BIODIVERSITY ASSESSMENT REPORT

Lot 2303, Jabiru, NT

Prepared for:

CDM Smith Australia Pty Ltd

28 January 2021

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Photo on front cover (from top to bottom): *Eucalyptus miniata* and *E. tetrodonta* woodland and Black-footed Tree-rat in Lot 2303. All photos in this report were taken by Connect Environmental.

Executive Summary

Connect Environmental was engaged by CDM Smith Australia Pty Ltd, on behalf of the Northern Territory (NT) Government Department of the Chief Minister and Cabinet (DCM&C), to conduct a biodiversity assessment of Lot 2303 in Jabiru. The lot is approximately 32.5 ha and is located next to the Jabiru landfill to the north-east of the town. The objectives of the biodiversity assessment were:

- To determine the vegetation communities within the lot and their habitat value for biodiversity, including threatened and migratory species.
- To determine the potential impacts of the proposed development on biodiversity, threatened and migratory species and the significance of such impacts.

Lot 2303 is broadly split into two roughly equally-sized habitats – a *Eucalyptus miniata* / *E. tetrodonta* woodland in the northern half and an irrigated grassland in the southern half (using untreated water from the nearby sewage treatment facility). Following a desktop review of available environmental information, and a reconnaissance survey, a total of nine threatened species and four migratory species were determined to potentially occur in Lot 2303. A preliminary assessment of the level of inherent risk to each of these was conducted to determine whether there was a real risk of significant impact to them. As a result, eight threatened and no migratory species were concluded as being the focus of on ground surveys.

To determine whether any of these species occupied Lot 2303, 20 motion-sensing cameras were deployed, and six diurnal and four nocturnal bird surveys were conducted, within Lot 2303. A total of 28 bird species, eight mammal species and two amphibian species were detected. Only one threatened species was detected – the Black-footed Tree-rat, however another threatened species – the Partridge Pigeon – was subsequently detected during supplementary surveys. The Black-footed Tree-rat is listed as Vulnerable under the NT *Territory Parks and Wildlife Conservation Act* and Endangered under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999*. The survey also detected three feral animal species (Cane Toads, Wild Dog / Dingoes and Pigs). Vegetation communities and weeds were also mapped.

The assessment of the likelihood of occurrence of threatened species was then repeated incorporating the survey results and site observations. It was determined that six threatened species may utilise Lot 2303, either occasionally for foraging or as residents (yet were just not present at the time of the surveys). For five of these remaining six species, the development of Lot 2303 is unlikely to result in a significant impact.

For the Black-footed Tree-rat, the level of potential impact following the initial surveys could not be accurately assessed. Therefore, 35 additional camera sites were deployed in suitable habitat to the north of Lot 2303 and in the Jabiru township with the aim of contextualizing the results of the initial surveys. In addition, two one-hour long spotlighting sessions were conducted to gather evidence of Black-footed Tree-rats using the landfill adjacent to Lot 2303. No individuals were observed during these spotlighting sessions, and only one individual was detected on a camera immediately north-west of Lot 2303. No others were detected, including in Jabiru. This suggests that the habitat in Lot 2303 provides a combination of adequate resources and protection for Black-footed Tree-rats not found elsewhere in the local area.

Several information gaps remain in relation to the Black-footed Tree-rats within Lot 2303, including the number of individuals occupying Lot 2303, the extent of the area they occupy, their use (if any) of the adjacent landfill, and the abundance and distribution of tree-rats in surrounding, un-surveyed areas. However, it appears as though Lot 2303 provides refuge for Black-footed Tree-rats from more substantial threatening processes in the surrounding landscape. As such, it appears that the habitat in Lot 2303 is necessary for foraging and breeding for the tree-rats in the local area and that the proposed development may reduce the size of the local population, adversely affect habitat that may be critical to its survival and disrupt the breeding cycle of those individuals occupying Lot 2303.

The Partridge Pigeons detected in Lot 2303 are not particularly unique in the region, given the numerous other sightings to the north of Lot 2303 and in Jabiru. As such, a significant impact to this species because of the proposed development is unlikely.

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Appendix A: Preliminary Threatened Species Likelihood of Occurrence Assessment

Appendix B: Preliminary Migratory Species Likelihood of Occurrence Assessment

Appendix C: EPBC Act Protected Matters Search Tool Report

Appendix D: Masked Owl Survey Method (DENR, 2019)

1 Introduction

1.1 Overview

Connect Environmental was engaged by CDM Smith Australia Pty Ltd, on behalf of the Northern Territory (NT) Government Department of the Chief Minister and Cabinet, to conduct a biodiversity assessment of Lot 2303 in Jabiru (**Figure 1**). The lot is approximately 32.5 ha and is zoned for utilities (refer to Jabiru Town Plan - **Figure 1**). It is in the industrial area, next to the Jabiru landfill, to the north-east of the town.

1.2 The Jabiru Futures Project

Jabiru is an important town in the NT, not just as a mining town but as the gateway to dual-World Heritage listed Kakadu National Park and as a service centre for those living in the West Arnhem Region. Land in Jabiru is currently leased by the Commonwealth Director of National Parks to the Jabiru Town Development Authority, a NT Government statutory authority.

A uranium mine, located approximately 7 km east of Jabiru and operated by Energy Resources of Australia (ERA), is required to cease processing activities no later than January 2021. The Australian Government, NT Government, ERA and the Mirarr Traditional Owners, represented by the Gundjeihmi Aboriginal Corporation (GAC), are working together under a Memorandum of Understanding to secure the future of Jabiru and provide certainty for residents, businesses and the tourism industry. As part of this, the NT Government is committed to securing Jabiru's future by investing in new essential developments, such as the new power station. This project has been necessitated due to the closure of the ERA Ranger Uranium Mine that supplies power to Jabiru.

1.3 Purpose and Objectives

The objectives of the biodiversity assessment were:

- To determine the vegetation communities within the lot and their habitat value for biodiversity, including threatened and migratory species.
- To determine the potential impacts of the proposed development on biodiversity, threatened and migratory species and the significance of such impacts.

1.4 Personnel

Mihkel Proos led the assessment with assistance from Justin Bott, as shown in **Table 1**.

Table 1 Project Team

Team Member	Relevant experience	Role
Mihkel Proos	Mihkel's background lies in terrestrial ecology, having completed over 30 surveys across northern Australia over the last decade. He has 18 years' experience in the environmental field, with core experience in ecology, approvals and management. He has worked for the NT and Australian Governments in project assessment and science roles.	Project Manager, fauna survey team leader, field assistant for flora surveys, reporting
Justin Bott	Justin is currently studying his second year of a Bachelor of Science (Ecology) at Charles Darwin University. He has assisted with several field surveys for Connect Environmental.	Field assistant, photo identification

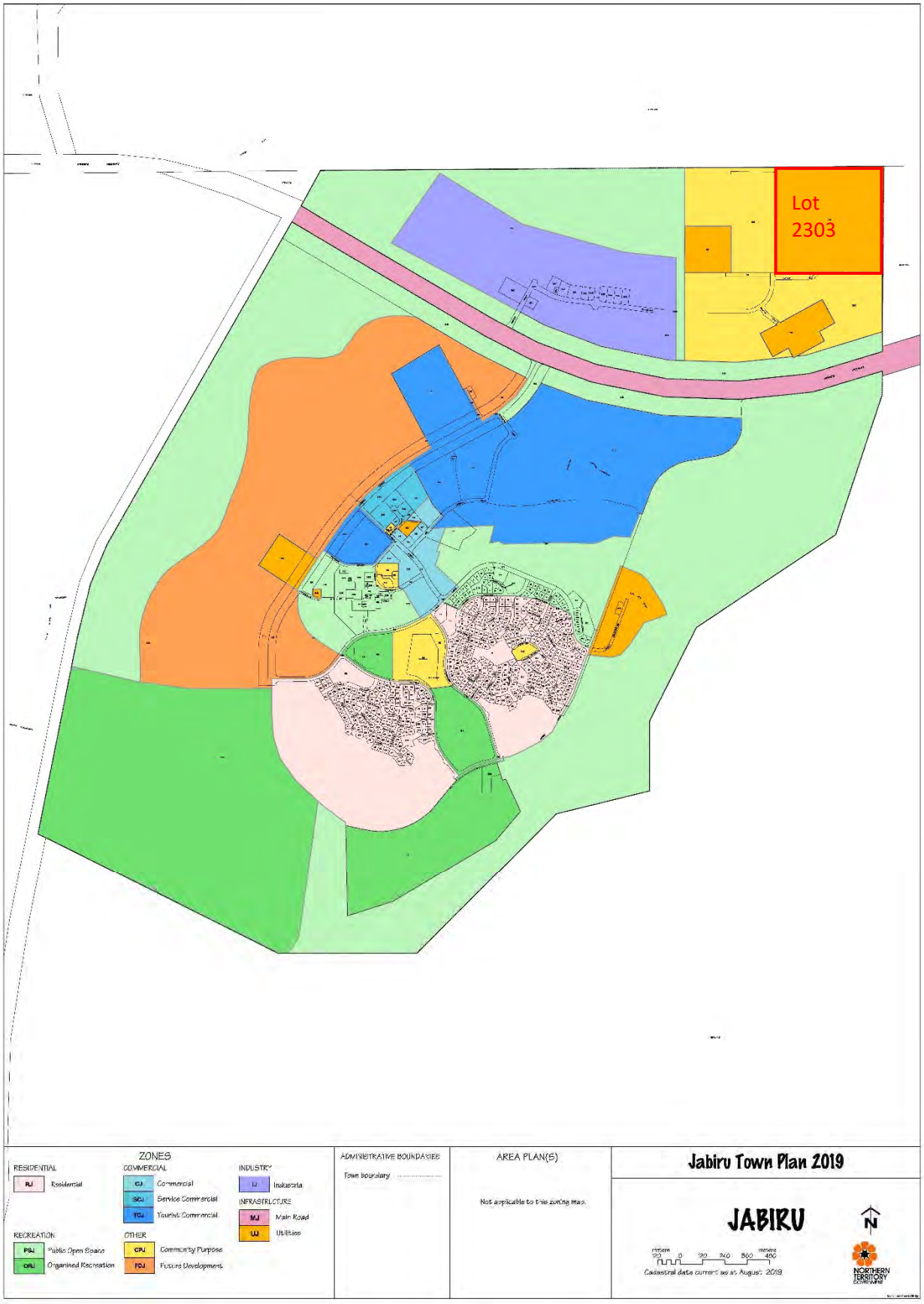

Figure 1 Location of Lot 2303 - Jabiru Town Plan 2019

2 Method of Assessment

The assessment uses an elimination process whereby species that are known to, or potentially occur in the region are assessed for their likelihood to be present within Lot 2303 and the likelihood of a significant impact resulting from the proposed development. It considers available environmental data to determine the characteristics of the habitats within the site. On ground surveys are undertaken when and where necessary, to determine the species presence, or likely presence.

The process followed is as follows:

1. Analysing, reporting and mapping of any relevant existing environmental information including:
    a. Land unit / system patterns
    b. Sites of Conservation Significance
    c. Vegetation communities including defining those which are 'sensitive' or 'significant' (under relevant NT legislation)
    d. Weeds including those which are declared under the NT *Weeds Management Act* (WM Act) as well as 'Weeds of National Significance' (WONS)
    e. Threatened species records in the region.
    f. Migratory species that have the potential to occur in the region.
2. Assessing the likelihood of occurrence of threatened and migratory species within the lot.
3. Assessing the likelihood of impact to each species, and its significance.
4. Conduct on ground surveys within Lot 2303 to determine:
    a. Vegetation communities
    b. The presence and quality of habitats for threatened and migratory species
    c. The presence of threatened species (further details of the survey methodology is provided in **Section 7**).
5. Re-assessing the likelihood of occurrence of threatened and migratory species within the lot based on the results of the surveys.
6. Re-assessing the likelihood of impact to each species, and its significance, based on the results of the surveys.
7. Based on the results of the initial camera surveys within Lot 2303, conduct additional surveys targeting the Black-footed Tree-rat in the local area outside Lot 2303 to determine their presence further afield.
8. Re-assessing the potential for significant impact to Black-footed Tree-rats.
9. Providing conclusions and recommendations.

3 Exclusions and Limitations

There are several inherent limitations to all assessments of this nature, including:

- This assessment focusses on terrestrial biodiversity, and does not include heritage, soil science, geotechnical or hydrodynamic matters.
- When conducting database searches for threatened species, buffers of between 1 and 100 km are generally used depending on the likely amount of survey effort conducted in that area. Buffers of 1, 5 and 50 km were used for this project as it was determined that these distances would satisfactorily characterise local and regional abundance and distributions of threatened species and adequately capture the potential for these species to exist on Lot 2303.
- Flora and fauna records obtained through NR Maps are not necessarily an accurate representation of the abundance and distribution of a species in any given area. Survey effort in that area is also a factor.
- The surveys were just a snapshot in time. Over time, including from season to season, habitat conditions and population abundance and distributions may change. In this regard, any cryptic or transient fauna may have not been detected, even though they may occur in the local area.
- Assessments and conclusions made by Connect Environmental are based on available information at the time of preparation of this report.
- Other matters protected under the EPBC Act, such as Matters of National Environmental Significance (except for threatened and migratory species), and the NT *Environment Protection Act 2019*, were not assessed in this report.

4 Existing Environmental Information

4.1 Land Units

Land units are areas that have similar biophysical attributes including landform, soil, and vegetation. They are mapped to describe the capability of each unit to support a range of land uses such as urban subdivision, farming, pasture improvement and resource extraction. For environmental assessments, land unit mapping assists in characterising the land features and habitats in the area, and in turn, aids in determining the potential for threatened and migratory species to exist.

No land unit mapping was identified for Lot 2303.

4.2 Vegetation Communities

Vegetation communities, in the local area, are mapped at a scale of 1:1,000,000 for the National Vegetation Information System (NVIS). This mapping incorporates mapping from the *Vegetation Survey of the Northern Territory, Australia* (Wilson *et al*., 1990) at a scale of 1:1,000,000, and from the *Melaleuca Survey of the Northern Territory* (Brocklehurst & Van Kerckhof, 1994), at a scale of 1:100,000. The information is used to broadly define landscape characteristics such as woodlands and drainage lines.

The vegetation on Lot 2303, as mapped in NVIS, is described as *Eucalyptus miniata*, *E. tetrodonta*, *Erythrophleum chlorostachys* mid open forest over *Livistona humilis*, *Cycas armstrongii*, *Acacia oncinocarpa* low sparse shrubland over *Heteropogon triticeus*, *Sorghum plumosum*, *Chrysopogon fallax* tall tussock grassland.

4.3 Land Systems

Land system descriptions provide information in relation to the main features of the landscape (Lynch *et al*., 2012) based on detailed information collected at specific sites. They have been mapped and described for the northern part of the NT by Lynch *et al*. (2012) at a scale of 1:250,000. Lot 2303 lies in the 'Kay' land system which is described in **Table 2**.

Table 2 Description of the Kay land system (Lynch et al., 2012)

'Kay' Land System	Description
Landscape class	Lateritic plains and rises
Landscape class description	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils.
Landform description	Level to gently undulating plains on deeply weathered rocks
Soils	Lateritic red and yellow earths
Vegetation description	Tall open woodland of *C. bleeseri*, *Erythrophleum chlorostachys*, *E. tetrodonta*, *E. miniata*, *E. tectifica* over *Sorghum* spp, *Chrysopogon fallax*, *Eriachne* spp.

4.4 Sensitive and Significant Habitats

The NT *Land Clearing Guidelines* (DENR, 2020) describe 'sensitive' or 'significant' vegetation as rainforest, vine thicket, closed forest, riparian vegetation, mangroves, monsoon vine forest, sand sheet heath and vegetation containing large trees with hollows suitable for fauna.

In addition, the NT EPA, in its Terms of Reference for several projects, have referred to sensitive or significant vegetation as also including important habitat corridors, wetlands and groundwater dependent ecosystems.

The NVIS vegetation mapping does not specifically show any significant or sensitive habitat within Lot 2303, however:

- Large hollow-bearing trees may be present.
- A creek line is located approximately 200 m to the south-east of Lot 2303.

4.5 Areas of High Biodiversity Value

4.5.1 Sites of Conservation Significance

Sites of Conservation Significance (SOCS) in the NT include those that support important wetland values, large aggregations of wildlife, concentrations of threatened species or endemic species, or are botanical hot spots. The closest SOCS are the Alligator River Coastal Floodplains and the Western Arnhem Plateau (**Figure 2**).

4.5.2 World and National Heritage

Jabiru is surrounded by Kakadu National Park (Kakadu). Kakadu is a World and National Heritage listed area, a Ramsar site and contains values that include containing a wide range of natural habitats.

Figure 2 - Sites of Conservation Significance, Parks and Reserves

Key

- Lot 2303
- Sites of Conservation Significance

Parks and Reserves

- Kakadu National Park
- Town of Jabiru within Kakadu

- Streams
- Minor drainage (creek)
- Major drainage (river)

Base layer: Google Satellite

0 1 2 3 km

1:80,000

GDA94, zone 53
Date: 25 August 2020

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4.6 Local Threatened Species Records

4.6.1 Flora

There are no of recordings of threatened flora species within 5 km of Lot 2303. Ten threatened species are recorded within 50km, according to the NT Flora Atlas (searched 15 August 2020; refer to **Table 3** and **Figure 3**). The EPBC Act Protected Matters Search Tool (PMST) does not show any threatened flora species as potentially occurring within 5 km of Lot 2303 (refer to **Appendix C**).

Table 3 Threatened flora recorded within 50 km of Lot 2303 (source: NT Flora Atlas)

Scientific name	Common name	Conservation Status[1]		No. records	Most recent
		TPWC Act	EPBC Act		
Abrodictyum obscurum	Cephalomanes	EN	Not listed	2	1984
Boronia quadrilata	Boronia	VU	VU	130	2014
Hibbertia brennanii	Hibbertia	VU	Not listed	13	2016
Hibbertia pancerea	Hibbertia	VU	Not listed	8	2016
Hibbertia sp. South Magela	Hibbertia	VU	Not listed	9	2016
Hibbertia tricornis	Hibbertia	VU	Not listed	4	2016
Hibiscus brennanii	Hibiscus	VU	Not listed	96	2016
Lithomyrtus linariifolia	Lithomyrtus	VU	Not listed	13	2017
Utricularia dunstaniae	Utricularia, Bladderwort	VU	Not listed	1	1981
Utricularia singeriana	Utricularia, Bladderwort	VU	Not listed	2	2010

4.6.2 Fauna

Fifteen threatened fauna species have been recorded within 5 km of Lot 2303 according to the NT Fauna Atlas (version 21 July 2020) (refer to **Table 4** and **Figure 4**). Most notable are the high number of Partridge Pigeon records, the recent Red Goshawk siting and the lack of Pale Field-rat records for nearly 20 years. In addition, the EPBC Act PMST has also modelled the following terrestrial species as potential occurring in the region:

- Curlew Sandpiper (*Calidris ferruginea*)
- Crested Shrike-tit (*Falcunculus frontatus whitei*)
- Eastern Curlew (*Numenius madagascariensis*)
- Australian Painted Snipe (*Rostratula australis*)
- Masked Owl (northern) (*Tyto novaehollandiae kimberli*)
- Arnhem Leaf-nosed Bat (*Hipposideros inornatus*)
- Nabarlek (*Petrogale concinna canescens*)
- Bare-rumped Sheath-tailed Bat (*Saccolaimus saccolaimus nudicluniatus*)

[1] *VU = Vulnerable, EN = Endangered*

- Plains Death Adder (*Acanthophis hawkei*)
- Arnhem Land Egernia (*Bellatoris obiri*).

The results of the PMST search are shown in **Appendix C**.

Table 4 Threatened fauna recorded within 5 km (NT Fauna Atlas)

Scientific name	Common name	Conservation Status[2]		No. records	Most recent
		TPWC Act	EPBC Act		
Acanthophis hawkei	Plains Death Adder	VU	VU	1	1983
Antechinus bellus	Fawn Antechinus	EN	VU	19	2013
Charadrius mongolus	Lesser Sand Plover	VU	EN	1	2000
Conilurus penicillatus	Brush-tailed Rabbit-rat	EN	VU	1	1983
Dasyurus hallucatus	Northern Quoll	CR	EN	23	2002
Erythrotriorchis radiatus	Red Goshawk	VU	VU	1	2019
Erythrura gouldiae	Gouldian Finch	VU	EN	4	2017
Geophaps smithii	Partridge Pigeon	VU	VU	107	2019
Macroderma gigas	Ghost Bat	Not listed	VU	2	2011
Mesembriomys gouldii gouldii	Black-footed Tree-rat (Kimberley and mainland NT)	VU	EN	7	2012
Phascogale pirata	Northern Brush-tailed Phascogale	EN	VU	7	2002
Rattus tunneyi	Pale Field-rat	VU	Not listed	5	2002
Varanus mertensi	Mertens' Water Monitor	VU	Not listed	20	2018
Varanus mitchelli	Mitchell's Water Monitor	VU	Not listed	2	1982
Varanus panoptes	Yellow-spotted Monitor	VU	Not listed	7	2013

[2] *VU = Vulnerable, EN = Endangered, CR = Critically Endangered*

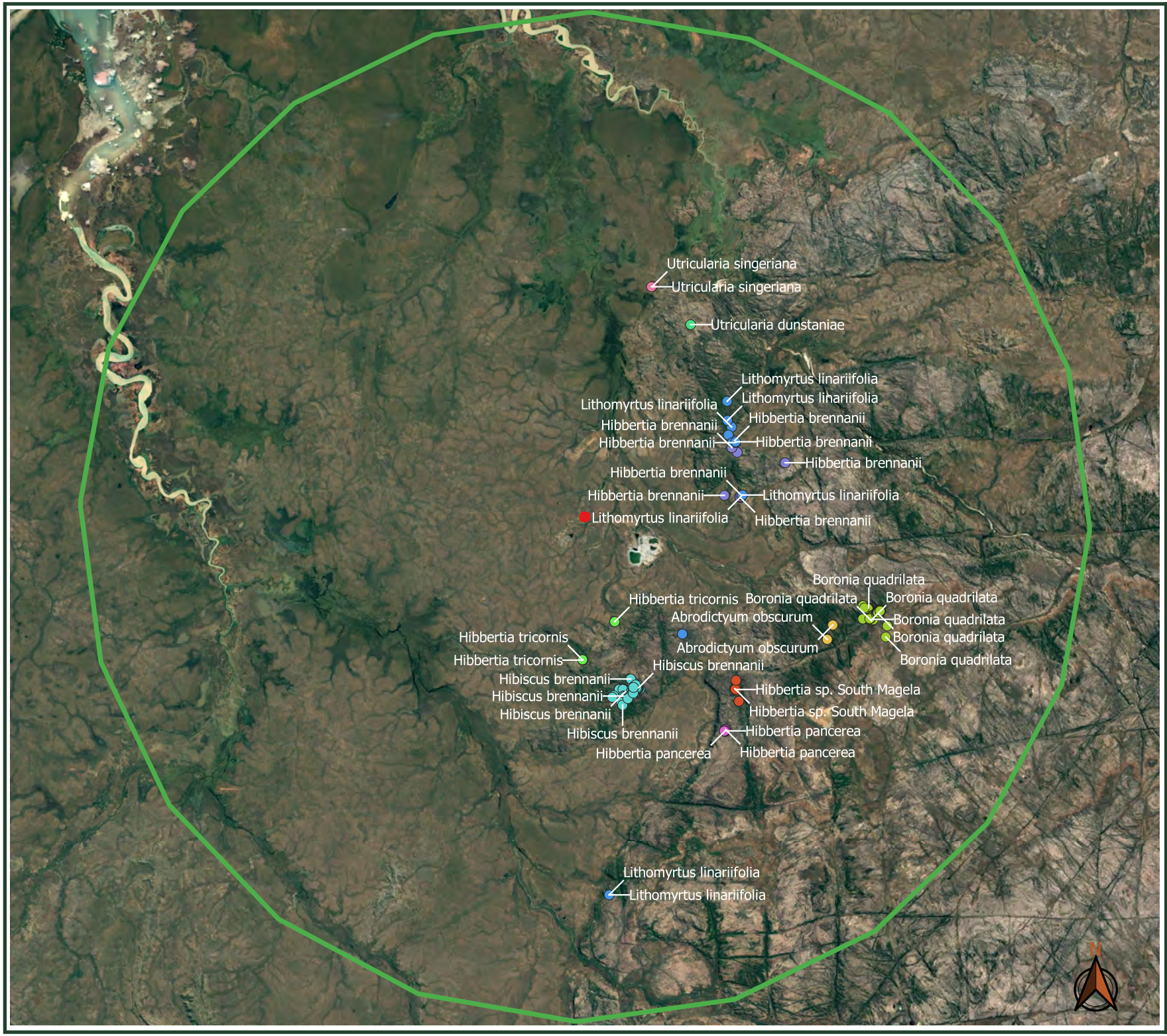

Figure 3 - Threatened flora recorded within 50 km of Lot 2303 (source: NT Flora Atlas)

Key

- Lot 2303
- 50 km buffer 2303

Threatened flora

- Abrodictyum obscurum
- Boronia quadrilata
- Hibbertia brennanii
- Hibbertia pancerea
- Hibbertia sp. South Magela
- Hibbertia tricornis
- Hibiscus brennanii
- Lithomyrtus linariifolia
- Utricularia dunstaniae
- Utricularia singeriana

Base layer: Google Satellite

0 10 20 km

1:500000

GDA94, zone 53
Date: 29 September 2020

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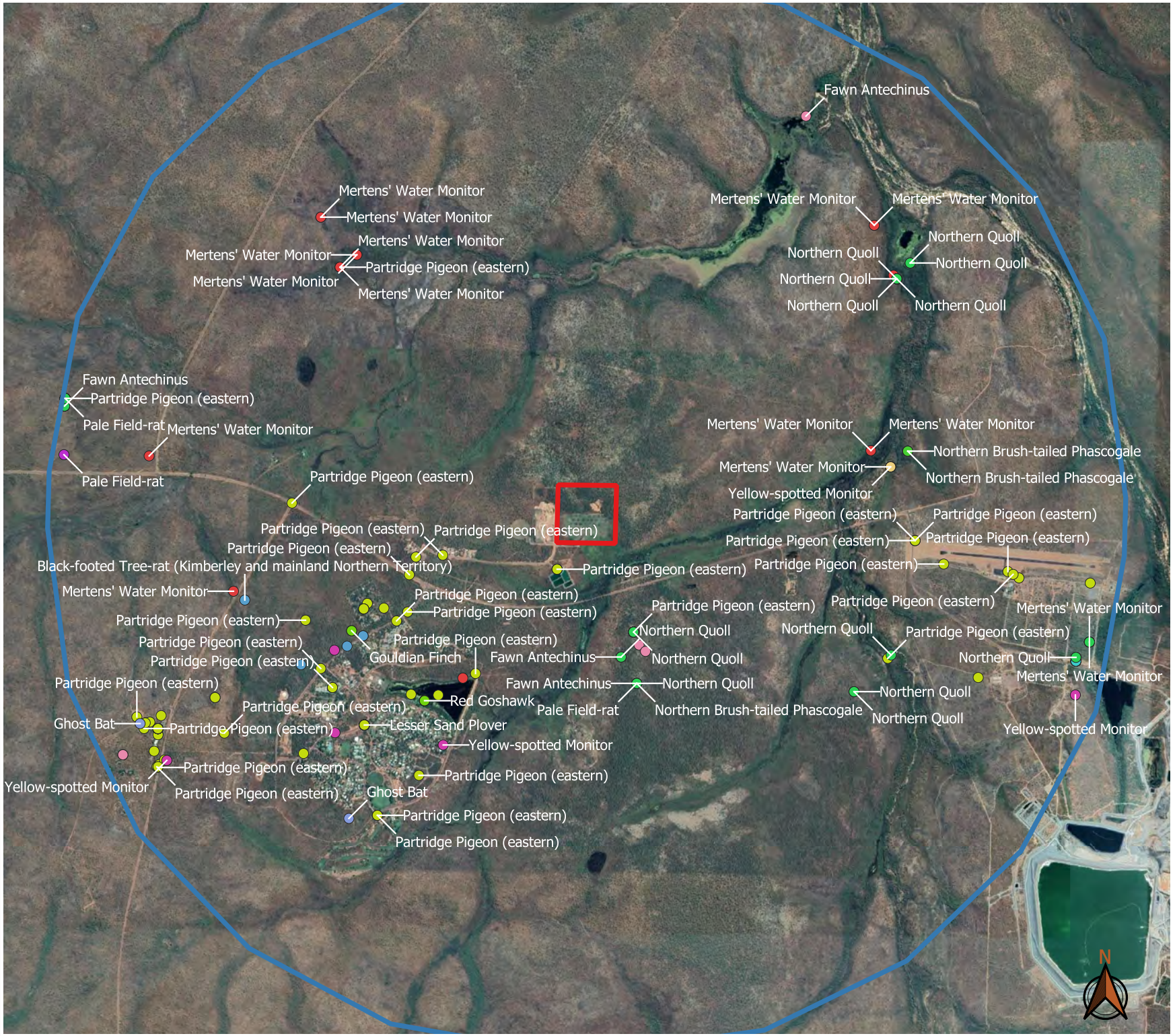

Figure 4 - Threatened fauna recorded within 5 km of Lot 2303 (source: NT Fauna Atlas)

Key

- Lot 2303
- 5 km buffer 2303

Threatened fauna

- Black-footed Tree-rat
- Brush-tailed Rabbit-rat
- Fawn Antechinus
- Ghost Bat
- Gouldian Finch
- Lesser Sand Plover
- Mertens' Water Monitor
- Mitchell's Water Monitor
- Northern Brush-tailed Phascogale
- Northern Quoll
- Pale Field-rat
- Partridge Pigeon (eastern)
- Plains Death Adder
- Red Goshawk
- Yellow-spotted Monitor

0 1000 2000 m

1:50000

GDA94, zone 53

Date: 29 September 2020

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4.7 Migratory Species

The EPBC Act PMST identifies 22 migratory species (as listed under the EPBC Act) as potentially occurring within the vicinity of Lot 2303 (**Appendix C**). The likelihood of these species occurring within or utilising Lot 2303 is discussed further in **Section 6**.

4.8 Weeds

Declared weeds are plants that have been identified for control, eradication, or prevention of entry into the NT under the NT's *Weeds Management Act* 2001 (WM Act). They are classed according to how difficult they are to control and how much harm they can cause. If a weed is declared under the WM Act, all landholders, land managers and land users must comply with the classification. There are three categories of declared weeds:

1. A - to be eradicated.
2. B - growth and spread to be controlled.
3. C - not to be introduced to the NT.

All Class A and Class B weeds are also Class C weeds.

Weeds of National Significance (WONS) are those listed by the Australian Government as plants that potentially cause detrimental impacts worth billions of dollars to the sustainability of Australia's productive capacity and natural ecosystems and as such a National Weeds Strategy exists for them.

A search of the NT Flora Atlas indicated that there are 64 weed species known to occur within 5 km of Lot 2303, of which nine are declared under the NT WM Act (**Table 5**). This information is used to inform the condition of habitat in Lot 2303 and the potential for threatened species to occur.

Table 5 Weeds recorded within 5 km of Lot 2303 (source: NT Flora Atlas)

Scientific name	Common name	Declared weed	WONS
Alysicarpus ovalifolius	Buffalo Clover	No	No
Amaranthus viridis	Amaranthus, Green Amaranth	No	No
Andropogon gayanus	Gamba Grass	Yes	Yes
Axonopus compressus	Axonopus	No	No
Bothriochloa pertusa	Bothriochloa, Indian Bluegrass	No	No
Calopogonium mucunoides	Calopo	No	No
Cenchrus ciliaris	Buffel Grass	No	No
Cenchrus echinatus	Mossman River Grass	B	No
Cenchrus pedicellatus	Annual Mission Grass	No	No
Cenchrus polystachios	Perennial Mission Grass	B	No
Centrosema molle	Centro	No	No
Chloris barbata	Chloris, Purple-top Chloris, Purple-top Rhodes Grass	No	No
Chrysopogon aciculatus	Chrysopogon	No	No
Crotalaria goreensis	Rattlepod	No	No
Cyanthillium cinereum var. cinereum	-	No	No

Scientific name	Common name	Declared weed	WONS
Cynodon dactylon var. dactylon	Bermuda Grass	No	No
Cyperus involucratus	Cyperus, Umbrella Sedge, Nutgrass	No	No
Dactyloctenium aegyptium	Coast Button Grass	No	No
Desmodium tortuosum	Desmodium	No	No
Desmodium triflorum	Desmodium	No	No
Digitaria bicornis	Finger Grass	No	No
Digitaria ciliaris	Digitaria, Summer Grass	No	No
Eleusine indica	Crowsfoot Grass	No	No
Euphorbia heterophylla	Euphorbia, Painted Spurge	No	No
Euphorbia hirta	Euphorbia, Asthma Plant, Asthma Herb, Snake Weed	No	No
Gomphrena celosioides	Gomphrena	No	No
Grewia asiatica	Grewia	No	No
Hemigraphis alternata	-	No	No
Hibiscus sabdariffa	Rosella	No	No
Ipomoea pes-tigridis	Ipomoea	No	No
Ipomoea quamoclit	Ipomoea	No	No
Ipomoea triloba	Ipomoea	No	No
Khaya senegalensis	African Mahogany	No	No
Macroptilium atropurpureum	Macroptilium, Siratro	No	No
Macroptilium lathyroides var. semierectum	Macroptilium, Phasey Bean	No	No
Malachra fasciata	Malachra	No	No
Megathyrsus maximus	Guinea Grass	No	No
Melinis repens	Red Natal Grass	No	No
Merremia dissecta	White Convolvulus Creeper	No	No
Mesosphaerum suaveolens	Hyptis, Hyptis, Mint Weed	B	No
Mitracarpus hirtus	Mitracarpus	No	No
Mollugo pentaphylla	Mollugo	No	No
Paspalum plicatulum	Paspalum	No	No
Passiflora foetida	Passiflora, Wild Passionfruit, Stinking Passion Flower, Stinking Passionfruit	No	No
Phyllanthus amarus	Phyllanthus	No	No
Portulaca pilosa subsp. pilosa	Pigweed	No	No
Ruellia tuberosa	Ruellia	No	No
Salvinia molesta	Salvinia	No	No

Scientific name	Common name	Declared weed	WONS
Senna occidentalis	Coffee Senna	B	No
Setaria sphacelata	Setaria	No	No
Sida acuta	Sida, Spiny-head Sida	B	No
Sida cordifolia	Flannel Weed	B	No
Sida rhombifolia	Sida, Paddy Lucerne	B	No
Sporobolus africanus	Rat-tail Grass	No	No
Sporobolus fertilis	-	No	No
Stachytarpheta cayennensis	Snakeweed	B	No
Stylosanthes hamata	Stylosanthes, Verano Stylo, Verano, Carribbean Stylo, Stylo	No	No
Stylosanthes scabra	Shrubby Stylo	No	No
Stylosanthes viscosa	Stylo	No	No
Themeda quadrivalvis	Themeda, Grader Grass	B	No
Trianthema portulacastrum	Trianthema, Giant Pigweed, Black Pigweed	No	No
Tridax procumbens	Tridax, Tridax Daisy	No	No
Triumfetta rhomboidea	Triumfetta	No	No
Urochloa mosambicensis	Urochloa, Sabi Grass	No	No

4.9 Feral animals

A search of the NT Fauna Atlas revealed six feral animals that have been recorded within 5 km of Lot 2303 (**Table 6**, **Figure 5**). One notable absence is the Cat (*Felis catus*), which is known to occur across the top end of the NT.

Table 6 Introduced animals recorded within 5 km of Lot 2303 (source: NT Fauna Atlas)

Scientific name	Common name	**No. records**	Most recent record
Hemidactylus frenatus	Asian House Gecko	13	2018
Rhinella marina	Cane Toad	2	2018
Bos taurus	Cattle	3	1983
Indotyphlops braminus	Flower-pot Blind Snake	3	2018
Sus scrofa	Pig	21	2003
Bubalus bubalis	Swamp Buffalo	9	2003

Figure 5 - Introduced fauna species recorded within 5 km of Lot 2303 (data source: NT Fauna Atlas)

Key

- Lot 2303
- 5 km buffer 2303

Introduced fauna

- Asian House Gecko
- Cane Toad
- Cattle
- Flower-pot Blind Snake
- Pig
- Swamp Buffalo

Base layer: Google Satellite

0 1000 2000 m

1:50000

GDA94, zone 53

Date: 29 September 2020

CONNECT environmental

4.10 Fire History

The fire frequencies and average timing of burns from 2000 to 2019 (total of 20 years) at three locations in relation to Lot 2303 were tabulated using data from the North Australia and Rangelands Fire Information service (NAFI, 2020) (**Table 7**).

Changed fire regimes in the top end are implicated in several species' declines over the last 50 to 100 years. Across Australia, it is thought that some 50 bird species and their habitats are threatened by poor fire management (Olsen & Weston, 2005). In general, high frequency and intensity fires have been shown to reduce vegetation diversity and complexity in all strata. For example, in sub-tropical eucalypt woodlands in Queensland, areas that burnt more than every four years were more open and contained less species richness than areas experiencing less frequent fires (Burgess *et al*., 2013). In such areas where there is a simpler structure of trees and grass, birds such as butcherbirds, kingfishers, and Red-backed Fairy-wrens are more abundant. In contrast, less burnt pastoral areas in northern Australia have increased densities and extents of vegetation, which favours birds such as White-throated Honeyeater, Dusky Honeyeater, White-gaped Honeyeater, Northern Fantail, Weebill, Lemon-bellied Flycatcher and Bar-shouldered Dove (Woinarski, J. in Olsen & Weston, 2005).

There are different short-term biodiversity responses to fire too. For example, Partridge Pigeons nest on the ground in the early dry season, and any early season burns are likely to destroy their nests (Woinarski, J. in Olsen & Weston, 2005). Conversely, burnt areas provide additional food resources for Partridge Pigeons (Woinarski, J. in Olsen & Weston, 2005).

Table 7 Frequency and timing of fire in Lot 2303, 1 km north of Lot 2303 and Lot 979 (in Jabiru) from 2000 to 2019

Year	Lot 2303		1 km north of Lot 2303		Lot 979[3]	
	Burnt (Y/N)[4]	Month burnt	Burnt (Y/N)[4]	Month burnt	Burnt (Y/N)[3]	Month burnt
2000	N	-	Y	June	N	-
2001	Y	June	Y	June	N	-
2002	Y	May	Y	June	N	-
2003	N	-	N	-	N	-
2004	Y	August	Y	August	N	-
2005	Y	July	Y	July	Y	June
2006	N	-	Y	June	Y	June
2007	N	-	N	-	N	-
2008	Y	May	Y	May	N	-
2009	Y	July	Y	July	N	-
2010	N	-	Y	September	N	-
2011	Y	July	Y	June	N	-
2012	Y	August	Y	August	N	-
2013	Y	June	Y	August	N	-

[3] *On The western side of the Jabiru township*

[4] *The site is considered burnt or not if most of the site shows as burnt in fire scar mapping for that year.*

Year	Lot 2303		1 km north of Lot 2303		Lot 979[3]	
	Burnt (Y/N)[4]	Month burnt	Burnt (Y/N)[4]	Month burnt	Burnt (Y/N)[3]	Month burnt
2014	Y	September	Y	June	N	-
2015	N	-	Y	July	N	-
2016	Y	August	Y	August	N	-
2017	Y	August	Y	June	N	-
2018	Y	September	Y	June	N	-
2019	Y	August	Y	August	Y	June
No. times burnt 2000-2019 (20 yrs)	-	14	-	18	-	3
No. times burnt 2010-2019 (10 yrs)	-	8	-	10	-	1
Average timing 2000-2019 (20 yrs)[5]	-	Early August	-	Late July	-	June
Average timing 2010-2019 (10 yrs)[5]	-	Late August	-	Early August	-	June

[5] *Using a weighted average*

5 Reconnaissance Survey (Lot 2303)

5.1 Procedure

A reconnaissance survey was conducted in Lot 2303 on 22 June 2020, between 9.00 am and 10.30 am, within the northern sections of woodland within Lot 2303[6], with the aim of:

- Conducting a series of vegetation 'check sites' which involve documenting a vegetation community's main species composition (i.e., 1-3 species) and the structural formation of the dominant layer (through estimates of the canopy cover and height class). Observations of geology, soils and landform are included, where relevant.
- Noting any obvious human-induced impacts on Lot 2303, with focus on the likelihood of the presence of threatened and migratory fauna.
- Recording any significant environmental weeds observed.
- Assessing the presence of suitable habitat for potentially occurring threatened species identified during steps 1-3 (above) including general vegetation structure and health, value as habitat for significant species, and threatening processes such as fire, weeds, and pests with a focus on:
  - Tall open eucalypt forest and/or riparian areas for the Partridge Pigeon and Masked Owl.
  - The abundance and diversity of mid-storey and ground vegetation, and complexity of ground woody debris (e.g., fallen logs) for Fawn Antechinus, Northern Quoll and Black-footed Tree-rat.
  - Seasonally saturated area (if any) for Pale Field-rat.
- Recording all fauna species incidentally observed.

Systematic habitat and/or vegetation assessments were not conducted and, as such, descriptions of densities or diversity are estimations only.

5.2 Results

5.2.1 Vegetation Types and Soils

Vegetation in the woodland consisted almost entirely of *Eucalyptus miniata*, *E. tetrodonta*, *Erythrophleum chlorostachys* mid open forest over *Livistona humilis*, *Terminalia ferdinandiana*, *Acacia platycarpa* (unconfirmed[7]) low sparse shrubland over mixed tall tussock grassland. *Pandanus spiralis* was observed very occasionally in the eastern half of Lot 2303. A moderate shrubby later existed across much of the woodland. An approximate 50 m stretch from north to south in the western half of the woodland was observed to contain younger *E. tetrodonta* trees (to 8 m) (refer to **Figure 7**) in satellite imagery (see sparsely vegetated area with patches of white surface). There was also a cleared area of about 60 m x 20 m in the south-eastern part of the woodland, along the southern border. It was devoid of trees or shrubs. Soils across the woodland mostly consisted of a white sand with a moderate cover of surface lateritic gravel (**Figure 8**).

[6] *At that stage, the scope of works was limited to the northern half of Lot 2303 only. After this, the scope of works was revised to include the entire parcel.*

[7] *No individuals of the detected plants had reproductive parts for which to identify to species level, though some attributes suggested it was A. platycarpa.*

5.2.2 Disturbances

The woodland appeared to be in relatively good ecological condition though contained scattered windblown rubbish along the western margin. The site is immediately north-east of the Jabiru Waste Disposal Facility. A fence line and tracks bordered the northern, western, and eastern boundaries of the woodland with a 4-6 m vehicle track on either side of the fence. Several tracks and a quarry were observed within the woodland (**Figure 9**).

5.2.3 Weeds

Two weeds were observed along the tracks at the transition to the irrigated grassland during the reconnaissance survey - Hyptis (*Hyptis suaveolens*) and Annual Mission Grass (*Cenchrus pedicellatus*). Other weeds, including Guinea Grass, were observed to the south around the irrigated grassland. An inventory was not produced as it was outside the proposed footprint (and scope of works for the assessment).

5.2.4 Fauna Observations

Observations of the evidence of fauna included:

- Dog prints observed along internal tracks.
- An unidentified medium sized mammal scuttled away from a grassy patch, although is expected to be a Northern Brown Bandicoot given the micro-habitat characteristics at that location.
- Torresian Crows and Black Kites were noted close to the landfill (within the woodland).
- Birds heard or observed included Bar-shouldered Dove, Red-tailed Black Cockatoo, Striated Pardalote and Mistletoebird (noting that a dedicated bird survey was not conducted, and the reconnaissance survey was conducted during a period of the day that is typically 'quieter' for bird activity).
- A Black Kite nest was located on the southern edge of the woodland (near the irrigated grassland).

5.2.5 Threatened Species Habitats

The primary objective of the reconnaissance survey was to characterise habitats on site for potentially occurring threatened species, based on the results of the initial desktop literature review. Individual characteristics of key habitat features for each species was observed for, such as woody ground debris (e.g., logs), the diversity and density of vegetation in each stratum, dominant flora species, the presence of hollow-bearing trees and their approximate sizes (including hollows), soils, and disturbances. This information was used to re-assess the potential for these threatened species to occur on site. As such, the likelihood of occurrence assessment in **Appendix A** was reviewed and revised with a summary of results presented in **Section 6**. Relevant habitat characteristics are described where necessary in **Appendix A** and the associated parts of this document, with key observations being:

- Lot 2303 appeared to be in relatively good ecological condition with a good diversity of upper, mid, and ground storey vegetation.
- Hollow bearing trees were scattered throughout Lot 2303, to a maximum height of approximately 20 m and diameter at breast heights of up to approximately 50 cm.
- Occasional logs were observed with very few exceeding 15 cm diameter, though very occasionally, logs with a diameter of approximately 30 cm were noted.
- The condition, diversity, and density of vegetation within Lot 2303 are expected to support threatened species such as Black-footed Tree-rats and Partridge Pigeons. However, a paucity of coarse woody ground debris containing adequate shelter habitat suggests that threatened small mammals such as the Fawn Antechinus are unlikely to occur there. This is further discussed for each species within the full likelihood of occurrence assessment in **Appendix A**, and summarised in **Section 6**.

Figure 6 E. miniata / E. tetrodonta woodland in the northern half of Lot 2303

Figure 7 Apparent regeneration along a 50 m strip within the western half of the woodland

Figure 8 Lateritic surface gravel (often over white sands), typically observed across the woodland

Figure 9 A track within the woodland

6 Preliminary Likelihood of Occurrence Assessment

6.1 Procedure

An assessment of the likelihood of occurrence of threatened and migratory species was conducted for Lot 2303 by:

1. Interrogating relevant information sources to obtain a list of potentially occurring threatened and migratory species for the area (including an appropriate geographic buffer), including:
    a. The NT Government's Flora and Fauna Atlases
    b. The Australian Government's EPBC Act 'Protected Matters Search Tool'
    c. Any publicly available environmental assessment documentation for nearby areas / projects.
2. Describing each species' conservation status, habitat preferences and number of records within an appropriate distance of the target site.
3. Analysing each species' habitat preferences and number of local records (as an indicator of the species' historic presence) against the vegetation mapping, land unit mapping, aerial imagery, or fire history (described in **Section 4.6**) to determine each species' likelihood of occurrence.
4. Collating and interpreting data and information collected during the reconnaissance survey on 22 June 2020.
5. Categorising each species into the following likelihood of occurrence classes:
    a. **Unlikely**: species or ecological community is not expected to occur on Lot 2303 based on the apparent lack of suitable habitat and/or local records
    b. **Possible**: species or ecological community may occur on Lot 2303 based on the occasional or potential presence of suitable habitat, however there is no obvious indication of this
    c. **Likely**: species or ecological community is expected to occur on Lot 2303 based on the apparent presence of suitable habitat and number / proximity of local records.

6.2 Attributes Assessed

All threatened flora recorded within 50 km of Lot 2303, and all threatened fauna within 5 km, utilising the NT Flora and Fauna Atlases, and contained within the EPBC Act Protected Matters Search Tool (**Appendix C**) have been included in this likelihood of occurrence assessment. No threatened flora is listed in the NT Flora Atlas as occurring within 5 km of Lot 2303.

A buffer of 50 km for flora was considered appropriate for this project because it satisfactorily characterised local and regional abundance and distributions of threatened species and adequately capture the potential for these species to exist in Lot 2303.

For fauna, a smaller buffer was utilised (5 km) given the number of records that existed, however all records within 50 km were analysed where relevant to aid in determining the potential for any of the species.

Threatened ecological communities were included in the search.

Threatened migratory shorebirds that are unlikely to occur inland and marine animals have been excluded from this assessment, even though records of them may exist within 50 km of Lot 2303. Analysis of vegetation mapping and aerial imagery indicates that no suitable habitat exists.

6.3 Results

A total of ten threatened flora, 34 threatened fauna and six migratory fauna species were preliminarily assessed for their likelihood of occurrence within Lot 2303. Refer to **Appendix A** for complete results. A summary is provided in **Table 8** and **Table 9**.

No threatened ecological communities listed under the EPBC Act were identified as potentially occurring in the area (see EPBC Act PMST report in **Appendix C**).

Table 8 Threatened species likelihood of occurrence (preliminary assessment)

Scientific Name	Common Name	Threatened status (NT / National)		Likelihood of occurrence (preliminary)
		TPWC Act	EPBC Act	
Plants				
Cephalomanes obscurum	Cephalomanes	Endangered	Not listed	Unlikely
Boronia quadrilata	Boronia	Vulnerable	Vulnerable	
Hibbertia brennanii	Hibbertia	Vulnerable	Not listed	
Hibbertia pancerea	Hibbertia	Vulnerable	Not listed	
Hibbertia sp. South Magela	Hibbertia	Vulnerable	Not listed	
Hibbertia tricornis	Hibbertia	Vulnerable	Not listed	
Hibiscus brennanii	Hibiscus	Vulnerable	Vulnerable	
Lithomyrtus linariifolia	Lithomyrtus	Vulnerable	Not listed	
Utricularia dunstaniae	Bladderwort	Vulnerable	Not listed	
Utricularia singeriana	Bladderwort	Vulnerable	Not listed	
Birds				
Amytornis woodwardi	White-throated Grasswren	Vulnerable	Vulnerable	Unlikely
Calidris ferruginea	Curlew Sandpiper	Vulnerable	Critically Endangered	
Calidris tenuirostris	Great Knot	Vulnerable	Critically Endangered	
Charadrius leschenaultii	Greater Sand Plover	Vulnerable	Vulnerable	
Charadrius mongolus	Lesser Sand Plover	Vulnerable	Critically endangered	
Epthianura crocea tunneyi	Yellow Chat	Endangered	Endangered	
Erythrotriorchis radiatus	Red Goshawk	Vulnerable	Vulnerable	
Falco hypoleucus	Grey Falcon	Vulnerable	Not listed	
Limosa lapponica	Bar-tailed Godwit	Vulnerable	Not listed	
Numenius madagascariensis	Far Eastern Curlew	Vulnerable	Critically endangered	
Rostralata australis	Australian Painted Snipe	Vulnerable	Endangered	
Erythrura gouldiae	Gouldian Finch	Vulnerable	Endangered	Possible

Scientific Name	Common Name	Threatened status (NT / National)		Likelihood of occurrence (preliminary)
		TPWC Act	EPBC Act	
Geophaps smithii	Partridge Pigeon	Vulnerable	Vulnerable	
Falcunculus frontatus whitei	Crested Shrike-tit	Not listed	Vulnerable	Possible
Tyto novaehollandiae kimberli	Masked Owl	Vulnerable	Vulnerable	
Mammals				
Conilurus penicillatus	Brush-tailed Rabbit-rat	Endangered	Vulnerable	Unlikely
Hipposideros inornatus	Arnhem Leaf-nosed Bat	Vulnerable	Endangered	
Hipposideros stenotis	Northern Leaf-nosed Bat	Vulnerable	Not listed	
Macroderma gigas	Ghost Bat	Near Threatened	Vulnerable	
Petrogale concinna canescens	Nabarlek	Vulnerable	Endangered	
Saccolaimus saccolaimus	Bare-rumped Sheath-tailed Bat	Data Deficient	Vulnerable	
Xeromys myoides	Water Mouse, False Water Rat	Not listed	Vulnerable	
Zyzomys maini	Arnhem Rock-rat	Vulnerable	Vulnerable	
Antechinus bellus	Fawn Antechinus	Endangered	Vulnerable	Possible
Dasyurus hallucatus	Northern Quoll	Critically Endangered	Endangered	
Phascogale pirata	Northern Brush-tailed Phascogale	Endangered	Vulnerable	
Rattus tunneyi	Pale Field-rat	Vulnerable	Not listed	
Mesembriomys gouldii gouldii	Black-footed Tree-rat	Vulnerable	Endangered	Likely
Reptiles				
Acanthopsis hawkei	Plains Death Adder	Vulnerable	Vulnerable	Unlikely
Bellatorias obiri	Arnhem Land Egernia	Endangered	Endangered	
Morelia oenpelliensis	Oenpelli Python	Vulnerable	Not listed	
Varanus mitchelli	Mitchells Water Monitor	Vulnerable	Not listed	
Varanus mertensi	Mertens' Water Monitor	Vulnerable	Not listed	Possible
Varanus panoptes	Yellow-spotted Monitor	Vulnerable	Not listed	

Table 9 Migratory species likelihood of occurrence (preliminary assessment)

Scientific Name	Common Name	Threatened status (NT / National)		Likelihood of occurrence (preliminary)
		TPWC Act	EPBC Act	
Motacilla cinerea	Grey Wagtail	Not listed	Marine, Migratory	Unlikely
Rhipidura rufifrons	Rufous Fantail	Not listed	Marine, Migratory	
Cecropis daurica	Red-rumped Swallow	Not listed	Marine, Migratory	Possible
Cuculus optatus	Oriental Cuckoo	Not listed	Migratory	
Hirundo rustica	Barn Swallow	Not listed	Marine, Migratory	
Motacilla flava	Yellow Wagtail	Not listed	Marine, Migratory	

7 Preliminary Assessment of Inherent Risks

7.1 Threatened Species

7.1.1 Significant Impact Definitions

Potentially occurring threatened species, as listed in **Section 6**, comprise 11 critically endangered, endangered and/or vulnerable species. Critically endangered and endangered species are assessed differently to vulnerable species in the *EPBC Act Significant Impact Guidelines* (DoE, 2013). The criteria used to assess critically endangered, endangered, or vulnerable species are listed in these guidelines. DoE (2013) also defines habitat critical to the survival of a species.

7.1.2 Consequence Levels of Unmitigated Impacts

A preliminary assessment of the level of potential inherent impact to the 11 potentially occurring species was conducted to determine whether further surveys and/or assessment is required for each species. It is specifically related to those species determined to be 'possible' or 'likely' to occur in Lot 2303 (**Section 6**). It considers *inherent* risks only (i.e., pre-mitigation). Potential impacts are listed in **Table 10**. Definitions for the consequence of impacts are in **Table 11** and are taken from the Species Expert Assessment Plan (SEAP) Manual (TSSC, 2015). The results of the preliminary assessment of inherent risks are in **Table 12**.

Species with ratings of 'insignificant' (and no greater) are unlikely to require on-ground surveys to determine their presence and/or distribution. Such potential impacts are considered acceptable and covered by current legislation and management. Where potential impacts are determined to be 'minor' or greater, further analyses is warranted, potentially including surveys.

The assessed risk may change following the on-site surveys once the true abundance of relevant species and potentially suitable habitat is better understood. Risk is re-assessed in **Section 11** following the surveys and interpretation of survey data.

Table 10 Potential impacts on biodiversity as a result of development of Lot 2303

Potential impact	During construction (immediate)	Residual (long-term)
Loss of approximately 14 ha of woodland habitat	✓	✓
Introduction or spread of weeds	✓	✓
Dust emissions resulting in reduced air quality, smothering of adjacent vegetation (and flow-on effects to fauna) and public nuisance	✓	
Noise	✓	✓
Erosion and sedimentation	✓	✓
Altered storm water flows	✓	✓
Fire (i.e., accidental or deliberate ignition of vegetation)	✓	
Hydrocarbons and/or hazardous materials spills resulting in reduced water or soil quality	✓	✓
Inappropriate waste disposal.	✓	✓

Table 11 Impact consequence definitions for threatened species (TSSC, 2015)

Consequence	Insignificant	Minor	Moderate	Major	Critical
Impact on population[3]	Minimal impact on local population numbers; area affected negligible compared to total population; minimal or acceptable impact on population size	Minor impact on local population numbers. Population in other locations not impacted	Moderate impact on local population numbers. Some impacts on populations in other locations; moderate and/or short-term effects	Major population reduction or loss of local population; recovery measure in years to decades; serious and significant impact on species	Population reduction which may results in species extinction; recovery period is greater than decades; very significant and serious impact on high value species
Fragmentation of habitat / loss of habitat connectivity / reduce the areas of occupancy[4]	Minimal losses of local habitat only, recovery likely in a relatively short period of time; threats are covered by current management or legislation	Minor losses of local habitat requiring recovery over short term	Moderate loss of local habitat requiring recovery over a short to medium term and resulting in loss of connectivity between habitats at a local scale	Loss of local habitat with no potential for recovery, or partial loss of habitat across large areas and/or with limited potential for recovery in the medium to long term. Results in a net reduction in connectivity over a large area	Complete loss of local habitat with no potential for recovery and loss of habitat in other locations with limited potential for recovery in the long-term resulting in a significant impact on habitat connectivity over a large area
Impact on the habitat critical to the survival of the species[5]	Minimal modification, destruction, removal or decrease of local habitat only, recovery likely in a relatively short period of time; insignificant impact to habitat or threat activity only occurs in a very small area of habitat; limited damage to minimal area of low significance; minor effects on physical environment	Minor modification, destruction, removal or decrease of local habitat requiring recovery over short term	Moderate modification, destruction, removal or decrease of local habitat requiring recovery over a short to medium term and resulting in loss of connectivity between habitats at a local scale	Modification, destruction, removal or loss of local habitat with no potential for recovery, or partial loss of habitat across large areas and/or with limited potential for recovery in the medium to long term. Results in a net reduction in connectivity over a large area; habitat is affected which may endanger the species and habitat long term survival – 70-90% habitat affected or removed; 30% fragile habitat affected or removed; 10-20% critical habitat affected or removed;	Significant impact resulting in the removal, destruction, fragmentation, and degradation of habitat; the entire habitat is in danger of being affected or removed, that >90% habitat, >50% fragile habitat, and >30% critical habitat
Disruption to breeding cycle[6]	Minimal impact on any aspect of the breeding cycle;	Minor disruption to the breeding cycle	Moderate disruption to breeding cycle resulting in modification of behaviour both within the direct impact zone and at nearby locations; long term recruitment and/or population dynamics are not adversely impacted	Direct impacts on breeding cycle resulting in a net decline in size of the population; there is limited information to judge the impact	Complete disruption of breeding cycles over several seasons with significant population decline and possible extinction
Impact of invasive species and/or disease[7]	Minimal impact on local population numbers or habitat quality	Minor impact on local population numbers or habitat quality. Population in other locations not impacted	Moderate impact on local population numbers or habitat quality. Some impacts on populations in other locations	Major population reduction or loss of local population or loss of habitat quality	Population reduction which may results in species extinction loss of critical habitat extent or quality
Interaction with species migration	Minimal impact on species migratory patterns	Results in minor behavioural modification on a local scale or impacts to physical conditions of animal interfering with migration for the short term only. Unlikely to negatively impact on the overall success of migration	Results in modification of behaviour or animal conditions such that there is potential for medium term impacts, with some possibility of individuals failing to complete migration	Results in modification of behaviour or animal condition such that there is potential for medium to long term impacts, both locally and in nearby locations, with some individuals failing to complete migration	Significant impact resulting in either complete failure, or failure of majority of individuals, to complete migration in that cycle

[3] Refers to the proportional changes to the numbers of individuals; change in the size of the population

[4] Refers to the physical destruction of the species habitat and/or chemical or physical barriers

[5]Refers to species habitat resource includes modify, destroy, isolate or decrease the availability or quality of habitat

[6]Breeding cycle including activities associated with breeding (mating, gestation, nesting). Assessment assumes that the species is present in the affected area during the breeding cycle

[7]Refers to the invasive species that is harmful to the species becoming established in the species habitat and introduced disease that may cause the species to decline

Table 12 Preliminary assessment of inherent risk level (orange shading indicates the species that will be the focus of site assessment / survey)

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[8] (bold shows greatest level)				
			Population	Habitat connectivity	Critical habitat[9]	Breeding cycle	Invasive species
Threatened Birds							
Erythrura gouldiae	Gouldian Finch	NT: Vulnerable; Nat: Endangered	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Geophaps smithii	Partridge Pigeon	NT: Vulnerable; Nat: Vulnerable	Insignificant	Insignificant	**Minor**	Insignificant	Insignificant
Falcunculus frontatus whitei	Crested Shrike-tit	NT: Not listed; Nat: Endangered	Insignificant	Insignificant	**Minor**	Insignificant	Insignificant
Tyto novaehollandiae kimberli	Masked Owl	NT: Vulnerable; Nat.: Vulnerable	**Minor**	Insignificant	**Minor**	**Minor**	**Minor**
Threatened Mammals							
Antechinus bellus	Fawn Antechinus	NT: Endangered; Nat.: Vulnerable	**Minor**	Insignificant	**Minor**	**Minor**	**Minor**
Dasyurus hallucatus	Northern Quoll	NT: Critically Endangered; Nat.: Endangered	**Minor**	Insignificant	**Minor**	**Minor**	**Minor**
Mesembriomys gouldii gouldii	Black-footed Tree-rat	NT: Vulnerable; Nat: Endangered	**Moderate**	**Minor**	**Minor**	**Minor**	**Minor**

[8] *That is, if a population of the species occurs on Lot 2303, what is the anticipated level of impact to each aspect listed in **Table 7**?*

[9] *As defined in the EPBC Act Significant Impact Guidelines (DoE, 2013), regardless of whether they are listed under the EPBC Act or the TPWC Act*

Scientific Name	Common Name	Conservation status (NT / National)	Maximum level of potential impact[8] (bold shows greatest level)				
			Population	Habitat connectivity	Critical habitat[9]	Breeding cycle	Invasive species
Phascogale pirata	Northern Brush-tailed Phascogale	NT: Endangered; Nat.: Vulnerable	**Minor**	Insignificant	**Minor**	**Minor**	**Minor**
Rattus tunneyi	Pale Field-rat	NT: Vulnerable; Nat.: Not listed	**Minor**[10]	Insignificant	Insignificant	Insignificant	Insignificant
Threatened Reptiles							
Varanus mertensi	Merten's Water Monitor	NT: Vulnerable; Nat.: Not listed	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Varanus panoptes	Floodplain Monitor	NT: Vulnerable; Nat.: Not listed	Insignificant	Insignificant	**Minor**[11]	Insignificant	Insignificant

[10] *At present, it is unknown whether a population occupies the dense grasslands in the southern half of Lot 2303, therefore a conservative approach is taken until further data is collected.*

[11] *It is unclear how the irrigated grassland habitat influences populations of fauna, therefore a conservative approach is taken until further data is collected. For the Floodplain Monitor, the irrigated grassland could be extensively used or relied upon (as there are likely to be an increased number of reptiles or amphibians, compared with an un-irrigated area).*

7.2 Migratory Species

Four migratory species have the potential to occur within Lot 2303 (as assessed in **Section 6**):

- Red-rumped Swallow
- Oriental Cuckoo
- Barn Swallow
- Yellow Wagtail.

7.2.1 Significant Impact Definitions

The *EPBC Act Significant Impact Guidelines* (DoE, 2013) identifies the criteria to determine whether an action is likely to have a significant impact on a migratory species, and what constitutes 'important habitat'. These criteria and definitions are discussed in the next section.

7.2.2 Assessment of Important Habitat

Lot 2303 is unlikely to contain important habitat for any of the four potentially occurring migratory species, as assessed in **Table 13**.

Table 13 Assessment of 'important habitat' for the four potentially occurring migratory species

Criteria	Red-rumped Swallow	Oriental Cuckoo	Barn Swallow	Yellow Wagtail
Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or	**Unlikely** Most records in Australia are around Cairns, the Gulf of Carpentaria, Darwin and Broome (DoE, 2015), with no records within 50 km of Lot 2303 (according to the NT Fauna Atlas). The species only sporadically migrates to Australia, and, subsequently, in some years it is not recorded in Australia.	**Unlikely** The Oriental Cuckoo is relatively wide-ranging in the NT (DoE, 2015) and the NT Fauna Atlas contains a total of only 390 records of the species across the whole NT, dating back to 1948. Sixty of these records are within 50 km of Lot 2303. Given the global population is estimated at over 20 million, it is unlikely that the region supports an ecologically significant proportion of it.	**Unlikely** Only a small number of Barn Swallows regularly migrate to northern Australia, with the global population estimated to be greater than 190 million (DoE, 2015). Most records in the NT are around Darwin, with no records within 50 km of Lot 2303 (according to the NT Fauna Atlas).	**Unlikely** No records of the species are shown in the NT Fauna as being within 50 km of Lot 2303, even though it is a regular wet season visitor to northern Australia, flocks of up to approximately 50 individuals have been recorded and the global population is estimated to be 48-168 million (DoE, 2015).
Habitat that is of critical importance to the species at particular life-cycle stages, and/or	**Unlikely** The suitable habitat within Lot 2303 (irrigated grassland) is unlikely to be of critical importance to the species given that there are no records within 50 km and the species only sporadically migrates to (DoE, 2015).	**Unlikely** The habitat within Lot 2303 is unlikely to be critical to a particular life-cycle stage for the species, given its location (i.e. adjacent to a landfill), condition and size.	**Unlikely** The suitable habitat within Lot 2303 (irrigated grassland) is unlikely to be of critical importance to the species given that there are no records within 50 km and only a small number migrate to Australia (DoE, 2015).	**Unlikely** The suitable habitat within Lot 2303 (irrigated grassland) is unlikely to be of critical importance to the species given that there are no records within 50 km. Whilst the irrigated grasslands on site could be suitable habitat, the species typically requires areas that are near water. The closest waters to Lot 2303 appear to be the sewage ponds (approximately 400 m to the south-west) and a creek line approximately 500 m to the south-east.

Criteria	Red-rumped Swallow	Oriental Cuckoo	Barn Swallow	Yellow Wagtail
Habitat utilised by a migratory species which is at the limit of the species range, and/or	**Unlikely** The species migrates to areas across northern Australia, particularly around Cairns, Gulf of Carpentaria, Darwin and Broome.	**Unlikely** Lot 2303 is not at the limit of the range for the species. It occurs across northern Australia and southwards on the east coast as far as Newcastle (DoE, 2015).	**Unlikely** Of the small number of Barn Swallows that migrate to Australia, some are vagrants to southern Australia.	**Unlikely** The species is a regular visitor to northern Australia, with vagrants in the south (DoE, 2015).
Habitat within an area where the species is declining	**Unlikely** The IUCN classifies the species as 'least concern' and the *Action Plan for Australian Birds 2010* classifies it as a vagrant (DoE, 2015).	**Unlikely** While the global population has not been formally quantified, the IUCN has classified the species as 'least concern' and the *Action Plan for Australian Birds 2010* classifies it as 'non-threatened' (DoE, 2015).	**Unlikely** Both the IUCN and the *Action Plan for Australian Birds 2010* classify the species as 'least concern' (DoE, 2015).	**Unlikely** The IUCN classifies the species as 'least concern' and the *Action Plan for Australian Birds 2010* classifies it as 'non-threatened' (DoE, 2015).

7.2.3 Assessment of Significant Impact

The proposed development is unlikely to significantly impact any of the four potentially occurring migratory species, as discussed in **Table 13**. The assessment uses the criteria defined in the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (DoE, 2013).

As such, no migratory species is considered further in this report and no on-site surveys are necessary to ascertain their presence or absence there.

Table 14 Assessment of significant impact to the four potentially occurring migratory species

Criteria	Assessment
Is there a real chance or possibility that the proposed activity will:	
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	**Unlikely** Lot 2303 is not considered to constitute important habitat for any of the species (as discussed in **Section 7.2.2**). In addition, it is unlikely that the development of Lot 2303 will destroy or isolate any nearby important habitat, should it occur.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Unlikely** Lot 2303 is not considered to constitute important habitat for any of the species (as discussed in **Section 7.2.2**), and it is unlikely that the proposed development will result in an invasive species that is harmful to the species becoming established in any nearby important habitat, should it occur. There are already numerous exotic flora species in and around Lot 2303.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	**Unlikely** The proposed vegetation clearing is not likely to seriously disrupt an ecological significant proportion of the population of any of these four species, as it is not plausible that an ecologically significant proportion of the species would be found within or near to Lot 2303.

8 Survey Methodology

Two surveys were conducted:

1. 31 August to 29 September 2020 – Lot 2303
2. 12 November to 10 December 2020 – three parcels in Jabiru and in woodland to the north and east of Lot 2303.

8.1 Within Lot 2303

8.1.1 Objectives and Overview

As a result of the desktop literature review (**Section 4**), preliminary threatened and migratory species likelihood of occurrence assessment (**Section 5**) and preliminary assessment of inherent risks to threatened and migratory species (**Section 7**), on ground surveys were conducted with three objectives:

- To determine and map vegetation communities across the lot
- To determine the presence and quality of habitats for threatened species (no migratory species were expected either to occur within Lot 2303, or be significantly impacted by the proposed development)
- To determine the presence of threatened species, using the methods described in the following sections.

Table 15 lists the species targeted for on ground surveys and describes the survey type, location and effort.

Table 15 Target species and habitats, survey type and effort

<table>
<tr><th>Species</th><th>Survey type</th><th>Target areas / habitats</th><th>Effort</th></tr>
<tr><td>Partridge Pigeon</td><td>Bird survey transects</td><td rowspan="6">Eucalypt woodland in the northern half of Lot 2303.</td><td rowspan="2">Approximately seven hours of bird surveys (seven separate bird surveys) over five days.</td></tr>
<tr><td>Crested Shrike-tit</td><td>Bird survey transects, call playback</td></tr>
<tr><td>Masked Owl</td><td>Call playback</td><td>Six call playback sessions over four nights at four sites.</td></tr>
<tr><td>Northern Quoll</td><td rowspan="4">Camera traps
Spotlighting transects (for Phascogale)</td><td rowspan="4">18 cameras (total of 472 camera nights)</td></tr>
<tr><td>Fawn Antechinus</td></tr>
<tr><td>Black-footed Tree-rat</td></tr>
<tr><td>Northern Brush-tail Phascogale</td></tr>
<tr><td>Pale Field-rat</td><td>Grassland in the southern half of Lot 2303</td><td rowspan="2">Two cameras (total of 58 camera nights)
Walking and driving transects for Floodplain Monitor</td></tr>
<tr><td>Floodplain Monitor</td><td>Search transects and camera traps</td><td>The open irrigated grasslands in the southern half of Lot 2303</td></tr>
</table>

8.1.2 Cameras

Twenty cameras were deployed in potentially suitable habitat for threatened mammals (**Table 16**, **Figure 10**). Cameras were deployed in accordance with *A guide for the use of remote cameras for wildlife survey in northern Australia* (Gillespie *et al*., 2015), summarised as:

- Cameras were placed on suitable trees and facing south, where possible, to prevent glare and sun damage to the camera lens and sensor.
- A bait station was placed approximately 1.5 m from the base of the tree consisting of a wooden stake with the bait housing at 30 cm above the ground.
- Bait stations were baited with a golf ball size (at least) mixture of oats, peanut butter, and honey.
- Cameras were aimed so that the centre of the image was pointed at the base of the bait station.
- Cameras were set at a height of approximately 40-60 cm to the top of the camera housing.

Weekly visits were made to each camera to check the camera's function, and that sufficient bait remained. All, except two, cameras were deployed from 31 August to 29 September 2020, a period of 29 nights (i.e., about four weeks).

Table 16 Description of camera sites in Lot 2303

Site no.	Period deployed	No. camera nights	Notes	Representative photo of site and habitat
Vegetation community E1: well drained eucalypt woodlands – 15 cameras				
1-1, 1-2, 1-3 2-1, 2-2, 2-3 3-1, 3-2, 3-3 4-1, 4-2, 4-3 5-1, 5-2, 5-3	31/8 – 29/9	435	*E. miniata* woodland across the northern half of Lot 2303. Threatened species targeted: - Black-footed Tree-rat - Northern Quoll - Fawn Antechinus - Northern Brush-tail Phascogale - Partridge Pigeon	

Site no.	Period deployed	No. camera nights	Notes	Representative photo of site and habitat
Vegetation community W1: Pandanus spiralis grassland – two cameras				
6-1, 6-2	31/8 – 29/9	58	Dense, tall grass (Guinea Grass) with *Pandanus spiralis* Threatened species targeted: - Pale Field Rat - Floodplain Monitor	

Site no.	Period deployed	No. camera nights	Notes	Representative photo of site and habitat
Vegetation community E2: Modified E. miniata open woodland – one camera				
7-1	31/8 – 29/9	29	Sparse trees though predominantly native species. Target species: - Northern Quoll - Black-footed Tree-rat - Partridge Pigeon	

Site no.	Period deployed	No. camera nights	Notes	Representative photo of site and habitat
Vegetation community C: Cleared areas (tracks) – two cameras				
Fence cam 1 Fence cam 2	31/8 – 4/9	8	Short term deployment to obtain snapshot of species and their activity levels utilising tracks to, and near, the tip. Cameras not baited.	
20 cameras	**31/8 – 29/9 (inclusive)**	**530 camera nights**	-	-

Figure 10 - Fauna camera and Masked Owl survey locations

Key

- Lot 2303
- Cameras
- Masked Owl survey sites

Base layer: Google Satellite

0 50 100 m

1:3000

GDA94, zone 53

Date: 29 September 2020

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8.1.3 Bird Surveys

Seven bird surveys were conducted over five days (1 to 4 and 11 September). All birds seen or heard were recorded. The methodology for each targeted bird species is described in the following sections.

8.1.3.1 Partridge Pigeon

Surveys for the Partridge Pigeon were conducted in accordance with the *Survey guidelines for Australia's threatened birds* (DEWHA, 2010). They involved walking transects in the wooded areas (predominantly the northern half of the lot). This included when walking to check fauna cameras. The species was also observed during all other times when on site (e.g., when driving, identifying weeds etc.). Two ecologists walked abreast with the aim of flushing the species.

At least eight hours of non-species-specific survey time was also spent on site.

8.1.3.2 Crested Shrike-tit

In accordance with the Australian Government's *Survey guidelines for Australia's threatened birds* (DEWHA, 2010) and the *Survey protocol for the Northern Shrike-tit* (Ward, 2019), the survey method for the Crested Shrike-tit consisted of:

- Broadcast surveys across Lot 2303 before 11 am or after 4.30 pm. The call was broadcast for five minutes at one spot then moved 5-10 m and broadcast in another direction for five minutes. Responses were listened for during the broadcast and at least two minutes after. Binoculars were used to identify any birds active in the trees around the broadcast site. A total of approximately four hours of broadcast surveys were conducted over seven days (1-4, and 11 September).
- Area searches, listening for their calls and observing for other birds including Varied Sittellas and Black-faced Woodswallows.

The calls were played from a mobile phone connected via Bluetooth to a portable speaker.

8.1.3.3 Masked Owl

The methodology for Masked Owl surveys was provided by DENR (2019; see **Appendix D**). A total of six call playback sessions (approximately 6 hours) was conducted over four nights using the following methodology:

- A cumulative call playback survey of 53 minutes at each site (using the sequence in **Table 17**).
- Four sites were surveyed (see site characteristics in **Table 18**, survey times and brief weather conditions in **Table 19** and locations in **Figure 10**).
- On each night, two ecologists were present.
- Ecologists were approximately 50 m from the megaphone, on either side.
- Prior to the surveys, ecologists ensured that they were able to distinguish Masked Owls (by both looks and call) from other potentially occurring owls, including Barking Owls, Barn Owls and Southern Boobooks.
- A range of Masked Owl calls were used during the broadcast including screeches, hisses and chattering (provided by B. Hill, DENR).
- Calls were played through a Samsung smart phone connected via Bluetooth to a Bose SoundLink Revolve speaker which was broadcast through a 25 W megaphone (allowing 360-degree call broadcast though greater volume towards the target direction).
- The megaphone was placed at head height and broadcast in various directions (towards target habitat) during each call playback session.
- A Zoom H5 recorder was used to record each session.

- Led Lenser H14R.2, XEO19R or MH11 lights were used for spotlighting.

The species is known to hunt in the early hours of the night (Birdlife Australia, 2020).

Table 17 Masked Owl call playback sequence (DENR, 2019)

Method	Duration (minutes)	Cumulative duration (minutes)	Period
Passive survey	5	5	Arrival
Playback	1	6	First round call playback
Passive survey	10	16	
Playback	1	17	Second round call playback
Passive survey	15	32	
Playback	1	31	Third round call playback
Passive survey	15	48	
Spotlight area search	5	53	Spotlight

Table 18 Masked Owl survey site characteristics

Site	Site characteristics
MO1	Northern boundary, where woodland continues north, and several hollow-bearing trees present
MO2	North-east corner of lot
MO3	Eastern boundary, transition between woodland and irrigated grassland
MO4	Western boundary, transition between woodland, irrigated grassland and the landfill

Table 19 Masked Owl survey details

Date	Site	Time commenced	Weather and moon conditions
31 August	MO1	8.00 pm	35°C, very warm and humid, mostly cloudy, moon waxing gibbous.
1 September	MO1	8.30 pm	32°C, moderately windy, nearly full moon, mostly clear sky.
	MO2	9.30 pm	31°C, moderately windy, nearly full moon, mostly clear sky.
2 September	MO1	8.30 pm	31°C, moderately windy, full moon, clear sky.
	MO3	9.30 pm	27°C, slightly windy, full moon, clear sky.
3 September	MO4	8.50 pm	30°C, lightly windy, near full moon (waning gibbous), clear sky.

8.1.4 Spotlighting

Immediately following each Masked Owl call playback session, 30-60 minutes of spotlighting was conducted to detect any nocturnal fauna utilising the site. The two ecologists would walk on their own (maintaining communications with UHF radio) around the site.

In addition, during the supplementary surveys (November/December), approximately one hour of passive spotlighting (i.e., stationary) was conducted on two nights to determine which species were foraging in the rubbish pile in the adjacent landfill. The objective was to determine whether Black-footed Tree-rats were utilising the food waste in the landfill site.

8.2 Camera sites around Jabiru and Lot 2303

Thirty-five additional camera sites were established around Jabiru and Lot 2303 to obtain more data on the local distribution of Black-footed Tree-rats given the paucity of records in the NT Fauna Atlas and the apparent lack of formal fauna surveys in the local area (**Table 20**, **Figure 11**). The objective was to determine the relative significance of the individuals detected within Lot 2303. These cameras were deployed following the original surveys in Lot 2303.

Conclusions made in relation to the suitability of habitat for the Black-footed Tree-rat are based on the ecologist's experience and relate to key indicators such as shrub density, vegetation community type, and the presence and density of large hollow-bearing trees. This is in line with other studies measuring site occupancy of Black-footed Tree-rats (e.g., Davies *et al*., 2018).

Table 20 Overview of camera sites in Jabiru and to the north of Lot 2303

Site no.	Camera no.	Period deployed	No. camera nights	Notes, including apparent suitability of habitat for the Black-footed Tree-rat	Representative photo of site and habitat
Lot 2317 – three cameras					
J1	24			Numerous vehicle tracks in vicinity, open *E. tetrodonta* woodland, bloodwoods, grassy though appears frequently burnt due to paucity of woody ground debris (e.g. logs), **Low to moderate suitability for Black-footed Tree-rat**	
		12-24/11	36		
J-2	16				
J-N-12	7	12-24/11	12		
Lot 2304 – five camera sites					
J-3	11	12/11-10/12			
	9	12-24/11	56	*E. miniata* and *E. tetrodonta* woodland, low to moderate density shrub layer. **Low (possibly moderate) suitability for Black-footed Tree-rat**	
J-7					
	22	24/11-10/12			

Site no.	Camera no.	Period deployed	No. camera nights	Notes, including apparent suitability of habitat for the Black-footed Tree-rat	Representative photo of site and habitat
J-4	8				
J-5	13	12-24/11	36	Open *E. tetrodonta* woodland, occasional *E. miniata* and *Erythrophleum chlorostachys* (Ironwood), *Livistona humilis* (Sand Palms), moderate tree sapling density, burnt (appears frequent due to paucity of woody ground substrate), relatively narrow patch. **Low suitability for Black-footed Tree-rat.**	
J-6	23				
Lot 948 – two camera sites					
	20	12-24/11			
J-8			28		
	5	24/11-10/12		*E. miniata* and *E. tetrodonta* grassy woodland, some large hollow-bearing trees, *Calytrix exstipulata*, *Erythrophleum chlorostachys* (Ironwood), *Livistona humilis* (Sand Palm). **Moderate suitability for Black-footed Tree-rat.**	
J-9	5	12-24/11	12		
Lot 979 – three camera sites					

Site no.	Camera no.	Period deployed	No. camera nights	Notes, including apparent suitability of habitat for the Black-footed Tree-rat	Representative photo of site and habitat
J-10	10	12/11-10/12	28		
J-11	14	12-24/11	12		
	22	12-24/11		*E. tetrodonta* and *E. miniata* woodland with occasional *Erythrophleum chlorostachys* (Ironwood), *Brachychiton diversifolius* (Kurrajong), *Livistona humilis* (Sand Palm), *Terminalia ferdinandiana*, *Calytrix exstipulatai*, good diversity of shrubs, good layer of leaf litter (up to 25 cm thick). Potential Fawn Antechinus habitat (most potential out of all camera sites). **Moderate to high suitability for Black-footed Tree-rat.**	
J-12			28		
	20	24/11-10/12			
North of Lot 2303 – 23 cameras					
J-N-1	12	12/11-3/12[12]	21		
J-N-2	19	12-24/11	12		
J-N-3	26	12/11-3/12[9]	21		

[12] *Cameras were retrieved after 3 weeks due to accessibility issues with rain and boggy tracks*

Site no.	Camera no.	Period deployed	No. camera nights	Notes, including apparent suitability of habitat for the Black-footed Tree-rat	Representative photo of site and habitat
J-N-4	27	12-24/11	12	Vegetation and habitat to north of Lot 2303 is generally *E. miniata* / *E. tetrodonta* woodland that is open and recently burnt, appears frequently burnt, little mid storey, shrub layer present in small patches. **Low suitability for Black-footed Tree-rat.**	
J-N-5	15	12/11-3/12[9]	105		
J-N-6	1				
J-N-7	6				
J-N-8	18				
J-N-9	21				
J-N-10	17	12/11-10/12	28		
J-N-11	3	12-24/11	24		
J-N-12	7				
J-N-13	19	24/11-10/12	64		
J-N-14	4				
J-N-16	16				
J-N-18	13				
J-N-19	15	3-10/12	35		
J-N-20	26				
J-N-21	6				
J-N-22	18				
J-N-23	1				
J-N-24	7	23/11-10/12	34		
J-N-25	8				
Total	**-**	**12/11-10/12**	**604**	**-**	**-**

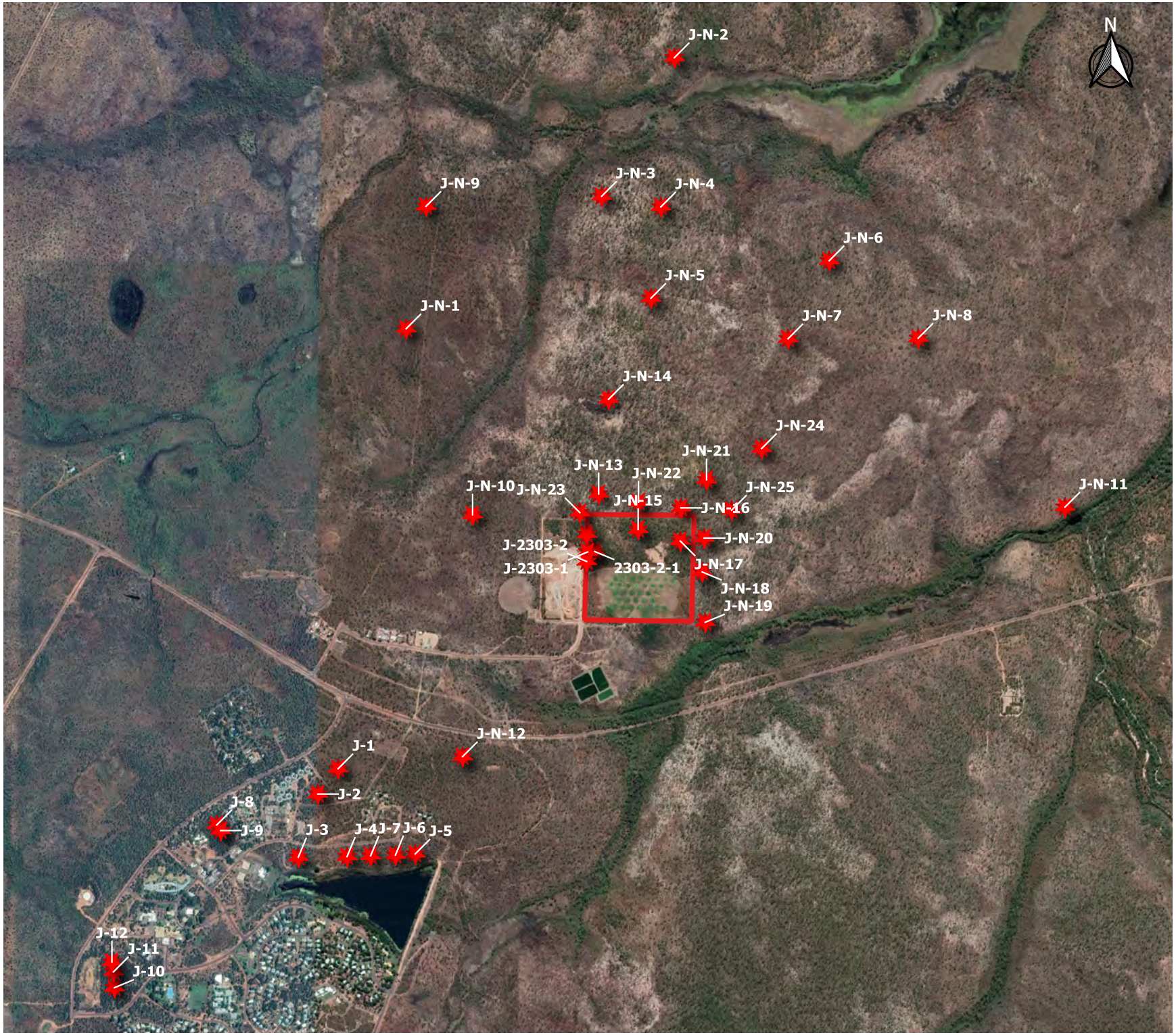

Figure 11
-
Locations of cameras

Key

Lot 2302

Cameras

Base layer: Google Satellite

0 0.5 1 km

1:27500

GDA94, zone 53

Date: 11 December 2020

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9 Results

9.1 Vegetation

Vegetation communities in Lot 2303 were mapped to a scale of 1:10,000. The minimum width mapped is approximately 10 m, with an expected precision of +/- 10 m. Communities are not always able to be clearly delineated and some transition is expected. There is also some variability within each community, however given the range of site influences, it was determined unnecessary to produce mapping at a finer scale.

The northern half of the lot was dominated by *Eucalyptus miniata* and *E. tetrodonta* woodland. *Pandanus spiralis* was observed very occasionally in the eastern half of Lot 2303. A moderate shrubby later existed across much of Lot 2303. An approximately 50 m transect from north to south in the western half of Lot 2303 was observed to contain younger *E. tetrodonta* trees (to 8 m). This area can clearly be seen in satellite imagery (see sparsely vegetated area with patches of white surface). There was also a cleared area of about 60 m x 20 m in the south-eastern part of the woodland. It was devoid of trees or shrubs. Soils across Lot 2303 mostly consisted of a white sand with a moderate cover of surface lateritic gravel.

Seven polygons were mapped, comprising five communities (**Figure 12**, **Table 21**).

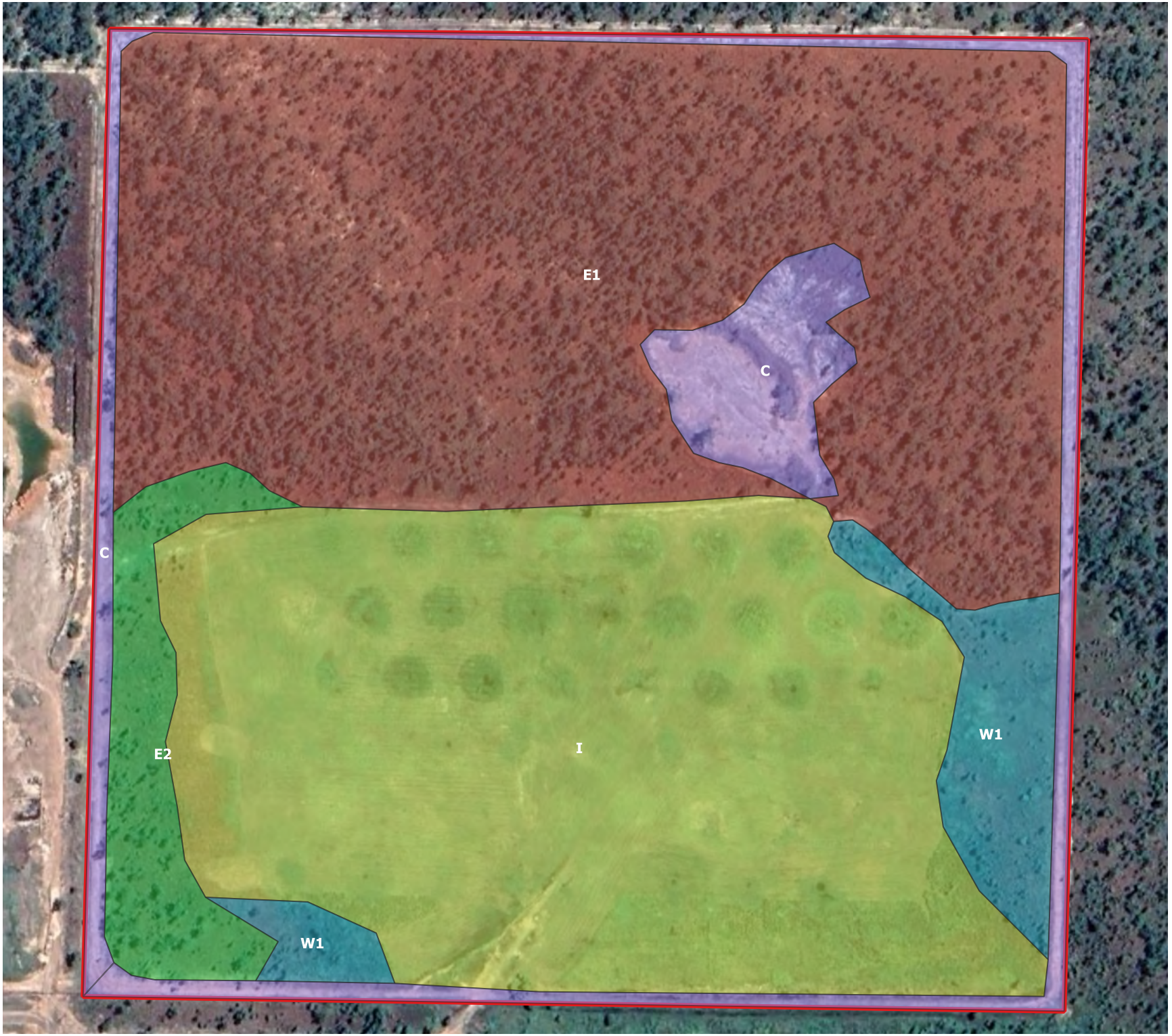


Figure 12
-
Vegetation communities

Key

Lot 2303

Vegetation communities

- E1 - Eucalyptus miniata, E. tetrodonta
- E2 - Eucalyptus miniata, E. tetrodonta (disturbed)
- I - Irrigated grassland
- W1 - Pandanus spiralis
- C - cleared (tracks, borrow pit)

Base layer: Google Satellite

0 50 100 m

1:3000

GDA94, zone 53

Date: 29 September 2020

CONNECT environmental

Table 21 Vegetation communities in Lot 2303

Code	Area (ha)	Description[13]	Other species	Comments	Representative photo
E1	14.3	*Eucalyptus miniata, E. tetrodonta, Erythrophleum chlorostachys* mid woodland over *Livistona humilis, Terminalia ferdinandiana, Acacia platycarpa* (unconfirmed) low sparse shrubland over mixed tall tussock grassland	*Pandanus spiralis*	Most ecologically intact community within the lot.	
E2	1.4	*Eucalyptus miniata* and *E. tetrodonta* low open woodland over *Livistona humilis, Terminalia ferdinandiana* low sparse shrubland over mixed tall tussock grassland (disturbed)		Species composition like E1 though there is a higher degree of disturbance and consequent change in community structure.	

[13] *Three most dominant species in each stratum*

Code	Area (ha)	Description[13]	Other species	Comments	Representative photo
W1	1.6	*Pandanus spiralis* mid sparse shrubland over mixed species grassland	A range of weeds present including Guinea Grass	-	
I	12.3	Irrigated grassland	-	Regularly mowed	No photo
C	3.0	Cleared – tracks and gravel borrow pit	-	-	

9.2 Feral Animals

9.2.1 Lot 2303

Three feral animal species were detected on the cameras – Wild Dogs / Dingoes (12 cameras), Cane Toads (six cameras) and Pigs (one camera). See their locations in **Figure 13** and representative photos of each species in **Figure 14** to **Figure 17**. Noteworthy observations include:

- Wild Dogs / Dingoes were detected by numerous cameras, and in combination with the frequent observations by Ecologists, are assumed to be very abundant in the local area and reliant on food waste at the landfill. Up to 10 were often seen crossing the track from the landfill into the woodland on approach of the Ecologists vehicle. Several Wild Dog / Dingo scats contained plastic (**Figure 17**).
- Pigs were detected in *E. miniata* woodland in the northern half of Lot 2303.
- No cats were detected (nor were any observed during the survey).

Dingoes and wild dogs have been classified together as feral animals for the purposes of this project because it is unknown whether they are 'pure' dingoes or hybrids. Stephens (2011) reported that 88% of DNA samples tested in the NT were pure dingoes, but that the percentage of hybrids is higher in areas with larger human populations (>25,000). However, we note that pure-breed dingoes are considered native and are therefore protected in the NT (and in most states / territories in Australia). Generally, in the NT, the term wild dog includes the dingo and feral domestic dogs (and hybrids) (DENR, 2019). Genetic testing has shown that a larger proportion of pure dingoes exist across northern Australia than southern Australia, where more hybrids exist (Stephens, 2011), however the distribution of testing appears to have been patchy.

Wild Dogs (including Dingoes) can adversely impact threatened fauna through direct predation and transmission of disease and pathogens (DENR, 2019; Wool Producers Australia, 2018). Stobo-Wilson *et al*. (2020) suggests that native small mammals are adversely impacted by Dingoes. However, there is some evidence to suggest they can be beneficial to the environment by predating on feral cats, introduced rodents and pigs, or by cats avoiding Dingoes (Fleming *et al*., 2012; Letnic *et al*., 2009). A recent extensive mammal survey across approximately 370,000 km^2 in northern Australia (Stobo-Wilson *et al*., 2020) did not find any evidence that Dingoes influenced the distribution of feral cats. Further, Fleming *et al*. (2012) discusses the possibility that Wild Dogs do not adversely affect threatened species such as the Northern Quoll (Dasyurus hallucatus). Overall, it is unclear what affect (positive or negative) Wild Dogs are having on the environment in Lot 2303. Whilst it may appear logical to suggest that their apparent relatively high abundance there would hinder native small mammal abundance in Lot 2303, sufficient food scraps in the adjacent landfill may reduce their desire to target and eat small mammals in the vicinity. Further studies are required to investigate this.

It is unclear what effect Cane Toads have had on threatened species locally, though there is much evidence to indicate that they have caused substantial impact to many species regionally and nationally (DSEWPaC, 2011b). Species that have been affected at the level of populations include the Freshwater Crocodile, various species of goanna (*Varanus* spp.), Northern Death Adder (*Acanthophis praelongus*), King Brown Snake (*Pseudechis australis*), Northern Quoll (*Dasyurus hallucatus*) and Pale Field-rat (*Rattus tunneyi*) (DSEWPaC, 2011b).

9.2.2 Around Jabiru and Lot 2303

Three feral animal species were detected on the cameras – Wild Dogs / Dingoes (10 cameras), Cane Toads (16 cameras) and Pigs (two cameras). Refer to locations in **Figure 18**. No cats were detected by the cameras during the surveys, nor were any cats observed by the Ecologists during the surveys.

Figure 13 - Locations of feral animals detected on cameras in Lot 2303

Key

Lot 2303

Feral animals

- Cane Toad
- Pig
- Wild Dog

Base layer: Google Satellite

0 50 100 m

1:3000

GDA94, zone 53

Date: 29 September 2020

CONNECT environmental

Figure 14 Wild Dog at Site 2-1

Figure 15 Pigs at Site 5-3

Figure 16 Cane Toad at Site 1-1

Figure 17 Wild Dog / Dingo scat with plastic

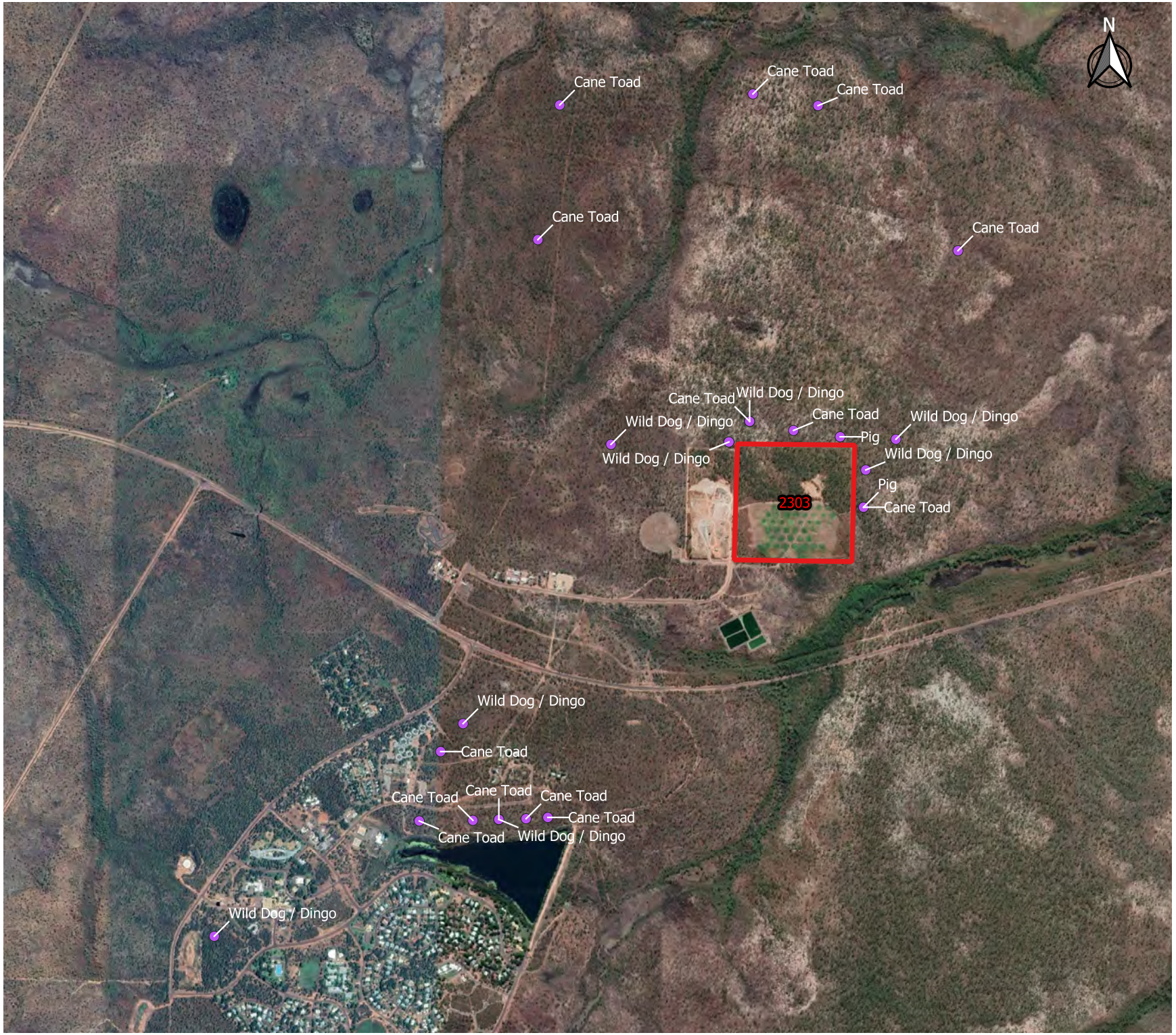


Figure 18 - Locations of feral animals detected on cameras in Jabiru and around Lot 2303

Key

- Lot 2303
- Feral animals

Base layer: Google Satellite

0 0.5 1 km

1:25000

GDA94, zone 53

Date: 12 December 2020

CONNECT environmental

9.3 Disturbances

Parts of Lot 2303 appeared to be in relatively good ecological condition. The site is in the industrial precinct and immediately adjacent to the Jabiru Waste Disposal Facility. As expected, rubbish was littered along the western margin of Lot 2303. A fence line and tracks bordered the entire boundary of Lot 2303. The track / firebreak, on each side of the fence is approximately 4 – 6m in width. Other observed disturbances in the woodland include several vehicle tracks and a quarry.

9.4 Weeds

At least ten weed species were identified on Lot 2303 (**Table 22**). Parts of Lot 2303 are mowed and many grasses and weeds on Lot 2303 are desiccated and have lost seed, making it difficult to detect and identify plants (particularly annuals). Perennial Mission Grass (*Cenchrus polystachios*) was thought to occur also, though could not be confirmed due to the paucity of seed heads on many of the grasses.

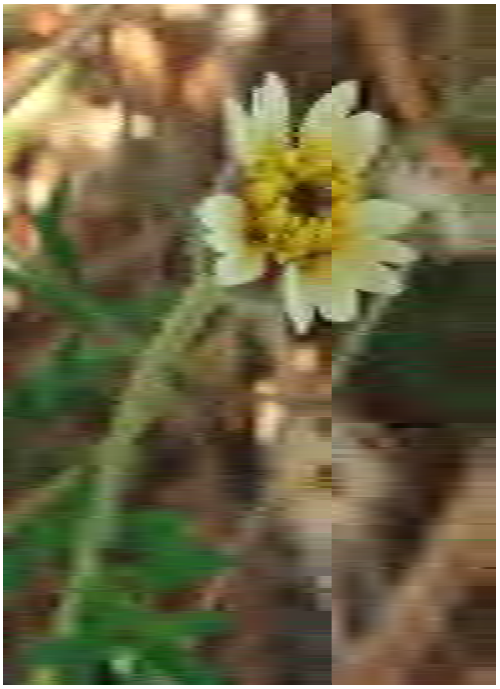
Table 22 Weeds detected in Lot 2303

Species	Declaration status – WM Act	Notes	Photo
Cenchrus pedicellatus (Annual Mission Grass)	Not declared	Scattered around the irrigated grassland and roadsides in the southern half of the lot	

Species	Declaration status – WM Act	Notes	Photo
Chloris barbata (Purple Top Chloris)	Not declared	Widespread along southern boundary	
Euphorbia hirta (Asthma Plant)	Not declared	Located near the gate along the southern boundary	

Species	Declaration status – WM Act	Notes	Photo
Hibiscus sabdariffa (Rosella)	Not declared	Occasional plant along southern boundary	
Hyptis suaveolens (Hyptis)	Class B	Observed in the south western corner of the lot	No photo
Macroptilium atropurpureum (Siratro)	Not declared	Located near the gate along the southern boundary	

Species	Declaration status – WM Act	Notes	Photo
Megathyrsus maximus (Guinea Grass)	Not declared	Widespread and in dense patches (monoculture) around the perimeter of the irrigated grassland	
Melinis repens (Red Natal Grass)	Not declared	Occasional along southern boundary	

Species	Declaration status – WM Act	Notes	Photo
Phyllanthes amarus	Not declared	Located near the gate along the southern boundary	
Tridax procumbens (Tridax Daisy)	Not declared	Widespread along southern boundary	

9.5 Cameras

9.5.1 Lot 2303

Seven mammal, one amphibian and nine bird species were detected on the cameras (**Table 23**, **Table 24**). The species detected on the highest number of cameras was the Northern Brown Bandicoot (18 cameras) followed

by the Black-footed Tree-rat (14 cameras) and Wild Dogs (12 cameras). The camera with the greatest number of different species was Site 5-3 with nine species.

9.5.2 Around Lot 2303

Seven mammal, two amphibian and three bird species were detected by cameras deployed in Jabiru and to the north of Lot 2303 (**Table 25**). One Black-footed Tree-rat was detected immediately north-west of Lot 2303, and nowhere else.

Table 23 Mammals and amphibians detected by cameras in Lot 2303 (grey shading indicates a threatened species, orange indicates a camera deployed in the second round of surveys)

Site	Wild Dog (*Canus lupus dingo*)	Northern Brown Bandicoot (*Isoodon macrourus*)	Agile Wallaby (*Macropus agilis*)	Grassland Melomys (*Melomys burtoni*)	Black-footed Tree-rat (*Mesembriomys gouldii*)	Northern Brush-tail Possum (*Trichosurus Vulpecula*)	Pig (*Sus scrofa*)	Cane Toad (*Rhinella marina*)	Total
1-1	X	X			X			X	4
	X	X						X	
1-2		X			X				2
1-3	X	X			X				3
2-1	X	X			X				3
2-2		X							1
2-3	X	X			X				3
3-1		X			X				2
		X							
3-2	X	X			X				3
3-3	X	X			X				3
4-1	X	X			X				3
4-2		X						X	2
4-3		X			X	X			3
5-1		X			X				2
5-2		X			X				3
		X			X			X	
5-3	X	X					X	X	5
6-1		X		X				X	3
6-2	X	X						X	3

Site	Wild Dog (*Canus lupus dingo*)	Northern Brown Bandicoot (*Isoodon macrourus*)	Agile Wallaby (*Macropus agilis*)	Grassland Melomys (*Melomys burtoni*)	Black-footed Tree-rat (*Mesembriomys gouldii*)	Northern Brush-tail Possum (*Trichosurus Vulpecula*)	Pig (*Sus scrofa*)	Cane Toad (*Rhinella marina*)	Total
7-1	X	X						X	3
FC1[14]	X				X				2
FC2[15]	X		X		X				3
	X						X	X	3
FC3[16]	X						X	X	3
TOTAL	12	18	1	1	14	1	1	6	9

Table 24 Birds detected by cameras in Lot 2303

Site	Australian White Ibis	Pheasant Coucal	Australian Owlet-Nightjar	Bush-stone Curlew	Masked Lapwing	Magpie-lark	Bar-shouldered Dove	Crimson Finch	Torresian Crow	Tawny Frogmouth	Total
1-1		X							X		2
1-2									X		1
1-3											0
2-1		X							X		2
2-2									X		1
2-3									X		1
3-1											0

[14] *Fence cam 1*

[15] *Fence cam 2*

[16] *Fence cam 3 (J-2303-1)*

Site	Australian White Ibis	Pheasant Coucal	Australian Owlet-Nightjar	Bush-stone Curlew	Masked Lapwing	Magpie-lark	Bar-shouldered Dove	Crimson Finch	Torresian Crow	Tawny Frogmouth	Total
3-2											0
3-3							X				1
4-1											0
4-2											0
4-3										X	1
5-1			X								1
5-2											0
											0
5-3				X	X	X	X		X		5
6-1								X	X		2
6-2								X	X		2
7-1		X						X	X		3
FC1[17]				X		X			X		3
FC2[18]				X							1
	X					X	X		X		4
FC3[19]	X								X		2
Total		**3**	**1**	**3**	**1**	**2**	**2**	**3**	**10**	**1**	**9**

[17] *Fence cam 1*

[18] *Fence cam 2*

[19] *Fence cam 3 (J-2303-1)*

Table 25 Fauna detected by cameras outside Lot 2303 (grey shading indicated a threatened species)

Site	Wild Dog / Dingo (*Canus lupus dingo*)	Northern Brown Bandicoot (*Isoodon macrourus*)	Agile Wallaby (*Macropus agilis*)	Black-footed Tree-rat (*Mesembriomys gouldii*)	Delicate Mouse (*Pseudomys delicatulus*)	Giant Frog (*Cyclorana australis)*	Green Tree Frog (Litoria caerulea)	Cane Toad (*Rhinella marina*)	Pig (*Sus scrofa*)	Northern Brush-tail Possum (*Trichosurus Vulpecula*)	Pheasant Coucal	Bar-shouldered Dove	Torresian Crow	Total
Jabiru township														
J-1	X									X			X	3
J-2								X		X				2
J-3								X		X		X		3
J-4								X		X				2
J-5								X						1
J-6								X						1
J-7	X							X			X			3
J-8										X				1
J-9										X				1
J-10		X												1
J-11														0
J-12	X	X												2
North of Jabiru (woodlands within 5 km)														
J-N-1		X						X						2
J-N-2														0
J-N-3							X	X						2
J-N-4								X						1
J-N-5	X									X				2
J-N-6			X											1
J-N-7					X[20]			X		X				3
J-N-8														0
J-N-9		X				X		X						3
J-N-10	X												X	2
J-N-11														0
J-N-12		X											X	2
J-N-13	X	X						X						3
J-N-14												X		1
J-N-16									X	X				2

[20] *The identity of the individual could not be confirmed, though it appears to be a Delicate Mouse*

Site	Wild Dog / Dingo (*Canus lupus dingo*)	Northern Brown Bandicoot (*Isoodon macrourus*)	Agile Wallaby (*Macropus agilis*)	Black-footed Tree-rat (*Mesembriomys gouldii*)	Delicate Mouse (*Pseudomys delicatulus*)	Giant Frog (*Cyclorana australis)*	Green Tree Frog (Litoria caerulea)	Cane Toad (*Rhinella marina*)	Pig (*Sus scrofa*)	Northern Brush-tail Possum (*Trichosurus Vulpecula*)	Pheasant Coucal	Bar-shouldered Dove	Torresian Crow	Total
J-N-18		X	X					X	X					4
J-N-19														0
J-N-20	X													1
J-N-21														0
J-N-22								X						1
J-N-23	X			X										2
J-N-24								X						1
J-N-25	X		X											2
Total	**10**	**9**	**3**	**1**	**1**	**1**	**1**	**16**	**2**	**10**	**1**	**2**	**3**	**10 species**

9.6 Bird Surveys

Twenty-two (non-threatened) bird species was seen or heard in Lot 2303 (**Table 26**). No threatened bird species were observed during the bird surveys, however Partridge Pigeons (listed as Vulnerable under both the TPWC and EPBC Acts) were detected during the subsequent fauna camera surveys in November and December.

Table 26 Results of the bird surveys

Birds	Date and time of bird survey						
	1/9, 7.30 am	1/9, 6.00 pm	2/9, 7.00 am	2/9, 5.30 pm	3/9, 8.30 am	4/9, 6.45 am	11/9, 9.30 am
Australian Hobby			X			X	X
Black Kite			X	X	X	X	X
Whistling Kite	X	X	X	X	X	X	X
Red-tailed Black Cockatoo	X		X			X	
Little Corella	X		X	X	X		X
Peaceful Dove			X				
Bar-shouldered Dove	X	X	X		X		X
Black-faced Cuckoo-shrike				X	X	X	
White-bellied Cuckoo-shrike	X	X	X		X	X	X
Pheasant Coucal			X		X		
Blue-winged Kookaburra		X	X		X	X	
Little Friarbird		X	X	X	X	X	X
Silver-crowned Friarbird		X			X	X	
Magpielark			X				X
Torresian Crow		X	X	X	X	X	X
Rainbow Bee-eater	X						
Striated Pardalote	X				X		
Mistletoebird	X		X				
Weebill			X	X	X	X	X
Red-backed Fairy-wren		X	X	X		X	X
Golden-headed Cisticola			X				
Crimson Finch	X		X		X		
TOTAL: 22 species	**9**	**8**	**18**	**8**	**14**	**12**	**11**

9.7 Threatened Fauna

The Black-footed Tree-rat was the only threatened species captured on camera in Lot 2303. It was also detected by one camera immediately north-west of Lot 2303. Partridge Pigeons were detected incidentally when ecologists were walking in and around Lot 2303. All targeted threatened species are discussed in the following sections.

9.7.1 Partridge Pigeon

9.7.1.1 Observations

Fourteen Partridge Pigeons were incidentally detected in Lot 2303 on 24 November 2020. The species was also incidentally detected at numerous other locations (outside Lot 2303) during the supplementary surveys (**Figure 19**). The species was not detected during the formal bird surveys in Lot 2303.

It is worth noting that that the 2019/20 wet season had substantially less rainfall than normal – a total of about 1,000 mm was recorded at the Jabiru airport BOM site, down from an average of about 1,500 mm. Woinarski (2006) indicates that the species is likely to do poorly in relatively dry years, given that it needs to drink daily. In this regard, this may have influenced its abundance in the local area.

9.7.1.2 Distribution and Habitat

There are numerous recent records of the species in proximity of Lot 2303 (i.e., 128 records within 5 km and over 1000 within 50 km). The species is mostly known from the north-west of the Top End, from the Yinberrie Hills in the south, Litchfield National Park in the west, Kakadu National Park in the east, and the Tiwi Islands in the north (Woinarski, 2004). Goodfellow (2005) and Woinarski (2006) indicate that the species is relatively abundant (and easiest to see) in Kakadu National Park, Litchfield National Park, and the Tiwi Islands, with alternative known locations at Umbrawarra Gorge Road (near Pine Creek) and closer to the coast (outskirts of Darwin and Palmerston, Berry Springs, Southport, Elizabeth Valley Road and Humpty Doo). The Reader's Digest (RDS, 1977) reported in the 1970's that this species was rare towards Darwin and common near Pine Creek.

Suitable habitat for the species is the *Eucalyptus* woodland in the northern half of Lot 2303.

9.7.1.3 Threats

Partridge Pigeons have experienced several threats in recent decades with the most apparent being altered fire regimes, weeds, and cats. The woodland area appears to burn every one to two years and several species of weeds were noted. No cats were detected.

9.7.1.4 Conclusions

Given the species' known ecology, distribution, and number of local records, it is logical to expect that the species would occur in Lot 2303. However, several key factors including Wild Dogs, fire, weeds, and the drier than average year may contribute to its abundance and distribution in and around Lot 2303. Nevertheless, there is approximately 14 ha of suitable habitat (i.e., *E. miniata / E. tetrodonta* dominated vegetation) in Lot 2303.

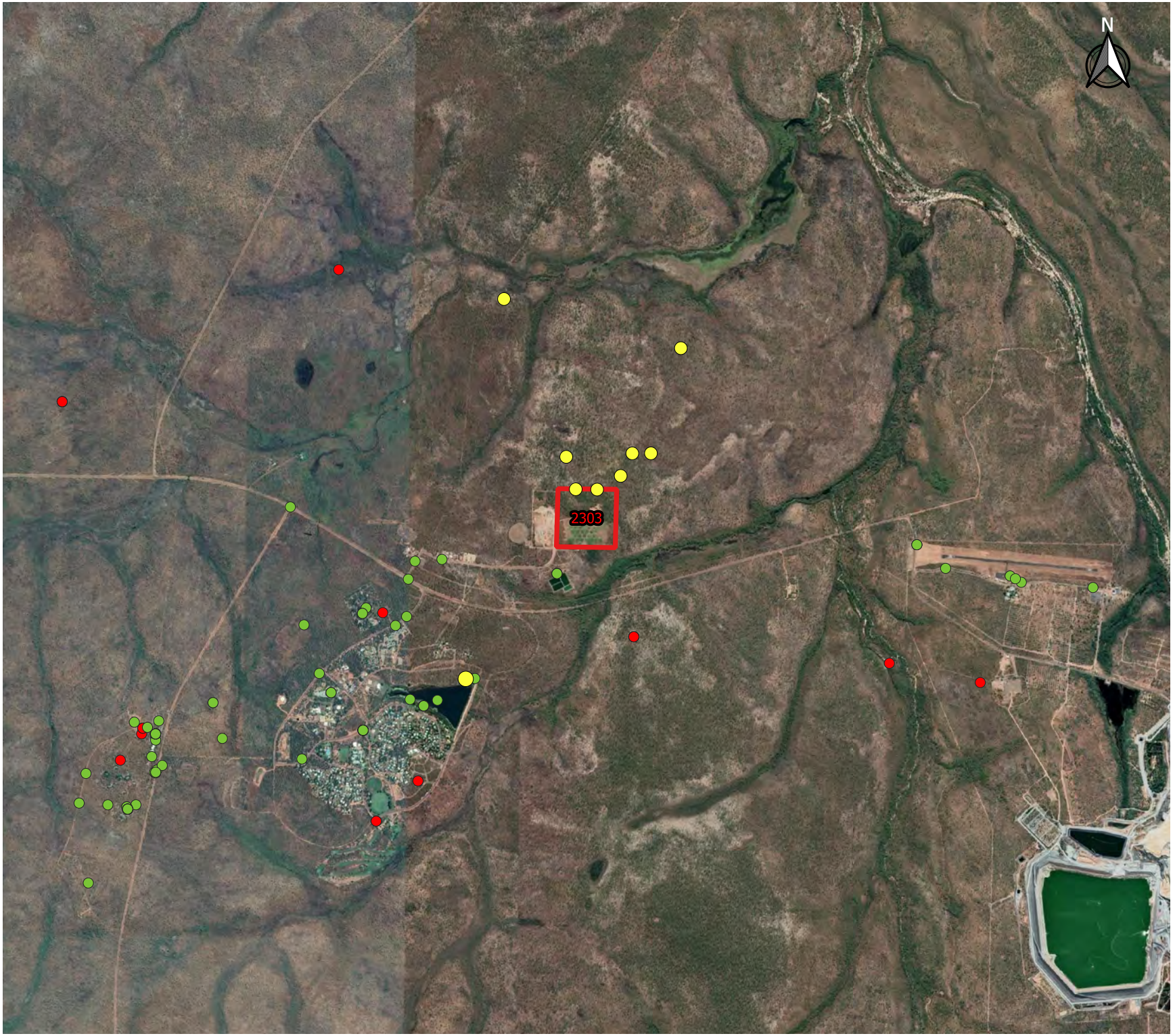


Figure 19 - Locations of Partridge Pigeons detected in and around Lot 2303 and Jabiru

Key

- Lot 2303
- Partridge Pigeons - this project
- Partridge Pigeons (2010 onwards - NT Fauna Atlas)
- Partridge Pigeons (pre-2010 (or unknown date) - NT Fauna Atlas

Base layer: Google Satellite

0 0.5 1 1.5 2 km

1:50000

GDA94, zone 53

Date: 12 December 2020

CONNECT environmental

9.7.2 Crested Shrike-tit

9.7.2.1 Observations

The Crested Shrike-tit was not detected within Lot 2303.

9.7.2.2 Distribution and Habitat

The species is known to occur in a wide range of eucalypt and Melaleuca woodlands – mainly those dominated by *Eucalyptus miniata*, *E. tetrodonta* or *E. bleeseri* (TSSC, 2016). It occurs in low densities and is very patchily distributed throughout its known range (Woinarski, 2004; cited in TSSC, 2016). As a result, suitable habitat for the species was classified as the *Eucalyptus* woodland in the northern half of Lot 2303. There are no records within 5 km of Lot 2303, and three exist within 50 km.

9.7.2.3 Threats

Frequent high intensity fires, habitat fragmentation, grazing and weeds are all known to threaten the persistence of the species across its range (TSSC, 2016).

9.7.2.4 Conclusions

Whilst the species was not detected within Lot 2303, its lack of detection may be because of several factors:

- Individuals of the species are present within the area, but they have ignored the broadcast, or have not heard it.
- The species does not occur in the area.

9.7.3 Masked Owl

9.7.3.1 Observations

The Masked Owl was not detected within Lot 2303. Observations of other fauna during the call playback sessions are in **Table 27**. Debus (2009) notes that Masked Owls, in response to a broadcasted call, can approach and call, sometimes while circling in flight overhead. He also indicates that Barn Owls can be attracted. Neither situation occurred during these surveys, despite six call playback sessions conducted. In addition, vehicle-based spotlighting was conducted when driving between sites.

9.7.3.2 Habitat

The presence of large hollow-bearing *E. miniata* or *E. tetrodonta* trees, regardless of abundance, indicates a potential for Masked Owl nesting sites. Debus (2009) describes Masked Owl nests being in hollows 10-45 m high, with an entrance more than 20 cm wide. Using this description, all vegetation containing *E. miniata* and / or *E. tetrodonta* could constitute potential breeding habitat for Masked Owls.

9.7.3.3 Threats

Current potential threats to Masked Owls include a decline of food resources (small and medium-sized mammals), altered fire regimes and invasive grasses (e.g. Gamba Grass) (Woinarski & Ward, 2012). No other nocturnal birds of prey were heard or observed during the surveys, except for one Barking Owl calling in the distance (i.e. off-site). This may indicate a lack of suitable prey on Lot 2303. Numerous species of small to medium sized mammals were present including the Grassland Melomys, Northern Brown Bandicoots and Northern Brush-tailed Possums.

9.7.3.4 Conclusions

Based on the available existing data, and these survey results, Lot 2303 does not appear to be an important area of habitat for the Masked Owl.

Table 27 Masked Owl survey observations

Date	Site	Time	Observations
31 August	MO1	8.00 pm	Observed eight adult dingoes when driving past landfill site on western boundary of site prior to commencing survey. Heard Blue-winged Kookaburras to north of site on arrival. Heard Bush-stone Curlews at 8.12 pm. Little Corellas calling to north of site at 8.19 pm. Observed Black Flying Fox flying overhead at 8.33 pm.
1 September	MO1	8.30 pm	Dingoes calling. Observed four Bynoe's Geckoes (*Heteronotia binoei*) during spotlighting after call playback survey.
	MO2	9.30 pm	Heard Asian House Gecko (*Hemidactylus frenatus*) calling.
2 September	MO1	8.30 pm	Magpie Geese and occasional Black Flying Fox flying overhead.
	MO3	9.30 pm	Occasional Black Flying Fox flying over. Rodent scats and *Litoria nasuta* observed during spotlighting session following survey adjacent to irrigated grassland.
3 September	MO4	8.50 pm	Dingoes observed along track.heard Bush-stone Curlews to west of site. Heard Asian House Gecko (*Hemidactylus frenatus*) calling. Occasional Black Flying Fox flying over. Heard one Barking Owl call in the distance (not on site).

9.7.4 Fawn Antechinus

9.7.4.1 Observations

The Fawn Antechinus was not detected in Lot 2303. This may be due to the lack of (or at least paucity of) ground substrate (e.g., coarse woody debris – logs, etc.), though other factors are likely implicated in its decline in the NT (see below).

9.7.4.2 Habitat

The Fawn Antechinus is the only Antechinus species found in top end. It shelters in tree hollows and fallen logs in tall, open forests dominated by eucalypts that have a grassy or shrubby understorey (Cole and Woinarski, 2002; Calaby, 1995). In many areas of the top end, this habitat is regularly burnt, likely leading to a reduction in coarse woody debris (e.g., logs and branches). As such, this species prefers locations with less frequent and intense fires (Woinarski et al 2004).

Potential habitat was initially identified as the eucalypt dominated woodland in the northern half of Lot 2303. However, the absence of the species' detection in Lot 2303 may be directly attributable to the lack of key resources required by the species. These factors are discussed further below. Our experience with other species of *Antechinus* in southern parts of Australia is that they appear to be dependent on the amount of fallen logs.

9.7.4.3 Threats

The woodland in the northern half of Lot 2303 has burnt every one to two years over the last 19 years (**Section 4.10**). It is probable that this frequency of fire may have altered the required habitat characteristics to the point where it may be no longer suitable for this species (if it ever was). The high fire frequency has likely resulted in a substantially reduced cover of woody ground substrate (e.g., logs, branches) and hence critically limits the opportunities for the species to shelter and breed.

The decline of the species more widely is thought to be related to altered fire regimes, weeds and grazing by livestock and feral animals. This may have resulted in a change to the availability of preferred or vital food resources and hollow logs and tree hollows (Woinarski *et al*., 2004).

9.7.4.4 Conclusions

The species was not detected within Lot 2303 (and the paucity of recent records within the region) is likely an indication that the species currently does not exist there. Probable reasons for this include:

- The habitats in Lot 2303 do not provide ideal resources required by the species (probably related to fire)
- Known threats to the species (e.g., fire) are implicated in its decline to the point where it no longer occurs in Lot 2303 (if it ever did).

9.7.5Northern Quoll

9.7.5.1 Observations

The Northern Quoll was not detected by any camera during the two rounds of survey.

9.7.5.2 Habitat

The species is found in a broad range of habitats include rocky areas, eucalypt forest and woodlands, dry rainforests and vine thickets, sandy lowlands and beaches, shrublands, grasslands and deserts. Breeding and refuge habitats are generally confined to rocky areas or structurally diverse woodlands (most commonly open forests dominated by eucalypts (Woinarski & Hill, 2012)) and the surrounding habitats are used for foraging and dispersal. In Kakadu, the species has been detected in (amongst other habitats not found in Lot 2303) open forest and woodlands dominated by *E. tetrodonta*, *E. miniata* and *E. tectifica* and riparian areas dominated by *Melaleuca viridiflora* and *Pandanus spiralis* (Oakwood, 2000).

The species has not been recorded within 5 km of Lot 2303 in the last 18 years, according to the NT Fauna Atlas, although there are records from further afield from as recently as 2019. Based on field observations and the definitions of breeding and refuge habitats provided above by DoE (2016) and DoEE (2019), potentially suitable breeding and refuge habitat includes the entirety of the *E. miniata* and *E. tetrodonta* woodland. Consequently, potentially suitable foraging and dispersal habitat may include the irrigated grassland.

An additional factor that influences the potential for these areas being suitable for the Northern Quoll is the presence of suitable prey. The species eats a wide range of food including insects, fruit and animals including the Northern Brown Bandicoot, Brushtail Possum, rats, Sugar Glider, insectivorous bats, quails, bird eggs, snakes and frogs (TSSC, 2005), some of which were detected in Lot 2303.

9.7.5.3 Threats

Key threats to the species are thought to include predation by feral cats, disease, changed fire regimes and Cane Toads (Woinarski & Hill, 2012). Fire has burnt most of Lot 2303 about every one to two years over the last 19 years, however most, if not all, of these fires occurred prior to 31 July. Such high frequency of fire may have diminished the value of habitat for the Northern Quoll by altering the structure and diversity of flora, reducing the availability and abundance of prey, and decreasing the amount of woody ground substrate and hollow-bearing trees (Woinarski *et al*, 2008; DoEE, 2019). However, some studies have demonstrated that sites that are annually burnt can retain relatively important habitat values and that the frequency and timing of fires play an important role in influencing Northern Quoll populations (Woinarski *et al*., 2004, Hill & Ward, 2010).

Six cameras detected Cane Toads across Lot 2303. Colonisation of an area by Cane Toads has been implicated in the immediate rapid decline of Northern Quoll populations because of poisoning from the consumption of Cane Toads (DoE, 2016). Many areas in the NT formerly occupied by Northern Quolls area now devoid of the species (DoE, 2016).

9.7.5.4 Conclusions

The Northern Quoll was not detected in Lot 2303, probably due to several factors:

- The habitats in Lot 2303 do not provide ideal resources required by the species.
- Known threats to the species (e.g., Cane Toads) are implicated in its decline to the point where it no longer occurs in Lot 2303 (and the local area).
- It was undetectable using the timing and methods employed for this project.

It is therefore concluded that Lot 2303 currently does not appear to be important for the Northern Quoll.

9.7.6 Black-footed Tree-rat

9.7.6.1 Observations

Lot 2303

The Black-footed Tree-rat was detected by 70% of the cameras deployed in Lot 2303 (14 cameras) (**Table 23**). Photos of two of the detections are in **Figure 20** and **Figure 21**. Given that cameras were typically set up in groups of three approximately 50 to 100 m apart, it is likely that any one individual was captured on more than one camera. All detections were in the *Eucalyptus miniata / E. tetrodonta* woodland in the northern half of Lot 2303. This correlates with its preferred habitat (i.e., the southern half of Lot 2303 does not contain habitat attributes typically utilised by the species).

The species peak breeding season is from August to September (Friend, 1987; Rankmore, 2006), which is the time that field surveys were conducted for this project. This may suggest that the species is more active at this time. The species has a lifespan of five years (TSSC, 2015b).

Around Lot 2303 and Jabiru

Despite the deployment of cameras at 35 sites in Jabiru and around Lot 2303, only one Black-footed Tree-rat was detected. This was immediately north-west of Lot 2303 at camera site J-N-23. No individuals of the species were detected on cameras elsewhere (including within Jabiru). Similarly, no Black-footed Tree-rats were observed in the landfill adjacent to Lot 2303 during spotlighting sessions.

9.7.6.2 Habitat

Lot 2303

The species lives in *E. miniata* and/or *E. tetrodonta* woodlands and open forests, particularly where these communities have a relatively dense shrubby understorey (Friend & Taylor, 1985; Friend, 1987, Woinarski, date unknown). Approximately 14 ha of suitable (known) habitat exists within Lot 2303 – the entirety of vegetation community E1 (refer to **Section 9.1** for a map of vegetation communities across Lot 2303). However, the proximity of the landfill may influence the species' abundance locally. Whether the species is dependent on food waste from it is unknown. Whilst no individuals of the species were detected entering the landfill site by cameras placed on the fence between the landfill and the *E. miniata* woodland, one individual was captured by the camera running along the track.

Estimates of Black-footed Tree-rat's activity (home) range include 7 to 18 ha in the Darwin region (Griffiths *et al*., 2002), 27 ha in fragmented habitats (Rankmore, 2006), 40 ha (Firth *et al*, 2006) and 67 ha in unfragmented open forests (Rankmore, 2006). Movements of over 2 km in one night have been observed (Woinarski, date unknown). The species is known to show a clear preference for denning in *E. tetrodonta* (Griffiths *et al*., 2002), although Woinarski (date unknown) indicates that the species uses both *E. tetrodonta* and *E. miniata*. Griffiths *et al.* (2002) measured a mean diameter at breast height (DBH) of den trees of 36 cm and mean tree height of 14 m.

North of Lot 2303

Woodland to the north of Lot 2303 consisted primarily of *E. tetrodonta / E. miniata* woodlands, with some variation in the density and diversity of vegetation in all layers, and soils. The most obvious difference between the woodlands north of Lot 2303 and those within Lot 2303 was the paucity of a dense shrub layer (in many areas) outside Lot 2303. In addition, the ability for Lot 2303 to be occupied by large herbivores (such as Buffaloes) is presumably reduced or eliminated because it is fenced (with a largely intact, 7 foot high, cyclone mesh fence). Though it should be noted that Pigs were observed within Lot 2303. Vegetation in Lot 2303 was not recently burnt, whereas it was across most of the woodlands to the north of Lot 2303.

Around Jabiru

Habitats at the camera sites around Jabiru are described in **Section 9.5.2** (**Table 25**).

9.7.6.3 Threats

Overall, habitats in Lot 2303 appear to be less exposed to threats such as frequent or intense fires and large feral herbivores, and possibly cats. This is likely because it is fenced, adjacent to a landfill (thereby altering food availability for some fauna), and not accessible by the public.

Fire

Generally, suitable habitats for the species are characterised by infrequent and / or low intensity fires (Friend, 1987). Infrequent fires are known to aid in increasing the diversity of shrubs in the mid-layer (Hill, 2012). Conversely, frequent and intense fires may reduce the abundance of hollow-bearing large trees and reduce shrub diversity (Price et al., 2005).

When examining fire frequency alone (rather than timing), it was expected that the species would be disadvantaged by the regular fires across Lot 2303 (**Section 4.10**). Lot 2303 burnt about 14 times between 2000 and 2019 (20 years), with an average timing of early August. However, the species' presence in Lot 2303 suggests that the current fire regime has not been a significant threat. Caution is applied to this speculation though, as no data was collected on the number of Black-footed Tree-rats across Lot 2303, nor on specific attributes of its habitat requirements (such as the diversity and abundance of shrubs or hollow-bearing trees).

Wild Dogs and Cats

Wild dogs may be adversely impacting the species through predation. To what extent this is, is unclear, however, as discussed in **Section 9.2** (**Feral Animals**), wild dogs are also known to benefit some species as a result of preying on cats and other feral animals. No cats were detected by any camera (both within Lot 2303 and around Jabiru), possibly because of the abundance of Wild Dogs. Wild Dogs were detected by 12 cameras in Lot 2303 and were frequently observed by Ecologists on site, both during the day and night. It is also worth noting that no cats have been recorded in the NT Fauna Atlas within 5 km of Lot 2303, which includes the town of Jabiru.

Large Feral Herbivores

Large feral herbivores (buffaloes and horses) were noted in the local area (outside Lot 2303). The high cyclone mesh fence around Lot 2303 presumably excludes these large herbivores, although it was noted that Pigs were able to enter and exit Lot 2303 via a hole in the fence that appeared too small for buffalo or horses to fit through.

Fragmentation

Habitat fragmentation is thought to disadvantage Black-footed Tree-rats (Rankmore, 2006). Lot 2303 is adjacent to widespread woodlands to the north and east and is therefore not substantially affected by fragmentation. Whilst it is bounded by approximately 6 m of track / fire break and fence, this does not appear to hinder an

individuals' movement, given that one individual was detected on the northern side of the fence, and one individual was detected running along the perimeter track.

On the contrary, the patches of woodland in Jabiru are more fragmented and this may be attributed to the lack of Black-footed Tree-rat detections in those areas.

9.7.6.4 Conclusions

Records of any threatened species should be treated as important, although each record ought to be put into a local and regional context. Whilst the species may occur across the lowland woodlands of the Kakadu region, without reliable information of the local and regional population trends, it is difficult to determine, with a high degree of certainty, whether the records on site are significant. Only seven records exist within 5 km of Lot 2303 in the NT Fauna Atlas, of which six are since 2000, though this may reflect low survey effort. However, given that the species is highly detectable (Einoder *et al*. 2019), the data collected for this project suggests that the habitat conditions within Lot 2303 is in relatively better condition than the surrounding woodlands. Whilst further studies are likely to be required to confirm the 'importance' of the animals detected on site (this is discussed further in **Section 11**), at present, a precautionary approach should be applied, and the animals found on site should be treated as locally important.

Figure 20 Black-footed Tree-rat detected at Site 1-3

Figure 21 Black-footed Tree-rat detected at Site 4-3

Figure 22 - Black-footed Tree-rat camera detection locations

Key

Lot 2303

Black-footed Tree-rats

Base layer: Google Satellite

0 50 100 m

1:3000

GDA94, zone 53

Date: 29 September 2020

CONNECT environmental

9.7.7 Northern Brush-tailed Phascogale

9.7.7.1 Observations

The Northern Brush-tailed Phascogale was not detected by any cameras.

9.7.7.2 Habitat

Suitable habitat for the species includes tall open forests dominated by *E. miniata* and *E. tetrodonta*. This habitat is found in the northern half of Lot 2303.

9.7.7.3 Threats

Threats to the species are thought to include cats and Cane Toads. Cats were not recorded during the surveys, and there are no records within 5 km in the NT Fauna Atlas. Other threats include altered fire regimes and/or pastoralism. Given Jabiru is bounded by Kakadu National Park, regular fires may be implicated in its decline in the local area (the species has not been recorded within 5 km since 2002), although there are a low number of records even in the wider region.

9.7.7.4 Conclusions

The species is unlikely to currently exist in Lot 2303 at present because:

- It was not detected there.
- The habitats in Lot 2303 do not provide ideal resources required by the species.
- Ongoing threats to the species (i.e., frequent fires, pigs, Wild Dogs) have limited its ability to inhabit Lot 2303.

9.7.8 Pale Field-rat

9.7.8.1 Observations

The Pale Field-rat was not detected in Lot 2303 despite the deployment of two cameras in the small area (1.6 ha) of potentially suitable habitat in the south-east corner of Lot 2303 (see **Section 8.1.2**).

9.7.8.2 Habitat

The species has been recorded in tall grasslands and forests, normally near a small ephemeral creek (Braithwaite & Baverstock, in Strahan, 1995; McKay, 2017). During the day, it shelters in extensive shallow burrows in loose, sandy soil (Braithwaite & Baverstock, in Strahan, 1995; Cole & Woinarski, 2002). Nests are also often located in termite mounds, possibly to avoid flooded areas in the riparian zones (Braithwaite & Baverstock, in Strahan, 1995). Potentially suitable habitat was identified as the Pandanus grassland in the south-east corner of Lot 2303.

9.7.8.3 Threats

The species' decline in the NT is reported to be because of inappropriate fire regimes, cats, and overgrazing (Young and Hill, 2012; ALA, 2019). Braithwaite & Baverstock (in Strahan, 1995) estimate that up to 90% of the species former range has been lost and that it is now restricted to the northern coastal areas of Australia. A search of the NT Fauna Atlas reveals that there are no recent records in the local area (i.e., within 5 km of Lot 2303), though there are numerous recent records further afield.

9.7.8.4 Conclusions

The species is probably unlikely to currently exist in Lot 2303 at present because:

- It was not detected there.

- The NT Fauna Atlas has no recent records of the species within 5 km of Lot 2303.
- The habitats in Lot 2303 do not provide ideal resources required by the species.
- Ongoing threats to the species (i.e., frequent fires, pigs, Wild Dogs) have limited its ability to inhabit Lot 2303.

9.7.9 Floodplain Monitor

9.7.9.1 Observations

The Floodplain Monitor was not detected on site.

9.7.9.2 Habitat

The irrigated grassland in the southern half of Lot 2303 contained a high abundance of frogs, mainly *Litoria nasuta* and Cane Toads. This area, whilst unnatural, may be suitable for the species, however given that up at least 90% of some populations are reported as being killed by Cane Toads (Ward *et al*., 2012), it appears as though this may be a key factor in its absence from Lot 2303.

9.7.9.3 Threats

As described above, Cane Toads have reportedly caused a substantial decline in populations of the species across the NT. This is reported as the most acute threat by Ward *et al*. (2012). Lot 2303 also contained a high abundance of Wild Dogs, which are known to eat reptiles. Though their impact on native wildlife populations is unclear at this site, given their apparent dependence on the adjacent landfill.

9.7.9.4 Conclusions

The species was not detected on site and given the modified habitats on site (i.e., irrigated grassland) and the high abundance of Cane Toads, Lot 2303 is not considered to be an important area for the species.

10 Finalised Likelihood of Occurrence Assessment

This revised assessment of the likelihood of occurrence of threatened species is based on the data collected and interpreted during the surveys. It re-considers each species that was originally considered to potentially occur in Lot 2303 (noting that the lack of detection of a species does not necessarily preclude its presence there). **Table 28** provides the results of the finalised assessment. As a result, the Black-footed Tree-rat is not included in the final impact assessment in **Section 11**.

This assessment is based on information known as of the date of this report and habitat changes over time may lead to changes in the conclusions made herein.

Table 28 Final threatened species likelihood of occurrence assessment

Species	Detected?	Likelihood of occurrence
Partridge Pigeon	Yes	**Confirmed** – may occasionally utilise the eucalypt woodland in the northern half of Lot 2303. Ample records locally.
Crested Shrike-tit	No	**Possible** – may occasionally utilise the eucalypt woodland in the northern half of Lot 2303, though it is thought to occur in low densities and is very patchily distributed throughout its known range.
Masked Owl	No	**Possible** – Whilst the species is unlikely to be currently nesting within Lot 2303 (and it is uncertain whether it ever would), at the very least, if the species occurs in the region, it may occasionally forage in the woodland and / or irrigated grassland given the range of small vertebrate fauna (i.e., prey) that occurs there.
Fawn Antechinus	No	**Unlikely** – Whilst the eucalypt woodland in the northern half of Lot 2303 may have once contained suitable sheltering, breeding, and foraging resources for the species, at present it does not appear to. There is insufficient ground woody debris (e.g., logs), probably because of regular fires. Other threats may also contribute to its absence (assuming the survey results are accurate) including the high abundance of Wild Dogs.
Northern Quoll	No	**Possible** – Whilst Lot 2303 is significantly disturbed and unlikely to contain sufficient resources for sheltering and breeding, the species may occasionally use Lot 2303 when traversing between better quality habitats.
Black-footed Tree-rat	Yes	**Confirmed** – The species was detected by 70% of the cameras.
Northern Brush-tailed Phascogale	No	**Unlikely** - Whilst the eucalypt woodland in the northern half of Lot 2303 may be suitable for the species to occupy, at present it does not appear to occur there. This may be because of regular fires over the last 20 years (or more), and the high abundance of Wild Dogs.
Pale Field-rat	No	**Unlikely** – The species was not detected in the small amount of potentially suitable grassland habitat in the south-east corner of Lot 2303. If individuals lived there, the cameras would most likely have detected them. Whilst there is a paucity of local and recent records for the species in the NT Fauna Atlas, there are ample further afield (i.e., within 50 km). This indicates that the species is persisting elsewhere.

Species	Detected?	Likelihood of occurrence
Floodplain Monitor	No	**Possible** – Even though the species was not detected on site, the irrigated grasslands on site may be suitable and the surveys may simply have failed to detect it. Nevertheless, there are reports of substantial population declines of the species following the arrival of Cane Toads. Given the high number of Cane Toads observed across Lot 2303, it may be feasible that the species does not occur locally, at least in high numbers.

11 Final Impact and Risk Assessment

11.1 Threatened Species

The preliminary analysis of inherent risks, as described in **Section 7**, has been reviewed and revised based on the results of the field surveys. This 'qualitative threat assessment' (i.e., risk assessment) has been undertaken for those threatened species that potentially occur even though they were not detected. It is specific to potential impacts from the proposed development.

The final risk assessment provides an indication of the level of impacts to any relevant species both before and after any recommended impact avoidance and mitigation measures are implemented. The risk assessment is based on the principles and procedures of the *Australian/New Zealand Standard for Risk Management ISO 31000:2009* (Standards Australia 2009; AZ/NZS 4360:1999) and *HB 203: 2000 Environmental Risk Management – Principles and Process* (Standards Australia 2009) and is taken from the Species Expert Assessment Plan (SEAP) Manual (TSSC, 2015c).

The potential significance of an impact is based on the likelihood and consequence of the impact to that species. The definitions used to determine likelihood are shown in **Table 29**. The definitions used to determine the consequence of an impact to a threatened species are shown in **Table 11**. Based on these, the level of threat was determined by the matrix shown in **Table 30**. The results of the risk assessment are shown in **Table 31**.

It is important to note that most of the potentially occurring threatened species will not be substantially affected by the proposed development and are already affected to a greater extent by existing threats such as inappropriate fire regimes, loss of critical or important habitat and Cane Toads. Nevertheless, it is prudent to recognise the cumulative effect on species, which includes activities such as those proposed on Lot 2303. Any adverse effects of the proposed development would not be able to be measured accurately without comprehensive surveys to determine pre- and post-impact population levels.

Table 29 Impact likelihood definitions

Score	Likelihood	Description
1	Rare	The outcome is not expected to occur; no record of occurring but not impossible; may occur in exceptional circumstances
2	Unlikely	The outcome will only occur in a few circumstances; uncommon but know to occur elsewhere
3	Possible	The outcome may occur; some evidence to support it will happen
4	Likely	The outcome will occur in most circumstances
5	Almost certain	The outcome is expected to occur

Table 30 Level of threat matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Critical
Almost Certain	Low	Medium	High	Severe	Severe
Likely	Low	Medium	Medium	High	Severe
Possible	Low	Low	Medium	High	Severe
Unlikely	Low	Low	Low	Medium	High
Rare	Low	Low	Low	Medium	High

Table 31 Finalised risk assessment for threatened species that potentially occur within Lot 2326

Species	Common name	Potential impact[21]	Inherent[22] risk			Recommended mitigation	Residual[23] risk		
			Likelihood [24]	Consequence	Rating and justification		Likelihood	Consequence	Rating and justification
Geophaps smithii	Partridge Pigeon	• Removal of up to 14 ha of eucalypt woodland habitat • Loss of hollow-bearing trees • Introduction and/or spread of weeds	Likely[25]	Insignificant	**Low** – Whilst some of these species may occasionally utilise Lot 2303 for foraging (though they were not detected there), Lot 2303 does not appear to be particularly important given its altered condition (e.g., effects of the irrigation and adjacent landfill). As such, the impact to each species from the proposed development are likely to be negligible.	• Fire and Weed Management • Erosion and sediment control	Likely	Insignificant	**Low**
Falcunculus frontatus whitei	Crested Shrike-tit			Insignificant					
Tyto novaehollandiae	Masked Owl			Insignificant					
Dasyurus hallucatus	Northern Quoll			Insignificant					
Varanus panoptes	Floodplain Monitor	• Removal of approximately 14 ha of grassland habitats		Insignificant	**Low** – Given the modified nature of the potentially suitable habitat on site (i.e., irrigated, and weedy grassland, which probably was woodland previously) and abundance of Cane Toads, Lot 2303 is probably not of great importance to the species.			Insignificant	**Low**

[21] *These are the key impacts, and others are listed in **Section 7**.*

[22] *With no mitigation measures in place.*

[23] *Following the application of appropriate impact mitigation measures.*

[24] *Likelihood of the impact occurring, should the development proceed.*

[25] *It is assumed that the entire lot will be developed for the sake of this assessment.*

11.2 Black-footed Tree-rat

To assist in determining the significance of the Black-footed Tree-rats identified on site, an assessment against the significant impact criteria contained within the Australian Government's *Significant Impact Guidelines* (DoE, 2013) was undertaken. These guidelines are used for NT-listed species also, in the absence of NT-specific impact criteria. Black-footed Tree-rats are listed as Endangered under the EPBC Act and Vulnerable under the NT TPWC Act. The species will be assessed against the higher of these rating (i.e., Endangered). An assessment of whether the habitat on Lot 2303 is critical to the survival the species is provided in **Table 32**, and an assessment against the significant impact criteria for critically endangered or endangered species is in **Table 33**.

Whilst the number of individuals occupying Lot 2303, and the extent of the area they occupy, is not known, the survey results indicate that they may be unique in the local area. It appears that Lot 2303 provides refuge for Black-footed Tree-rats from more substantial threatening processes in the surrounding landscape. However, the species' reliance on the adjacent landfill, and therefore, the subsequent 'true' suitability of habitat in Lot 2303, is unclear. Regardless, based on the results of the surveys, it appears that the habitat in Lot 2303 is necessary for foraging and breeding for the tree-rats in the local area (as assessed in **Table 32**) and that it is possible that proposed development may reduce the size of the local population, adversely affect critical habitat and disrupt the breeding cycle of those individuals occupying Lot 2303 (as assessed in **Table 33**).

Table 32 Assessment of habitat critical to the survival of the Black-footed Tree-rat

Criteria	Response
Is the area necessary:	
For activities such as foraging, breeding, roosting, or dispersal	**Possible** – It appears that the habitat in Lot 2303 is necessary for the local population for foraging and breeding, given that no individuals were detected in the surrounding area, except for one immediately north of Lot 2303. However, the size and extent of the local population (outside Lot 2303) is unclear.
For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)	**Unlikely** (**though uncertain**) – Based on the area of suitable habitat, the modified landscape setting, its geographic position, and noting the relatively high number of recent regional records, this area is probably not necessary for the long-term maintenance of the species, to maintain genetic diversity and long-term evolutionary development, for the reintroduction of populations or for recovery of the species.
To maintain genetic diversity and long-term evolutionary development, or	
For the reintroduction of populations or recovery of the species or ecological community.	

Table 33 Significant impact assessment for the Black-footed Tree-rat

Criteria	Response
Will the action:	
Lead to a long-term decrease in the size of a population	**Possible** – The species occurs in the Jabiru area, though the size and extent of the population in the Jabiru area is not known. The NT Fauna Atlas contains six records within 5 km of Lot 2303 since 2000[26], with the nearest being approximately 2 km to the south-west. The species has also been recorded from the uranium mine site to the south-west (Eidoder *et al*., 2019). In mid-January 2021, the Djurrubu Rangers informed Connect Environmental that they had recorded a Black-footed Tree-rat on a camera located approximately 300-400 m west of the Jabiru Kart Track (approximately 2 km west of Lot 2303)[27]. However, the species was not detected during the surveys for this project outside Lot 2303, except at one site immediately north-west of Lot 2303. There are several possible causes for this including a higher fire frequency (which is likely to have influenced the vegetation structure and composition and the abundance of coarse woody ground debris (e.g., logs)), and the presence of large feral herbivores. The species is reported to have declined most likely because of too frequent fires (Fitzsimons *et al*., 2010). The habitat within Lot 2303 has a lower fire frequency in the last 19 years (refer to **Section 9.7.6**), is fenced from large feral herbivores (except Pigs) and has a seemingly high abundance of Dingoes. It is also possible that the adjacent landfill provides a food source for Black-footed Tree-rats, though this could not be verified. These factors appear to have resulted in a refuge for tree-rats within Lot 2303. In this regard, it is plausible to suggest that, given the relative condition and consequential importance of habitat within Lot 2303, the development of Lot 2303 could lead to a long-term decrease in the size of the population in the immediate Jabiru area, though this may not be substantial.
Reduce the area of occupancy of the species	**Unlikely** – Using available data (i.e., results of the surveys and existing NT Fauna Atlas data), it is unlikely that the loss of habitat in Lot 2303 will reduce the area of occupancy of the species. The species occurs in the Jabiru region, with the NT Fauna Atlas containing seven records within 5 km of Lot 2303 since 2000[26], with the nearest being approximately 2 km to the south-west. The species has also been recorded from the uranium mine site to the south-west (Eidnoder *et al*., 2019). In mid-January, the Djurrubu Rangers informed Connect Environmental that they had recorded a Black-footed Tree-rat on a camera located approximately 300-400 m west of the Jabiru Kart Track (approximately 2 km west of Lot 2303).
Fragment an existing population into two or more populations	**Uncertain** – The extent of the local population is unclear.
Adversely affect habitat critical to the survival of a species	**Possible** – The habitats within Lot 2303 appear to be supportive to the survival of the species in the locality (as discussed in **Table 32**) and given those more suitable habitat qualities appear to be primarily confined to Lot 2303, the proposed development could adversely affect that habitat.
Disrupt the breeding cycle of a population	**Possible** – Breeding may occur throughout the year, though could peak in August to September (TSSC, 2015). Development of Lot 2303 could disturb the population, depending on how extensive the population is in the local area.

[26] *Post-2000 was selected as the timeframe for which records may still be relevant (i.e., current).*

[27] *The photo was verified by Connect Environmental as a Black-footed Tree-rat*

Criteria	Response
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Unlikely** – Given the high number of regional records, it is unlikely that the removal of the habitat will cause a species decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	**Unlikely** – Many weeds already occur in the local area.
Introduce disease that may cause the species to decline, or	**Unlikely** – The author is unaware of any diseases that may cause the species to decline.
Interfere with the recovery of the species.	**Unlikely -** Given the high number of regional records, and the apparent small size of this 'population', it is unlikely that the removal of the habitat will interfere with the recovery of the species.

11.3 General Biodiversity

An additional risk assessment has been conducted to determine the level of unmitigated and mitigated risks to general biodiversity. **Table 29** (**Section 11**) and **Table 34** contain the definitions of likelihood and consequence, respectively. **Table 30** (**Section 11**) contains the risk assessment matrix and **Table 35** shows the results.

Table 34 Consequence definitions

Aspect	Consequence				
	Insignificant	Minor	Moderate	Major	Critical
General Biodiversity	Negligible effect	Small scale native vegetation / habitat loss; habitat fragmented	Medium to large scale native vegetation loss / habitat fragmented.	Significant impact. Recovery measured in years to decades.	Severe impacts; recovery period decades

Table 35 Biodiversity risk assessment

Environment aspect	Risk / potential impact	Inherent Risk			Mitigation	Residual Risk		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Land	Loss of native flora and fauna during vegetation clearing activities and when accessing sites.	Almost certain	Minor	Medium	• Induct staff and contractors in minimizing environmental impacts, including only clearing areas necessary for the development. • Aim to position the development within previously cleared or disturbed areas, if possible. • Use previously disturbed areas for temporary laydown areas and vehicle parking. • Avoid areas of high-quality vegetation (e.g., large trees), where possible, as these areas contain valuable nesting / sheltering habitat for many fauna species. • Avoid trees that have active nests until no longer being used.	Possible	Minor	Low

Environment aspect	Risk / potential impact	Inherent Risk			Mitigation	Residual Risk		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Land	Introduction, or spread, of weeds from people and vehicles	Possible	Minor	Low[28]	• Ensure staff and contractors are aware of key weed species that may be encountered during the project – see **Sections 4.8** and **9.4** for a list of weed species. • Ensure vehicle weed hygiene techniques are followed – see methods recommended by the NT Government at https://nt.gov.au/environment/weeds/how-to-manage-weeds/prevent-weed-spread-industry-and-recreation/keep-your-vehicles-and-equipment-clean. • Check vehicles and plant before and after construction or earthmoving works. • Monitor area for weed growth in following season to ensure no new weed growth.	Possible	Minor	Low
Land	Waste materials causing soil contamination	Possible	Minor	Low	• Avoid, reduce, reuse, and recycle materials, where possible. • Waste will be stored securely while on-site to minimise windblown rubbish and access by feral animals. • Non-biodegradable and dangerous / hazardous waste to be disposed at appropriate waste management facility.	Unlikely	Minor	Low
Land	Wastewater causing soil contamination	Possible	Minor	Low	• Wastewater will be managed appropriately (e.g., septic)	Unlikely	Insignificant	Low

[28] *There are already a wide range of weeds known to occur on Lot 2303, and locally.*

Environment aspect	Risk / potential impact	Inherent Risk			Mitigation	Residual Risk		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Land	Dangerous and hazardous materials causing soil contamination	Possible	Minor	Low	• Appropriate permits will be obtained for storage and use of dangerous or hazardous materials will be obtained. • Appropriate bunding for fuel and oil storage, if appropriate. • Staff are appropriately trained to use dangerous and hazardous materials.	Unlikely	Minor	Low
Land	Fire	Possible	Minor	Low	• All vehicles to carry fire extinguishers	Unlikely	Minor	Low
Water	Contamination of surface water from oil and fuel spills during refueling or accidental	Possible	Moderate	Medium	• Spill containment and clean up equipment to be present on site. • Ensure vehicles are maintained. • Spills cleaned up immediately	Possible	Minor	Low
Air	Dust from machinery entering and exiting sites	Almost certain	Insignificant	Low	• Water tracks to reduce dust generation, if required.	Possible	Insignificant	Low
Air	Visible exhaust emissions from vehicles and plant	Possible	Minor	Low	• Up to date service of vehicles.	Possible	Insignificant	Low
Noise	Noise disturbance of native fauna from machinery	Possible	Minor	Low	• Equipment used and maintained appropriately.	Possible	Minor	Low

12 Discussion and Conclusions

The vegetation in the northern half of Lot 2303 is comprised of *Eucalyptus miniata* and *E. tetrodonta* woodland in relatively good condition. The site appears to contain a moderate diversity and structural complexity of flora and fauna, however it is adversely affected by the adjacent landfill. Rubbish is spread along the western boundary of Lot 2303 (probably windblown and carried there by fauna) and a seemingly high density of Dingoes / Wild Dogs occupy the western parts of the eucalypt woodland.

The irrigated grassland and adjacent Pandanus and eucalypt fragmented open woodlands in the southern portion of Lot 2303 are weedy and support a different suite of fauna than in the northern part. Nevertheless, these areas have created a unique opportunity for some wetland-inhabiting terrestrial fauna such as frogs, snakes and grassland birds.

Four migratory bird species were assessed to potentially occur within the habitats on Lot 2303 though none is at risk of significant impact given the nature and scale of the proposed development.

Two threatened species were detected in Lot 2303 – Partridge Pigeons and Black-footed Tree-rats. Partridge Pigeons were also detected at numerous other locations around Lot 2303 and in Jabiru. As such, their presence in Lot 2303 is not considered unique and the species is unlikely to be significantly impacted from the proposed development.

The presence of Black-footed Tree-rats in Lot 2303 appears to be important. The survey results indicate that the habitat in Lot 2303 provides a combination of adequate resources and protection for Black-footed Tree-rats not found elsewhere in the local area. However, some knowledge gaps remain such as the number of individuals occupying Lot 2303, the extent of the area they occupy around Lot 2303, their use (if any) of the adjacent landfill, and the abundance and distribution of tree-rats in surrounding, un-surveyed areas. Whilst the study did not aim to compare, in detail, differences in habitat characteristics for the Black-footed Tree-rat between Lot 2303 and neighbouring woodland, the observed key differences related to the species presence in Lot 2303 and apparent absence in adjacent woodlands were:

- There was a reduced, or absent, shrubby layer outside Lot 2303 in most areas observed.
- Large feral herbivores such as buffaloes and horses could not access Lot 2303.
- There was a substantial number of dingoes in Lot 2303.
- The landfill may be a potentially reliable food source (noting that it was not confirmed whether Black-footed Tree-rats were using it).

It is also noted that over the period from 2000 to 2019, Lot 2303 burnt on four less occasions than the adjacent habitat (at an arbitrarily chosen location 1 km north of Lot 2303) (see **Section 4.10**). Whether this is a significant difference is unclear. Other variables potentially influence the distribution of the species in the area including distance to water and cats (however, no cats were detected by any camera).

Overall, Lot 2303 appears to provide refuge for Black-footed Tree-rats, though the relative importance and dynamics of the potential factors associated with their presence is unclear. Either way, the loss of 10 ha of habitat in Lot 2303 may reduce the size of the local population, adversely affect critical habitat and disrupt the breeding cycle of those individuals occupying Lot 2303.

It is possible that other threatened species occasionally utilise the site such as Masked Owls, Northern Quolls and Crested Shrike-tits, at least for foraging. However, their lack of detection is not unexpected in this setting and is probably representative of their absence in the local area or region. Threats to these species, such as altered fire regimes, cane toads and large feral herbivores, are wide-ranging and are far more significant to the long-term maintenance of each species than the loss of the habitats within Lot 2303. As such, it is unlikely that the loss or modification of the habitats within Lot 2303 will significantly impact any other potentially occurring threatened species.

A range of measures has been recommended to reduce the level of impacts to biodiversity (in general) from the proposed development (**Table 35**).

13 References

ABC (Australian Broadcasting Corporation), 2018. *Zorro the sniffer pup is on the hunt for masked owl vomit — it's all in the name of research*. News article. Accessed 8 October 2019.

ALA (Atlas of Living Australia), 2019. *Rattus tunneyi (Thomas, 1904)*. Accessed from https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:ee8f37fd-7222-411a-bb00-c121dd894db1.

Birdlife Australia, 2020. *Masked Owl, Tyto novaehollandiae*. Species profile at https://www.birdlife.org.au/bird-profile/masked-owl.

Brocklehurst, P., and Van Kerckhof, D., 1994. *Melaleuca Survey of the Northern Territory, Document 2, Methodology and Data-base Description*. Conservation Commission of the Northern Territory, Palmerston.

Burgess, E. E., Moss, P., Haseler, M. and Maron, M., 2013. The influence of a variable fire regime on woodland structure and composition. *International Journal of Wildland Fire*. 24(1) 59-69. https://doi.org/10.1071/WF14052.

Calaby, J.H. 1995. Fawn Antechinus, in *The Mammals of Australia*, edited by Ronald Strahan, 1995. Reed Books, Chatswood, NSW.

Cole, J. and Woinarski, J., 2002. *Field Guide to Rodents and Dasyurids of the Northern Territory*. Surrey Beatty & Sons, Sydney.

Davies, H.F., McCarthy, M.A., Firth, R.S.C., Woinarski, J.C.Z., Gillespie, G., Andersen, A.N., Rioli, W., Puruntatameri, J., Roberts, W., Kerinaiua, C., Kerinauia, V., Brooks, K. and Murphy, B. Declining populations in one of the last refuges for threatened mammal species in northern Australia. *Austral Ecology*.

Debus, S., 2009. *The Owls of Australia – A Field Guide to Australian Night Birds*. Envirobook, Canterbury, NSW.

DENR (NT Government Department of Environment and Natural Resources), 2019. *Wild dog*. Website (https://nt.gov.au/environment/animals/feral-animals/wild-dog). Visited on 7 October 2019.

DENR (Department of Environment and Natural Resources), 2020. *Land Clearing Guidelines, Northern Territory Planning Scheme*.

DERM (Department of Environment and Resource Management), 2012. *National recovery plan for the red goshawk Erythrotriorchis radiatus*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra. Queensland DERM, Brisbane.

DEWHA (Australian Government Department of the Environment, Water, Heritage and the Arts), 2010. *Survey guidelines for Australia's threatened birds*. Australian Government, Canberra, ACT.

DoE (Australian Government Department of the Environment), 2013. *Matters of National Environmental Significance, Significant Impact Guidelines 1.1*.

DoE (Australian Government Department of the Environment), 2015. *Referral guideline for 14 birds listed as migratory species under the EPBC Act.*

DoE (Australian Government Department of the Environment), 2016. *EPBC Act referral guideline for the endangered northern quoll*. Commonwealth of Australia.

DoEE (Australian Government Department of the Environment and Energy), 2019. *Dasyurus hallucatus* in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Wednesday, 6 November 2019.

Einoder, L.D., Hill, B. and Fisher. A., 2019. *Rehabilitation of vertebrate assemblages at Ranger Uranium Mine: assessment standards and monitoring methodology*. Department of Environment and Natural Resources, NT Government, Darwin.

Firth, R.S.C., Woinarski, J.C.Z., Brennan, K.G. and Hempel, C., 2006. Environmental relationships of the brush-tailed rabbit-rat, Conilurus penicillatus, and other small mammals on the Tiwi Islands, northern Australia. *Journal of Biogeography*, 33, 1820–1837. doi:10.1111/J.1365-2699.2006.01543.

Fitzsimons, J., Legge, S., Traill, B. and Woinarski, J., 2010. *Into oblivion? The disappearing native mammals of northern Australia*. The Nature Conservancy, Melbourne.

Fleming, P., Allen, B., Ballard, G. and Allen, L., 2012. *Wild dog ecology, impacts and management in northern Australian cattle enterprises: a review with recommendations for RD&E investments*. Meat & Livestock Australia Limited, North Sydney, Australia.

Friend, G.R., 1987. Population ecology of Mesembriomys gouldii. *Australian Mammalology* 23: 181 – 183.

Friend, G.R. and Taylor, J.A., 1985. Habitat preferences of small mammals in tropical open forest of the Northern Territory. *Australian Journal of Ecology* 10, 173-185.

Garnett, S., Szabo, J. and Dutson, G., 2011. *Action Plan for Australian Birds* 2010.

Gillespie, G.R., Brennan, K., Gentles, T., Hill, B., Low Choy, J., Mahney, T., Stevens, A., and Stokeld, D., 2015. *A guide for the use of remote cameras for wildlife survey in northern Australia*. Charles Darwin University, Darwin.

Goodfellow, D.L., 2005. *Birds of Australia's Top End*. New Holland Publishers (Australia) Pty Ltd, Sydney, NSW.

Hill, B., 2012. *Threatened Species of the Northern Territory, Black-footed Tree-rat*. Northern Territory Government, NT.

Letnic, M., Koch, F., Gordon, C., Crowther, M.S. and Dickman, C.R., 2009. Keystone effects of an alien top-predator stem extinctions of native mammals. *Proc. Royal Society B*, published online 17 June 2009. Doi:10.1098/rspb.2009.0574.

Kerrigan, R. and Cowie, I., 2006. *Threatened Species of the Northern Territory, Abrodictyum obscurum*. NT Government.

Lynch, B., Cuff, N. and Green, C., 2012. *Summary of the Origin and Derivation of the 1:250,000 Land System Descriptions for the Northern Part of the Northern Territory, DRAFT*. Land Resource Assessment Unit, Department of Land Resource Management, Palmerston, NT.

McKay, L., 2017. *A guide to Wildlife and protected areas of the Top End*. The Environment Centre Northern Territory, Darwin, NT.

NAFI (Northern Australian Fire Information), 2020. Accessed at https://firenorth.org.au/nafi3/.

Oakwood, M., 2000. Reproduction and demography of the northern quoll, Dasyurus hallucatus, in the lowland savanna of northern Australia. *Australian Journal of Zoology*. 48:519-539. Cited in DoEE, 2019.

Olsen, P., and Weston, M., 2005. Fire and Birds. Fire management for biodiversity. Supplement to *Wingspan*, vol. 15, no. 3, September 2005. Birds Australia.

Price, O., Rankmore, B., Milne, D.J., Brock, C., Tynan, C., Kean, L., and Roger, L., 2005. Regional patterns of mammal abundance and their relationships to landscape variables in eucalypt woodlands near Darwin, northern Australia. *Wildlife Research* 32, 435-446.

Rankmore, B., 2006. *Impacts of habitat fragmentation on the vertebrate fauna of the tropical savannas of northern Australia; with special reference to medium-sized mammals.* Ph.D. thesis. Darwin: Charles Darwin University.

RDS (Reader's Digest Services Pty Ltd), 1977. *Complete Book of Australian Birds*. Reader's Digest Services Pty Ltd, Surry Hills, NSW.

Stephens, D., 2011. *The Molecular Ecology of Australian Wild Dogs: Hybridisation, Gene Flow and Genetic Structure at Multiple Geographic Scales*. PhD Thesis. The University of Western Australia, Perth.

TSSC (Threatened Species Scientific Committee), 2005. *Northern Quoll (Dasyurus hallucatus), Advice to the Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the list of Threatened Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*. Accessed at http://www.environment.gov.au/node/16356 on 8 November 2019.

TSSC (Threatened Species Scientific Committee), 2015a. *Conservation Advice, Antechinus bellus, fawn antechinus*. Canberra, ACT.

TSSC (Threatened Species Scientific Committee), 2015b. *Conservation Advice, Mesembriomys gouldii gouldii, Black-footed Tree-rat*.

TSSC (Threatened Species Scientific Committee), 2015c. *Species Expert Assessment Plan (SEAP) Manual*. Australian Government, Canberra, ACT.

TSSC (Threatened Species Scientific Committee), 2016. *Conservation Advice, Falcunculus frontatus whitei, crested shrike-tit (northern).*

Ward, S., 2012. *Threatened Species of the Northern Territory, Grey Falcon, Falco hypoleucos.* NT Government.

Ward, S., Woinarski, J., Griffiths, T., and McKay, L., 2012a. *Threatened Species of the Northern Territory, Mertens Water Monitor, Varanus mertensi*. Northern Territory Government, NT.

Ward, S., Woinarski, J., Griffiths, T., and McKay, L., 2012b. *Threatened Species of the Northern Territory, Yellow-spotted Monitor, Varanus panoptes*. Northern Territory Government, NT.

Ward, S., 2019. *Survey protocol for the Northern Shrike-tit (Falcunculus frontatus whitei)*. NT Government.

Wilson, B.A., Brocklehurst, P.S., Clark, M.J. and Dickinson, K.J.M., 1990. *Vegetation Survey of the Northern Territory, Australia – Explanatory Notes to Accomany 1:1 000 000 Map Sheets*. Conservation Commission of the Northern Territory, Palmerston.

Woinarski, J., date unknown. *Black-footed Tree-rat Mesembriomys gouldii.* At https://www.awrc.org.au/uploads/5/8/6/6/5866843/john_woinarski-handraising_black_footed_tree_rats.pdf.

Woinarski, J.C.Z., 2004. National Multi-species Recovery plan for the Partridge Pigeon [eastern subspecies] *Geophaps smithii smithii*, Crested Shrike-tit [northern (sub)species] *Falcunculus (frontatus) whitei*, Masked Owl [north Australian mainland subspecies] *Tyto novaehollandiae kimberli*; and Masked Owl [Tiwi Islands subspecies] *Tyto novaehollandiae melvillensis*, 2004 - 2009. Northern Territory Department of Infrastructure Planning and Environment, Darwin.

Woinarski, J., 2006. *Threatened Species of the Northern Territory, Partridge Pigeon.* NT Government.

Woinarski, J. and Hill, B., 2012a. *Threatened Species of the Northern Territory, Brush-tailed Rabbit-rat.* Northern Territory Government.

Woinarski, J. and Hill, B., 2012b. *Threatened Species of the Northern Territory, Northern Quoll Dasyurus hallucatus*. NT Government.

Woinarski, J. and Ward, S., 2012. *Threatened Species of the Northern Territory, Masked Owl (north Australian mainland subspecies), Tyto novaehollandiae kimberli*. Northern Territory Government.

Woinarski, J.C.Z., M. Oakwood, J. Winter, S. Burnett, D. Milne, P. Foster, H. Myles and Holmes, B., 2008. *Surviving the toads: patterns of persistence of the northern quoll Dasyurus hallucatus in Queensland*. Report submitted to the Natural Heritage Trust Strategic Reserve Program. Cited in DoEE, 2019.

Wool Producers Australia, 2018 (revision). *National Wild Dog Action Plan (2014): Promoting and supporting community-driven action for landscape-scale wild dog management*. Barton, ACT.

Young, S., 2012. *Threatened Species of the Northern Territory, Fawn Antechinus, Antechinus bellus*. NT Government.

Young, S. and Hill, B., 2012. *Threatened Species of the Northern Territory, Pale Field-rat, Rattus tunneyi*. NT Government.

Appendix A: Preliminary Threatened Species Likelihood of Occurrence Assessment

Note that this assessment is *preliminary* and is based on a desktop literature review (as per the information collated in **Section 4**) and the reconnaissance survey conducted on 22 June 2020. Following the on-ground surveys, the assessment was repeated in **Section 9.7**.

The following caveats are applied to this assessment:

- Threatened migratory shorebirds and marine animals (including sharks and turtles) have been excluded from this assessment, even though records of them may exist within 5 km of Lot 2303. Analysis of vegetation mapping and aerial imagery indicates that no suitable habitat exists within Lot 2303.
- Survey effort has been recognised as a factor in the consideration of the number of local records.
- For flora, no threatened species have been recorded in the NT Flora Atlas within 5 km of Lot 2303, therefore the assessment is for species occurring within 50 km.

Scientific Name	Common Name	Threatened status (NT / National)[29] TPWC Act	EPBC Act	Preferred habitat[30]	Records within 50 km[31]	Most recent record	Preliminary assessment of likelihood of occurrence
Plants[32]							
Cephalomanes obscurum	Cephalomanes	EN	-	Damp gullies, along creek banks or under rock ledges, in tropical and subtropical rainforest, and in the splash zones of permanent waterfalls (Kerrigan & Cowie, 2006)	2	1984	**Unlikely** No suitable habitat exists within Lot 2303
Boronia quadrilata	Boronia	VU	VU	Sandstone outcrops and rocky scree slopes (Kerrigan & Cowie, 2006)	130	2014	**Unlikely** No suitable habitat exists within Lot 2303
Hibbertia brennanii	Hibbertia	VU	-	Dissected sandstone on top of the escarpment of the Arnhem Plateau (Westaway & Cowie, 2012)	13	2016	**Unlikely** No suitable habitat exists within Lot 2303
Hibbertia pancerea	Hibbertia	VU	-	Sandstone on top of the Arnhem Land escarpment (Westaway & Cowie, 2012)	8	2016	**Unlikely** No suitable habitat exists within Lot 2303
Hibbertia sp. South Magela	Hibbertia	VU	-	Sandstone cliff faces in semi-shaded situations (Westaway & Cowie, 2012)	9	2016	**Unlikely** No suitable habitat exists within Lot 2303

[29] *VU = Vulnerable, EN = Endangered, '-' = not listed*

[30] *Notes on habitats taken from the NT Government's Threatened Species of the Northern Territory factsheets found at https://nt.gov.au/environment/native-plants/threatened-plants and https://nt.gov.au/environment/animals/threatened-animals.*

[31] *As per the NT Flora and Fauna Atlases. No records exist within 5 km of Lot 2303.*

[32] *All flora listed here have been recorded within 50 km of Lot 2303.*

Scientific Name	Common Name	Threatened status (NT / National)[29]		Preferred habitat[30]	Records within 50 km[31]	Most recent record	Preliminary assessment of likelihood of occurrence
		TPWC Act	EPBC Act				
Hibbertia tricornis	Hibbertia	VU	-	Sand on scree of the sandstone escarpment (Westaway & Cowie, 2012)	4	2016	**Unlikely** No suitable habitat exists within Lot 2303
Hibiscus brennanii	Hibiscus	VU	VU	Sandstone cliffs, in gullies and on broken sandstone (Kerrigan & Cowie, 2006)	96	2016	**Unlikely** No suitable habitat exists within Lot 2303
Lithomyrtus linariifolia	Lithomyrtus	VU	-	Heaths or eucalypt woodlands on sandstone (Kerrigan & Cowie, 2006)	13	2017	**Unlikely** No suitable habitat exists within Lot 2303
Utricularia dunstaniae	Bladderwort	VU	-	Wet sand, often in shallow water, in *Melaleuca nervosa* woodland or *Verticordia* shrubland (Kerrigan & Cowie, 2012)	1	1981	**Unlikely** No suitable habitat exists within Lot 2303
Utricularia singeriana	Bladderwort	VU	-	Margins of wet sandy flats and swamps with short relatively open grasses and sedges (Cowie & Kerrigan, 2012)	2	2010	**Unlikely** No suitable habitat exists within Lot 2303

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Birds							
Amytornis woodwardi	White-throated Grasswren	VU	VU	Hummock grasslands ("spinifex"), sometimes with open shrubland or woodland overstorey, mixed among dense boulder fields, sandstone pavements	0	36 / 2017	**Unlikely** No suitable habitat exists within Lot 2303
Calidris ferruginea	Curlew Sandpiper	VU	CE	Coastal lagoons, intertidal mud and sand flats, estuaries, saltmarshes and occasionally on inland freshwater wetlands (Ward, 2012).	0	22 / 2018	**Unlikely** No suitable habitat exists within Lot 2303
Calidris tenuirostris	Great Knot	VU	CE	Large sheltered intertidal mudflats and sand-flats, especially in mangrove areas.	0	2 / 2015	**Unlikely** No suitable habitat exists within Lot 2303
Charadrius leschenaultii	Greater Sand Plover	VU	VU	Sandy beaches and sheltered mudflats	0	4 / 2002	**Unlikely** No suitable habitat exists within Lot 2303
Charadrius mongolus	Lesser Sand Plover	VU	CE	Sheltered mudflats, sandy beaches, estuaries and mangroves (Ward, 2012)	1 / 2000	10 / 2000	**Unlikely** No suitable habitat exists within Lot 2303
Epthianura crocea tunneyi	Yellow Chat	EN	EN	Tall grasslands and samphire shrublands (on coastal saltpans)	0	34 / 2003	**Unlikely** No suitable habitat exists within Lot 2303

[33] *VU = Vulnerable, EN = Endangered, CE = Critically Endangered, '-' = not listed*

[34] *Notes on habitats taken from the NT Government's Threatened Species of the Northern Territory factsheets found at https://nt.gov.au/environment/native-plants/threatened-plants and https://nt.gov.au/environment/animals/threatened-animals.*

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Erythrotriorchis radiatus	Red Goshawk	VU	VU	In the NT, the Tiwi Islands are the stronghold (15% of the Australian population found there (Woinarski *et al*., 2000, cited in DERM, 2012). On the mainland, the species is found along major rivers (Marchant & Higgins, 1993, Garnett & Crowly, 2000; cited in DERM, 2012). Coastal and subcoastal tall, open forest and woodlands, tropical savannas traversed by rivers lined with timber, and along the edges of rainforest (including paperbark forest and gallery forests) (Woinarski, 2006; Marchant & Higgins 1993 cited in DEWHA, 2010). The species generally only nests in trees taller than 20 m and within 1 km of a watercourse or wetland, but not in areas with fragmented vegetation (Aumann & Baker-Gabb, 1991; Czechura, 2001 cited in TSSC, 2015b). The species hunts within a home range of up to 200 km^2 in open forests and gallery forests (Czechura & Hobson, 2000, cited in TSSC, 2015b).	1 / 2019	10 / 2019	**Unlikely** Whilst there is one recent record locally (at the Jabiru town lake (approximately 2 km south-west of Lot 2303)), in the NT, Red Goshawks generally nest along major rivers. Lot 2303 may contain several potentially suitable nesting trees (i.e., 20 m tall eucalypts), however it is not located near a major river or wetland. The nearest creek is about 600 m to the south-east. There is also a paucity of local records[35] and the existing disturbances around Lot 2303 (such as the Jabiru landfill) suggests that the species may not favour such a site.

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Erythrura gouldiae	Gouldian Finch	VU	EN	Feb-Oct: wooded hills with Eucalyptus tintinnans. Nov-Jan: lowland drainages (DEWHA, 2010).	4 / 2017	18 / 2017	**Possible** Whilst there are recent local records, they are not abundant. Further, only 18 records exist within 50 km of Lot 2303. Suitable breeding habitat (*E. tintinnans* trees) does not occur within Lot 2303. Given these factors, Lot 2303 is not expected to be regionally important for the species. However, during the non-breeding season, birds move across large distances within the surrounding landscape (DEWHA, 2010; TSSC, 2016a)) and it is reasonable to suggest that the species may occasionally forage within Lot 2303.
Falco hypoleucus	Grey Falcon	VU	-	Areas of lightly timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm (Ward, 2012)	0	3 / 1980	**Unlikely** No suitable habitat within the project and the species does not typically occur this far north.
Falcunculus frontatus whitei	Crested Shrike-tit	-	VU	A range of eucalypt and melaleuca woodlands; from relatively wet, though still strongly seasonal, areas in Arnhem Land to semi-arid woodlands of the southern Victoria River District (Woinarksi & Ward, 2012).	0	3 / 2009	**Possible** Whilst there are no records within the local area, there is suitable habitat within Lot 2303 (i.e., *E. miniata* and/or *E. tetrodonta* woodland). Given this, and that the species occurs in low densities and is very patchily distributed throughout its known range (Woinarski, 2004; cited in TSSC, 2016b), it is feasible to suggest that it may occur, at least occasionally, within Lot 2303.

[35] *Noting that survey effort in an area must be recognised as a factor in atlas record data.*

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Geophaps smithii	Partridge Pigeon	VU	VU	Principally in lowland eucalypt open forests and woodlands, with grassy understoreys and dominated by Eucalyptus tetrodonta and E. miniata that has a structurally diverse understorey (DEWHA, 2010).	128 / 2019	1311 / 2019	**Possible** There are a substantial number of local and recent records, plus there is suitable habitat on site (eucalypt woodland).
Limosa lapponica	Bar-tailed Godwit	VU	-	Intertidal mudflats or in shallow water	0	6 / 2019	**Unlikely** No suitable habitat appears to exist within Lot 2303.
Numenius madagascariensis	Far Eastern Curlew	VU	CE	Mangroves, intertidal flats and saltmarshes (Ward, 2012)	0	27 / 2017	**Unlikely** No suitable habitat appears to exist within Lot 2303.
Rostralata australis	Australian Painted Snipe	VU	EN	Shallow ephemeral wetlands in central or southern NT (possibly in northern areas of the NT) (Taylor et al., 2013)	0	1 / 2006	**Unlikely** No records exist within 5 km and suitable habitat does not appear to exist within Lot 2303.
Tyto novaehollandiae kimberli	Masked Owl	VU	VU	Mainly in eucalypt tall open forests (esp. those dominated by *Eucalyptus miniata*, *E. tetrodonta* and *Corymbia nesophila*). Also, commonly roosts in monsoon rainforests and forages in more open vegetation types, including grasslands and “treeless plains” (Woinarski & Ward, 2012a).	0	11 / 2018	**Possible** Suitable breeding exists within Lot 2303 (eucalypt tall open forest) and the irrigated grassland on Lot 2303 may be suitable for foraging.

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Mammals							
Antechinus bellus	Fawn Antechinus	EN	VU	Savannah woodland and tall open forest; shelters in tree hollows and fallen logs (Young, 2012). It occurs mostly in open forests and woodlands dominated by *Eucalyptus miniata* and/or *E. tetrodonta*, particularly where these forests have a relatively dense shrubby understorey (Friend, 1985; Friend and Taylor, 1985; cited in TSSC, 2015a). It is less frequently found in areas with frequent intense fires (Corbett *et al*., 2003; cited in TSSC, 2015a)).	19 / 2013	364 / 2019	**Possible** Some suitable habitat characteristics for the species are present within the lot, such as occasional hollow-bearing eucalypts and a moderate amount of woody ground debris (e.g., logs). It is necessary to consider that it may occur until demonstrated otherwise.

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Conilurus penicillatus	Brush-tailed Rabbit-rat	EN	VU	Eucalypt tall open forest, coastal grasslands (with scattered large *Casuarina equisetifolia* trees, beaches, and stunted eucalypt woodlands on stony slopes) (Woinarski & Hill, 2012)	1 / 1983	17 / 2009	**Unlikely** There is only one record within 5 km of Lot 2303, from 1983. Monitoring indicates that the species may be extinct in Kakadu National Park with the last known population recorded there in 2008-2009[36, 37, 38] The relatively high frequency of burning in the surrounding landscape may contribute to the species being unlikely to occur there. Frequent fire events are thought to be a key threat.[39] Possible altered population dynamics in local fauna, such as an increase in Dingo numbers, may also affect native small and medium-sized mammal numbers.

[36] *Firth, R.S.C., Brook, B.W., Woinarski, J.C.Z., and Fordham, D.A., 2010. Decline and likely extinction of a northern Australian native rodent, the Brush-tailed Rabbit-rat Conilurus penicillatus. Biological Conservation 143, 1193-1201.*

[37] *Threatened Species Scientific Committee (TSSC), 2016. Conservation Advice, Conilurus penicillatus, Brush-tailed Rabbit-rat.*

[38] *Woinarski, J.C.Z., Hill, B.M, and Ward, S., 2017. Recovery, Management and Monitoring Plan for the Brush-tailed Rabbit-rat Conilurus penicillatus. Department of Environment and Natural Resources, Darwin.*

[39] *Woinarski, J.C.Z., Hill, B.M, and Ward, S., 2017. Recovery, Management and Monitoring Plan for the Brush-tailed Rabbit-rat Conilurus penicillatus. Department of Environment and Natural Resources, Darwin.*

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Dasyurus hallucatus	Northern Quoll	CE	EN	Wide range of habitats, but the most suitable habitats appear to be rocky areas (Woinarski & Hill, 2012)	23 / 2002	558 / 2019	**Possible** Lot 2303 may be occasionally used for foraging or traversed by dispersing individuals of the species, although there is a paucity of recent records from the local area. Lot 2303 may contain some habitat characteristics that are preferred by the species, including a eucalypt woodland with occasional hollow bearing trees, a moderately shrubby understorey, though the abundance of woody debris (e.g., logs) is unknown. Overall, Lot 2303 appears to contain suitable sheltering and foraging habitat and this species should be considered further (i.e., surveyed for). However, as for other small to medium-sized mammals, the adjacent landfill probably changes the population dynamics of fauna (e.g., possible increase in Dingo numbers and a consequential flow on effect to other fauna).
Hipposideros inornatus	Arnhem Leaf-nosed Bat	VU	EN	Caves or abandoned mine adits in cool draughty areas, close to water (Woinarski & Milne, 2015)	0	21 / 2009	**Unlikely** Its distribution is influenced by the availability of suitable caves and mines for roost sites which do not appear to be within or near to Lot 2303
Hipposideros stenotis	Northern Leaf-nosed Bat	VU	-	Roosts in shallow caves, boulder piles and disused mines. It forages in a variety of habitats from monsoon vine thickets and woodlands to open grasslands.	0	4 / 1981	**Unlikely** No records exist in the local area and no suitable habitat appears to exist.

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Macroderma gigas	Ghost Bat	-	VU	Roosts in a deep crack or cave (Ward & Milne, 2016)	2 / 2011	90 / 2014	**Unlikely** Its distribution is influenced by the availability of suitable caves and mines for roost sites which do not appear to be within or near to Lot 2303. It may occasionally forage on Lot 2303 if it is within the range of a roost, though Lot 2303 does not appear to be substantially important for the species overall.
Mesembriomys gouldii gouldii	Black-footed Tree-rat	VU	EN	Tropical woodlands and open forests in coastal areas (Hill, 2012).	7 / 2012	1016 / 2019	**Likely** Whilst there is a paucity of recent records in the local area, suitable habitat exists on site in the form of eucalypt woodland with several large hollow-bearing trees and a moderately shrubby and grassy understorey. Although the adjacent landfill may influence this likelihood, if, for example, there is a consequential increase in abundance of Dingoes and a flow-on effect to small and medium-sized mammals because of predation.
Petrogale concinna canescens	Nabarlek	VU	EN	Rocky areas (sandstone or granite), especially on steep slopes, with large boulders, caves and crevices. May move to forage in adjacent flat areas.	0	14 / 2009	**Unlikely** No suitable habitat exists on site.

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Phascogale pirata	Northern Brush-tailed Phascogale	EN	VU	Tall open forests dominated by *Eucalyptus miniata* and *E. tetrodonta*. Shelters in hollows during the day.	7 / 2002	39 / 2009	**Possible** The northern half of Lot 2303 is comprised of *E. miniata* and *E. tetrodonta* woodland, containing numerous large hollow-bearing trees. There is also a moderately diverse understorey. As with other small to medium mammals, the level of influence of the adjacent landfill is uncertain on local fauna population dynamics.
Rattus tunneyi	Pale Field-rat	VU	-	Dense vegetation along creeks, though can reside in other dense vegetation in seasonally saturated areas.	5 / 2002	283 / 2019	**Possible** Whilst there are no recent records in the local area, there are areas of dense grassy vegetation along the southern boundary, presumably as a result of the wastewater irrigation. These areas are likely to support numerous small mammals, though the diversity and abundance of them is not clear. It is worth investigating further to determine whether this species is present.
Saccolaimus saccolaimus	Bare-rumped Sheath-tailed Bat	-	VU	Open Pandanus woodland fringing the sedgelands and eucalypt tall open forests (Milne & Woinarski, 2006)	0	0	**Unlikely** It has been recorded from Cobourg Peninsula to Keep River, yet there appears to be substantial uncertainty of its range. However, it has not ever been recorded within 50 km. Until such time that there is other data to suggest the species may occur there, it is considered unlikely at present.
Xeromys myoides	Water Mouse, False Water Rat	-	VU	Mangrove forests, freshwater swamps and floodplain saline grasslands	0	2 / 1902	**Unlikely** No suitable habitat exists within Lot 2303.

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Zyzomys maini	Arnhem Rock-rat	VU	VU	Areas with large sandstone boulders or escarpment with fissures and cracks	0	426 / 2019	**Unlikely** No suitable habitat exists within Lot 2303.
Reptiles							
Acanthopsis hawkei	Plains Death Adder	VU	VU	Floodplains and cracking soil plains across mainland northern Australia	1 / 1983	11 / 2011	**Unlikely** No recent records exist locally and no suitable exists in Lot 2303.
Bellatorias obiri	Arnhem Land Egernia	EN	EN	Sandstone outcrops, typically with extensive fissures and cave systems (Ward et al., 2012)	0	23 / 2011	**Unlikely** No suitable habitat exists within Lot 2303.
Morelia oenpelliensis	Oenpelli Python	VU	-	Cracks, caves and crevices of rugged broken sandstone escarpments and gorges; or in large shady trees. Monsoon rainforest patches, riparian areas, woodlands, open heathlands and bare rock pavements	0	48 / 2013	**Unlikely** No suitable habitat exists within Lot 2303.

Scientific Name	Common Name	Threatened status (NT / National)[33] TPWC Act	EPBC Act	Preferred habitat[34]	Records within 5 km / most recent	Records within 50 km / most recent	Preliminary assessment of likelihood of occurrence
Varanus mertensi	Mertens' Water Monitor	VU	-	Coastal and inland waters, often seen climbing on rocks or trees near water (Ward et al, 2006)	20 / 2018	76 / 2018	**Possible (during the wet season)** Whilst no preferred habitat exists on Lot 2303, some individuals range far from water ways to areas containing temporary waters.[40] The modified habitats resulting from the irrigation is likely to have altered the population dynamics of native species, though to what extent is unclear. Overall, whilst Lot 2303 may be infrequently visited by the species during the wet season, it is unlikely to support populations or individuals of the species.
Varanus mitchelli	Mitchells Water Monitor	VU	-	Margins of watercourses, swamps, and lagoons (Ward, 2012)	2 / 1982	14 / 2019	**Unlikely** No recent records exist in the local area and no suitable habitat exists on site.
Varanus panoptes	Yellow-spotted Monitor	VU	-	Variety of habitats, including coastal beaches, floodplains, grasslands, and woodlands	11 / 2013	64 / 2019	**Possible** There are several relatively recent local records and, given its broad range of preferred habitats, it may occasionally use Lot 2303 for foraging, particularly given the likely altered population dynamics of native fauna due to the irrigated grasslands on site.

[40] *McKay, L., 2017. A guide to wildlife and protected areas of the Top End. The Environment Centre Northern Territory.*

Appendix B: Preliminary Migratory Species Likelihood of Occurrence Assessment

The EPBC Act Protected Matters Search Tool Report (**Appendix C**) lists 22 migratory species (that are listed under the EPBC Act) as potentially occurring within 5 km of Lot 2303. However, 16 of these are marine and/or wetland species that will not occur on Lot 2303 as there is no suitable habitat. Therefore, the remaining six species are assessed.

Scientific Name	Common Name	Threatened / marine / migratory status (NT / National) TPWC Act	EPBC Act	Preferred habitat[41]	No. records within 50 km	Most recent record	Preliminary assessment of likelihood of occurrence
Cecropis daurica	Red-rumped Swallow	Not listed	Marine Migratory	Non-breeding habitat only: predominately forages over wetlands and open well-watered grasslands.	0	-	**Possible** The southern half of Lot 2303 is irrigated with untreated water and is consequently green all year round. However, it is also regularly mowed, which may influence the suitability of habitat for the species.
Cuculus optatus	Oriental Cuckoo	Not listed	Migratory	Non-breeding habitat only: monsoonal rainforest, vine thickets, wet sclerophyll forest or open Casuarina, Acacia or Eucalyptus woodlands. Frequently at edges or ecotones between habitat types. Riparian forest is favoured habitat in the Kimberley region.	60	2019	**Possible** Suitable habitat may exist given its broad habitat preference.
Hirundo rustica	Barn Swallow	Not listed	Marine Migratory	Non-breeding habitat only: occurs in the air above open vegetated areas including native and agricultural grasslands as well as over open water areas.	0	-	**Possible** The southern half of Lot 2303 is irrigated with untreated water and is consequently green all year round. However, it is also regularly mowed, which may influence the suitability of habitat for the species.
Motacilla cinerea	Grey Wagtail	Not listed	Marine Migratory	Non-breeding habitat only: has a strong association with water, particularly rocky substrates along water courses but also lakes and marshes.	1	1990	**Unlikely** No suitable habitat exists.

[41] *Notes on habitats taken from the Referral guideline for 14 birds listed as migratory species under the EPBC Act (found at http://www.environment.gov.au/biodiversity/threatened/publications/epbc-act-referral-guidelines-migratory-birds).*

Scientific Name	Common Name	Threatened / marine / migratory status (NT / National)		Preferred habitat[41]	No. records within 50 km	Most recent record	Preliminary assessment of likelihood of occurrence
		TPWC Act	EPBC Act				
Motacilla flava	Yellow Wagtail	Not listed	Marine Migratory	Non-breeding habitat only: mostly well-watered open grasslands and the fringes of wetlands. Roosts in mangroves and other dense vegetation.	0	-	**Possible** The southern half of Lot 2303 is irrigated with untreated water and is consequently green all year round. However, it is also regularly mowed, which may influence the suitability of habitat for the species.
Rhipidura rufifrons	Rufous Fantail	Not listed	Marine Migratory	Moist, dense habitats, including mangroves, rainforest, riparian forests and thickets, and wet eucalypt forests with a dense understorey. When on passage a wider range of habitats are used including dry eucalypt forests and woodlands and Brigalow shrublands.	0	-	**Unlikely** No suitable habitat exists, though the species may use Lot 2303 when on passage, though this would be rare (if ever) at this site.

Appendix C: EPBC Act Protected Matters Search Tool Report

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

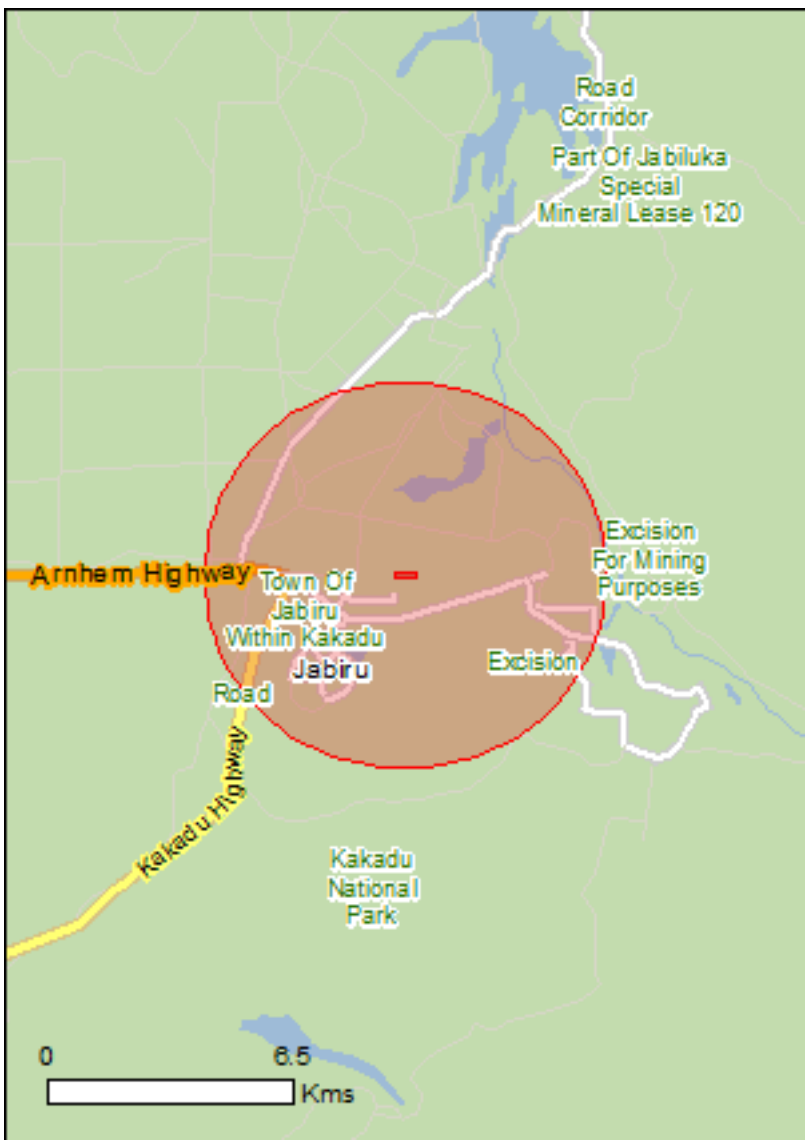
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 04/06/20 12:39:43

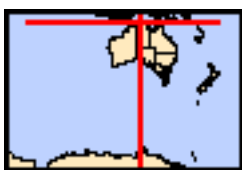
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 5.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	20
Listed Migratory Species:	22

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	4
Commonwealth Heritage Places:	None
Listed Marine Species:	28
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	18
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

World Heritage Properties		[Resource Information]
Name	State	Status
Kakadu National Park	NT	Declared property

National Heritage Properties		[Resource Information]
Name	State	Status
Natural		
Kakadu National Park	NT	Listed place

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Kakadu national park	Within Ramsar site

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat likely to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii smithii Partridge Pigeon (eastern) [64441]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Antechinus bellus Fawn Antechinus [344]	Vulnerable	Species or species habitat known to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
[Dasyurus hallucatus](#) Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
[Hipposideros inornatus](#) Arnhem Leaf-nosed Bat [86675]	Endangered	Species or species habitat likely to occur within area
[Macroderma gigas](#) Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
[Mesembriomys gouldii gouldii](#) Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat known to occur within area
[Petrogale concinna canescens](#) Nabarlek (Top End) [87606]	Endangered	Species or species habitat may occur within area
[Phascogale pirata](#) Northern Brush-tailed Phascogale [82954]	Vulnerable	Species or species habitat known to occur within area
[Saccolaimus saccolaimus nudicluniatus](#) Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
[Acanthophis hawkei](#) Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
[Bellatorias obiri](#) Arnhem Land Egernia [83161]	Endangered	Species or species habitat likely to occur within area
Sharks		
[Pristis pristis](#) Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Marine Species		
[Crocodylus porosus](#) Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
[Pristis pristis](#) Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat likely to occur within area
Migratory Terrestrial Species		
[Cecropis daurica](#) Red-rumped Swallow [80610]		Species or species habitat may occur within area
[Cuculus optatus](#) Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
[Hirundo rustica](#) Barn Swallow [662]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat likely to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Kakadu Holiday Village National Park
Commonwealth Land - Kakadu National Park
Defence - NORFORCE DEPOT - JABIRU

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat likely to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat likely to occur within area
Reptiles		
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Commonwealth ReservesTerrestrial		[Resource Information]
Name	State	Type
Kakadu	NT	National Park (Commonwealth)

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Bubalus bubalis Water Buffalo, Swamp Buffalo [1]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Plants		
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Mimosa pigra Mimosa, Giant Mimosa, Giant Sensitive Plant, ThornySensitive Plant, Black Mimosa, Catclaw		Species or species habitat likely to occur

Name	Status	Type of Presence
Mimosa, Bashful Plant [11223]		within area
Pennisetum polystachyon		
Mission Grass, Perennial Mission Grass, Missiongrass, Feathery Pennisetum, Feather Pennisetum, Thin Napier Grass, West Indian Pennisetum, Blue Buffel Grass [21194]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus		
Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat known to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Kakadu National Park	NT

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-12.652072 132.853005,-12.652051 132.858348,-12.653276 132.858305,-12.653234 132.852984,-12.652072 132.853005

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix D: Masked Owl Survey Method (DENR, 2019)

MASKED OWL SURVEY METHOD

Background

This survey methodology is adapted from the Mapping the Future Program surveys from Gunn Point. The method is based on current knowledge and may change over time, as more knowledge is gained.

The masked owl mainly occurs in tall open eucalypt forests and woodlands, typically of *Eucalyptus miniata, E. tetrodonta* and or *Corymbia nesophila*, but typically roosts during the day in areas of thicker vegetation, such as monsoon rainforests or mangroves. Preferred roosts are in large hollows in standing trees and such hollows are also required for nesting. There are remarkably few records of the north Australian masked owl in the NT, so its distribution is poorly known. Most records have come from the Cobourg Peninsula and the north-western Top End (Kakadu, Daly region, Katherine,) but there are also isolated records from the Victoria River District, Borroloola area, Barkly Tablelands, and one from the Tanami Desert. The Tiwi masked owl is found across both Bathurst and Melville Islands, but is restricted to these two Tiwi Islands.

Masked owls are nocturnal hunters and most of the diet comprises small mammals (up to the size of possums). The major threatening process for the Tiwi masked owl is the loss to habitat through the clearing of tall forests and woodlands for plantation forestry. For the mainland Australian subspecies, broad-scale decline of small native mammals across northern Australia, combined with habitat alteration caused by changed fire regimes (particularly the loss of old large hollow-bearing trees) are the most likely threatening processes.

Nesting typically occurs in the early dry-season. In the lead-up to nesting (i.e., build up and wet-season) they communicate within the pair and to advertise their territories using a range of screeches, screams, hisses and chatter calls. During this period a breeding pair also defend their territories to exclude other masked Owl individuals or breeding pairs. Once nesting commences masked owls are less vocal. Calling by owls is a form of territorial and/or mate defence that may change with the stage of breeding. Surveys for masked owls are best done at night, and typically combine: listening for calls; playback of calls to illicit a vocal response or draw a bird towards the observer; and spotlighting. Owls can hear considerably further than humans, so playback likely draws owls towards the observer. Thus, the distance and area that you sample changes between passive and playback methods. Available data from the Top End suggests surveys are likely to be most successful in the lead-up to nesting (i.e. build-up and wet-season). Moonlit nights improve the ability to

spot owls flying overhead in listening bouts when spotlights are not in use, thus surveys should be timed to occur on moonlit nights to improve detectability of owls.

Pairs of masked owls occupy large exclusive home ranges (estimated at 5-10 km^2 in south-eastern Australia), but can be highly varied depending on habitat quality. Established territories are expected to encompass areas of varied habitat, with Open Forest or Monsoon vine-thicket likely used for breeding, and vast areas of dry woodland required for hunting.

Survey design considerations

- Because Masked Owls are likely to occur at low densities it is very possible that call-playback within an occupied territory will not be heard by resident birds, in which case they will not be detected during a single survey of a single site.
- To overcome the low density of owls/large territories:
    - multiple sites should be positioned within potential territories and;
    - sites should be surveyed on more than one occasion, to increase the chance that the observer and the owl interact in the same space thereby allowing the owl to hear the playback and give a response that the observer can detect. Repeat surveys are recommended either on consecutive nights or within 3-5 days of each other.
- Rain or windy weather makes it difficult to detect owl and surveys should not occur under such conditions.
- Powerful Owl calls can be heard during calm, fine weather from 1-2 km away (DSE powerful owl survey methods, 2011). Hence, when sampling extensive areas, it is recommended that sites should be at least 3 km apart, if you require independent samples (when assessing population size not for initial presence/absence detection).

Locating call-playback sites

When walking into sites, keep noise to an absolute minimum. Scan trees and treetops with a spotlight as you walk toward the site waypoint, keeping an eye out for owls, and any hollow bearing trees, stop to take a waypoint of any hollows located and record on datasheet for that site. If an owl is located get a positive identification using binoculars. Take a waypoint and any relevant notes as an opportunistic records and record on datasheet for that site.

Call-playback method

Upon arrival at the site:

i. 5 minutes of passive survey - immediately allow 5 minutes of passive survey which is quite listening with no spotlighting, and minimal to no walking about.

ii. 1 minutes broadcast - Broadcast the Masked Owl call for approx. 1 minute to play the 'Screech' call sequence directing the call in several different directions.

iii. 10 minutes of passive survey - listen for calls of masked owls with no spotlighting and watch the sky (two observers watching different areas) for silhouettes of birds flying in to the area around the site.

iv. 1 minutes broadcast - Broadcast the Masked Owl call for approx. 1 minute to play the 'Hisses' call sequence directing the call in several different directions.

v. 15 minutes of passive survey - listen for calls of masked owls with no spotlighting and watch the sky (two observers watching different areas) for silhouettes of birds flying in to the area around the site.

vi. 1 minutes broadcast - Broadcast the Masked Owl call for approx. 1 minute to play the 'Chattering' call sequence directing the call in several different directions.

vii. 15 minutes of passive survey - listen for calls of masked owls with no spotlighting and watch the sky (two observers watching different areas) for silhouettes of birds flying in to the area around the site.

viii. 5 minutes spotlight search - After the listening period, keep listening for owl calls but use a spotlight to scan all trees while walking around a 100x100m (1ha) area for 5 minutes.

METHOD	DURATION	CUMULATIVE DURATION	PERIOD
Passive survey	5	5	arrival
Playback	1	6	first round call playback
Passive survey	10	16	
Playback	1	17	second round call playback
Passive survey	15	32	
Playback	1	31	second round call playback
Passive survey	15	48	
Spotlight area search	5	53	Spotlight

The most common responses by Masked Owls to a broadcast are:

- ignore the broadcast (in which case they will not be detected – false negative);
- make a territorial call and continue previous activity from their initial location (i.e. be heard but not seen) – can be a very distant call;
- make a territorial call and fly into to a tree close to the speaker/observer. The bird may continue to call or may be quiet; or
- not respond vocally, but fly overhead and either perch in a nearby tree, or fly off.

If a Masked Owl is heard calling in the distance early in the survey then continue the survey schedule, including call-playback to try and draw the bird in closer.

If an owl flies in and perches in a tree within sight of the observers during the broadcast or listening period/s, turn on the spotlight and identify the species. Masked Owls and Barn Owls are very similar. Ensure the observer can tell the difference between them.

If another owl species is heard during the listening period then identify them by call (e.g., Rufous Owl, Barking Owl, Southern Boobook) and avoid turning on the spotlight - this may deter an approaching Masked Owl.

Once a masked owl has been drawn into the survey site and been sighted the playback should be discontinued to allow the owl to resume its normal activities. Once a masked owl is detected there is no need to undertake the remainder of the survey for that particular site.

Record the exact time of first detection on the datasheet.

NOTE: if a Masked Owl is detected on the first surveys the second survey should also be completed, as the two surveys will return valuable data for estimating probability of occupancy and detection.

Owls have been recorded taking several hours to fly-in or respond vocally to call-playback. Due to practical constraints remaining at each site for longer than 53 minutes is not required. Time spent at a site should only be shortened if a Masked Owl is positively identified at the site.

Call playback - Should include the range of Masked Owl calls including screeches, hisses and chattering. The calls should be broadcast through a hand held megaphone at an appropriate volume. Ideally, a high quality speaker should be used so there is no background crackling or hissing sounds – this can affect the survey results. The volume of the speaker should be adjusted such that at 10-20 m away the volume is similar to that of an owl, i.e., played at ~ 110% of natural volume. Consistent and appropriate volume is imperative as a quiet broadcast will be ineffective, and a ridiculously loud broadcast may scare off resident birds. When broadcasting the calls it is important to hold the megaphone above the ground, preferably at head height, and rotate by 45 degrees to direct each call in the call sequence (usually four) in different directions. For example, in an area of contiguous woodland rotate 360 degrees so the call is broadcast across the entire surrounding area. If on the coast at the edge of a patch of suitable habitat, rotate through a smaller arc to broadcast across the entire suitable habitat. If the site has undulating terrain then walk to the highest point to broadcast calls from there, enabling the noise to travel further.

Spotlighting - Do an initial scan of all the trees in a 360 degree view around the location of call-playback, then spend the rest of the 5 minutes walking the broader 100x100m (1ha) area doing a more-careful search of the trees for owls. During spotlighting note any small mammals on the grounds or arboreal mammals (potential prey) seen or heard, as well as any trees bearing large hollows, suitable for owl roosting or nesting, and record any observations on datasheet.

Timing of surveys

Masked owls are most vocal, and therefore most amenable to playback-based survey techniques, in the lead-up to the nesting season. On the Tiwi Islands nesting has been observed as starting soon after the end of the wet season, that calling was most evident during the build-up and that calling continued through the wet season (J Smith *pers comm*). Hence the best times of year for surveys of masked owls in the NT are the build-up (October-December) and the wet season (approximately January-March). Although the season may be slightly later in the Groote Eylandt region. Masked owls may respond to broadcast surveys at other times of year, but their detectability will be lower, so more false negatives should be expected.

SURVEY EQUIPMENT

- megaphone
- mp3 player or USB
- spotlight
- camera
- Iphone to record calls