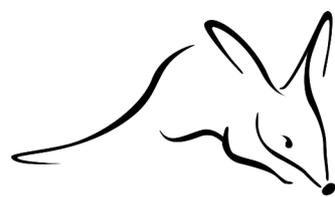


# Mount Zero–Taravale Wildlife Sanctuary Ecohealth Report 2021



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## Summary

Australian Wildlife Conservancy (AWC) has implemented an Ecological Health Monitoring Program (Ecohealth) across Mount Zero-Taravale Wildlife Sanctuary (Mount Zero-Taravale) 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 2020 and 2021. The complete set of metrics and their values are summarised in the accompanying Ecohealth Scorecard.

In implementing the Ecohealth program in 2021, AWC conducted 2068 camera trap nights as part of a targeted survey for Sharman's Rock-wallaby (*Petrogale sharmani*). In 2018-2021, 37 mammals, 47 reptiles, 37 birds, 4 frogs and 5 introduced vertebrates (4 mammals, 1 amphibian) were detected from a combination of surveys and incidental observations. Six of these, the Magnificent Broodfrog (*Pseudophryne covacevichae*), Greater Large-eared Horseshoe-bat (*Rhinolophus robertsi*), Sharman's Rock-wallaby, Greater Glider (*Petauroides volans*), Koala (*Phascolarctos cinereus*) and Atherton Delma (*Delma mitella*) are nationally listed threatened species, while the Northern Masked Owl (*Tyto novaehollandiae kimberli*) is a nationally listed threatened subspecies.

Throughout July-August 2021, AWC deployed camera traps to determine the presence of Sharman's Rock-wallabies at 37 sites. Sharman's Rock-wallaby was detected at 25 sites during the 28-day monitoring period (68% occupancy). Sharman's Rock-wallaby has now been detected at 37 locations across the sanctuary, representing around 70% of the identified colonies for the species across its known distribution.

The Sharman's Rock-wallaby Survey also collected data on the site occupancy of Common Wallaroo (*Macropus robustus*); one of a suite of surveillance indicator species used in Mount Zero-Taravale's Ecohealth program. Common Wallaroo was detected at 19 of the 37 sites sampled during the Sharman's Rock-wallaby survey (51% occupancy).

Feral cats were detected at 11% of the Sharman's Rock-wallaby Survey sites during the survey period. This is comparable to the results that were found during the sanctuary-wide camera survey in 2018 (13% occupancy).

The 2021 fire metrics indicate improvements from baseline levels during AWC fire management on Mount Zero-Taravale, which will likely benefit native species and ecosystems. The average extent of early dry season fire has increased above baseline levels, while the average extent of late dry season fire has decreased (to only 1% of the sanctuary in 2021), and the distance to unburnt vegetation has substantially decreased.

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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?'

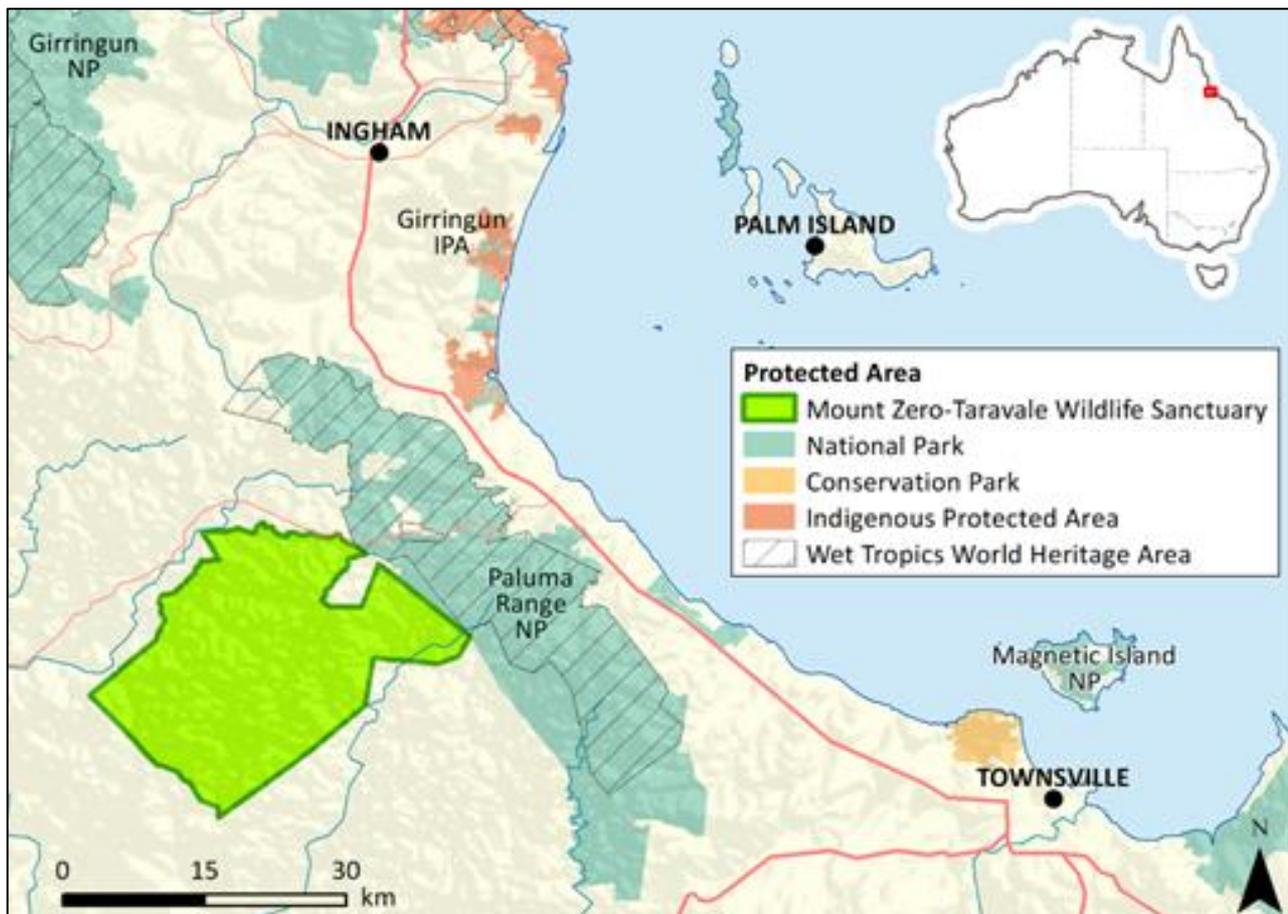
For threatened and iconic species, including reintroduced species, AWC's monitoring program aims to obtain more detailed information related to their conservation management; for example, data on survival, recruitment, condition, distribution and/or population size.

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 one of a series of annual Ecohealth Reports for Mount Zero-Taravale Wildlife Sanctuary (referred to here as Mount Zero-Taravale). The companion Ecohealth Scorecard presents the indicators and their metrics in a summary format.

### Mount Zero-Taravale

Mount Zero-Taravale is located in north-east Queensland and is 59,138 ha in extent (Figure 1). The sanctuary is within the traditional lands of the Gugu Badhun people. It is located on the slopes of the Coane Range, and supports a diverse range of ecosystems including rainforest, wet sclerophyll forests, woodlands and spinifex grasslands (Stanton 2007). The sanctuary encompasses parts of the Wet Tropics and Einasleigh Uplands bioregions and supports elements of both wet tropical and rangeland biotas. Prior to acquisition by AWC, the Mount Zero and Taravale leases had a history of pastoral activities, timber harvesting and mining.



**Figure 1. Location and regional context of Mount Zero-Taravale, north-east Queensland.**

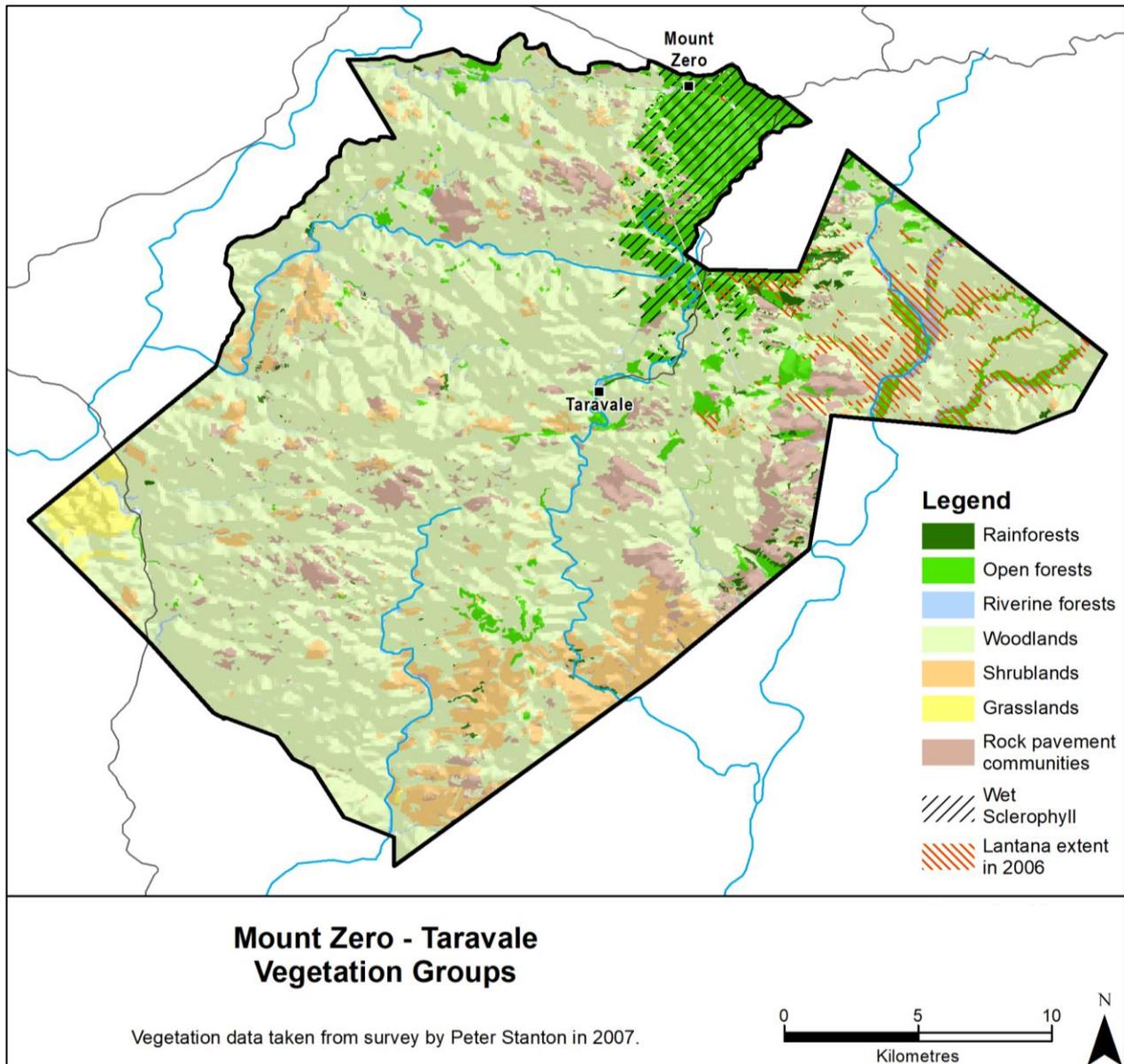
The vegetation types present on Mount Zero-Taravale are diverse reflecting the range of rainfall (800-2,000 mm), altitude (300 m - >1,000 m) and sheer ruggedness that create fine scale habitat variation. There are 68 vegetation types on Mount Zero-Taravale (Figure 2), which can be grouped into 19 broad vegetation groups (Stanton 2007). The geology of the sanctuary comprises alluvial flats in the Star Valley, quartz arenite, rhyolite metamorphics and granite outcroppings (Stanton 2003).

To date, 220 bird species have been detected on the sanctuary, along with 91 reptile, 63 mammal, 21 frog, and seven fish species. Fifteen 'threatened' or 'near threatened' vertebrate species have been confirmed on Mount Zero-Taravale. This includes Sharman's Rock-wallaby (*Petrogale sharmani*; listed as Vulnerable), with around 70% of all known colonies existing on the sanctuary, and historic records of the Northern Bettong (*Bettongia tropica*; Endangered).

Since acquisition in 2004, AWC has undertaken considerable survey effort at Mount Zero-Taravale across all major vegetation types including wet sclerophyll forests, savanna woodlands and spinifex. This includes inventory survey work, surveys for the Northern Bettong, as well as a preliminary study of the response of the fauna of wet sclerophyll forest to invasion by rainforest plants (Middleton 2009; Kanowski et al. 2012; Kanowski 2016). Past survey effort has expanded the list of species found on the sanctuary, including records of species on the edge of their known range. This includes Black-striped Wallaby (*Macropus dorsalis*), and the Australian Coral Snake (*Brachyuophis australis*), threatened species such as the Atherton Delma (*Delma mitella*), and new range extensions like that of the Magnificent Broodfrog (*Pseudophryne covacevichae*). Major conservation actions implemented by AWC at Mount Zero-Taravale include: (i) fire management, particularly the restoration of a fine-scale mosaic of early dry season burning across the savanna woodlands; (ii) ongoing weed control programs, particularly for lantana (*Lantana camara*) infestations; (iii) a large-scale restoration program for wet sclerophyll forests (Kanowski et al. 2012; Kanowski 2016); and the construction of a feral predator-free exclusion fence.

The overarching aim of fire management on Mount Zero-Taravale is to re-establish ecologically appropriate fire regimes; those which promote the conservation of species, ecological communities and ecosystem

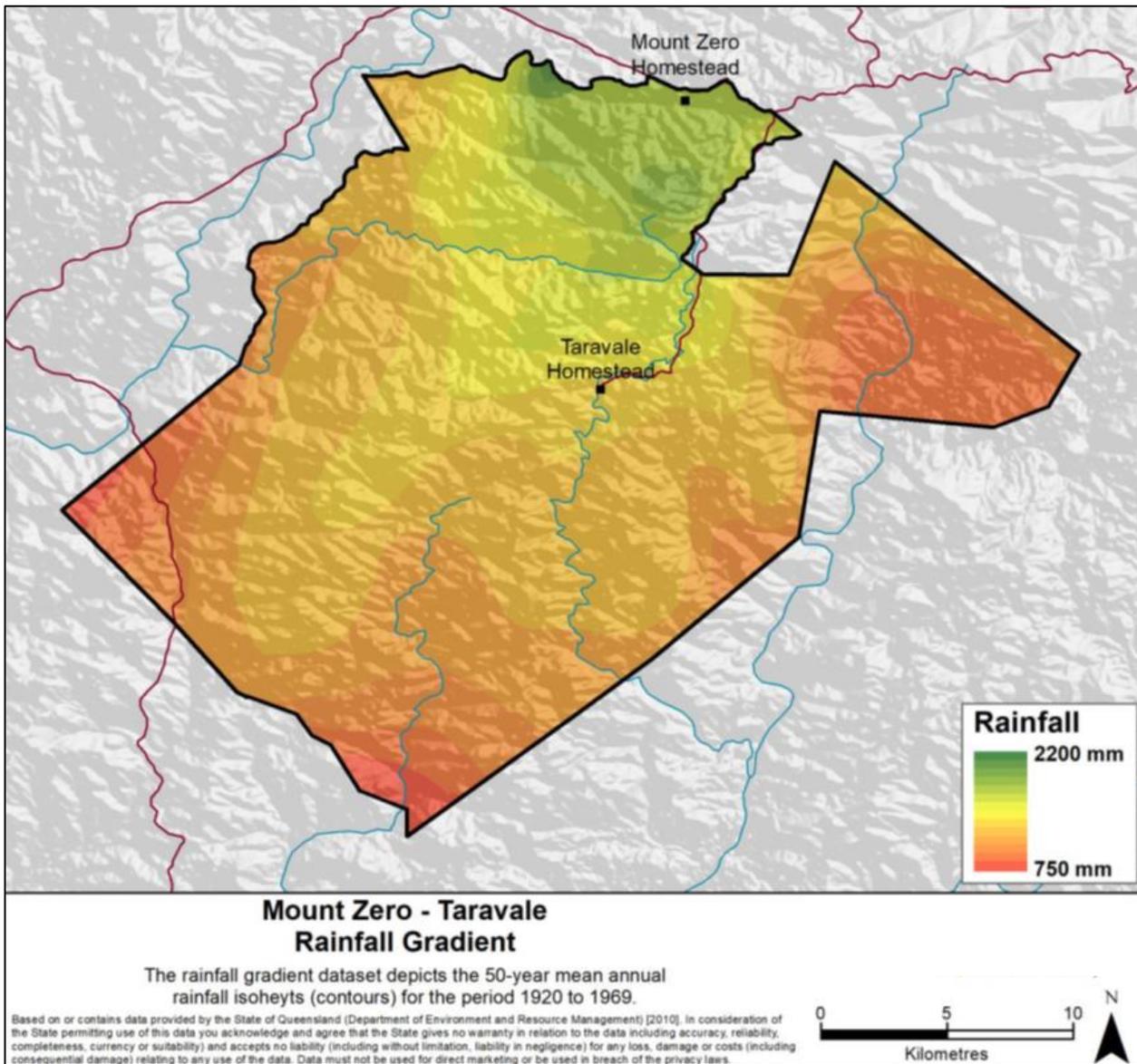
processes (Cooper et al. 2019; Webb et al. 2022). Additional objectives include the protection of life and property and control of invasive weeds. The outcomes of fire management are assessed annually through an analysis of satellite imagery (e.g. Cooper et al. 2019; Webb et al. 2022).



**Figure 2. Broad vegetation groups of Mount Zero-Taravale.** Source: Stanton (2007).

### Climate and weather summary

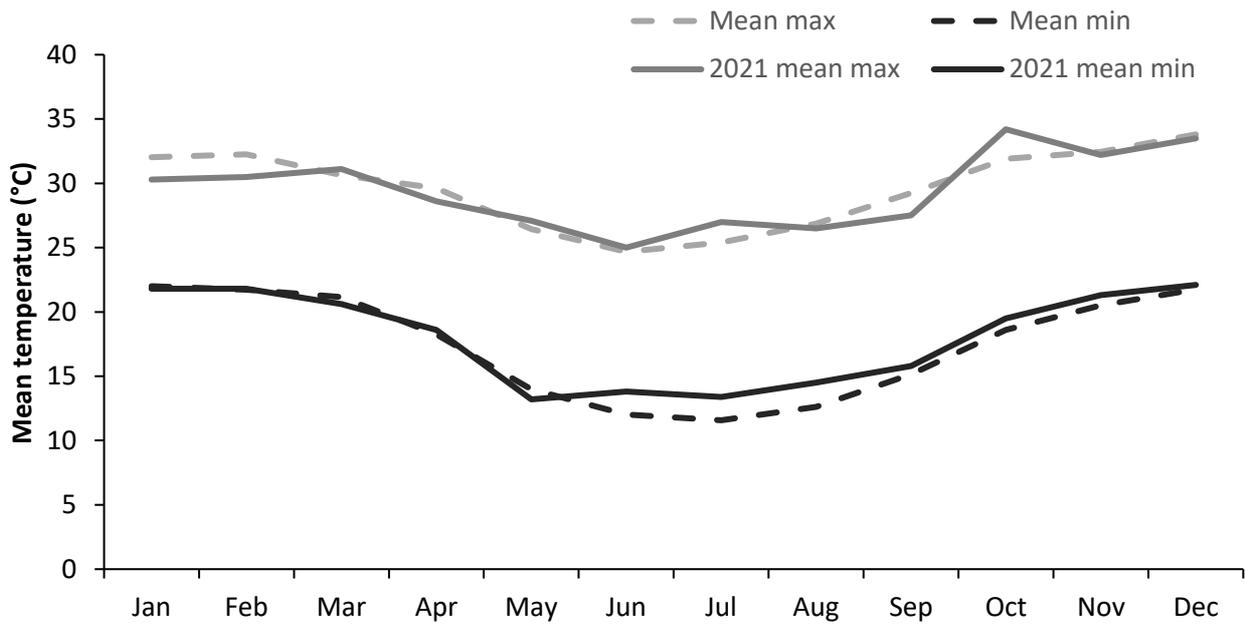
A strong rainfall gradient exists across Mount Zero-Taravale. The north-eastern elevated parts of the sanctuary (around Mount Zero) receive over 2000 mm annually, declining to less than 800 mm in the lower elevation parts of the south-west (Figure 3).



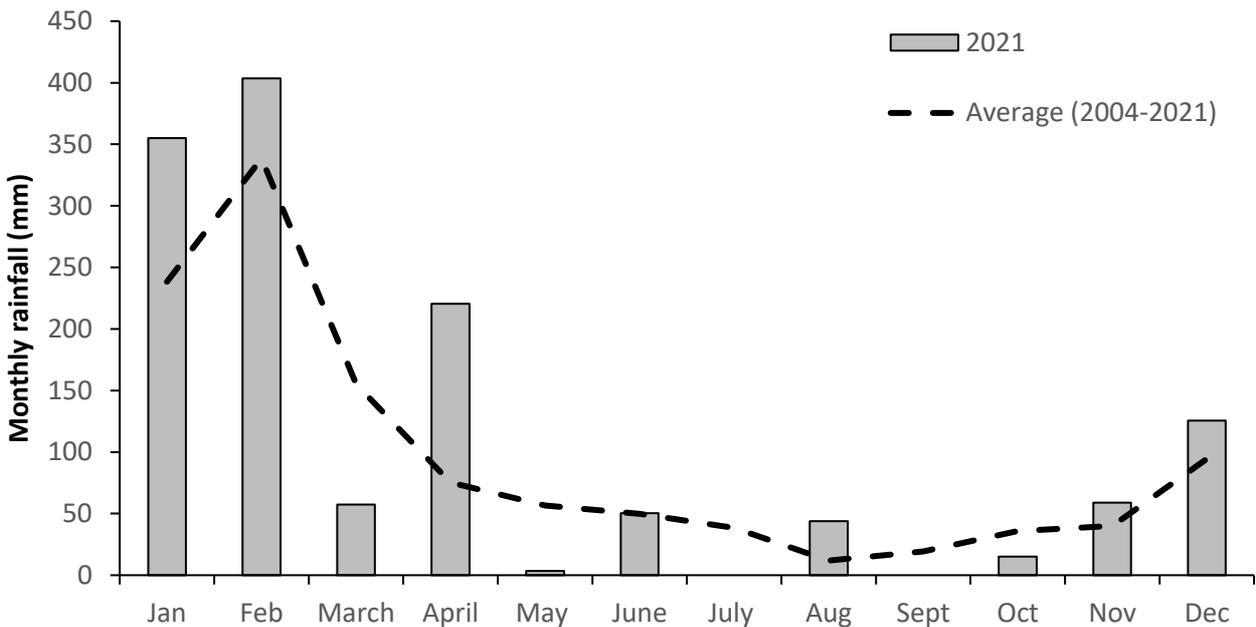
**Figure 3. Modelled rainfall across Mount Zero-Taravale.** Source: Cooper et al. (2019).

The climate typically consists of warm summers and mild winters. Mean maximum temperatures range between 35°C in summer and 25°C in winter (Figure 4). Rainfall is concentrated during the ‘wet season’ (approximately December to March), with comparatively dry conditions usually experienced in the latter half of the year (Figure 5).

Climate records are currently sourced from the Taravale homestead (a manual rain-gauge), and Bureau of Meteorology weather station data. The nearest weather station is located at the Townsville Weapons Range, ~26 km south-east of the Taravale Homestead (installed August 2017, BOM weather station number 32196). The mean maximum temperature in 2021 (29.5°C) was slightly cooler than the historical mean maximum (29.7°C), while the mean minimum temperature in 2021 was 0.5°C warmer than the historical mean minimum (18°C and 17.5°C respectively; Figure 4; Bureau of Meteorology 2021a,b).



**Figure 4. Average maximum and minimum temperatures as recorded at Bureau of Meteorology weather station Townsville – Air Weapons Range (Defence), Station number 32196. Dashed line = average 2017-2021.**



**Figure 5. Monthly rainfall at Taravale Homestead in 2021. Dashed line = average monthly rainfall, 2004-2021. Note: in 2021, Ecohealth surveys were undertaken in June-August.**

Since 2004, the mean rainfall recorded at Taravale Homestead was 1,153 mm (Figure 6). In 2021, annual rainfall was slightly higher than average, with 1,334 mm recorded. This was largely attributed to above average falls recorded within the first quarter of the year (Figure 5).

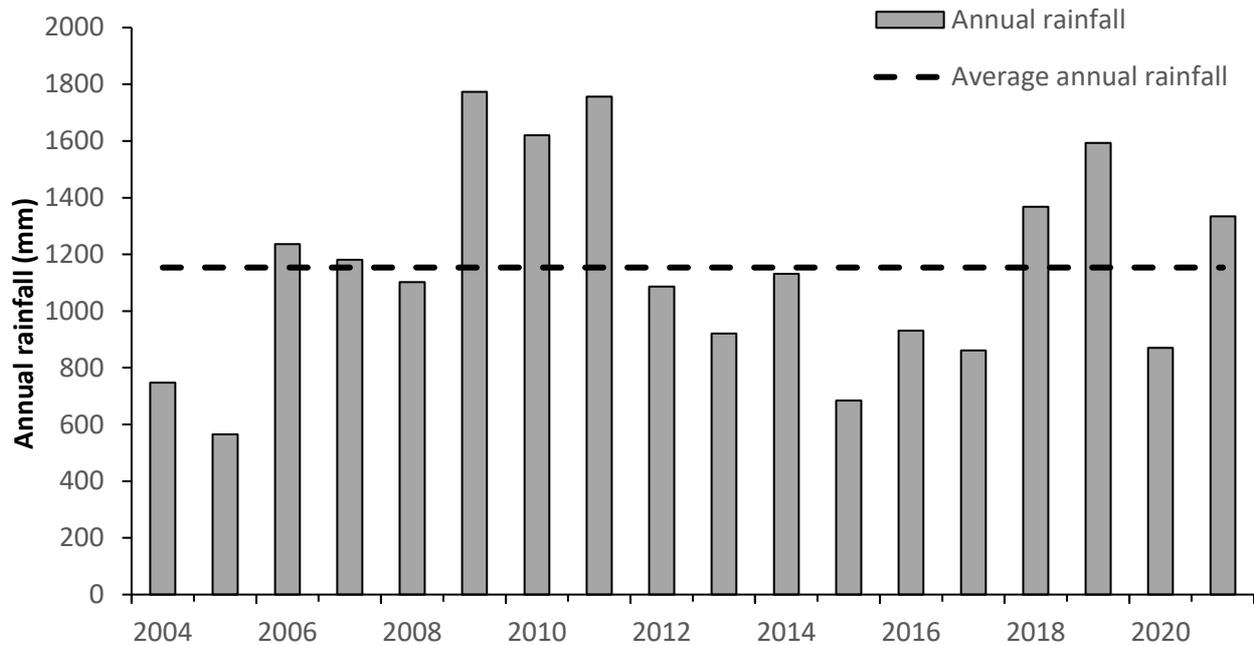


Figure 6. Annual rainfall at Taravale Homestead. Dashed line = average 2004-2021.

## Methods

Mount Zero-Taravale’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 are evaluated against performance criteria relevant to each species, guild or assemblage.

### Key threatened and iconic species

The Ecohealth program is focused on species of high conservation value, including 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). Where relevant, reintroduced species are also in this category.

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.

### Vertebrate assemblages and surveillance species

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 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 Mount Zero-Taravale, 63 biodiversity (species, guilds and assemblages) indicators have been selected for monitoring (Table 1). Six of these indicators were reported on in 2021, including one related to threatened and iconic species, and the remaining indicator to surveillance monitoring of faunal assemblages.

Threat metrics are selected to monitor the status and trends of weeds, introduced predators and herbivores, and fire regimes. Seven threat indicators have been selected for monitoring (Table 2). One of these threat indicators (fire) was assessed in 2021.

**Table 1. Biodiversity indicators and metrics for Mount Zero-Taravale.**

**Key threatened and iconic vertebrates.** TN = trap nights.

Indicator	Survey name	Survey method	Metric/s
<b>Mammals</b>			
Northern Quoll ( <i>Dasyurus hallucatus</i> ; planned reintroduction)	TBD	TBD	Population estimate Abundance (per 100TN) Occupancy
Koala ( <i>Phascolarctus cinereus</i> )	TBD	TBD	Occupancy
Greater Glider ( <i>Petauroides volans minor</i> )	Nocturnal Arboreal Mammal Survey	Spotlighting	Abundance (per transect) Occupancy
Northern Bettong ( <i>Bettongia tropica</i> ; planned reintroduction)	Standard Trapping Survey Targeted Survey	Live trapping	Population estimate Abundance (per 100TN) Occupancy
Sharman’s Rock-wallaby ( <i>Petrogale sharmani</i> )	Sharman’s Rock-wallaby Survey	Camera trapping	Population estimate (method TBC) Abundance (detection interval TBC) Occupancy
<b>Frogs</b>			
Magnificent Broodfrog ( <i>Pseudophryne covacevichae</i> )	TBD	Acoustic monitoring	Abundance (per 100TN) Occupancy
<b>Fish</b>			
Running River Rainbowfish ( <i>Melanotaenia</i> sp.)	Running River Rainbowfish Survey	TBD	Abundance Occupancy

## Vertebrate assemblages and surveillance species

Indicator	Survey name	Survey method	Metric/s
<b>Mammals</b>			
Assemblage richness	All mammal surveys	Live trapping, camera trapping, spotlighting, incidental records	Number of species
Small-medium mammals			
Rainforest and wet sclerophyll small-medium mammal guild	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Richness
Savanna woodlands small-medium mammal guild	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Richness

Indicator	Survey name	Survey method	Metric/s
Spinifex guild small-medium mammal guild	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Richness
Yellow-footed Antechinus ( <i>Antechinus flavipes</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Common Planigale ( <i>Planigale maculata</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Common Dunnart ( <i>Sminthopsis murina</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Northern Brown Bandicoot ( <i>Isodon macrourus</i> )	Standard Camera Survey	Camera trapping	Abundance (per 100TN) Occupancy
Northern Long-nosed Bandicoot ( <i>Perameles pallescens</i> )	Standard Camera Survey	Camera trapping	Abundance (per 100TN) Occupancy
Rufous Bettong ( <i>Aepyprymnus rufescens</i> )	Standard Camera Survey	Camera trapping	Abundance (per 100TN) Occupancy
Red-legged Pademelon ( <i>Thylogale stigmatica</i> )	Standard Camera Survey	Camera trapping	Abundance (per 100TN) Occupancy
Northern Short-tailed Mouse ( <i>Leggadina lakedownensis</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Delicate Mouse ( <i>Pseudomys delicatulus</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Eastern Chestnut Mouse ( <i>Pseudomys gracilicaudatus</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Eastern Pebble-mouse ( <i>Pseudomys patrius</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Common Rock-rat ( <i>Zyomys argurus</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Grassland Melomys ( <i>Melomys burtoni</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Fawn-footed Melomys ( <i>Melomys cervinipes</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Giant White-tailed Rat ( <i>Uromys caudimaculatus</i> )	Standard Camera Survey	Camera trapping	Abundance (per 100TN) Occupancy
Bush Rat ( <i>Rattus fuscipes</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Swamp Rat ( <i>Rattus lutreolus</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Canefield Rat ( <i>Rattus sordidus</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Arboreal mammals			
Common Ringtail Possum ( <i>Pseudocheirus peregrinus</i> )	Nocturnal Arboreal Mammal Survey	Spotlighting	Abundance (per transect) Occupancy
Common Brushtail Possum ( <i>Trichosurus vulpecula</i> )	Nocturnal Arboreal Mammal Survey Standard Camera Survey	Spotlighting Camera trapping	Abundance (per transect/ trap site) Occupancy
Large herbivores			
Eastern Grey Kangaroo ( <i>Macropus giganteus</i> )	Standard Camera Survey	Camera trapping	Abundance (per 100TN) Occupancy
Whiptail Wallaby ( <i>Macropus parryi</i> )	Standard Camera Survey	Camera trapping	Abundance (per 100TN) Occupancy
Common Wallaroo ( <i>Macropus robustus</i> )	Sharman's Rock-wallaby Survey	Camera trapping	Occupancy
Swamp Wallaby	Standard Camera Survey	Camera trapping	Abundance (per 100TN)

Indicator	Survey name	Survey method	Metric/s
( <i>Wallabia bicolor</i> )			Occupancy
Large predatory mammals			
Dingo ( <i>Canis dingo</i> )	Standard Camera Survey Targeted Predator Survey (TBD)	Camera trapping	Abundance (per 100TN) Occupancy
<b>Reptiles</b>			
Assemblage richness			Number of species
Small-medium reptiles			
Rainforest and wet sclerophyll small-medium reptile guild	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Richness
Savanna woodlands small-medium reptile guild	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Richness
Spinifex guild small-medium reptile guild	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Richness
Tommy Roundhead ( <i>Diporiphora australis</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Eastern Spiny-tailed Gecko ( <i>Strophurus williamsi</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Bynoe's Prickly Gecko ( <i>Heteronotia binoei</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Black-throated Rainbow-skink ( <i>Carlia rostralis</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Red-throated Rainbow-skink ( <i>Carlia rubrigularis</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
Straight-browed Ctenotus ( <i>Ctenotus spaldingi</i> )	Standard Trapping Survey	Live trapping	Abundance (per 100TN) Occupancy
<b>Birds</b>			
Assemblage richness	All bird surveys	Call playback, incidental records, other methods (TBD)	Number of species
Targeted species (TBD) - spinifex guild	Targeted Survey (TBD)	Call playback	Occupancy
Brown Honeyeater ( <i>Lichmera indistincta</i> )	Targeted Bird Survey (TBD)	Call playback	Occupancy
Red-backed Fairywren ( <i>Malurus melanocephalus</i> )	Targeted Bird Survey (TBD)	Call playback	Occupancy
Golden Whistler ( <i>Pachycephala pectoralis</i> )	Targeted Bird Survey (TBD)	Call playback	Occupancy
Rufous Whistler ( <i>Pachycephala rufiventris</i> )	Targeted Bird Survey (TBD)	Call playback	Occupancy
Victoria's Riflebird ( <i>Ptiloris victoriae</i> )	Targeted Bird Survey (TBD)	Call playback	Occupancy
Eastern Yellow Robin ( <i>Eopsaltria australis</i> )	Targeted Bird Survey (TBD)	Call playback	Occupancy
Noisy Pitta ( <i>Pitta versicolor</i> )	Targeted Bird Survey (TBD)	Call playback	Occupancy
Glossy Black Cockatoo ( <i>Calyptorhynchus lathami</i> )	Targeted Survey (external researcher)	TBD	Population Estimate Occupancy
Masked Owl ( <i>Tyto novaehollandiae kimberli</i> )	Nocturnal Bird Survey (TBD)	Call playback	Abundance (per site) Occupancy
<b>Frogs</b>			
Assemblage richness			Number of species
Terrestrial frog guild	Standard Trapping Survey Frog Survey - Acoustic (TBD)	Live trapping Acoustic monitoring	Occupancy Richness

Indicator	Survey name	Survey method	Metric/s
Desert Tree Frog ( <i>Litoria rubella</i> )	Standard Trapping Survey Frog Survey - Acoustic (TBD)	Live trapping Acoustic monitoring	Abundance (per 100TN) Occupancy
Northern Banjo Frog ( <i>Limnodynastes terraereginae</i> )	Standard Trapping Survey Frog Survey - Acoustic (TBD)	Live trapping Acoustic monitoring	Abundance (per 100TN) Occupancy
Ornate Burrowing Frog ( <i>Platyplectrum ornatum</i> )	Standard Trapping Survey Frog Survey - Acoustic (TBD)	Live trapping Acoustic monitoring	Abundance (per 100TN) Occupancy
Southern Ornate Nursery-frog ( <i>Cophixalus australis</i> )	Standard Trapping Survey Frog Survey - Acoustic (TBD)	Live trapping Acoustic monitoring	Abundance (per 100TN) Occupancy

**Table 2. Threat indicators and metrics for Mount Zero-Taravale.**

Indicator	Survey name/method	Metric/s	Performance criteria
<b>Pest animals</b>			
Feral cats ( <i>Felis catus</i> )	Standard Camera Survey; Sharman's Rock Wallaby Survey	Abundance Occupancy	TBD
Foxes ( <i>Vulpes vulpes</i> )	Standard Camera Survey	Abundance Occupancy	TBD
Feral cattle ( <i>Bos taurus</i> )	TBD		TBD
Feral horses ( <i>Equus caballus</i> )	TBD		TBD
Pigs ( <i>Sus scrofa</i> )	Standard Camera Survey	Abundance Occupancy	TBD
Cane toads ( <i>Rhinella marina</i> )	Standard Trapping Survey	Abundance Occupancy	TBD
<b>Fire</b>			
Fire	Fire Scar Analysis	Area burnt by early dry season fire, area burnt by late dry season fire (1 yr and past 3 yr), distance to unburnt vegetation, distance to vegetation unburnt by late dry season fire for 3 yr)	TBD

## Survey types and history

To report on the biodiversity and threat indicators, our teams conduct a variety of surveys repeated on a schedule of 1-5 years, as required to obtain timely information on each indicator.

For threatened and iconic species, a range of targeted surveys are used:

- Sharman's Rock-wallaby Survey
- Running River Rainbowfish Survey
- Magnificent Broodfrog Survey (TBD)
- Standard Trapping Survey
- Standard Camera Survey
- Nocturnal Arboreal Mammal Survey

For monitoring of assemblages and surveillance species, the following surveys are used:

- Standard Trapping Survey
- Standard Camera Survey
- Frog Survey – Acoustic (TBD)
- Nocturnal Arboreal Mammal Survey

- Nocturnal Bird Survey
- Targeted Bird Survey (TBD)
- Targeted Predator Survey (TBD)
- Sharman’s Rock-wallaby Survey (Common Wallaroo, *Macropus robustus*)
- Incidental Observations

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

- Standard Trapping Survey
- Standard Camera Survey
- Fire Scar Analysis

One of the ecological surveys (Sharman’s Rock-wallaby Survey) was conducted at Mount Zero-Taravale in 2021, in addition to the collection of incidental observations by on-site and visiting staff. A fauna survey associated with a planned feral-free exclusion fence was also completed in 2021; while not currently included in Ecohealth reporting, records of species presence contributed towards the summary of assemblage completeness.

Below is a list of surveys presented in this Ecohealth Report (Table 3). Fire Scar Analysis was completed using satellite data from 1997 (7 years prior to acquisition) to 2021. The methodology is described and results of these surveys and computations are reported on in this document.

**Table 3. Survey history and effort for Ecohealth surveys on Mount Zero-Taravale presented in this report.**

Survey name	Effort	Description/comment	Previous surveys
Sharman’s Rock-wallaby Survey	2068 camera trap nights	37 monitoring sites. Two cameras deployed per site, positioned ~50 m apart, for 28 nights.	2019 – 31 sites (855 trap nights) 2020 – 11 sites (308 trap nights)
Incidental Observations	Variable	Records collected on sanctuary throughout the year  Inside/Outside exclosure fence surveys	

## Survey design and methods

### Sharman’s Rock-wallaby Survey

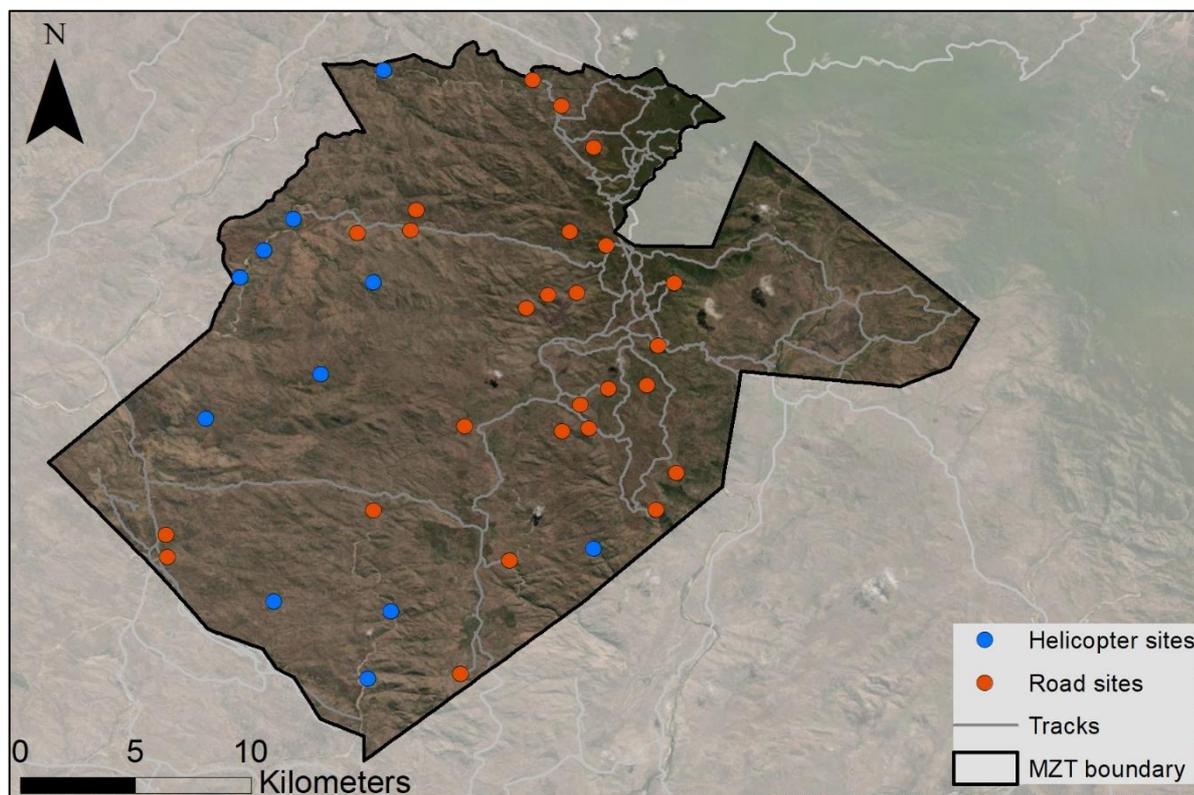
In 2021, 37 sites were selected for ongoing monitoring (Figure 7). Surveys sites were spaced at least 1 km apart, based on Sharman’s Rock-wallaby’s typical nightly foraging distance of 220 m from rocky shelter sites (Hayes 2019). Two camera traps deployed at each site for a 28-day survey period.

Site selection was revised from those identified in 2019, with a primary focus on locations where Sharman’s Rock-wallaby had been previously detected (35 sites) and remaining effort across sites with a high likelihood of occurrence based on habitat. In 2019, 69 potential sites were identified, including 28 locations where Sharman’s Rock-wallaby were known to occur previously (16 road-accessed sites and 12 helicopter access) and an additional 41 sites selected in potential habitat (16 road-accessed and 25 helicopter sites). Thirty-one sites were surveyed in 2019 and 11 in 2020, with a single camera trap deployed at each site. The survey method was refined in 2021, with funding under the Queensland Government’s Threatened Species Recovery and Resilience category of the Community Sustainability Action grant program.

Camera traps were deployed to monitoring sites in June-August 2021. Road and helicopter-based deployments were necessarily spread across a two-month period due to above average rainfall in the preceding months which delayed both 4WD and helicopter access to the survey sites. Two Reconyx Hyperfire PC850 Whiteflash motion sensor camera traps were set in complex rocky habitat at each monitoring site and left in place for 28 days. At each site, the cameras were placed at least 50 m apart.

All grass was cleared from the immediate vicinity of the camera trap site. The camera was set 1 m high on a tree. A bait ball comprised of oats, peanut butter, Fluidarom (a strongly-scented stock food additive) and vanilla essence was placed inside a PVC baitholder and pegged into the ground 1.5 m from the base of the

tree. If it was not possible to peg the bait container into the ground, the baitholder was weighed down with a rock (ensuring that the vent was sufficiently open to allow the bait ball scent to be detected). Cameras were set facing north or south, if possible, to avoid interference from the sun.



**Figure 7. Sharman's Rock-wallaby survey sites across Mount Zero-Taravale, 2021.**

The cameras were set to rapidfire, high sensitivity, 3 pictures per trigger, with no delay and no quiet period between triggers. The tree was marked with flagging tape and a GPS waypoint of each camera trap taken. Cameras were retrieved 28 days or more after deployment. Data captured beyond the 28-day sampling period were considered 'incidental' only. All but one of the 74 camera traps was operational for the full survey period.

The Common Wallaroo also occurs on rocky habitat at Mount Zero-Taravale (Hayes 2019). The targeted survey for Sharman's Rock Wallaby was therefore also used to provide the 2021 metrics for the Common Wallaroo.

### Incidental Observations

Incidental observations of fauna were recorded by on-site and visiting staff, volunteers and/or researchers, and verified as required. For each observation, details were recorded of date, observer, species observed, observation type (e.g. seen, heard), number of individuals and location.

### Analysis methods

Most Ecohealth metrics are common across the indicator species for Mount Zero-Taravale. Unless noted otherwise, the metrics are calculated as set out in Table 4.

As there are diverse ecosystems on Mount Zero-Taravale ranging from rainforest to open grassland, the metrics are reported for species and groups of species of a particular 'guild'. This requires that all sites surveyed, and all species reported on, are correctly assigned to a particular guild (or guilds) prior to undertaking these calculations.

**Table 4. Metrics and associated calculations for Mount Zero-Taravale, 2021.**

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 4 years is compared to the number of species listed as 'confirmed', 'very likely' or 'likely' on the sanctuary species list.
Sharman's Rock-wallaby; Common Wallaroo	Occupancy	Sharman's Rock-wallaby survey	A measure of distribution; the proportion of sites where the species was recorded using a particular technique	For individual species:  (Number of sites at which the species was recorded/ number of sites surveyed) [x 100 if reporting as a %]
Feral cat	Occupancy	Sharman's Rock-wallaby survey	A measure of distribution; the proportion of sites where the species was recorded using a particular technique	For individual species:  (Number of sites at which the species was recorded/ number of sites surveyed) [x 100 if reporting as a %]

### Sharman's Rock-wallaby Survey

Camera data were downloaded and processed using the Microsoft Azure Image Detection Application Programming Interface (API), facilitated by the Microsoft Azure Storage Explorer and Postman platforms. Once the API processing component was completed, data were uploaded into the program 'Timelapse'. Animals were identified to species level if possible. A file containing all species captures was exported from Timelapse into Microsoft Excel.

Analysis of the 2021 camera trap survey results is ongoing. The appropriate detection interval to calculate an index of abundance for Sharman's Rock-wallaby is under consideration. As such, only occupancy is presented for the current reporting period, calculated as described in Table 4.

Future analyses will include investigation of the temporal association between feral cat (*Felis catus*) and Sharman's Rock-wallaby detections, and detailed investigation of the long-term fire history and environmental variables at each survey site.

### Incidental Observations

Incidental Observations from 2020-2021 were used to generate a list of species incidentally observed on Mount Zero-Taravale. These were combined with data recorded during survey effort from 2021 to provide a summary of assemblage completeness recorded across the reporting period.

### Fire Scar Analysis

Fire scar data were derived from Landsat satellite imagery, and in later years supplemented by Sentinel-2 satellite imagery. 'Hotspot' data from the North Australian Fire Information (NAFI) website were used to help identify the month of the fire when the Landsat satellite imagery interval extended across two months. Each scar was attributed by year, month and season. Fire scars detected from January to August (inclusive) were attributed as 'Early', whereas those detected September to December were attributed as 'Late'. For each year, unburnt areas were created by erasing the recorded fires from the entire boundary area. The maps and statistics for the analyses were created using ArcGIS (Environmental System Research Institute Inc., Redlands, CA, USA) with Spatial Analyst, and were semi-automated using Python scripting. Graphs were produced using Microsoft Excel. Detailed methods are provided in Webb et al. (2022).

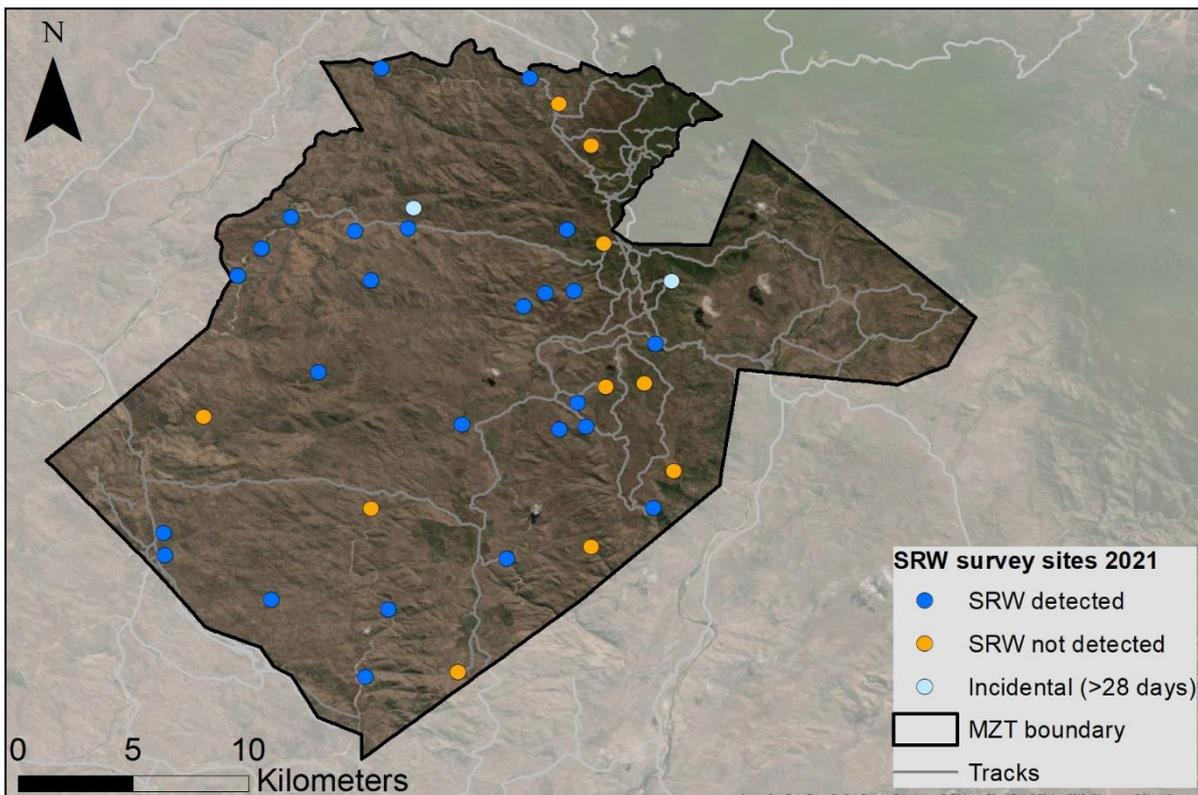
## Results

### Key threatened and iconic vertebrates

#### Sharman’s Rock-wallaby

Sharman’s Rock-wallabies were detected at 42 of the 74 cameras deployed over the survey period, and at an additional 8 cameras outside the survey period. These latter detections were recorded as ‘incidental’ detections.

At the site level, Sharman’s Rock-wallabies were detected at 25 of the 37 survey sites (an occupancy of 68%; Figure 8 and Figure 9). At a further 2 sites, the species was detected outside the survey period. While this is a large increase in occupancy rates compared to those recorded in 2019 and 2020 (23% and 27% respectively), different sites were sampled meaning the data are not directly comparable.



**Figure 8. Detections of Sharman's Rock-wallaby ('SRW') across 37 sites during 2021 surveys.** 'Incidental' detections occurred where Sharman’s Rock-wallabies were recorded at a site, but outside the 28-day survey period.



**Figure 9. Sharman’s Rock-wallaby recorded on camera trap during the 2021 survey.**

Three additional key threatened species, the Magnificent Broodfrog, Greater Glider (*Petauroides volans minor*) and Koala (*Phascolarctos cinereus*) were recorded through a combination of incidental observation and survey effort beyond the Ecohealth program.

## **Vertebrate assemblages and surveillance species**

### **Mammals**

Mammal assemblage data were not targeted in the Ecohealth surveys undertaken in 2021. Of the 63 species known to occur at Mount Zero-Taravale, 37 species (59%) were confirmed in 2018-21. These species records were largely attained through survey effort associated with the feral predator-free exclusion fence. Most of the mammal species not detected in 2018-21 were bats. Of the 23 bat species known to occur at Mount Zero-Taravale, only 3 species (13%) were confirmed. This included the Greater Large-eared Horseshoe bat (*Rhinolophus robertsi*), a nationally listed threatened species (Vulnerable), which was recorded during survey effort outside the Ecohealth program.

### **Common Wallaroo**

Common Wallaroo was detected at 19 of the 37 survey sites sampled in 2021 (occupancy of 51%). This is a similar occupancy estimate to that recorded in 2020 (55%) and an increase from 2019 (23%), however the data are not directly comparable as a different suite of monitoring sites were sampled.

### **Birds**

Bird assemblage data were not targeted in the Ecohealth surveys undertaken in 2021. Of the 220 species known to occur at Mount Zero-Taravale, 37 species (19%) were confirmed in 2018-21. These species records were biased towards larger, easy to observe species. This included the Northern Masked Owl (*Tyto novaehollandiae kimberli*), a nationally listed threatened subspecies (Vulnerable), which was recorded during surveys outside the Ecohealth program.

### **Reptiles**

Reptile assemblage data were not targeted in the Ecohealth surveys undertaken in 2021. Of the 91 species known to occur at Mount Zero-Taravale, 47 species (52%) were confirmed in 2018-21. These species records were largely attained through survey effort associated with the feral predator-free exclusion fence. This included the Atherton Delma, a nationally listed threatened species (Vulnerable), which was recorded during survey effort outside the Ecohealth program.

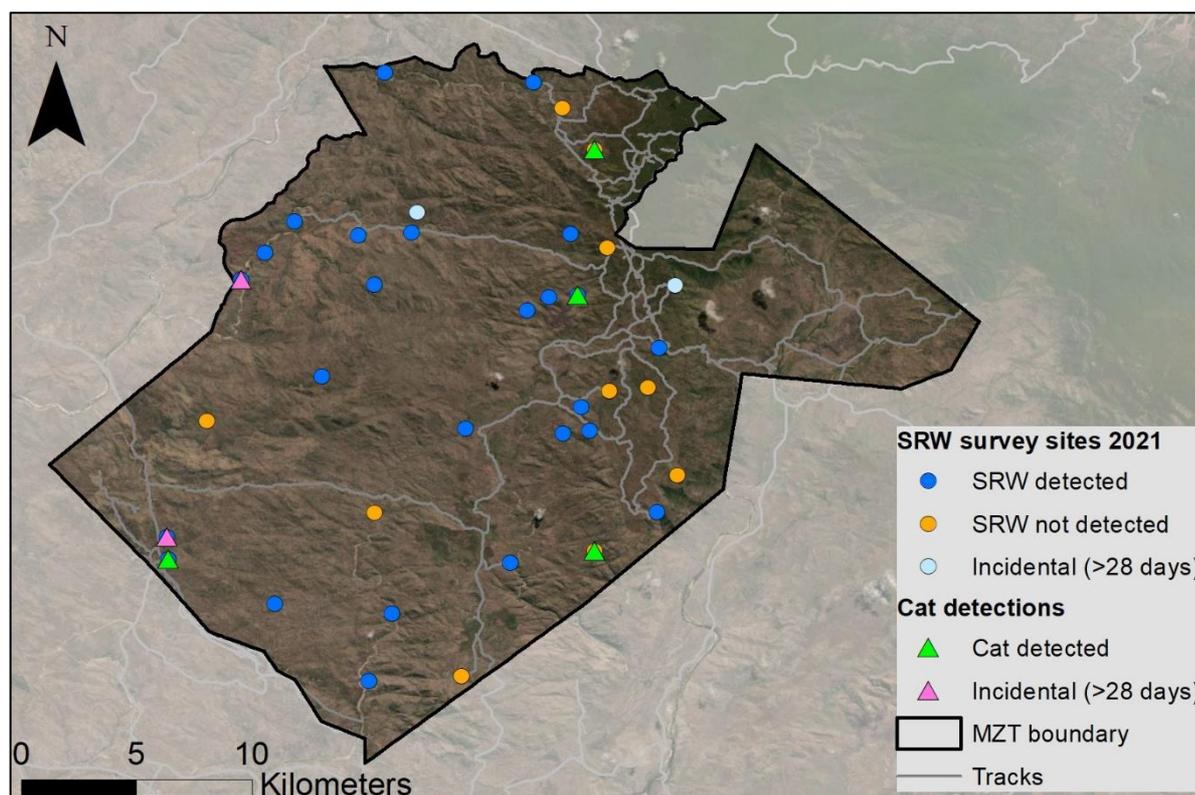
### **Frogs**

Frog assemblage data were not targeted in the Ecohealth surveys undertaken in 2021. Of the 22 species known to occur at Mount Zero-Taravale, 4 species (18%) were confirmed in 2018-21.

## **Threat indicators**

### **Feral cat**

Feral cats were detected at 4 sites during the Sharman Rock-wallaby Survey (occupancy of 11%), and at 2 additional sites outside the survey period (Figure 10). Of the 6 sites feral cats were detected at (including incidental detections), Sharman's Rock-wallabies were detected at 4 of those sites in 2021.



**Figure 10. Detections of feral cats during Sharman's Rock-wallaby survey, 2021.** Two 'incidental' detections occurred where cats were recorded at a site, but outside the 28-day survey period.

### Fire

The 2021 fire metrics reveal improvements from baseline values that are likely to benefit ecological health. Since AWC commenced fire management, the area burnt by early dry season fire has increased from a baseline of 0% to an average of 14%, while the area burnt by late dry season fire has reduced substantially (to 1% in 2021; Table 5). Both the mean distance to unburnt vegetation, and the mean distance to vegetation unburnt by a late dry season fire for 3 or more years were both one third of the baseline value in 2021. More detail on the Mount Zero-Taravale fire program is provided in the annual Fire Reports (e.g., Webb et al. 2022).

**Table 5. Fire metrics for Mount Zero-Taravale for 2021.**

Metric	Baseline average	AWC average	2021 result	Trend (AWC vs baseline)	Trend (2021 vs baseline)
Area burnt by early dry season (EDS) fire (%)	0	14	2	↑	↑
Area burnt by late dry season (LDS) fire (%)	12	6	1	↓	↓
Cumulative extent burnt by LDS fire in past 3 years (%)	43	17	30	↓	↓
Mean distance to unburnt vegetation (km)	0.6	0.5	0.2	↓	↓
Mean distance to vegetation unburnt by LDS fire for 3 or more years (km)	1.2	0.5	0.4	↓	↓

**Notes:**

**Baseline** values for metrics are the average for the years immediately prior to acquisition of Brooklyn by AWC: i.e., 1999-2004, for annual metrics, and 2001-2004, for 3-year metrics.

**AWC management** values for metrics are the average for the years following acquisition of Brooklyn by AWC: i.e., 2005 onwards, for annual metrics, and 2007 onwards, for 3-year metrics.

**Trend:** change in metric compared with baseline, considering (i) average across AWC management; (ii) current year. Change in magnitude shown by arrows: increase ↑, no change ↔, reduction ↓).

Inferred consequences for ecological health depicted by colour: improving in green (e.g., ↑ or ↓, depending on the metric); deteriorating in red (e.g., ↑ or ↓); no change, or if the change cannot be interpreted in terms of ecological health, in black. (↔, ↑ or ↓).

## Discussion

Results from the 2021 Sharman's Rock-wallaby monitoring are encouraging. Across all 37 survey sites, this threatened species was detected at 68% of sites, with detections at an additional 5% of sites outside the survey period. This confirms that Mount Zero-Taravale is very important for the conservation of this species, with around 70% of the global population found on the sanctuary. Occupancy rates in this survey are much higher than previous surveys, however, this could be due to several factors related to survey effort. In 2021, Two camera traps were deployed at each site which doubled the previous effort of 2019 and 2020 surveys. Additionally, refined site selection focused on confirmed colony locations with 35 of the 37 monitoring sites located at previously confirmed locations and the remaining 2 in suitable habitat. Future surveys of the same sites will provide trends in these occupancy patterns, particularly for those sites that appear to be only infrequently used by Sharman's Rock-wallaby.

Similar to Sharman's Rock-wallaby, the Common Wallaroo showed high occupancy across Mount Zero-Taravale. The Sharman's Rock-wallaby Survey will continue to inform wildlife managers on the status and trends of this species in future years.

Feral cats were detected at 11% of the Sharman's Rock-wallaby survey sites (4 sites during the survey period; detections were also made at an additional 2 sites, 5%, outside of the survey period). This is comparable to the results that were found during the sanctuary-wide camera survey in 2018 (13% occupancy). However, the detection of feral cats at 6 sites is potentially concerning, with rock-wallaby species vulnerable to predation by both native and introduced predators (Spencer 1991; Read et al. 2018). Future survey effort and interrogation of data will aim to determine any temporal associations between the two species and whether an interaction with fire histories exists.

Incidental observations were used to inform species' presence across the sanctuary in 2021. Although the total number of species detected was low (19% of bird species known to occur on the sanctuary, reptiles 52%, frogs 18%, mammals 59%) 6 threatened species, already known to occur on Mount Zero-Taravale, were detected using this method. Several of these threatened species will become the focus of further targeted work, with research and monitoring currently underway or planned for the Magnificent Broodfrog, Koala and Greater Glider. As further targeted surveys are conducted, combined with continued incidental observations, we expect to gain an increased understanding of the full suite of species present on Mount Zero-Taravale as well as trends in fauna assemblages over time.

In 2021, only 1% of Mount Zero-Taravale was affected by late dry season fire, and the fire metrics indicate improvements from baseline values that will benefit the ecological health of the sanctuary. Surveys will be developed to monitor introduced herbivores (cattle, horses) while the selection and monitoring of weed indicators will be further guided by AWC weed strategies.

## Acknowledgments

AWC acknowledges the Gugu Badhun people, the Traditional Custodians, of Gugu Badhun Country on which Mount Zero-Taravale resides. We also acknowledge their continuing connection to land, culture and community. We pay our respects to Gugu Badhun Elders past present and emerging.

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

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The Sharman's Rock-wallaby Survey has received funding support from the Queensland Government's Community Sustainability Action Grant program.



**Figure 11. Personnel involved in 2021 Ecohealth survey and fire management efforts.** Left to right: Josh McAllister (MZT Sanctuary Manager), Dr Catherine Hayes (Wildlife Ecologist), Felicity L’Hotellier (Senior Field Ecologist), Dr Eridani Mulder (Senior Wildlife Ecologist) and Kelly Forster (Helipower Director/Chief Pilot). Image credit Lou Petho/AWC.

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