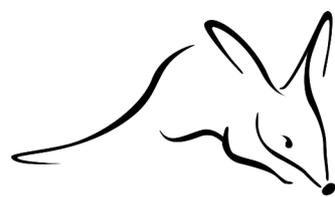


# Buckaringa Wildlife Sanctuary Ecohealth Report 2021



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## Summary

Australian Wildlife Conservancy (AWC) has implemented an Ecological Health Monitoring Program (Ecohealth) across Buckaringa Wildlife Sanctuary (Buckaringa) to measure the changes in the status and trend of conservation assets and threats to those assets. Metrics from the program are reported in annual Ecohealth Reports and Scorecards. This is the Ecohealth Report for 2021. Values of metrics derived in this report were based on data collected during surveys carried out between 2009 and 2021. The complete set of metrics and their values are summarised in the accompanying Ecohealth Scorecard.

At Buckaringa, five long-term surveys are conducted to report on 29 Biodiversity and 6 Threat Indicators using data collected on a periodic schedule since acquisition of the property in 2002. Standard Trapping Surveys commenced in 2009 and have occurred every 1 to 5 years; annual surveys targeting the threatened, Yellow-footed Rock-wallaby (*Petrogale xanthopus*) also commenced in 2009, with only two years of surveys missed as a result of Covid related travel restrictions; Standard Bird Surveys have taken place annually since 2014 and lastly, the Large Herbivore and Feral Predator Surveys have been undertaken annually since 2009.

In implementing the Ecohealth program in 2021, AWC conducted 96 observational point counts, approximately 40 km of large herbivore transects, approximately 85 km of feral predator transects, and 54 bird surveys. These surveys detected 7 mammal and 42 bird species.

Effort and area-based observational counts for Yellow-footed Rock-wallaby in May and December 2021 resulted in an index of 14 individuals. This is the lowest value for this species since the Yellow-footed Rock-wallaby Survey's inception. It is thought that this result is due to a preceding period of well below average rainfall. Unfortunately, we have been unable to conduct this count for several years prior to 2021 so are unable to determine speed of decline.

Bird surveys were carried out in April 2021 at the 18 Ecohealth monitoring sites located in the major vegetation communities on Buckaringa. This resulted in a total of 42 species of resident diurnal birds being recorded. Diversity was similar to previous year's surveys, but abundance was reduced. Again, this is thought to be driven by the period of below average rainfall experienced and continued a decline in abundance over the past few surveys. There were no new species for the sanctuary list from this survey.

Large herbivore transects indicated that numbers of feral goats (*Capra hircus*) and macropod species (Western Grey Kangaroo, *Macropus fuliginosus*; Red Kangaroo, *Macropus rufus*; Euro, *Macropus robustus*) remain high. This data informed integrated feral animal and macropod management programs on Buckaringa in 2021.

Feral predator spotlight transects indicated that while both fox (*Vulpes vulpes*) and cat (*Felis catus*) are present on Buckaringa the number sighted continues to be low. Pressure has been maintained on these species by shooting cats and foxes when encountered and baiting foxes several times throughout the year.

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## Introduction

Australian Wildlife Conservancy (AWC) currently owns, manages, or works in partnerships across 31 properties in Australia, covering almost 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 outcomes.

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). Data from the monitoring program are used to address the following broad questions relevant to our mission:

- 'are species persisting on a property?'
- 'are habitats being maintained?'
- 'are threats below ecologically-significant thresholds?'

For threatened and iconic species, including reintroduced species, AWC's monitoring program aims to obtain more detailed information related to their conservation management, for example data on survival, recruitment, condition, distribution and/or population size.

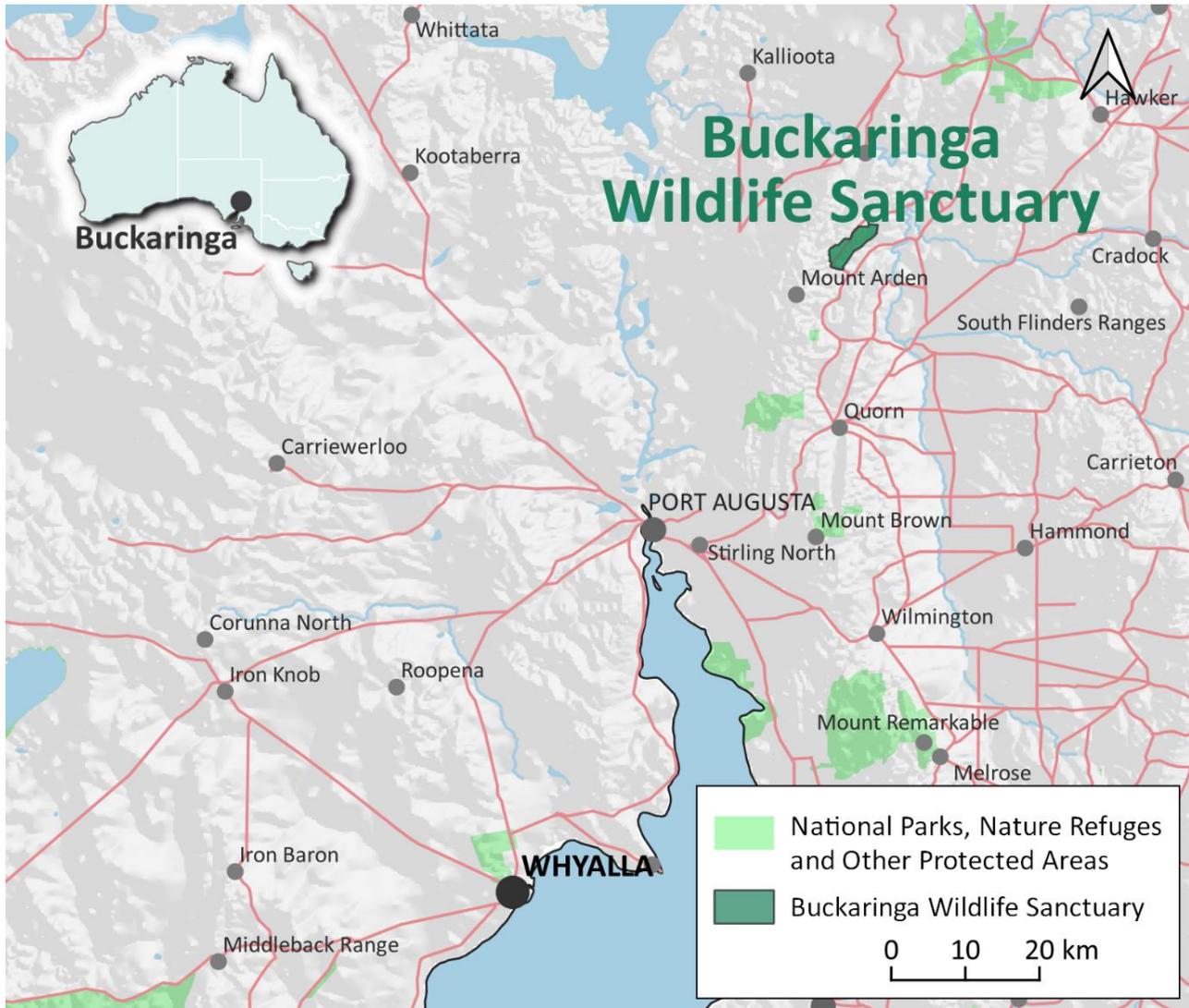
The structure of the Ecohealth Program is as follows. AWC's Monitoring and Evaluation framework provides guidance on the development of the Ecohealth Monitoring Plans for each property managed by AWC: these plans describe the conservation values and assets of each property, the threats to these assets, and the monitoring program that will be used to track their status and trend, and to evaluate outcomes. 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 second in a series of annual Ecohealth Reports for Buckaringa Wildlife Sanctuary (referred to here as Buckaringa). The companion Ecohealth Scorecard presents the indicators and their metrics in a summary format.

## Buckaringa Wildlife Sanctuary

### Conservation values

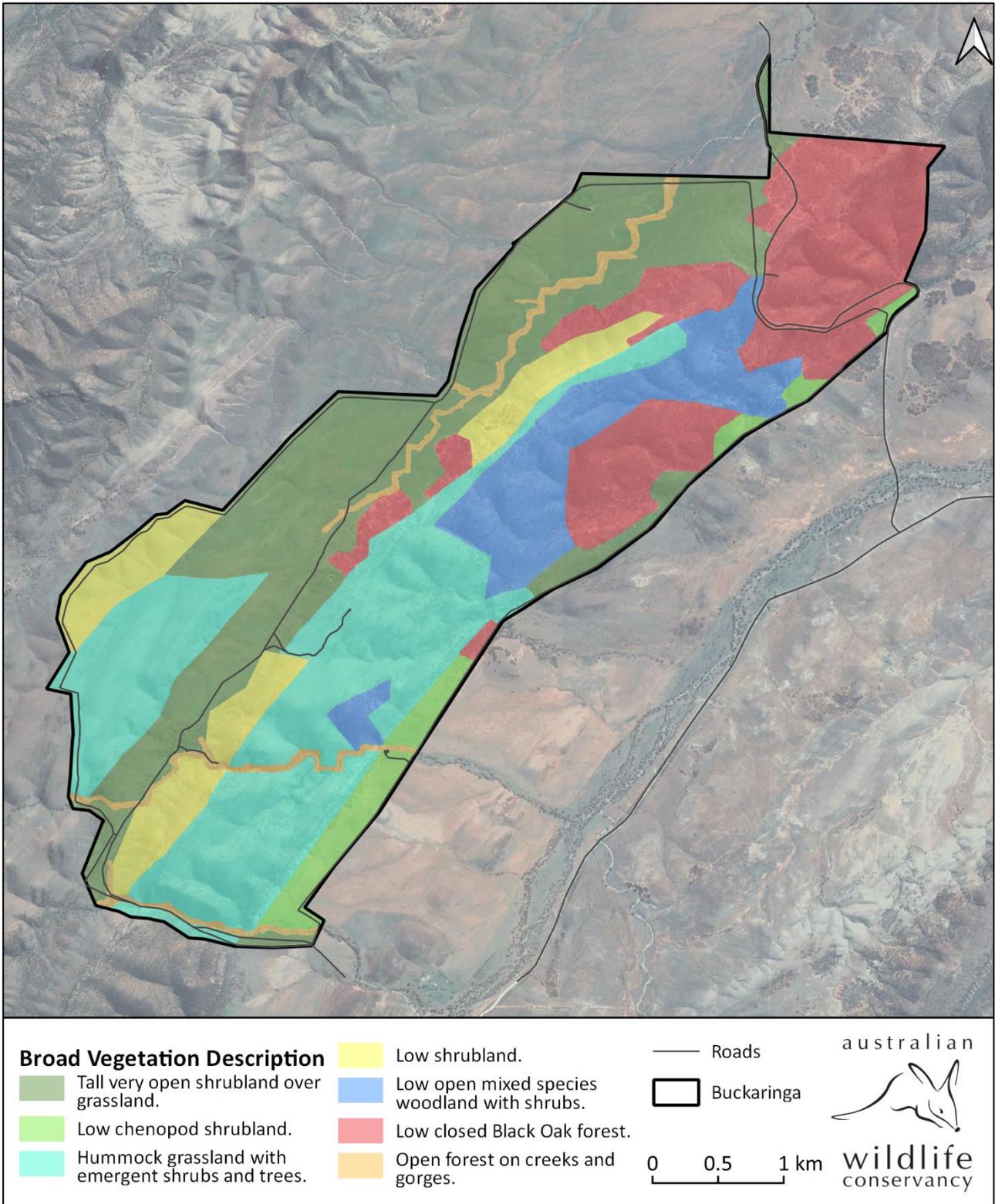
Buckaringa is located in central-southern South Australia and is 2,085 ha in extent (Figure 1). AWC acquired the property from Earth Sanctuaries in 2002. The property contributes to the protection of the species and ecosystems of the Flinders Lofty Block Bioregion (Interim Biogeographic Regionalisation for Australia, IBRA7). The Flinders Lofty Block Bioregion is under-represented within the National Reserves System, with less than 10% protected (Department of Agriculture, Water and the Environment 2020).



**Figure 1. Location and regional context of Buckaringa in South Australia.**

Buckaringa consists of rugged quartzite ranges interspersed with broad valleys. It is located in an area of high species diversity where, because of topography and orographic rainfall, fauna and flora of the more mesic regions to the south are able to penetrate into the arid regions of the north. It is also located on the biogeographic barrier identified as the Eyrean Barrier (Keast 1961; Ford 1974). This barrier to dispersal runs through Spencer Gulf and the northern Flinders Ranges and has throughout recent evolutionary history separated the arid and semi-arid adapted species either side.

Buckaringa contains seven broad vegetation communities (Figure 2). The most common vegetation communities on Buckaringa are the Tall very open shrubland on previously cleared valley floors, Hummock grassland of spinifex on rocky quartzite ranges, and Low closed Black Oak forest on rocky slopes—each of which occupy approximately 20% of the total sanctuary area.



**Figure 2. Extent and distribution of broad vegetation types of Buckaringa.**

With the long history of pastoralism and cropping in the region, the majority of the pre-European vegetation on Buckaringa has been altered to some degree. The valley floors have been almost entirely cleared of the original native vegetation to enable cropping. Due to the steepness and rockiness of the ranges on Buckaringa, the vegetation on the ranges is likely to be largely intact structurally, but these areas have been altered floristically by feral herbivores, predominantly goats, and by changed fire regimes.

Approximately 325 species of native plants have been recorded on Buckaringa of which Sandalwood (*Santalum spicatum*) and Broad-leaf Nancy (*Wurmbea latifolia* spp. *Latifolia*) are listed as Vulnerable in South Australia; and Long-flowered Cryptandra (*Cryptandra* ssp. *Long Hypanthium*) is listed as Rare in South Australia (National Parks and Wildlife ACT 1972). In addition to the above listed species, Buckaringa is also known to conserve a number of species that are of regional conservation significance because of past habitat alteration or current impacts of feral herbivores. This suite of species ranges from small ground orchids to mallees.

A total of 209 species of native vertebrates are currently known or considered likely to occur on Buckaringa. These include 16 mammals, 126 birds, 65 reptiles, and two frogs. Five extant species including one mammal and four birds are listed as threatened under federal (Environment Protection and Biodiversity Conservation Act 1999) or state (National Parks and Wildlife Act 1972) legislation.

The presence of some mammal species prior to European occupation is reasonably well known. For others, presumed presence is based on sub-fossil deposits (Medlin 1993), Aboriginal informants (Turnbridge 1991), or inference from records outside the region and present known habitat requirements of the species. Based on this, up to 18 of the estimated 48 mammal species thought to have been present in the Flinders Ranges at time of settlement have been lost from Buckaringa.

The Bush Stone-curlew (*Burhinus grallarius*) is the only bird species thought to have become extinct in the Flinders Ranges following European settlement (the Night Parrot, *Pezoporus occidentalis* is a possible regional extinction). Two species (Diamond Firetail, *Stagonopleura guttata*, Australian Bustard, *Ardeotis australis*) are functionally extinct at Buckaringa, with very infrequent recent records. The Flinders Ranges Short-tailed Grasswren has been observed on Buckaringa in the past and has been observed on nearby properties but is not currently known from Buckaringa.

There are approximately 96 species of reptile and 10 species of amphibian recorded from the greater Flinders Ranges region; however, only 65 and 2, respectively, are confirmed on Buckaringa. Early knowledge of these groups is poor with little survey work undertaken until the late 1960s. It is thought that no reptile or amphibian species have become extinct in the Flinders Ranges.

## Threats

### Pest animals

Buckaringa, like much of southern Australia, has been impacted by a range of feral animals, including goats (*Capra hircus*), house mice (*Mus musculus*), red foxes (*Vulpes vulpes*), feral cats (*Felis catus*), European rabbits (*Oryctolagus cuniculus*), and several feral species of bird: house sparrow (*Passer domesticus*) and Common Starling (*Sturnus vulgaris*). Feral predators and large feral herbivores are subject to ongoing control and monitoring on the sanctuary.

### Weeds

A total of 58 introduced plant species have been identified on Buckaringa, of which two are Weeds of National Significance (WONS): Creeping Wheel Cactus (*Opuntia engelmannii*) and Boxthorn (*Lycium ferocissimum*). Four others are declared species, Horehound (*Marrubium vulgare*), Variegated Thistle (*Silybum marianum*), Bathurst Burr (*Xanthium spinosum*) and Salvation Jane (*Echium plantagineum*).

There have been intensive and on-going efforts to eradicate Creeping Wheel Cactus and Boxthorn from Buckaringa. These efforts have resulted in eradication of Boxthorn and a monitoring and targeted eradication phase for Creeping Wheel Cactus. Variegated Thistle, Bathurst Burr and Thorn Apple (*Datura* spp.) are also treated as encountered. The area infested with Horehound and Salvation Jane is extensive, therefore the impacts of weeds on ecological health range from substantial to minor.

### Changed fire regimes

In most regions of Australia fire is a major driver of the structure and composition of local ecosystems, and thus wildlife habitat. Fire is not currently an ecological driver on Buckaringa Wildlife Sanctuary, but the lack of fire may be of ecological significance. There have been no large wildfires in this landscape in many years.

Aboriginal fire practices in the Flinders Ranges region are poorly documented. However, in other landscapes where Aboriginal fire practices have been documented (e.g., central Australia: Bird et al. 2008), the fire regime typically comprised numerous small low intensity fires, distributed patchily in time and space, grading to less frequent but larger fires elsewhere. There were readily available permanent natural water sources in the Flinders Ranges so it can be assumed to have been subject to some level of Aboriginal fire management, particularly in Triodia-dominated ecosystems found on the ranges. Lightning strike is likely to have been another source of fire particularly after favourable seasons produced flushes of growth.

The advent of pastoralism and the dislocation of Aboriginal people from their traditional lands resulted in a change in fire patterns, towards infrequent but extensive and relatively intense summer fires. This shift in fire patterns has caused declines in old growth vegetation, including spinifex communities, and a reduction in the extent of fire sensitive communities. Significantly, recent pastoral management of the Triodia vegetation community involved frequent burning of Triodia on the ranges to provide fresh green pick for stock. This frequent burning for stock also causes the loss of fire sensitive species and the eventual loss of Triodia.

There are no management burns planned for Buckaringa and there have been no planned or unplanned fire events on Buckaringa in more than 10 years.

## Climate and weather summary

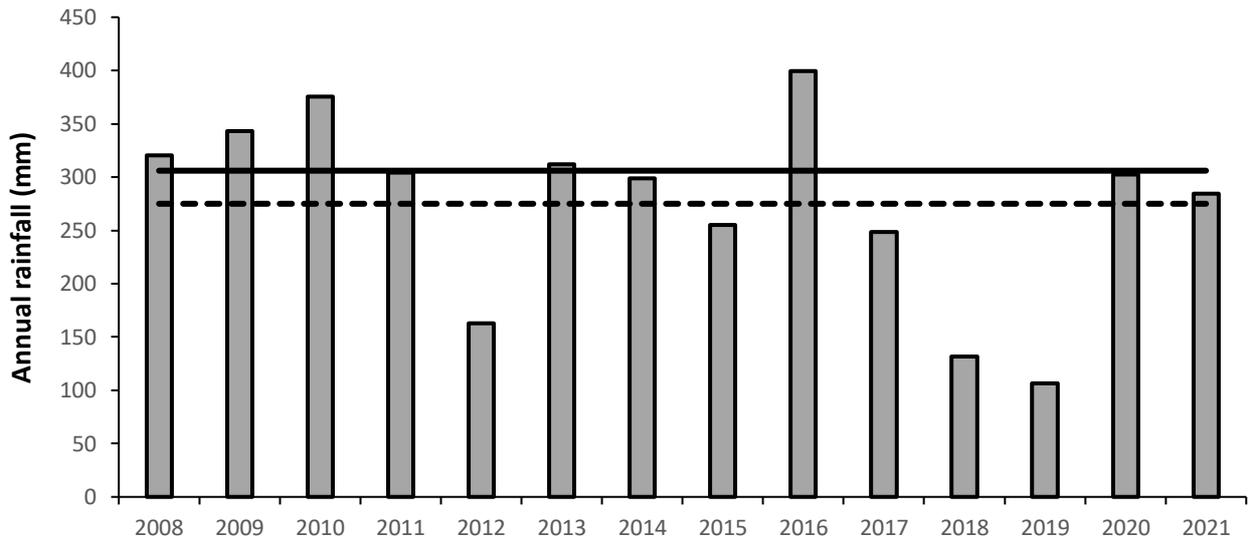
Buckaringa is located at the northern extremity of the warm temperate and the southern extremity of the semi-arid climate types, and experiences hot dry summers and mild winters. Average annual rainfall is 275 mm (2008- 2021) at Buckaringa; the long-term average from nearby Hawker (BOM Station ID 019017) is 305 mm (1882- 2021) and is distributed relatively evenly across the year, with slightly wetter winters (Table 1; Figure 3).

Annual rainfall in seven of the last ten years at Hawker was markedly below the long-term average (1882 to 2021), while 2021 was also below average. Annual rainfall at Buckaringa in five of the last ten years was markedly below the long-term average (2008 to 2021), while 2021 was an average year (Figure 3). There was a dry end to summer 2020/21 and autumn with average rain in winter and a dry autumn with the yearly total enhanced by a significant rainfall event in November (Figure 4).

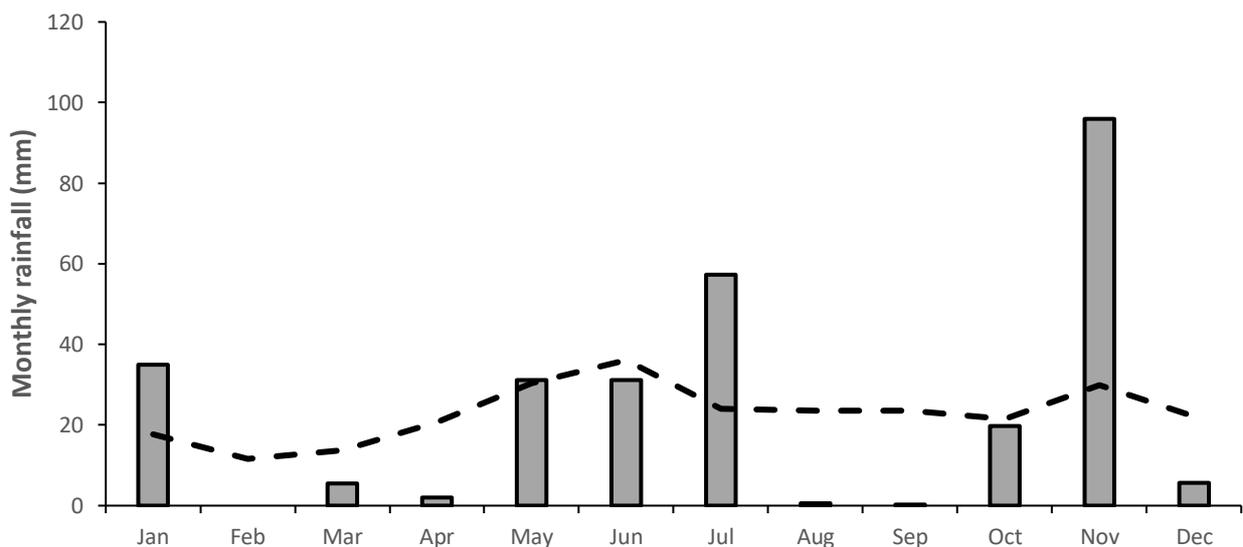
Mean maximum temperatures range between 34.3°C in summer and 16.0° C in winter (Table 1). Mean maximum temperatures in 2021 (taken from Hawker BOM Station) were slightly cooler than the long-term average during summer and spring with winter and autumn being same as long term average (Table 1). Mean minimum temperatures in 2021 (taken from Hawker BOM Station) were slightly cooler than the long-term average during summer and early autumn with late autumn through to spring being a little warmer than long term average (Table 1).

**Table 1. Long-term average annual temperatures and rainfall for Hawker weather station – BoM Station 019017 - (Temperature data since 1969, rainfall data since 1882).**

Hawker	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Long term Mean max (°C)	34.3	33.4	30.1	25.5	20.0	16.4	16.0	17.8	21.8	25.9	29.3	32.1	
2021 Mean max (°C)	32.2	30.8	28.9	25.5	19.9	15.5	15.8	18.0	22.8	24.8	25.7	32.3	
Long term Mean min (°C)	18.1	18.0	15.0	11.1	7.2	4.5	3.7	4.2	6.8	10.0	13.6	16.1	
2021 Mean min (°C)	17.2	16.1	15.3	10.1	7.6	5.8	4.6	4.8	7.5	10.3	12.9	15.8	
Long term Avg rainfall (mm)	20.2	20.8	16.2	19.9	30.2	37.5	32.9	31.4	27.1	24.2	22.7	22.0	304.8



**Figure 3. Annual rainfall at Buckaringa, 2008–2021.** Dashed line = Buckaringa rainfall average (2008–2021). Solid line = Hawker rainfall average (1882–2021).



**Figure 4. Monthly rainfall at Buckaringa.** Dashed line = average monthly rainfall (2008–2021).

## Methods

### Monitoring and evaluation framework

Buckaringa’s Ecohealth Monitoring Program has been designed to measure and report on the status and trends of selected biodiversity and threat indicators on the property, using metrics derived from data collected through a series of purpose-designed surveys. Where possible, outcomes will be evaluated against performance criteria relevant to each species, guild or assemblage.

### Reintroduced, threatened and iconic species

The Ecohealth program is focused on species of high conservation value, including reintroduced species (where present), and key threatened and ‘iconic’ species (e.g., regional endemics, species with high public profile and other species of conservation importance because of the role they play in an ecosystem, etc).

Monitoring programs for reintroduced species in the establishment phase (i.e., within 5–10 years of establishment) are typically set out in a *Translocation Proposal*, along with success criteria to evaluate outcomes around survival, recruitment, population size, etc.

AWC will develop *Population Management Plans* to underpin management of long-established populations of reintroduced species, to ensure early detection of any serious issues that arise, and to trigger timely responses. These plans will specify a monitoring and evaluation program (e.g., Berry et al. 2021).

AWC will aim to develop *Conservation Plans* for the remaining (extant) threatened and iconic species, with similar objectives to Population Management Plans. These plans will specify metrics to monitor outcomes for target species against nominated performance criteria.

## Assemblages

AWC's mission involves the conservation of all wildlife, not only threatened or reintroduced species. For this reason, AWC's monitoring program extends to surveillance monitoring of faunal assemblages (mammals, birds, reptiles, frogs). The monitoring program aims to address questions relevant to the conservation of assemblages.

At the most basic level, the program seeks to establish whether all species that are known to occur on the property are still persisting on the property (i.e., 'are all species present?').

With increasing information, the monitoring program can address more detailed questions relating to conservation of assemblages, such as 'have species maintained their distributions or abundance?' However, the boom/ bust conditions of most Australian environments can lead to large variations in the numbers of individuals in a population and the habitats or sites occupied by a species – these variations may not necessarily be informative in relation to the conservation of a species at a property over the long term.

AWC is currently working on developing an evaluation framework for surveillance monitoring of faunal assemblages. At present, we will continue to present data on a range of metrics relating to indicator species and guilds.

## Indicators and metrics

On Buckaringa, 29 biodiversity (species and guilds) indicators have been selected for monitoring (Table 2). Ten of these indicators are reported on in this 2021 Ecohealth Report, including one related to threatened and iconic species, and the remainder to surveillance monitoring of faunal assemblages.

Threat metrics are selected to monitor the status and trends of introduced weeds, predators and herbivores. Six threat indicators have been selected for monitoring (Table 3). All of these threat metrics are reported on in 2021.

**Table 2. Biodiversity indicators and metrics for Buckaringa.**

### Key threatened and iconic vertebrates

Indicator	Survey name	Survey method	Metric/s
<b>Mammals</b>			
<b>Large herbivores</b>			
Yellow-footed Rock-wallaby (YFRW; <i>Petrogale xanthopus</i> )	Yellow-footed Rock-wallaby Survey	1-hour counts	Abundance
<b>Birds</b>			
Flinders Ranges Short-tailed Grasswren ( <i>Amytornis merrotsyi merrotsyi</i> )	Targeted Grasswren Survey (TBD)	20-min counts	Abundance, occupancy
<b>Frogs</b>			
North Flinders Froglet ( <i>Crinia flindersensis</i> )	Targeted Frog Survey (TBD)	Count	Abundance, occupancy

## Vertebrate assemblages and surveillance species

Indicator	Survey name	Survey method	Metric/s
<b>Mammals</b>			
Assemblage richness	All surveys listed for mammals, incidental observations	All survey methods listed for mammals	Number of species
<b>Small-medium mammals</b>			
Assemblage richness	Standard Trapping Survey	All survey methods listed for small-medium mammals	Number of species
All small-medium mammals (trappable)	Standard Trapping Survey	Pitfall, Elliot, and funnel traps	Abundance
Dasyurids - guild	Standard Trapping Survey	Pitfall, Elliot, and funnel traps	Abundance
Fat-tailed Dunnart ( <i>Sminthopsis crassicaudata</i> )	Standard Trapping Survey	Pitfall, Elliot, and funnel traps	Abundance, occupancy
Stripe-faced Dunnart ( <i>Sminthopsis macroura</i> )	Standard Trapping Survey	Pitfall, Elliot, and funnel traps	Abundance, occupancy
<b>Large native herbivores</b>			
Western Grey Kangaroo ( <i>Macropus fuliginosus</i> ), Red Kangaroo ( <i>Macropus rufus</i> ), Euro Kangaroo ( <i>Macropus robustus</i> )	Large Herbivore Survey	Count	Population estimate
<b>Reptiles</b>			
Assemblage richness	All surveys listed for reptiles, incidental observations	All survey methods listed for reptiles	Number of species
<b>Small-medium reptiles</b>			
Assemblage richness	Standard Trapping Survey; incidental observations	All survey methods listed for small-medium reptiles	Number of species
All reptiles – (excl. varanids / snakes)	Standard Trapping Survey	Pitfall and funnel traps	Abundance, richness
Skinks - guild	Standard Trapping Survey	Pitfall and funnel traps	Abundance, richness
Geckos - guild	Standard Trapping Survey	Pitfall and funnel traps	Abundance, richness
Agamids - guild	Standard Trapping Survey	Pitfall and funnel traps	Abundance, richness
Robust Ctenotus ( <i>Ctenotus robustus</i> )	Standard Trapping Survey	Pitfall and funnel traps	Occupancy
Bynoe's Gecko ( <i>Heteronotia binoei</i> )	Standard Trapping Survey	Pitfall and funnel traps	Occupancy
Tawny Dragon ( <i>Ctenophorus decresii</i> )	Standard Trapping Survey	Pitfall and funnel traps	Occupancy
<b>Birds</b>			
Assemblage richness	Standard Bird Survey; incidental observations	20-min counts	Number of species
All birds	Standard Bird Survey	20-min counts	Abundance, richness
Honeyeaters – guild	Standard Bird Survey	20-min counts	Abundance, richness
Ground active birds – guild	Standard Bird Survey	20-min counts	Abundance, richness
Woodland birds – guild	Standard Bird Survey	20-min counts	Abundance, richness
Nocturnal birds – guild	TBD	TBD	Mean activity
<b>Frogs</b>			
Assemblage richness	Frog Survey; incidental observations	Count	Number of species
Frogs – guild	Frog Survey (TBD)	Count	Abundance, richness

## Key threatened plants

Indicator	Survey name	Survey method	Metric/s
<b>Vegetation</b>			
<b>Threatened plants</b>			
Sandalwood ( <i>Santalum spicatum</i> )	Targeted Survey (TBD)	Count	TBD
Broad-leaf Nancy ( <i>Wurmbea latifolia ssp latifolia</i> )	Targeted Survey (TBD)	Count	TBD

**Table 3. Threat indicators and metrics for Buckaringa in 2021.**

Indicator	Survey name/ methods	Metric/s	Performance criteria
<b>Pest animals</b>			
Feral cats ( <i>Felis catus</i> )	Feral Predator Survey	Abundance	TBD
Fox ( <i>Vulpes vulpes</i> )	Feral Predator Survey	Abundance	TBD
<b>Feral herbivores</b>			
Goat ( <i>Capra hircus</i> )	Large Herbivore Survey	Population estimate	TBD
Rabbit ( <i>Oryctolagus cuniculus</i> )	Large Herbivore Survey	Abundance	TBD
<b>Weeds</b>			
Weeds	Vegetation Surveys (TBD)	TBD	TBD
<b>Other threatening processes</b>			
Overabundant macropod species	Large Herbivore Survey	Population estimate	TBD

## 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. These include:

For threatened and iconic species, targeted surveys:

- Yellow-footed Rock-wallaby Survey
- Targeted Grasswren Survey (TBD)
- Targeted Frog Survey (TBD)
- Targeted Threatened Plant Surveys (TBD)

For surveillance monitoring of assemblages, the surveys include:

- Standard Trapping Survey
- Standard Bird Survey
- Large Herbivore Survey
- Frog Survey (TBD)
- Weed and vegetation surveys (TBD)

To monitor threats, a range of surveys are used, including:

- Feral Predator Survey

Four of the ecological surveys were conducted at Buckaringa in 2021: Yellow-footed Rock-wallaby Survey, Standard Bird Survey, Large Herbivore Survey, and Feral Predator Survey. Below is a list of surveys reported upon in this Ecohealth Report (Table 4). The methodology is described and results of these surveys and computations are reported on in this document.

**Table 4. Survey history and effort for Ecohealth surveys on Buckaringa reported on in this report.**

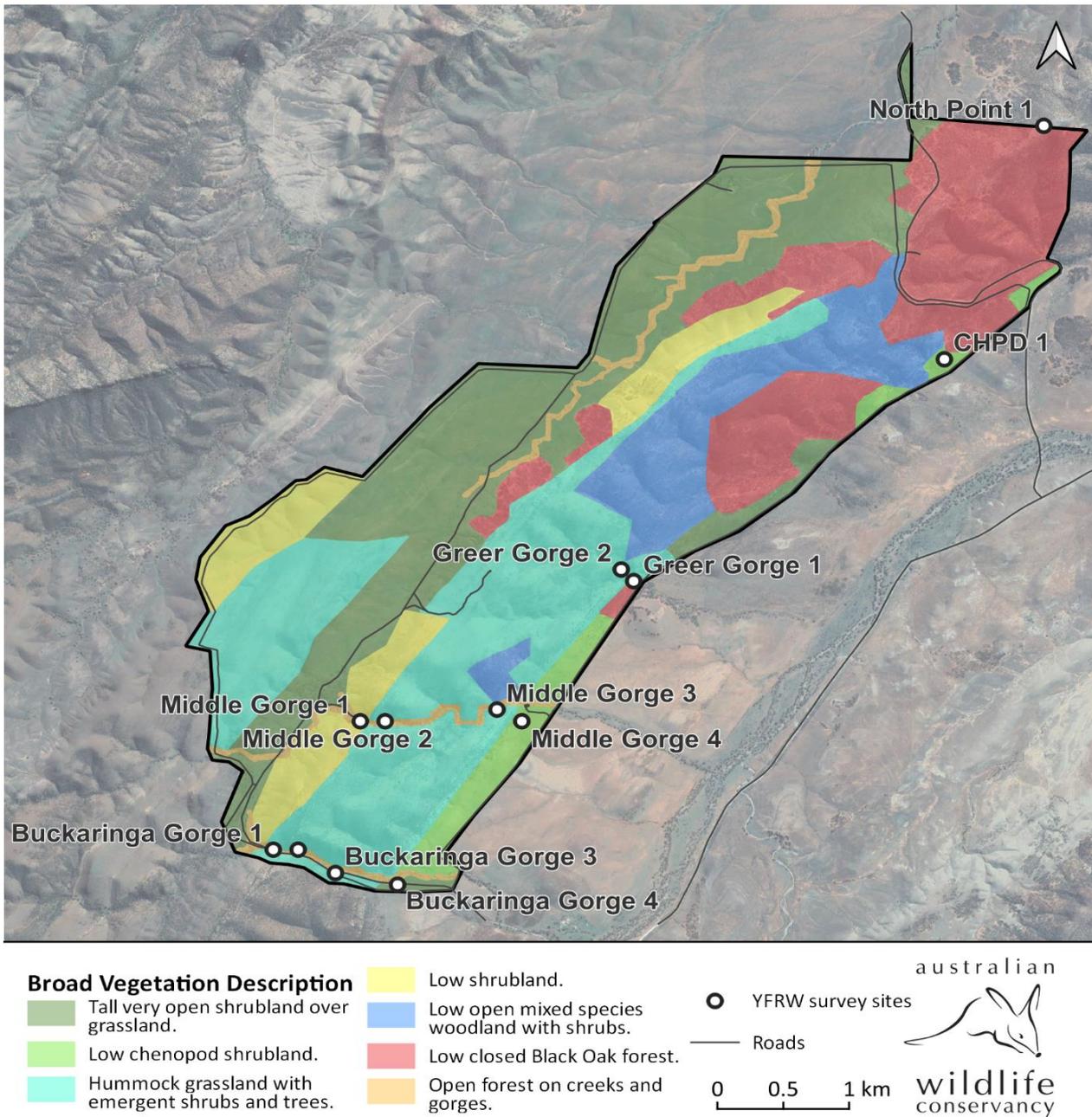
Survey name	Effort (2021)	Description/comment	Previous surveys
Yellow-footed Rock-wallaby Survey	96 hours	12 sites surveyed for 1 hour at dawn and again at dusk on two consecutive days. Two surveys per year. Numbers counted in set area in set time.	2018: 48 hours 2017: 48 hours 2016: 96 hours 2015: 96 hours 2014: 96 hours 2013: 96 hours 2012: 64 hours 2011: 44 hours 2010: 92 hours
Standard Bird Survey	18 sites (54 bird surveys)	20 minute - 2 ha survey at 18 survey sites on three consecutive mornings shortly after dawn with a single observer. (Some years have had more than 1 survey period).	2020: 54 bird surveys 2019: 108 bird surveys 2018: 54 bird surveys 2017: 54 bird surveys 2016: 54 bird surveys 2015: 216 bird surveys 2014: 216 bird surveys
Large Herbivore Survey	35.5 km	7.1 km transect down central valley driven five times spread throughout the year.	2021: 35.5km 2020: 42.6 km 2019: 14.2 km 2016: 35.5 km 2015: 42.6 km 2014: 42.6 km 2013: 42.6 km 2012: 49.7 km 2011: 56.8 km 2010: 49.7 km 2009: 49.7 km
Feral Predator Survey	82 km	20.5 km spotlight transect driven four separate times across the year.	2020: 61.5 km 2019: 82.0 km 2018: 61.5 km 2017: 164.0 km 2016: 143.5 km 2015: 205.0 km 2014: 246.0 km 2013: 287.0 km 2012: 164.0 km 2011: 287.0 km 2010: 287.0 km 2009: 164.0 km

## Survey design and methods

### Yellow-footed Rock-wallaby Survey

Twelve permanent sites located within known Yellow-footed Rock-wallaby (YFRW, *Petrogale xanthopus*) habitat were used for observational effort-based counts (Figure 5). These surveys were typically conducted biannually. Four observation-based counts per site were conducted in autumn and early summer in each of five general areas on Buckaringa along the main range in areas at which the YFRW is most commonly observed (Figure 5). Counts were conducted for one hour during two survey periods each day (dawn and dusk), repeated on two consecutive days by the same observer.

Two surveys were conducted in 2021, during late autumn (May) and early summer (December). A total of 96 hours of count effort were made. Surveys had not been conducted during the previous two years due to covid-related travel restrictions.



**Figure 5. Location of Yellow-footed Rock-wallaby observation count areas on Buckaringa.**

### Standard Bird Survey

Standard Bird Surveys are conducted at a minimum annually, and more frequently in some years (two to four surveys per year). The Standard Bird Survey was conducted in autumn 2021 at 18 Standard Trapping sites (Figure 6), replicated across 3 mornings (54 survey days).

Standard Bird Surveys were carried out using the BirdLife Australia Atlas methodology (Blakers et al. 1984). Observers spent 20 minutes actively searching two hectares centred on the survey site identifying and recording any sightings or vocalisations. When more than one individual of the same species is 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 with observers rotating across sites and sites being rotated across morning session times

### Large Herbivore Survey

Large Herbivore Surveys are typically undertaken multiple times per year (2–8 surveys). In 2021, five surveys were completed. On each occasion, a single transect of approximately 7.1 km using internal tracks was driven in a north to south direction down the central valley of the property in the late afternoon (Figure 6). Each time an animal, either target species (Western Grey Kangaroo, *Macropus fuliginosus*; Red Kangaroo, *Macropus rufus*, Euro, *Macropus robustus*; YFRW, goat; Emu, *Dromaius novaehollandiae*) or non-target species (rabbit, fox, cat) was observed, the vehicle was stopped and the distance to the animal was measured with a range finder and the bearing from the vehicle to the animal was determined with a sighting compass. The bearing of the track at the point at which the observation was made was also determined with a sighting compass.

Sighting distance can vary throughout the transect depending on topography and the structure and density of the vegetation cover. If the observation was of animals on a neighbouring property, then it was included in the count as they can move freely through the boundary fence. Each observation was identified to species, the number of individuals and sex is noted plus any other useful observation information. There is not sufficient transect length to calculate a density estimate with the Distance package, but numbers observed are sufficient to provide an estimate of raw counts per set width strip transect averaged over several consecutive days counts for that survey period.

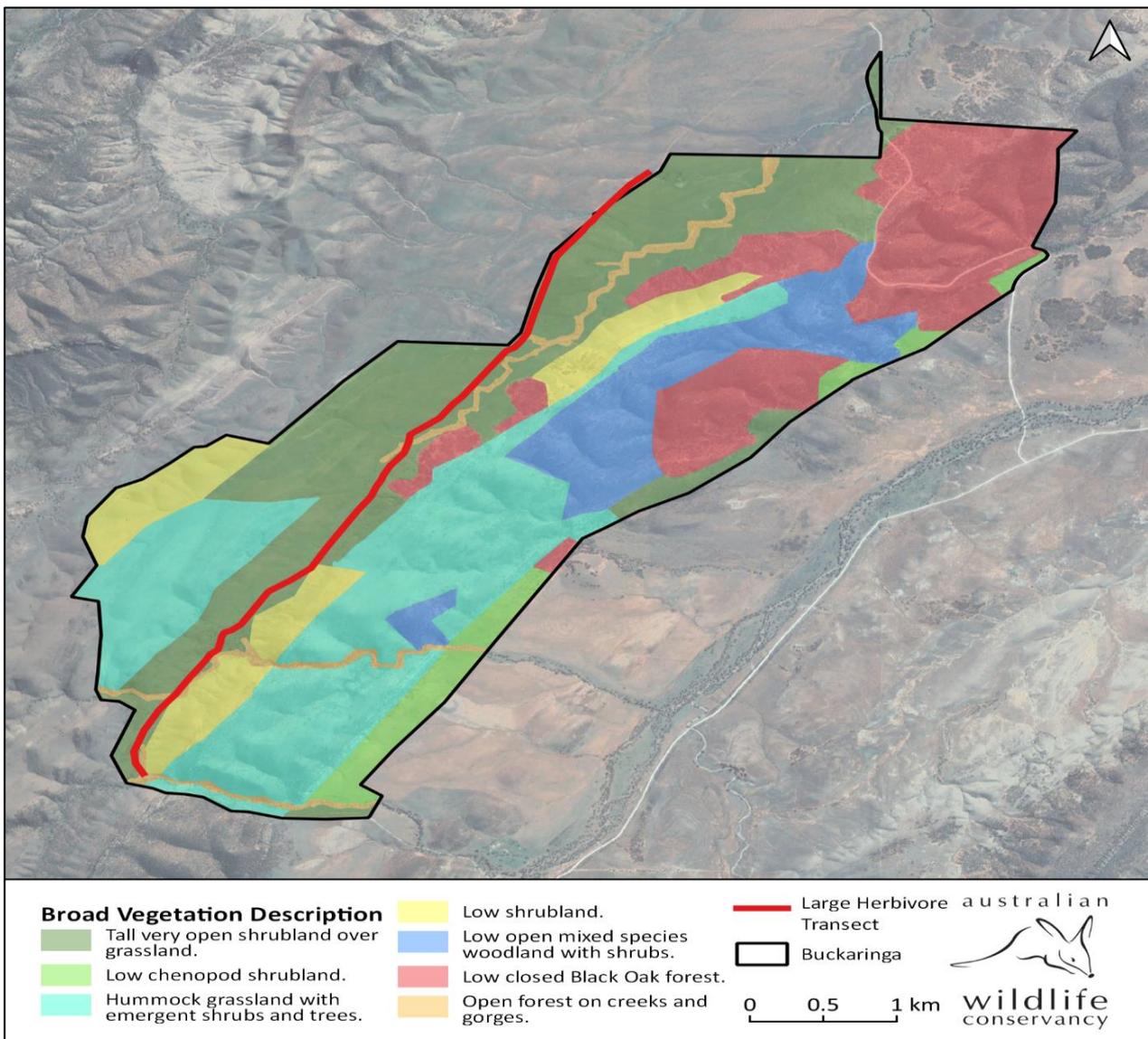


Figure 6. Route of large herbivore driven transect on Buckaringa.

### Feral Predator Survey

Spotlighting surveys along a single transect of approximately 20.5 km (Figure 7) were used to assess feral predator numbers. The track was driven at approximately 10 km/ hour while systematically scanning each side of the track using a spotlight fitted with a 100 W globe. Where the transect was routed along a shared boundary, the animals on the off-sanctuary property were also included in the count. Feral Predator Surveys are typically conducted multiple times per year (3–14). In 2021, four surveys were completed.

Each observation of a feral animal (fox, cat) was recorded to species, other key data recorded includes: the number individuals; travelled distance along the transect; and the distance from the transect when first observed.

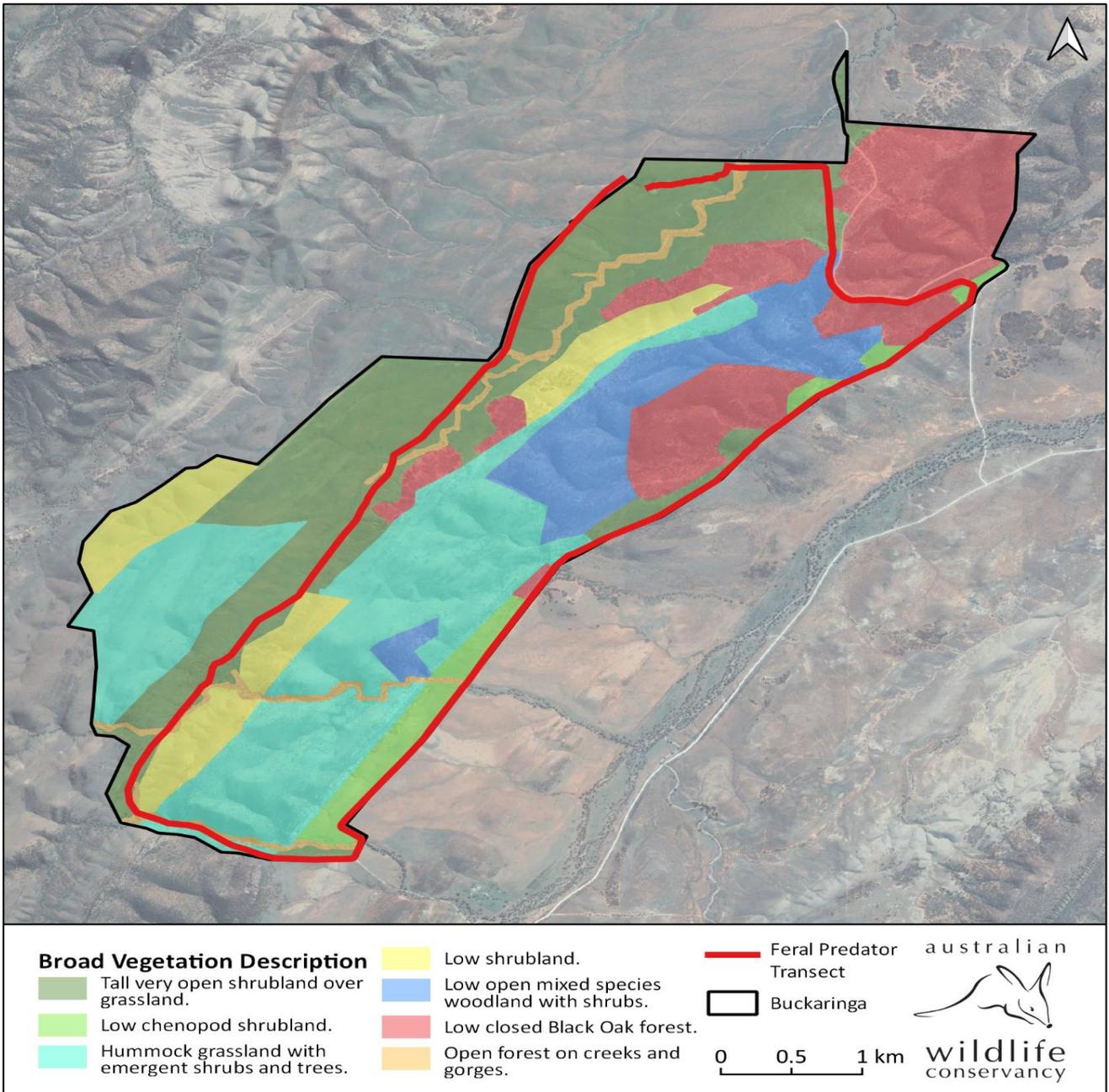


Figure 7. Route of Feral Predator Survey driven transect on Buckaringa.

## Analysis methods

Most Ecohealth metrics are common across the indicator species for Buckaringa. Unless noted otherwise, the metrics are calculated as set out in Table 5 below.

On Buckaringa, the metrics are reported for species and groups of species of a particular 'guild'. This requires that all species reported on are correctly assigned to a particular guild (or guilds) prior to undertaking these calculations.

**Table 5. Metrics and associated calculations for Buckaringa.**

Indicator	Metric	Survey data sources	Description	Analysis summary / calculation
Assemblage richness	Number of species	All surveys and incidental records	A measure of intactness for the whole sanctuary	The number of species detected on the sanctuary within the last 2+ years is compared to the number of species listed as 'confirmed', 'very likely' or 'likely' on the sanctuary species list.
Yellow-footed Rock-wallaby	Abundance	Yellow-footed Rock-wallaby Survey	A measure of activity; number of detections per survey.	The maximum counts from each site during each count (dawn/dusk) is used to calculate a site total for that period (i.e. May or December). All the site counts are combined together to generate the sanctuary abundance index.
Large native herbivore (macropods); goats	Population estimate	Large Herbivore Survey	Estimate of total number of individuals in the population based upon transect sightings.	(Number of individuals seen / total area surveyed) * total area of suitable habitat
Various species	Abundance	Standard Bird Survey	A measure of activity; number of detections per survey day	Individual species: Abundance: average number of individuals recorded across surveys at each site, averaged across all sites  Guilds: Average number of individuals within a guild recorded across surveys at each site, averaged across all sites
Various species	Occupancy	Standard Bird Survey	A measure of distribution; the proportion of sites where the species was recorded.	(Number of sites at which a species was recorded / number of sites surveyed)* 100
Various species	Richness	Standard Bird Survey	A measure of diversity; average number of species per site/survey.	Total number of species recorded within the relevant guild / total number of sites or surveys
Feral cat, fox	Abundance	Feral Predator Survey	A measure of activity; number of detections per km.	Number of individuals recorded / total km

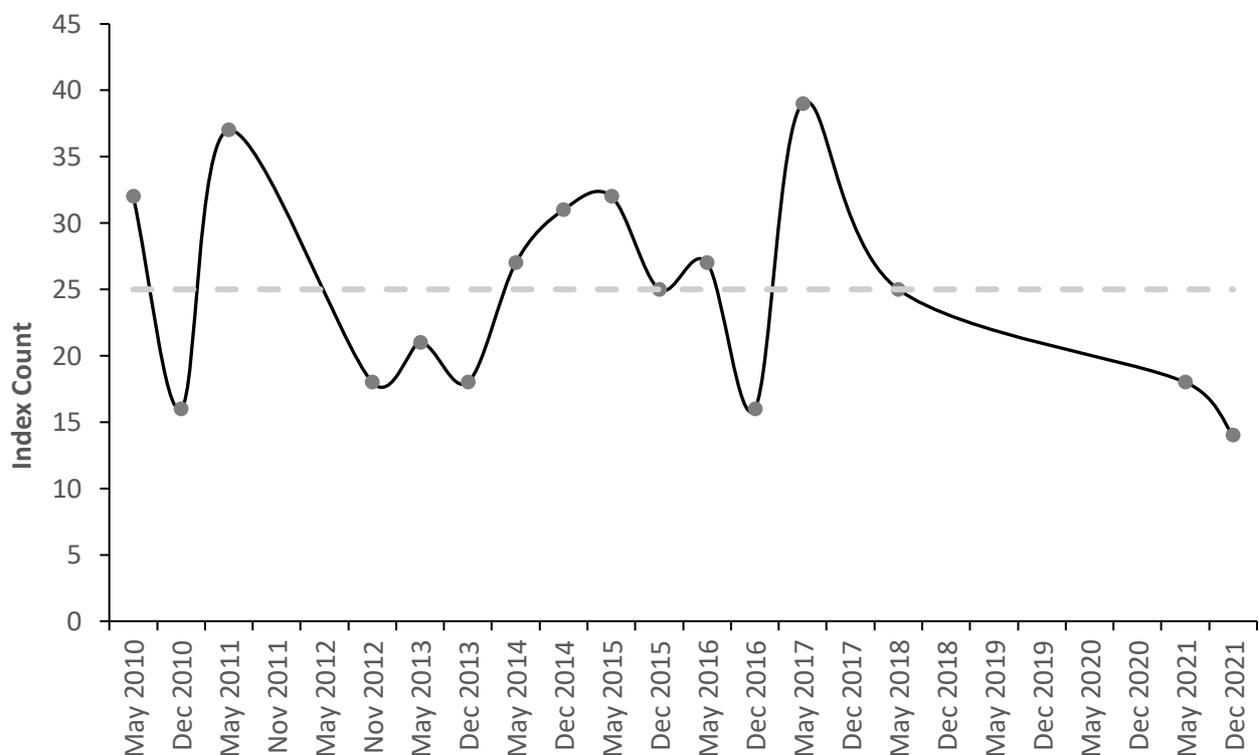
## Results

### Threatened and iconic species

#### Yellow-footed Rock-wallaby

The Yellow-footed Rock-wallaby Surveys in 2021 generated an abundance of 18 individuals (May) and 14 individuals (December; Figure 10). This value is well below the long-term average abundance (25; 2010-2021). During both survey periods at least some individual rock-wallabies were observed at all but one site (occupancy = 92%) with some adult females being observed with large pouch young, especially during the December survey, providing evidence of successful breeding.

The values obtained in December 2021 are the lowest since the surveys began more than ten years ago (Figure 8). It is likely that the low abundance recorded in 2021 are due to several years of well below average rainfall in the region which persisted until late 2021. Over recent years, it is likely that while adult females were able to breed and produce pouch young most joeys were not surviving once independent due to poor seasonal conditions.



**Figure 8. Abundance of Yellow-footed rock-wallaby over time on Buckaringa.** Long-term average (2010-2021) (dashed line).

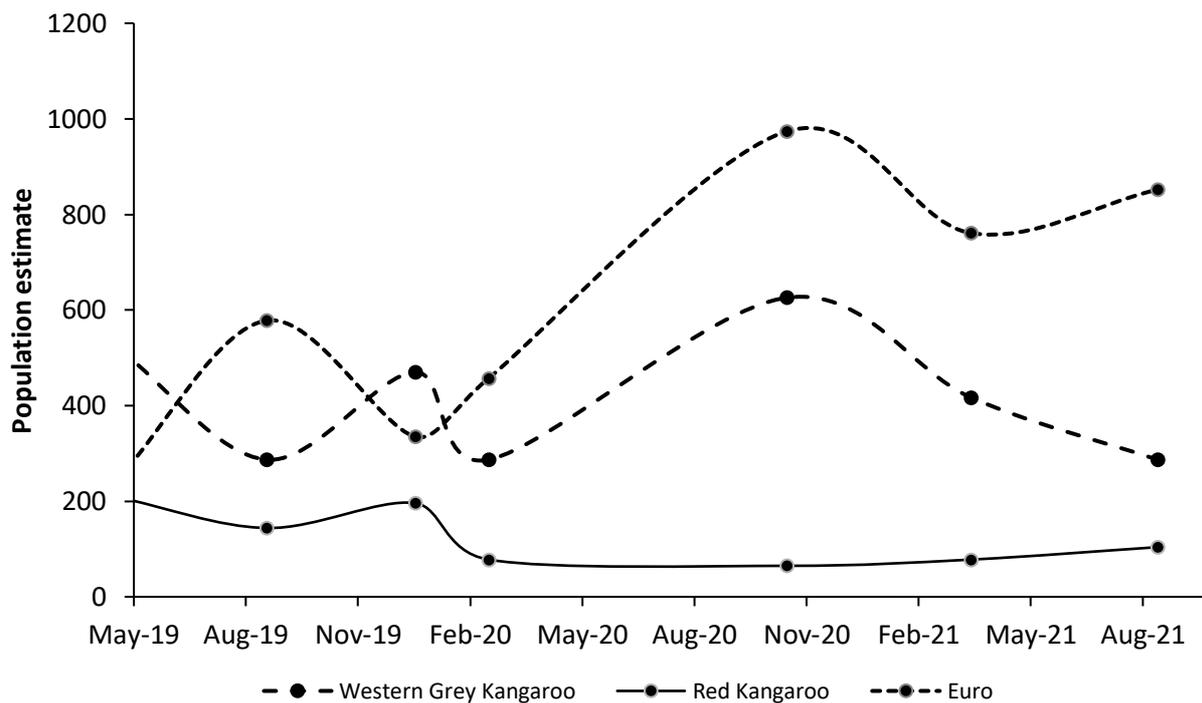
### Assemblages

#### Mammals

Since 2020, 7 of 8 mammal species known to occur on Buckaringa have been detected (this does not include the microbats (8 species), which have not surveyed). The 1 unrecorded species (*Bolam's Mouse*, *Pseudomys bolami*) has not been detected on Buckaringa since 2009; the reason for which is unknown.

## Large native herbivores

By the end of 2021, there was an estimated 287 Western Grey Kangaroo, 104 Red Kangaroo and 852 Euro on Buckaringa (Figure 9). The estimated Euro population size has increased substantially over the past three years, this is likely due to the sedentary Euro having a good breeding season on Buckaringa, where there was some available feed and water compared with neighbouring pastoral properties. The Red Kangaroo numbers appear to be recovering from declines in 2020, however, have not yet returned to higher numbers reported in 2019. In contrast, estimates are lower than previous year for Western Grey Kangaroo (Figure 9). These population estimates are well above what is considered environmentally sustainable for the Sanctuary, despite a kangaroo harvester removing between 40 and 70 mixed species individuals of these large macropod species several times throughout the year.



**Figure 9: Population estimates of large native herbivores for Buckaringa.**

## Reptiles

A total of 20 of 65 reptile species known or likely to occur were detected on Buckaringa since 2020. Species that were not detected, haven't been detected previously (although considered 'likely' or 'very likely' to occur) and the dry conditions in the recent period may explain low detections.

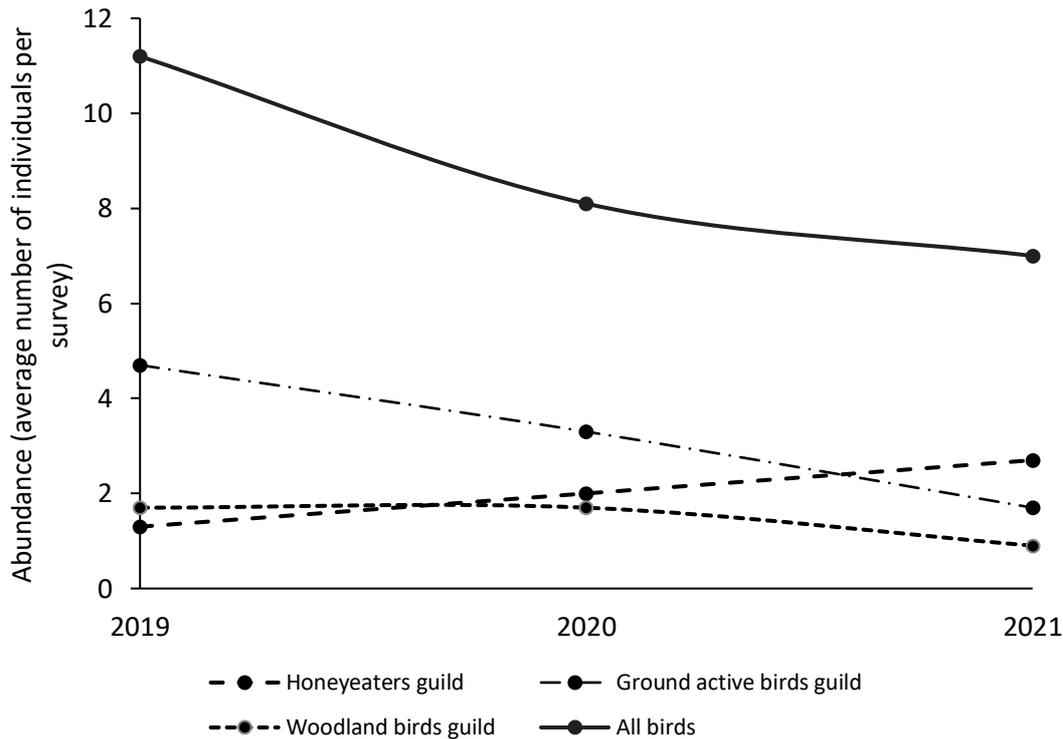
## Birds

A total of 122 species were recorded of the 130 species known or likely to occur on Buckaringa since 2009. An additional 22 species are considered possible from Buckaringa but have yet to be recorded as the habitat may not be quite right although within known range or there may only be small areas of suitable habitat on sanctuary at the edge of their known range. Species confirmed previously that were not detected during Standard Bird Survey were largely irruptive/ nomadic species, usually detected only after substantial rainfall or seasonal migrants.

In 2021, 24 species were recorded during the Standard Bird Survey; this result is slightly lower than 2020 (46 species), with an abundance of 7 individuals per site compared with 8.1 and 11.2 in 2020 and 2019, respectively (Figure 10), and a richness of 4 species per site compared with 7.4 and 4.7 species per site in 2020 and 2019, respectively. There were no new species recorded during this survey. The Standard Bird

Survey was conducted in autumn in 2021 compared with spring in 2020. This change in methodology may have affected the estimates.

In 2021, the Honeyeater guild was the most abundant guild and was more abundant than previous years – likely due to some heavily flowering *Xanthorrhoea* on several sites (Figure 10). Both Ground active and Woodland bird guilds were less abundant than previous surveys. All guilds were less widespread than previous surveys. These results reflect the impact of the prolonged dry period this area has experienced over the past few years where diversity is broadly stable but numbers of individuals of each species are reduced. This is particularly evident with the resident small ground active bush birds and woodland birds that do not move compared to many species of honeyeater that attempt to move to more favourable areas when conditions become unfavourable.



**Figure 10: Bird abundance from 2019 – 2021 across Buckaringa.**

### Frogs

Both known species of frogs, Spotted Grass Frog (*Limnodynastes tasmaniensis*) and Northern Flinders Ranges Froglet (*Crinia flindersensis*), have been detected on Buckaringa since 2020.

### Threat indicators

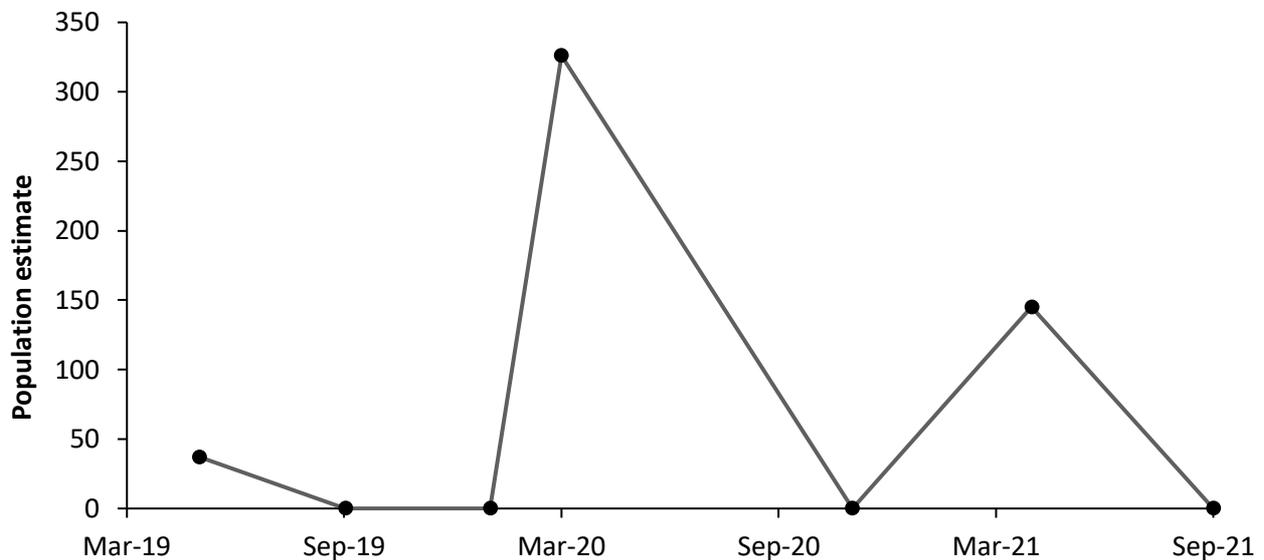
#### Feral predators

Estimated cat abundance was <0.05 cats per km of spotlight transect. This very low abundance is similar to previous years, likely reflecting the dry conditions and reduced rabbit numbers.

Fox abundance was estimated to be 0.05 foxes per km of spotlight transect through 2021. This is slightly lower than previous years (0.1 foxes per km in 2020), again probably reflecting the dry conditions and reduced rabbit numbers. AWC’s continued quarterly 1080 poison baiting program on Buckaringa, in alignment with several neighbouring properties, may also be contributing towards maintaining lowered fox abundance.

## Feral herbivores

The feral goat metric is a population estimate gained from the large herbivore transects also used to estimate large native herbivore populations. The results of this survey over the past few years are indicated in Figure 11. The results of this survey would indicate that at times there are no goats on sanctuary, which is not true. The location of the transect is a key contributing factor to the nil results, as opposed to there being a true absence of goats. As most of 2021 was a below average rainfall year, goats formed small mobile mobs looking for food and water, which precluded large-scale control efforts



**Figure 11. Population estimates of feral goats on Buckaringa.**

There was an estimated rabbit abundance of 0.05 rabbits per km of spotlight transect. This very low abundance is similar to previous years, likely reflecting the dry conditions and past management actions included ripping accessible warrens, shooting individuals and releasing Calici-virus. These actions, combined with the ongoing dry conditions, has meant that the rabbit population is thought to be very low. We plan to implement a new density estimate method in future.

## Discussion

Buckaringa is a relatively small sanctuary within the AWC property portfolio, however it supports important conservation values. The sanctuary is located at the ecotone of the arid north and mesic south climatic zones as well on a biogeographic barrier between eastern and western regions. It supports one mammal and 4 bird species with national conservation significance as well as a number of state rated fauna and flora species. The topography is dominated by spectacular range and gorge features characteristic of the Flinders Ranges. The degraded nature of a significant proportion of the sanctuary due to past land management practices, combined with it being surrounded by much larger pastoral properties, makes some management issues challenging.

Yellow-footed Rock-wallaby surveys were re-commenced in 2021 and the surveys indicated that the abundance was as low as it has been since the surveys began ten years ago. This is likely due to a lack of recruitment in the population due to some below average rainfall years prior to the surveys.

Standard Bird Surveys were conducted in 2021 detecting 42 species of birds, with no new species detected. Most metrics for bird guilds continued to decline, also likely due to continued dry conditions, except for the abundance of the Honeyeater Guild which has increased in recent years, likely because of the presence of flowering Xanthorrhoeas on several sites.

Large herbivore populations have been found to fluctuate over time, however, recent increases in population metrics were observed in 2021 compared to recent years. Euros are in particularly large numbers.

The highest priority management issues are feral herbivores combined with over-abundant large macropods, which can lead to higher total grazing pressure and numbers of feral predators. These pressures in turn impact on the smaller native species by way of competition and predation. Ongoing monitoring and management of these threats is essential to support conservation efforts, particularly for species of high conservation concern, such as the Vulnerable Yellow-footed Rock-wallaby.

Looking ahead, a planned research project on Yellow-footed Rock-wallaby will provide valuable information on the species' ecology, as well as guide future land management activities. Another focus area relates to fire, and AWC is currently developing an ecological burn program for Buckaringa that aims to enhance the remnant areas of Spinifex hummock grasslands.

## **Acknowledgments**

AWC acknowledges the Nukunu Traditional Owners of the country on which Buckaringa Wildlife Sanctuary resides. We also acknowledge their continuing connection to land, culture and community. We pay our respects to Traditional Owner Elders past, present, and emerging.

AWC's Ecohealth Program is only possible because of the generosity of AWC's supporters.

For their assistance in conducting Ecohealth surveys at Buckaringa in 2021, we particularly thank Joss Haiblen, Trish Macdonald, Tyson Brown, Alexandra Ross and Lachlan McRae.

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