>Ozimops ridei</i>	Ride's Free-tailed Bat	Possible		
Mammalia	Chiroptera	Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	Confirmed		
Mammalia	Chiroptera	Vespertilionidae	<i>Chalinolobus morio</i>	Chocolate Wattled Bat	Confirmed		
Mammalia	Chiroptera	Vespertilionidae	<i>Chalinolobus picatus</i>	Little Pied Bat	Possible		Endangered
Mammalia	Chiroptera	Vespertilionidae	<i>Myotis macropus</i>	Large-footed Myotis	Possible		Endangered
Mammalia	Chiroptera	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	Confirmed		
Mammalia	Chiroptera	Vespertilionidae	<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat	Likely		
Mammalia	Chiroptera	Vespertilionidae	<i>Vespadelus baverstocki</i>	Inland Forest Bat	Possible		
Mammalia	Chiroptera	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Large Forest Bat	Likely		
Mammalia	Chiroptera	Vespertilionidae	<i>Vespadelus regulus</i>	Southern Forest Bat	Confirmed		
Mammalia	Chiroptera	Vespertilionidae	<i>Vespadelus vulturnus</i>	Little Forest Bat	Likely		
Mammalia	Dasyuromorphia	Dasyuridae	<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart	Confirmed		
Mammalia	Dasyuromorphia	Dasyuridae	<i>Sminthopsis murina</i>	Common Dunnart	Confirmed		
Mammalia	Dasyuromorphia	Myrmecobiidae	<i>Myrmecobius fasciatus</i>	Numbat	Confirmed	Endangered	Endangered
Mammalia	Diprotodontia	Burramyidae	<i>Cercartetus concinnus</i>	Western Pygmy-possum	Confirmed		
Mammalia	Diprotodontia	Macropodidae	<i>Macropus fuliginosus</i>	Western Grey Kangaroo	Confirmed		
Mammalia	Diprotodontia	Macropodidae	<i>Macropus rufus</i>	Red Kangaroo	Confirmed		
Mammalia	Diprotodontia	Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum	Confirmed		Rare
Mammalia	Diprotodontia	Potoroidae	<i>Bettongia lesueur lesueur</i>	Boodie (Shark Bay)	Confirmed		Endangered
Mammalia	Diprotodontia	Potoroidae	<i>Bettongia penicillata ogilbyi</i>	Woylie	Confirmed	Endangered	Rare
Mammalia	Diprotodontia	Vombatidae	<i>Lasiorhinus latifrons</i>	Southern Hairy-nosed Wombat	Confirmed		
Mammalia	Monotremata	Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	Confirmed		
Mammalia	Peramelomorphia	Thylacomyidae	<i>Macrotis lagotis</i>	Bilby	Confirmed	Vulnerable	Vulnerable
Mammalia	Rodentia	Muridae	<i>Leporillus conditor</i>	Greater Stick-nest Rat, Wopilkara	Possible	Vulnerable	Vulnerable
Mammalia	Rodentia	Muridae	<i>Notomys mitchellii</i>	Mitchell's Hopping-mouse, Pankot	Possible		
Mammalia	Rodentia	Muridae	<i>Pseudomys australis</i>	Plains Mouse, Palyoora	Possible	Vulnerable	Vulnerable

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Mammalia	Rodentia	Muridae	<i>Pseudomys bolami</i>	Bolam's Mouse, Poonta	Possible		
Reptilia	Squamata	Agamidae	<i>Amphibolurus norrisi</i>	Mallee Tree Dragon	Confirmed		
Reptilia	Squamata	Agamidae	<i>Ctenophorus fordi</i>	Mallee Military Dragon	Very Likely		
Reptilia	Squamata	Agamidae	<i>Ctenophorus pictus</i>	Painted Dragon	Confirmed		
Reptilia	Squamata	Agamidae	<i>Diporiphora nobbi</i>	Nobbi	Confirmed		
Reptilia	Squamata	Agamidae	<i>Pogona barbata</i>	Bearded Dragon	Confirmed		
Reptilia	Squamata	Agamidae	<i>Pogona vitticeps</i>	Central Bearded Dragon	Very Likely		
Reptilia	Squamata	Agamidae	<i>Tympanocryptis petersi</i>	Lined Earless Dragon	Very Likely		
Reptilia	Squamata	Boidae	<i>Morelia spilota</i>	Carpet Python and Diamond Python	Confirmed		Rare
Reptilia	Squamata	Carphodactylidae	<i>Underwoodisaurus milii</i>	Thick-tailed Gecko	Confirmed		
Reptilia	Squamata	Diplodactylidae	<i>Diplodactylus calcicolus</i>	Eastern Stone Gecko	Confirmed		
Reptilia	Squamata	Diplodactylidae	<i>Diplodactylus furcosus</i>	Ranges Stone Gecko	Confirmed		
Reptilia	Squamata	Diplodactylidae	<i>Diplodactylus vittatus</i>	Wood Gecko	Confirmed		
Reptilia	Squamata	Diplodactylidae	<i>Lucasium damaeum</i>	Beaded Gecko	Very Likely		
Reptilia	Squamata	Diplodactylidae	<i>Rhynchoedura eyrensis</i>	Eyre Basin Beaked Gecko	Possible		
Reptilia	Squamata	Diplodactylidae	<i>Rhynchoedura ormsbyi</i>	Eastern Beaked Gecko	Very Likely		
Reptilia	Squamata	Diplodactylidae	<i>Strophurus intermedius</i>	Southern Spiny-tailed Gecko	Confirmed		
Reptilia	Squamata	Elapidae	<i>Brachyuropsis australis</i>	Coral Snake	Likely		
Reptilia	Squamata	Elapidae	<i>Demansia psammophis</i>	Yellow-faced Whipsnake	Confirmed		
Reptilia	Squamata	Elapidae	<i>Echiopsis curta</i>	Bardick	Very Likely		Rare
Reptilia	Squamata	Elapidae	<i>Parasuta nigriceps</i>	Short-tailed Snake	Confirmed		
Reptilia	Squamata	Elapidae	<i>Parasuta spectabilis</i>	Spectacled Hooded Snake	Very Likely		
Reptilia	Squamata	Elapidae	<i>Pseudechis australis</i>	Mulga Snake	Confirmed		
Reptilia	Squamata	Elapidae	<i>Pseudonaja aspidorhyncha</i>	Strap-snouted Brown Snake	Confirmed		
Reptilia	Squamata	Elapidae	<i>Pseudonaja mengdeni</i>	Western Brown Snake	Very Likely		
Reptilia	Squamata	Elapidae	<i>Pseudonaja textilis</i>	Eastern Brown Snake	Confirmed		
Reptilia	Squamata	Elapidae	<i>Suta suta</i>	Curl Snake	Very Likely		
Reptilia	Squamata	Elapidae	<i>Vermicella annulata</i>	Eastern Bandy-bandy	Confirmed		Rare

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Reptilia	Squamata	Gekkonidae	<i>Christinus marmoratus</i>	Marbled Gecko	Confirmed		
Reptilia	Squamata	Gekkonidae	<i>Gehyra lazelli</i>	Lazell's Dtella	Confirmed		
Reptilia	Squamata	Gekkonidae	<i>Gehyra versicolor</i>	Eastern Variegated Dtella	Confirmed		
Reptilia	Squamata	Gekkonidae	<i>Heteronotia binoei</i>	Bynoe's Prickly Gecko	Confirmed		
Reptilia	Squamata	Pygopodidae	<i>Aprasia inaurita</i>	Mallee Worm-lizard	Very Likely		
Reptilia	Squamata	Pygopodidae	<i>Aprasia striolata</i>	Striated Worm-lizard	Confirmed		
Reptilia	Squamata	Pygopodidae	<i>Delma australis</i>	Marble-faced Delma	Very Likely		
Reptilia	Squamata	Pygopodidae	<i>Delma butleri</i>	Unbanded Delma	Very Likely		
Reptilia	Squamata	Pygopodidae	<i>Delma inornata</i>	Patternless Delma	Very Likely		
Reptilia	Squamata	Pygopodidae	<i>Lialis burtonis</i>	Burton's Snake-lizard	Confirmed		
Reptilia	Squamata	Pygopodidae	<i>Pygopus lepidopodus</i>	Common Scaly-foot	Very Likely		
Reptilia	Squamata	Pygopodidae	<i>Pygopus schraderi</i>	Eastern Hooded Scaly-foot	Possible		
Reptilia	Squamata	Scincidae	<i>Cryptoblepharus australis</i>	Inland Snake-eyed Skink	Very Likely		
Reptilia	Squamata	Scincidae	<i>Cryptoblepharus pannosus</i>	Ragged Snake-eyed Skink	Confirmed		
Reptilia	Squamata	Scincidae	<i>Ctenotus atlas</i>	Southern Mallee Ctenotus	Possible		
Reptilia	Squamata	Scincidae	<i>Ctenotus brachyonyx</i>	Short-clawed Ctenotus	Likely		
Reptilia	Squamata	Scincidae	<i>Ctenotus orientalis</i>	Oriental Ctenotus	Confirmed		
Reptilia	Squamata	Scincidae	<i>Ctenotus regius</i>	Pale-rumped Ctenotus	Very Likely		
Reptilia	Squamata	Scincidae	<i>Ctenotus robustus</i>	Robust Ctenotus	Very Likely		
Reptilia	Squamata	Scincidae	<i>Ctenotus schomburgkii</i>	Barred Wedgesnout Ctenotus	Confirmed		
Reptilia	Squamata	Scincidae	<i>Ctenotus taeniatus</i>	Ribbon Ctenotus	Very Likely		
Reptilia	Squamata	Scincidae	<i>Egernia striolata</i>	Tree Skink	Confirmed		
Reptilia	Squamata	Scincidae	<i>Eremiascincus richardsonii</i>	Broad-banded Sand-swimmer	Confirmed		
Reptilia	Squamata	Scincidae	<i>Hemiergis decresiensis</i>	Three-toed Earless Skink	Confirmed		
Reptilia	Squamata	Scincidae	<i>Hemiergis millewae</i>	Triodia Earless Skink	Very Likely		
Reptilia	Squamata	Scincidae	<i>Hemiergis peronii</i>	Lowlands Earless Skink	Confirmed		
Reptilia	Squamata	Scincidae	<i>Lerista bougainvillii</i>	South-eastern Slider	Very Likely		
Reptilia	Squamata	Scincidae	<i>Lerista dorsalis</i>	Southern Slider	Confirmed		

Class	Order	Family	Scientific Name	Common Name	Likelihood	EPBC Species	State Species and Subspecies
Reptilia	Squamata	Scincidae	<i>Lerista punctatovittata</i>	Eastern Robust Slider	Confirmed		
Reptilia	Squamata	Scincidae	<i>Lerista timida</i>	Timid Slider	Likely		
Reptilia	Squamata	Scincidae	<i>Liopholis inornata</i>	Desert Skink	Very Likely		
Reptilia	Squamata	Scincidae	<i>Menetia greyii</i>	Common Dwarf Skink	Confirmed		
Reptilia	Squamata	Scincidae	<i>Morethia adelaidensis</i>	Saltbush Morethia Skink	Very Likely		
Reptilia	Squamata	Scincidae	<i>Morethia boulengeri</i>	South-eastern Morethia Skink	Confirmed		
Reptilia	Squamata	Scincidae	<i>Morethia obscura</i>	Shrubland Morethia Skink	Confirmed		
Reptilia	Squamata	Scincidae	<i>Tiliqua occipitalis</i>	Western Blue-tongued Lizard	Confirmed		
Reptilia	Squamata	Scincidae	<i>Tiliqua rugosa</i>	Shingle-back	Confirmed		
Reptilia	Squamata	Scincidae	<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard	Likely		
Reptilia	Squamata	Typhlopidae	<i>Anilius bicolor</i>	Dark-spined Blind Snake	Confirmed		
Reptilia	Squamata	Typhlopidae	<i>Anilius bituberculatus</i>	Prong-snouted Blind Snake	Confirmed		
Reptilia	Squamata	Varanidae	<i>Varanus gouldii</i>	Gould's Goanna	Confirmed		

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Enquiries should be made to [John.Kanowski@australianwildlife.org](mailto:John.Kanowski@australianwildlife.org)