

# Piccaninny Plains Wildlife Sanctuary

## Ecohealth Report 2020



## Summary

Australian Wildlife Conservancy (AWC) has implemented an Ecological Health Monitoring Program to measure changes in the status and trend of conservation assets, and threats to those assets, across Piccaninny Plains Wildlife Sanctuary. Metrics from the program are reported in annual Ecohealth Reports and Scorecards. This is the Ecohealth Report for 2020. Values of metrics derived in this report were based on data collected during surveys carried out between 2013 and 2020. The complete set of metrics and their values are summarised in the accompanying Ecohealth Scorecard.

In 2020, AWC conducted a total of 1,526 camera trap nights, seven wetland condition assessments and 572 km of aerial feral herbivore survey. In 2019, 142 bird surveys, 42 wetland condition assessments and the aerial feral herbivore survey were conducted. This report also presents results from the 2016 arboreal mammal survey (eight transects) and the 2015 targeted survey of rocky habitat (960 camera trap nights). The aerial feral herbivore survey has been undertaken annually since 2016.

In August 2020, AWC conducted a targeted survey of the Black-footed Tree-rat, with cameras deployed at 55 sites in the southern area of the sanctuary. This species has only been recorded at six locations on Piccaninny Plains since 2012. In the survey, the Black-footed Tree-rat was detected at eight of the 55 sites. These data will inform the development of future surveys to examine the response of this species to management, including fire regimes (in particular, to storm burning).

In November 2020, the annual aerial feral herbivore survey was undertaken. The survey recorded 185 feral cattle (*Bos taurus*), down from the 275 cattle recorded in 2019. During 2020, 944 feral cattle and 1,117 feral pigs (*Sus scrofa*) were removed from Piccaninny Plains through feral control operations and the annual cattle muster.

The ongoing feral control operations appear to be driving continued improvement in wetland condition since surveys commenced in 2013. On-ground wetland condition assessments were conducted at up to 50 individual sites (depending on access) in most years between 2013 and 2020. The majority of the 2019 wetland sites were in 'fair' condition, consistent with all prior years. However, there were substantially fewer sites in 'very poor' condition in 2019 (3% of sites) than in 2013 (24% of sites).

An aerial assessment of wetland condition was conducted at seven sites on the largest wetland on Piccaninny Plains, Green Swamp, in November 2020. The condition of these seven sites (a subset of the on-ground monitoring sites) remained stable since November 2019; most sites were in 'good' condition.

The 2019 bird survey obtained baseline occupancy and abundance measures for terrestrial and wetland birds. Average abundance and species richness of wetland birds were lower in 2019 than in 2015, possibly due to high rainfall in early 2019. The Vulnerable Palm Cockatoo (*Probosciger aterrimus*) was recorded at 21% of sites.

The only arboreal mammal detected in the 2016 spotlighting survey was the Common Spotted Cuscus (*Spilocuscus maculatus*); it was detected at 50% of the eight transects at an average abundance of 0.75 individuals per transect. The Cape York Rock-wallaby (*Petrogale coenensis*) was detected at 9% of camera trap sites surveyed in 2015.

# Contents

Introduction.....	1
Piccaninny Plains Wildlife Sanctuary .....	1
Climate and weather summary .....	3
Methods .....	5
Indicators and metrics .....	5
Survey types and history .....	8
Survey design and methods .....	9
Black-footed Tree-rat .....	9
Spotlighting Survey .....	10
Rocky Outcrop Camera Survey .....	10
Standard Bird Surveys.....	10
Wetland Bird Survey .....	11
Red Goshawk and Buff-breasted Buttonquail Surveys.....	12
Wetland Condition Surveys (ground) .....	12
Wetland Condition Surveys (aerial).....	13
Feral Herbivore Survey .....	13
Analysis methods.....	14
Biodiversity and threat indicators .....	14
Camera Surveys (Black-footed Tree-rats and Rocky Outcrop) .....	15
Fire analysis .....	15
Results .....	15
Biodiversity indicators .....	15
Black-footed Tree-rat .....	15
Cape York Rock-wallaby and Common Rock-rat .....	16
Arboreal mammals .....	16
Terrestrial birds .....	16
Wetland Birds .....	17
Red Goshawk and Buff-breasted Buttonquail .....	18
Wetland condition .....	18
Threat indicators .....	19
Feral herbivores.....	19
Fire .....	19
Discussion .....	19
Acknowledgments .....	20
References .....	20
Appendices .....	22

*Document citation:* Hayes C, Rush E, Watson A, Wauchope M, Joseph L, Kanowski J (2021). *Piccaninny Plains Wildlife Sanctuary Ecohealth Report 2020*. Australian Wildlife Conservancy, Perth, WA.

*Cover photograph:* Clockwise from top: view over the woodland savannas of Piccaninny Plains (AWC/Catherine Hayes); the Archer River on the southern boundary of Piccaninny Plains (AWC/Emily Rush); an Azure Kingfisher *Ceyx azureus* (AWC/Patrick Webster).

## Introduction

Australian Wildlife Conservancy (AWC) owns, manages, or works in partnerships across 30 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 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 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, above, Ecohealth Monitoring Plans are developed, describing the conservation values or assets of each property, and threats to these assets; and setting 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, the Piccaninny Plains Ecohealth Report 2020, draws on surveys conducted between 2013 and 2020 to calculate values for metrics that track the status and trend of the Ecohealth indicators. The companion Piccaninny Plains Ecohealth Scorecard 2020 presents these metrics in a summary format.

## Piccaninny Plains Wildlife Sanctuary

Piccaninny Plains is a 166,522 hectare wildlife sanctuary located on Cape York Peninsula (Figure 1) and is within the traditional lands of the Wik and Wik Way peoples. The property was purchased by AWC in partnership with The Tony and Lisette Lewis Foundation (TLLF) WildlifeLink in 2008, and is managed by AWC. Prior to its acquisition, Piccaninny Plains was a pastoral station.

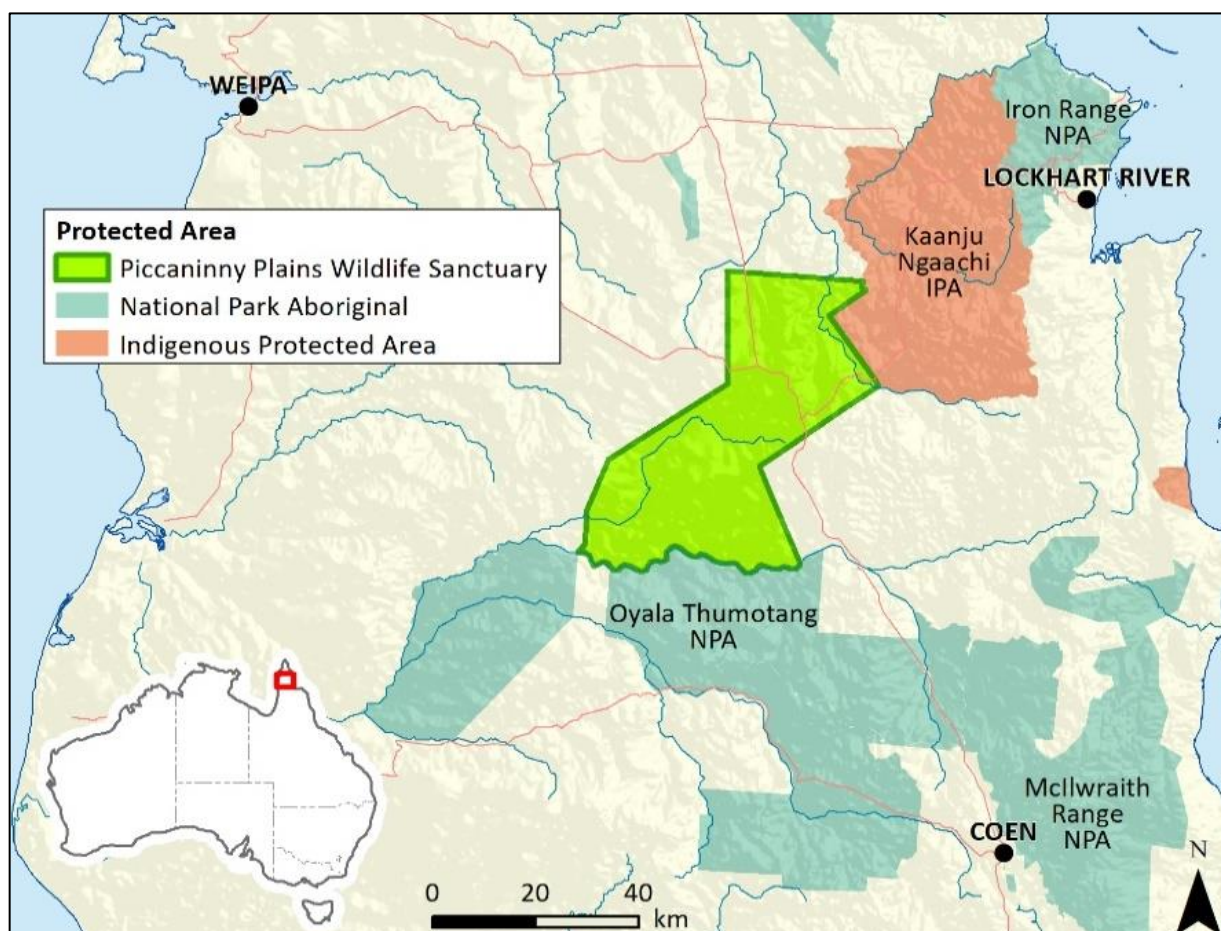


Figure 1. Location of Piccaninny Plains

Piccaninny Plains is an important part of the network of protected areas on Cape York Peninsula (Figure 1), protecting a diverse suite of ecosystems (Stanton et al. 2016). The terrain is mostly flat, rising to low hills in the north-east. The plains are underlain by shales and siltstones which have weathered to cracking clay soils, with distinctive gilgais ('melonholes') caused by high clay soils swelling and shrinking. The hills in the north-east are comprised of sandstone and other sedimentary rocks, weathering to sandy and gravelly soils. Alluvial sands extend over parts of the floodplains of the Archer and Wenlock Rivers. Extensive savanna woodlands occur on the sanctuary, cut by ribbons of gallery rainforest and deciduous vine thicket (Figure 2).

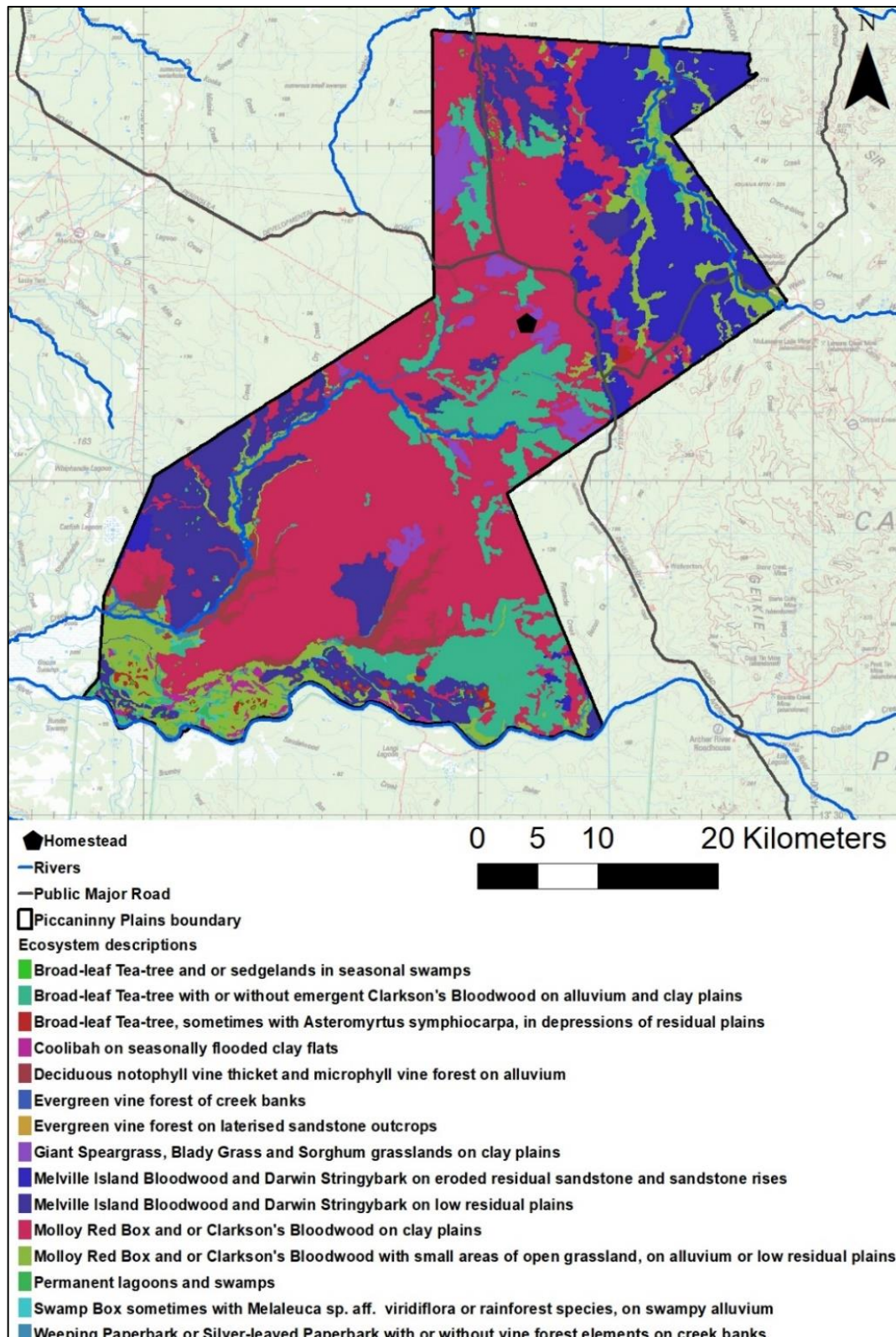


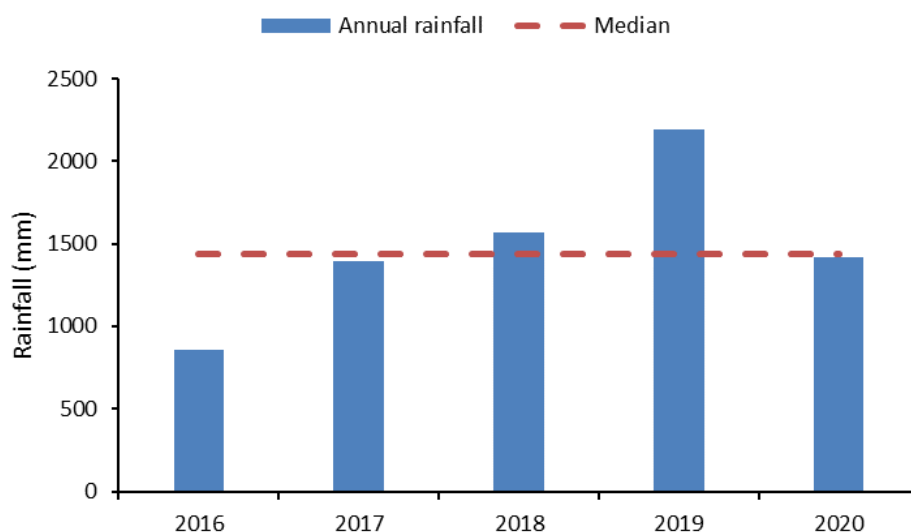
Figure 2. Ecosystems on Piccaninny Plains. Source: Stanton et al. (2016)

Small rainforest patches occur in sheltered locations on low hills on the divide between the Archer and Wenlock catchments. Grasslands are present on black soil plains. A diverse array of wetlands occur on the sanctuary, including the extensive shallow waters of Green Swamp, long and deep water-holes such as Crescent and Watson's Lagoons, and numerous smaller waterholes and ephemeral swamps (Stanton and Murphy 2006). The sanctuary includes over 50 km frontage to the Archer River, one of the largest and least disturbed rivers on Cape York Peninsula. Gallery rainforest occurs along the Archer and Wenlock rivers and their major tributaries, forming a continuous link with the extensive rainforests of the Iron and McIlwraith Ranges (Figure 1). Its location and the diverse ecosystems that occur across the sanctuary means Piccaninny Plains supports many species endemic to Cape York and Papua New Guinea, including the Cape York Rock-wallaby (*Petrogale coenensis*), Palm Cockatoo (*Probosciger aterrimus*) and Trumpet Manucode (*Phonygammus keraudrenii*). The non-protected areas that border Piccaninny Plains are pastoral properties.

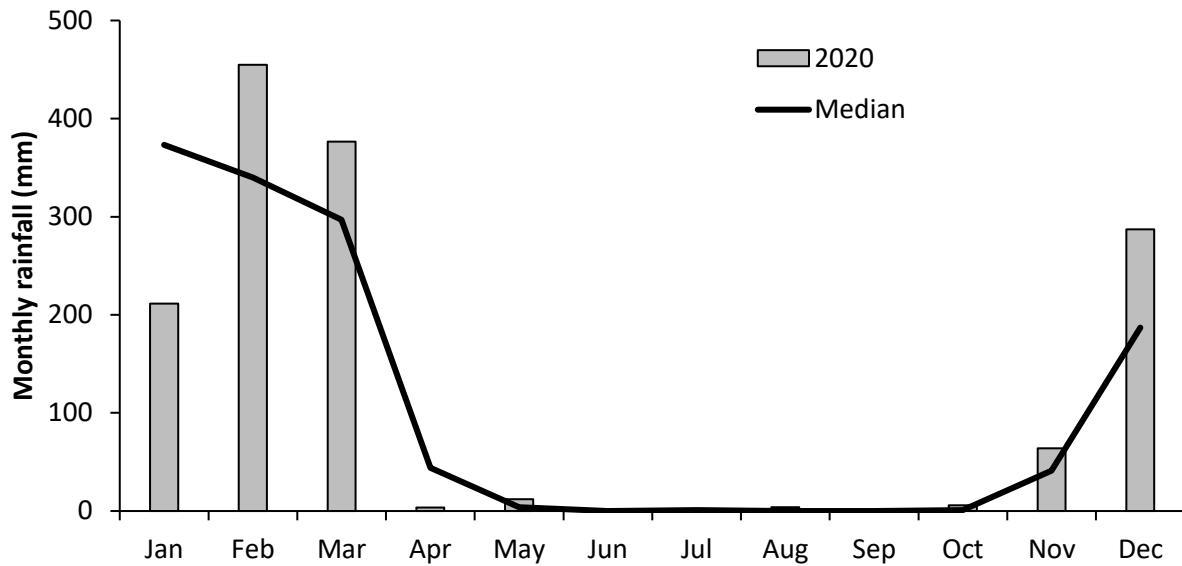
Several major conservation actions are implemented by AWC at Piccaninny Plains. Pressures from introduced herbivores and feral pigs (*Sus scrofa*) are reduced through targeted feral animal control and annual mustering. Fire management is undertaken, with the overarching objective of re-establishing an ecologically appropriate fire regime that promotes the conservation of species, ecological communities and ecosystem processes. Since acquisition, fire management on Piccaninny Plains aims to reduce the extent of late dry season fire in the savanna woodlands; this involves strategies including burning in the early dry season to reduce fuel loads and establish fire breaks (Webb et al. 2020). A further objective of fire management is the control of woody thickening and invasive weeds. Storm burns (fires lit in the late dry season after the initial rains) are employed to reduce woody thickening in the grasslands and savanna woodlands (Neldner et al. 1997; Crowley et al. 2009; Stanton 2021). Key weed species including hymenachne (*Hymenachne amplexicaulis*), sicklepod (*Senna obtusifolia*), thatch (*Hyparrhenia rufa*), and grader grass (*Themeda quadrivalvis*) are targeted in ongoing control operations by managers. Several major roads through Cape York runs through Piccaninny Plains. This creates challenges for the Sanctuary Managers including trespassers and arson attacks.

## Climate and weather summary

Piccaninny Plains experiences a tropical climate and lies in the high rainfall area of Cape York Peninsula. It has received median annual rainfall of 1,436 mm (range between 856 mm to 2,192 mm) since recording began in 1997, although only seven of those years have complete records (Bureau of Meteorology 2021; Piccaninny Plains weather station number 027064). Most of this rainfall occurs during the wet season between November to April. In 2020, total rainfall was 1,420 mm, close to the median (Figure 3; Figure 4). Rainfall in 2019 was 2,192 mm, due to three tropical cyclones in the wet season of 2018-2019 (Figure 3).



**Figure 3. Annual rainfall 2016-2020 at Piccaninny Plains (source: Bureau of Meteorology, Piccaninny Plains, weather station number 027064).** Data are displayed from 2016 as some data were unavailable in 2014-2015. Dashed line shows the median rainfall for this period.



**Figure 4. 2020 rainfall and median at Piccaninny Plains** (source: Bureau of Meteorology, Piccaninny Plains, weather station number 027064).

Historical temperature data are available between 1913 to 1938, and between 1968 to 1987, for Moreton Telegraph Station (77 km north of Piccaninny Plains; weather station number 027015). As the Moreton Telegraph Station is no longer open, current temperature data for 2020 used in this report are taken from the Coen Airport (weather station number 027073), 86 km from Piccaninny Plains, which opened in 2002 (Bureau of Meteorology 2021). Mean minimum and maximum temperatures range from 16.6°C in July to 35.1°C in November (Bureau of Meteorology 2021, data from Moreton Station). The mean maximum temperature during 2020 (32.6°C) was slightly above the historical mean (32.1°C), as was the minimum temperature (21.1°C, compared with (29.9°C).

## Methods

### Indicators and metrics

Piccaninny Plains' 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). On Piccaninny Plains, 56 biodiversity (species and guilds) indicators have been selected for monitoring (Table 1). Twenty-two of these indicators have been surveyed with the Ecohealth methodology and were reported on in this report. Threat indicators were selected to ensure monitoring the status and trends of introduced weeds, predators and herbivores and inappropriate fire regimes. Six threat indicators have been selected for monitoring (Table 2); 3 of these were reported on in 2020. In future years, reporting for key weed species and threatened plant and communities will be added.

**Table 1. The biodiversity indicators for the Ecohealth Monitoring Program on Piccaninny Plains.**

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

Metric definitions: abundance = average number of detections per 100 live trap or camera trap nights across all sites (for all taxa except arboreal mammals and birds), or average abundance per site or transect (for arboreal mammals and birds); occupancy = percentage of sites where specie or guild recorded; richness = average number of species per site; population estimate = estimated number of individuals on sanctuary; wetland assessment index = score reflecting extent and intensity of damage to wetland.

Indicator	Rationale			Survey method	Metric/s
	T	D	S		
<b>Mammals</b>					
<b>Small-medium mammals</b>					
Black-footed Tree-rat ( <i>Mesembriomys gouldii</i> )	*			Targeted Survey	Abundance, Occupancy
Long-tailed Planigale ( <i>Planigale ingrami</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Common Planigale ( <i>Planigale maculate</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Red-cheeked Dunnart ( <i>Sminthopsis virginiae</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Bandicoot assemblage (Northern Brown Bandicoot <i>Isodon macrourus</i> ; Cape York Bandicoot <i>Isodon peninsulae</i> )			*	Standard Camera Survey	Abundance, Occupancy
Northern Short-tailed Mouse ( <i>Leggadina lakedownensis</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Grassland Melomys ( <i>Melomys burtoni</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Cape York Melomys ( <i>Melomys capensis</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Delicate Mouse ( <i>Pseudomys delicatulus</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Cape York Rat ( <i>Rattus leucopus</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Canefield Rat ( <i>Rattus sordidus</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Giant White-tailed Rat ( <i>Uromys caudimaculatus</i> )			*	Standard Camera Survey	Abundance, Occupancy

Indicator	Rationale			Survey method	Metric/s
	T	D	S		
Common Rock-rat ( <i>Zyomys argurus</i> )			*	Rocky Outcrop Camera Survey	Abundance, Occupancy
Cape York Rock-wallaby ( <i>Petrogale coenensis</i> )	*			Rocky Outcrop Camera Survey	Abundance, Occupancy
Savanna small mammal guild			*	Standard Trapping Survey	Abundance, Occupancy, Richness
Savanna medium mammal guild			*	Standard Camera Survey	Abundance, Occupancy, Richness
Rainforest small mammal guild			*	Standard Trapping Survey	Abundance, Occupancy, Richness
Rainforest medium mammal guild			*	Standard Camera Survey	Abundance, Occupancy, Richness
Grassland small mammal guild			*	Standard Trapping Survey	Abundance, Occupancy, Richness
Grassland medium mammal guild			*	Standard Camera Survey	Abundance, Occupancy, Richness
<b>Arboreal mammals</b>					
Krefft's Glider ( <i>Petaurus notatus</i> )			*	Spotlighting Survey	Abundance, Occupancy
Common Spotted Cuscus ( <i>Spilocuscus maculatus</i> )			*	Spotlighting Survey	Abundance, Occupancy
Common Brushtail Possum ( <i>Trichosurus vulpecula</i> )			*	Spotlighting Survey	Abundance, Occupancy
Arboreal mammal guild			*	Spotlighting Survey	Abundance, Richness
<b>Large herbivores</b>					
Agile Wallaby ( <i>Macropus agilis</i> )		*	*	Standard Camera Survey	Abundance, Occupancy
Antilopine Wallaroo ( <i>Macropus antilopinus</i> )		*	*	Standard Camera Survey	Abundance, Occupancy
Eastern Grey Kangaroo ( <i>Macropus giganteus</i> )		*	*	Standard Camera Survey	Abundance, Occupancy
Euro, Common Wallaroo ( <i>Macropus robustus</i> )		*	*	Standard Camera Survey	Abundance, Occupancy
Swamp Wallaby ( <i>Wallabia bicolor</i> )		*	*	Standard Camera Survey	Abundance, Occupancy
<b>Predators</b>					
Dingo ( <i>Canis dingo</i> )		*	*	Standard Trapping Survey	Population estimate, Abundance, Occupancy
<b>Reptiles</b>					
<b>Small-medium-sized reptiles</b>					
Macleay's Rainbow-skink ( <i>Carlia sexdentata</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Black-tailed Bar-lipped Skink ( <i>Glaphyromorphus nigricaudis</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Black-throated Two-pored Dragon ( <i>Diporiphora jugularis</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Straight-browed Ctenotus, Spalding's Ctenotus ( <i>Ctenotus spaldingi</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Cape York Bent-toed Gecko ( <i>Nactus eboracensis</i> )			*	Standard Trapping Survey	Abundance, Occupancy
Savanna small-medium reptile guild			*	Standard Trapping Survey	Abundance, Richness
Rainforest small-medium reptile guild			*	Standard Trapping Survey	Abundance, Richness
Grassland small-medium reptile guild			*	Standard Trapping Survey	Abundance, Richness
<b>Reptiles – other</b>					
Yellow-spotted Monitor ( <i>Varanus panoptes</i> )		*	*	Standard Camera Survey	Abundance, Richness
<b>Birds</b>					

Indicator	Rationale			Survey method	Metric/s
	T	D	S		
Red Goshawk ( <i>Erythrorchis radiatus</i> )	*			Targeted Survey	Occupancy
Australian Palm Cockatoo ( <i>Probosciger aterrimus</i> )	*			Standard Bird Survey	Abundance, Occupancy
Buff-breasted Buttonquail ( <i>Turnix olivii</i> )	*			Targeted Survey	Occupancy
Rainbow Lorikeet ( <i>Trichoglossus moluccanus</i> )			*	Standard Bird Survey	Abundance, Occupancy
Green Oriole ( <i>Oriolus flavocinctus</i> )			*	Standard Bird Survey	Abundance, Occupancy
White-throated Honeyeater ( <i>Melithreptus albogularis</i> )			*	Standard Bird Survey	Abundance, Occupancy
Peaceful Dove ( <i>Geopelia placida</i> )			*	Standard Bird Survey	Abundance, Occupancy
Magpie Goose ( <i>Anseranas semipalmata</i> )			*	Standard Bird Survey	Abundance, Occupancy
Blue-winged Kookaburra ( <i>Dacelo leachii</i> )			*	Standard Bird Survey	Abundance, Occupancy
Red-browed Finch ( <i>Neochmia temporalis</i> )			*	Standard Bird Survey	Abundance, Occupancy
Savanna bird guild			*	Standard Bird Survey	Abundance, Occupancy, Richness
Rainforest bird guild			*	Standard Bird Survey	Abundance, Occupancy, Richness
Grassland bird guild			*	Standard Bird Survey	Abundance, Occupancy, Richness
Wetland bird guild			*	Targeted Survey	Abundance, Occupancy, Richness
Nocturnal bird guild			*	Targeted Survey	Abundance, Occupancy, Richness
<b>Ecological process</b>					
Wetland condition			*	Wetland condition assessment (on-ground)	Wetland assessment score (mode)
Wetland condition: Green Swamp			*	Wetland condition assessment (aerial)	Wetland assessment score (mode)

**Table 2. Threat indicators for Ecohealth Monitoring Program for Piccaninny Plains. Definitions: abundance = number of individuals per 100 trap nights (for feral cats, pigs, cane toads), or the count obtained during the aerial feral herbivore survey (horses and cattle); occupancy = percentage of sites where species recorded.**

Indicator	Rationale	Survey method	Metric/s
<b>Feral predators</b>			
Feral cat ( <i>Felis catus</i> )	Major threat to wildlife	Standard Camera Survey	Abundance, Occupancy
<b>Feral herbivores</b>			
Horse ( <i>Equus caballus</i> )	Threat to wildlife, vegetation	Standard Camera Survey (for occupancy metric); Feral Herbivore Survey (for abundance metric)	Abundance, Occupancy
Cattle ( <i>Bos taurus</i> )	Threat to wildlife, vegetation	Standard Camera Survey (for occupancy metric); Feral Herbivore Survey (for abundance metric)	Abundance, Occupancy
Pig ( <i>Sus scrofa</i> )	Threat to wildlife, vegetation	Standard Camera Survey	Abundance, Occupancy
<b>Other</b>			
Cane toad ( <i>Rhinella marina</i> )	Major threat to wildlife	Standard Trapping Survey	Abundance, Occupancy
<b>Fire</b>			
Suite of ecologically relevant metrics	Key ecological driver	Remote sensing	Extent, Frequency, Time since fire, Distance to unburnt vegetation

## Survey types and history

AWC has conducted fauna surveys at Piccaninny Plains every year since 2008 (Table 3). Many surveys were designed to identify the wildlife species present and their distributions across the property (i.e. inventory surveys), or were associated with specific research projects. However, since 2019, surveys have been designed specifically to provide data for the Ecohealth Monitoring Plan metrics. To report on the full set of biodiversity and threat indicators, 13 surveys are to be conducted:

- Standard Trapping Survey
- Standard Camera Survey
- Rocky Outcrop Camera Survey
- Spotlighting Survey
- Standard Bird Survey
- Wetland Bird Survey
- Wetland Condition Assessment (aerial and ground)
- Feral Herbivore Survey
- A variety of targeted surveys (Black Footed Tree Rat, Red Goshawk, Buff-breasted Buttonquail, and nocturnal birds)

In addition to surveys, computations of sanctuary-wide satellite data are conducted for:

- Fire Scar Analysis

In this report, we report on all of the Ecohealth surveys conducted to date (Table 3).

**Table 3. Survey effort, descriptions and history for metrics in Piccaninny Plains 2020 Ecohealth Report.**

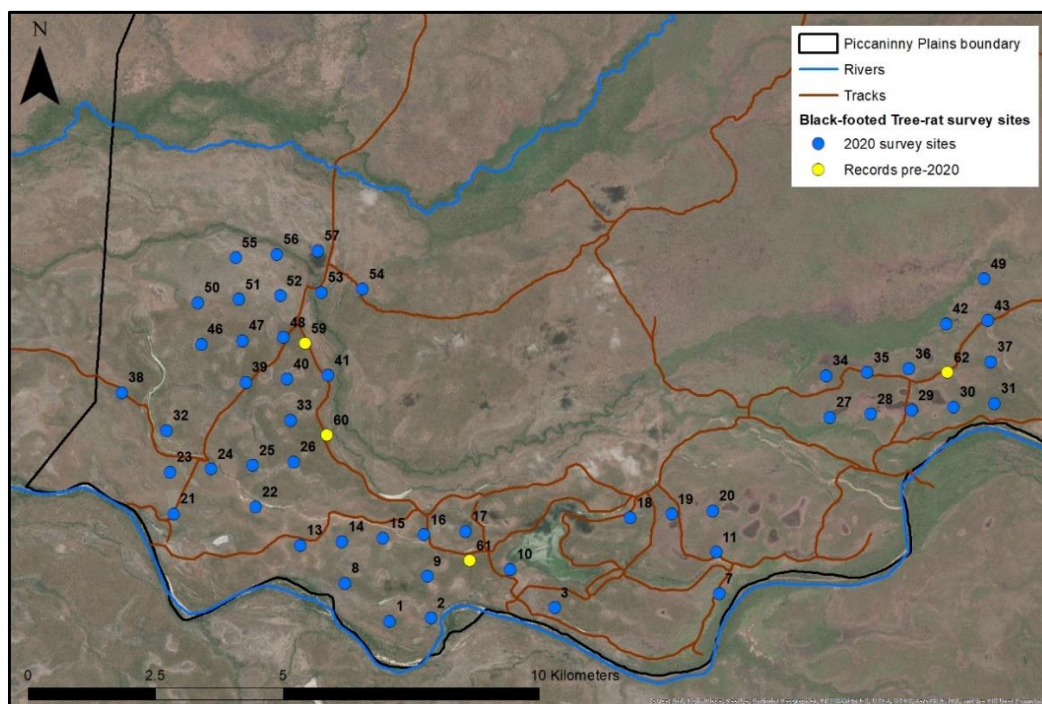
Survey name	Effort*	Description	Survey history
Black-footed Tree-rat	1,526 TN	55 sites, each containing 2 camera traps, set for 14 nights. Stratified by ecosystems and overlaid in a 800 x 800 m grid	2020
Spotlighting Survey	8 surveys	750 m transects along river bed, each repeated once	2016
Rocky Outcrop Camera Survey	960 TN	32 sites camera trapped for 30 nights	2015
Standard Bird Survey	96 surveys	Two ha 20 minute searches, each site repeated three times	2019
Wetland Bird Survey	29 surveys	Point counts at wetlands; number of repeats varied depending on wetland size	2015, 2019
Red Goshawk, and Buff-breasted Buttonquail	17 surveys	Active searches for Red Goshawk and Buff-Breasted Buttonquail. 34 km walked	2019
Wetland Condition Assessment (ground)	34 assessments	34 sites in the southern half of Piccaninny Plains; condition scored at each site ('very good' to 'very poor')	2013, 2014, 2015, 2016, 2018, 2019
Wetland Condition Assessment (aerial)	7 assessments	7 sites on Green Swamp, surveyed from the air; condition scored at each site ('very good' to 'very poor')	2019, 2020
Feral Herbivore Survey	572 km of transect	Fixed aerial transect repeated annually in November. All feral herbivores counted	2016, 2017, 2018, 2019, 2020

\*TN = trap night

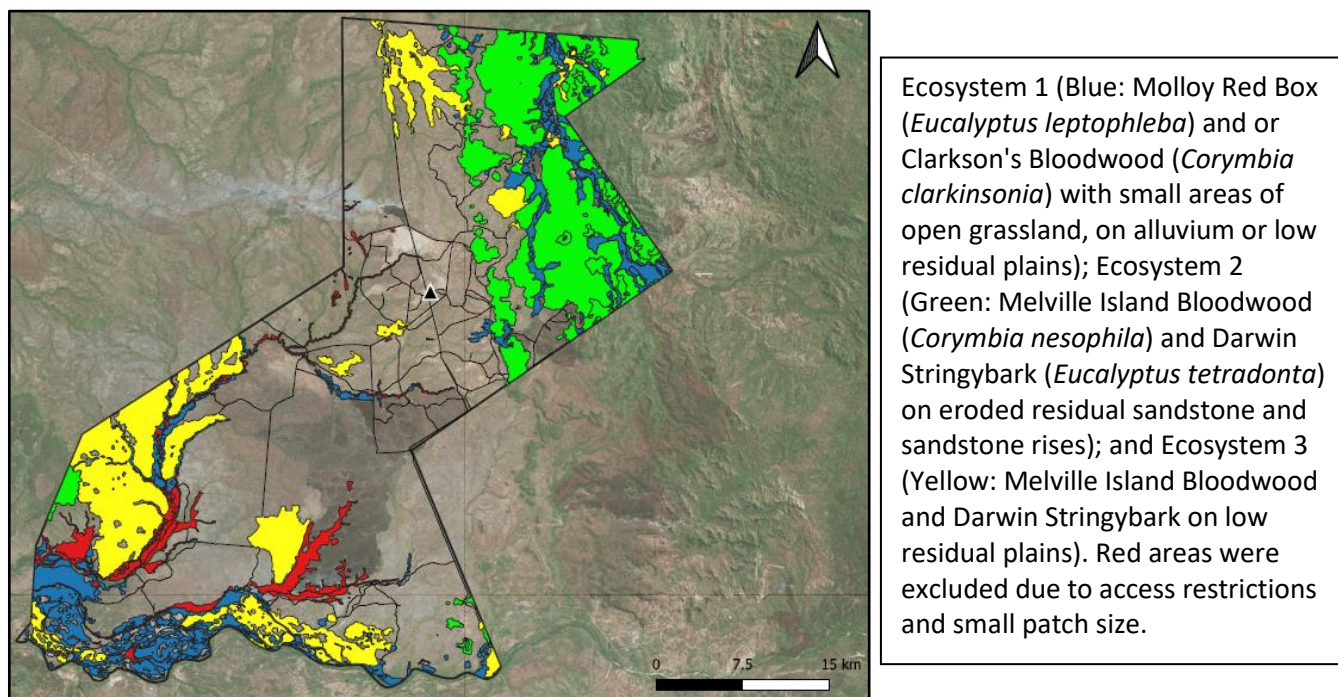
## Survey design and methods

### Black-footed Tree-rat

In 2020, 55 sites were established for targeted Black-footed Tree-rat surveys focused on areas with suitable habitat (Figure 5). Three woodland ecosystems were considered suitable (Figure 6). Sites were stratified by habitat type based on the literature (Friend and Taylor 1985; Friend 1987; Risler 2017). The target area was constrained to the southern end of the sanctuary as it holds most records for the species (four of six). In future years, surveys will be expanded to suitable habitat in the remainder of the sanctuary. Survey sites were generated by overlaying an 800 m x 800 m grid across the sanctuary. Sites were then stratified to > 1 ha patch size, within 1.5 km of a road, and accessible on foot. Sites locations were refined onsite due to a sicklepod infestation and access limitations.



**Figure 5. 2020 survey sites for the Black-footed Tree-rat.** Yellow circles were sites surveyed in 2020 at which Black-footed Tree-rats had previously been detected.



**Figure 6. Priority vegetation types identified for the Black-footed Tree-rat on Piccaninny Plains.**

In 2020, two Reconyx Whiteflash cameras were deployed at 55 sites for a minimum of 14 nights. The cameras were placed 50 m to 80 m apart, at a height of 50 cm, facing north or south, and angled down towards the bait container (Figure 7), placed 1.5 m away. Bait comprised peanut butter, oats, sardines and vanilla. Cameras were set to take three consecutive photos, one second apart, with no delay between triggers.



**Figure 7. Camera trap and bait set up for the Black-footed Tree-rat survey at Piccaninny Plains**

### Spotlighting Survey

Along three major watercourses, 10 transects of 750 m (comprising 2, 3 or 5 transects per watercourse) were established to conduct the Spotlighting Survey. Transects were conducted when conditions allowed, usually in conjunction with the Standard Trapping Survey. Six transects were established in 2014 and a further four transects were established in 2015. Eight transects were surveyed in 2016, conducted over 750 m transects on river beds along the Wenlock River (three separate transects, each repeated once), the Archer River (two transects, each repeated once) and Piccaninny Creek (three transects, each repeated once). Observers used 200 lumen LED head-torches to search the gallery rainforest on either side of the watercourse for nocturnal fauna. Each transect took approximately 45 minutes to complete.

### Rocky Outcrop Camera Survey

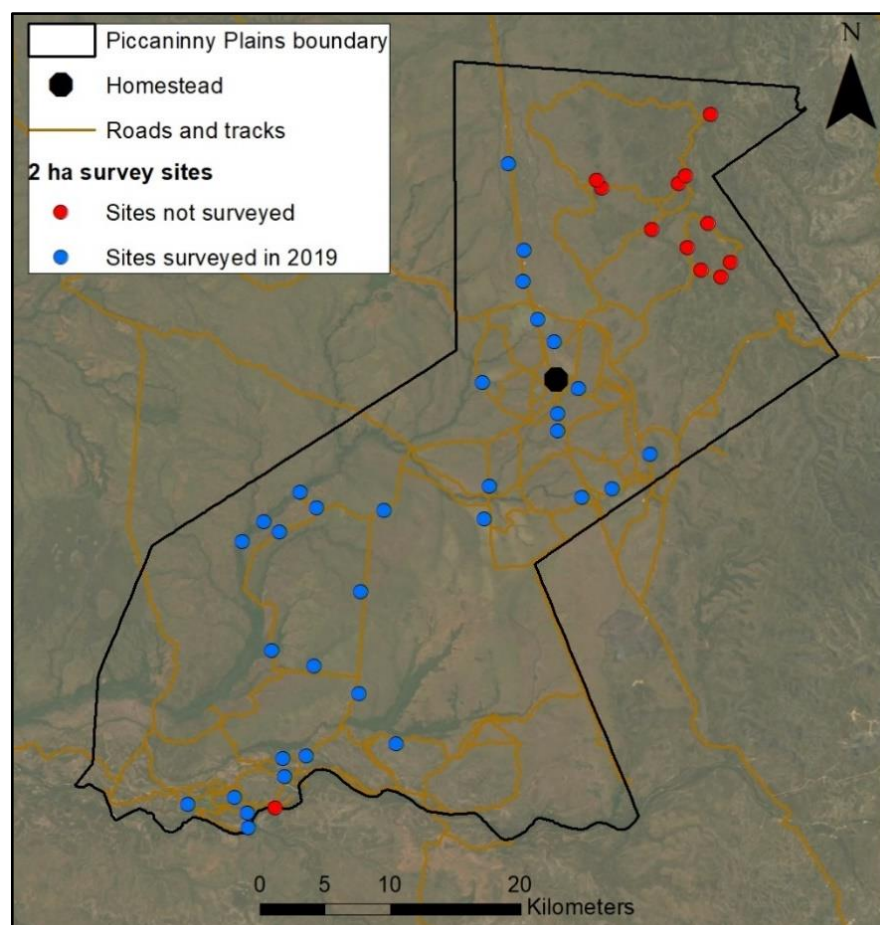
A Rocky Outcrop Camera Survey was undertaken in the north-east corner of Piccaninny Plains in 2015. The focus of this survey was obtaining baseline occupancy and distribution data on the Cape York Rock-wallaby (*Petrogale coenensis*). Data were also collected on the Common Rock-rat (*Zyomys argurus*; Mulder et al. 2016). A total of 32 Reconyx Whiteflash cameras were deployed for 30 nights in the rocky outcrops of the north-east corner of Piccaninny Plains. Cameras were centred on a bait holder containing a bait ball comprised of rolled oats, vanilla, peanut butter and Dairy Krave.

### Standard Bird Surveys

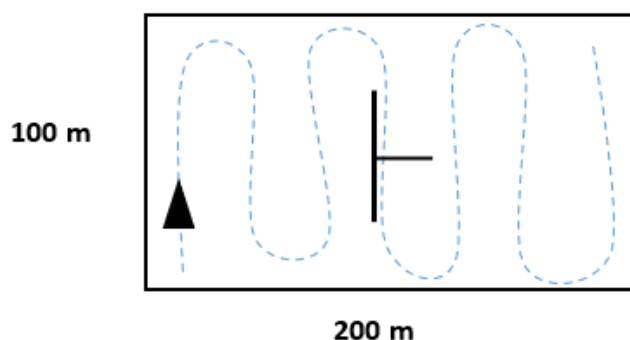
Bird surveys were conducted at 32 sites in 2019 (Figure 8), comprised of four grassland sites, five rainforest sites and 23 savanna sites. The 32 sites are a subset of 44 permanent fauna monitoring sites which were selected in 2019, following a process to stratify the survey by vegetation type. Of these, 12 sites were not surveyed due to damage from three tropical cyclones in 2019; the north-eastern area of Piccaninny Plains was inaccessible in August 2019.

The Standard Bird Survey is based on BirdLife Australia's standard survey technique (BirdLife Australia 2020). Two observers conducted a 20 minute search of a two hectare plot, during which all species seen and/ or heard were recorded (Figure 9). Each site was surveyed three times; two morning surveys (staggered at different times post sunrise) and one afternoon survey (within two hours of sunset; Eyre et al. 2018). Surveys started at sunrise and were completed by four hours post-sunrise, or by sunset for afternoon surveys. A tally of all unique records for each species was taken during each replicate. Birds recorded outside of the plot were

recorded as 'incidental' sightings. The raw abundance of each species at each site was taken as the highest count for that species of the three repeats.



**Figure 8. Bird survey sites (2 ha) at Piccaninny Plains.** Sites with by red circles were inaccessible in 2019.



**Figure 9. Two hectare search area centred on standard 'T' trapping site array.** Arrow shows general direction of observer travel.

### Wetland Bird Survey

Fifteen wetland sites were surveyed for waterbirds in 2019. Nine of these sites were established in 2015 (Roshier et al. 2016), and six sites were established in 2019. Two sites previously surveyed by Roshier et al. (2016) were not re-surveyed in 2019 due to logistical constraints.

Following Roshier et al. (2016), point count methods at wetland sites varied depending on the size of the wetland. Small wetlands were surveyed once. Three surveys were conducted over three days at the largest wetland, Green Swamp. Observers with binoculars remained at each survey site until all waterbirds were tallied. For wetlands where repeats were conducted, the highest count for each species was recorded as the abundance of that species (Roshier et al. 2016). For consistency with the prior survey, at Green Swamp, counts were conducted at five separate (non-overlapping) locations to cover the majority of the wetland.

All shorebirds and other birds that are dependent on or closely associated with wetland habitats were considered 'wetland birds' for these counts (Department of Environment and Science 2020). Birds that flew into the wetland during the count were included (Eyre et al. 2018).

### Red Goshawk and Buff-breasted Buttonquail Surveys

Targeted searches for two Endangered birds (the Red Goshawk (*Erythrorchis radiatus*) and Buff-breasted Buttonquail (*Turnix olivii*)) were undertaken in 2019. Searches were done in the eastern area of Piccaninny Plains in *Eucalyptus tetradonta* woodlands (for the Red Goshawk) and in areas of open woodland with short sparse grass (for the Buff-breasted Buttonquail).

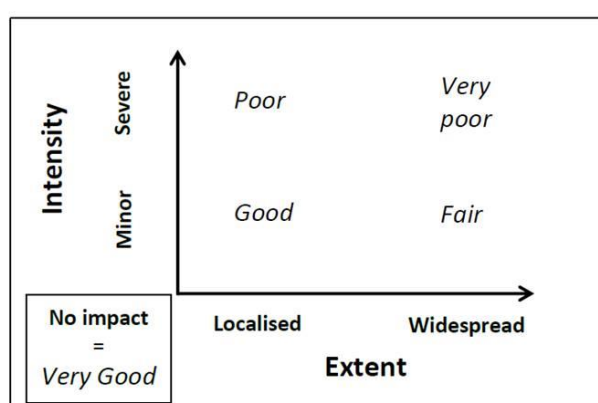
Red Goshawk searches were undertaken along north-south transect lines in *Eucalyptus tetradonta* dominant and co-dominant woodlands, in accordance with guidance provided by PhD student Chris MacColl. Teams of two walked transects separated by 100 m, scanning the canopy for nests on horizontal limbs, and for birds flying overhead. The team walked 13 transects for a total of around 26 km. Searching was done in both directions.

Buff-breasted Buttonquail searches were undertaken in areas of open woodland with short sparse grass and patches of bare ground. PhD student Patrick Webster attended the 2019 survey as a volunteer and provided on-ground advice on the appropriate habitat and search techniques. The team of up to six observers spread out in a straight line (around 5-10 m between each person) and walked through the targeted habitat searching for Buttonquail. Four transects were walked for a total of around eight km. Searching was done in both directions.

### Wetland Condition Surveys (ground)

The condition of 34 wetland monitoring sites was assessed on-ground in the Archer River floodplain in August 2019. Surveys commenced in 2013 and were usually conducted annually in conjunction with the Standard Trapping Survey. Fifty individual wetland sites exist, but the total number of sites surveyed in a given year depends on access and water levels following the wet season (e.g. nine sites in the Wenlock River floodplain were inaccessible following cyclone damage in 2019).

The 'Wetland Assessment Index Score' is the ecological process metric for assessing the health of wetland habitats at Piccaninny Plains. It provides a rapid, repeatable metric by which damage from feral animals to these sensitive habitats can be monitored over time. This metric is based on the classification developed by Russell-Smith and Bowman (1992), which considered the intensity and the extent of the impacts of fires on vegetation (Figure 10). Based on this classification system, for the Wetland Assessment Index Score, each wetland surveyed was given an overall rating of 'very good', 'good', 'fair', 'poor' or 'very poor'.



**Figure 10. Point assessment ratings for impacts of feral animals at wetlands**

During on-ground wetland surveys, an observer stood at the exact point where the assessment had been undertaken in previous years. Depending on the preceding wet season, at some sites this observation point was underwater, or previously separate wetlands had joined. In these cases, an assessment was made at only one of the two pre-existing sites, or at the nearest location to the previous observation point. The observer gave the wetland a score of 'very good' to 'very poor' (Figure 10).

When assessing the intensity of damage, the following aspects were taken into account: visible water quality, the health and occurrence of aquatic vegetation, bank erosion, the health of surrounding vegetation, and the impact of feral animal disturbance from wallows, footprints and diggings.

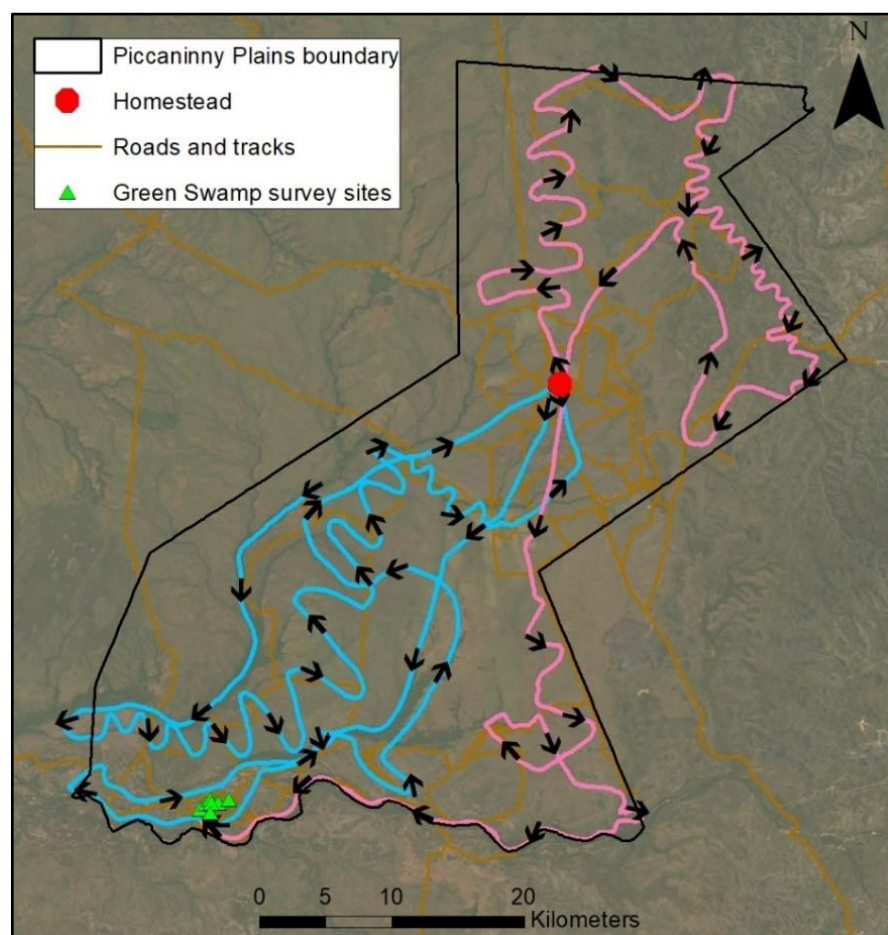
### Wetland Condition Surveys (aerial)

In 2019 and 2020, the condition of seven sites at Green Swamp (a subset of the existing monitoring sites) was re-assessed during aerial surveys in each November (Figure 11). These surveys provide a late dry-season assessment of condition at this important wetland (the largest on Piccaninny Plains) following the muster in August. It was not feasible to re-survey all 50 wetland monitoring sites in November, so only this subset was monitored during the aerial run.

### Feral Herbivore Survey

A fixed aerial transect covering the north and south of Piccaninny Plains was used to survey feral herbivores (Figure 11). Surveys have been conducted annually since 2016. The survey route was flown at 300 feet above ground level and at a steady 60 knots. Half of the sanctuary was covered in each of the two separate aerial runs. The survey took approximately six hours and required a refuelling stop at the Piccaninny Plains homestead. Depending on conditions, this survey is usually completed in the early morning soon after sunrise, or in the early morning and later afternoon, when cattle (*Bos taurus*) are likely to be visible.

During the survey, the two spotters counted the number of feral cattle and horses (*Equus caballus*). When one or more animals was observed, a waypoint was taken on a handheld GPS unit and the number and species were recorded. The flight path was tracked during the survey.



**Figure 11. The aerial feral herbivore survey route;** south-west of the homestead (blue) and north of the homestead, finishing along the eastern boundary (pink). At the conclusion of the survey, seven wetland sites on Green Swamp are assessed (green triangles).

## Analysis methods

### Biodiversity and threat indicators

Most of the Ecohealth analysis methods and resulting metrics are common to many indicator species for Piccaninny Plains. Unless noted otherwise, the metrics were calculated as set out in Table 4 below. As there are diverse ecosystems on Piccaninny Plains, metrics are reported for species and groups of species of a particular 'guild'. This required that all sites surveyed, and all species reported on, were correctly assigned to one or more of the following guild/s prior to undertaking these calculations: grassland ('G'), savanna woodland ('S'), rainforest ('R'), wetland ('W'), and 'rocky'. Some birds were also assigned to a bird-specific nocturnal guild ('N'). The total number of sites used to calculate each metric only includes sites of the relevant habitat type; e.g. if 10 rainforest sites are surveyed out of 30 sites total, only those 10 sites will be considered when calculating abundance and occupancy metrics for rainforest-dependant fauna. The relevant guild to which a species has been assigned for Ecohealth reporting purposes is set out below the metric in the following results tables. If no guild is noted, then all survey sites were used in calculating the relevant metrics.

**Table 4. Metrics and associated calculations for Piccaninny Plains 2020 Ecohealth Report**

Metric	Description	Calculation	Taxa
Abundance	A measure of activity, either per 100 trap nights, or per site or transect	<b>Per 100 trap nights:</b> The average ( $\pm$ SE) number of individuals recorded per 100 trap nights across all sites <i>For individual species:</i> The average ( $\pm$ SE) over all survey sites of: $\left( \frac{\text{Total number of individuals of that species (excluding recaptures) recorded at survey site}}{\text{total number of trap nights at survey site}} \right) \times 100$ <i>For guilds:</i> The average ( $\pm$ SE) over all survey sites of: $\left( \frac{\text{Total number of individuals of the guild (excluding recaptures) recorded at survey site}}{\text{total number of trap nights at survey site}} \right) \times 100$	Small-medium mammals
		<b>Per site or transect:</b> The average ( $\pm$ SE) number of individuals recorded across all sites or transects <i>For individual species:</i> $\left( \frac{\text{Total number of individuals of that species (excluding recaptures) recorded across all sites or transects}}{\text{total number of sites or transects}} \right) \pm \text{SE}$ <i>For guilds:</i> $\left( \frac{\text{Total number of individuals of the guild (excluding recaptures) recorded across all sites or transects}}{\text{total number of sites or transects}} \right) \pm \text{SE}$	Arboreal mammals  Diurnal birds
Occupancy	A measure of distribution; percentage of sites where the species is 'present' (naïve occupancy)	<i>For individual species:</i> $\left( \frac{\text{Total number of sites at which the species was recorded}}{\text{total number of sites surveyed}} \right) \times 100$ <i>For guilds:</i> $\left( \frac{\text{Total number of sites at which any species within the relevant guild were recorded}}{\text{total number of sites surveyed}} \right) \times 100$	Small-medium mammals  Arboreal mammals  Diurnal birds
Richness	A measure of diversity; average number of species per site	$\left( \frac{\text{Total number of species recorded across all sites}}{\text{Total number of sites surveyed}} \right) (\pm \text{SE})$	Diurnal birds
Wetland Assessment Index Score	A measure of wetland health	A rating is assigned to each wetland: Very Good, Good, Fair, Poor or Very Poor. The mode (most common value) is reported for the set of monitoring sites	N/A

### Camera Surveys (Black-footed Tree-rats and Rocky Outcrop)

Camera data were downloaded and categorised as “animal present” or “animal absent” using the Artificial Intelligence (AI) software (Microsoft Azure and Postman). Once images were sorted, images with animals present were uploaded into the program ‘Timelapse’ (Greenberg et al. 2019) and animals were identified to species level where possible. A spreadsheet containing all captures of species was exported from Timelapse.

A 15 minute event interval was chosen for the analyses based on the use of this interval for species of a similar size and in similar habitats (e.g. Diete et al. 2016). A measure of relative abundance (abundance per 100 camera trap nights) and occupancy (percentage of sites occupied) were then calculated as per Table 4.

### Fire analysis

Fire scar data were obtained from 2000-20 from the North Australian Fire Information (NAFI) website. Each scar was attributed by year, month and season. For most years, scars detected from January to July (inclusive) were attributed as “Early”, whereas those detected August to December were attributed as “Late”. The maps and statistics for the analyses were created using ArcGIS with Spatial Analyst, and were semi-automated using Python scripting. Graphs were produced using Microsoft Excel. Webb et al. (2020) provide further detail on the annual fire scar mapping and analysis undertaken.

## Results

### Biodiversity indicators

#### Black-footed Tree-rat

The Black-footed Tree-rat was detected at 8 of 54 sites (15% occupancy; Figure 12). There were 20 independent detection events (Appendix 1). Abundance was estimated at  $1.3 \pm 0.5$  individuals per 100 camera trap nights across the 54 sites. The Black-footed Tree-rat was detected at 1 site where it had previously been recorded. Seven of the 2020 records are new locations for the species on Piccaninny Plains. Conversely, the species was not detected at 3 previously-known locations. Feral cats were detected at 4 sites near the original detections.

In future years the survey will be extended to include additional areas of likely suitable habitat near existing Black-footed Tree-rat records; at Piccaninny Creek and in the north-east of the sanctuary. All but two of the records in the southern end of the property occurred in the landform ‘residual sandy plains and rises,’ and the remaining records were in close proximity (150-230 m). Geology will be included in the future stratification of sites. Future surveys will also incorporate analysis of fire history at the Black-footed Tree-rat monitoring sites.

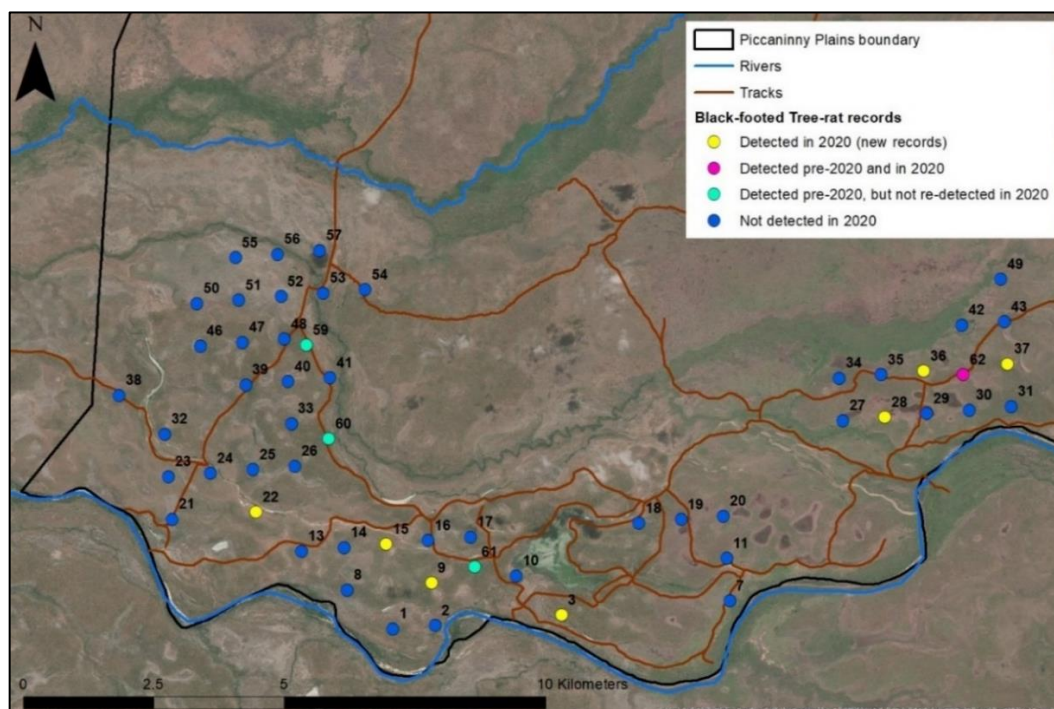


Figure 12. Detections of Black-footed Tree-rats in August 2020



*Black-footed Tree-rat detected on camera trap on Piccaninny Plains*

### **Cape York Rock-wallaby and Common Rock-rat**

The 2015 Rocky Outcrop Camera Survey was successful in detecting the Cape York Rock-wallaby. It was recorded at 3 of the 32 sites (9% occupancy) with an average abundance of  $0.3 \pm 0.2$  individuals per 100 trap nights across the 32 sites. The Common Rock-rat was also detected at 1 site (3% occupancy) with an average abundance of  $0.1 \pm 0.1$  per 100 trap nights across the 32 sites.

### **Arboreal mammals**

Six Common Spotted Cuscus were recorded during the 2016 spotlighting transects, including 3 observed within 1 transect. No other arboreal mammals were recorded during these surveys (Table 5). The Common Brushtail Possum has only been caught in cage and on camera traps at Piccaninny Plains, while Krefft's Glider has only been recorded incidentally.

**Table 5. Arboreal mammal metrics derived from 2016 spotlighting surveys**

Indicator	Metric*	Value
Krefft's Glider	Abundance	0
	Occupancy	0%
Common Spotted Cuscus	Abundance	$0.75 \pm 0.37$
	Occupancy	50%
Common Brushtail Possum	Abundance	0
	Occupancy	0%
Arboreal mammal guild	Abundance	$0.75 \pm 0.37$
	Occupancy	50%

\*Abundance is average abundance across 8 transects.

### **Terrestrial birds**

149 bird species were recorded during the 2019 bird surveys at Piccaninny Plains (Hayes 2021; Table 6). The Palm Cockatoo was detected at 21% of sites in the savanna woodland and rainforest. This species is regarded as having undergone severe declines across Cape York (Keighley et al. 2021), so further monitoring will be vital to tracking its status on Piccaninny Plains. The Green Oriole was present at all 5 rainforest sites, while the

Rainbow Lorikeet and White-throated Honeyeater both occupied over 80% of sites (Table 6). By contrast, the Red-browed Finch was detected at only 1 of the 32 sites. These species were chosen for surveillance monitoring; future surveys will clarify their appropriateness as indicators and monitor these species for unexpected declines. The rainforest guild had both the highest abundance and species richness, while the grassland guild had the lowest (Table 6).

**Table 6. Bird metrics derived from the 2019 surveys.** Habitat types used to calculate metrics are noted for each species: grassland 'G' (4 sites); savanna 'S' (23 sites); rainforest 'R' (5 sites); and wetland 'W' (15 site).

Indicator	Metric*	Value
Red Goshawk S, R	Abundance Occupancy	0 0%
Australian Palm Cockatoo S, R	Abundance Occupancy	$0.32 \pm 0.13$ 21.4%
Buff-breasted Buttonquail S	Abundance Occupancy	0 0%
Rainbow Lorikeet G, S, R	Abundance Occupancy	$4.3 \pm 0.9$ 81.3%
Green Oriole R	Abundance Occupancy	$2.4 \pm 0.5$ 100.0%
White-throated Honeyeater S, R	Abundance Occupancy	$2.2 \pm 0.3$ 82.1%
Peaceful Dove G, S	Abundance Occupancy	$0.4 \pm 0.2$ 25.9%
Magpie Goose W	Abundance Occupancy	$38.3 \pm 21.7$ 26.7%
Blue-winged Kookaburra G, S, R	Abundance Occupancy	$0.2 \pm 0.1$ 18.8%
Red-browed Finch G, S	Abundance Occupancy	$0.2 \pm 0.2$ 3.1%
Savanna bird guild	Abundance Occupancy Richness	$28.7 \pm 2.3$ 100% $12.1 \pm 0.4$
Rainforest bird guild	Abundance Occupancy Richness	$29.8 \pm 5.6$ 100% $15.0 \pm 2.2$
Grassland bird guild	Abundance Occupancy Richness	$8.3 \pm 4.0$ 100% $3.0 \pm 0.4$
Wetland bird guild	Abundance Occupancy Richness	$84.2 \pm 32.4$ 80% $6.8 \pm 1.4$

\*Abundance is average abundance across all sites within the relevant habitat type.

## Wetland Birds

With the exception of 2 sites, the 2019 survey team revisited the 9 wetland sites surveyed in September 2015 by Roshier et al. (2016), including 5 separate sites on the large Green Swamp wetland. Table 7 compares the average abundance and species richness from the 2015 and 2019 surveys.

**Table 7. Comparison of average abundance and richness of waterbirds at wetland sites at Piccaninny Plains in 2015 and in 2019.**

Metric	2015	2019
Abundance	$859 \pm 794$	$143 \pm 124$
Richness	$14.8 \pm 6.5$	$7.8 \pm 4.0$

Abundance and species richness were both lower in 2019 than in 2015 (Table 7). However, this may partly be a survey artefact, as the 2015 survey used spotting scopes, but the 2019 survey did not. Several species were recorded in much lower abundance at Green Swamp in 2019 than in 2015: e.g. Magpie Goose (1879 in 2015; 325 in 2019) and Royal Spoonbill (*Platalea regia*; 595 in 2015; 10 in 2019). There was substantially more

rainfall between January-August in 2019 (2018 mm) than during the same period in 2015 (1254 mm), as well as widespread flooding in early 2019 in the wake of three tropical cyclones. It is possible that fewer birds were recorded in 2019 simply due to availability of suitable wetland habitat elsewhere in Cape York outside Piccaninny Plains following the increased rainfall. Repeat counts at these sites, combined with consideration of rainfall data and the use of a tscope in future surveys, will provide further insights into these results.

### Red Goshawk and Buff-breasted Buttonquail

The Red Goshawk and Buff-breasted Buttonquail were not detected during the targeted searches. Extensive survey work has failed to detect the Buff-breasted Buttonquail at any site on Cape York Peninsula, suggesting the species (last collected in the early 20th century) could possibly be extinct (Webster et al. 2021).

### Wetland condition

The on-ground wetland monitoring sites were not surveyed in 2020 due to logistical constraints. In 2019, the majority of surveyed wetlands (53%) were in 'fair' condition, while 24% were in 'good' condition (Table 8). Although the mode of the assessment scores has remained stable since 2013, the percentage of wetlands in the most damaged category ('very poor') has reduced from 24% in 2013 to 3% in 2019. Similarly, sites have been recorded in 'very good' condition only since 2015 (Table 8).

**Table 8. The number of sites in each condition at on-ground wetland monitoring sites 2013-2019.**

Condition score	2013	2014	2015	2018	2019
Very good	0	0	2	3	2
Good	6	6	5	10	8
Fair	10	8	10	18	18
Poor	9	3	8	14	5
Very poor	8	4	5	2	1
<b>Mode</b>	<b>Fair</b>	<b>Fair</b>	<b>Fair</b>	<b>Fair</b>	<b>Fair</b>

In November 2020, the Green Swamp wetland condition assessments had a mode of 'good', which was unchanged from the 2019 November survey (Table 9). The pre-2019 condition scores (which were all undertaken on-ground, and in August) suggest continued improvement in wetland health since assessments began in 2013, when the site had a mode of 'very poor'. Caution must be had in interpreting these results, given possible subjective differences between observers and in comparing August to November observations. Nonetheless, these results suggest that there was improved condition of the large wetland after August following the removal of a large number of feral cattle and pigs in 2019 and 2020. Repeat assessments in both August and November in coming years will help to better clarify these patterns.

**Table 9. Wetland condition scores at Green Swamp 2013-2020.** 'VP' = very poor; 'P' = poor; 'F' = fair; 'G' = good; 'VG' = very good.

Wetland site	2013 Aug	2014 Aug	2015 Aug	2018 Aug	2019 Aug	2019 Nov	2020 Nov
PIC_Green Swamp WA01	P	F	F	F	F	G	G
PIC_Green Swamp WA02	F	F	F	G	F	F	G
PIC_Green Swamp WA03	VP	VP	P	F	F	G	G
PIC_Green Swamp WA04	VP	P	VP	F	F	G	G
PIC_Green Swamp WA05	VP	-	VP	P	P	F	P
PIC_Green Swamp WA06	VP	VP	-	-	-	G	P
PIC_Green Swamp WA07	F	G	-	G	G	G	G
<b>Mode</b>	<b>VP</b>	<b>-</b>	<b>-</b>	<b>F</b>	<b>F</b>	<b>G</b>	<b>G</b>

## Threat indicators

### Feral herbivores

As the dry season progresses and water bodies dry out in the landscape, there is typically an annual influx of feral cattle to the permanent lagoons on Piccaninny Plains. During the Feral Herbivore Survey, 185 feral cattle were recorded in November 2020 (Table 10). AWC managers have steadily reduced the abundance of feral cattle since the survey commenced in 2016.

The Sanctuary Managers report a substantial reduction in feral pig numbers in the interior of the sanctuary; the vast majority of feral pigs are now found close to the sanctuary boundary and almost none have been seen more than 5 km from the boundaries (personal communication with G Woods, March 2021). The results of the Wetland Condition Assessment suggest that condition of Green Swamp has continued to improve since 2013 (Hayes 2021). The reduced pressure on the wetland habitats from the sustained removal of feral cattle, horses and pigs on Piccaninny Plains is likely resulting in wetlands in better condition.

**Table 10. Results of the 2020 Feral Herbivore Survey**

Year	Cattle	Horses
2016	442	75
2017	255	51
2018	376	27
2019	275	7
2020	185	17

### Fire

All fire metrics indicate improvements considered to be beneficial for ecological health since commencement of AWC management. The area burnt in the early dry season has increased, while the area burnt by late dry season wildfire has reduced substantially (Table 11). Similarly, the cumulative extent of the sanctuary burnt by late dry season fire in the previous three years has reduced by over 40% compared to baseline measures (Table 11). More detail on the Piccaninny Plains fire program is in the annual Fire Reports (Webb et al. 2020).

**Table 11. Metrics derived from mapping of 2020 fire scars.**

Metric	Baseline average	AWC management	2020 result
Total area burnt (% of property)	76%	55%	44%
Area burnt by early dry season fire (% of property)	22%	37%	33%
Area burnt by late dry season fire (% of property)	54%	18%	11%
Cumulative extent of sanctuary burnt by late dry season fire in previous three years (% of property)	90%	43%	30%
Modal frequency of fires in last 9 years	9		5
Modal frequency of LDS fires in last 9 years	4		1
Mean distance to unburnt vegetation (km)	1.8	1.0	0.9
Mean distance to veg. unburnt by late dry season fire 3 or more years (km)	2.7	1.1	0.9

*Note: Baseline values for metrics are the average for the years immediately prior to acquisition of Piccaninny Plains by AWC: i.e., 2000-2008 for annual metrics, and 2002-2008 for 3 year metrics. AWC management values for metrics are the average for the years following acquisition of Piccaninny Plains by AWC: i.e., 2009 onwards, for annual metrics, and 2012-2020, for 3 year metrics.*

## Discussion

The Ecohealth survey program on Piccaninny is providing useful information on the distribution, occupancy, abundance and trends of the species, guilds, ecological process and threats indicators of the sanctuary. As we repeat the surveys in future years, we will gain a better understanding and confidence in these metrics. The data presented in this report shows that the status of many of the indicators on Piccaninny Plains are good.

AWC completed the first targeted survey of the Black-footed Tree-rat on Piccaninny Plains in 2020. Encouragingly, an additional seven locations were added to the known sites for Black-footed Tree-rats on Piccaninny Plains. The survey provided baseline data which will be used to inform the development of specific methods to monitor this species, in particular its response to management actions, such as storm burning.

Species richness of birds was highest in the gallery rainforest habitat. Two species selected for surveillance monitoring had very high occupancy across the survey sites; the Rainbow Lorikeet and White-throated Honeyeater. Future surveys will assist in clarifying the trends for these species and their appropriateness as Ecohealth indicators. The abundance and occupancy of the Palm Cockatoo (currently present at just over one-fifth of sites) will be closely monitored in light of recent research predicting severe declines in the Cape York meta-population (Keighley et al. 2021).

The number of feral cattle recorded in the aerial feral herbivore survey was the lowest since the survey began in 2016. The mode of the wetland condition at Green Swamp has remained stable, in 'good' condition, since 2019, suggesting that the continued removal of feral cattle and pigs from Piccaninny Plains is benefiting the sensitive wetland ecosystems.

## Acknowledgments

AWC acknowledges the Wik and Wik Way people, the Traditional Custodians, of Wik and Wik Way Country on which Piccaninny Plains resides. We also acknowledge their continuing connection to land, culture and community. We pay our respects to Wik and Wik Way Elders past present and emerging.

AWC's Ecohealth Program on Piccaninny Plains is only possible because of the generosity of AWC's supporters and the partnership with the Tony and Lisette Lewis Foundation.

The North-east Science team is grateful for the assistance from the Piccaninny Plains Sanctuary Managers, Graham Woods and Sally Gray, during the 2020 surveys and for undertaking the 2020 aerial feral survey and wetland assessments.

AWC staff participating in the 2020 surveys:

- Catherine Hayes
- Emily Rush
- David Nelson
- Andy Howe

Survey support:

- Sally Gray
- Graham Woods
- Alexander Watson

## References

- BirdLife Australia (2020) Become an Atlasser. Available at: <https://birdlife.org.au/projects/atlas-and-birddata/become-an-atlasser>, accessed 31 March 2020.
- Bureau of Meteorology (2021) Climate data online. Available at: <http://www.bom.gov.au/climate/data/>, accessed 30 March 2021.
- Crowley G, Garnett S, Shephard S (2009) Impact of storm-burning on *Melaleuca viridiflora* invasion of grasslands and grassy woodlands on Cape York Peninsula, Australia. *Austral Ecology* 34, 196-209.
- Department of Environment and Science, Queensland Government (2020) Birds: WetlandInfo 2014, available at: <https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/fauna/birds/>, accessed 5 April 2020.
- Diete RL, Meek PD, Dixon KM, et al. (2016) Best bait for your buck: bait preference for camera trapping north Australian mammals. *Australian Journal of Zoology* 63, 376-382.
- Eyre TJ, Ferguson DJ, Hourigan CL, et al. (2018) Terrestrial vertebrate fauna survey assessment guidelines for Queensland. Department of Environment and Science, Queensland Government, Brisbane.

- Friend G (1987) Population Ecology of *Mesembriomys Gouldii* (Rodentia, Muridae) in the Wet-Dry Tropics of the Northern Territory. *Wildlife Research* 14, 293-303.
- Friend G, Taylor J (1985) Habitat preferences of small mammals in tropical open-forest of the Northern Territory. *Australian Journal of Ecology* 10, 173-185.
- Greenberg S, Godin T, Whittington J (2019) Design patterns for wildlife-related camera trap image analysis. *Ecology and Evolution* 9, 13706-13730.
- Hayes C (2021) *Piccaninny Plains Wildlife Sanctuary 2019 survey report*. Australian Wildlife Conservancy, Perth, WA. *In prep*.
- Kanowski J, Joseph L, Kavanagh R, Fleming A (2018) Designing a monitoring framework for Australian Wildlife Conservancy, a national conservation organisation. In: *Monitoring Threatened Species and Ecological Communities* (Eds S Legge, DB Lindenmayer, NM Robinson, BC Scheele, DM Southwell, BA Wintle) pp 241-253. CSIRO, Melbourne.
- Keighley MV, Haslett S, Zdenek CN, Heinsohn R (2021) Slow breeding rates and low population connectivity indicate Australian palm cockatoos are in severe decline. *Biological conservation* 253, 108865.
- Mulder E, Cliff H, Kanowski J (2016) *Piccaninny Plains 2015 survey report*. Australian Wildlife Conservancy, Perth, WA.
- Mulder E, Kemp J, Jensen R, et al. (2014a) *Piccaninny Plains 2013 survey report*. Australian Wildlife Conservancy, Perth, WA.
- Mulder E, Kemp J, Jensen R, et al. (2014b) *Piccaninny Plains 2014 survey report*. Australian Wildlife Conservancy, Perth, WA.
- Neldner VJ, Fensham RJ, Clarkson JR, et al. (1997) The natural grasslands of Cape York Peninsula, Australia. Description, distribution and conservation status. *Biological Conservation* 81, 121-136.
- Risler J (2017) Optimising camera trap survey effort to reliably detect a threatened species, the Black-footed Tree-rat, *Mesembriomys gouldii*, in open forest and woodland of tropical savannas of the Top End, Northern Territory. Masters thesis, Charles Darwin University, Darwin.
- Roshier D, Reid J, Emmott A, Traill B, Bond S (2016) *Piccaninny Plains Bird and Butterfly Surveys 2015/16*. Australian Wildlife Conservancy, Perth, WA.
- Russell-Smith J, Bowman DMJS (1992) Conservation of monsoon rainforest isolates in the Northern Territory, Australia. *Biological Conservation* 59, 51-63.
- Stanton P (2021) Draft fire management strategy: Piccaninny Plains Wildlife Sanctuary. Australian Wildlife Conservancy, Perth, WA. *In prep*.
- Stanton P, Jensen R, Kemp J, Cooper T, Webb T (2016) *Vegetation Mapping of Piccaninny Plains Wildlife Sanctuary: Report to accompany a Vegetation Map based on aerial photography between 1969 and 1974*. Australian Wildlife Conservancy, Perth.
- Stanton P, Murphy S (2006) *Report on an inspection of Piccaninny Plains Pastoral Holding, northern Cape York Peninsula*. Australian Wildlife Conservancy, Perth, WA.
- Webb T, Cooper T, Lewis F, et al. (2020) *Piccaninny Plains Wildlife Sanctuary: 2019 fire pattern analysis*. Australian Wildlife Conservancy, Perth, WA.
- Webster P, Watson J, Murphy S, et al. (2021) *Essential research to secure the Buff-breasted Buttonquail Turnix olivii*. NESP Threatened Species Recovery Hub Project 2.6 report, Brisbane.

## Appendices

### Species recorded during the 2020 Black-footed Tree-rat camera trap survey

Scientific Name	Common Name
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar
<i>Alectura lathamii</i>	Australian Brushturkey
<i>Aprosmictus erythropterus</i>	Red-winged Parrot
<i>Bos taurus</i>	European Cattle
<i>Canis dingo</i>	Dingo
<i>Canis lupus familiaris</i>	Common Dog
<i>Centropus phasianinus</i>	Pheasant Coucal
<i>Corvus orru</i>	Torresian Crow
<i>Dacelo leachii</i>	Blue-winged Kookaburra
<i>Felis catus</i>	Feral cat
<i>Geopelia humeralis</i>	Bar-shouldered Dove
<i>Geopelia placida</i>	Peaceful Dove
<i>Grallina cyanoleuca</i>	Magpie-lark
<i>Isodon sp.</i>	Isodon macroura or peninsulae
<i>Macropus agilis</i>	Agile Wallaby
<i>Macropus antilopinus</i>	Antilopine Wallaroo
<i>Malurus melanocephalus</i>	Red-backed Fairywren
<i>Mesembriomys gouldii rattoides</i>	Black-footed Tree-rat (north Queensland)
<i>Podargus strigoides</i>	Tawny Frogmouth
<i>Rhinella marina</i>	Cane Toad
<i>Rhipidura leucophrys</i>	Willie Wagtail
<i>Sus scrofa</i>	Feral pig
<i>Trichosurus vulpecula</i>	Common Brushtail Possum
<i>Varanus panoptes</i>	Yellow-spotted Monitor

### Independent events of Black-footed Tree-rats across the camera traps

Site Name	Date	Time
BFTR062	10-Aug-20	20:35:41
BFTR062	12-Aug-20	1:36:27
BFTR062	18-Aug-20	2:23:13
BFTR062	23-Aug-20	23:26:15
BFTR015	9-Aug-20	23:43:14
BFTR015	10-Aug-20	0:24:08
BFTR015	25-Aug-20	1:35:22
BFTR022	14-Aug-20	3:35:08
BFTR022	18-Aug-20	0:35:38
BFTR022	18-Aug-20	1:33:56
BFTR022	22-Aug-20	1:31:01
BFTR022	23-Aug-20	19:19:26
BFTR036	15-Aug-20	6:12:40
BFTR009	19-Aug-20	3:26:17
BFTR003	12-Aug-20	22:34:53
BFTR003	19-Aug-20	3:53:03
BFTR037	19-Aug-20	2:57:37
BFTR037	26-Aug-20	4:38:54
BFTR028	17-Aug-20	4:06:37
BFTR028	22-Aug-20	21:42:27

Copyright © Australian Wildlife Conservancy 2021

Images © individual photographers and AWC

All images, text and graphics in this Report are protected by copyright law.

Apart from fair dealing for the purpose of private study research, criticism or review, as permitted under the *Copyright Act 1968*, no part of this Report may be reproduced by any process or reused for any purposes whatsoever without prior written permission from AWC.

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

## Document history

Note: Data used to derive Ecohealth metrics in this report was drawn from the following survey reports: Mulder et al. 2016; Hayes 2021.

### Text and analyses

Name	Position	Date
Emily Rush	Field ecologist	30/03/2021
Catherine Hayes	Wildlife ecologist	30/03/2021

### Review

Name	Position	Date
Alexander Watson	Regional ecologist	31/03/2021
Mareshell Wauchope	Senior Field Ecologist – National Science Team	22/04/2021
Jenny Pierson	Senior Ecologist – National Science Team	27/05/2021
Catherine Hayes	Wildlife Ecologist – National Science Team	15/06/2021
Liana Joseph	National Science Manager – National Science Team	14/10/2021

### Approval

Name	Position	Date
John Kanowski	Chief Science Officer	18/10/2021