Hemi Gold Project

Vertebrate Fauna Surveys 2021 – 2024

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Executive Summary

Introduction

De Grey Mining Limited proposes to develop the Hemi Gold Project, located in the Pilbara region of Western Australia, approximately 85 km south of Port Hedland, within the Town of Port Hedland Local Government Area. Western Wildlife was commissioned to carry out a two-phase detailed fauna survey of the Hemi study area, and a basic survey of the proposed infrastructure corridors. The purpose of the fauna survey was to gather baseline fauna data to inform environmental impact assessment as part of Project approvals. This report includes the findings of the two-phase baseline vertebrate fauna survey, conducted in September 2021, March 2022 and April/May 2024, with some supporting data collected in August - October 2022.

Methods

The fauna survey was undertaken in accordance with the Technical Guidance: terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020) and relevant State and Federal Guidelines on surveying conservation significant fauna. The fauna survey comprised six fieldtrips, 19 – 30 September 2021, 14 – 25 March 2022, 9 – 12 August 2022, 15 – 23 September 2022, 6 – 17 October 2022 and 12 – 18 April 2024 with methods including:

- Trapping at six sites for seven nights, each with ten pitfall traps, ten funnel traps, ten Elliott traps and two cage traps.
- Bird surveys at each trapping site and opportunistically.
- Bat surveys with ultrasonic detectors .
- Night Parrot survey with passive acoustic detectors at 13 sites in March 2022 and 18 sites in April/May 2024.
- Camera trap survey, particularly targeting Northern Quoll (*Dasyurus hallucatus*).
- Nocturnal transects and searches.
- Diurnal transects and searches, particularly targeting the Bilby (*Macrotis lagotis*).
- Keeping opportunistic records of fauna.

Species of conservation significance were classified as: **Threatened** if listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or *Biodiversity Conservation Act 2016* (BC Act); **Migratory** if listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened; **Specially Protected** if listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act; **Priority** if listed as Priority by DBCA and **Locally Significant** if considered by the author to potentially be of local significance.

Results and Discussion

Six fauna habitats were identified in the study area:

- Spinifex Sandplain
- Sandplain Drainage
- Sand Dune
- Major River
- Stony Hills
- Rocky Outcrops

Of these habitats, the Rocky Outcrops and Sand Dune are limited in extent in the study area and the wider region. The Major River is an ecological linkage and an area of higher productivity due to the presence of waterholes.

The predicted faunal assemblage includes up to ten frogs, 115 reptiles, 165 birds, 36 native mammals and eight introduced mammals. The observed assemblage thus far includes six frogs, 56 reptiles, 89 birds, 22 native mammals and six introduced mammals.

Thirty-one conservation significant fauna have either been recorded or may occur in the study area, nine Threatened, 12 Migratory, one Specially Protected, eight Priority and one Locally Significant.

The nine **Threatened** species are:

- Northern Quoll (*Dasyurus hallucatus*) – EBPC Act (Endangered), BC Act (Endangered)
- Pilbara Olive Python (*Liasis olivaceous barroni*) – EBPC Act (Vulnerable), BC Act (Vulnerable)
- Grey Falcon (*Falco hypoleucos*) – EBPC Act (Vulnerable), BC Act (Vulnerable)
- Night Parrot (*Pezoporus occidentalis*) – EBPC Act (Endangered), BC Act (Critically Endangered)
- Bilby (*Macrotis lagotis*) – EBPC Act (Vulnerable), BC Act (Vulnerable)
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) – EBPC Act (Vulnerable), BC Act (Vulnerable)
- Ghost Bat (*Macroderma gigas*) – EBPC Act (Vulnerable), BC Act (Vulnerable)
- Common Greenshank (*Tringa nebularia*) – EBPC Act (Endangered & Migratory), BC Act (Migratory)
- Sharp-tailed Sandpiper (*Calidris acuminata*) – EBPC Act (Vulnerable & Migratory), BC Act (Migratory)

The Northern Quoll was recorded and the study area provides Rocky Outcrop and Major River habitat critical to the survival of the species. These habitats are also likely to support the Pilbara Olive Python and the Grey Falcon may breed along the Major River. It is considered possible that the Night Parrot occurs in the study area, as this scarce species is poorly known, however, no birds were detected and the small areas of open spinifex have been impacted by frequent fire. It is considered unlikely that the study area currently comprises critical habitat for this species.

Secondary signs of the Bilby were recorded in the Sand Dune and Spinifex Sandplain habitats, and this species is likely to be widespread in the region. Pilbara Leaf-nosed Bat was recorded in low numbers on this survey and the study area provides foraging habitat for both this species and the Ghost Bat, but diurnal roosting habitat is absent. The Common Greenshank and Sharp-tailed Sandpiper may use waterholes in the Major Rivers and claypans in the Spinifex Drainage habitat, but these habitats are not likely to support nationally or international significant numbers of birds.

The 12 **Migratory** species are:

- Fork-tailed Swift (*Apus pacificus*)
- Oriental Plover (*Charadrius veredus*)
- Pectoral Sandpiper (*Calidris melanotos*)
- Red-necked Stint (*Calidris ruficollis*)
- Wood Sandpiper (*Tringa glareola*)
- Marsh Sandpiper (*Tringa stagnatilis*)
- Common Sandpiper (*Actitis hypoleucos*)
- Eastern Osprey (*Pandion cristatus*)
- Oriental Pratincole (*Glareola maldivarum*)
- Gull-billed Tern (*Gelochelidon nilotica*)
- Caspian Tern (*Hydroprogne caspia*)
- Glossy Ibis (*Plegadis falcinellus*)

Of the Migratory species predicted to occur, only the Fork-tailed Swift was recorded. Most of the remaining species are likely to be non-breeding summer visitors to the study area, many being shorebirds that may use waterholes in the Major Rivers and possibly claypans in the Spinifex Drainage habitat. In general, the study area is unlikely to provide important habitat to Migratory fauna.

The one **Specially Protected** species is:

- Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon potentially occurs in the study area but its favoured breeding habitat is absent.

The eight **Priority** species are:

- Pin-striped Finesnout Ctenotus (*Ctenotus nigrilineatus*) – Priority 1
- Gane's Blind Snake (*Anilios ganei*) – Priority 1
- Northern Coastal Free-tailed Bat (*Ozimops cobourgianus*) – Priority 1
- Long-tailed Dunnart (*Sminthopsis longicaudata*) – Priority 4
- Brush-tailed Mulgara (*Dasycercus blythi*) – Priority 4
- Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) – Priority 4
- Lakeland Downs Mouse (*Leggadina lakedownensis*) – Priority 4
- Western Pebble-mound Mouse (*Pseudomys chapmani*) - Priority 4

The Pin-striped Finesnout Ctenotus and Gane's Blind Snake are poorly known, but possibly occur in the study area. The Northern Coastal Free-tailed Bat was recorded in the study area, foraging over Spinifex Sandplain and Sandplain Drainage habitats. The Long-tailed Dunnart is known from the region and potentially occurs in the Stony Hills and Rocky Outcrops. The Brush-tailed Mulgara was recorded in the Spinifex Sandplain and Sandplain Drainage habitats on this survey and is widely recorded on sandplains in the region. The Spectacled Hare-wallaby is likely to occur in the Spinifex Sandplain and Spinifex Drainage habitats where there is mature spinifex to provide shelter. The Lakeland Downs Mouse potentially occurs, possibly favouring the Sandplain Drainage habitat. Active mounds of the Western Pebble-mound Mouse were recorded in the Stony Hills habitat.

The one **Locally Significant** species is:

- Rufous-crowned Emu-wren (*Stipiturus rufus*)

This species is only likely to occur where there is mature spinifex and is likely to be locally extinct in areas that experience frequent fires. It was recorded on this fauna survey.

Table of Contents

Tables, Figures and Plates

1. Introduction

De Grey Mining Limited proposes to develop the Hemi Gold Project, located in the Pilbara region of Western Australia, approximately 85 km south of Port Hedland, within the Town of Port Hedland Local Government Area.

An application for Mining Lease is 47/1628 is currently pending for the Hemi deposit and processing facilities. Several applications for Miscellaneous Licenses covering associated project infrastructure include L45/600, L45/604, L45/635, L47/962, L47/963, L47/964, L47/965, L47/966, L47/967, L47/975, L47/1047, L47/1048 and L47/1049.

Project components are likely to comprise:

- Open cut mining of gold bearing ore from the Hemi deposits.
- The construction and subsequent operation of a 10 Mtpa processing facility located adjacent to the Hemi deposit, capable of achieving 90% to 94% gold recovery from free milling and semi refractory ores.
- Disposal of process tailings to a surface Tailings Storage Facility (TSF) with a capacity for 130 Mt of processed ore.
- Water supply from the local groundwater aquifer with accompanying groundwater and surface water management infrastructure to facilitate mine dewatering.
- Stockpiling of waste rock to form permanent landforms.
- A village with messing and accommodation capacity for approximately 600 personnel.
- A power supply from the 220 kilo Volt (“kV”) network grid approximately 40 to 60 kilometres (“km”) north of the processing facility.
- A 9 km sealed access road from the Great Northern Highway.
- An airstrip with capacity for 100 seat jet aircraft.
- Other supporting infrastructure (offices, workshops, waste facilities, laydowns).

Western Wildlife was commissioned to carry out a two-phase detailed fauna survey of the Hemi study area, and a basic survey of the proposed infrastructure corridors. The purpose of the fauna survey was to gather baseline fauna data to inform environmental impact assessment as part of Project approvals. The key objectives of the fauna survey were to:

- Identify and describe the fauna habitats present.
- List the vertebrate fauna that were recorded and/or have the potential to occur.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur.

This report includes the interim findings of the two-phase baseline vertebrate fauna survey and targeted surveys conducted in September 2021 and March 2022, additional targeted surveys in April/May 2024, and some supporting data collected in August - October 2022.

1.1 Regional Context

1.1.1 IBRA Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies the land surface of Australia into 89 Bioregions and 419 subregions, each defined by a set of environmental influences that impact the occurrence of flora and fauna and their interaction with the physical environment (DCCEEW 2020).

The Project is situated in the Chichester subregion of the Pilbara Bioregion (DEWHA 2004), which is comprised of undulating plains of Achaean granite and basalt, with basalt ranges (Kendrick and McKenzie 2001). The plains support open shrublands of *Acacia* over spinifex hummock grasslands, and the ranges support an open tree-steppe of *Eucalyptus leucophloia* over spinifex hummock grasslands.

The climate is semi-desert tropical, receiving about 300mm of rain per year (Kendrick and McKenzie 2001). The dominant land-uses are grazing on native pastures, Aboriginal lands and reserves, Unallocated Crown Land and Crown Reserves, Conservation and Mining (Kendrick and McKenzie 2001).

1.1.2 Botanical Province

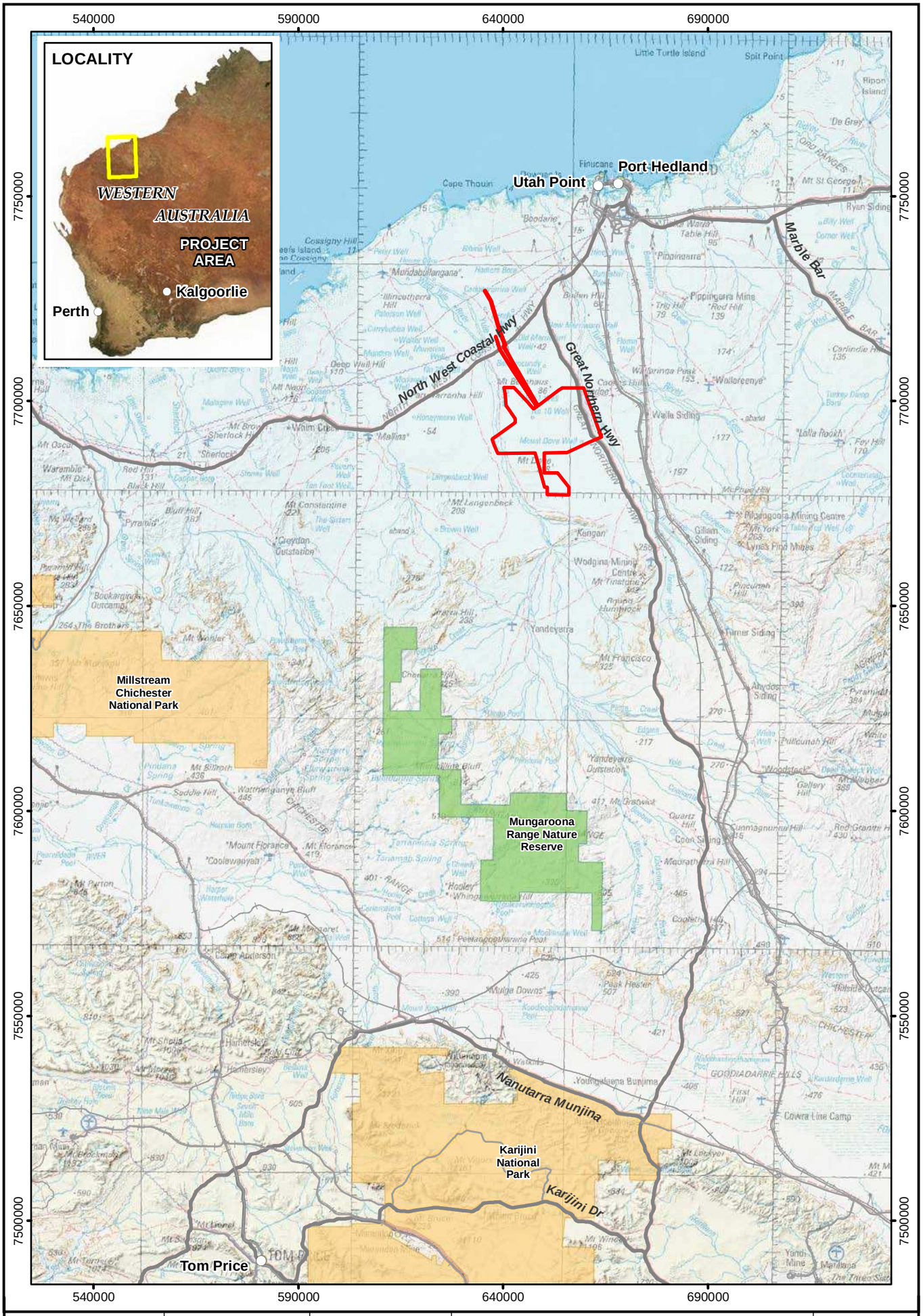
The Botanical Provinces are determined by vegetation mapping (Beard 1980) and broadly correspond to climactic regions; the Southwest (Bassian) Province experiencing warm dry summers and cool wet winters, the Northern Province experiencing warm wet summers and cool dry winters and the Eremaean Province experiencing low, irregular rainfall. The study area is in Eremaean Province.

1.1.3 Parks and Reserves

There are no reserves in or directly adjacent to the study area. The nearest reserves are Mungaroona Nature Reserve (45km south) and Millstream-Chichester National Park (50km south) (Figure 1).

1.1.4 Threatened or Priority Ecological Communities

The study area includes the Priority 3 Ecological Community *Gregory Land System*. This ecological community is defined primarily by its vegetation so its significance is not further discussed in this report, except in terms of its habitat value to fauna.



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1.1.5 Land Systems

Land systems are broad descriptions of landform, geology and soils. The study area intersects six land systems (Figure 2), which are characterised as follows:

- **Uaroo System:** Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs.
- **Mallina System:** Sandy surfaced alluvial plains supporting soft spinifex grasslands and minor hard spinifex and tussock grasslands.
- **Ruth System:** Hills and ridges of volcanic and other rocks supporting shrubby hard spinifex and occasionally soft spinifex grasslands.
- **River System:** Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.
- **Gregory System:** Linear dunes and restricted sandplains supporting shrubby hard spinifex (and occasionally soft spinifex) grasslands.
- **Talga System:** Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.

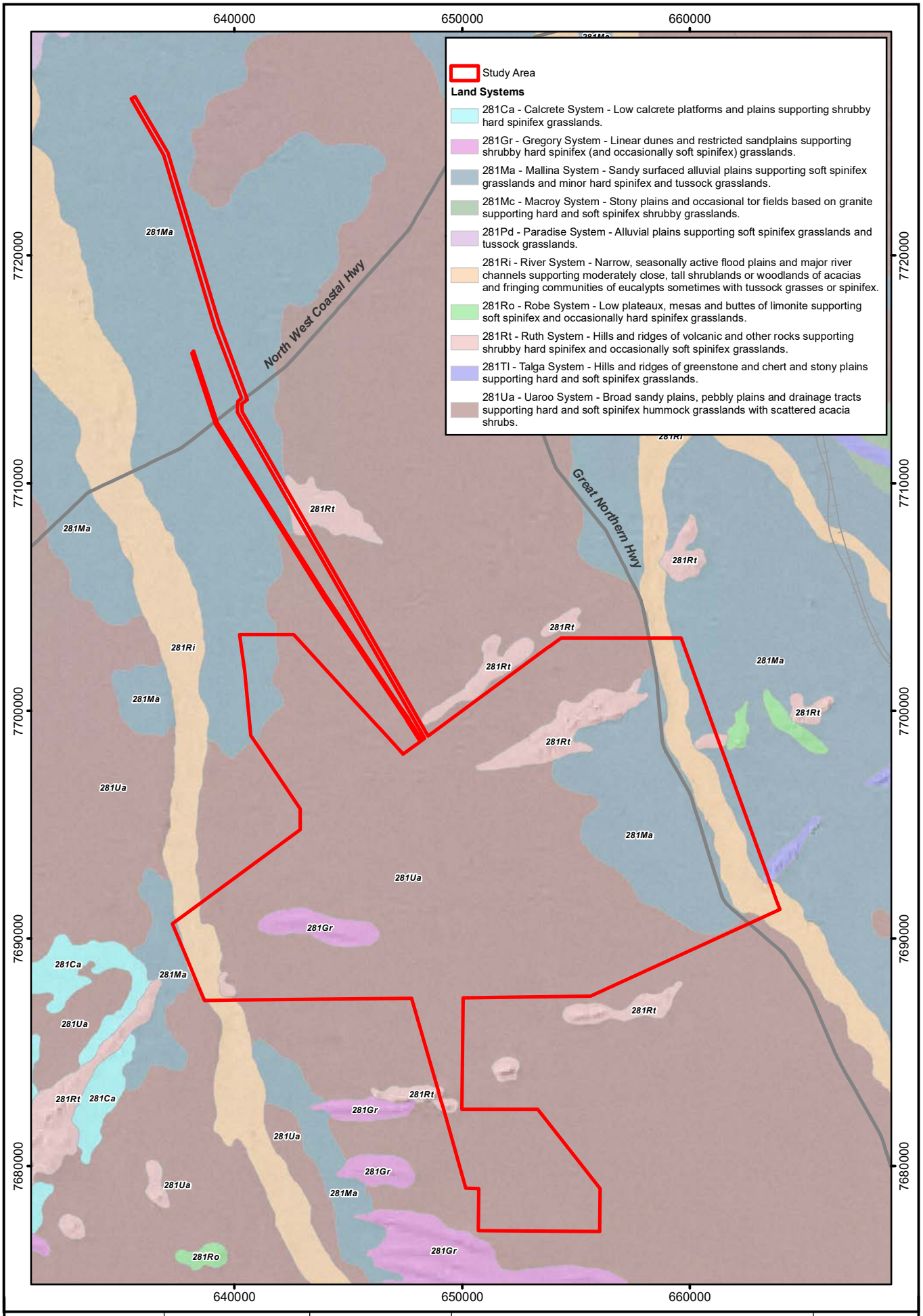
1.1.6 Fire History

The regional fire history is shown on Figure 3, as sourced from *Northern Australia & Rangelands Fire Information* (NAFI 2024). The majority of the study area has been burnt within the last 20 years. Large parts of the study area were burnt in 2021, prior to the first phase of the detailed fauna survey.

1.2 Study Area

The study area is 34,687 ha and is shown in Figure 4. It includes two proposed infrastructure corridors extending from the edge of the study area 20 – 30 km to the north.

The majority of the study area is located on Indee Station. Except for roads and tracks, the entire area is under native vegetation over which the dominant land use is cattle grazing. There are several wells with cattle troughs, some with open water in small turkey's nests. The study area includes a portion of both the Yule and Turner Rivers.



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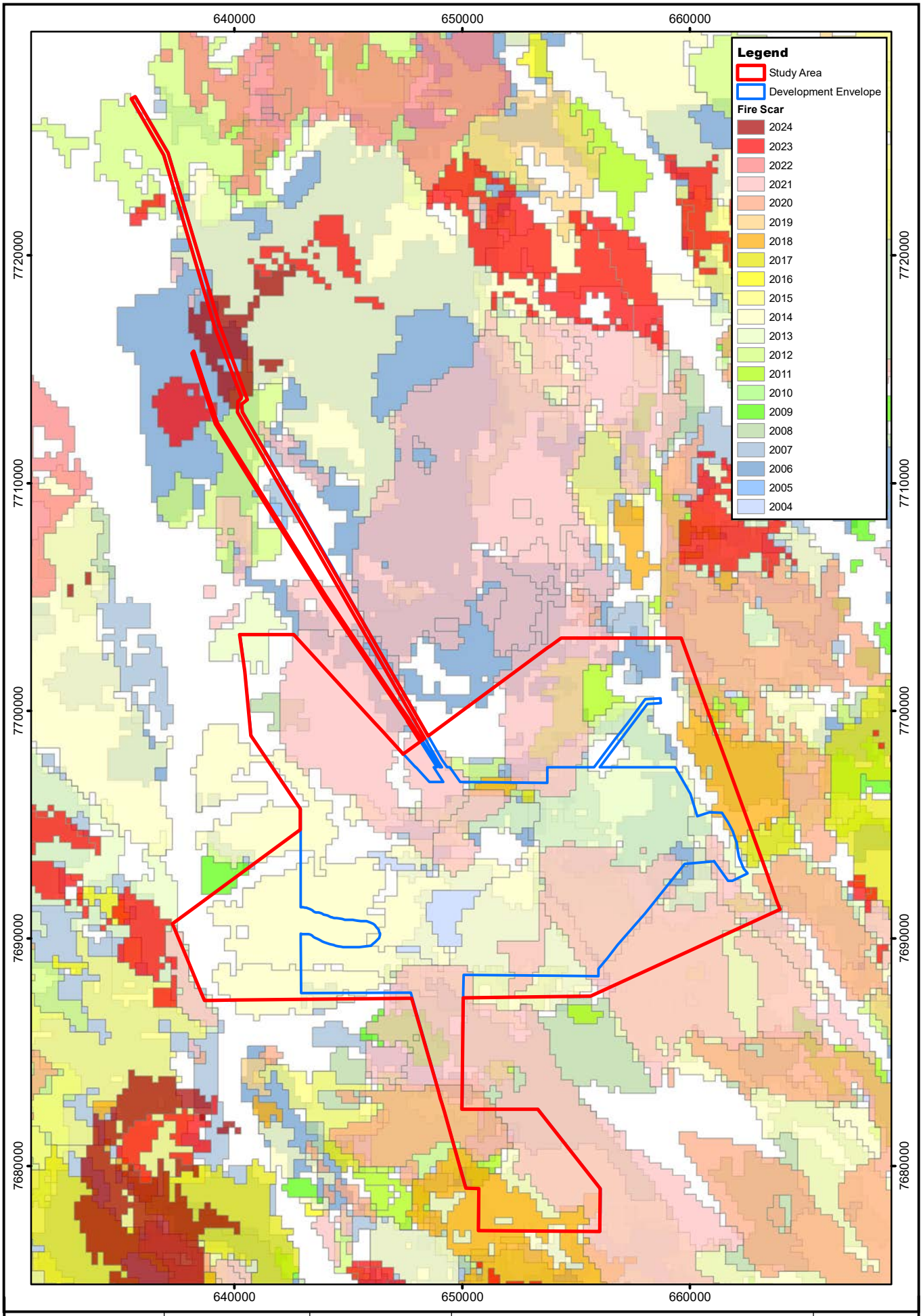
Western Wildlife

Hemi Gold Project
Land Systems

Figure: **2**



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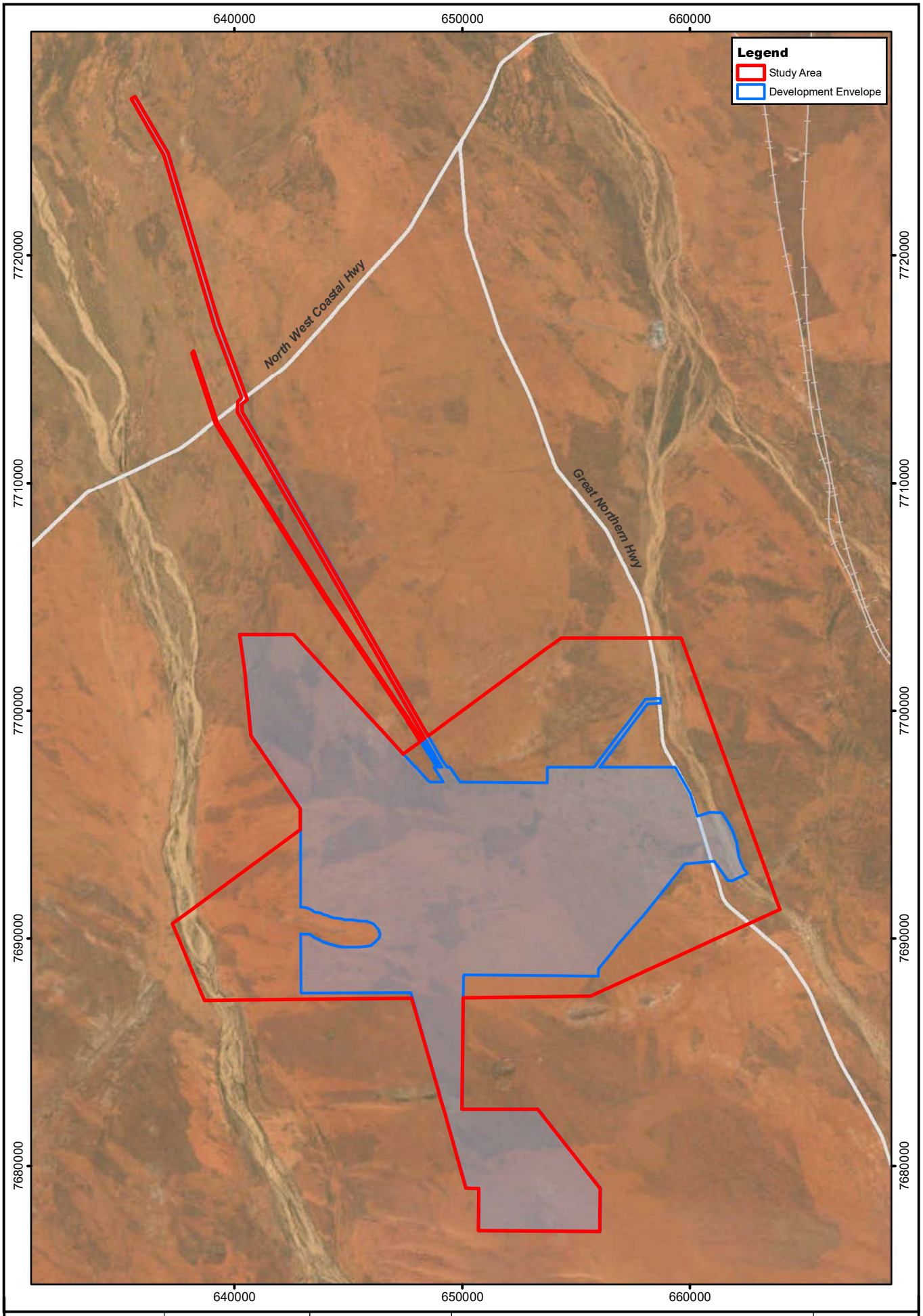

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Western Wildlife

Hemi Gold Project
Study Area

Figure: **4**

1.3 Climate and Weather

The nearest weather station is Port Hedland Airport (site number 004032), about 80km north of the study area. The mean monthly maximum and minimum temperatures and rainfall for this weather station are presented in Figure 5. The data indicate that the highest rainfall and temperatures occur in the summer months.

The long-term average annual rainfall for Port Hedland is 313.5mm, based on data collected between 1942 and 2024 (Bureau of Meteorology 2024). The annual rainfall was about average in 2020 (310.6mm), lower than average in 2021 (204.0mm), above average in 2022 (385.0mm) and lower than average again in 2023 (183.0mm). Weather during both phases of the detailed survey was characterised by warm nights, hot days and high humidity. The daily temperatures and rainfall prior to and during the field surveys (as recorded at Port Hedland), are presented in Appendix 1.

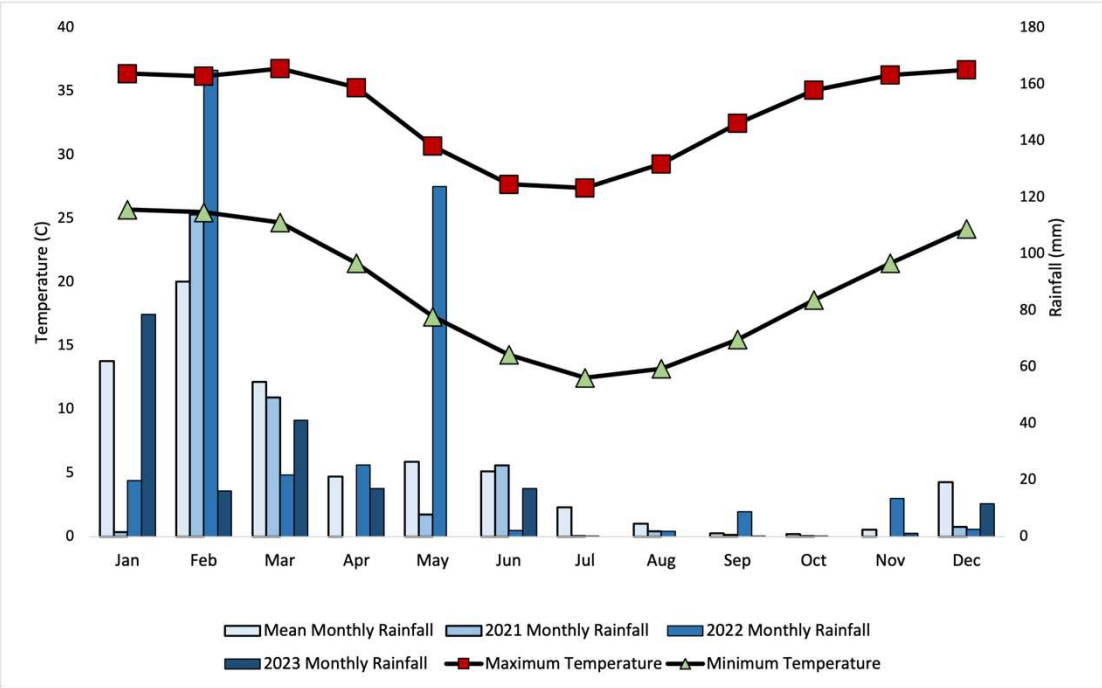

Figure 5. Monthly Climate Statistics for Port Hedland Airport.

2. Methods

2.1 Overview

A two-phase detailed vertebrate fauna survey was conducted across the study area in September 2021 and March 2022, with some additional targeted surveys in August 2022 and April/May 2024. Some additional records obtained from surveys in overlapping study areas to the east (September 2022) and west (October 2022) have also been included where relevant.

Surveys targeting conservation significant fauna, including the Northern Quoll (*Dasyurus hallucatus*), Bilby (*Macropus lagotis)* and the Night Parrot (*Pezoporus occidentalis*), were undertaken where there was habitat that potentially supported each species.

The methods are further described in the sections below.

2.2 Guidance Documents

The fauna survey was conducted with reference to the following documents:

- Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020)
- Interim guideline for preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia (DPAW 2017)
- EPBC Act Referral Guideline for the Endangered Northern Quoll (DoE 2016)
- Guidelines for Surveys to Detect the Presence of Bilbies and to Assess the Importance of Habitat in Western Australia (DBCA 2017)
- Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
- Survey Guidelines for Australia's Threatened Bats (DEWHA 2010a)
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010b)
- Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b)

2.3 Personnel

Two to six zoologists undertook each phase of the fieldwork, with bat call analysis provided by Specialised Zoological (2022). Details of the survey team and their experience are shown in Table 1. This report was prepared by Ms Jenny Wilcox.

Table 1. Fauna survey personnel.

Name	Role	Qualification	Experience	Survey*
Jenny Wilcox	Supervising Vertebrate Zoologist (plan and lead fieldwork, analyse data, prepare report)	BSc.Biol/Env.Sci., Hons.	>20 years	1, 2, 3, 4, 5, 6
Mike Brown	Vertebrate zoologist (fieldwork)	BSc.Env.Sci.	15 years	1, 2, 4, 5, 6
Samantha Lostrom	Vertebrate zoologist (fieldwork)	BSc.Biol., Hons.	>10 years	1, 2, 5
Brenden Metcalf	Vertebrate zoologist (fieldwork)	BSc.Biol., Hons.	>20 years	2
Wes Bancroft	Vertebrate zoologist (fieldwork)	PhD. Zool.	>20 years	1
Judy Dunlop	Vertebrate zoologist (fieldwork)	PhD. Zool.	>10 years	1, 2
Joanna Riley	Vertebrate zoologist (fieldwork)	PhD. Zool.	>5 years	2
Louis Masarei	Vertebrate zoologist (fieldwork)	BSc.	>10 years	3
Kyle Armstrong	Bat call analysis only	PhD. Zool.	>20 years	1, 2

*Surveys: 1 = September 2021, 2 = March 2022, 3 = August 2022, 4 = September 2022, 5 = October 2022, 6 = April 2024.

2.4 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists. In the text, common names are used where appropriate, and all scientific names are given in species lists. Where a species lacks a common name, they are referred to by their scientific name.

2.5 Literature Review

Lists of fauna predicted to occur in the study area were produced using information from several sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al*. 2000), reptiles (Storr *et al*. 1983, 1990, 1999 and 2002, Wilson and Swan 2017), birds (Barrett *et al*. 2003; Johnstone and Storr 1998; Johnstone and Storr 2004) and mammals (Churchill 2007, Menkhorst and Knight 2011; Van Dyck and Strahan 2008).

The databases in Table 2 were searched for fauna records in and around the study area. In all cases the extent of the database search was larger than the extent of the study area in order to pick up records of species in the wider area that may also occur in the study area.

Some species may occur on database results that are not likely to be present in the study area, usually due either to lack of suitable habitat or the study area being outside the known range of the species (i.e., erroneous records or records of vagrants). Some records may be historical, with the species known to be locally or regionally extinct. These species are generally not included in lists of predicted fauna unless some discussion is thought to be necessary.

Table 2. Databases used in the preparation of this report.

Database	Type of records held	Area searched
DBCA's Threatened and Priority Fauna Database (DBCA 2021)	Information and records on Threatened and Priority species in Western Australia. Includes records collated from Birds Australia, the Fauna Survey Returns Database and the Western Australian Museum Database.	Mallina Gold Project tenements with a 20km buffer
Dandjoo (DBCA 2023)	Records of fauna, excluding Threatened and Priority Fauna from several sources including industry and research.	Study area with a 100km buffer
Atlas of Living Australia (ALA) Database (ALA 2022)	• Birds Australia Atlas Database - records of bird observations in Australia, 1998-2009. • Birdata - records of bird observations in Australia, 2010-current. • WA Museum Specimen Databases for reptiles frogs, birds and mammals - records of specimens held in the Western Australian Museum. Includes historical records.	Study area with a 40km buffer
Index of Biological Surveys for Assessment (IBSA) Database	Reports and spatial data from fauna surveys undertaken for environmental impact assessment in Western Australia.	Surveys in the Pilbara Bioregion, within 50km of the study area.
EPBC Act Protected Matters Search Tool	Information and modelled distributions for matters protected under the EPBC Act, including threatened species and ecological communities, migratory species and marine species.	Study area with a 5km buffer

In addition, the results of the following fauna survey reports from Projects within 50km of the study area were used to compile the lists of fauna predicted to occur in the study area:

- 360 Environmental. (2018a). *Flora, Vegetation and Fauna Assessment Wodgina Mine and Proposed Airstrip*. Unpublished report prepared for Mineral Resources Limited.
- 360 Environmental. (2018b). *Wodgina Mine and Additional Gas Pipeline: Flora, Vegetation, Fauna and Northern Quoll Assessment*. Unpublished report prepared for Mineral Resources Limited.
- Biologic (2018a). *Wodgina DSO Project: Northern Quoll Monitoring Survey*. Unpublished report to Atlas Iron Limited.
- Biologic (2018b). *Wodgina DSO Project: Pilbara Leaf-nosed Bat and Ghost Bat Monitoring Survey*. Unpublished report to Atlas Iron Limited.
- Biota (2002a) *An Assessment of the Distribution of the Mulgara* Dasycercus cristicauda *and Bilby* Macrotis lagotis *Along and Adjacent to the Proposed Hope Downs to Port Hedland Rail Corridor*. Unpublished report to Hope Downs Management Services.
- Biota (2002b) *Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland – Vertebrate Fauna Survey*. Unpublished report to Hope Downs Management Services.
- Biota (2004) *Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor.* Unpublished report to Fortescue Metals Group.
- Outback Ecology (2009). *Wodgina DSO Project: Terrestrial Vertebrate Fauna Assessment*. Unpublished report prepared for Atlas Iron Limited.

- Outback Ecology (2011). *Mt Dove DSO Project: Vertebrate Fauna Assessment*. Unpublished report to Atlas Iron Limited.
- Outback Ecology (2012). *Hercules Project: Terrestrial Vertebrate Fauna Baseline Survey*. Unpublished report prepared for Atlas Iron Limited.
- Stantec (2017). *Northern Quoll Monitoring Survey 2017*. Unpublished report prepared for Atlas Iron Limited.
- Stantec (2018a). *Results of the Wodgina Supplementary Bat Survey*. Unpublished memo to Mineral Resources Limited, November 2018.
- Stantec (2018b). *Wodgina Project: Level 1 fauna Survey, targeted conservation significant fauna survey and desktop assessment*. Unpublished report prepared for Mineral Resources Limited, September 2018.

2.6 Field Survey

2.6.1 Licensing

The fauna survey was carried out under Regulation 27 Fauna Taking (Biological Assessment) License BA27000508 issued by the Department of Biodiversity, Conservation and Attractions (DBCA) and Section 40 Authorisation to Take or Disturb Threatened Species TFA 2021-0107.

2.6.2 Timing

The fieldwork was undertaken on the following dates:

- 19 – 30 September 2021 (detailed survey Phase 1)
- 14 - 25 March 2022 (detailed survey Phase 2)
- 9 – 12 August 2022 (basic survey)
- 15 – 23 September and 6 – 17 October 2022 (some targeted surveys from overlapping study areas)
- 12 – 18 April 2024 (targeted surveys)

The detailed survey was undertaken in September and March. This is during the recommended September – April survey period for reptiles in the Eremaean region. The March survey was timed to follow summer rainfall, targeting birds and mammals (EPA 2020), however, limited rainfall fell in the region during the 2021-2022 summer period. The August 2022 survey involved methods for which timing was not critical, such as diurnal transects.

2.6.3 Trapping for Terrestrial Fauna

Trapping for terrestrial fauna (frogs, reptiles and small mammals) was undertaken using a combination of pitfall traps, Elliot traps, funnel traps and cage traps, in September 2021 and March 2022.

Six trapping sites were installed in 2021, each trapping site consisting of ten pitfall traps, ten funnel traps, 10 Elliott traps and two cage traps open for seven nights (Figure 6, Table 3). The number and types of traps were chosen to sample the likely faunal assemblage while allowing for timely checking of traps to preserve animal welfare in hot conditions. Recently burnt areas were avoided due to the lack of cover for trapped animals and the likelihood that faunal populations were still recovering after fire. The Rocky Outcrop habitat was not trapped, but this limited habitat was targeted with camera traps and nocturnal searches.

Each pitfall trap consisted of a 40cm deep, white 20L bucket. Each pair of pitfall traps was placed on a 15m flywire drift fence. A piece of egg carton and a small amount on native soil was used as shelter for any fauna in the trap. Two funnel traps were set with each pair of pitfall traps with the drift-fence bisecting the funnel entrances. Funnel traps were shaded with a reflective 'aircell' insulation cover and spinifex (Plate 1).

Plate 1. Examples of trap line set-up.

Elliot traps were placed in a separate transect with the cage traps at either end. All cage and Elliot traps were placed under vegetation to shade any captured animals and cage traps were covered with a hessian sack. All Elliott and cage traps were baited with a mixture of rolled oats, sardines, peanut butter and vanilla essence. Hot conditions during the March survey necessitated the shutting of all traps in the morning and re-opening in the late afternoon to avoid mortalities due to excessive heat.

The number of trap-nights for each trap type in each survey phase was 420 (pitfalls), 420 (funnel traps), 420 (Elliott traps) and 84 (cage traps), giving a total of 2,688 trap-nights in total. All animals caught were identified and recorded, and generally released immediately at the site of capture.

Table 3. Trapping site locations.

Site	Dates open	Zone	Easting	Northing	Habitat
MG Site 01	• 19 – 26/9/21 • 16 – 23/3/22	50	656498	7700031	**Stony hills**. Occasional tall *Acacia* shrubs over open spinifex hummock grassland on stony slopes. Dense *Acacia* shrubland in minor drainage. Plate 2
MG Site 02	• 20 – 27/9/21 • 17 – 24/3/22	50	656877	7694113	**Sandplain drainage**. Patchy tall *Acacia* shrubs over spinifex hummock grassland on consolidated red sands and clayey flats. Plate 3.
MG Site 03	• 20 – 27/9/21 • 18 – 25/3/22	50	649850	7692702	**Spinifex sandplain**. Occasional *Acacia* and *Melaleuca* shrubs over spinifex hummock grassland on consolidated red sands. Plate 4.
MG Site 04	• 20 – 27/9/21 • 17 – 24/3/22	50	645070	7688150	**Spinifex sandplain**. Patchy tall *Acacia* shrubland over spinifex hummock grassland on consolidated red sands. Plate 5.
MG Site 05	• 21 – 28/9/21 • 17 – 24/3/22	50	643859	7690367	**Sand dune.** Open *Acacia* shrubland over open low shrubs, spinifex and grasses on the slopes of a low sand dune. Plate 6
MG Site 06	• 21 – 28/9/21 • 16 – 23/3/22	50	661221	7694476	**Major river.** *Eucalypt* and *Melaleuca* woodland over tall *Acacia* shrubland over patchy Spinifex hummock grassland on sandy rises and open sandy riverbed on the edge of the Turner River. Plate 7

Plate 2. MG Site 01.

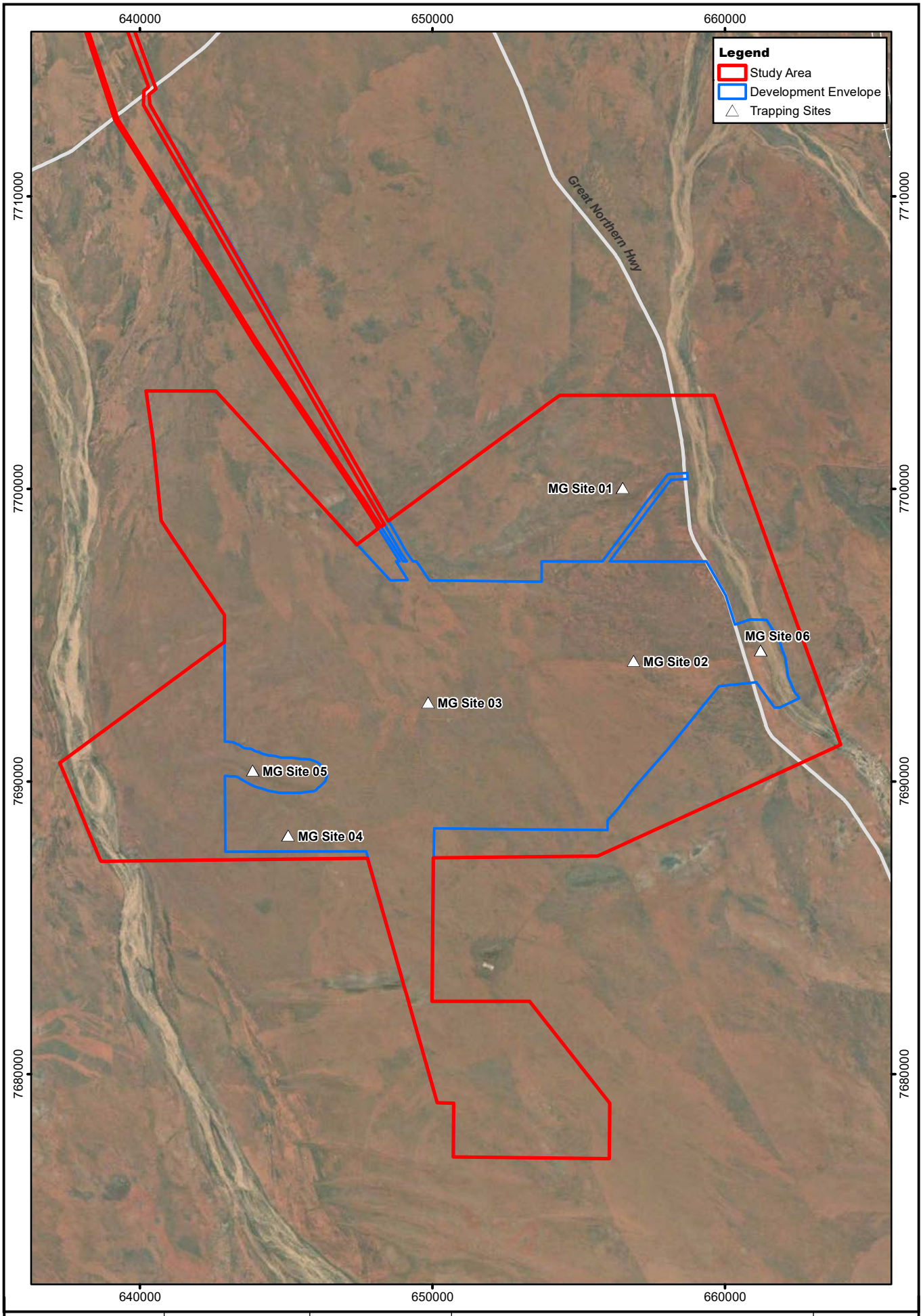

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Plate 3. MG Site 02.

Plate 4. MG Site 03.

Plate 5. MG Site 04.

Plate 6. MG Site 05.

Plate 7. MG Site 06.

2.6.4 Bird Surveys

Bird surveys were undertaken at each trapping site to give a total of six 20-minute surveys at each site on each of the September and March surveys, resulting in 72 surveys or 24 hours of survey across the two phases of survey. Surveys were within 300m of the trapping site and were undertaken concurrently with morning trap checks, between sunrise and approximately 9am. Birds were recorded if seen or heard. Birds were recorded as present only, and a frequency of occurrence calculated for each site. Birds were also recorded opportunistically throughout the study area.

2.6.5 Bat Survey

Bat calls were recorded using Anabat Swift call detectors set to record full spectrum recordings between dusk and dawn. Detectors were deployed one or two nights at each trap site and then for one to three nights at selected sites around the study area, to give a total of 16 nights of recordings in September 2021 and 16 nights of recording in March 2022 (Appendix 2, Figure 7). The calls were then analysed by Specialised Zoological (2022a, 2022b), and the bat calls identified to species level where possible (Appendix 10).

All Rocky Outcrop habitat was assessed for the presence of caves suitable for diurnal roosting by bats.

2.6.6 Night Parrot Survey

Aerial photography and fire age mapping were used to identify areas of potential Night Parrot roosting habitat, i.e. long-unburnt open spinifex.

In March 2022 and April/May 2024, timed to occur after summer rainfall, Songmeter 4 (SM4) passive acoustic detectors were deployed in potentially suitable habitat across the survey area (Figure 7, Appendix 2). Each SM4 was secured to a stake to hold it about 0.5m off the ground and set to record between dusk and dawn each night for six nights, giving a total of at least six recording nights across 13 sites in 2022 and 12 sites in 2024. The data collected during the March survey were analysed for the presence of Night Parrot calls by Adaptive NRM (2022) (Appendix 11). The data collected in the April/May survey were similarly analysed by Malu Fauna (2024) (Appendix 11).

2.6.7 Camera Trap Survey

Cameras were primarily deployed to target rocky or riverine habitats that may support the Northern Quoll (*Dasyurus hallucatus*) and sandplains that may support the Spectacled Hare-wallaby (*Lagorchestes conspicillatus*), Bilby (*Macrotis lagotis*) or Brush-tailed Mulgara (*Dasycercus blythi*).

Camera traps were deployed at 36 sites in September 2021 for a total of 180 trap-nights, 31 sites in March 2022 for a total of 221 trap-nights and five sites in August 2022 for a total of 40 trap-nights (Appendix 2, Figure 7).

Transects of ten camera traps spaced 100m apart were deployed in the Turner and Yule River specifically to target Northern Quoll. Cameras on transects were set for four or five nights, with transects were undertaken in September 2022 (one site on the Turner River totalling 40 trap-nights), October 2022 (one site on the Yule River with only six cameras in the transect, totalling 30 trap-nights) and April 2024 (three sites in the Turner River, one site in the Yule River totalling 200 trap-nights).

Cameras were baited with either fish oil or a mixture of rolled oats, peanut butter and sardines and each individual camera was set for between 5 and 8 nights.

2.6.8 Nocturnal Searches

Spotlighting was carried out on the 27th and 28th September 2021, from 6:00pm – 9:00pm, and the 22nd and 23rd March 2022, from 6:00pm to 9:30pm. Three teams, each of two personnel, undertook a combination of road-spotting using vehicle headlights with targeted hand-searching using head-torches. The routes followed are shown in Figure 7.

2.6.9 Diurnal Searches

Transects and point searches for fauna were undertaken across the study area (Figure 7). Although all vertebrate fauna were recorded, the diurnal searches were particularly focused on detecting conservation significant species. Searches were undertaken for:

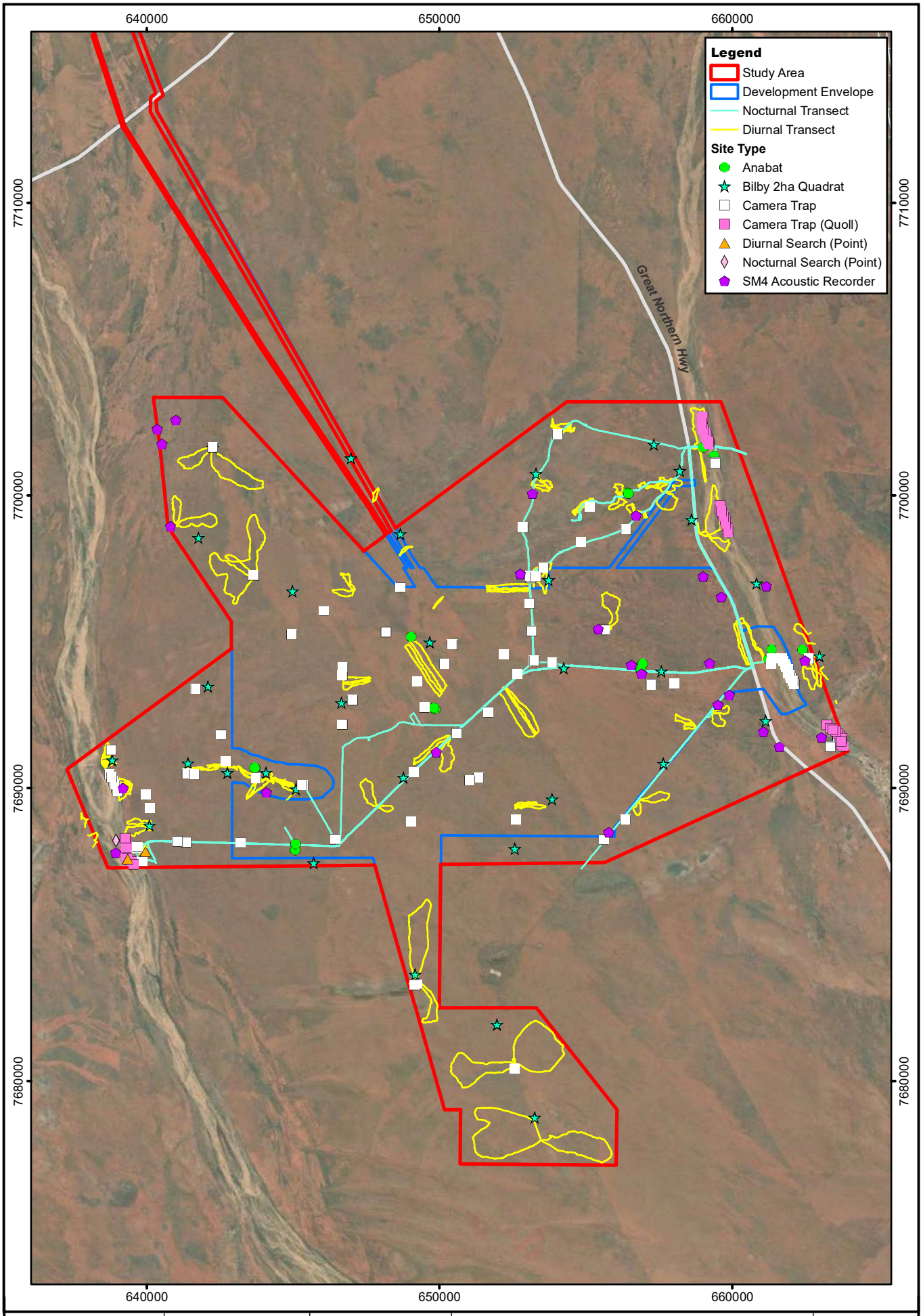
- Burrows, diggings, tracks or scats of the Bilby (*Macrotis lagotis*) in sandplain habitats.
- Scats of the Northern Quoll (*Dasyurus hallucatus*) in rocky habitats and tracks in sandy habitats such as riverbeds.
- Burrows, diggings, tracks or scats of the Brush-tailed Mulgara (*Dasycercus blythi*) in sandplain habitats.
- The presence of the Peregrine Falcon (*Falco peregrinus*), Grey Falcon (*Falco hypoleucos*) and Fork-tailed Swift (*Apus pacificus*) using general vigilance.
- Presence of Migratory shorebirds such as the Common Sandpiper (*Actitis hypoleucos*) and other conservation significant waterbirds at waterholes.
- Pebble-mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*) in stony habitats.

2.6.10 Bilby 2ha Quadrats

To complement the diurnal searches undertaken, a total of 32, 2ha quadrats were searched for signs of the Bilby in April 2024. Each quadrat was searched for 20 minutes by 2 people. Quadrats were spaced approximately 4km apart in all potential Bilby habitats (Sand Dune, Spinifex Sandplain and Sandplain Drainage). Quadrats were selected in locations with a variety of fire ages (Figure 7).

2.6.11 Opportunistic Records

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included casual observations of reptiles, mammals and birds seen while travelling between sites or while undertaking other activities. Opportunistic observations were recorded to a general location for common species, and conservation significant species were recorded with a GPS location.



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2.7 Habitat Assessment

2.7.1 Habitat Assessment Sites

Habitat assessments were undertaken at 85 points across the study area (shown on Figure 8, Appendix 3). At each habitat assessment point the following were recorded:

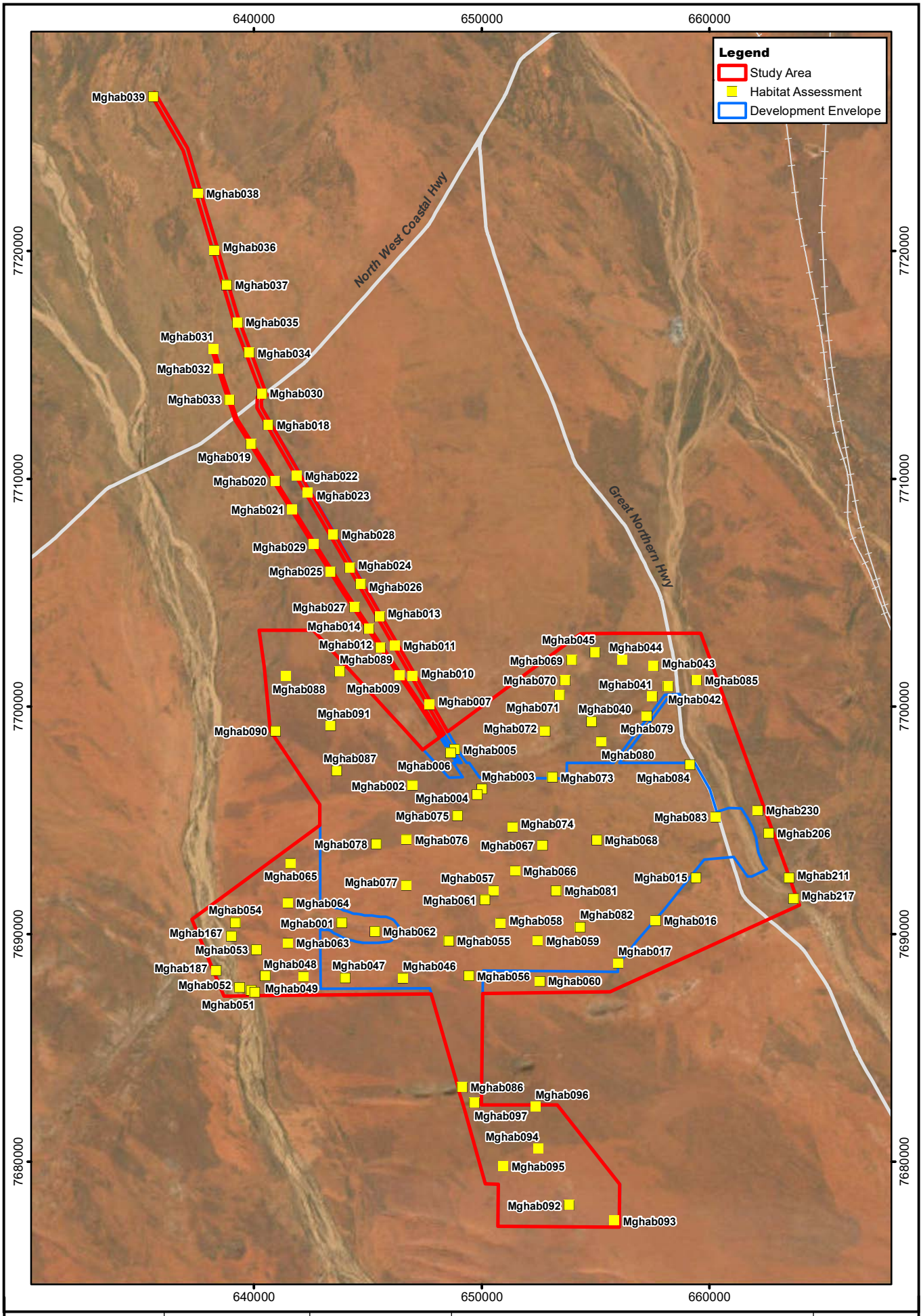
- GPS co-ordinates
- Representative photographs
- Habitat name
- Landform
- Vegetation (brief description of structure and dominant species, if known)
- Evidence of fire
- Disturbance (e.g., weeds, grazing, firewood collection)
- Soil colour and type
- Rock type and presence of any outcropping
- Important habitat elements, including, but not limited to the presence of:
    - Leaf litter accumulations
    - Woody debris and logs
    - Tree hollows or crevices
    - Soils suitable for burrowing
    - Long-unburnt vegetation
    - Water
    - Caves or rock crevices
    - Dense shelter vegetation
    - Important plant species for conservation significant fauna
- Presence of wetlands
- Any fauna

2.7.2 Fauna Habitat Mapping

The fauna habitats were identified and mapped using the habitat assessments (Appendix 3) and observations made in the field during the fauna survey, interpretation of vegetation mapping (Umwelt Australia 2022), aerial photography and land system mapping.

2.7.3 Northern Quoll Habitat Mapping

Northern Quoll habitat was mapped within a 20km buffer of the study area. Shelter habitat was deemed to be rocky habitat, including rocky ridges and granite hills, as well as major drainage lines. Foraging habitat was mapped as all habitat within 1km of shelter habitat. Shelter habitat was identified using a combination of aerial photography and land system mapping.



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2.8 Species Accumulation Curves

A species accumulation curve at its most simple is a graph of the number of detected species against sampling effort. However, the curve is usually derived through sub-sampling the dataset to find a mean curve, otherwise known as a sample-based rarefaction curve.

Species accumulation curves were calculated for reptiles, mammals and birds for all habitats combined. For frogs, reptiles and mammals, an individuals-based approach was used. This means that the species richness was graphed against the number of individuals caught, rather than per each sample. The sampling unit for birds was all species observed in a 20 minute bird survey at a trapping site.

The statistical package EstimateS (Colwell 2013) was used to find a non-parametric estimator of species richness; either Chao1, ICE (Incidence-based Coverage Estimator) or Chao2. Chao1 uses abundance data to provide an estimation of the lower bound of species richness and is a good estimator of the actual species richness when the sample size is large or the rare species in the sample have similar detection probabilities (Chao and Chiu 2016). ICE or Chao2 are similar, but uses incidence (presence only, no abundance) data only.

EstimateS (Colwell 2013) uses a bias-corrected form of Chao1 and Chao2 as a default, though these become imprecise when the co-efficient of variation or incidence distribution >0.5. In these cases, the classic Chao1 and Chao2 were used, and the larger estimate of Chao1(classic) and ACE (Abundance-based Coverage Estimator) or Chao2(classic) and ICE (Incidence-based Coverage Estimator) is used as the estimate of species richness. For large sample sizes, if Chao 1 or Chao 2 are equal to the observed number of species, then the accumulation of species is assumed to have reached an asymptote (Colwell 2013).

Jackknife estimators of species richness are not used, as they typically underestimate the true species richness when the sample is small, (as is often the case in detailed surveys) and overestimate when the sample is large. Thus, there is only a small window when the Jackknife estimators are close to the true species richness (Chao and Chiu 2016).

2.9 Assessment of Conservation Significance

2.9.1 Legislative Protection for Fauna

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth Government's primary piece of environmental legislation. Listed under Part 3 of the EPBC Act are 'Matters of National Environmental Significance' (MNES); these include threatened species, threatened ecological communities and migratory species. Threatened fauna species are assessed against categories based on International Union for Conservation of Nature (IUCN) criteria.

The migratory species listed under the EPBC Act are those recognised under international agreements. These agreements are the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), or species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) for which Australia is a range state.

Matters of National Environmental Significance (MNES) include the following categories:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.
- **Migratory (Mi):** Taxa listed under international agreements to which Australia is a party.

Reports on the conservation status of most vertebrate fauna species have been produced by the federal Department of Environment and Energy (DoEE) in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for amphibians (Tyler 1998), reptiles (Cogger *et al*. 1993), birds (Garnett and Barker 2020) and mammals (Woinarski *et al*. 2014). These publications also use categories similar to those used by the EPBC Act. The information presented in some of the earlier Action Plans may be out of date due to changes since publication.

The *Biodiversity Conservation Act 2016* (BC Act) is State legislation that aims to conserve and protect biodiversity and biodiversity components in Western Australia, including threatened fauna. It is administered by the Department of Biodiversity, Conservation and Attractions (DBCA). In addition to threatened fauna, the BC Act has scope to protect threatened ecological communities and important habitats.

Fauna species are listed under the BC Act as threatened species using IUCN categories, or as specially protected species, as described below.

Threatened Species:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.

Specially Protected Species:

- **Migratory (Mi)**: A subset of the migratory fauna that are known to visit Western Australia that are protected under the international agreements or treaties, excluding species that are listed as Threatened species.
- **Conservation dependent fauna (CD):** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened

- **Other specially protected species (OS):** fauna in need of special protection to ensure their conservation.

Priority species are not listed under State or Commonwealth Acts. In Western Australia, DBCA maintains a list of Priority Fauna made up of species that are possibly Threatened but do not meet adequacy of survey requirements or are otherwise data deficient. There are four levels of Priority as defined by DBCA, as listed below.

- **Priority 1:** Poorly known species (on threatened lands)
- **Priority 2:** Poorly known species in few locations (some on conservation lands)
- **Priority 3:** Poorly known species in several locations (some on conservation lands)
- **Priority 4:** Rare, near threatened and other species in need of monitoring

2.9.2 Levels of Conservation Significance in this report

Five levels of conservation significance are used within this report to indicate the level of significance of fauna species, according to the following criteria:

- **Threatened (T):** Taxa listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the EPBC Act and/or BC Act. These species are grouped as they are all species considered to be at risk of extinction, are often rare and are likely to be subject to on-going threatening processes.
- **Migratory (Mi):** Taxa listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened. These species are grouped as they are not necessarily rare, but may be dependent on specific habitats for a portion of their life-cycle. For these species, loss of important foraging, breeding or stop-over sites may have a disproportionately large impact on populations.
- **Specially Protected (SP):** Taxa listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act. These species are not necessarily rare, but may be dependent on on-going conservation to ensure their protection.
- **Priority (P):** Taxa listed as Priority by DBCA. These species are grouped as they are either conservation dependent or data deficient and in need of further survey.
- **Locally Significant (LS):** Locally significant taxa are not listed under State or Commonwealth Acts or in publications on threatened fauna or as Priority species by DBCA, but are considered by the author to potentially be of local significance because they are at the limit of their distribution in the area, they have a very restricted range or restricted habitat requirements, or they occur in breeding colonies (e.g. some waterbirds). This level of significance has no legislative recognition and is based on interpretation of information on the species patterns of distribution. For example, the Government of Western Australia (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Bush Forever. Recognition of such species is consistent with the aim of preserving regional biodiversity.

2.10 Likelihood of Occurrence

Fauna of conservation significance were assessed and ranked for their likelihood of occurrence in the study area, according to the criteria in Table 4.

Table 4. Criteria for assessing likelihood of occurrence.

Likelihood	Criteria
Unlikely	• The study area is outside the current known distribution of the species as presented in the literature. • No suitable habitat was identified as being present during the field survey. • For some species, individuals may occur occasionally as vagrants, especially if suitable habitat is located nearby, but the study area itself would not support the species. • May include species generally accepted as being locally extinct.
Possible	• The study area is within or just outside the current known distribution of the species, as presented in the literature. • Any habitat present is either limited in extent or of marginal quality at best. • No recent or nearby records of the species on databases. • The species is generally known to be less common in the vicinity of the study area (e.g., for inland sites, where the species usually occurs on the coast).
Potential	• The study area is within the current known distribution of the species, as presented in the literature. • Habitat of reasonable quality was identified as being present during the field survey. • There are some recent and/or nearby records of the species of databases.
Likely	• The study area is well within the current known distribution of the species, as presented in the literature. • Habitat of good quality was identified as being present during the field survey. • Many recent and nearby records of the species on databases.
Known to occur	• The species was positively identified in the study area during this field survey or recorded as occurring in the study area on previous recent field surveys. • Note that for a species 'known to occur', the habitat may still be marginal and therefore the population may be small, or the species may visit the site irregularly.

3. Survey Limitations

Various factors can limit the effectiveness of a fauna survey. Pursuant to EPA Technical Guidance (EPA 2020), these factors have been identified and their potential to impact on the effectiveness of the surveys has been assessed in Table 5. All fauna surveys have limitations, and not all fauna species present on the site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year.

Table 5. Fauna survey limitations.

Potential Limitation	Extent of limitation for the fauna survey
Availability of data and information	**Not Limiting.** The Pilbara is a relatively well-studied region due to the prevalence of mining activities. The Pilbara Biological Survey also gives context to fauna studies in this region. There are numerous records in the vicinity of the study area on databases and other fauna surveys have been undertaken nearby.
Competency/experience of the survey team, including experience in the bioregion surveyed	**Not Limiting.** Key personnel have over 20 years' experience with fauna surveys in Western Australia and are experienced with targeted surveys for Northern Quoll, Night Parrot, Bilby and conservation significant bats. All personnel have undertaken previous surveys, including detailed fauna surveys, in the Pilbara Bioregion.
Scope of survey (e.g., faunal groups excluded from the survey)	**Not Limiting.** The detailed survey covered all vertebrate faunal groups. Conservation significant species were targeted with a variety of methods including camera traps and searches for secondary signs.
Timing, weather and season	**Minor Limitation.** The timing of the survey was consistent with that recommended in the Technical Guidelines (EPA 2020). The weather during the survey was warm to hot and suitable for trapping and spot-lighting, however, the summer rainfall was lower than average resulting in drier post-wet conditions than in an average year. Hot conditions during the March survey necessitated the shutting of all traps in the morning and re-opening in the late afternoon to avoid mortalities due to excessive heat, thus limiting the time spent on other sampling methods. Hot conditions also limited the distances that could be walked safely.
Disturbance that may have affected the results	**Minor Limitation.** Parts of the study area were recently burnt and therefore temporarily unlikely to support key species such as the Bilby. Much of the study area is burnt on a regular basis (for pastoralism) which is likely to have resulted in a smaller extent of mature spinifex.
The proportion of fauna identified, recorded or collected	**Not Limiting.** Over half of the potentially occurring species were recorded during the survey. The field component of the survey was supported with a literature review.
The adequacy of the survey intensity and proportion of survey achieved (e.g., extent to which the area was surveyed)	**Not Limiting.** The intensity and coverage of the fauna survey was adequate and appropriate for the level of survey. A representative portion of all habitats were visited during the survey. Trapping was undertaken in all habitats except the Rocky Outcrop habitat, which was limited in extent in the study area and sampled with other methods.
Access problems	**Not Limiting.** All habitats were readily accessible by vehicle and/or on foot and a representative portion of each habitat was able to be surveyed.
Problems with data and analysis, including sampling biases	**Not Limiting.** No complex analyses were undertaken, and no problems were noted.

4. Fauna Habitat

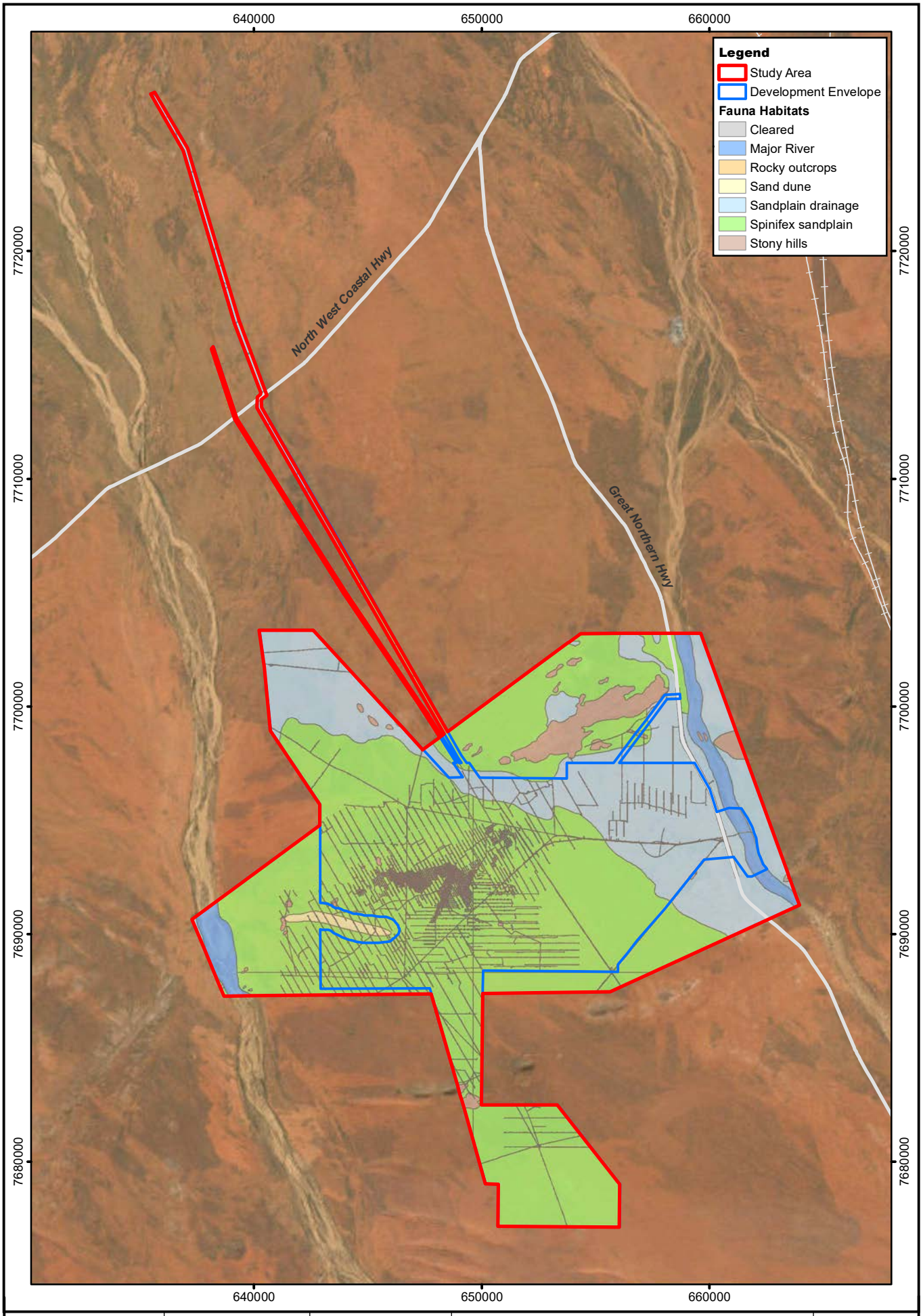
4.1 Habitats of the Hemi Gold Project

Six fauna habitats were identified in the study area (Table 6, Figure 9). They are described in the following sections, with the vegetation descriptions drawn from Umwelt Australia (2022). Of these habitats, Spinifex Sandplain, Sandplain Drainage and Stony Hills are widespread in the region. The sand dune habitat is uncommon in the region, roughly corresponding to the Gregory Land System (a Priority 3 Ecological Community). Rocky Outcrops are very uncommon in the study are but are more common, although still limited in extent, in surrounding areas.

Table 6. Fauna habitats in the study area.

Habitat	Key Habitat Elements	Area (ha)
Spinifex sandplain	• Consolidated sands suitable for burrowing reptiles and mammals.	22,162
Sandplain drainage	• Consolidated sands suitable for burrowing reptiles and mammals. • Claypans of various sizes that hold water and may be breeding habitat for frogs. • Mature spinifex in some areas, where encouraged by water runoff and/or protection from fire.	9247
Sand dune	• Loose flowing sands provide habitat for fossorial reptiles.	188
Stony hills	• Minor drainages lines (not mapped separately) provide dense habitat for birds. • Small stones suitable for Western Pebble-mound Mouse. • Minor rocky outcrops provide shelter for saxicoline reptiles.	1,189
Major river	• Likely to function as a corridor for fauna movement. • Waterholes provide habitat for bathing and drinking, as well as breeding habitat for frogs. • Tree hollows for arboreal reptiles, bats and hollow-nesting birds. • Leaf litter accumulations and woody debris in the creek bed provides habitat for reptiles.	1,232
Rocky outcrops	• Outcropping rocky areas, boulders, overhangs and rock crevices provide shelter for reptiles and mammals (no large caves present).	2
Cleared	• None noted.	667
	Total:	**34,687**

The main disturbance noted was from mining exploration activities (e.g., drilling access tracks, drill pads, service areas) and pastoral activities (e.g., station tracks, bores, livestock). Areas around rivers, wells and stands of trees showed trampling by livestock cattle. Parts of the study area were burnt prior to the first phase of the detailed survey in September 2021 (Figure 3), mainly across the Spinifex Sandplain and Sandplain Drainage habitats.



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Hemi Gold Project
Fauna Habitats

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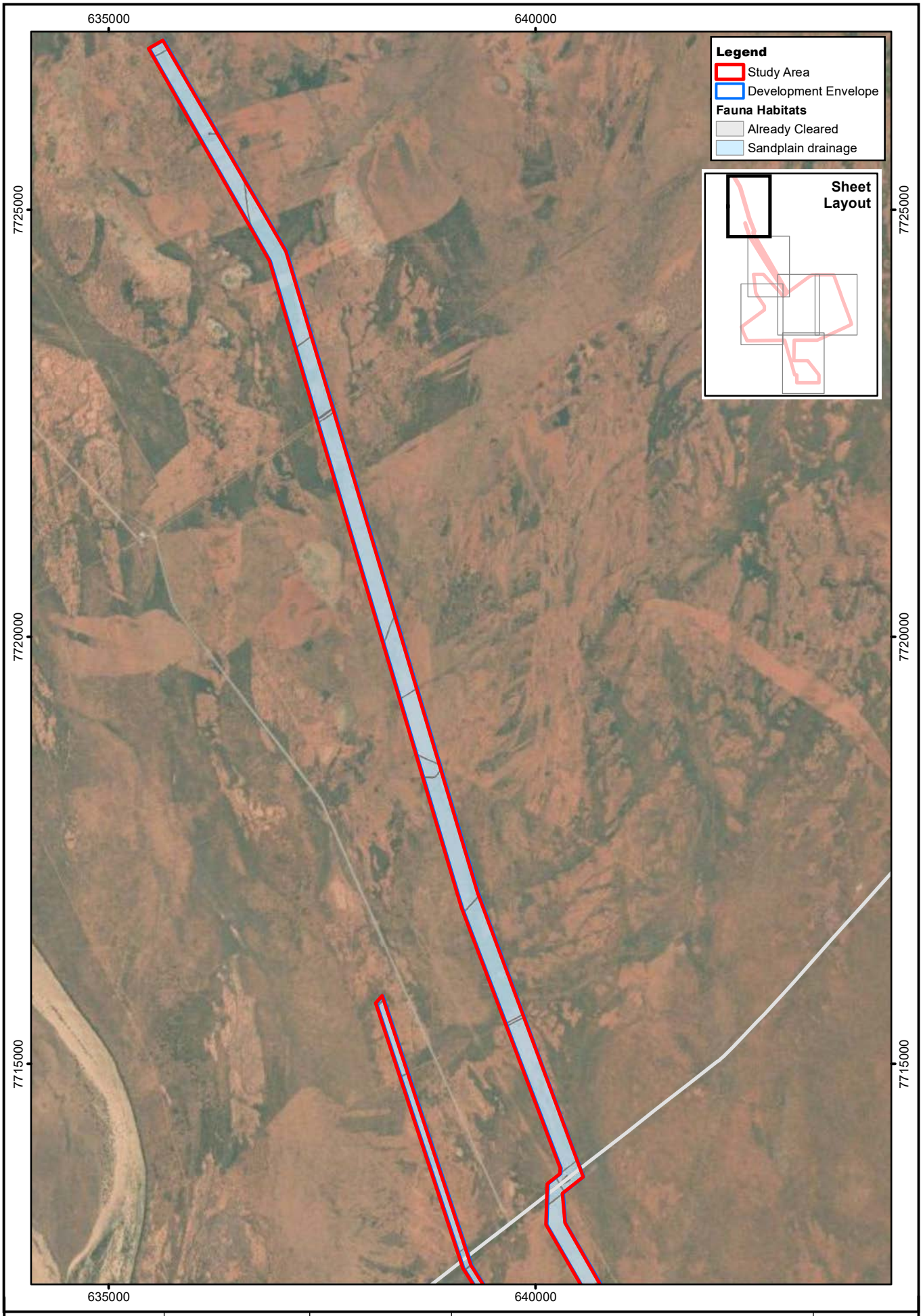

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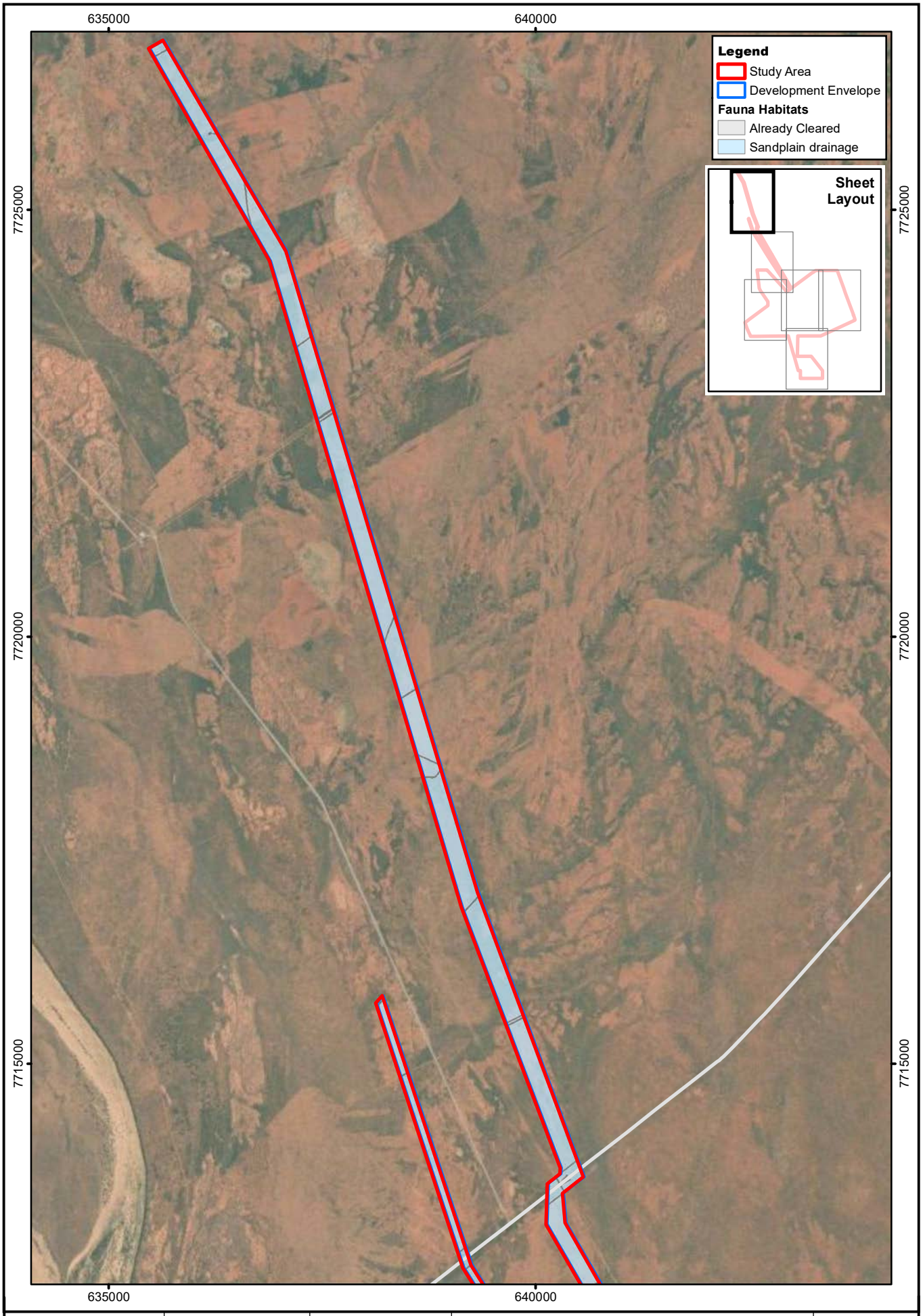

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Hemi Gold Project
Fauna Habitats
Sheet 1 of 6

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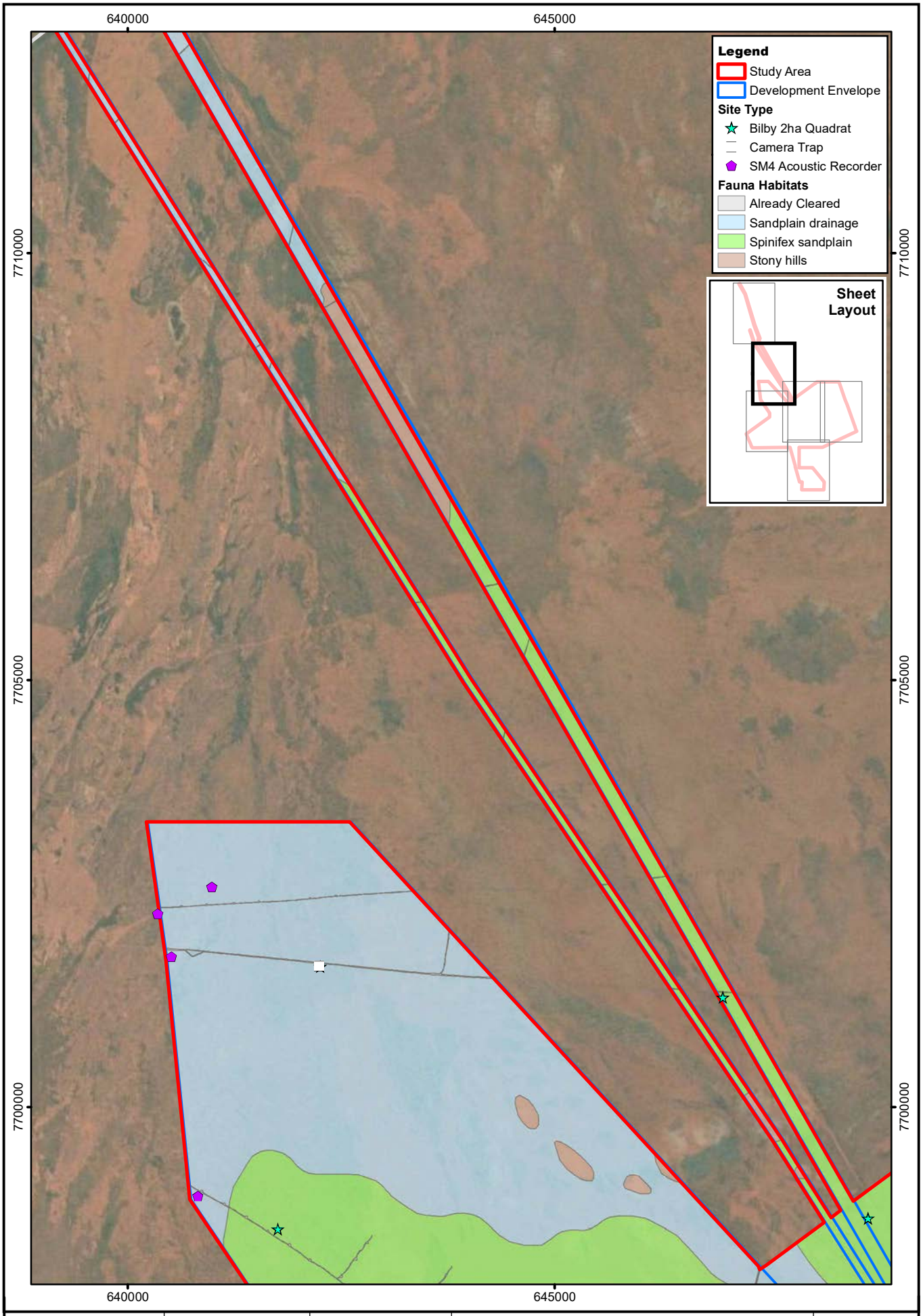

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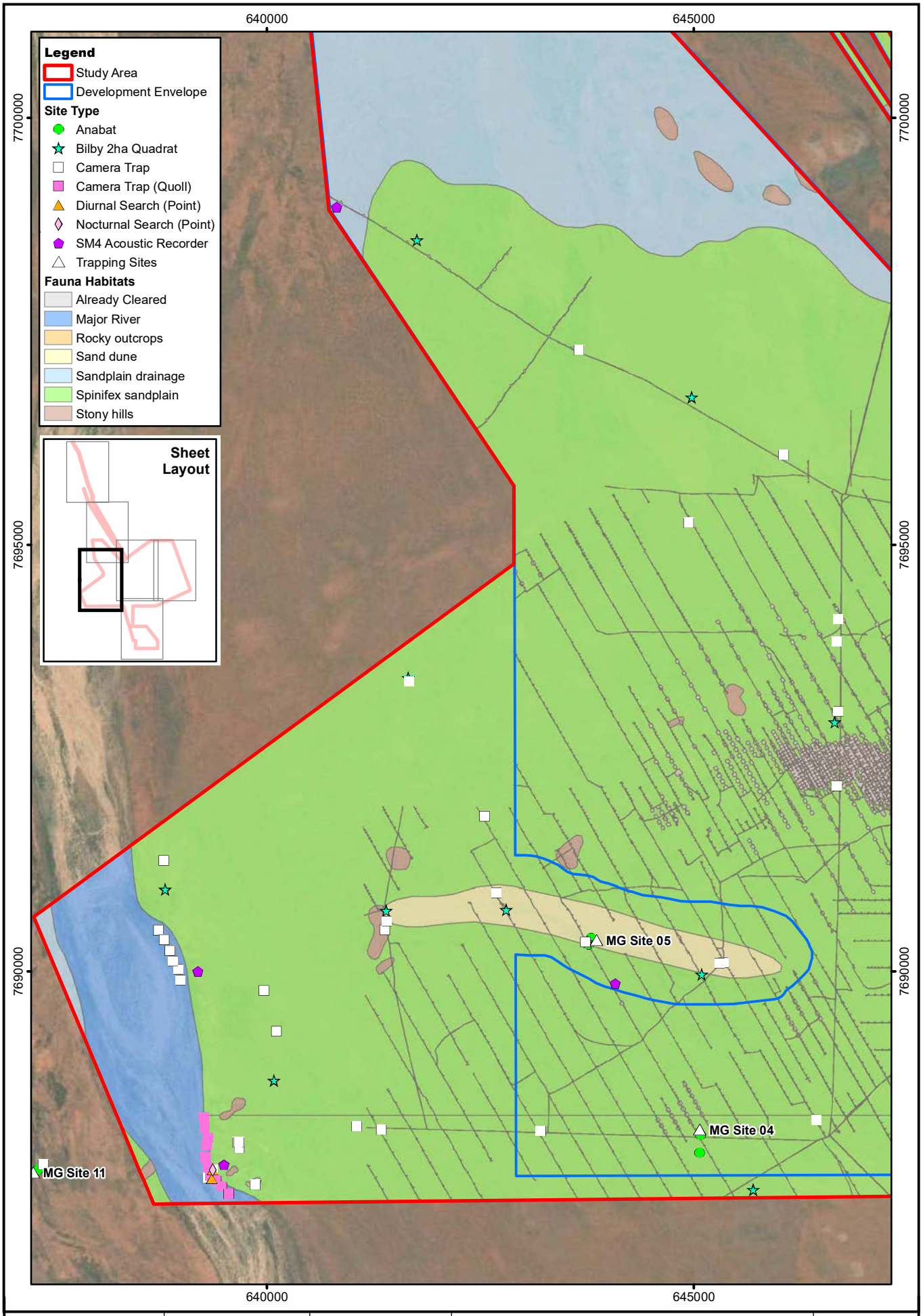

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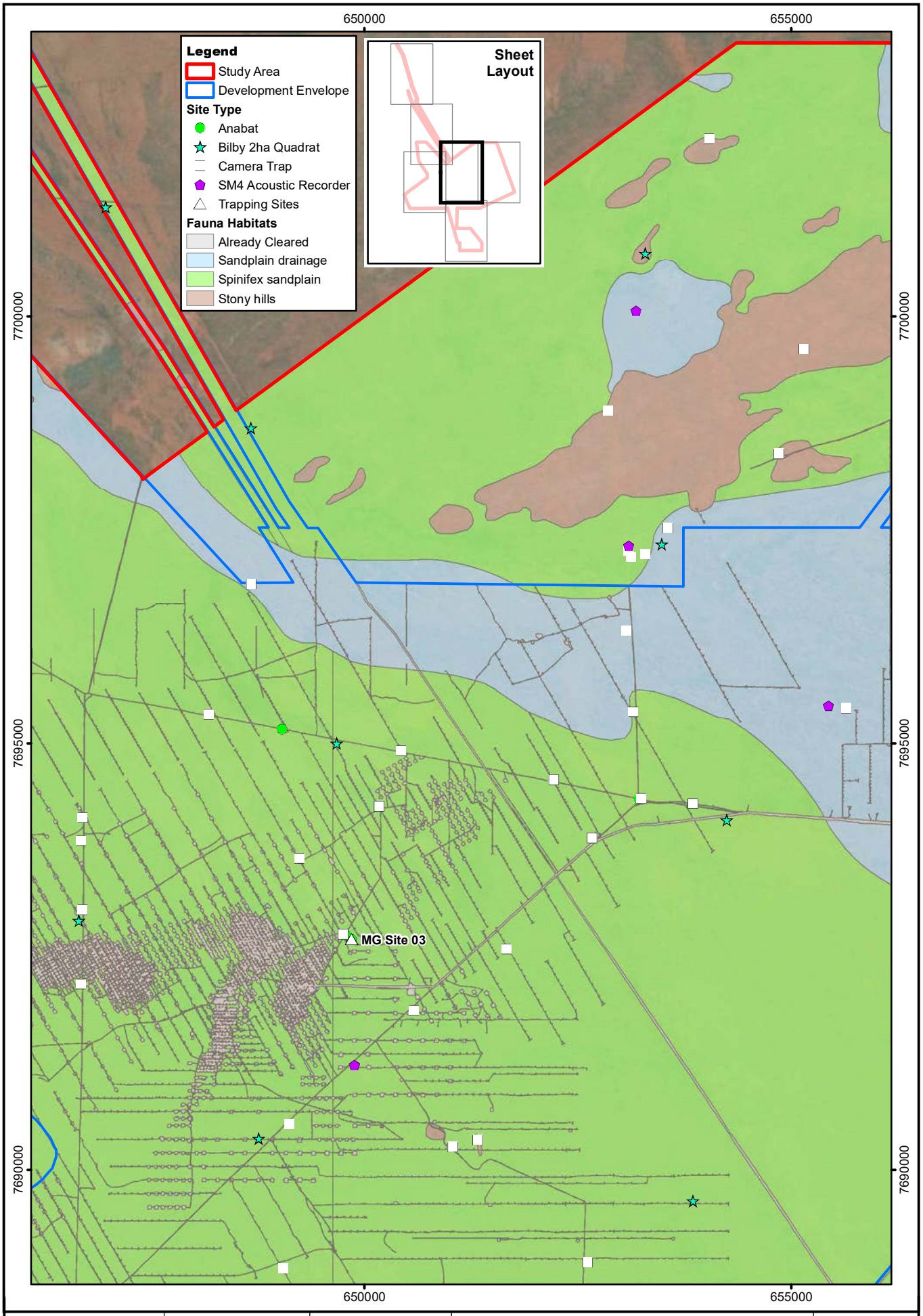

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Fauna Habitats
Sheet 4 of 6

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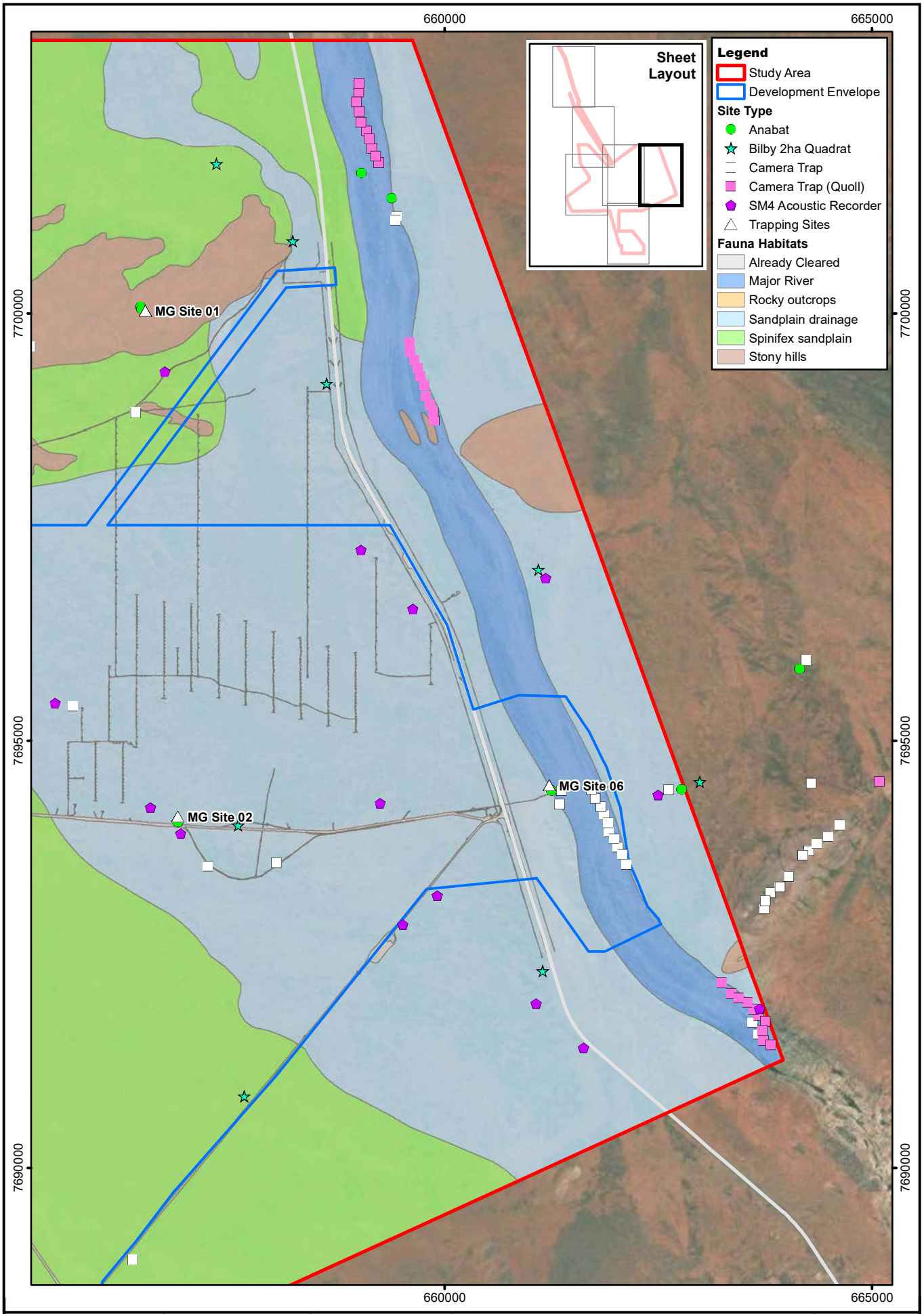

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Hemi Gold Project
Fauna Habitats
Sheet 5 of 6

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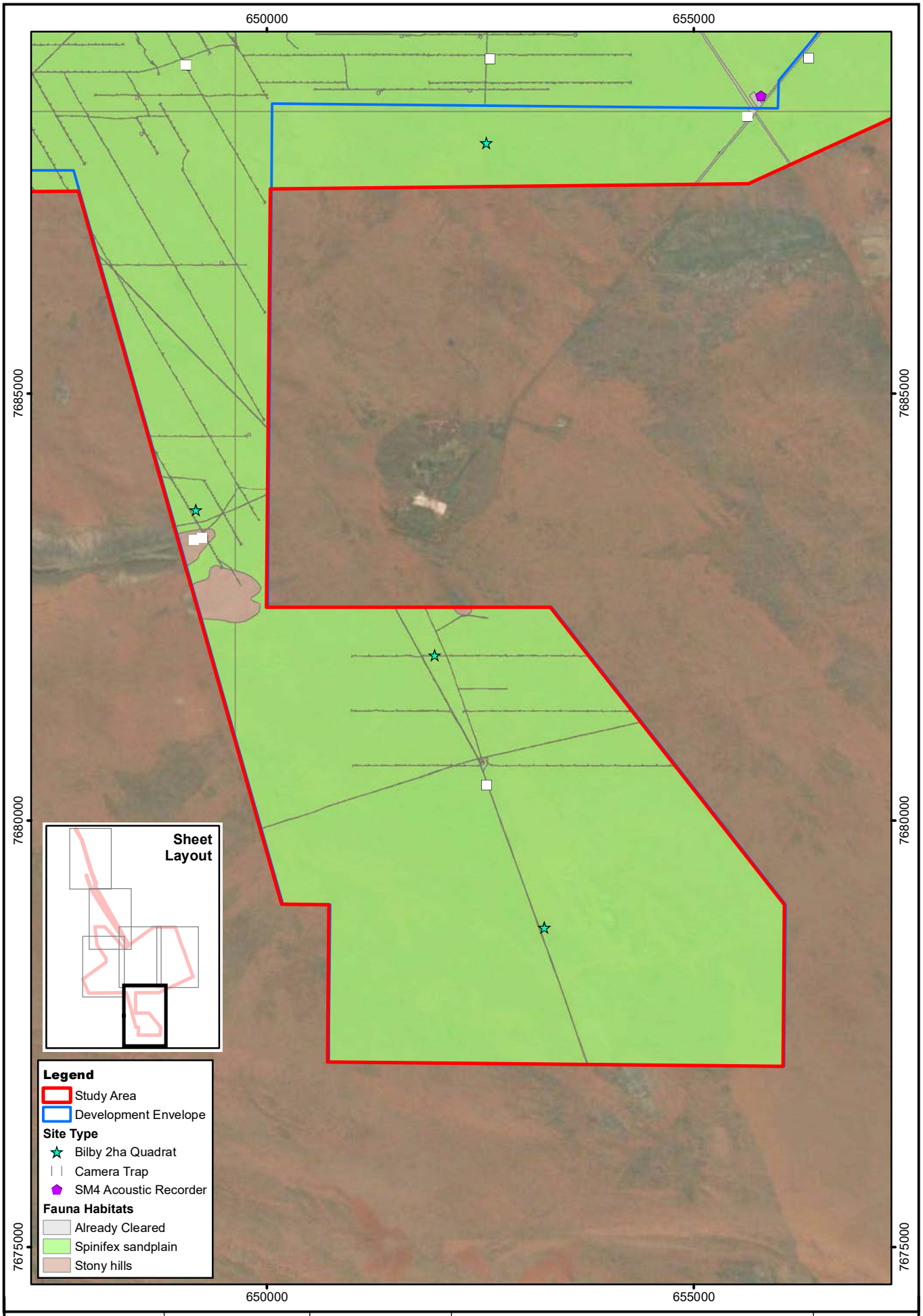

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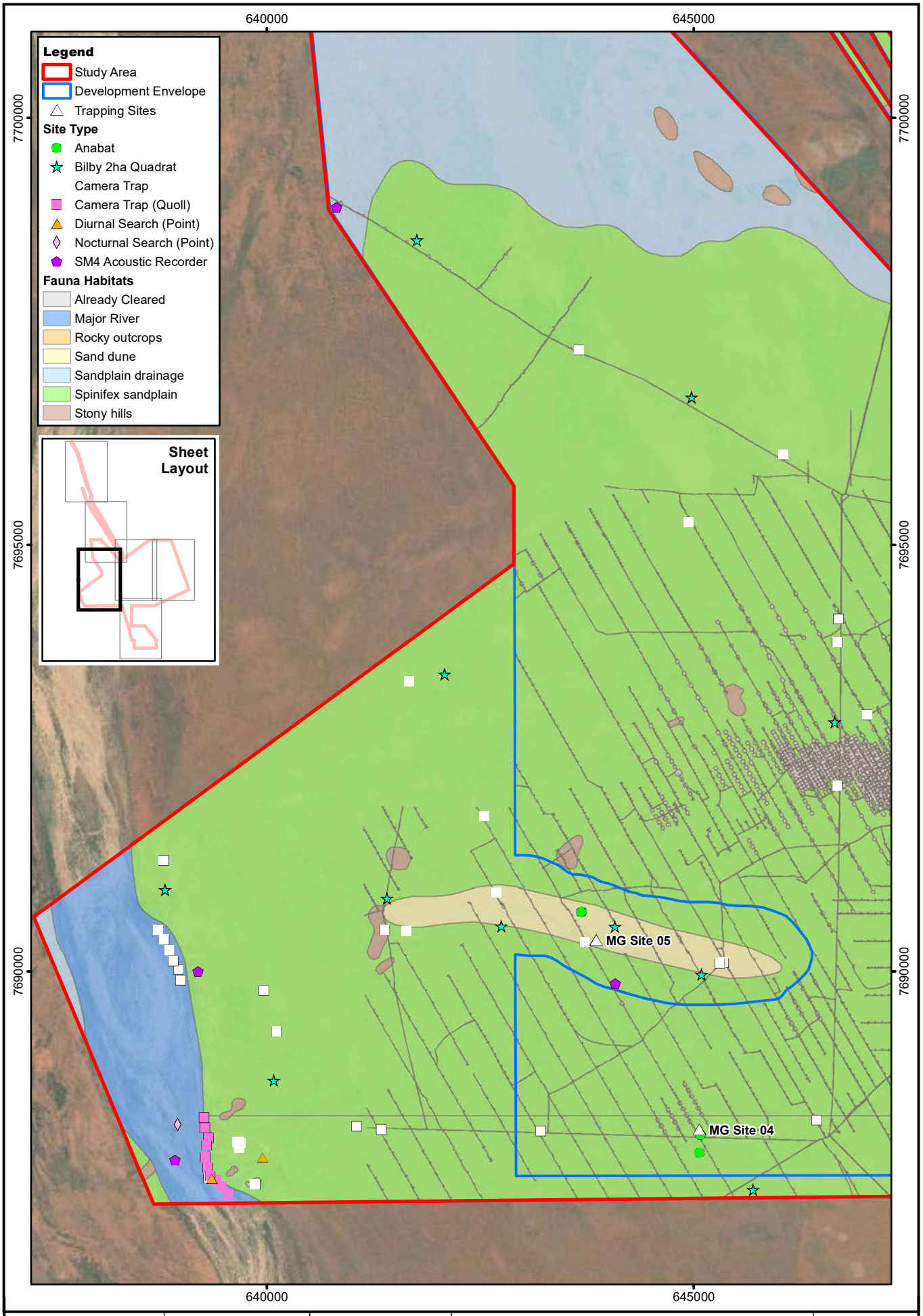
Author: J. Wilcox

Western Wildlife

Hemi Gold Project
Fauna Habitats
Sheet 6 of 6

Figure:
9.6



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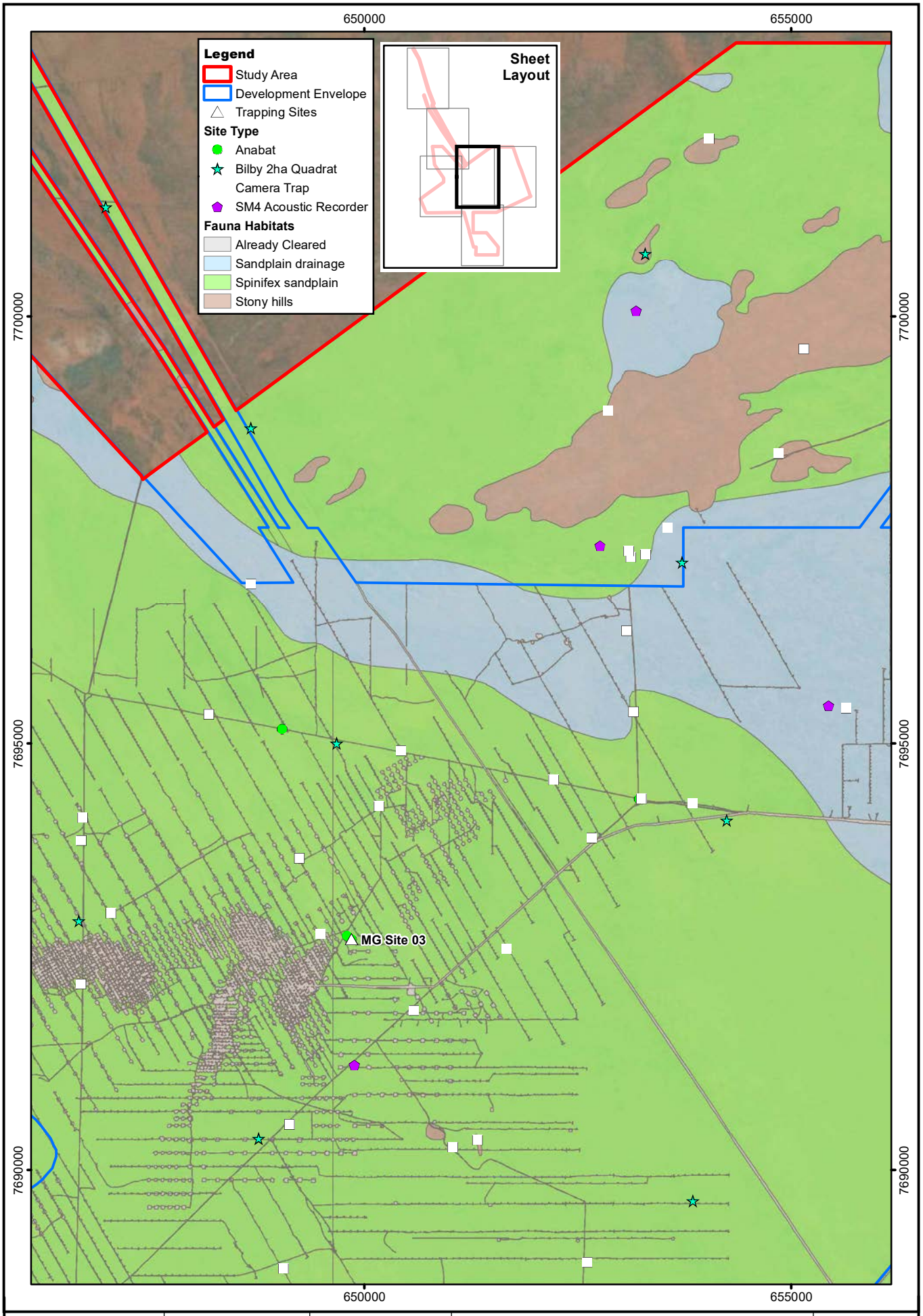
Western Wildlife

Hemi Gold Project
Fauna Habitats
Sheet 3 of 6

Figure:
9.3



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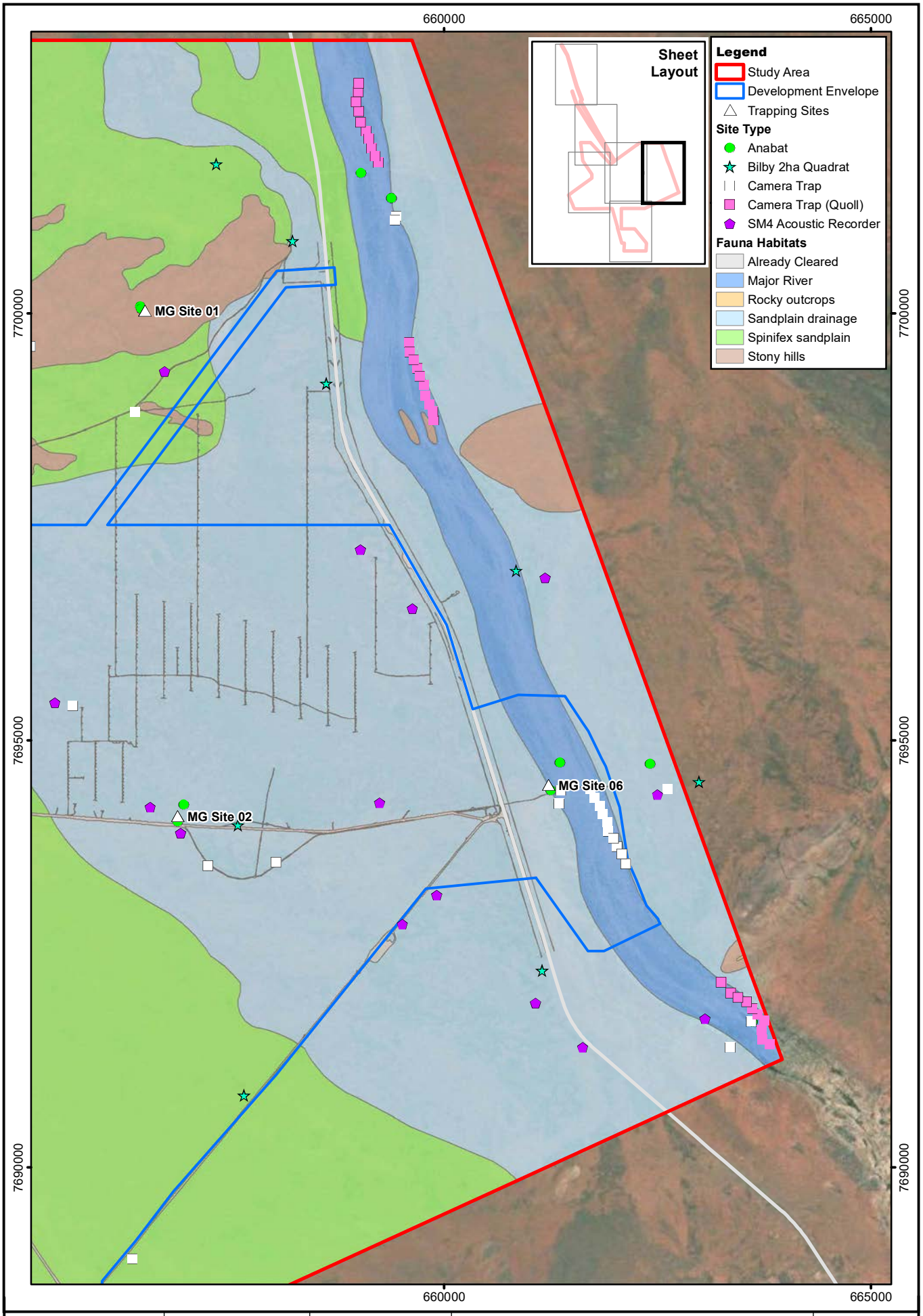

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Western Wildlife

Hemi Gold Project
Fauna Habitats
Sheet 5 of 6

Figure:
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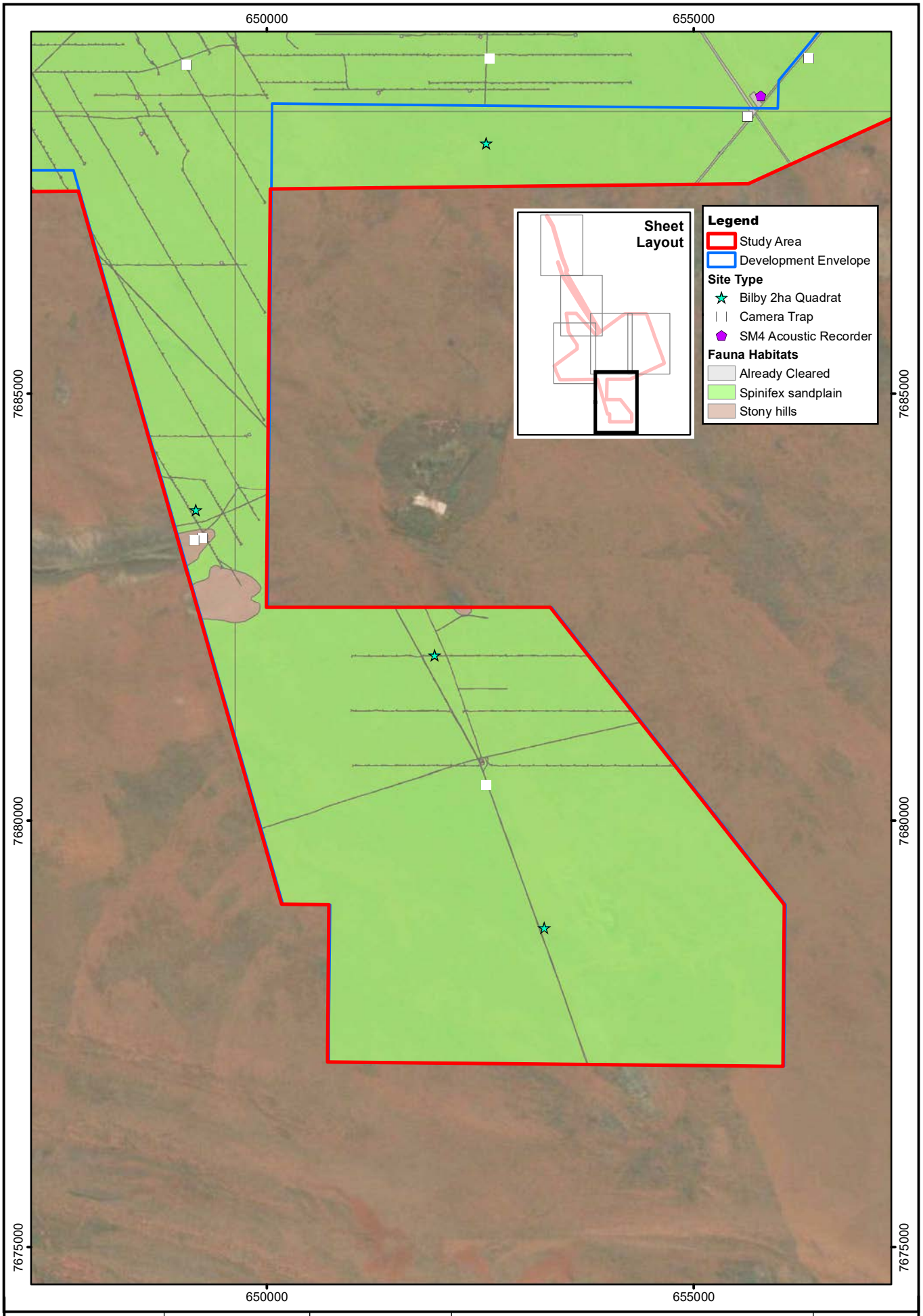

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Western Wildlife

Hemi Gold Project
Fauna Habitats
Sheet 6 of 6

Figure:
9.6

4.1.1 Spinifex Sandplain

Red consolidated sands support a patchy *Acacia* shrubland (*Acacia ancistrocarpa*, *Acacia inaequilatra* and *Acacia acradenia*) over spinifex (*Triodia lanigera* and *Triodia schinzii*) hummock grassland mixed with a low shrubland of Poverty Bush (*Acacia stellaticeps*). There are occasional other trees (*Corymbia zygophylla* and *Corymbia hamersleyana*) or shrubs (*Grevillea wickhamii*, *Hakea lorea* or *Melaleuca lasiandra*) (Plates 8 – 11). Although somewhat variable in vegetation structure, the defining feature of this habitat is the red sandplain.

Plate 8. Spinifex Sandplain.

Plate 9. Spinifex Sandplain.

This habitat roughly corresponds to the Uaroo Land System. Conservation Significant fauna that may be associated with this habitat are the Bilby (*Macrotis lagotis*: Vulnerable), Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardtii*: Priority 4) and Brush-tailed Mulgara (*Dasycercus blythi*: Priority 4).

Plate 10. Spinifex Sandplain (burnt).

Plate 11. Spinifex Sandplain (recently burnt).

4.1.2 Sandplain Drainage

Low-lying areas with heavy clay soils support an open spinifex hummock grassland, and sandy rises support a tall *Acacia* shrubland (*Acacia ancistrocarpa*, *Acacia inaequilatra* and *Acacia colei*) over spinifex (*Triodia epactica* and *Triodia schinzii*) hummock grassland mixed with a low shrubland of Poverty Bush (*Acacia stellaticeps*) (Plates 12 – 13). Low-lying areas are seasonally wet and include areas of open claypan (Plates 14 – 15). The sandy rises are similar to the Spinifex Sandplain habitat and it is likely to support a similar faunal assemblage. This habitat roughly corresponds to the Mallina Land System.

Plate 12. Sandplain Drainage.

Plate 13. Sandplain Drainage.

Conservation Significant fauna that may be associated with this habitat are the Bilby (*Macrotis lagotis*: Vulnerable), Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardtii*: Priority 4) and Brush-tailed Mulgara (*Dasycercus blythi*: Priority 4).

Plate 14. Sandplain Drainage – claypan.

Plate 15. Sandplain Drainage – claypan.

4.1.3 Sand Dune

A single low sand dune, about 4.6km long, occurs in the study area. The red flowing sands support an open shrubland of *Acacia sabulosa* and *Sida arenicola* over an open grassland of Spinifex (*Triodia schinzii* and *Triodia lanigera*) and *Corchorus incanus* (Plates 16 – 17). This habitat roughly corresponds to the Gregory Land System. A Conservation Significant fauna species that may be associated with this habitat is the Bilby (*Macrotis lagotis*: Vulnerable).

Plate 16. Sand Dune.

Plate 17. Sand Dune.

4.1.4 Stony Hills

Low stony hills and gently sloping stony flats occur mainly in the north-eastern part of the study area, with isolated low stony rises patchily occurring elsewhere. Minor rocky outcrops occur, but there are no cave-bearing formations present. The hills support a mixed low grassland and shrubland of Spinifex (*Triodia wiseana* and *Triodia epactica*) and Poverty Bush (*Acacia stellaticeps*) with scattered tall shrubs (*Acacia inaequilatra*, *A. ancistrocarpa* and *A. acradenia*) (Plates 18 – 19). This habitat roughly corresponds to the Ruth Land System. A Conservation Significant fauna species that may be associated with this habitat is the Western Pebble-mound Mouse (*Pseudomys chapmani*: Priority 4).

Plate 18. Stony Hills.

Plate 19. Stony Hills.

4.1.5 Major River

The Turner and Yule Rivers both traverse the study area. The rivers support an open woodland of River Red Gum (*Eucalyptus camaldulensis*), Little Ghost Gum (*Eucalyptus victrix*) and Silver Cadjuput (*Melaleuca argentea*) over Acacia shrubland (*Acacia trachycarpa* and *Acacia pyrifolia*) over grasses and Spinifex (Plates 20 – 21). There are also considerable expanses of open stony or sandy riverbed and a series of permanent and semi-permanent waterholes (Plates 22 – 23).

Plate 20. Major River – Turner River.

Plate 21. Major River – Turner River.

This habitat roughly corresponds to the River Land System. Conservation Significant fauna that may be associated with this habitat are the Northern Quoll (*Dasyurus hallucatus*: Endangered), Pilbara Olive Python (*Liasis olivaceous barroni*: Vulnerable), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*: Vulnerable), Common Sandpiper (*Actitis hypoleucos*: Migratory) and other birds listed as Migratory.

Plate 22. Major River – permanent pool on the Yule River.

Plate 23. Major River – open pool on the Yule River.

4.1.6 Rocky Outcrops

Very small rocky outcrops occur in the study area (Plates 24 – 25). No caves are present, but boulders and rocky crevices provide fauna habitat. This habitat roughly corresponds to parts of the Ruth and Talga Land Systems. Conservation Significant fauna that may be associated with this habitat are the Northern Quoll (*Dasyurus hallucatus*: Endangered) and Pilbara Olive Python (*Liasis olivaceous barroni*: Vulnerable).

Plate 24. Rocky Outcrop – edge of a ridge that just extends into the eastern edge of the study area.

Plate 25. Rocky Outcrop – very small, isolated outcrop near the Yule River.

5. Faunal Assemblage of the Study Area

5.1 Vertebrate Fauna Assemblage

The results of the literature review and field survey were combined to create a list of all the vertebrate fauna potentially occurring at in the study area (Appendices 4 - 7). Indicated in the fauna lists are all the species observed in the study area during the fauna survey and those recorded in the region as part of the literature review.

The potentially occurring faunal assemblage is summarised in Table 7. The overall vertebrate faunal assemblage is likely to be largely intact, with the exception of species that are extinct or greatly reduced in their distribution in the Bioregion. The faunal assemblage and conservation significant species likely to occur are further discussed in the sections below.

Table 7. Summary of vertebrate fauna predicted to occur in the study area.

Taxon	Total Species Predicted	Total Species Recorded	Conservation significant species				
			Threatened (T)	Migratory (Mi)	Specially Protected (SP)	DBCA Priority (P)	Locally significant (LS)
Amphibians	10	6	-	-	-	-	-
Reptiles	115	56	1	-	-	2	-
Birds	165	89	4	12	1	-	1
Native Mammals	36	22	4	-	-	6	-
Int. Mammals	8	6	-	-	-	-	-
Totals:	**334**	**179**	**9**	**12**	**1**	**8**	**1**

5.1.1 Amphibians

Ten species of frog potentially occur, of which six were recorded in the study area on this survey (Table 8, Appendix 5). The majority of species were recorded at MG Site 06 on the Turner River (Table 8). The frog species potentially occurring in the study area are common and widely distributed in the semi-arid zone.

The Desert Tree Frog (*Litoria rubella*) is likely to be common, occurring in Major Rivers, but also using artificial water sources such as wells and cattle troughs (Plate 26). Burrowing species aestivate underground when conditions are dry, so are difficult to sample except immediately after wet conditions. The Desert Spadefoot (*Notaden nichollsi*) is a burrowing species recorded in both the Major River and Sand Dune habitats and is also likely to occur in the Sandplain Drainage habitat (Plate 26). This species burrows in sandy soil, breeding in temporary pools formed after cyclonic summer rain. The tadpole develop into frogs very quickly. Adult frogs of this and other burrowing species also forage in adjacent terrestrial habitats when conditions are suitable.

Table 8. Amphibians recorded in the study area.

Species	Number trapped at each site (Sept/Mar)						
	1 – Stony Hills	2 – Sandplain Drainage	3 – Spinifex Sandplain	4 – Spinifex Sandplain	5 – Sand Dune	6 – Major River	Other methods only
Water-holding Frogs							
Cyclorana maini						-/12	
Litoria rubella						-/1	
Ground Frogs							
Notaden nichollsi					-/14	-/2	
Platyplectrum spenceri						-/4	
Uperoleia glandulosa						-/16	
Uperoleia saxatilis						-/2	
Total species:	**0**	**0**	**0**	**0**	**1**	**6**	**0**

Plate 26. Desert Tree Frogs (*Litoria rubella*) and Desert Spadefoot (*Notaden nichollsi*).

5.1.2 Reptiles

There are 115 species of reptile that have the potential to occur, of which 56 were recorded in the study area (Table 9, Appendix 5). The reptile assemblage of the Pilbara Bioregion is very diverse, including a suite of endemic species associated with rocky surfaces (Doughty *et al*. 2011). As the reptile assemblage is generally informed by the ground surface (e.g. sandy, clayey or rocky surfaces) the study area is likely to support several distinct assemblages. Despite this, many reptile species are likely to occur across all habitats, although they may be more common in one.

Of the 55 species were recorded during this survey, 46 were captured in trapping sites and nine were recorded through other methods, mainly nocturnal searches (Table 9). The highest species richness was recorded in the Sand Dune habitat at MG Site 05. Some species, including the Northern Spiny-tailed gecko (*Strophurus ciliaris*), Fourteen-lined Ctenotus (*Ctenotus quattuordecimlineatus*), Rufous Finesnout Ctenotus (*Ctenotus rufescens*) and Pindan Dragon (*Diporiphora pindan*) were only recorded in this habitat, although at least some of these are also likely to occur on the Spinifex Sandplain and Sandplain Drainage habitats as there is likely to be considerable overlap in the reptile assemblage across these sandy-surfaced habitats. Many species, including the Desert Banded Snake (*Simoselaps anomalus*), Grand Ctenotus (*Ctenotus grandis*) and Military Dragon (*Ctenophorus isolepis*) were recorded in more than one sandy habitat (Table 9, Plate 27). Species such as the Bearded Dragon (*Pogona minor*) and Sand Goanna (*Varanus gouldii*) require sandy soil for burrowing and egg-laying but are also likely to use other habitats (Plate 28).

Plate 27. *Simoselaps anomalus* and *Ctenotus grandis*.

The Stony Hills habitat (MG Site 01) supports a small suite of species that favour stony-surfaced habitats, including the Large Pilbara Rock Gehyra (*Gehyra macra*), Medium Pilbara Rock Gehyra (*Gehyra media*), Ring-tailed Dragon (*Ctenophorus caudicinctus*) and Rock Ctenotus (*Ctenotus saxatilis*). These species are likely to be largely restricted to the Stony Hills and Rocky Outcrop habitats.

Table 9. Reptiles recorded in the study area.

Species	Number trapped at each site (Sept/Mar)						
	1 – Stony Hills	2 – Sandplain Drainage	3 – Spinifex Sandplain	4 – Spinifex Sandplain	5 – Sand Dune	6 – Major River	Other methods only
Geckoes							
Diplodactylus laevis	4/2	1/9	-/10	1/4			
Gehyra macra	-/1						
Gehyra media	-/11						
Gehyra micra	3/-						
Gehyra montium	1/2	1/-	1/1	9/5	56/28		
Heteronotia binoei	1/-				1/-	2/4	
Lucasium stenodactylum				3/-	-/2		
Nephrurus levis		3/1			1/2		
Rhynchoedura ornata							N
Strophurus ciliaris					1/		
Legless Lizards							
Delma butleri				-/2			
Delma pax	-/1	1/-				-/1	
Lialis burtonis			1/-				
Pygopus nigriceps							N
Dragons							
Ctenophorus caudicinctus	1/4						
Ctenophorus isolepis		5/-	6/2	21/3	8/2	1/-	
Ctenophorus nuchalis							D
Diporiphora pindan					2/2		
Gowidon longirostris						-/1	
Pogona minor			1/-	-/1	-/3		
Skink Lizards							
Carlia munda						1/-	
Carlia triacantha	-/1	4/-					
Ctenotus grandis		1/5	-/4	-/2	1/-	2/7	
Ctenotus hanloni				-/1			
Ctenotus helenae		1/9	-/5	3/7	-/1	-/1	
Ctenotus pallasotus	-/1	2/-	5/-		2/-		
Ctenotus pantherinus		2/1	2/-	6/5	4/-		
Ctenotus quattuordecimlineatus					9/14		
Ctenotus rufescens					1/1		
Ctenotus saxatilis	3/18	1/1			1/-	1/11	
Ctenotus schomburgkii	-/1						
Egernia epsisolus							C
Eremiascincus pallidus		1/-			16/9		

Table 9. (cont.)

Species	Number trapped at each site (Sept/Mar)						
	1 – Stony Hills	2 – Sandplain Drainage	3 – Spinifex Sandplain	4 – Spinifex Sandplain	5 – Sand Dune	6 – Major River	Other methods only
Lerista bipes		2/5	13/19	16/42	38/45	1/14	
Lerista clara			1/-			3/-	
Menetia greyii			1/-		-/1		
Morethia ruficauda	1/-	1/-			3/-	1/-	
Tiliqua multifasciata	-/1			-/1			
Goannas / Monitors							
Varanus acanthurus	1/-		1/-			1/-	
Varanus brevicauda	1/1	3/-	2/-				
Varanus bushi							D
Varanus eremius	1/-	1/1		1/-		1/-	
Varanus giganteus							D
Varanus gouldii	-/1				1/1	1/-	
Varanus panoptes							C
Varanus tristis						1/-	
Blind Snakes							
Anilios ammodytes		-/1	-/3			-/1	
Anilios hamatus			-/1				
Pythons							
Aspidites ramsayi							N
Elapid Snakes							
Demansia psammophis		2/-					
Demansia rufescens				-/1	4/-		
Furina ornata							N
Pseudechis australis							N
Pseudonaja mengdeni					-/1		
Pseudonaja modesta		1/-	2/1	-/1			
Simoselaps anomalus		1/-		1/-	8/2		
Total species:	**18**	**20**	**17**	**16**	**23**	**16**	**10**

*C = camera trap, N = night sighting, D = day sighting.

The Major River habitat is likely to support species that favour both sandy and stony surfaces, as it includes both substrates. This habitat also has tree hollows, providing habitat for the Black-tailed Monitor (*Varanus tristis*) and other arboreal species. Other species commonly associated with Major Rivers are the Long-nosed Dragon (*Gowidon longirostris*) and Flat-shelled Turtle (*Chelodina steindachneri*).

Plate 28. *Pogona minor* and *Varanus gouldii*.

5.1.3 Birds

There are 165 species of bird that potentially occur in the study area, of which 89 species were recorded on this survey (Table 10, Appendix 6). The terrestrial bird fauna of the Pilbara region is thought to be generally uniform, with a higher species richness where there is riparian vegetation such as tall *Eucalyptus* or *Melaleuca* trees (Burbidge *et al*. 2010). Most of the potentially occurring bird species have wide distributions through the Pilbara Bioregion, many occurring in a variety of habitats.

Of the 83 species recorded, more than 40% were recorded opportunistically. The most species rich sites were in the Major River (MG Site 06) and Sand Dune (MG Site 05) habitats, each with 28 species (Table 10). This is likely due to the more complex vegetation structure at these sites, which provide habitat for a greater range of species.

The Major River habitat is likely to support a large group of species that are absent or very uncommon in other habitats. Several wetland dependent bird species, such as ducks, herons, cormorants, grebes and shorebirds, were recorded during the current survey, mostly in association with waterholes on the Yule River. The Star Finch (*Neochmia ruficauda*) is also likely to be restricted to the Major River habitat (Plate 29). These species are likely to be present whenever water is present in the Turner and Yule Rivers, some species occurring in small numbers year-round on permanent waterholes. Waterholes also provide habitat for terrestrial birds to drink and bathe (Plate 29).

Plate 29. Little Corella bathing in a waterhole and Star Finch on the Yule River.

Sites in the Sandplain Drainage (MG Site 02) and Spinifex Sandplain (MG Site 03 and MG Site 04) habitats were less species rich. The vegetation in the Spinifex Sandplain habitat is relatively low and open, supporting fewer bird species. The Sandplain Drainage habitat varies, with patches of open spinifex grassland and claypans, with denser shrublands on sandy rises. Although the species richness at MG Site 02 was relatively low, it is likely that some parts of this habitat support more species.

The bird assemblage is likely to include a suite of species that are resident in the study area, a second group that makes regular or nomadic movements into and through the study area Resident species include many of the small insectivores such as fairywrens, whistlers and robins. Resident species are present all year, though their populations may fluctuate in response to rainfall and fire.

Birds that make regular seasonal movements include the Rainbow Bee-eater (*Merops ornatus*), cuckoos and some birds of prey. Honeyeaters are also likely to make seasonal or nomadic movements to take advantage of flowering events (Plate 30). Although not present all year, these species are likely to use the study area for foraging, breeding or shelter on a seasonal basis or when conditions are suitable.

Plate 30. Honeyeaters in the study area.

Table 10. Birds recorded in the study area.

Species*	Frequency of occurrence (n=6) at each site (Sept/Mar)						
	1 – Stony Hills	2 – Sandplain Drainage	3 – Spinifex Sandplain	4 – Spinifex Sandplain	5 – Sand Dune	6 – Major River	Opportunistic
Australasian Darter							+
Australasian Pipit							+
Australasian Reed Warbler							+
Australian Bustard				1/1	6/1		
Australian Hobby							+
Australian Owlet-nightjar							+
Australian Pelican							+
Australian Magpie	2/-						
Australian Ringneck					1/-	-/1	
Banded Lapwing							+
Barking Owl							+
Bar-shouldered Dove					-/1		
Black Kite							+
Black-eared Cuckoo							+
Black-faced Cuckoo-shrike			2/-	1/-	6/1	1/-	
Black-faced Woodswallow		1/2	1/-	-/1	2/3	-/1	
Black-fronted Dotterel							+
Black-necked Stork							+
Blue-winged Kookaburra						1/-	
Brown Falcon				-/1	2/2		
Brown Goshawk							+
Brown Honeyeater	1/-				1/-		
Brown Quail							+
Budgerigar	-/2		1/1	1/1	3/5	1/2	
Bush Stone-curlew							**+**
Cockatiel			-/1			1/1	
Collared Sparrowhawk							**+**
Common Bronzewing	2/-	1/-				-/2	
Crested Bellbird	1/-				2/-	2/2	
Crested Pigeon		1/-		2/-	4/2	1/1	
Crimson Chat	-/1						
Diamond Dove	1/-	1/-	1/-		3/3	-/2	
Eastern Great Egret							**+**
Emu							**+**
Fairy Martin							**+**
Fork-tailed Swift **(Mi)**	-/1						
Galah		2/-				1/2	

*see Appendix 6 for scientific names

Table 10. (cont.)

Species	Frequency of occurrence (n=6) at each site (Sept/Mar)						
	1 – Stony Hills	2 – Sandplain Drainage	3 – Spinifex Sandplain	4 – Spinifex Sandplain	5 – Sand Dune	6 – Major River	Opportunistic
Great Cormorant							+
Grey Teal							+
Grey-crowned Babbler						1/1	
Grey-headed Honeyeater	4/2	1/-		-/1			
Grey Shrike-thrush					-/1		
Horsfield's Bronze-cuckoo		2/-	-/1	1/2	4/4	-/1	
Horsfield's Bush Lark			-/1		1/4		
Little Black Cormorant							+
Little Button-quail				-/1			
Little Corella							+
Little Crow							+
Little Eagle					-/1		
Little Pied Cormorant							+
Magpie-lark	1/-	1/-				3/3	
Masked Woodswallow							+
Nankeen Kestrel	-/1						
Nankeen Night-heron							+
Pacific Black Duck							+
Painted Finch	-/3		-/2	-/2			
Pallid Cuckoo							+
Peaceful Dove					-/1	1/2	
Pheasant Coucal							+
Pied Butcherbird	5/-						
Purple-backed Fairy-wren	-/1	1/1		-/1	4/5		
Rainbow Bee-eater		1/1			6/6	4/6	
Red-backed Kingfisher							+
Red-browed Pardalote						1/-	
Rufous Songlark							+
Rufous Whistler					2/-	1/-	
Rufous-crowned Emu-wren							+
Sacred Kingfisher						-/6	
Singing Honeyeater	4/6	6/2	5/5	5/2	6/4	-/1	
Southern Boobook							+
Spinifex Pigeon	2/-			1/-		-/1	
Spinifexbird	1/-						
Spotted Harrier				1/-	1/-	1/-	
Spotted Nightjar							+
Straw-necked Ibis							+

Table 10. (cont.)

Species	Frequency of occurrence (n=6) at each site (Sept/Mar)						
	1 – Stony Hills	2 – Sandplain Drainage	3 – Spinifex Sandplain	4 – Spinifex Sandplain	5 – Sand Dune	6 – Major River	Opportunistic
Star Finch							+
Torresian Crow	1/1		2/1	4/1	2/1	-/2	
Tree Martin						-/1	
Wedge-tailed Eagle							+
Western Bowerbird							+
Whistling Kite							+
White-browed Babbler							+
White-faced Heron							+
White-plumed Honeyeater			-/1		5/2	6/6	
White-winged Fairy-wren		2/1	2/6	4/5	4/1		
White-winged Triller					1/-		
Willie Wagtail					3/-		
Yellow-throated Miner	6/3	4/-		-/1	2/1	1/1	
Zebra Finch	-/6	4/4	-/5	4/4	6/6	-/1	
Total species:	**20**	**14**	**13**	**18**	**28**	**28**	**34**

5.1.4 Mammals

There are 44 species of mammal that have the potential to occur in the study area, of which 36 are native and eight introduced (Appendix 7). A total of 28 species were recorded on this survey, of which 22 were native and six introduced (Table 11). The mammal assemblage is likely to be relatively intact, with the exception of species that are extinct in the Pilbara Bioregion. Australia has a history of mammal extinctions since European settlement, most likely due to changed fire regimes and the impacts of feral Cats and Foxes (Woinarski *et al*. 2015). Of the mammals known from the Pilbara Bioregion, 15% are now extinct (McKenzie *et al*. 2009).

Between one and six species were recorded in trapping grids, but most species were recorded by other methods including, camera trapping, bat call records and opportunistic observation (Table 11). MG Site 03 on the Spinifex Sandplain was the most species rich, but all of the species trapped were also recorded at other sites.

The Spinifex Sandplain and Sandplain Drainage habitats are likely to support a similar range of sandplain species, including the Lesser Hairy-footed Dunnart (*Sminthopsis youngsoni*), Spinifex Hopping Mouse (*Notomys alexis*) and Desert Mouse (*Pseudomys desertor*) (Plate 31). The Pilbara Ningaui (*Ningaui timealeyi*) is widespread but likely to favour productive low-lying habitats such as the Major River and Sandplain Drainage (Plate 31).

Plate 31. Desert Mouse (*Pseudomys desertor*) and Pilbara Ningaui (*Ningaui timealeyi*).

A small suite of species favour rocky habitats, including Woolley's False Antechinus (*Pseudantechinus woolleyae*), Long-tailed Dunnart (*Sminthopsis longicaudata*), Common Rock-rat (*Zyzomys argurus*), Rothschild's Rock-wallaby (*Petrogale rothschildi*), Northern Quoll (*Dasyurus hallucatus*) and some bat species. The Rocky Outcrop habitat is likely to provide important habitat for these species, however, this habitat is extremely limited in the study area.

Although the mammal fauna of the Pilbara is relatively well-studied, there are still taxonomic issues to be resolved, for example there are several undescribed species of *Planigale* present in the Pilbara (Westerman *et al*. 2016). Although this example does not impact the outcomes of this survey, it provides an indication that despite the many surveys that are undertaken in the region, there are still knowledge gaps.

Six introduced mammal species were recorded in the study area (Table 11, Appendix 7). Cats (*Felis catus*) and Foxes (*Vulpes vulpes*) were both recorded on camera traps (Plate 32). The Cat, Fox and Wild Dog (*Canis familiaris dingo*) are feral predators known to prey on native fauna species. 'Predation by Feral Cats' and 'Predation by the European Red Fox' are listed as a key threatening processes under the EPBC Act. Foxes prey on 'critical weight range' mammals (i.e. those between 35g and 5.5kg) and ground-nesting birds (Commonwealth of Australia 2018). Feral Cats have contributed to the extinction of many small to medium sized native mammals and ground-nesting birds in the arid zone (Commonwealth of Australia 2015). Though mammals tend to be the dominant prey (Commonwealth of Australia 2015), each Feral Cat in natural environments kills on average 225 reptiles per year, with cats in arid areas taking even more, equating to the predation of about 1.8 million reptiles per day (Woinarski *et al*. 2018).

Table 11. Mammals recorded in the study area.

Species	Number trapped at each site (Sept/Mar)						
	1 – Stony Hills	2 – Sandplain Drainage	3 – Spinifex Sandplain	4 – Spinifex Sandplain	5 – Sand Dune	6 – Major River	Other methods only*
Echidna							
Tachyglossus aculeatus							S
Dasyurid marsupials							
Dasycercus blythi **(P4)**							C
Dasyurus hallucatus **(En)**							C,S
Dasykaluta rosamondae	1/6	12/9	1/1	2/-		5/2	
Ningaui timealeyi		1/-				3/3	
Planigale sp. 1	7/-		1/-				
Sminthopsis youngsoni		1/1	4/-	5/1			
Bilbies							
Macrotis lagotis **(Vu)**							S
Kangaroos							
Osphranter robustus							D
Osphranter rufus							D
Bats							
Chaerephon jobensis							A
Chalinolobus gouldii							A
Ozimops cobourgiana **(P1)**							A
Rhinonicteris aurantia **(Vu)**							A
Saccolaimus flaviventris							A
Scotorepens greyii							A
Taphozous georgianus							A
Vespadelus findlaysoni							A
Rodents							
Notomys alexis				1/-			
Pseudomys chapmani **(P4)**							S
Pseudomys desertor		1/-	1/-				
Pseudomys hermannsburgensis	3/-	7/-	7/2	-/1		1/1	
Introduced species							
Mus musculus			-/1		1/-		
Felis catus							C
Vulpes vulpes							C
Camelus dromedarius							S
Canis familiaris dingo							C
Bos taurus							S
Total species:	**3**	**5**	**6**	**4**	**1**	**3**	**19**

*A = Anabat call recording, S = secondary signs, C = camera trap, N = night sighting, D = day sighting.

Plate 32. Fox (*Vulpes vulpes*) and Cat (*Felis catus*).

5.2 Vertebrate Fauna of Conservation Significance

There are 31 vertebrate fauna of conservation significance that potentially occur in the study area: nine Threatened, 12 Migratory, one Specially Protected, eight Priority and one Locally Significant species (Table 12). Each species is summarised in Table 12 and discussed in the sections below. The results of the DBCA Threatened and Priority Fauna Database extract is shown on Figure 10 and the conservation significant fauna recorded on this survey are shown in Figure 11. The results EPBC Protected Matters Search Tool extract is shown in Appendix 8.

Several conservation significant species listed on database searches in the area have been omitted from the list of potential fauna in Appendices 4 – 7 and the discussion below. These species are listed in Appendix 9 and includes Migratory shorebirds that primarily occur in coastal habitats, seabirds, marine turtles and species only likely to occur as vagrants. The study area does not provide habitat likely to regularly support these species.

Table 12. Summary of conservation significant fauna.

Key to status: Cr = Critically Endangered, En = Endangered, Vu = Vulnerable, Mi = Migratory, OS = Other Specially Protected, P1 – P4 = Priority 1 – 4, LS = Locally Significant.

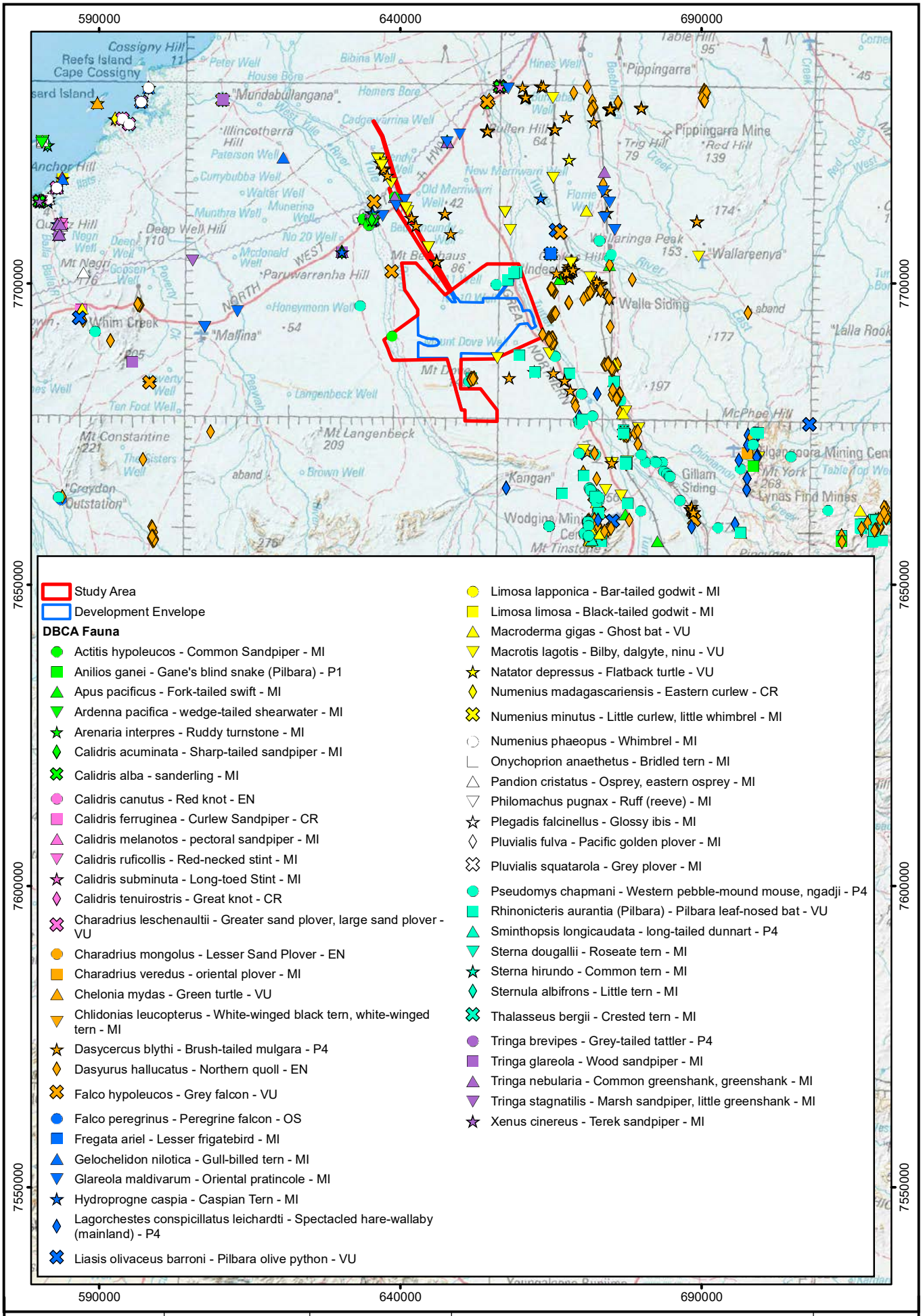
Species	Conservation Status				Likelihood of Occurrence	Notes
	EPBC Act	BC Act	DBCA Priority	Locally significant		
Threatened Species						
Pezoporus occidentalis **Night Parrot**	En	Cr			Possible	This species is known from very few records anywhere. Patches of open spinifex within the Sandplain Drainage habitat may be breeding habitat when long-unburnt, but no currently suitable habitat was present.
Dasyurus hallucatus **Northern Quoll**	En	En			Known to occur	**Recorded in the study area in September 2021, March and August 2022.** Likely to be a resident of the Rocky Outcrops and Major River habitats, dispersing and foraging in adjacent habitats.
Tringa nebularia **Common Greenshank**	En & Mi	Mi			Likely	Non-breeding summer visitor to waterholes on Major Rivers, possibly also to claypans in the Sandplain Drainage habitat.
Calidris acuminata **Sharp-tailed Sandpiper**	Vu & Mi	Mi			Potential	Non-breeding summer visitor to waterholes on Major Rivers, possibly also to claypans in the Sandplain Drainage habitat.
Macrotis lagotis **Bilby**	Vu	Vu			Known to occur	**Secondary signs recorded in the study area in September 2021 and March 2022.** Likely to be an uncommon resident to the Spinifex Sandplain, Sandplain Drainage and Sand Dune habitats.
Rhinonicteris aurantia **Pilbara Leaf-nosed Bat**	Vu	Vu			Known to occur	**Recorded in the study area in September 2021 and March 2022.** Likely to be a regular foraging visitor in low numbers to all habitats, particularly of the Rocky Outcrops and Major River habitats. No diurnal roosting habitat present.
Macroderma gigas **Ghost Bat**	Vu	Vu			Likely	Likely to be a regular foraging visitor to all habitats. No diurnal roosting habitat present.
Liasis olivaceus barroni **Pilbara Olive Python**	Vu	Vu			Likely	Known to occur nearby (Figure 10), this species is likely to be a foraging visitor and possible breeding resident of the Major River and Rocky Outcrop habitats.

Table 12. (cont.)

Species	Conservation Status				Likelihood of Occurrence	Notes
	EPBC Act	BC Act	DBCA Priority	Locally significant		
Falco hypoleucos **Grey Falcon**	Vu	Vu			Likely	Known to occur nearby (Figure 10), this species is likely to be a foraging visitor to open habitats and possible breeding resident of the Major River habitat.
Migratory Species						
Charadrius veredus **Oriental Plover**	Mi	Mi			Possible	May be a non-breeding summer visitor to open plains and recently burnt areas, but there are very few records of this species in the region.
Actitis hypoleucos **Common Sandpiper**	Mi	Mi			Likely	Non-breeding summer visitor to waterholes on Major Rivers, possibly also to claypans in the Sandplain Drainage habitat.
Calidris melanotos **Pectoral Sandpiper**	Mi	Mi			Possible	May be a non-breeding summer visitor to waterholes on Major Rivers, possibly also to claypans in the Sandplain Drainage habitat.
Calidris ruficollis **Red-necked Stint**	Mi	Mi			Potential	Non-breeding summer visitor to waterholes on Major Rivers, possibly also to claypans in the Sandplain Drainage habitat.
Tringa glareola **Wood Sandpiper**	Mi	Mi			Likely	Non-breeding summer visitor to waterholes on Major Rivers, possibly also to claypans in the Sandplain Drainage habitat.
Tringa stagnatilis **Marsh Sandpiper**	Mi	Mi			Potential	Non-breeding summer visitor to waterholes on Major Rivers, possibly also to claypans in the Sandplain Drainage habitat.
Pandion cristatus **Eastern Osprey**	Mi	Mi			Potential	Foraging visitor to waterholes on Major Rivers. No breeding habitat present.
Apus pacificus **Fork-tailed Swift**	Mi	Mi			Known to occur	**Recorded in the study area in March 2022.** Although likely to occur on occasion, this species is largely aerial in Australia so the terrestrial habitats in the study area are unlikely to be of particular importance to the species.
Glareola maldivarum **Oriental Pratincole**	Mi	Mi			Potential	Non-breeding summer visitor to open plains or claypans in the Sandplain Drainage habitat.
Gelochelidon nilotica **Gull-billed Tern**	Mi	Mi			Potential	Foraging visitor to waterholes on Major Rivers. No breeding habitat present.
Hydroprogne caspia **Caspian Tern**	Mi	Mi			Likely	Foraging visitor to waterholes on Major Rivers. No breeding habitat present.

Table 12. (cont.)

Species	Conservation Status				Likelihood of Occurrence	Notes
	EPBC Act	BC Act	DBCA Priority	Locally significant		
Plegadis falcinellus **Glossy Ibis**	Mi	Mi			Potential	Occasional foraging visitor to waterholes on Major Rivers. No breeding habitat present.
Specially Protected						
Falco peregrinus **Peregrine Falcon**		OS			Potential	This species potentially occurs as a foraging visitor but breeding habitat is limited in the study area.
Priority Species						
Ctenotus nigrilineatus **Pin-striped Finesnout Ctenotus**			P1		Possible	This species is known from very few records, but habitats in the study area may be suitable.
Anilios ganei **Gane's Blind Snake**			P1		Possible	This species is known from very few records, but habitats in the study area may be suitable.
Ozimops cobourgiana **Northern Coastal Free-tailed Bat**			P1		Known to occur	**Recorded in the study area in March 2022.** Likely to be a foraging visitor to most habitats, may roost in tree hollows in the Major River habitat.
Dasycercus blythi **Brush-tailed Mulgara**			P4		Known to occur	**Recorded in the study area in September 2021, March and August 2022.** Likely to be a common resident of the Spinifex Sandplain and Spinifex Drainage habitats.
Lagorchestes conspicillatus **Spectacled Hare-wallaby**			P4		Likely	This species is known to occur in the region and suitable habitat is present in the Spinifex Sandplain and Sandplain Drainage habitats.
Sminthopsis longicaudata **Long-tailed Dunnart**			P4		Potential	This species is known to occur in the region, and potentially suitable habitat is present in the Stony Hills and Rocky Outcrops.
Leggadina lakedownensis **Lakeland Downs Mouse**			P4		Potential	This species is known to occur in the region, and potentially suitable habitat is present in the Sandplain Drainage habitat.
Pseudomys chapmani **Western Pebble-mound Mouse**			P4		Known to occur	**Active mounds recorded in the study area in September 2021, March and August 2022.** Likely to be a common resident of the Stony Hills habitat.
Stipiturus ruficeps **Rufous-crowned Emu-wren**				LS	Known to occur	**Recorded on acoustic detectors in April 2024.** Likely to occur where mature spinifex is present.



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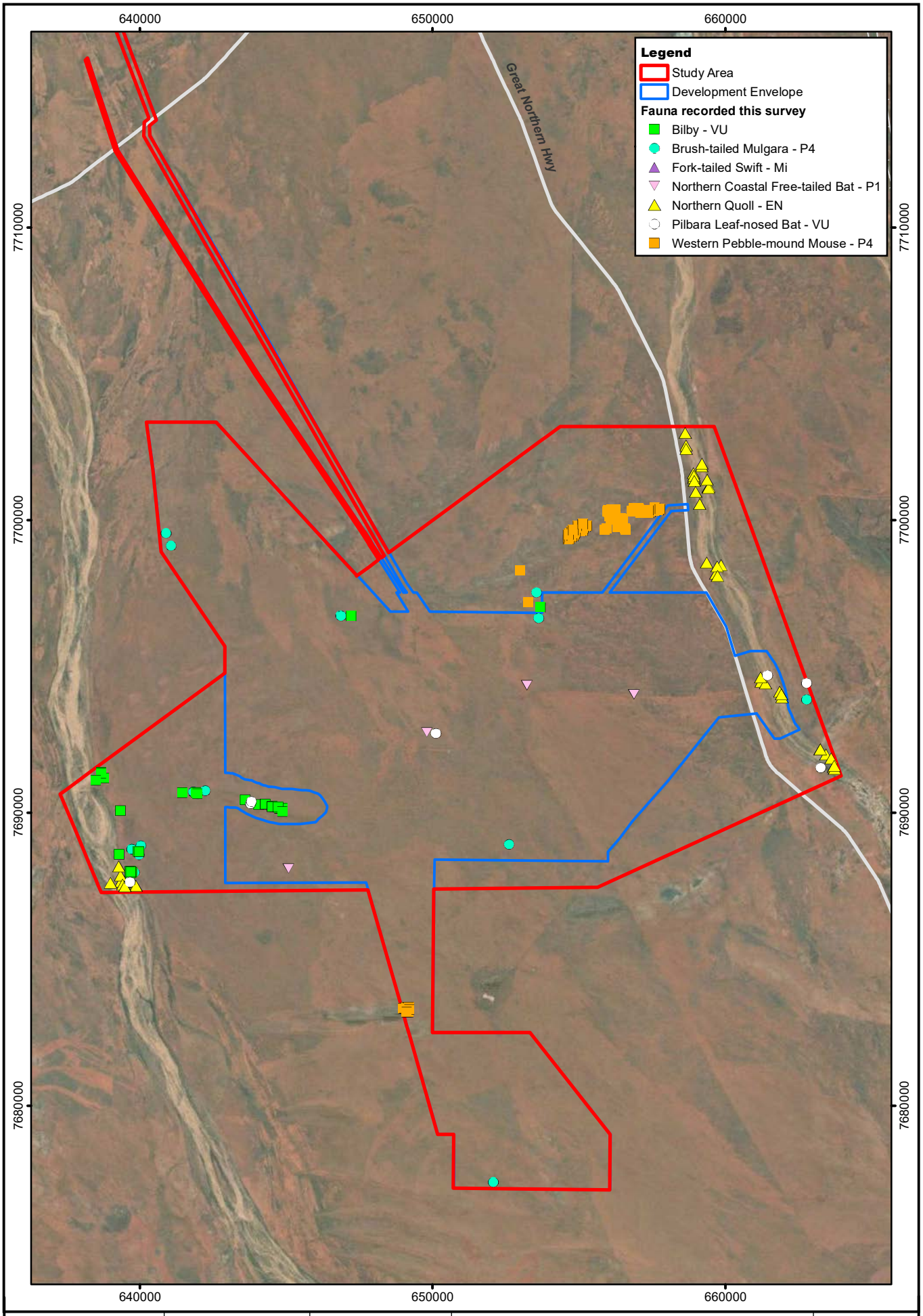
Hemi Gold Project
DBCA Threatened and Priority Fauna Database Records

Figure: **10**



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Hemi Gold Project
Conservation Significant fauna recorded this survey

Figure: **11**

5.2.1 Threatened Fauna

There are nine Threatened species that potentially occur in the study area (Table 12).

Threatened species are those that are considered in danger of extinction as their populations have declined and/or are still declining, and their total population size is small and/or fragmented or geographically restricted. Sites that support these species may be important for their long-term conservation, particularly if the site supports a resident or breeding population.

Night Parrot – *Pezoporus occidentalis*

The Night Parrot is listed as Endangered under the EPBC Act and Critically Endangered under the BC Act.

Historically, the Night Parrot was recorded across a large range in Australia's arid and semi-arid interior (Garnett *et al*. 2011). In recent times however, there are very few verified records of the species. Contemporary Western Australian records of this species have been associated with salt lakes and marshes. Western Australia records are from six sites including Lake Gregory, a site near Wiluna and near the Fortescue Marsh in the Pilbara (NPRT 2019, Davis and Metcalf 2008, Garnett and Baker 2021). Across Australia, no more than 30 individual Night Parrots have been detected 2013 – 2020, and sampling with passive acoustic detectors over the last few years have failed to find any further birds (Garnett and Baker 2021).

Based on current knowledge, the Night Parrot's key habitats are mature Spinifex grasslands (breeding and roosting sites) and chenopod-dominated systems in and around salt lakes (Garnett and Baker 2021). Nesting sites are usually in mature Spinifex, often large ring-forming clumps, generally in *Triodia longiceps* (DPAW 2017), but also in other species. Foraging habitats are likely to vary across Australia, but include herbs, grasses, grass-like plants, *Sclerolaena spp*. and other chenopods (DPAW 2017).

Key threats to the Night Parrot include habitat degradation due to large-scale over-grazing, habitat loss due to potash mining, fires that result in loss of mature spinifex and predation by cats (Garnett and Baker 2021).

Knowledge about the Night Parrot's current distribution and habitat requirements in Western Australia is based on very few records. Therefore, there is considerable uncertainty when assessing the likelihood of occurrence of this species.

Most habitats in the study area lack the large spinifex clumps required for roosting habitat, at least in part due to regular fires by the pastoralist. All but the Sandplain Drainage habitat are also likely to be too wooded to support roosting birds. Tree and shrub density at known roosting sites is typically 10 – 15 stems/ha or lower (Adaptive NRM 2021). The Sandplain Drainage is the only habitat with small areas of open spinifex, typically located in and around claypan depressions. Some of these areas support a few large spinifex clumps, usually where water runoff has promoted growth in depressions. However, examination of aerial photography, fire age mapping and on-ground searches failed to find any habitat currently sufficiently long-unburnt to provide roosting habitat for the species. Despite this, passive acoustic recorders were deployed in areas of larger spinifex as a precautionary measure.

The targeted survey in March 2022 deployed passive acoustic detectors at 13 sites across the study area, and no Night Parrots were detected (Adaptive NRM 2022, Appendix 11). Seventeen additional sites outside the study area to the east and west also did not detect the species. A survey at a further 12 sites in the study area in 2024 also failed to detect the species (Malu Fauna 2024, Appendix 11).

The Sandplain Drainage habitat is also potential foraging habitat, as the low-lying claypan areas are likely to be productive after rains.

It is considered possible that the Night Parrot occurs in the study area, as this scarce species is poorly known, however, no birds were detected and the small areas of open spinifex have been impacted by frequent fire. It is considered unlikely that the study area currently comprises critical habitat for this species.

Northern Quoll – *Dasyurus hallucatus*

The Northern Quoll is listed as Endangered under the EPBC Act and BC Act.

The Northern Quoll occurs across the northern parts of Australia including Western Australia, the Northern Territory, Queensland and some offshore islands (Van Dyck and Strahan 2008). The Northern Quoll has declined, now occurring as several disjunct populations (Braithwaite and Griffiths 1994). Within the Pilbara population, genetic studies have suggested that a high level of dispersal occurs between subpopulations, (Spencer *et al*. 2013).

The reduction in population size is estimated at 50% over the last decade, with a further 25% reduction expected over the next decade (Woinarski *et al*. 2014). An 'important population' is one that is important to the long-term survival of the Northern Quoll. This may be a population that is high density, a population free of Cane Toads and where Cane Toads are unlikely to gain a foothold, or a population subject to on-going research.

The Northern Quoll is reproductively mature at 11 months, and breed in their first year (Van Dyck and Strahan 2008). Breeding occurs between July and September and is usually synchronised within a population. At about two months old the young are left in a den while the mother forages, and at six months about two or three young are weaned (Van Dyck and Strahan 2008). In general, all adults die after breeding, though some females have been recorded living up to three years in the wild (Van Dyck and Strahan 2008).

The Northern Quoll occurs in a variety of habitats across its range, but favours dissected rocky escarpments in the Pilbara (Hill and Ward 2010, Van Dyck and Strahan 2008). Where shelter habitat occurs within the Northern Quolls predicted range, it is considered 'habitat critical to the survival of the species' (DoE 2016). In the Pilbara, shelter and denning habitat consists of rocky habitats such as ranges, escarpments, mesas, gorges, breakaways and boulder fields (DoE 2016). Northern quoll habitat preferences have been modelled (Molloy *et al.* 2017; Shaw *et al*. 2023), with granite areas south of Port Hedland identified as a habitat stronghold.

Little is known about Northern Quoll foraging and dispersal habitats, however, the EPBC Act referral guidelines recognise that all native vegetation within 1km of shelter habitat or Northern Quoll records may be considered foraging and dispersal habitat (DoE 2016). Recent studies have shown that Northern Quolls in the Pilbara form two subpopulations (roughly east and west) with a great deal of mixing, indicating that individuals have a great capacity for dispersal (Shaw *et al*. 2023). Females tend to stay close (about 2km) to their maternal dens, whereas males disperse further (4-10 km) (Shaw *et al*. 2023). Higher dispersal capacity is linked to proximity to watercourses (Shaw *et al*. 2023).

Cane Toads are considered the main threat to the Northern Quoll in the parts of its range that overlap the Cane Toad distribution (Hill and Ward 2010). As yet the Pilbara is free of Cane Toads, though it is uncertain whether this will be the case in the future. The Northern Quoll was already in decline in parts of its range prior to Cane Toad invasion, so other threatening processes are thought to be at play (Hill and Ward 2010).

Feral Predators, such as the Fox (*Vulpes vulpes*) and Cat (*Felis catus*), are likely to prey on Northern Quolls. Henandez-Santin (2018) suggests that in the Pilbara Cats may exclude quolls from open spinifex plains, restricting them to rocky habitats. Inappropriate fire regimes, such as too-frequent fires, appear to impact Northern Quolls, possibly through decreased cover resulting in increased predation, changes to habitat structure or reduction in food availability. However, these mechanisms are not well understood (Hill and Ward 2010).

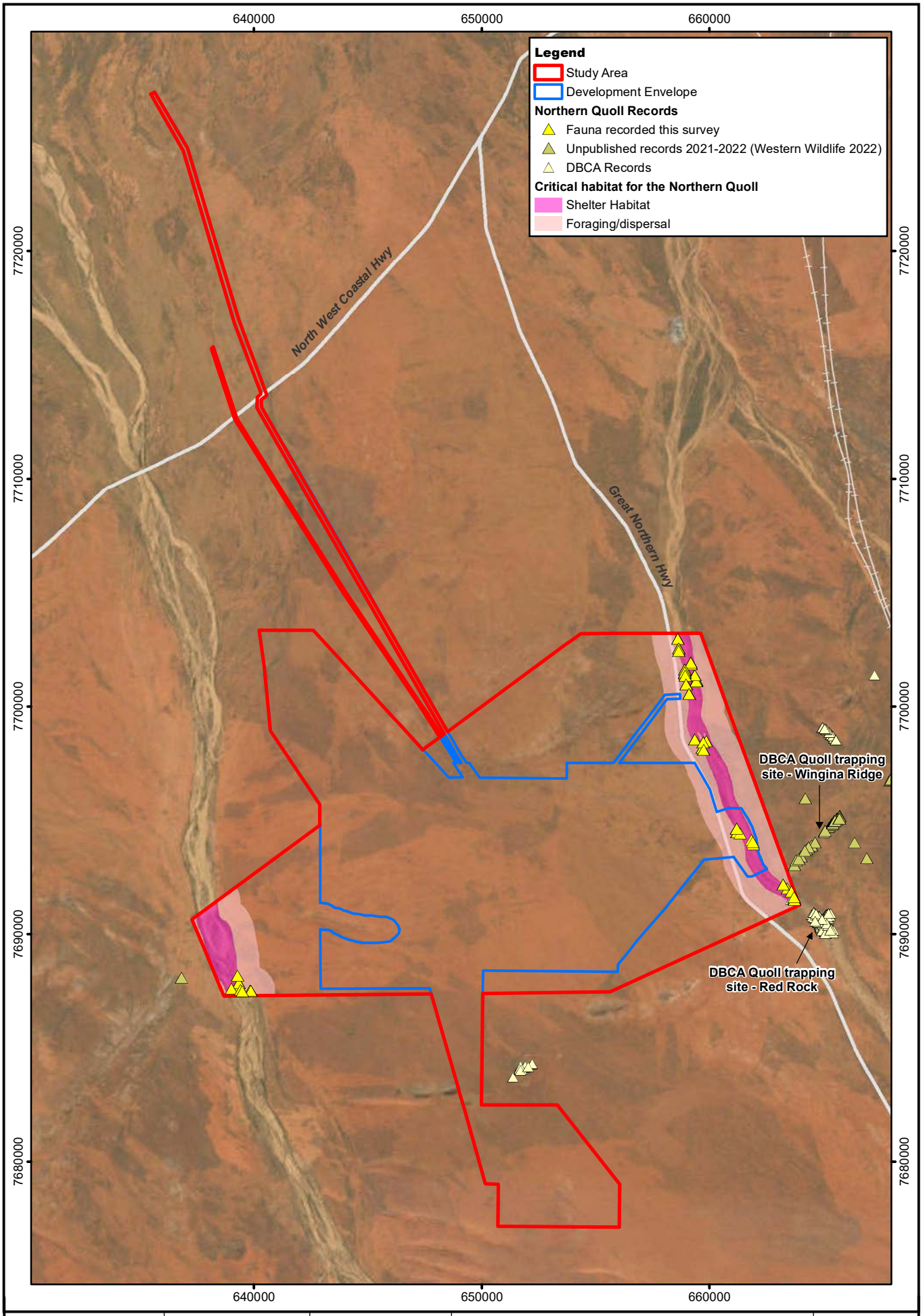
Habitat degradation caused by livestock is of concern in the northern savannah habitats, and together with inappropriate fire regimes, may be the cause of declines of this species in the Pilbara (Hill and Ward 2010). Habitat destruction occurs through developments such as mining, housing and agriculture, and though it occurs on a smaller scale than habitat degradation, it may still have a significant impact on critical habitat (Hill and Ward 2010).

The Northern Quoll population on Indee Station has been subject to long-term monitoring by DBCA since 2013 and has also been a study site for two PhD projects (Dunlop *et al*. 2019). Two of the DBCA study sites at Indee Station are located about 1km to the southeast of the study area at Red Rock and adjacent to the east of the study area on the Wingina Ridge, as shown on Figure 12. Indee Station has been a stronghold for Northern Quoll every year, compared to other sites that have fluctuated or had local extinctions and reinvasions. The only site that is comparable is Dolphin Island, off Karratha, which is a rocky island free of feral cats, foxes and other feral species. Trapping between 2014 and 2019 resulted in 410 captures of 125 individuals from several sites, including Red Rock and Wingina Ridge (Dunlop *et al*. 2019). In 2018, seven individual females were captured on the west end of Wingina Ridge, each with eight pouch young. This is an unusually high density of denning females in such a small area. By comparison, denning females from Dolphin Island and around the Turner River were captured across a much broader area and tracked back to dens that were sparsely separated across the landscape (Chan 2017, Cowan 2019).

The Northern Quoll was commonly recorded in the study area, on camera traps in the Yule and Turner Rivers as well as through secondary signs (scats and tracks) (Plate 33, Figure 11). The Northern Quolls in the study area are abundant and part of the population studied by DBCA and thus considered an 'important population'. Shelter habitat in the study area is comprised of the Rocky Outcrop and Major River habitats (Figure 9, Figure 12). The Major River habitat is likely to be important for foraging and dispersal, as it contains shelter such as tree hollows and is likely to be a higher productivity foraging environment due the seasonal presence of water. Breeding is likely to be restricted to Rocky Outcrops, or rocky areas within the rivers. It is likely that both the Rocky Outcrop and Major River habitats are critical habitat for the Northern Quoll. Foraging and dispersal habitat within 1km of these habitats is also considered critical habitat (Figure 12). Northern Quolls have been found to generally avoid spinifex sandplain habitat, and when found in this habitat they remain close to rocky areas and unburnt areas with higher vegetation cover (Dunlop *et al*. 2023). However, lack of genetic structuring in the Northern Quoll population suggests that males must move through spinifex sandplains when dispersing.

Regionally, shelter habitat for the Northern Quoll is relatively uncommon within 20km (Figure 13). Rocky habitat is limited to the Wingina Ridge and other small areas to the east, an unnamed range to the south and numerous granite hills to the southeast. The distribution of Northern Quoll records suggests that much of this habitat is occupied, and the granite hills are considered a stronghold for the species (Molloy *et al.* 2017; Shaw *et al*. 2023). Lack of records from the range in the south is likely to indicate a lack of survey effort rather than a true absence. Shelter habitat is also likely to be available in the Yule and Turner Rivers, however, it is uncertain how important the rivers are for shelter when away from rocky areas. At the minimum, the rivers are likely to be dispersal pathways (Dunlop *et al*. 2023).

Plate 33. Northern Quoll on camera in the Yule River.



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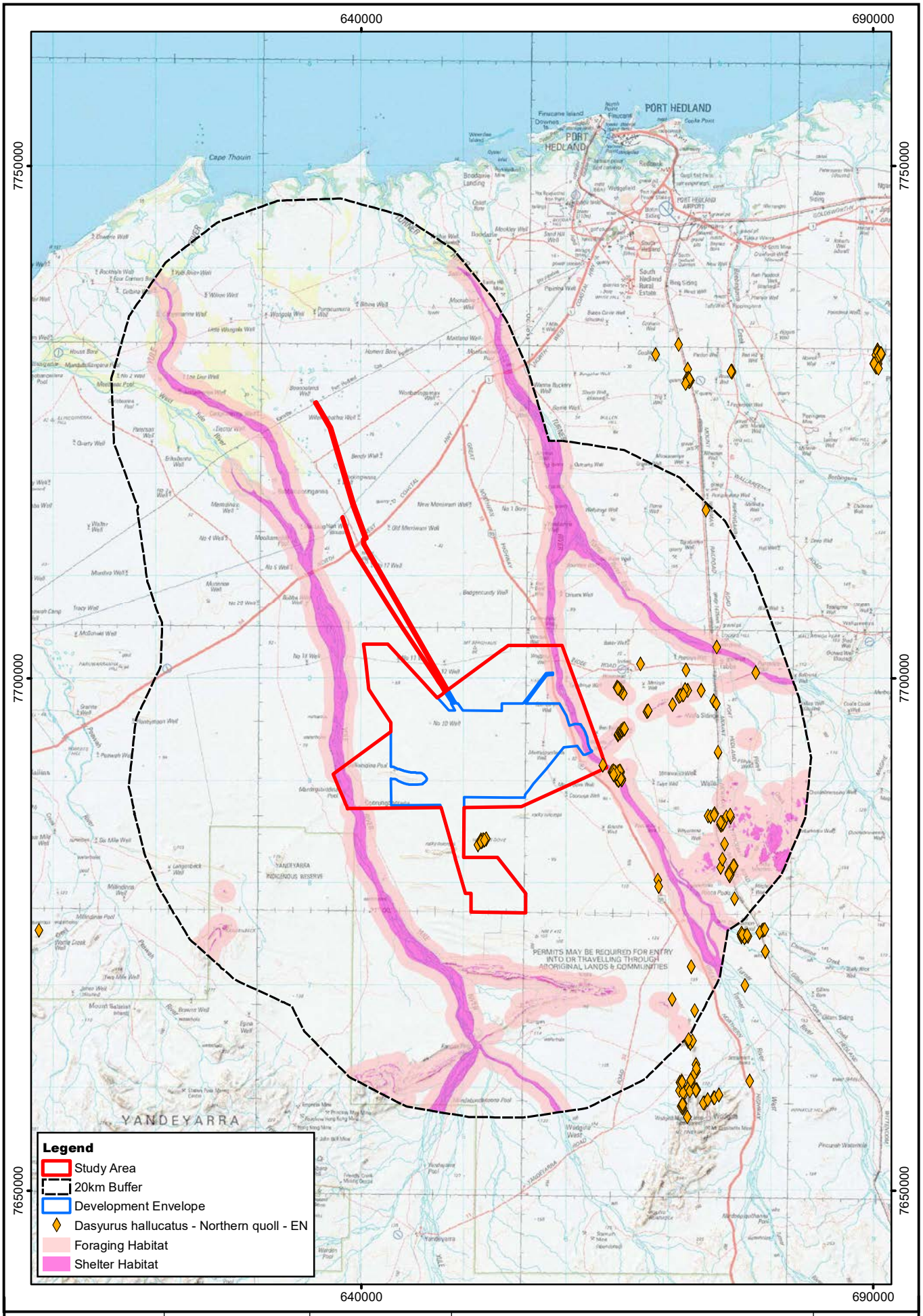
Hemi Gold Project
Northern Quoll records and critical habitat

Figure: **12**



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Date: July 2024 | Rev: A	Author: J. Wilcox			

Common Greenshank – *Tringa nebularia*

The Common Greenshank is listed as Migratory under the BC Act and both Endangered and Migratory under the EPBC Act.

The Common Greenshank breeds in the northern hemisphere and is a visitor to Australia generally between September and March (Johnstone and Storr 1998). It inhabits a range of fresh and salt waters both on the coast and inland (Geering *et al*. 2007, Johnstone and Storr 1998).

Threats to this species occur mainly outside Australia in its coastal stopover locations (Garnett and Baker 2021). Within Australia the key threats include increased frequency and length of droughts and sea level rise due to climate change, loss and degradation of coastal and wetland habitats and disturbance at foraging and roosting sites (Garnett and Barker 2021, DCCEEW 2023b). Critical habitat for this species is defined in the Conservation Advice and includes a mosaic of foraging and roosting habitat, occurring in marine, freshwater or artificial wetlands (DCCEEW2023b). The Common Greenshank avoids open coastlines, but has been recorded in swamps, lakes, large rivers, sewage farms, saltworks, inundated rice fields, reservoirs, flooded grasslands, saltmarsh, sandy or muddy coastal flats, mangroves estuaries, lagoons and pools on tidal reefs (DCCEEW 2023b). To be considered critical habitat, the site would need to support nationally or internationally important numbers of birds (Table 13).

There are 21 records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). This includes records from the Yule River in 2005, as well as coastal sites (DBCA 2021). In addition, this species was recorded on a passive acoustic detector 8.5km to the east of the study area in March 2022 (Western Wildlife, unpublished data 2022).

Although not recorded on this survey, this species is likely to be a non-breeding visitor to waterholes in the study area and may also occur on claypans in the Sandplain Drainage habitat when these are inundated after rain. These habitats are not likely to regularly support more than a few individuals so are unlikely to be considered critical habitat.

Sharp-tailed Sandpiper – *Calidris acuminata*

The Sharp-tailed Sandpiper is listed as Migratory under the BC Act and both Vulnerable and Migratory under the EPBC Act.

This species was recently listed as Vulnerable due to population decline (DCCEEW 2024a). The Sharp-tailed Sandpiper favours non-tidal freshwater, brackish or hypersaline wetlands, though it also occurs in other habitats including coasts and sewage farms (Geering *et al*. 2007, Garnett and Baker 2021, DCCEEW 2024a). It occurs on both coastal and inland waters, and in years of heavy inland rainfall they may remain at ephemeral wetlands instead of migrating to Southern Australia (Weller *et al*. 2019). This species is a non-breeding visitor to the southwest, mostly between September and March (Johnstone and Storr 1998).

Threats to this species occur mainly outside Australia in its coastal stopover locations (Garnett and Baker 2021). Within Australia the key threats include increased frequency and length of droughts and sea level rise due to climate change, loss and degradation of wetland habitats (Garnett and Barker 2021, DCCEEW 2024a). Critical habitat for this species is defined in the Conservation Advice and it is noted that this species is more adaptable in its habitat choice compared to other shorebirds, using both coasts and inland waters, with some of the highest densities occurring in the grassy edges of shallow inland freshwaters (DCCEEW 2024a). To be considered critical habitat, the site would need to support nationally or internationally important numbers of birds (Table 13).

There are nine records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 9). There is a record of the Sharp-tailed Sandpiper form the Yule River in 2007 (DBCA 2021). Although not recorded on this survey, this species is likely to be a non-breeding visitor to waterholes in the study area and may also occur on claypans in the Sandplain Drainage habitat. These habitats are not likely to regularly support more than a few individuals so are unlikely to be considered critical habitat.

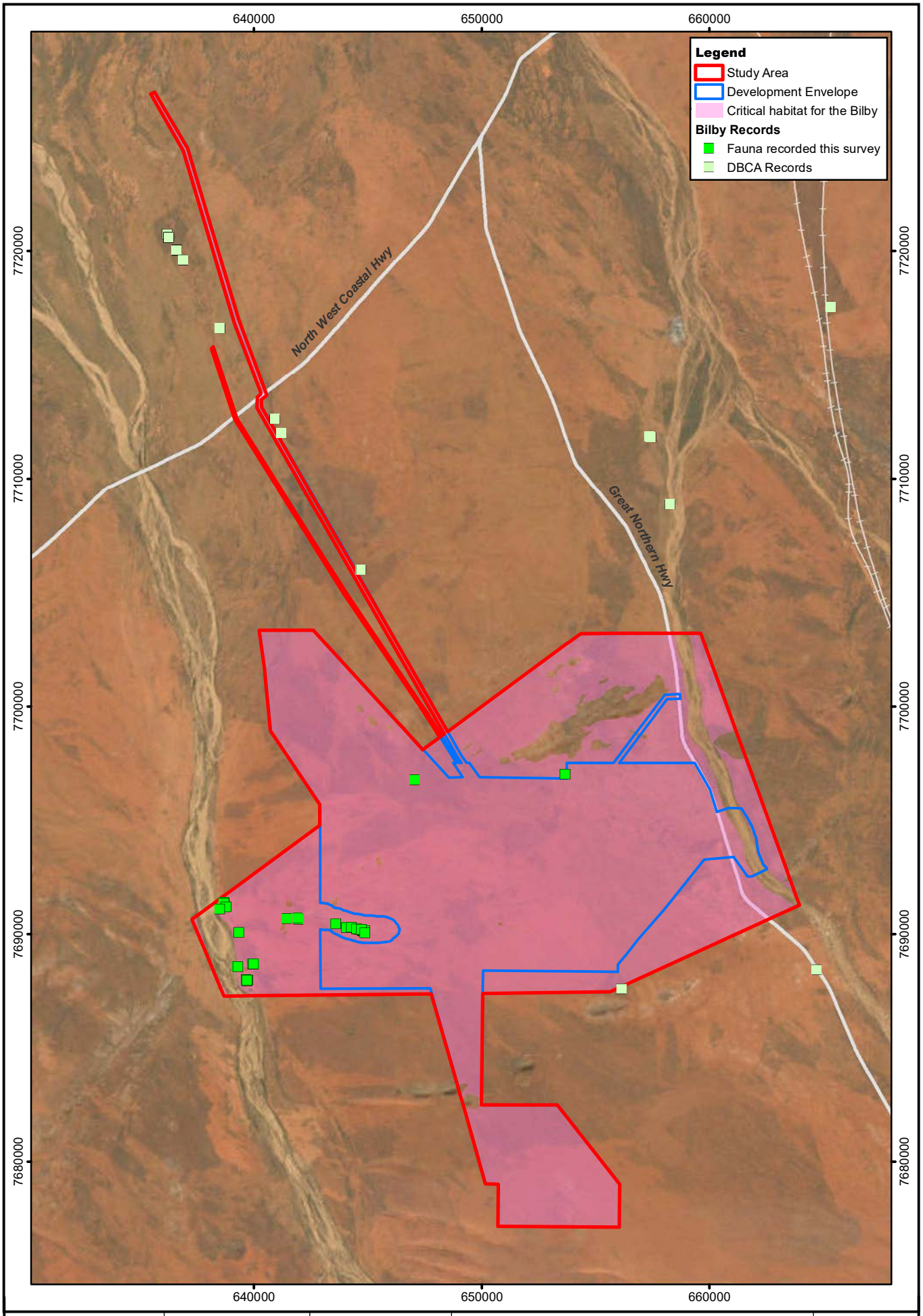
Bilby – *Macrotis lagotis*

The Bilby is listed as Vulnerable under the BC Act and EPBC Act.

The Bilby currently occurs patchily across the Pilbara and inland northern Australia with the total population estimated at less than 10,000 individuals and in decline (Woinarski *et al*. 2014). The Bilby inhabits spinifex on plains and alluvial areas, Mulga on ridges and rises and tussock grasslands on uplands and hills (Pavey 2006). Key threats to the Bilby are introduced predators (foxes and cats) and too-frequent fires, with lesser threats including predation by Dingo/Dogs and habitat degradation due to Rabbits and livestock (Woinarski *et al*. 2014).

Secondary signs of the Bilby were recorded in September 2021 and March 2022, mostly of old burrows (inactive, but active in the past year) (Figure 14, Plate 34). Surveys in August 2022 and April 2024 failed to find additional evidence. The records were in the Sand Dune and Spinifex Sandplain habitats, particularly in the vicinity of the Yule River. There are several records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). As the Bilby can move its home range in response to the changing availability of food (Van Dyck and Strahan 2008), they may not always be present despite suitable habitat being available.

Critical habitat for this species is not well understood (Pavey 2006), but is likely to include the Sand Dune, Spinifex Sandplain and Sandplain Drainage habitats. Unlike critical habitat for other species, Bilby habitat is often widespread, and in this case constitutes most of the study area (Figure 14).



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MGA94 (Zone 50)

Western Wildlife

Hemi Gold Project
Bilby records and critical habitat

Figure: **14**

Plate 34. Dis-used Bilby burrows in the Sand Dune habitat.

Pilbara Leaf-nosed Bat – *Rhinonicteris aurantia*

The Pilbara Leaf-nosed Bat is listed as Vulnerable under the EPBC Act and BC Act.

The Pilbara Leaf-nosed Bat requires warm, humid diurnal (daytime) roost sites and forages in gorges, along watercourses and over low Spinifex-covered hills (TSSC 2016d). The local distribution of the Pilbara Leaf-nosed Bat is mostly strongly influenced by the suitability of roost caves (hot and with a high humidity level) rather than habitat type. The species is heavily reliant on warm (28 - 32°C), humid (85 - 100%) sites for roosting, which enables individuals to reduce water loss and energy expenditure (Baudinette *et al*. 2000). Core roost sites are thought to be restricted to caves where at least semi-permanent water is nearby (Armstrong 2001, Churchill 2008), although significant roosts have also become established in man-made structures such as abandoned mines in the Pilbara region (Churchill 1991).

For the Pilbara Leaf-nosed Bat, 'habitat critical to the survival of the species' is defined by TSSC (2016d) as underground diurnal roosts with warm temperatures and high humidity, listed in order of priority for conservation, they are:

- **Permanent Diurnal Roost**:

  "occupied year-round and likely the focus for some part of the 9-month breeding cycle; considered as critical habitat that is essential for the daily survival of the Pilbara leaf-nosed bat."

- **Non-Permanent Diurnal Roost**:

  "*evidence of usage during some part of the 9-month breeding cycle (July–March), but not occupied year-round; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara leaf-nosed bat*."

- **Transitory Diurnal Roost:**

  "occupied for part of the year only, outside the breeding season (April–June), and which could facilitate long distance dispersal in the region; considered as critical habitat that is essential for both the daily and long-term survival of the Pilbara leaf-nosed bat."

Habitat important for the persistence of the local population, although not considered to be critical habitat, is:

- **Nocturnal Refuge:**

  "occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. Excludes overhangs. Not considered critical habitat but are important for persistence in a local area."

It is difficult to define critical foraging habitat (TSSC 2016d). Foraging habitat appears to be diverse and not a restricting factor, however, suitable foraging habitat located within vicinity of a diurnal roost in order of priority for conservation includes gorges with pools (Priority 1), gullies (Priority 2), rocky outcrops (Priority 3), major watercourses (Priority 4) and open grasslands and woodlands (Priority 5).

The TSSC (2016d) lists nine threats to the conservation status of the Pilbara Leaf-nosed Bat:

- heat and water loss: the species is known for its poor ability to maintain body temperature and water
- mine collapse: resulting in direct mortality
- flooding: resulting in destruction of roost sites and possibly direct mortality
- natural predators
- mine development: may result in the destruction of roost sites
- blasting in adjacent workings: resulting in abandoning of roost sites by bats
- human entry of roosts: resulting in animals abandoning the site
- road kills: direct mortality resulting from increased vehicle activity
- site rehabilitation.

There are several records of the Pilbara Leaf-nosed Bat in the surrounding area on DBCA's Threatened and Priority Fauna Database (Figure 10). The records are relatively recent, ranging from 2010 to 2019 (DBCA 2021).

The Pilbara Leaf-nosed Bat was recorded in this survey, with very low numbers of calls detected at several sites across the study area (Figure 15). These records are of foraging or dispersing bats, and the Pilbara Leaf-nosed Bat is likely to forage in the study area, most likely in Rocky Outcrops habitat (Priority 3 foraging habitat) and the Major River habitat (Priority 4 foraging habitat). The remainder of the study area can be considered Priority 5 foraging habitat. These are roughly consistent with the habitat ratings system in Bat Call WA (2021b), where the Major River habitat would be rated as 4 (very high) with bats considered very likely to forage and drink here if in range of a diurnal roost. The low number of calls recorded at pools on the Yule and Turner Rivers suggests that a roost is not nearby. The remainder of the of the study area, including the Rocky Outcrops habitat, would rate as 1 (poor), likely only to be traversed by bats crossing to more productive areas.

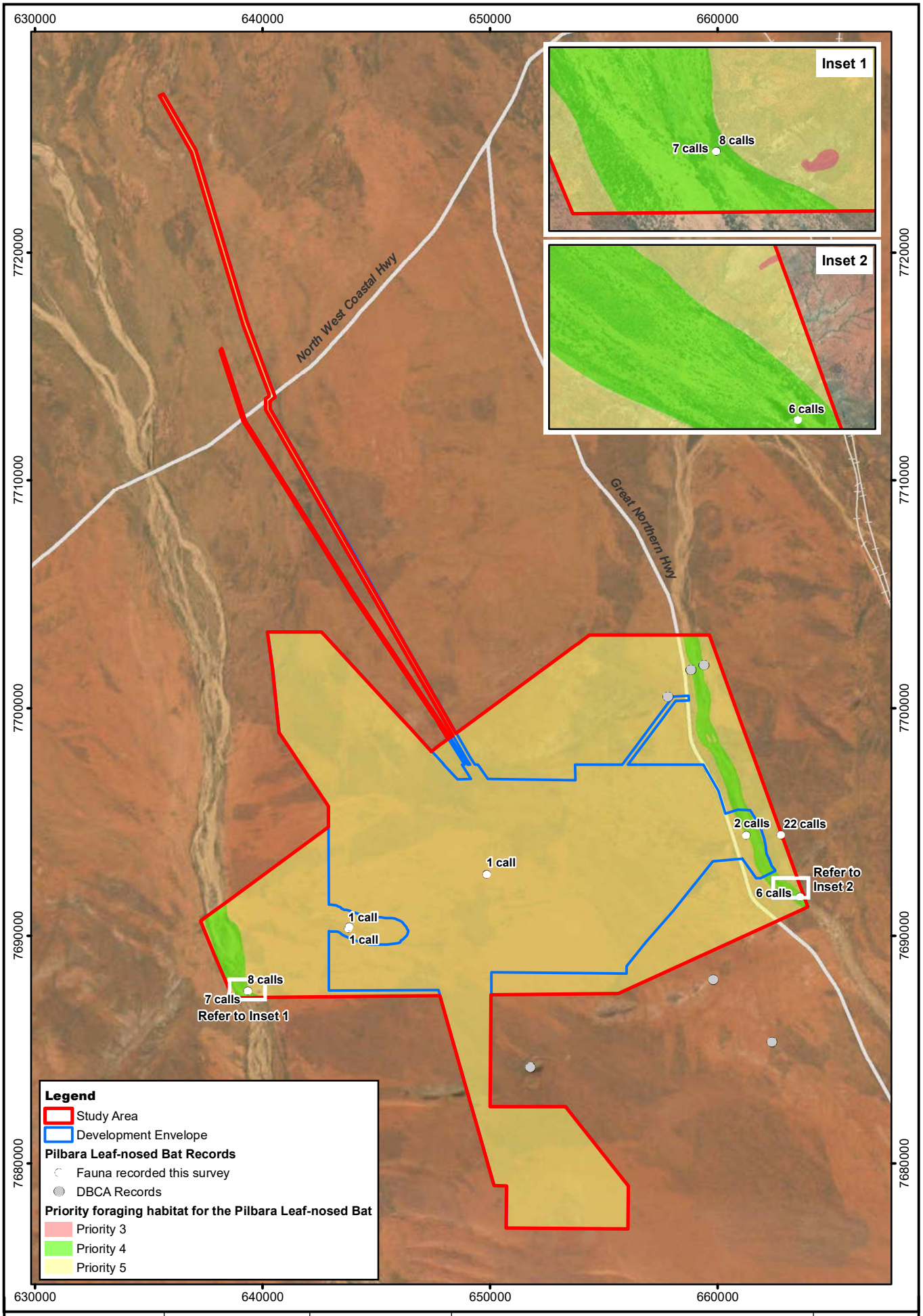
No diurnal roosts were recorded or considered likely to occur in the study area, due to the lack of suitable cave-bearing rocky formations. Only two small areas of rocky outcrop are present, and these only bore crevices. The closest known permanent diurnal roost, and the only one known within 30km, is 'Yule River' (Figure 16), 6.2km south of the study area. The exact location of this roost is not known, but is inferred from unpublished data (Bullen, *pers. comm*. 2024). Other permanent diurnal roosts in the region include Abydos (64km southeast) and East Turner River (40km southeast), although East Turner River was abandoned in 2019 after two dry years (Bat Call WA 2021b), and it is unknown whether bats have returned. Transitory diurnal roosts are known from Wodgina (35km south) (Stantec 2018b, Figure 16). Mt Dove, 1.8km east of the study area, is a nocturnal refuge for the Pilbara Leaf-nosed Bat, but no diurnal roosting was detected (Outback Ecology 2009). Based on the data available, it is likely that the bats recorded in the study area are from the Yule River roost, as bats are thought to forage 20km or sometimes up to 30km from a roost, (Bat Call WA 2021b) and the number of calls recorded in the study area are modest (Figures 15 and 16). There may also be other diurnal and transitory diurnal roosts in the region, however, there is limited cave bearing rocky habitat within 20km of the study area.

Ghost Bat – *Macroderma gigas*

The Ghost Bat is listed as Vulnerable under the EPBC Act and BC Act.

The Ghost Bats of the Pilbara region are disjunct and genetically distinct to those that occur in the Kimberley, Northern Territory and Queensland. The Pilbara population is divided between those in the Hamersley Ranges and those in the Chichester Ranges, though the genetic differentiation is low, suggesting bats move between these populations (Ottewell *et al*. 2017). Ghost Bats in the study area would fall within the Chichester Range subpopulation, which is estimated to be about 1,500 individuals (TSSC 2016a).

In the Chichester region, Ghost Bats are often found in large maternal roosts and these congregations are important for the survival of the species. However, smaller roosts are also likely to be important, allowing bats to occupy and forage through more of the landscape, resulting in dispersal and gene-flow between larger roosts. As the overall Chichester population is so small, all populations are likely to be important.



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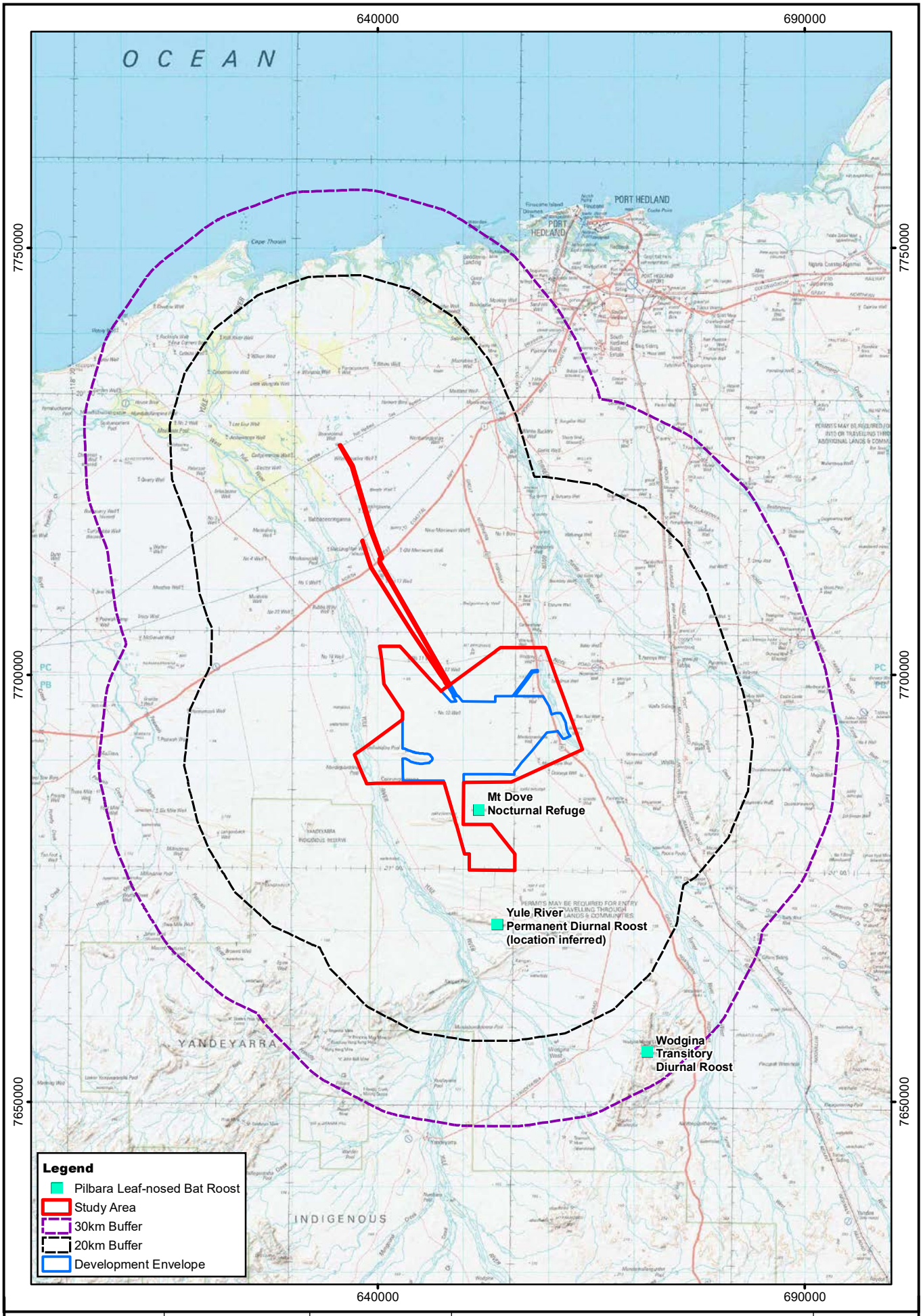
Western Wildlife

Hemi Gold Project
Pilbara Leaf-nosed Bat records and priority habitat

Figure: **15**



Drawn: CAD Resources www.cadresources.com.au Tel: (08) 9246 3242	N 0 4.5 9 km Scale: 1:600,000 MGA94 (Zone 50)	Western Wildlife	Hemi Gold Project **Pilbara Leaf-nosed Bat Roosts within 30km**	Figure: **16**
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Ghost Bats utilise several diurnal and nocturnal roost caves within an area for feeding, resting, breeding and maternity. In the Pilbara, a number of natural formations are used by the Ghost Bat intermittently as short-term transient roosts and for feeding activity for single or small numbers of individuals, whilst others are used by maternity colonies (Armstrong and Anstee, 2000).

The structure of a roost site is largely indicative of its use. Transient day roosts or feeding sites for Ghost Bats are often shallower with microclimates similar to ambient conditions (Armstrong and Anstee, 2000). Breeding activity for Ghost Bats is associated with roost sites that have a relative humidity of above 80% (Armstrong and Anstee, 2000). Restricted to gorges and escarpments in the Pilbara where access to surface water, particularly where permanent or semi-permanent rock pools are present, is reasonably accessible. Individuals and small groups may shelter in deep rock crevices and abandoned mine pits.

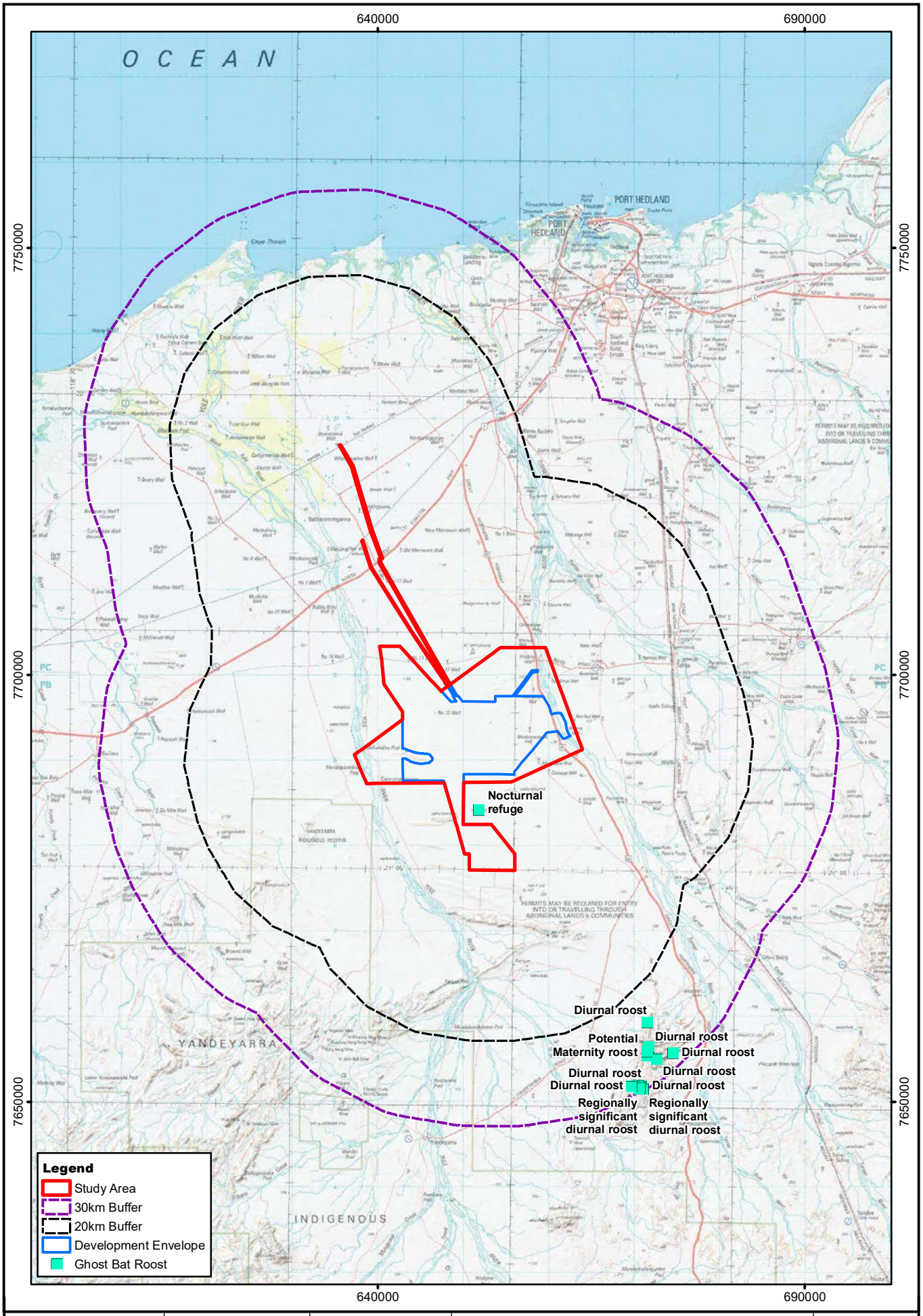
Although the foraging ecology of the Ghost Bat has not been well-studied, a Queensland study found that male Ghost Bats forage up to 11.8km from the roost, while lactating females forage within 3km (Augusteyn *et al*. 2018). A study in the Northern Territory found that bats foraged on average 1.9km from their diurnal roost (Tidemann *et al*. 1985). Radio-tracking studies in the Pilbara have recorded bats transiting to foraging sites 20-30km distant from the roost site (Bat Call WA 2021a).

Ghost Bats have large wings and are capable of flying considerable distances to forage, but there is uncertainty around the relative importance of close versus distant foraging habitats. If bats are forced to fly further to forage, this may impact on breeding success and cause population decline (Augusteyn *et al*. 2018). Therefore, at the minimum any foraging habitat within 3km of a diurnal roost or potential maternity roost may be considered important, as these habitats are likely to support lactating females.

Ghost Bats forage mainly by sight, perching in vegetation to ambush prey or gleaning prey from the ground while in flight. Habitats used for foraging have not been well-quantified, but in Queensland bats mostly foraging over open agricultural areas, on the edges of woodlands or along ephemeral creeks (Augusteyn *et al*. 2018). Pilbara studies found that bats foraged over lightly wooded productive plains, using isolated trees and trees on the edge of watercourses or open woodlands as vantage points (Biologic 2019, Bat Call WA 2021a).

Threats to the conservation status of the Ghost Bat include:

- direct heat and water loss: the species is known for its poor ability to maintain body temperature and water
- wide fluctuations in cave temperature and humidity due to extrinsic disturbances, especially maternity caves, leading to direct mortality and cave abandonment
- mine/cave collapse: resulting in direct mortality
- flooding: resulting in destruction of roost sites and possibly direct mortality
- mine development: may result in the destruction of roost sites
- blasting in adjacent workings: resulting in abandoning of roost sites by bats
- human entry of roosts: resulting in animals abandoning the site.



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Hemi Gold Project
Ghost Bat Roosts within 30km

Figure: **17**

There are several records of the Ghost Bat in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). The Ghost Bat was not recorded on this survey, but it has been recorded nearby, with a night sighting of two individuals at Wingina Ridge in March 2022, about 7km east of the study area (Western Wildlife, unpublished data, 2022). Ghost Bats were recorded nearby in a cave at Mt Dove, however, this site was considered a nocturnal refuge only, with no evidence of diurnal roosting (Outback Ecology 2009). No diurnal roosting habitat is present in the study area, and the nearest known diurnal roosts occur 25km south at Wodgina (Figure 17). The Ghost Bat is likely to occur as a foraging visitor to the study area. Foraging habitat in the study area potentially includes all habitat types, as all habitats have open plains and/or treed areas for perching. While foraging habitat is important, it is also widespread and unlikely to be habitat critical to the survival of the species unless in close proximity to a roost. The closest known diurnal roost is 25km south of the study area.

Pilbara Olive Python – *Liasis olivaceous barroni*

The Pilbara Olive Python is listed as Vulnerable under the EPBC Act and BC Act.

An iconic species of the Pilbara region, the Pilbara Olive Python is large and mostly nocturnal. Adults are usually around 2.5m long, with individuals reliably measured up to 4.5m long (Pearson 2003). Due to its cryptic habits, there are no reliable estimates of population size (DEWHA 2008), however, it was thought to be uncommon with the initial description of the subspecies in 1981 performed on a mere eight specimens collected over 65 years (Pearson 2003). There is still a lack of information on the basic ecology of the Pilbara Olive Python. Although radio-tracking studies have been completed in several Pilbara locations, these datasets remain largely unpublished. The cryptic habits of this species make it difficult to systematically survey, as even a large-scale survey may fail to record any individuals.

Within its range, the Pilbara Olive Python has been found to be widely distributed with many sizable populations (Pearson 2003). It is generally associated with large river systems, such as the Coongan, Shaw, Yule, Harding, Fortescue, Ashburton and Robe Rivers (DSEWPaC 2011). The favoured habitat of the Pilbara Olive Python is generally considered to be deep gorges with waterholes, however, it also occurs in riverine habitats (DSEWPaC 2011) and on the Burrup Peninsula it inhabits large rock piles in spinifex grasslands (Tutt *et al*. 2004). Radio-tracking studies on the Robe and Fortescue Rivers have found that in summer pythons range along rivers, visiting permanent pools, and in winter they shelter in rocky areas away from water, including caves in flat-topped hills (Pearson 2003, DEWHA 2008). Artificial waters, such as sewage ponds and recreational lakes, are also used (Pearson 2003).

Breeding occurs in winter, with males travelling up to three or four kilometres in search of females (Tutt *et al*., 2004, Pearson 2003). Females only breed every 3 – 4 years (DPAW 2013). Nest sites have been observed under large slabs of rock at a considerable distance from water (DPAW 2013, Pearson 2003). In January the eggs hatch, and the young disperse (Pearson 2003). Although only preliminary results are available, on the Burrup Peninsula the Pilbara Olive Python has been found to occupy a large and distinct home-range (Tutt *et al*. 2004). Females have been found to have a highly localised home-range of 89.76 – 365.33 ha (based on three individuals) and males wander widely in search of females and have a home range of 449.26 ha (based on a single individual) (Tutt *et al*. 2004, DPAW 2013).

Threats to the Pilbara Olive Python are listed in the Conservation Advice for the species (DEWHA 2008):

- Direct predation by feral cats (*Felis catus*) and foxes (*Vulpes vulpes*), particularly of juveniles.
- Loss of prey species, such as Northern Quolls (*Dasyurus hallucatus*) and rock-wallabies (*Petrogale spp*.) to predation by foxes.
- Loss of habitat to gas and mining developments, including changes to hydrology and downstream impacts such as sedimentation or pollution.
- Deliberate road-kills.
- Killed due to being mis-identified as a venomous snake species.

There are six records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). The most recent record is from Indee Station in 2012, near Turner River East (DBCA 2021). There is also a recent anecdotal record of this species from 'Red Rock', a site on the Turner River 1.5km south of the study area.

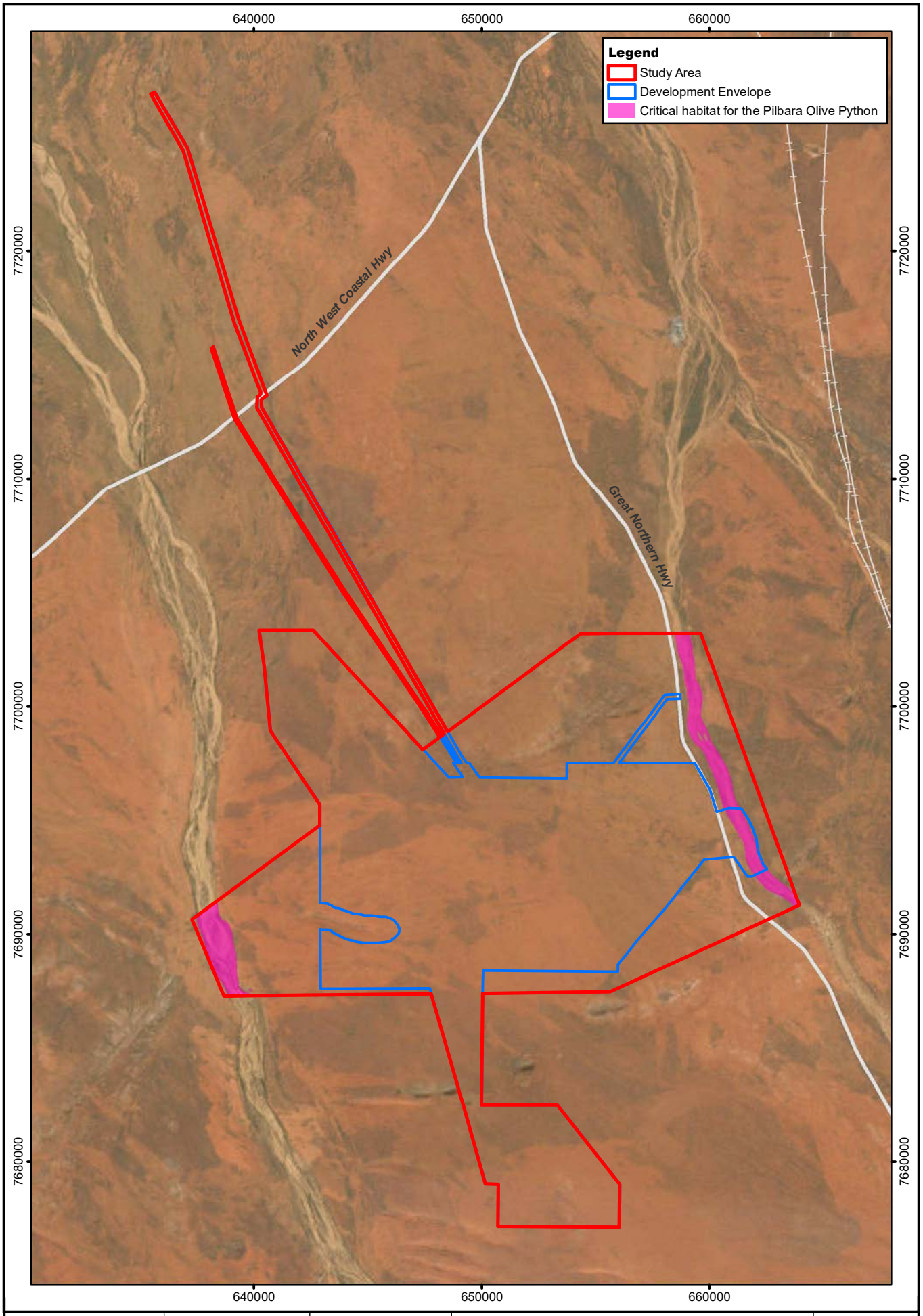
The Pilbara Olive Python is likely to occur in the study area. This species potentially occurs in a variety of habitats when dispersing and looking for mates, however, habitats in the study area likely to be habitat critical for survival are the Major River and Rocky Outcrop habitats (Figure 18).

Grey Falcon – *Falco hypoleucos*

The Grey Falcon is listed as Vulnerable under the EPBC Act and BC Act.

The Grey Falcon may number fewer than 1000 individuals, though it occurs across a large portion of arid and semi-arid Australia with its distribution centred on inland drainages (Garnett *et al*. 2011). It forages over timbered plains, including *Acacia* shrublands, also ranging out onto treeless plains. The Grey Falcon nests in tall trees on watercourses (Garnett *et al*. 2011) and occasionally on man-made structures such as transmission line towers (pers. obs.). Threats to this species are unknown but may include habitat degradation due to overgrazing or clearing and provision of water in arid areas favouring the closely related Peregrine Falcon (Garnet *et al*. 2011).

The Grey Falcon has been recorded nearby on DBCA's Threatened and Priority Fauna Database (Figure 10) and is likely to occur in the study area, at least on occasion. There is potential breeding habitat on the Yule and Turner Rivers, and the Major River habitat is likely to be habitat critical to the survival of this species (Figure 19).



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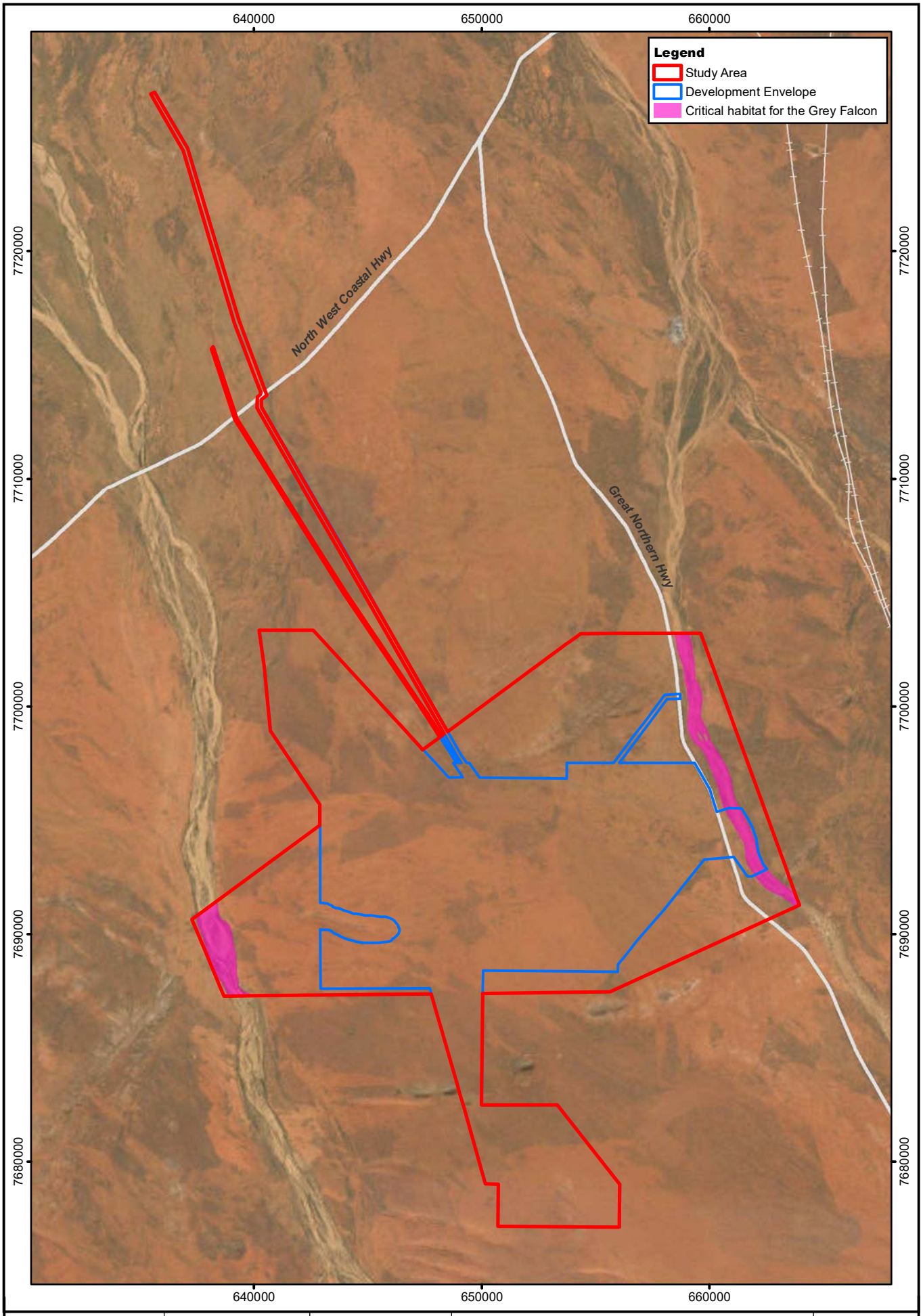

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5.2.2 Migratory Fauna

There are 12 Migratory species that potentially occur in the study area (Table 12). Two additional Migratory species, the Common Greenshank and Sharp-tailed Sandpiper, have been have been discussed above as they are also listed as Threatened. Other migratory shorebird species are present in the region but favour coastal habitats such as beaches and intertidal mudflats, habitats that are absent from the study area.

Migratory species are not always present at a site, but a particular site may have significance as a seasonal or ephemeral foraging, breeding or shelter area. Impacts to these sites may then impact the population both within the site and further afield. The study area is only likely to be an internationally significant site for Migratory shorebirds if it supports 20,000 birds or 1% or more of the flyway population of a species, or a nationally significant site if it supports 2,000 birds or 0.1% or more of the flyway population of a species (DoEE 2017, Hansen *et al*. 2016). The flyway population estimates, 1% and 0.1% criteria for selected shorebirds are given in Table 13.

Table 13. Flyway population estimates for selected migratory shorebirds.

Species	Flyway Population Estimate*	1% Flyway Population Criterion*	0.1% Flyway Population Criterion*
Oriental Plover	230,000	2,300	230
Common Sandpiper	190,000	1,900	190
Sharp-tailed Sandpiper	85,000	850	85
Pectoral Sandpiper	1,220,000 – 1,930,000	12,200	1,220
Red-necked Stint	475,000	4,750	475
Wood Sandpiper	130,000	1,300	130
Common Greenshank	110,000	1,100	110
Marsh Sandpiper	130,00	1,300	130
Oriental Pratincole	2,880,000	28,800	2,880

*Data from Hansen *et al*. (2016).

Oriental Plover – *Charadrius veredus*

The Oriental Plover is listed as Migratory under the BC Act and EPBC Act.

The Oriental Plover favours dry grasslands and open plains, including recently burnt areas (Geering *et al*. 2007). This species is a non-breeding summer visitor to Australia, migrating from northern China and Mongolia through the East Asian-Australasian Flyway (Geering *et al*. 2007).

There is only a single record of the Oriental Plover in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). This record is from the Pilgangoora Project in 1999 (DBCA 2021), about 40km southeast of the study area. In addition, a single bird was observed 7km to the west of the study area in recently burnt country in 2022 (Western Wildlife, unpublished data 2022).

The Oriental Plover possibly occurs in small numbers as a non-breeding visitor to the study area, however, an ecologically important proportion of the population is not likely to occur. If present, the Oriental Plover is likely to favour open habitats such as recently burnt areas and claypans.

Common Sandpiper – *Actitis hypoleucos*

The Common Sandpiper is listed as Migratory under the BC Act and EPBC Act.

The Common Sandpiper may be present at any time of the year, but more likely between September and March (Johnstone and Storr 1998). This species occurs in a range of salt and freshwater habitats, including coasts, river pools, drying swamps and floodwaters (Johnstone and Storr 1998), however, it is most common on the coast (Geering *et al*. 2007).

There are 16 records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). Many of these records are from the Yule River, including a record from Jelliabidina Pool in 2002, which is within the study area (DBCA 2021). Although not recorded on this survey, the Common Sandpiper is likely to occur on waterholes along the Yule and Turner Rivers and may also occur on flooded claypans in the Sandplain Drainage habitat. It is likely to be a regular visitor in small numbers, but the study area is not likely to support a nationally or internationally important proportion of the population.

Red-necked Stint – *Calidris ruficollis*

The Red-necked Stint is listed as Migratory under the BC Act and EPBC Act.

The Red-necked Stint was listed as Near Threatened in the *Action Plan for Australian Birds 2020* as recent analyses have suggested that slow declines in this species have accelerated in the last decade (Garnett and Baker 2021). The Red-necked Stint occurs in a range of freshwater and saltwater habitats, both on the coast and inland (Geering *et al*. 2007). Threats to this species within Australia are considered relatively minor compared to destruction of migratory stop-over sites outside Australia (Garnett and Baker 2021).

There are eleven records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), including on the Yule River in 2005 (DBCA 2021). Although not recorded on this survey, this species is likely to be a non-breeding visitor to waterholes in the study area and may also occur on claypans in the Sandplain Drainage habitat. These habitats are not likely to regularly support more than a few individuals.

Pectoral Sandpiper – *Calidris melanotos*

The Pectoral Sandpiper is listed as Migratory under the BC Act and EPBC Act.

The Pectoral Sandpiper favours freshwater wetlands, although it may also occur on brackish waters or samphire flats (Geering et al. 2007, Johnstone and Storr 1998). It is a non-breeding visitor to south-west Australia between December and March (Johnstone and Storr 1998).

There is a single record of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), from Forestier Bay in 2013 (DBCA 2021). Although not recorded on this survey, this species may possibly be a non-breeding visitor to waterholes in the study area and may also occur on claypans in the Sandplain Drainage habitat. These habitats are not likely to regularly support more than a few individuals.

Wood Sandpiper – *Tringa glareola*

The Wood Sandpiper is listed as Migratory under the BC Act and EPBC Act.

In northern Australia, the Wood Sandpiper inhabits inland freshwater wetlands (Geering *et al*. 2007).

There are six records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), including from the Yule River in 2005 (DBCA 2021). Although not recorded on this survey, this species is likely to be a non-breeding visitor to waterholes in the study area and may also occur on claypans in the Sandplain Drainage habitat. These habitats are not likely to regularly support more than a few individuals.

Marsh Sandpiper – *Tringa stagnatilis*

The Marsh Sandpiper is listed as Migratory under the BC Act and EPBC Act.

The Marsh Sandpiper occurs on coastal and inland freshwater and saltwater wetlands, generally avoiding intertidal mudflats (Geering *et al*. 2007).

There are five records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), including on the Yule River in 2005 and 2007 (DBCA 2021). Although not recorded on this survey, this species is likely to be a non-breeding visitor to waterholes in the study area and may also occur on claypans in the Sandplain Drainage habitat. These habitats are not likely to regularly support more than a few individuals.

Oriental Pratincole – *Glareola maldivarum*

The Oriental Pratincole is listed as Migratory under the BC Act and EPBC Act.

The Oriental Pratincole inhabits open plains, and wetland margins, occurring in flocks of a few birds up to very large flocks, including the notable record of 2.88 million birds on Eighty Mile Beach in 2004 (Geering *et al*. 2007).

There are 12 records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), including a flock of 100 birds at Indee in 2012 (DBCA 2021). Although not recorded on this survey, this species may be a non-breeding visitor to plains and claypans in the study area. It is unlikely that a nationally or internationally significant proportion of the population would ever be present (Table 13), and its movements in Australia are unpredictable, possibly based on patterns of rainfall (Geering *et al*. 2007).

Gull-billed Tern – *Gelochelidon nilotica*

The Gull-billed Tern is listed as Migratory under the BC Act and EPBC Act.

This species occurs on sheltered seas and estuaries as well as on inundated inland claypans and salt lakes (Johnstone and Storr 1998). Globally, this species has a very large range and although thought to be decreasing, its population size is very large (Birdlife International 2022).

There are 16 records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), including a record from the Yule River in 2004 (DBCA 2021). This species potentially forages over waterholes on the Major Rivers, but the habitats in the study area are unlikely to be important for the Gull-billed Tern.

Caspian Tern – *Hydroprogne caspia*

The Caspian Tern is listed as Migratory under the BC Act and EPBC Act.

Globally, the Caspian Tern has an extremely large range, a large population and the population trend is increasing (BirdLife International 2022). It usually inhabits sheltered seas, estuaries and tidal creeks, but also occurs on near-coastal salt lakes and the lower reaches of rivers (Johnstone and Storr 1998).

There are 32 records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), including a records from the Yule River in 1999, 2004 and 2007 (DBCA 2021). Although not recorded on this survey, this species potentially occurs as a non-breeding visitor to waterholes on the Turner and Yule River on occasion.

Eastern Osprey – *Pandion cristatus*

The Eastern Osprey is listed as Migratory under the BC Act and EPBC Act.

Globally, the Eastern Osprey has an extremely large range, a large population and the population trend is increasing (BirdLife International 2022). The Eastern Osprey inhabits mainly nests on offshore islands, foraging in sheltered seas and in the lower reaches of rivers (Johnstone and Storr 1998).

There are 12 records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), including a records from the Yule River in 1999, and 2000 (DBCA 2021). Although not recorded on this survey, this species potentially visits waterholes on the Turner and Yule River. The study area lacks breeding habitat and river pools are not likely to be important foraging habitat for this species.

Fork-tailed Swift – *Apus pacificus*

The Fork-tailed Swift is listed as Migratory under the EPBC Act and BC Act.

The Fork-tailed Swift is a non-breeding visitor to Australia between September and April (Boehm 1962, Johnstone and Storr 1998). The bird is primarily observed foraging for insects in proximity to cyclonic weather (Boehm 1962). Although a migratory species, the Fork-tailed Swift has a large range and a large population that appears to be stable (BirdLife International 2022).

This species was recorded in the study area in March 2022 (Table 10, Figure 11). There are also eleven records from the surrounding area on DBCA's Threatened and Priority Fauna Database (Figure 10). The Fork-tailed Swift is likely to be a regular summer visitor in small numbers, but as it is a largely aerial species in Australia it is unlikely to be affected by changes to the study area.

Glossy Ibis – *Plegadis falcinellus*

The Glossy Ibis is listed as Migratory under the BC Act and EPBC Act.

The Glossy Ibis has an extremely large global range and although its population size is thought to be decreasing, it is not at a rate sufficient to justify listing the species as Vulnerable (Birdlife International 2022). In Western Australia, the Glossy Ibis occurs mainly on well-watered flats in the Kimberley region, favouring freshwater wetlands, and is a vagrant in drier and hillier regions (Johnstone and Storr 1998).

There is a single record of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), from the Yule River in 2004 (DBCA 2021). Although not recorded during this survey, it potentially occurs on waterholes on the Yule and Turner Rivers. It is only likely to occur as an occasional foraging visitor and is unlikely to breed in the study area.

5.2.3 Specially Protected Fauna

There is one specially protected vertebrate species that potentially occurs in the study area (Table 12). The populations of Specially Protected species are large enough that they are not considered to be Threatened. However, they require on-going conservation intervention (i.e., Conservation Dependent) or be specially protected in order to prevent them from becoming Threatened.

Peregrine Falcon – *Falco peregrinus*

The Peregrine Falcon is listed as Other Specially Protected Fauna under the BC Act.

The Peregrine Falcon is a widespread bird of prey that globally has a very large range and a very large population that appears to be stable (BirdLife International 2022). In Western Australia the population is secure, though this species may experience reductions at a local level due to human disturbance at nesting sites (Debus 1998). The Peregrine Falcon nests mainly on ledges on cliffs or rocky outcrops, and it may also use tall trees (Johnstone and Storr 1998). This species often takes advantage of man-made structures such as abandoned open pits or quarries.

There are three records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). Although not recorded on the fauna survey, the Peregrine Falcon potentially occurs as a non-breeding visitor to the study area.

5.2.4 Priority Fauna

There are eight Priority fauna species that potentially occur in the study area (Table 12).

Priority 1, 2 or 3 species need further survey effort, as insufficient data exist to adequately determine their status. Many Priority 1, 2 and 3 species are known from only a few records in a limited number of locations, thus determining their status in the study area may be problematic. Priority 4 species are considered to require regular monitoring, as although they are adequately known, they are either rare, near threatened or recently removed from the threatened list.

Pin-striped Finesnout Ctenotus – *Ctenotus nigrilineatus*

This species is listed as Priority 1 by DBCA.

The Pin-striped Finesnout Ctenotus is a small lizard that is confined to a small area of the Pilbara interior. It is only known from a few records near Woodstock, Meentheena and Nullagine, and its distribution is thought to be patchy (Chapple *et al*. 2019). Little is known of the species, but those trapped have been from Spinifex plains on granitic soils near watercourses. It is possible that its rarity is natural and there are no known threats to the species (Chapple *et al*. 2019).

There are no records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). The study area is currently just outside the known range of this species, but as it is rarely recorded and its distribution is patchy, it possibly occurs. If present, it may occur on the Spinifex Sandplains, Spinifex Drainage or Major River habitats.

Gane's Blind Snake – *Anilios ganei*

Gane's Blind Snake is listed as Priority 1 by DBCA.

The habitat requirements for Gane's Blind Snake are poorly known, as this species is known from relatively few records and was only formally described in 1998. It is endemic to the Pilbara, occurring between Newman and Pannawonica. This species is tentatively associated with moist gorges and gullies, though some of the early specimens are from the Newman townsite and Mt Whaleback waste dump (Aplin 1998).

There are three records of Gane's Blind Snake in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 9). It is unknown but possible that the habitats of the study area are suitable for Gane's Blind Snake, and it is likely that the study area falls within the range of this species. Therefore, this species possibly occurs in the study area.

Northern Coastal Free-tailed Bat – *Ozimops cobourgiana*

This bat is listed as Priority 1 by DBCA.

This bat occurs within 100km of the coast in the Pilbara and Kimberley, as well as in the Northern Territory (Woinarski *et al*. 2014). Although generally associated with mangroves, it has also been recorded in other habitats including *Melaleuca* forests, rainforest, eucalypt forest, woodlands, open floodplains and coastal flats (Woinarski *et al*. 2014). This bat usually roosts in tree hollows. Although considered data deficient by DBCA, this species is listed as 'Least Concern' in the *Action Plan for Australian Mammals 2012*, as it has a large range, its population size is likely to be more than 10,000 and there is no evidence of a decline (Woinarski *et al*. 2014). Threats to the species are habitat loss on a local level around coastal developments and the future risk of sea-level rises due to climate change.

There are no records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10), however, it was recorded at several sites across the study area in the March field survey (Figure 11). It is likely that this species forages across all habitats, potentially roosting in tree hollows in the Major River habitat. It is possible that this species uses the Major River habitat to disperse into the region from coastal mangrove habitats, however, the dispersal patterns of this species are poorly known.

Brush-tailed Mulgara – *Dasycercus blythi*

The Brush-tailed Mulgara is listed as Priority 4 by DBCA.

This species is widely distributed across arid Australia, and though its population has declined in the past, it is currently thought to be stable or declining only slowly (Woinarski *et al*. 2014). It is thought that its ability to use a variety of food resources, tolerate severe declines in bodyweight, enter torpor and dig deep burrows has buffered the species from the impacts of feral predators and a variable climate and resource availability (Masters and Dickman 2012). It is therefore listed as of 'Least Concern' in the *Action Plan for Australian Mammals 2012* (Woinarski *et al*. 2014). The Brush-tailed Mulgara occurs mostly on Spinifex grasslands, sheltering during the day in burrows.

The Brush-tailed Mulgara was recorded mainly in the Spinifex Sandplain and Sandplain Drainage habitats on this survey (Figure 11). Secondary signs such as burrows and diggings were recorded, as well as records on camera traps (Plate 35). There are also numerous records in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). This species is likely to be a relatively common resident, although its population will fluctuate from year to year depending on prevailing environmental conditions.

Plate 35. Brush-tailed Mulgara burrow with scat.

Long-tailed Dunnart – *Sminthopsis longicaudata*

The Long-tailed Dunnart is listed as Priority 4 by DBCA.

The Long-tailed Dunnart occurs in the Pilbara, Mid-West and the central deserts of Western Australian and Northern Territory. It is associated with breakaways and scree slopes, but also occurs on gravel or stony plains (Van Dyck and Strahan 2008). There is a single record in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). This record is from the Wodgina Project in 2009, about 25km south of the study area (DBCA 2021, Outback Ecology 2009). Although not recorded on this survey, the Long-tailed Dunnart possibly occurs in the study area, in the Stony Hills or Rocky Outcrops.

Spectacled Hare-wallaby – *Lagorchestes conspicillatus leichardti*

The mainland population of the Spectacled Hare-wallaby is listed as Priority 4 by DBCA.

On the mainland, the Spectacled Hare-wallaby is sparsely distributed and generally uncommon (Woinarski *et al.* 2014). It occurs in a range of tropical grassland habitats, sheltering in large spinifex hummocks when in spinifex grasslands (Van Dyck and Strahan 2008). It is listed as 'Near Threatened' in the Action Plan for Australian Mammals, due to past and continuing declines in its population (Woinarski *et al*. 2014). In Western Australia it currently occurs in isolated populations in the Pilbara, Kimberley and north-eastern Great Sandy Desert. Threats to the species include predation by foxes and feral cats and inappropriate fire regimes (Woinarski *et al*. 2014). The Pilbara population has declined significantly, possibly due to frequent fires preventing large Spinifex clumps from forming, as well as predation by foxes (Van Dyck and Strahan 2008).

There are several DBCA Threatened and Priority Fauna Database records of this species in the vicinity of the study area (Figure 10). The nearest are records from Indee Station in 2019, about 14km south of the study area (DBCA 2021). A dead individual was also recorded at the Wodgina Project in 2018 (Biologic 2018a), about 32km south. This species is likely to occur in low densities in the Spinifex Sandplain and Spinifex Drainage habitats, particularly where there are large, long-unburnt spinifex hummocks in which to shelter.

Lakeland Downs Mouse – *Leggadina lakedownensis*

The Lakeland Downs Mouse is listed as Priority 4 by DBCA.

The Lakeland Downs Mouse (also known as the Short-tailed Mouse) favours cracking and gilgaied clays (Gibson and McKenzie 2009), but it also occurs in a range of other habitats, including spinifex grasslands and stony ranges (Van Dyck and Strahan 2008). Populations of this species can fluctuate dramatically (Van Dyck and Strahan 2008), so it may be common in one year and virtually absent in another.

There are no records in the vicinity on DBCA's Threatened and Priority Fauna Database (DBCA 2021), however, the study area is within the known range of the species. The Lakeland Downs Mouse potentially occurs in the study area, possibly favouring the Sandplain Drainage habitat.

Western Pebble-mound Mouse – *Pseudomys chapmani*

The Western Pebble-Mound Mouse is listed as Priority 4 by DBCA.

The Western Pebble-Mound Mouse occurs in the ranges of the central and southern Pilbara, and the smaller ranges of the Little Sandy Desert. It inhabits gentle stony slopes where it constructs its pebble mounds, often situating them near *Acacia*-lined minor drainages (Van Dyck and Strahan 2008). This species has disappeared from parts of its range along the Pilbara coast, Murchison and Gascoyne, possibly due to the fox and introduced herbivores (Van Dyck and Strahan 2008). Despite this, mining is not considered to be a threatening process for this species, as its habitat is relatively widespread (Woinarski *et al*. 2014).

There are many records of this species in the vicinity of the study area on DBCA's Threatened and Priority Fauna Database (Figure 10). Active, inactive and historic mounds of this species were found on the stony hills in the study area (Figure 11, Plate 36). The Western Pebble-mound Mouse is likely to occur throughout the Stony Hills habitat of the study area and in similar habitats the wider region.

Plate 36. Active Western Pebble-mound Mouse (*Pseudomys chapmani*) mounds.

5.2.5 Locally Significant Fauna

A single locally significant species was identified: the Rufous-crowned Emu-wren (*Stipiturus ruficeps*). Although widespread across arid Australia, this species relies on mature spinifex for habitat, usually in association with low shrubs. In areas where fires are frequent, this species may become locally extinct as it is likely to be a poor disperser. The Rufous-crowned Emu-wren was recorded in the study area in 2024, and is likely to prefer long-unburnt areas within the Spinifex Sandplain and Sandplain Drainage habitats.

6. Survey Adequacy

6.1 Species Accumulation Curves

Species accumulation curves were calculated for frogs, reptiles, mammals and birds for all habitats combined (Figures 20 - 23). Estimates of species richness for reptiles and mammals are given in Table 14, using the Chao1 estimator for abundance-based trapping data and the Chao-2 estimator for incidence-based bird survey data. These are good indicators of the lower bound of the total species richness with small sample sizes. There are several singletons (unique records) in the reptile and bird samples, indicating that the sample size may be low, and the accuracy of these estimates is likely to be poor. This is a common feature of all detailed fauna surveys, with many species represented by a single capture or observation and is ameliorated by using other survey techniques to increase the number of species recorded across the overall study area.

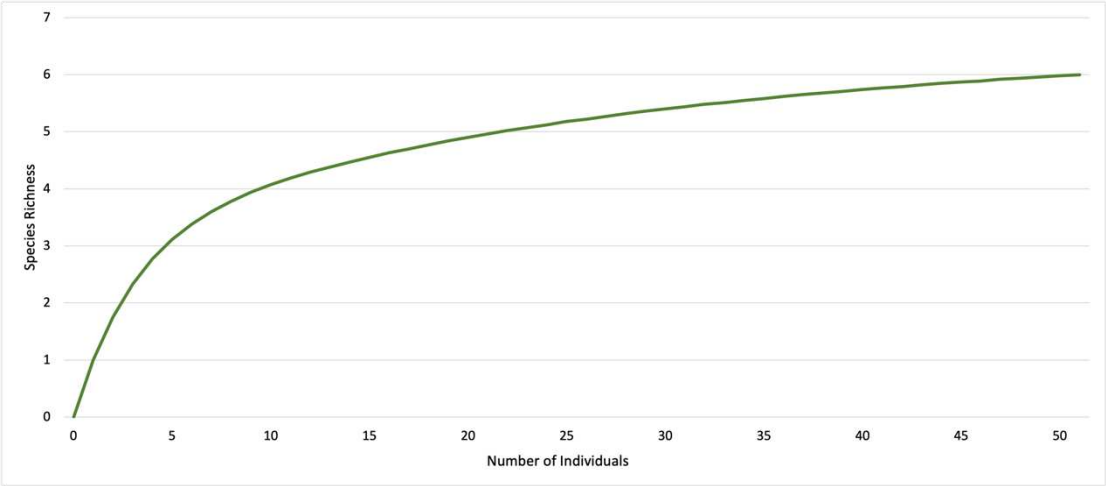

Figure 20. Species accumulation curve for frogs in all habitats.

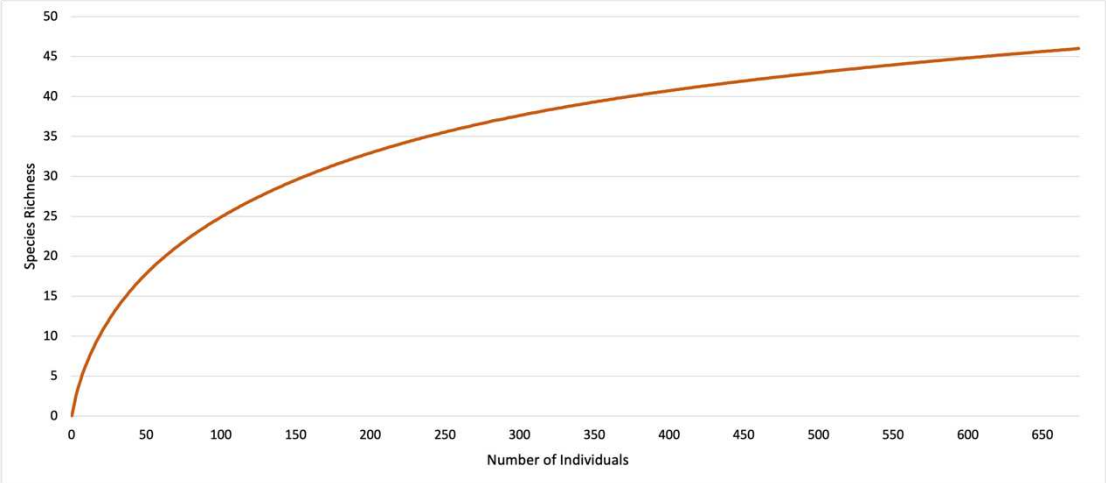

Figure 21. Species accumulation curve for reptiles in all habitats.

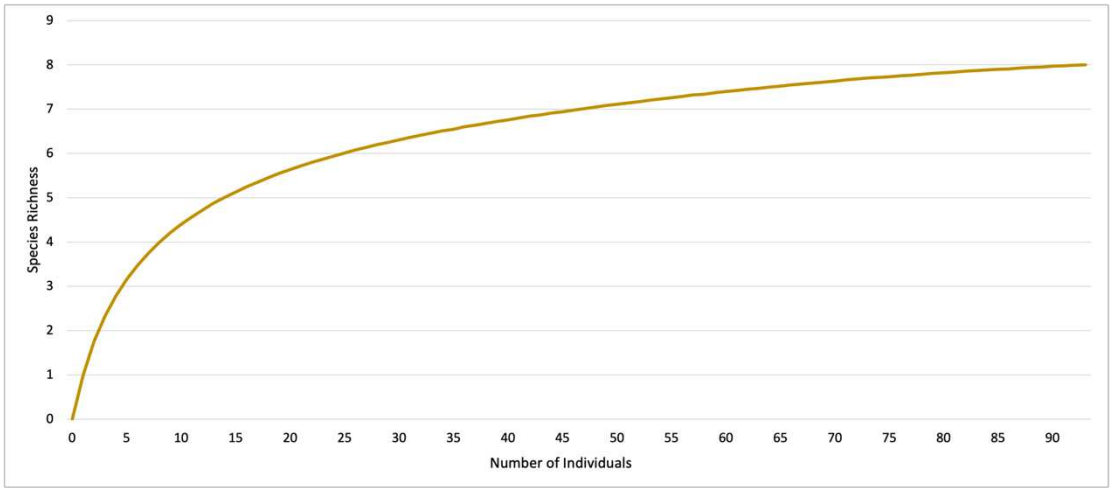

Figure 22. Species accumulation curve for mammals in all habitats.

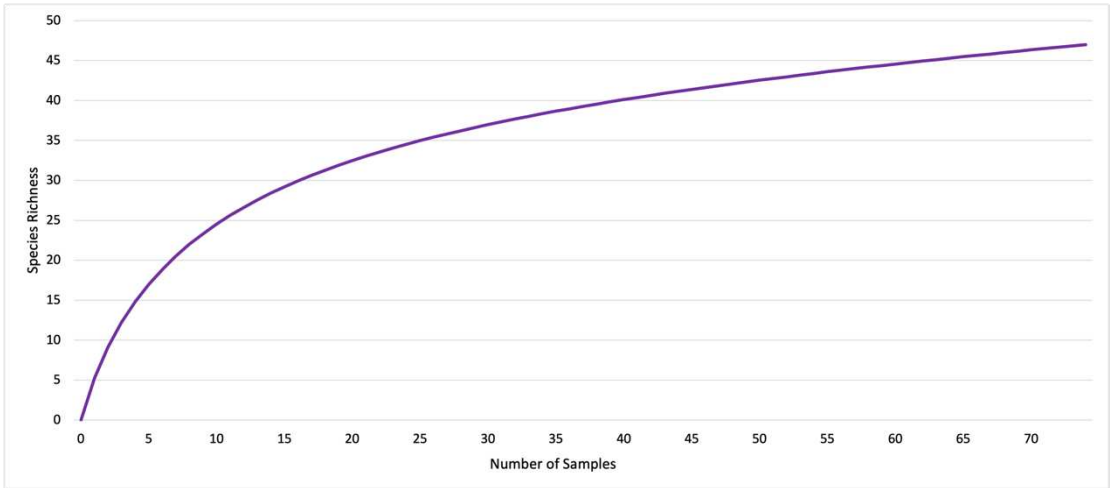

Figure 23. Species accumulation curve for birds in all habitats.

When interpreting species accumulation curves and estimators of species richness in the context of a detailed fauna survey, it is vital to remember that the data collected is influenced by the sampling methods. All sampling methods have inherent biases that favour the detection of some species over others, i.e. some species will be readily trapped and others may be trapped rarely or not at all. Thus, the species accumulation curves and estimates of species richness are that of the 'trappable' component of the fauna only. Species may not be trappable if they are temporarily absent from the site (e.g. migratory, nomadic species or irruptive species), are too large to be targeted by standard trapping techniques (e.g. kangaroos) or are shy of entering traps. Fauna may also be patchy in their distribution within a habitat and may only be trapped if the trapping site intersects their home-range. The trappable component of the fauna is also likely to vary due to the prevailing conditions, e.g. burrowing frogs may be trappable after heavy rains, but virtually impossible to sample in dry conditions. Long-term drought conditions may reduce some species to undetectable levels, or cool conditions may result in reptiles being inactive.

Table 14. Estimated species richness for each species group.

Species Group	Observed species richness (systematic data only)	Sample Size (number of records)	Number of uniques in the sample	Chao1 Estimate of species richness (± SD)	Chao2 Estimate of species richness (± SD)
Frogs	6	51 (Individuals)	1	6.0 ± 0.25	-
Reptiles	46	674 (individuals)	10	53.49 ± 6.35	-
Mammals	8	93 (individuals)	1	8.0 ± 0.16	-
Birds	47	74 (samples)	12	-	60.02 ± 10.1

For frogs and mammals, the species accumulation curves were close to reaching asymptote, suggesting that almost all of the trappable fauna had been recorded and if trapping had continued, few, if any species would have been added to the list of observed species. For both of these groups the estimate of species richness was similar to the observed species richness, suggesting no species remained unrecorded.

For birds, and reptiles the species accumulation curve did not reach asymptote, although it should be noted that many species were observed outside of systematic surveys. The estimated species richness for birds was about 50 - 70 species (Table 14) and 89 species were recorded on the current survey (Table 10). The estimated species richness for reptiles was about 47 - 60 species (Table 14) and 56 species were recorded on the current survey (Table 9). This suggests that further sampling is likely to have resulted in up to four additional species being recorded.

Overall, it appears likely that a large proportion of the fauna able to be recorded through systematic methods, were recorded.

6.2 Proportion of the Fauna Identified

Species accumulation curves are not the complete picture, as they are based only on the systematically collected trapping and bird survey data. Many species are observed opportunistically or through targeted surveys, and these records often add considerably to the total species inventory of a particular site. The total number of species observed can be compared to the number of species potentially occurring on the site. A total of ten frogs, 115 reptiles, 166 birds, 36 native mammals and eight introduced mammals potentially occur, based on the literature review (Table 7, Appendices 4 - 7). Of these, 60.0% of frogs, 48.7% of reptiles, 53.6% of birds, 61.1% of native mammals and 75.0% of introduced mammals were recorded in the study area (Figure 24).

As the list of potentially occurring species in Appendices 4 - 7 is relatively conservative, it is quite likely that some of the unrecorded species, though known from the wider region, do not in fact occur in the study area. Some of the predicted species are on the edge of their known range in the study area and it is probable that for at least some of these species, their range does not extend into the study area.

Bird species that remain unrecorded include several waterbird species that may occur when river pools are flooded, irruptive species that may move into the area during flowering events or after a fire, and sparsely distributed species such as some birds of prey. Of the reptiles and mammals that remain unrecorded, several are species that inhabit rocky habitats that are largely absent from the study area, although they occur nearby.

It is likely that further work in the study area would result in more species being recorded. This is the case with all fauna surveys, as the short survey periods only provide a 'snapshot' of the fauna occurring in the study area. Despite these limitations, this fauna survey has resulted in a significant proportion of the predicted fauna being recorded.

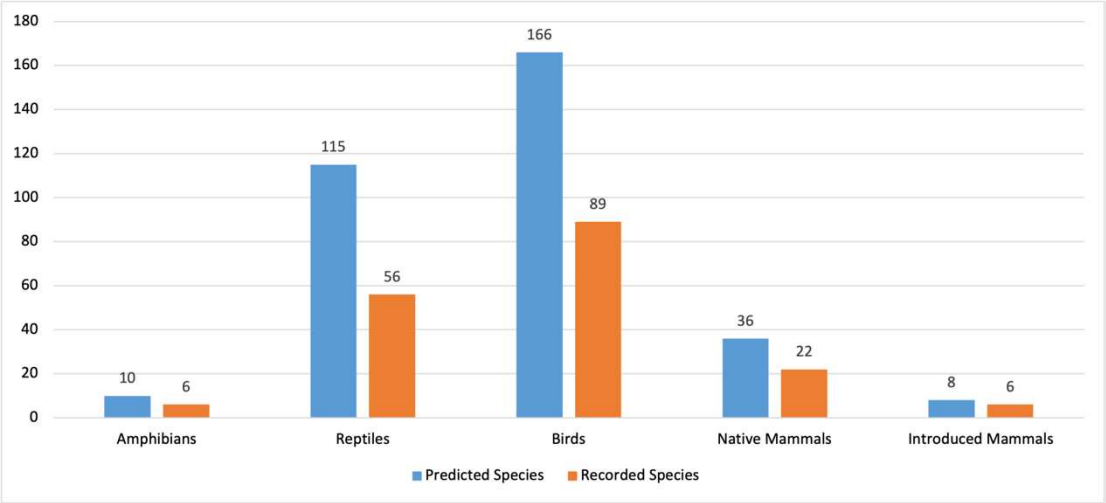

Figure 24. Proportion of the vertebrate fauna identified.

7. Conclusions

7.1 Faunal Assemblage

The predicted faunal assemblage includes up to ten frogs, 115 reptiles, 166 birds, 36 native mammals and eight introduced mammals. The observed assemblage to date includes six frogs, 56 reptiles, 89 birds, 22 native mammals and six introduced mammals.

7.2 Important Habitats

All habitats have some importance in that they support native fauna, however, habitats may be of particular importance if they:

- support very diverse or unique faunal assemblages
- are restricted or rare in the region (and thus the faunal assemblages are restricted or rare)
- are refugia (e.g. from drought or fire)
- provide ecological linkage
- support conservation significant fauna

None of the habitats in the study area supported a particularly unique faunal assemblage, as although relatively diverse, the fauna present are typical of the Pilbara Bioregion. The Rocky Outcrop and Sand Dune habitats are limited in their extent in both the study area and the region, so the faunal assemblages associated with these habitats will also be limited in extent.

The Rocky Outcrop habitat provides cracks and crevices for shelter, offering breeding and roosting sites for a range of native fauna. Although there are no caves present to support diurnal roosting by conservation significant bats, this habitat is likely to be habitat critical to the survival of the Northern Quoll (*Dasyurus hallucatus*: Endangered) and Pilbara Olive Python (*Liasis olivaceous barroni*: Vulnerable) both of which may shelter in this habitat.

The Sand Dune habitat is uncommon and patchily distributed in the region. It provides habitat for the Bilby (*Macrotis lagotis*: Vulnerable), as this species appeared to favour the Sand Dune for burrowing compared to the surrounding Spinifex Sandplain habitat.

The Major River habitat is likely to function as an ecological linkage, as well as providing habitat that is more productive than surrounding areas due to the presence of water. The higher productivity is likely to support a greater abundance and diversity of fauna, and there are many species that are only likely to occur in this habitat, such as waterbirds. Waterholes in the rivers provide water to fauna in an otherwise relatively dry landscape, permanent waterholes offering a refuge for fauna in dry conditions. The open riverbed may provide a refuge from fire and a natural firebreak.

The Major River habitat supports several conservation significant species. The Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*: Vulnerable) forages in this habitat. There are several shorebirds that may forage at waterholes in the summer, including the Common Greenshank (*Tringa nebularia*: Endangered) and Sharp-tailed Sandpiper (*Calidris acuminata*: Vulnerable), however, the habitat is unlikely to support nationally or internationally important numbers of any shorebird species. The Major River habitat is likely to be habitat critical to the survival of the Northern Quoll (*Dasyurus hallucatus*: Endangered), Pilbara Olive Python (*Liasis olivaceous barroni*: Vulnerable) and Grey Falcon (*Falco hypoleucos*: Vulnerable). The Northern Quoll and Pilbara Olive Python are likely to forage and disperse through the area, with tree hollows and rocky riverbanks providing shelter sites for the Northern Quoll. The taller trees potentially provide nesting habitat for the Grey Falcon.

Spinifex Sandplain and Sandplain Drainage habitats support conservation significant species, including the Bilby (*Macrotis lagotis*: Vulnerable) and Brush-tailed Mulgara (*Dasycercus blythi*: Priority 4). However, these habitats are relatively contiguous and widespread in the region, so their importance is comparatively lower than habitats that are limited in extent. Spinifex Sandplain and Sandplain Drainage may still be vulnerable to threats that operate on a widespread level, such as homogenising fires, grazing pressure and the presence of introduced predators supported by watering points.

The Stony Hills support the Western Pebble Mound Mouse (*Pseudomys chapmani*: Priority 4) and potentially the Long-tailed Dunnart (*Sminthopsis longicaudata*: Priority 4) but this habitat is comparatively common in the region.

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Appendices.

Appendix 1. Daily weather observations before and during each survey period.

Data after BOM (2022).

Month	Date	Survey Period	Daily Temperature (°C)		Rainfall (mm)
			Minimum	Maximum	
September 2021	01 – 09 – 21		17.5	30.6	0.4
	02 – 09 – 21		15.3	34.1	0
	03 – 09 – 21		17.7	31.9	0
	04 – 09 – 21		19	32.3	-
	05 – 09 – 21		13	32.9	0
	06 – 09 – 21		21.1	33.9	0
	07 – 09 – 21		18.5	31.5	0
	08 – 09 – 21		14.2	30.8	0
	09 – 09 – 21		14.7	33.5	0
	10 – 09 – 21		13.9	34.8	0
	11 – 09 – 21		15.3	35.8	0
	12 – 09 – 21		16.9	30.6	0
	13 – 09 – 21		14.3	30.9	0
	14 – 09 – 21		14.4	31.1	0
	15 – 09 – 21		15.5	31.9	0
	16 – 09 – 21		17.9	32	0
	17 – 09 – 21		14.6	35.6	0
	18 – 09 – 21		15.9	35.5	0
	19 – 09 – 21	Phase 1	16.9	36.6	0
	20 – 09 – 21	Phase 1	17	39.2	0
	21 – 09 – 21	Phase 1	23.3	38.9	0
	22 – 09 – 21	Phase 1	26.4	36.3	0
	23 – 09 – 21	Phase 1	22.2	32.8	0
	24 – 09 – 21	Phase 1	14.8	35.4	0
	25 – 09 – 21	Phase 1	14.5	31	0
	26 – 09 – 21	Phase 1	15.7	32.9	0
	27 – 09 – 21	Phase 1	15.7	33.8	0
	28 – 09 – 21	Phase 1	15.9	34.3	0
	29 – 09 – 21	Phase 1	14.8	32.7	0
	30 – 09 – 21	Phase 1	14.3	31.3	0.2

Appendix 1. (cont.)

Month	Date	Survey Period	Daily Temperature (°C)		Rainfall (mm)
			Minimum	Maximum	
February 2022	21 – 02 – 22		24.9	41.1	-
	22 – 02 – 22		26.1	36.4	0.2
	23 – 02 – 22		26.9	37	0
	24 – 02 – 22		27.7	38	0
	25 – 02 – 22		29	38.6	0
	26 – 02 – 22		26.8	35.7	0
	27 – 02 – 22		27.6	35.1	0
	28 – 02 – 22		27.2	36	0
March 2022	01 – 03 – 22		27.2	36.6	0
	02 – 03 – 22		21.7	36.7	19.6
	03 – 03 – 22		27.1	37.7	0.2
	04 – 03 – 22		27	35.4	0
	05 – 03 – 22		24.8	38	0
	06 – 03 – 22		23.9	38.5	0
	07 – 03 – 22		25.3	42.2	0
	08 – 03 – 22		27.4	39.8	0
	09 – 03 – 22		26.5	38.2	0
	10 – 03 – 22		26.1	36.7	0
	11 – 03 – 22		27.2	40.5	0
	12 – 03 – 22		26.2	42	0
	13 – 03 – 22		26	40.2	0
	14 – 03 – 22	Phase 2	26.3	38.5	0
	15 – 03 – 22	Phase 2	27.8	39.4	0
	16 – 03 – 22	Phase 2	28.1	42.3	0
	17 – 03 – 22	Phase 2	25.7	43.7	0
	18 – 03 – 22	Phase 2	28.5	36.2	0
	19 – 03 – 22	Phase 2	26.4	39.6	0
	20 – 03 – 22	Phase 2	23	39.2	1.8
	21 – 03 – 22	Phase 2	26.3	39	0.2
	22 – 03 – 22	Phase 2	26.1	39.9	0
	23 – 03 – 22	Phase 2	31	42.8	0
	24 – 03 – 22	Phase 2	29.7	37.9	0
	25 – 03 – 22	Phase 2	26.5	38.4	0

Appendix 1. (cont.)

Month	Date	Survey Period	Daily Temperature (°C)		Rainfall (mm)
			Minimum	Maximum	
July 2022	11 – 07 – 22		9.3	27.2	0
	12 – 07 – 22		10.8	28.2	0
	13 – 07 – 22		13.0	28.2	0
	14 – 07 – 22		10.6	25.8	0
	15 – 07 – 22		9.6	28.2	0
	16 – 07 – 22		10.6	28.0	0
	17 – 07 – 22		11.1	28.6	0
	18 – 07 – 22		11.1	28.9	0
	19 – 07 – 22		12.5	28.1	0
	20 – 07 – 22		13.0	29.3	0
	21 – 07 – 22		11.7	30.4	0
	22 – 07 – 22		13.9	29.0	0
	23 – 07 – 22		17.8	28.1	0
	24 – 07 – 22		12.9	28.2	0.2
	25 – 07 – 22		13.8	29.0	0
	26 – 07 – 22		15.1	30.1	0
	27 – 07 – 22		13.2	32.0	0
	28 – 07 – 22		14.6	28.3	0
	29 – 07 – 22		13.2	28.4	0
	30 – 07 – 22		10.9	30.1	0
	31 – 07 – 22		15.6	29.2	0
August 2022	01 – 08 – 22		14.8	28.8	0
	02 – 08 – 22		20.9	25.9	0
	03 – 08 – 22		17.2	27.9	1.8
	04 – 08 – 22		12.6	27.6	0
	05 – 08 – 22		11.2	27.9	0
	06 – 08 – 22		13.3	28.5	0
	07 – 08 – 22		9.6	29.1	0
	08 – 08 – 22		10.7	30.0	0
	09 – 08 – 22	Survey	11.0	31.3	0
	10 – 08 – 22	Survey	17.8	22.8	0
	11 – 08 – 22	Survey	11.9	29.2	0
	12 – 08 – 22	Survey	17.7	29.6	0

Month	Date	Survey Period	Daily Temperature (°C)		Rainfall (mm)
			Minimum	Maximum	
April 2024	11 – 07 – 22		9.3	27.2	0
	12 – 07 – 22		10.8	28.2	0
	13 – 07 – 22		13.0	28.2	0
	14 – 07 – 22		10.6	25.8	0
	15 – 07 – 22		9.6	28.2	0
	16 – 07 – 22		10.6	28.0	0
	17 – 07 – 22		11.1	28.6	0
	18 – 07 – 22		11.1	28.9	0
	19 – 07 – 22		12.5	28.1	0
	20 – 07 – 22		13.0	29.3	0
	21 – 07 – 22		11.7	30.4	0
	22 – 07 – 22		13.9	29.0	0
	23 – 07 – 22		17.8	28.1	0
	24 – 07 – 22		12.9	28.2	0.2
	25 – 07 – 22		13.8	29.0	0
	26 – 07 – 22		15.1	30.1	0
	27 – 07 – 22		13.2	32.0	0
	28 – 07 – 22		14.6	28.3	0
	29 – 07 – 22		13.2	28.4	0
	30 – 07 – 22		10.9	30.1	0
	31 – 07 – 22		15.6	29.2	0
May 2024	01 – 08 – 22		14.8	28.8	0
	02 – 08 – 22		20.9	25.9	0
	03 – 08 – 22		17.2	27.9	1.8
	04 – 08 – 22		12.6	27.6	0
	05 – 08 – 22		11.2	27.9	0
	06 – 08 – 22		13.3	28.5	0
	07 – 08 – 22		9.6	29.1	0
	08 – 08 – 22		10.7	30.0	0
	09 – 08 – 22	Survey	11.0	31.3	0
	10 – 08 – 22	Survey	17.8	22.8	0
	11 – 08 – 22	Survey	11.9	29.2	0
	12 – 08 – 22	Survey	17.7	29.6	0

Appendix 2. Sampling Locations.

Appendix 2						
Site Type	Site Name	Zone	Easting	Northing	Start Date	Stop Date
Anabat	Bat01	50	643769.798	7690313.383	21/9/21	23/9/21
Anabat	Bat02	50	661248.06	7694420.317	23/9/21	25/9/21
Anabat	Bat03	50	659381.457	7701353.459	25/9/21	27/9/21
Anabat	Bat04	50	591435.422	7680020.814	27/9/21	29/9/21
Anabat	Bat05	50	656879.819	7694048.08	20/9/21	21/9/21
Anabat	Bat06	50	645066.126	7687877.761	21/9/21	23/9/21
Anabat	Bat07	50	624344.836	7689710.563	23/9/21	25/9/21
Anabat	Bat08	50	624806	7687949	25/9/21	27/9/21
Anabat	Bat09	50	591336.78	7679986.602	27/9/21	29/9/21
Anabat	Bat10	50	656440.421	7700083.816	19/9/21	21/9/21
Anabat	Bat11	50	649850	7692702	21/9/21	23/9/21
Anabat	Bat12	50	621522.296	7688730.206	24/9/21	26/9/21
Anabat	Bat13	50	649035.189	7695165.997	26/9/21	27/9/21
Anabat	Bat14	50	639354	7687572	27/9/21	29/9/21
Anabat	Bat17	50	643799	7690390	17/3/2022	19/3/2022
Anabat	Bat18	50	645079	7688087	17/3/2022	19/3/2022
Anabat	Bat19	50	649797.917	7692742.931	19/3/2022	21/3/2022
Anabat	Bat20	50	656877.764	7694051.198	19/3/2022	21/3/2022
Anabat	Bat21	50	659023.162	7701647.693	21/3/2022	23/3/2022
Anabat	Bat22	50	661248.931	7694412.996	21/3/2022	23/3/2022
Anabat	Bat24	50	656450	7700056	23/3/2022	25/3/2022
Anabat	Bat23	50	653220.158	7694349.542	23/3/2022	25/3/2022
Camera Trap	Cam02	50	651328.629	7690351.291	24/9/21	29/9/21
Camera Trap	Cam03	50	641670	7693394	24/9/21	29/9/21
Camera Trap	Cam04	50	653553.807	7697519.584	24/9/21	29/9/21
Camera Trap	Cam05	50	653153.71	7695369.101	24/9/21	29/9/21
Camera Trap	Cam06	50	623711.027	7690361.727	24/9/21	29/9/21
Camera Trap	Cam07	50	639365	7687675	24/9/21	29/9/21
Camera Trap	Cam08	50	622166.952	7688905.716	24/9/21	29/9/21
Camera Trap	Cam09	50	641381	7690490	24/9/21	29/9/21
Camera Trap	Cam10	50	646051	7696056	24/9/21	29/9/21
Camera Trap	Cam13	50	648179	7695335	24/9/21	29/9/21
Camera Trap	Cam17	50	644939	7695259	24/9/21	29/9/21
Camera Trap	Cam20	50	638789	7691303	24/9/21	29/9/21
Camera Trap	Cam21	50	661347	7694257	24/9/21	29/9/21
Camera Trap	Cam22	50	642550	7691820	24/9/21	29/9/21

Appendix 2						
Site Type	**Site Name**	**Zone**	**Easting**	**Northing**	**Start Date**	**Stop Date**
Camera Trap	Cam23	50	646683	7693860	24/9/21	29/9/21
Camera Trap	Cam24	50	646682	7692177	24/9/21	29/9/21
Camera Trap	Cam25	50	643209	7688131	24/9/21	29/9/21
Camera Trap	Cam26	50	646445	7688260	24/9/21	29/9/21
Camera Trap	Cam27	50	639864	7687504	24/9/21	29/9/21
Camera Trap	Cam29	50	655149.033	7699617.21	24/9/21	29/9/21
Camera Trap	Cam30	50	658027	7693574	24/9/21	29/9/21
Camera Trap	Cam31	50	641343	7688148	24/9/21	29/9/21
Camera Trap	Cam32	50	649241	7693651	24/9/21	29/9/21
Camera Trap	Cam35	50	659438.996	7701141.125	24/9/21	29/9/21
Camera Trap	Cam40	50	661364	7694418	24/9/21	29/9/21
Camera Trap	Cam41	50	639966	7689778	24/9/21	29/9/21
Camera Trap	Cam42	50	645350	7690105	24/9/21	29/9/21
Camera Trap	Cam44	50	655629.493	7688242.31	24/9/21	29/9/21
Camera Trap	Cam45	50	656382.565	7698846.084	24/9/21	29/9/21
Camera Trap	Cam45	50	656383	7698846	24/9/21	29/9/21
Camera Trap	Cam46	50	642689	7690919	24/9/21	29/9/21
Camera Trap	Cam47	50	624801.159	7687949.755	24/9/21	29/9/21
Camera Trap	Cam48	50	657233	7693532	24/9/21	29/9/21
Camera Trap	Cam49	50	659426.065	7701095.416	24/9/21	29/9/21
Camera Trap	Cam50	50	656348.858	7688927.755	24/9/21	29/9/21
Camera Trap	Rde02sl2409	50	648674	7696864	24/9/21	29/9/21
Camera Trap	Cam07B	50	651668.139	7692589.922	16/3/22	24/3/22
Camera Trap	Cam05B	50	652665.345	7693891.299	16/3/22	24/3/22
Camera Trap	Cam23B	50	650587.667	7691869.231	16/3/22	24/3/22
Camera Trap	Cam31B	50	651036.793	7690271.344	16/3/22	24/3/22
Camera Trap	Cam42B	50	652615.397	7688919.759	16/3/22	24/3/22
Camera Trap	Cam20B	50	649122.659	7690534.624	16/3/22	24/3/22
Camera Trap	Cam27B	50	649053.097	7688848.522	16/3/22	24/3/22
Camera Trap	Cam30B	50	639351.102	7687653.67	17/3/22	24/3/22
Camera Trap	Cam40B	50	639312.041	7687585.796	17/3/22	24/3/22
Camera Trap	Cam25B	50	640109.936	7689301.868	17/3/22	24/3/22
Camera Trap	Cam47B	50	641048.666	7688185.725	17/3/22	24/3/22
Camera Trap	Cam32B	50	641407.835	7690591.689	17/3/22	24/3/22
Camera Trap	Cam09B	50	643732.437	7690348.686	17/3/22	24/3/22
Camera Trap	Cam08B	50	645305.05	7690099.958	17/3/22	24/3/22
Camera Trap	Cam45B	50	649754.165	7692761.259	18/3/22	24/3/22

Appendix 2						
Site Type	**Site Name**	**Zone**	**Easting**	**Northing**	**Start Date**	**Stop Date**
Camera Trap	Cam16B	50	650173.125	7694259.895	18/3/22	24/3/22
Camera Trap	Cam10B	50	646699.459	7694130.273	18/3/22	24/3/22
Camera Trap	Cam13B	50	646699.436	7693046.478	18/3/22	24/3/22
Camera Trap	Cam41B	50	668933.938	7697217.071	15/3/22	22/3/22
Camera Trap	Cam24B	50	653849	7694292	16/3/22 0:00	24/3/22
Camera Trap	Cam29B	50	653074	7696317	18/3/22 0:00	24/3/22
Camera Trap	Cam04B	50	668795	7697145	15/3/22 0:00	24/3/22
Camera Trap	Cam44B	50	655649	7695406	16/3/22 0:00	24/3/22
Camera Trap	Cam46B	50	653244	7694354	16/3/22 0:00	24/3/22
Camera Trap	Cam48B	50	652853	7698899	18/3/22 0:00	24/3/22
Camera Trap	Cam49B	50	654043	7702083	18/3/22 0:00	24/3/22
Camera Trap	Cam06B	50	668624	7697080	15/3/22 0:00	24/3/22
Camera Trap	Cam21B	50	650431	7694911	18/3/22	24/3/22
Camera Trap	Cam22B	50	654858	7698394	18/3/22	24/3/22
Camera Trap	Cam24B	50	653849	7694292	16/3/22	24/3/22
Camera Trap	Cam26B	50	652222	7694568	18/3/22	24/3/22
Camera Trap	DeGrey Cam 01	50	639674	7687936	20/3/22	9/4/22
Camera Trap	DeGrey Cam 02	50	639653	7688002	20/3/22	9/4/22
Camera Trap	DeGrey Cam 03	50	639672	7687998	20/3/22	9/4/22
Camera Trap	DeGrey Cam 04	50	653122	7697179	21/3/22	9/4/22
Camera Trap	DeGrey Cam 05	50	653100	7697251	21/3/22	9/4/22
Camera Trap	DeGrey Cam 06	50	653295	7697213	21/3/22	9/4/22
Camera Trap	Cam25D	50	643656.545	7697280.912	10/8/2022	18/8/2022
Camera Trap	Cam40D	50	649240.124	7683310.42	10/8/2022	18/8/2022
Camera Trap	Cam46D	50	649148.067	7683284.678	10/8/2022	18/8/2022
Camera Trap	Cam48D	50	652573.025	7680415.2	10/8/2022	18/8/2022
Camera Trap	Cam49D	50	642244.78	7701645.619	10/8/2022	18/8/2022
Diurnal Search (Point)	MB_T01	50	639364	7687675	28/9/21	28/9/21
Diurnal Search (Point)	Yule	50	639354	7687572	28/9/21	28/9/21
Bilby 2ha Quadrat	Bq001	50	654245	7694098	13/4/2024	13/4/2024
Bilby 2ha Quadrat	Bq002	50	648765	7690373	13/4/2024	13/4/2024
Bilby 2ha Quadrat	Bq003	50	646653	7692919	14/4/2024	14/4/2024

Appendix 2						
Site Type	**Site Name**	**Zone**	**Easting**	**Northing**	**Start Date**	**Stop Date**
Bilby 2ha Quadrat	Bq004	50	644976	7696731	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq005	50	641755	7698570	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq006	50	642254	7701643	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq007	50	646971	7701280	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq008	50	648669	7698696	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq009	50	649674	7694996	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq010	50	653294	7700734	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq011	50	657326	7701751	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq012	50	657654	7690841	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq013	50	651965	7681936	14/4/2024	14/4/2024
Bilby 2ha Quadrat	Bq014	50	653250	7678744	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq015	50	649166	7683641	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq016	50	653852	7689638	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq017	50	652569	7687933	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq018	50	645698	7687446	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq019	50	657584	7694008	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq020	50	661147	7692303	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq021	50	658619	7699186	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq022	50	658221	7700850	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq023	50	645094	7689968	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq024	50	643756	7690345	15/4/2024	15/4/2024
Bilby 2ha Quadrat	Bq025	50	642801	7690723	16/4/2024	16/4/2024
Bilby 2ha Quadrat	Bq026	50	640081	7688727	16/4/2024	16/4/2024
Bilby 2ha Quadrat	Bq027	50	638809	7690958	16/4/2024	16/4/2024
Bilby 2ha Quadrat	Bq028	50	641395	7690711	16/4/2024	16/4/2024
Bilby 2ha Quadrat	Bq029	50	641655	7693446	16/4/2024	16/4/2024
Bilby 2ha Quadrat	Bq030	50	653486	7697332	16/4/2024	16/4/2024
Bilby 2ha Quadrat	Bq031	50	661097	7697005	16/4/2024	16/4/2024
Bilby 2ha Quadrat	Bq032	50	662988	7694515	17/4/2024	17/4/2024
Camera Trap (Quoll)	Q1-04	50	659825.062	7698931.788	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-27	50	659876.754	7698752.273	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-30	50	659591.647	7699663.256	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-31	50	659867.032	7698846.47	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-46	50	659782.288	7699031.719	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-55	50	659768.107	7699160.831	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-57	50	659687.222	7699357.558	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-59	50	659716.864	7699267.598	12/4/2023	17/4/2024

Appendix 2						
Site Type	**Site Name**	**Zone**	**Easting**	**Northing**	**Start Date**	**Stop Date**
Camera Trap (Quoll)	Q1-62	50	659596.586	7699548.513	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q1-65	50	659643.646	7699460.494	12/4/2023	17/4/2024
Camera Trap (Quoll)	Q2-05	50	659228.046	7701766.202	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-20	50	658999.656	7702366.088	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-21	50	659085.493	7702139.421	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-22	50	659147.003	7701938.344	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-25	50	659117.945	7702047.562	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-41	50	658993.486	7702594.089	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-44	50	659191.19	7701843.497	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-51	50	659017.23	7702243.033	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-53	50	659001.025	7702698.199	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q2-61	50	658969.91	7702479.292	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-07	50	663732.342	7691492.99	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-09	50	663818.706	7691439.333	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-23	50	663674.859	7691786.611	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-29	50	663613.74	7691857.735	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-32	50	663751.236	7691712.348	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-47	50	663720.041	7691607.587	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-52	50	663242.955	7692165.04	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-60	50	663541.565	7691936.494	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-63	50	663356.719	7692039.71	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q3-64	50	663443.127	7691990.156	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-06	50	639404.719	7687547.61	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-08	50	639280.627	7687821.966	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-24	50	639305.769	7687706.632	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-42	50	639273.19	7688165.979	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-43	50	639313.868	7688053.392	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-49	50	639261.307	7688287.521	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-54	50	639295.323	7687962.549	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-56	50	639473.736	7687478.397	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-58	50	639333.215	7687605.105	13/4/2024	18/4/2024
Camera Trap (Quoll)	Q4-66	50	639553.457	7687396.364	13/4/2024	18/4/2024
SM4 Acoustic Recorder	SM4-01 170424	50	640513.008	7701757.271	17/4/2024	25/4/2024
SM4 Acoustic Recorder	SM4-02 170424	50	659911.318	7693187.744	17/4/2024	25/4/2024
SM4 Acoustic Recorder	SM4-03 170424	50	661182.353	7696905.749	17/4/2024	25/4/2024
SM4 Acoustic Recorder	SM4-04 170424	50	663683.69	7691860.151	17/4/2024	25/4/2024
SM4 Acoustic Recorder	SM4-05 170424	50	640819.859	7698955.857	17/4/2024	25/4/2024

Appendix 2						
Site Type	**Site Name**	**Zone**	**Easting**	**Northing**	**Start Date**	**Stop Date**
SM4 Acoustic Recorder	SM4-06 170424	50	659243.478	7694266.448	17/4/2024	25/4/2024
SM4 Acoustic Recorder	SM4-01 250424	50	640349	7702261	25/4/2024	2/5/2024
SM4 Acoustic Recorder	SM4-02 250424	50	656557	7694215	25/4/2024	2/5/2024
SM4 Acoustic Recorder	SM4-03 250424	50	659021	7697236	25/4/2024	2/5/2024
SM4 Acoustic Recorder	SM4-04 250424	50	659631	7696541	25/4/2024	2/5/2024
SM4 Acoustic Recorder	SM4-05 250424	50	640984	7702577	25/4/2024	2/5/2024
SM4 Acoustic Recorder	SM4-06 250424	50	661070	7691921	25/4/2024	2/5/2024

Appendix 3. Habitat Assessment.

Appendix 3	
Habitat Assessment	**Photograph**
Mghab001 **Habitat:** Sand Dune **Landform:** slope **Vegetation:** Tall Acacia shrubland over open spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** leaf litter, sand for burrowing. **Wetlands:** none	
Mghab002 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland over mixed low Acacia and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab003 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Sparse Acacia shrubland over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab004 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Sparse Acacia shrubs and Corymbia trees over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** near recently burnt area. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab005 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Tall Acacia shrubland with occasional Corymbia over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, near recently burnt area. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab006 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered tall Acacia, Hakea and Corymbia over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab007 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered tall Acacia and Corymbia over mixed low Acacia shrubalnd and spinifex hummock grassland. **Evidence of fire:** edge of recently burnt area. **Disturbance:** none noted. **Soil:** red sand **Rock:** surface gravel. **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab008 **Habitat:** Stony Hill **Landform:** low rise **Vegetation:** Scattered tall Acacia over spinifex hummock grassland. **Evidence of fire:** edge of recently burnt area. **Disturbance:** cattle **Soil:** fine pink sand **Rock:** stony surface. **Important elements:** small stones for Western Pebble-mound Mouse. **Wetlands:** none	
Mghab009 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia and Corymbia over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab010 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Acacia, Hakea and Corymbia over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab011 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Acacia, Hakea and Corymbia over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab012 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Acacia, Hakea and Corymbia over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab013 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Acacia and Corymbia over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab014 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Corymbia and open tall Acacia shrubland over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab015 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Open Acacia shrubland in bands over open spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sandy clay **Rock:** sparse surface stones. **Important elements:** small claypans **Wetlands:** small claypans, seasonally wet.	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab016 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open tall Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab017 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, near recnelty burnt area. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab018 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Sparse Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab019 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Occasional tall Acacia shrub over mixed low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** leaf litter. **Wetlands:** seasonally wet?	
Mghab020 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Patches of Acacia shrubland on higher ground, low spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted. **Wetlands:** seasonally wet.	
Mghab021 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Open Acacia shrubland and scattered Corymbia over mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** leaf litter, occasional small tree hollows. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab022 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Tall Acacia shrubland with occasional eucalypts over sparse spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** dense vegetation, leaf litter, woody debris. **Wetlands:** drainage area.	
Mghab023 **Habitat:** Stony Hills **Landform:** low rise **Vegetation:** Open Acacia and Hakea shrubland with sparse Corymbia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** stony surface **Important elements:** leaf litter, woody debris, small tree hollows. **Wetlands:** none	
Mghab024 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Patchy tall Acacia shrubland with sparse Corymbia over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, potential bilby habitat **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab025 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Acacia, Hakea and Corymbia over mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, potential bilby habitat **Wetlands:** none	
Mghab026 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Sparse Acacia and Hakea over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab027 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Sparse Corymbia, Acacia and Hakea over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab028 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open tall Acacia shrubland over mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, large termite mounds **Wetlands:** none	
Mghab029 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Acacia, Hakea and Melaleuca over mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, seasonal nectar (Melaleuca) **Wetlands:** none	
Mghab030 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Patchy Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted **Wetlands:** seasonally damp (?)	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab031 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Small patches of Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted **Wetlands:** seasonally damp (?)	
Mghab032 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Small patches of Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted **Wetlands:** seasonally damp (?)	
Mghab033 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Small patches of Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted **Wetlands:** seasonally damp (?)	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab034 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Small patches of Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, drill pad **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted **Wetlands:** seasonally damp (?)	
Mghab035 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Open tall Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted. **Wetlands:** seasonally damp (?)	
Mghab036 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Scattered Acacia and Hakea over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** none noted. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab037 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Sparse Coymbia and Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, near recently burnt area. **Soil:** orange sandy-clay **Rock:** none **Important elements:** some very large spinifex, small tree hollows. **Wetlands:** none	
Mghab038 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Sparse tall Acacia shrubland over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab039 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Occasional Acacia over open spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange clay **Rock:** none **Important elements:** large spinifex clumps **Wetlands:** seasonally wet	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab040 **Habitat:** Stony Hills **Landform:** gentle slope **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** none noted. **Soil:** fine pink sand **Rock:** stony surface, small pebbles, very occasional rocky outcrop. **Important elements:** rocky outcrops, small pebbles for Western Pebble-mound Mouse. **Wetlands:** none	
Mghab041 **Habitat:** Stony Hills **Landform:** gentle slope **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** none noted. **Soil:** fine pink sand **Rock:** stony surface, small pebbles. **Important elements:** small pebbles for Western Pebble-mound Mouse. **Wetlands:** none	
Mghab042 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Occasional Corymbia over open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sandy-clay **Rock:** none **Important elements:** tree hollows, sone large spinifex clumps. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab043 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab044 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab045 **Habitat:** Stony Hills **Landform:** low rise **Vegetation:** Scattered Corymbia over open low Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** stony surface **Important elements:** none noted. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab046 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia and Melaleuca shrubland over degraded understory. **Evidence of fire:** none **Disturbance:** cattle, bore **Soil:** red sand **Rock:** none **Important elements:** none noted. **Wetlands:** none	
Mghab047 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland over a mix of low Acaica shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab048 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland over a mix of low Acaica shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab049 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Corymbia over an open Acacia shrubland over a mix of low Acaica shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter, small tree hollows. **Wetlands:** none	
Mghab050 **Habitat:** Rocky Outcrops **Landform:** hill **Vegetation:** Occasional Fig, open Acacia and Hakea shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** rocky outcropping and stony surfaces. **Important elements:** small rock crevices, leaf litter. **Wetlands:** none	
Mghab051 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** large spinifex clumps. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab052 **Habitat:** Major River **Landform:** drainage valley **Vegetation:** Tall forest of Melaleuca and Eucalyptus over Typha. **Evidence of fire:** none **Disturbance:** cattle **Soil:** brown coarse sand **Rock:** surface river stones **Important elements:** permanent water, tree hollows, leaf litter. **Wetlands:** permament river pool, seasonal flows.	
Mghab053 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland and scattered Corymbia over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab054 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab055 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland and scattered Corymbia over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab056 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scatttered Corymbia, Hakea and Acacia over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, small tree hollows. **Wetlands:** none	
Mghab057 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia and Hakea over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab058 **Habitat:** Stony Hills **Landform:** low hill **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** drill pads **Soil:** fine red sand **Rock:** surface rocks and stones **Important elements:** small pebbles for Western Pebble-mound Mouse. **Wetlands:** none	
Mghab059 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** recently burnt (1-2 yrs) **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing **Wetlands:** none	
Mghab060 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia and Hakea over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab061 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia, Melaleuca and Hakea over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, seasonal nectar (Melaleuca) **Wetlands:** none	
Mghab062 **Habitat:** Sand Dune **Landform:** slope **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab063 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Patchy Acacia shrubland over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab064 **Habitat:** Stony Hills **Landform:** low rise **Vegetation:** Open Grevillea and Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sand **Rock:** none **Important elements:** seasonal nectar (Grevillea). **Wetlands:** none	
Mghab065 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Patchy Acacia shrubland and scattered Corymbia over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, small tree hollows, leaf litter. **Wetlands:** none	
Mghab066 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Patchy Acacia shrubland over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab067 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open tall Acacia shrubland and occasional Corymbia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab068 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open tall Acacia shrubland and occasional Corymbia over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** none noted **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab069 **Habitat:** Stony Hills **Landform:** gentle slope **Vegetation:** Scattered Acacia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** small pebbles for Western Pebble-mound Mouse. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab070 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Corymbia and Acacia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab071 **Habitat:** Sandplain Drainage **Landform:** depression **Vegetation:** Open eucalypt woodland over tussock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange clay **Rock:** none **Important elements:** tree hollows, claypan **Wetlands:** seasonally wet.	
Mghab072 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sandy-clay **Rock:** none **Important elements:** leaf litter, large spinifex clumps **Wetlands:** seasonally wet (?)	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab073 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** leaf litter **Wetlands:** none	
Mghab074 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia shrubland over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab075 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia shrubland over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, near recently burnt area. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab076 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia and Melaleuca shrubland over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, drilling **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, leaf litter. **Wetlands:** none	
Mghab077 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia, Hakea and Melaleuca over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, seasonal nectar (Melaleuca) **Wetlands:** none	
Mghab078 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia and Melaleuca over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, seasonal nectar (Melaleuca) **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab079 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Occasional Acacia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sandy-clay **Rock:** none **Important elements:** large spinifex clumps. **Wetlands:** seasonally wet (?)	
Mghab080 **Habitat:** Stony Hills **Landform:** low rise **Vegetation:** Patchy Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** surface pebbles and stones. **Important elements:** none noted. **Wetlands:** none	
Mghab081 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Scattered Acacia and Hakea over a mix of low Acacia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, near recently burnt area. **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab082 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Corymbia and scattered Acacia, Grevillea and Hakea over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, seasonal nectar (Grevillea). **Wetlands:** none	
Mghab083 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Scattered Acacia shrubland over a mix of low Acacaia shrubland and spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sandy-clay **Rock:** none **Important elements:** large spinifex hummocks. **Wetlands:** seasonlly wet	
Mghab084 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Patchy Corymbia and Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sandy-clay **Rock:** some surface gravel **Important elements:** large spinifex hummocks, termite mounds, small hollows **Wetlands:** seasonlly wet	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab085 **Habitat:** Major River **Landform:** drainage valley **Vegetation:** Open Eucalypt and Melaleuca woodland over sparse spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, cats **Soil:** caorse brown sand **Rock:** river stones and pebbles, some outcropping rock. **Important elements:** tree hollows, seasonal water **Wetlands:** seasonal water flow	
Mghab086 **Habitat:** Stony Hills **Landform:** slope **Vegetation:** Occasional Acacia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** none noted. **Soil:** fine red sand **Rock:** rocky outcropping, stones, pebbles. **Important elements:** rock crevices, pebbles for Western Pebble-mound Mouse. **Wetlands:** none	
Mghab087 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Corymbia, open Acacia and Melaleuca shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing, seasonal nectar (Melaleuca) **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab088 **Habitat:** Sandplain Drainage **Landform:** plain **Vegetation:** Scattered Acacia and Hakea over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** orange sandy-clay **Rock:** none **Important elements:** some large spinifex clumps **Wetlands:** seasonally wet	
Mghab089 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia shrubland with occasional Corymbia over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle, bore **Soil:** red sand **Rock:** none **Important elements:** small tree hollows. **Wetlands:** none	
Mghab090 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia and Hakea shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, grasses **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab091 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open Acacia, Melaleuca and Hakea shrubland over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab092 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Patchy mixed Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab093 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Occasional Corymbia and Acacia over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab094 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open mixed Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle, bore **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab095 **Habitat:** Spinifex sandplain **Landform:** plain **Vegetation:** Open mixed Acacia shrubland with occasional Melaleuca and Corymbia over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab096 **Habitat:** Stony Hills **Landform:** low rise **Vegetation:** Open Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** red sand **Rock:** outcropping rocks, stones **Important elements:** rock crevices **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab097 **Habitat:** Stony Hills **Landform:** low rise **Vegetation:** Open Acacia and Grevillea shrubland over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1 yr) **Disturbance:** cattle **Soil:** red sand **Rock:** stony outwash **Important elements:** seasonal nectar (Grevillea) **Wetlands:** none	
Mghab206 **Habitat:** Sandplain drainage **Landform:** plain **Vegetation:** Open mixed Acacia shrubland with occasional Melaleuca and Corymbia over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1yr) **Disturbance:** cattle **Soil:** red sand **Rock:** surface rocks and pebbles **Important elements:** sand for burrowing. **Wetlands:** none	
Mghab211 **Habitat:** Rocky Outcrop **Landform:** hill **Vegetation:** Sparse Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** none **Disturbance:** cattle **Soil:** brown silty sand **Rock:** outcropping rocks, rocky surface **Important elements:** rock crevices. **Wetlands:** none	

Appendix 3	
Habitat Assessment	**Photograph**
Mghab217 **Habitat:** Spinifex sandplain **Landform:** valley **Vegetation:** Open Melaleuca and Eucalypt woodland over sparse Acacia shrubland. **Evidence of fire:** none **Disturbance:** cattle, 4WD, people. **Soil:** coarse river sand **Rock:** rocky outcrops in riverbed. **Important elements:** waterhole, woody debris, rock crevices**, tree hollows.** **Wetlands:** seasonal waterhole, seasonally flooded	
Mghab230 **Habitat:** Sandplain drainage **Landform:** plain **Vegetation:** Open mixed Acacia shrubland over spinifex hummock grassland. **Evidence of fire:** recently burnt (<1yr) **Disturbance:** cattle **Soil:** red sand **Rock:** none **Important elements:** sand for burrowing. **Wetlands:** none	

Appendix 4. Amphibians potentially occurring in the Study Area.

Key to records:

- Regional = species recorded within 50km of the study area 2021 – 2022 (Western Wildlife unpublished data 2022).
- Wodgina Project = species recorded at the Wodgina Project 2009 – 2019 by Western Wildlife (2020), 360 Environmental (2018a), Stantec (2017), Outback Ecology (2012) and/or Outback Ecology (2009).
- Wodgina Pipeline = species recorded on the Wodgina Pipeline and Mine in 2018 (Stantec 2018b).
- Mt Dove Project = species recorded at the Mt Dove Project in 2010 (Outback Ecology 2011).
- FMG Stage A Rail = species recorded in the northern section of the FMG Stage A Rail in 2004 (Biota 2004).
- Hope Downs Rail = species recorded in the northern section of the Hope Downs Rail Corridor in 2001 (Biota 2002a, 2002b).

EPBC = modelled occurrence of species or species habitat in the area on the EPBC Protected Matters Search Tool.
DBCA = species recorded in the area on DBCA's Threatened and Priority Fauna Database (DBCA 2021).
Dandjoo = species recorded within 100km on the Dandjoo Database (DBCA 2023)
ALA = species recorded within 20km on ALA Database (ALA 2022).

Species	Conservation Status	Recorded	Records									
			Surveys						Databases			
			Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Pelodraydidae (tree frogs and water-holding frogs)												
Giant Frog *Cyclorana australis*							+	+			+	+
Main's Frog *Cyclorana maini*		+	+	+		+	+	+			+	+
Desert Tree Frog *Litoria rubella*		+	+	+			+	+				+
Limnodynastidae (burrowing frogs)												
Centralian Burrowing Frog *Platyplectrum spenceri*		+	+				+	+			+	
Northern Burrowing Frog *Neobatrachus aquilonius*												+
Sudell's Frog *Neobatrachus sudellae*												+
Desert Spadefoot *Notaden nichollsi*		+	+	+			+	+			+	+
Myobatrachidae (ground frogs)												
Glandular Toadlet *Uperoleia glandulosa*		+	+									+
Pilbara Toadlet *Uperoleia saxatilis*		+	+	+			+	+			+	
Ratcheting Toadlet *Uperoleia talpa*												
Number of frog species predicted:		**10**										

Appendix 5. Reptiles potentially occurring in the Study Area.

Key to records:

- Regional = species recorded within 50km of the study area 2021 – 2022 (Western Wildlife unpublished data 2022).
- Wodgina Project = species recorded at the Wodgina Project 2009 – 2019 by Western Wildlife (2020), 360 Environmental (2018a), Stantec (2017), Outback Ecology (2012) and/or Outback Ecology (2009).
- Wodgina Pipeline = species recorded on the Wodgina Pipeline and Mine in 2018 (Stantec 2018b).
- Mt Dove Project = species recorded at the Mt Dove Project in 2010 (Outback Ecology 2011).
- FMG Stage A Rail = species recorded in the northern section of the FMG Stage A Rail in 2004 (Biota 2004).
- Hope Downs Rail = species recorded in the northern section of the Hope Downs Rail Corridor (Biota 2002a, 2002b).

EPBC = modelled occurrence of species or species habitat in the area on the EPBC Protected Matters Search Tool.
DBCA = species recorded in the area on DBCA's Threatened and Priority Fauna Database (DBCA 2021).
Dandjoo = species recorded within 100km on the Dandjoo Database (DBCA 2023)
ALA = species recorded within 20km on ALA Database (ALA 2022).

Species		Conservation Status	Recorded	Records									
				Survey						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Cheloniidae													
Flat-shelled Turtle	*Chelodina steindachneri*							+					
Carphodactylidae (knob-tailed geckoes)													
Smooth Knob-tailed Gecko	*Nephrurus levis*		+		+			+					
Diplodactylidae (ground geckoes)													
Clawless Gecko	*Crenadactylus pilbarensis*												
Western Fat-tailed Gecko	*Diplodactylus bilybara*				+								
Northern Pilbara Beak-faced Gecko	*Diplodactylus galaxias*				+								
Desert Fat-tailed Gecko	*Diplodactylus laevis*		+	+	?		?	?	?			?	?
Southern Pilbara Beak-faced Gecko	*Diplodactylus savagei*				+							+	+
	Lucasium stenodactylum		+	+	+		+	+	+				+
	Lucasium wombeyi				+			+					
Western Marbled Velvet Gecko	*Oedura fimbria*				+		+						
Beaked Gecko	*Rhynchoedura ornata*		+		+		+						+
Northern Spiny-tailed Gecko	*Strophurus ciliaris*		+						+				+
Jewelled Gecko	*Strophurus elderi*				+			+	+			+	
	Strophurus jeanae							+					+
Gekkonidae (geckoes)													
Robust Termitaria Gecko	*Gehyra kimberleyi*				+								
Large Pilbara Rock Gehyra	*Gehyra macra*		+										
Medium Pilbara Spotted Rock Gehyra	*Gehyra media*		+										
Small Pilbara Spotted Rock Gehyra	*Gehyra micra*		+	+									
	Gehyra montium		+	+									
Pilbara Dtella	*Gehyra pilbara*				+		+						
Spotted Dtella	*Gehyra punctata*				+				+			+	+
Purplish Dtella	*Gehyra purpurascens*						+	+					
Variegated Dtella	*Gehyra variegata*				+		+	+	+				+

Appendix 5. (cont.)

Species		Conservation Status	Recorded	Records									
				Survey						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Gekkonidae (cont.)													
Bynoe's Gecko	*Heteronotia binoei*		+		+		+	+	+				+
Pilbara Cave Gecko	*Heteronotia spelea*				+								+
Asian House Gecko	*Hemidactylus frenatus*	Int.											+
Pygopodidae (legless lizards)													
	Delma butleri		+	+	+							+	+
	Delma elegans												
	Delma nasuta				+			+	+				
	Delma pax		+	+	+			+	+			+	+
	Delma tincta			+	+			+	+			+	+
Burton's Legless Lizard	*Lialis burtonis*		+	+	+		+	+	+			+	+
Hooded Scaly-foot	*Pygopus nigriceps*		+	+					+			+	+
Agamidae (dragon lizards)													
Western Ring-tailed Dragon	*Ctenophorus caudicinctus*		+	+	+	+	+	+	+				+
Military Dragon	*Ctenophorus isolepis*		+	+	+	+	+	+	+			+	+
Central Netted Dragon	*Ctenophorus nuchalis*		+	+			+		+			+	+
Western Netted Dragon	*Ctenophorus reticulatus*												+
Pindan Dragon	*Diporiphora pindan*		+	+									
Northern Pilbara Tree Dragon	*Diporiphora vescus*				?		?		?				
Long-nosed Dragon	*Gowidon longirostris*		+	+	+			+	+				+
Bearded Dragon	*Pogona minor*		+	+	+		+		+			+	+
Fortescue Pebble Dragon	*Tympanocryptis fortescuensis*							+					+
Scincidae (skink lizards)													
	Carlia munda		+	+	+		+	+	+				+
	Carlia triacantha		+	+	+		+	+	+			+	
	Cryptoblepharus buchananii												
	Cryptoblepharus ustulatus												
	Ctenotus duricola			+	+		+	+	+			+	
	Ctenotus grandis		+	+	+		+	+	+			+	+
Nimble Ctenotus	*Ctenotus hanloni*		+		+								
	Ctenotus helenae		+	+	+		+	+	+				+
	Ctenotus leonhardii				+								
Pin-striped Finesnout Ctenotus	*Ctenotus nigrilineatus*	P											
	Ctenotus pallasotus		+	+									
Leopard Ctenotus	*Ctenotus pantherinus*		+	+	+		+	+	+			+	+
	Ctenotus piankai											+	+
Fourteen-lined Ctenotus	*Ctenotus quattuordecimlineatus*		+	+									

Appendix 5. (cont.)

Species		Conservation Status	Recorded	Records									
				Survey						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Scincidae (cont.)													
	Ctenotus rubicundus				+			+				+	
Rufous Finesnout Ctenotus	*Ctenotus rufescens*		+	+								+	
Rock Ctenotus	*Ctenotus saxatilis*		+	+	+		+	+	+				+
	Ctenotus schomburgkii		+	+				+					
	Ctenotus serventyi											+	+
Sharp-browed Ctenotus	*Ctenotus superciliaris*												
Slender Blue-tongue	*Cyclodomorphus melanops*			+	+			+	+				
Eastern Pilbara Spiny-tailed Skink	*Egernia epsisolus*		+	+	+				+				+
	Egernia formosa												
Pilbara Skink	*Egernia pilbarensis*				+								
Mosaic Desert Skink	*Eremiascincus musivus*											+	
Western Narrow-banded Skink	*Eremiascincus pallidus*		+	+	+								+
Broad-banded Sand Swimmer	*Eremiascincus richardsonii*								+			+	
	Lerista bipes		+	+	+		+	+	+			+	+
	Lerista clara		+	+									
	Lerista jacksoni				+							+	
	Lerista muelleri				+			+	+			+	
	Lerista verhmens											+	
Night Skink	*Liopholis striata*						+						
Dwarf Skink	*Menetia greyii*		+	+	+			+	+			+	+
	Menetia surda				+								
	Morethia ruficauda		+	+	+	+	+	+	+			+	+
	Notoscincus ornatus							+					
	Proablepharus reginae			+				+	+			+	
Central Blue-tongue	*Tiliqua multifasciata*		+	+	+			+	+			+	
Varanidae (goanna or monitor lizards)													
Spiny-tailed Goanna	*Varanus acanthurus*		+	+	+			+	+			+	+
Short-tailed Pygmy Goanna	*Varanus brevicauda*		+	+	+			+	+			+	
Bush's Monitor	*Varanus bushi*		+	+								+	
Pygmy Desert Goanna	*Varanus eremius*		+	+	+		+	+	+			+	
Perentie	*Varanus giganteus*		+	+	+	+			+				
Pygmy Mulga Monitor	*Varanus gilleni*												+
Gould's Monitor	*Varanus gouldii*		+	+	+		+	+	+			+	+
	Varanus panoptes		+	+	+			+				+	+
Northern Pilbara Rock Monitor	*Varanus pilbarensis*			+	+							+	
Black-tailed Monitor	*Varanus tristis*		+	+									

Appendix 5. (cont.)

Species		Conservation Status	Recorded	Records									
				Survey						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Typhlopidae (blind snakes)													
	Anilios ammodytes		+	+	+		+	+				+	
Gane's Blind Snake	*Anilios ganei*	P									+		
Beaked Blind Snake	*Anilios grypus*			+	+			+				+	
	Anilios hamatus		+	+									
Pilbara Blind Snake	*Anilios pilbarensis*			+	+		+						
Boidae (pythons)													
Pygmy Python	*Antaresia perthensis*				+			+	+			+	
Stimson's Python	*Antaresia stimsoni*			+	+			+	+				+
Black-headed Python	*Aspidites melanocephalus*			+	+			+				+	
Woma	*Aspidites ramsayi*		+	+								+	
Pilbara Olive Python	*Liasis olivaceus barroni*	T								+	+		
Elapidae (front-fanged snakes)													
Desert Death Adder	*Acanthophis pyrrhus*												+
Pilbara Death Adder	*Acanthophis wellsi*												
Northwestern Shovel-nosed Snake	*Brachyurophis approximans*				+			+					+
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolatus*				+								
Yellow-faced Whipsnake	*Demansia psammophis*		+	+	+			+	+				+
Rufous Whipsnake	*Demansia rufescens*		+	+	+			+				+	
Moon Snake	*Furina ornata*		+	+	+		+	+				+	
Mulga Snake	*Pseudechis australis*		+	+	+			+	+			+	+
Ringed Brown Snake	*Pseudonaja modesta*		+	+			+						
Gwardar	*Pseudonaja mengdeni*		+	+	+				+			+	
Desert Banded Snake	*Simoselaps anomalus*		+	+					+			+	+
Rosen's Snake	*Suta fasciata*				+			+					
Spotted Snake	*Suta punctata*			+				+	+			+	+
Pilbara Bandy-bandy	*Vermicella snelli*												
# reptile species predicted:				**115 (114 native, 1 introduced)**									

Appendix 6. Birds potentially occurring in the Study Area.

Key to records:

- Regional = species recorded within 50km of the study area 2021 – 2022 (Western Wildlife unpublished data 2022).
- Wodgina Project = species recorded at the Wodgina Project 2009 – 2019 by Western Wildlife (2020), 360 Environmental (2018a), Stantec (2017), Outback Ecology (2012) and/or Outback Ecology (2009).
- Wodgina Pipeline = species recorded on the Wodgina Pipeline and Mine in 2018 (Stantec 2018b).
- Mt Dove Project = species recorded at the Mt Dove Project in 2010 (Outback Ecology 2011).
- FMG Stage A Rail = species recorded in the northern section of the FMG Stage A Rail in 2004 (Biota 2004).
- Hope Downs Rail = species recorded in the northern section of the Hope Downs Rail Corridor (Biota 2002a, 2002b).

EPBC = modelled occurrence of species or species habitat in the area on the EPBC Protected Matters Search Tool.
DBCA = species recorded in the area on DBCA's Threatened and Priority Fauna Database (DBCA 2021).
Dandjoo = species recorded within 100km on the Dandjoo Database (DBCA 2023)
ALA = species recorded within 20km on ALA Database (ALA 2022).

Species		Conservation Status	Recorded	Records									
				Surveys						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Dromaiidae (emus)													
Emu	*Dromaius novaehollandiae*		+	+			+	+	+			+	+
Anatidae (ducks & swans)													
Grey Teal	*Anas gracilis*		+	+	+							+	+
Pacific Black Duck	*Anas superciliosus*		+	+	+			+	+			+	+
Hardhead	*Aythya australis*				+								+
Australian Wood Duck	*Chenonetta jubata*											+	+
Black Swan	*Cygnus atratus*												+
Pink-eared Duck	*Malacorhynchus membranaceus*												+
Australasian Shoveler	*Spatula rhynchotis*												+
Phasianidae (quails)													
Stubble Quail	*Coturnix pectoralis*							+					
Brown Quail	*Synoicus ypsilophora*		+	+			+					+	+
Podicipedidae (grebes)													
Hoary-headed Grebe	*Poliocephalus poliocephalus*											+	+
Australasian Grebe	*Tachybaptus novaehollandiae*			+	+				+			+	+
Ciconiidae (storks)													
Black-necked Stork	*Ephippiorhynchus asiaticus*		+	+	+			+	+			+	+
Threskiornithidae (ibis & spoonbills)													
Yellow-billed Spoonbill	*Platalea flavipes*												+
Royal Spoonbill	*Platalea regis*												+
Glossy Ibis	*Plegadis falcinellus*	Mi									+		+
Australian White Ibis	*Threskiornis moluccus*								+				+
Straw-necked Ibis	*Threskiornis spinicollis*		+	+					+			+	+

Appendix 6. (cont.)

Species		Conservation Status	Recorded	Records									
				Surveys						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Ardeidae (herons, egrets, bitterns & night-herons)													
Little Egret	*Ardea garzetta*								+				+
Eastern Great Egret	*Ardea modesta*		+	+					+				+
White-faced Heron	*Egretta novaehollandiae*		+	+				+					+
Cattle Egret	*Ardea ibis*												+
White-necked Heron	*Ardea pacifica*				+	+			+			+	+
Rufous Night-heron	*Nycticorax caledonicus*		+						+				+
Pelecanidae (pelicans)													
Australian Pelican	*Pelecanus conspicillatus*		+	+					+				+
Phalacrocoracidae (cormorants)													
Great Cormorant	*Phalacrocorax carbo*			+									+
Little Black Cormorant	*Phalacrocorax sulcirostris*		+	+					+			+	+
Pied Cormorant	*Phalacrocorax varius*								+				+
Little Pied Cormorant	*Microcarbo melanoleucos*		+	+					+				+
Anhingidae (darter)													
Australasian Darter	*Anhinga novaehollandiae*		+	+				+	+				+
Accipitridae (osprey, hawks, eagles & harriers)													
Black-shouldered Kite	*Elanus axillaris*				+			+	+				+
Square-tailed Kite	*Lophoictinia isura*							+					+
Black-breasted Buzzard	*Hamirostra melanosternon*					+		+	+				
Black Kite	*Milvus migrans*		+	+	+	+		+	+			+	+
Brahminy Kite	*Halliastur indus*								+			+	+
Whistling Kite	*Haliastur sphenurus*		+	+	+	+	+	+	+			+	+
White-bellied Sea-eagle	*Haliaeetus leucogaster*												+
Brown Goshawk	*Accipiter fasciatus*		+	+	+			+	+			+	+
Collared Sparrowhawk	*Accipiter cirrocephalus*		+	+				+					+
Little Eagle	*Hieraaetus morphnoides*		+	+				+	+				+
Wedge-tailed Eagle	*Aquila audax*		+	+	+	+	+	+	+			+	+
Eastern Osprey	*Pandion cristatus*	Mi								+	+		+
Swamp Harrier	*Circus approximans*							+					+
Spotted Harrier	*Circus assimilis*		+	+	+			+	+			+	+
Otididae (bustard)													
Australian Bustard	*Ardeotis australis*		+	+	+		+	+	+			+	+

Appendix 6. (cont.)

Species	Conservation Status	Recorded	Records									
			Surveys						Database			
			Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Rallidae (crakes, rails and gallinules)												
Eurasian Coot *Fulica atra*				+								+
Buff-banded Rail *Gallirallus philippensis*												+
Purple Swamp Hen *Porphyrio porphyrio*				+								
Spotless Crake *Porzana tabuensis*												
Black-tailed Native-hen *Tribonyx ventralis*												+
Turnicidae (button-quails)												
Little Button-Quail *Turnix velox*		+	+	+	+		+	+			+	+
Burhinidae (stone-curlews)												
Bush Stone-Curlew *Burhinus grallarius*		+	+	+			+	+			+	+
Recurvirostridae (stilts & avocets)												
Black-winged Stilt *Himantopus himantopus*			+				+	+			+	+
Red-necked Avocet *Recurvirostra novaehollandiae*												+
Charadriidae (plovers, dotterels & lapwings)												
Oriental Plover *Charadrius veredus*	Mi		+						+	+		
Black-fronted Dotterel *Elseyornis melanops*		+	+	+			+	+			+	+
Red-kneed Dotterel *Erythrogonys cinctus*											+	+
Masked Lapwing *Vanellus miles*												+
Banded Lapwing *Vanellus tricolor*		+	+									
Scolopacidae (sandpipers, tattlers, godwits & allies)												
Common Sandpiper *Actitis hypoleucos*	Mi			+				+	+	+		+
Sharp-tailed Sandpiper *Calidris acuminata*	T								+	+		+
Pectoral Sandpiper *Calidris melanotos*	Mi								+	+		
Red-necked Stint *Calidris ruficollis*	Mi									+		+
Wood Sandpiper *Tringa glareola*	Mi			+						+		+
Common Greenshank *Tringa nebularia*	T		+							+		+
Marsh Sandpiper *Tringa stagnatilis*	Mi									+		+
Glareolidae (pratincoles)												
Oriental Pratincole *Glareola maldivarum*	Mi								+	+		+
Australian Pratincole *Stiltia isabella*			+									+
Laridae (noddies, gulls & terns)												
Silver Gull *Chroicocephalus novaehollandiae*								+			+	+
Gull-billed Tern *Gelochelidon nilotica*	Mi							+		+	+	+
Caspian Tern *Hydropgrogne caspia*	Mi							+		+		+
Whiskered Tern *Sterna hybrida*												+

Appendix 6. (cont.)

Species		Conservation Status	Recorded	Records									
				Surveys						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Columbidae (pigeons and doves)													
Common Bronzewing	*Phaps chalcoptera*		+	+	+		+		+			+	+
Flock Bronzewing	*Phaps histrionica*											+	+
Crested Pigeon	*Ocyphaps lophotes*		+	+	+	+	+	+	+			+	+
Spinifex Pigeon	*Geophaps plumifera*		+	+	+	+	+	+	+			+	+
Diamond Dove	*Geopelia cuneata*		+	+	+	+		+	+			+	+
Bar-shouldered Dove	*Geopelia humeralis*		+	+					+				+
Peaceful Dove	*Geopelia striata*		+	+	+				+			+	+
Cuculidae (cuckoos)													
Pheasant-Coucal	*Centropus phasianinus*		+	+					+				+
Pallid Cuckoo	*Cacomantis pallidus*		+		+			+	+				+
Black-eared Cuckoo	*Chalcites osculans*		+	+					+				+
Horsfield's Bronze-Cuckoo	*Chalcites basalis*		+	+	+		+	+	+			+	+
Tytonidae (barn owls)													
Eastern Barn Owl	*Tyto javanica*			+									+
Strigidae (hawk owls)													
Barking Owl	*Ninox connivens*		+	+									+
Southern Boobook	*Ninox boobook*		+	+		+	+	+	+				+
Podargidae (frogmouths)													
Tawny Frogmouth	*Podargus strigoides*				+			+	+				+
Caprimulgidae (nightjars)													
Spotted Nightjar	*Eurostopodus argus*		+	+	+	+	+	+	+			+	+
Aegothelidae (owlet-nightjars)													
Australian Owlet-Nightjar	*Aegotheles cristatus*		+	+	+			+	+				
Apodidae (swifts)													
Fork-tailed Swift	*Apus pacificus*	Mi	+	+				+	+	+	+		+
Alcedinidae (kingfishers)													
Blue-winged Kookaburra	*Dacelo leachii*		+	+	+	+		+	+			+	+
Red-backed Kingfisher	*Todiramphus pyrrhopygius*		+	+	+	+	+	+	+			+	+
Sacred Kingfisher	*Todiramphus sanctus*		+	+	+			+	+			+	+
Meropidae (bee-eaters)													
Rainbow Bee-eater	*Merops ornatus*		+	+	+	+	+	+	+			+	+

Appendix 6. (cont.)

Species		Conservation Status	Recorded	Records									
				Surveys						Database			
				Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Falconidae (falcons)													
Brown Falcon	*Falco berigora*		+	+	+		+	+	+			+	+
Nankeen Kestrel	*Falco cenchroides*		+	+	+	+	+	+	+			+	+
Australian Hobby	*Falco longipennis*		+	+	+			+	+				+
Grey Falcon	*Falco hypoleucos*	T						+		+	+		+
Peregrine Falcon	*Falco peregrinus*	OS						+	+		+		+
Black Falcon	*Falco subniger*				+								+
Cacatuidae (cockatoos)													
Galah	*Eolophus roseicapilla*		+	+	+	+	+	+	+			+	+
Little Corella	*Cacatua sanguinea*		+	+	+	+	+	+	+			+	
Cockatiel	*Nymphicus hollandicus*		+	+	+			+	+			+	+
Psittacidae (parrots, lorikeets and rosellas)													
Australian Ringneck	*Barnardius zonarius*		+	+	+		+	+	+			+	+
Budgerigar	*Melopsittacus undulatus*		+	+	+	+		+	+			+	+
Night Parrot	*Pezoporus occidentalis*	T								+			
Ptilonorhynchidae (bowerbirds)													
Western Bowerbird	*Chlamydera guttata*		+	+	+		+		+				+
Climacteridae (treecreepers)													
Black-tailed Treecreeper	*Climacteris melanurus*												+
Maluridae (fairy-wrens, grasswrens and emu-wrens)													
Striated Grasswren	*Amytornis striatus*			+	+			+				+	
Purple-backed Fairy-wren	*Malurus assimilis*		+	+	+		+	+	+			+	+
White-winged Fairy-wren	*Malurus leucopterus*		+	+	+		+	+	+			+	+
Rufous-crowned Emu-wren	*Stipiturus ruficeps*	LS	+	+					+				+
Meliphagidae (honeyeaters and chats)													
Brown Honeyeater	*Lichmera indistincta*		+	+	+	+		+	+			+	+
Black Honeyeater	*Sugomel niger*				+			+	+				+
Pied Honeyeater	*Certhionyx variegatus*				+			+					+
Singing Honeyeater	*Gavicalis virescens*		+	+	+	+	+	+	+			+	+
Grey Honeyeater	*Lacustroica whitei*				+								
Grey-headed Honeyeater	*Ptilotula keartlandi*		+	+	+	+		+	+			+	+
White-plumed Honeyeater	*Ptilotula penicillata*		+	+	+	+	+	+	+			+	+
Grey-fronted Honeyeater	*Ptilotula plumulus*				+		+						
Black-chinned Honeyeater	*Melithreptus gularis*			+				+					+
White-fronted Honeyeater	*Purnella albifrons*												
Yellow-throated Miner	*Manorina flavigula*		+	+	+	+	+	+	+			+	+
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*			+	+			+	+				
Crimson Chat	*Epthianura tricolor*		+	+	+		+	+	+				+

Appendix 6. (cont.)

Species	Conservation Status	Recorded	Records									
			Surveys						Database			
			Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Pardalotidae (pardalotes)												
Red-browed Pardalote *Pardalotus rubricatus*		+	+	+			+	+			+	+
Striated Pardalote *Pardalotus striatus*				+			+					+
Acanthizidae (thornbills, gerygones & allies)												
Weebill *Smicrornis brevirostris*			+				+	+				+
Western Gerygone *Gerygone fusca*				+								+
Pomatostomidae (babblers)												
White-browed Babbler *Pomatostomus superciliosus*		+	+				+					
Grey-crowned Babbler *Pomatostomus temporalis*		+	+	+	+			+				+
Artamidae (woodswallows)												
White-breasted Woodswallow *Artamus leucorynchus*											+	+
Masked Woodswallow *Artamus personatus*		+	+				+				+	+
Black-faced Woodswallow *Artamus cinereus*		+	+	+	+	+	+	+			+	+
Little Woodswallow *Artamus minor*			+	+				+			+	+
Cracticidae (butcherbirds & magpie)												
Grey Butcherbird *Cracticus torquatus*				+		+	+	+				
Pied Butcherbird *Cracticus nigrogularis*		+	+	+		+	+	+			+	+
Australian Magpie *Gymnorhina tibicen*		+	+	+			+	+			+	+
Neosittidae (sittellas)												
Varied Sittella *Daphoenositta chrysoptera*							+					
Campephagidae (cuckoo-shrikes and trillers)												
Ground Cuckoo-shrike *Coracina maxima*												
Black-faced Cuckoo-Shrike *Coracina novaehollandiae*		+	+	+	+	+	+	+			+	+
White-winged Triller *Lalage tricolor*		+	+	+			+	+			+	+
Oreoicidae (bellbirds)												
Crested Bellbird *Oreoica gutturalis*		+	+	+		+	+	+				+
Pachycephalidae (shrike-tits, whistlers and allies)												
Rufous Whistler *Pachycephala rufiventris*		+	+	+		+	+	+			+	+
Grey Shrike-thrush *Colluricincla harmonica*		+	+	+			+				+	+
Rhipiduridae (fantails)												
Grey Fantail *Rhipidura albiscapa*												+
Willie Wagtail *Rhipidura leucophrys*		+	+	+	+	+	+	+			+	+
Monarchidae (flycatchers, monarchs and magpie-lark)												
Magpie-lark *Grallina cyanoleuca*		+	+	+	+	+	+	+			+	+
Corvidae (ravens and crows)												
Torresian Crow *Corvus orru*		+	+	+	+	+	+	+			+	+
Little Crow *Corvus bennetti*		+		+				+			+	+

Appendix 6. (cont.)

Species	Conservation Status	Recorded	Records									
			Surveys						Database			
			Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Petroicidae (robins)												
Red-capped Robin *Petroica goodenovii*							+	+				+
Hooded Robin *Melanodryas cucullata*							+					+
Alaudidae (larks)												
Horsfield's Bushlark *Mirafra javanica*		+	+				+	+			+	+
Hirundinidae (swallows and martins)												
White-backed Swallow *Cheramoeca leucosterna*												+
Welcome Swallow *Hirundo neoxena*				+								+
Tree Martin *Petrochelidon nigricans*		+	+	+			+	+				+
Fairy Martin *Petrochelidon ariel*		+	+	+			+	+				+
Acrocephalidae (reed warblers)												
Australian Reed Warbler *Acrocephalus australis*		+	+	+				+				+
Locustellidae (warblers, songlarks and grassbirds)												
Spinifexbird *Poodytes carteri*		+	+	+	+	+	+	+			+	+
Rufous Songlark *Cincloramphus mathewsi*		+	+	+	+		+	+				+
Brown Songlark *Cincloramphus cruralis*			+	+		+	+	+			+	+
Dicaeidae (flowerpeckers)												
Mistletoebird *Dicaeum hirundinaceum*							+	+			+	+
Estrildidae (grassfinches, sparrows and allies)												
Zebra Finch *Taeniopygia castanotis*		+	+	+	+	+	+	+			+	+
Star Finch *Neochmia ruficauda*		+	+	+								+
Painted Finch *Emblema pictum*		+	+	+	+	+	+	+			+	+
Motacillidae (pipits and wagtails)												
Australian Pipit *Anthus australis*		+	+	+		+	+	+			+	+
# bird species predicted:		**166**										

Appendix 7. Mammals potentially occurring in the Study Area.

Key to records:

- Regional = species recorded within 50km of the study area 2021 – 2022 (Western Wildlife unpublished data 2022).
- Wodgina Project = species recorded at the Wodgina Project 2009 – 2019 by Western Wildlife (2020), 360 Environmental (2018a), Stantec (2017), Outback Ecology (2012) and/or Outback Ecology (2009).
- Wodgina Pipeline = species recorded on the Wodgina Pipeline and Mine in 2018 (Stantec 2018b).
- Mt Dove Project = species recorded at the Mt Dove Project in 2010 (Outback Ecology 2011).
- FMG Stage A Rail = species recorded in the northern section of the FMG Stage A Rail in 2004 (Biota 2004).
- Hope Downs Rail = species recorded in the northern section of the Hope Downs Rail Corridor (Biota 2002a, 2002b).

EPBC = modelled occurrence of species or species habitat in the area on the EPBC Protected Matters Search Tool.
DBCA = species recorded in the area on DBCA's Threatened and Priority Fauna Database (DBCA 2021).
Dandjoo = species recorded within 100km on the Dandjoo Database (DBCA 2023)
ALA = species recorded within 20km on ALA Database (ALA 2022).

Species	Conservation Status	Recorded	Records									
			Other Survey						Database			
			Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Tachyglossidae (echidnas)												
Echidna *Tachyglossus aculeatus*		+	+	+	+	+	+	+				
Dasyuridae (dasyurid marsupials)												
Brush-tailed Mulgara *Dasycercus blythi*	P	+	+				+	+		+		+
Little Red Kaluta *Dasykaluta rosamondae*		+	+	+	+	+	+	+			+	+
Northern Quoll *Dasyurus hallucatus*	T	+	+	+	+	+	+	+	+	+		+
Woolley's Pseudantechinus *Pseudantechinus woolleyae*				+				+			+	
Pilbara Ningaui *Ningaui timealeyi*		+	+	+			+	+			+	+
Common Planigale *Planigale maculata*												
Pilbara Planigale *Planigale sp 1*		+	+	+		+	+	+				
Long-tailed Dunnart *Sminthopsis longicaudata*	P			+						+		
Striped-faced Dunnart *Sminthopsis macroura*			+		+	+	+	+			+	+
Ooldea Dunnart *Sminthopsis ooldea*												
Lesser Hairy-footed Dunnart *Sminthopsis youngsoni*		+	+				+	+			+	+
Thylacomyidae (bilbies)												
Bilby *Macrotis lagotis*	T	+	+					+	+	+		
Macropodidae (kangaroos and wallabies)												
Spectacled Hare-Wallaby *Lagorchestes conspicillatus*	P				+					+		+
Euro *Osphranter robustus*		+	+	+	+	+	+	+				+
Red Kangaroo *Osphranter rufus*		+	+			+		+				+
Rothschild's Rock-Wallaby *Petrogale rothschildi*			+	+	+		+	+			+	
Muridae (rats and mice)												
Lakeland Downs Mouse *Leggadina lakedownensis*	P						+	+				
House Mouse *Mus musculus*	Int.	+	+	+			+	+			+	
Spinifex Hopping Mouse *Notomys alexis*		+	+	+	+	+		+			+	+

Appendix 7. (cont.)

Species	Conservation Status	Recorded	Records									
			Other Survey						Database			
			Regional	Wodgina Project	Wodgina Pipeline	Mt Dove Project	FMG Stage A Rail	Hope Downs Rail	EPBC	DBCA	Dandjoo	ALA
Muridae (cont.)												
Western Pebble-mound Mouse *Pseudomys chapmani*	P	+	+	+	+	+				+		+
Delicate Mouse *Pseudomys delicatulus*							+	+			+	+
Desert Mouse *Pseudomys desertor*		+	+	+			+	+			+	+
Sandy Inland Mouse *Pseudomys hermannsburgensis*		+	+	+		+	+	+			+	+
Common Rock-rat *Zyzomys argurus*			+	+	+		+	+			+	+
Rhinonycteridae (orange leaf-nosed bats)												
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Pilbara)	T	+	+	+	+	+			+	+		
Megadermatidae (ghost bat)												
Ghost Bat *Macroderma gigas*	T		+	+	+	+		+	+	+		+
Emballonuridae (sheathtail bats)												
Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*		+	+	+		+					+	
Common Sheathtail Bat *Taphozous georgianus*		+	+	+	+	+		+				+
Molossidae (freetail bats)												
Greater Northern Freetail Bat *Chaerephon jobensis*		+	+	+				+				
Northern Coastal Free-tailed Bat *Ozimops cobourgiana*	P	+	+									
Northern Freetail Bat *Ozimops lumsdenae*												
White-striped Freetail Bat *Austronomus australis*				+	+			+				
Vespertilionidae (ordinary bats)												
Gould's Wattled Bat *Chalinolobus gouldii*		+	+	+	+	+	+	+			+	
Lesser Long-eared Bat *Nyctophilus geoffroyi*												
Little Broad-nosed Bat *Scotorepens greyii*		+	+	+	+	+	+	+			+	
Finlayson's Cave Bat *Vespadelus finlaysoni*		+	+	+	+	+		+			+	+
Canidae (dogs and foxes)												
Dog / Dingo *Canis familiaris*	Int.	+	+	+	+	+	+	+				+
Fox *Vulpes vulpes*	Int.	+	+		+	+						
Felidae (cats)												
Feral / House Cat *Felis catus*	Int.	+	+	+	+	+	+	+			+	
Equidae (horses)												
Donkey *Equus asinus*	Int.					+	+	+				
Horse *Equus caballus*	Int.			+								
Camelidae (camels)												
Camel *Camelus dromedarius*	Int.	+	+			+	+					
Bovidae (horned ruminants)												
Cow *Bos taurus*	Int.	+	+	+	+	+						
Number of Mammals Predicted:			**44 (36 native, 8 introduced)**									

Appendix 8. EPBC Protected Matters Search Tool results.

Species listed for the study area with a 5km buffer.

Species	EPBC Act Status	Type of Presence
Calidris ferruginea **Curlew Sandpiper**	Critically Endangered, Migratory	Species or species habitat **MAY** occur within area
Numenius madagascariensis **Eastern Curlew**	Critically Endangered, Migratory	Species or species habitat **MAY** occur within area
Pezoporus occidentalis **Night Parrot**	Endangered	Species or species habitat **MAY** occur within area
Dasyurus hallucatus **Northern Quoll**	Endangered	Species or species habitat **KNOWN** to occur within area
Rostratula australis **Australian Painted Snipe**	Endangered	Species or species habitat **MAY** occur within area
Macrotis lagotis **Bilby**	Vulnerable	Species or species habitat **KNOWN** to occur within area
Rhinonicteris aurantia **Pilbara Leaf-nosed Bat**	Vulnerable	Species or species habitat **KNOWN** to occur within area
Macroderma gigas **Ghost Bat**	Vulnerable	Species or species habitat **KNOWN** to occur within area
Liasis olivaceus barroni **Pilbara Olive Python**	Vulnerable	Species or species habitat **LIKELY** to occur within area
Falco hypoleucos **Grey Falcon**	Vulnerable	Species or species habitat **LIKELY** to occur within area
Charadrius veredus **Oriental Plover**	Migratory	Species or species habitat **MAY** occur within area
Actitis hypoleucos **Common Sandpiper**	Migratory	Species or species habitat **KNOWN** to occur within area
Calidris acuminata **Sharp-tailed Sandpiper**	Vulnerable, Migratory	Species or species habitat **MAY** occur within area
Calidris melanotos **Pectoral Sandpiper**	Migratory	Species or species habitat **MAY** occur within area
Pandion cristatus **Eastern Osprey**	Migratory	Species or species habitat **LIKELY** to occur within area
Apus pacificus **Fork-tailed Swift**	Migratory	Species or species habitat **LIKELY** to occur within area
Glareola maldivarum **Oriental Pratincole**	Migratory	Species or species habitat **MAY** occur within area
Hirundo rustica **Barn Swallow**	Migratory	Species or species habitat **MAY** occur within area
Motacilla cinerea **Grey Wagtail**	Migratory	Species or species habitat **MAY** occur within area
Motacilla flava **Yellow Wagtail**	Migratory	Species or species habitat **MAY** occur within area

Appendix 9. Excluded Fauna

Fauna recorded on the DBCA's Threatened and Priority Fauna Database (Figure 9, DBCA 2021) or the EPBC Act Protected Matters Search Tool (Appendix 8) but excluded from the lists in Appendices 4 – 7.

Species	Status		Database		Reason for Exclusion
	EPBC Act	BC Act	DBCA	EPBC	
Australian Painted Snipe (*Rostratula australis*)	En	En		+	Vagrant to the region.
Bar-tailed Godwit (*Limosa lapponica*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Barn Swallow (*Hirundo rustica*)	Mi	Mi		+	Vagrant to the region.
Black-tailed Godwit (*Limosa limosa*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Bridled Tern (*Onychoprion anaethetus*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.
Common Tern (*Sterna hirundo*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.
Crested Tern (*Thalasseus bergii*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.
Curlew Sandpiper (*Calidris ferruginea*)	Cr, Mi	Cr, Mi	+	+	Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Eastern Curlew (*Numenius madagascariensis*)	Cr, Mi	Cr, Mi	+	+	Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Flatback Turtle (*Natator depressus*)	Mi	Mi	+		Marine turtle, does not use inland waters.
Great Knot (*Calidris tenuirostris*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Greater Sand Plover (*Charadrius leschenaultii*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Green Turtle (*Chelonia mydas*)	Mi	Mi	+		Marine turtle, does not use inland waters.
Grey Plover (*Pluvialis squatarola*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Grey Wagtail (*Motacilla cinera*)	Mi	Mi		+	Vagrant to the region.
Grey-tailed Tattler (*Tringa brevipes*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Lesser Frigatebird (*Fregata ariel*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.
Lesser Sand Plover (*Charadrius mongolus*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Little Curlew (*Numenius minutus*)	Mi	Mi	+		Shorebird that primarily uses short dry grasslands and the grassy edges of freshwater wetlands.
Little Tern (*Sternula albifrons*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.
Long-toed Stint (*Calidris subminuta*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Pacific Golden Plover (*Pluvialis fulva*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Red Knot (*Calidris canutus*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Roseate Tern (*Sterna dougallii*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.

Appendix 9. (cont.)

Species	Status		Database		Reason for Exclusion
	EPBC Act	BC Act	DBCA	EPBC	
Ruddy Turnstone (*Arenaria interpres*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Ruff/Reeve (*Philomachus pugnax*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Sanderling (*Calidris alba*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Terek Sandpiper (*Xenus cinereus*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
Wedge-tailed Shearwater (*Ardenna pacifica*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.
Whimbrel (*Numenius phaeopus*)	Mi	Mi	+		Shorebird that primarily uses coastal habitats (mudflats, mangroves, beaches)
White-winged Black Tern (*Chlidonius leucopterus*)	Mi	Mi	+		Seabird that forages and breeds on coasts and offshore islands.
Yellow Wagtail (*Motacilla flava*)	Mi	Mi		+	Vagrant to the region.

Appendix 10. Bat Call Analysis

Acoustic analysis and bat call identification from Mallina, Western Australia

Prepared for **Western Wildlife Pty Ltd**

Version **4 April 2022**

SZ project reference **SZ580**

Prepared by **Dr Kyle Armstrong and Yuki Konishi**

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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2022). Acoustic analysis and bat call identification from Mallina, Western Australia. Unpublished report by Specialised Zoological for Western Wildlife Pty Ltd, 4 April 2022, project reference SZ580.

Summary

Bat identifications from acoustic recordings are provided from Mallina, in the Pilbara region of Western Australia. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics. Particular attention was given to the detection of the Threatened-listed Ghost Bat *Macroderma gigas* (Megadermatidae) and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Rhinonycteridae).

Eight species of bat were identified unambiguously as being present (**Tables 1** and **2**), including the ghost bat and Pilbara leaf-nosed bat. Summaries of activity levels and times of detection are provided for these two species of conservation significance that are relevant to determining whether a diurnal roost might be present. Representative echolocation calls for each identification are illustrated (**Figure 1**), as recommended by the Australasian Bat Society (ABS 2006). Further details are available should verification be required.

Methods

The data provided were recorded in full spectrum WAV format with Titley Scientific Anabat Swift bat detectors (sampling rate 500 kHz, set to turn on automatically at sunset and off at sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong et al. 2021a,b) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (SCAN'R parameters) from each putative bat pulse. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language application that performed three tasks:

1. undertook a Discriminant Function Analysis on training data from representative calls in the Pilbara region;
2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over ellipses representing one standard deviation of the variation for the defined call types; and
3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition version 22.

Species were identified based on information in McKenzie and Bullen (2009) and the author's own unpublished material. Nomenclature follows Jackson and Groves (2015).

Species of conservation significance

A single echolocation call of the ghost bat was observed in WAV file 450083_2021-09-27_18-46-58.wav (at a mine adit). This time was 20 minutes after the end of civil twilight after sunset, which was around or a little after the usual emergence time of the species. This might indicate diurnal roosting of one individual in the mine adit at the time. Alternatively, the detection might instead be from a visitation from a diurnal roost nearby. It would be straightforward to choose between the two candidate explanations by making infrared or thermal video recordings of the entrance at sunset and documenting the emergence or entry of this large species of bat.

The Pilbara leaf-nosed bat was detected on 12 survey nights. The times of first and last detection, and the periods relative to sunset and sunrise times have been calculated (**Table 3**), and provide evidence that two sites (mine adit entrances; unit 450007 on 27 and 28 September 2021; and unit 450083 on 27 and 28 September 2021) have presence of the species soon after sunset. When the levels of activity (number of bat passes, as estimated by the number of 2-second WAV files with one or more echolocation pulses of the species) are plotted across the night, a different pattern can be seen at each site (**Figure 2**).

The site with unit 450007 has relatively high levels, a significant peak of activity in the first hour after the end of civil twilight, and elevated activity during the middle of the night. Together with the times of first and last detection soon after sunset and close to dawn, this is strong (but not unambiguous) evidence of a diurnal roost.

The site with unit 450083 had relatively lower overall activity, and a smaller peak of activity in the first hour after the end of civil twilight, but similar times of first and last detection. This site might be used as a nocturnal refuge, and be relatively close to a diurnal roost site.

To confirm diurnal roosting, the entrance barricade method described by DEWHA (2010) that separates bats emerging after sunset from those entering from elsewhere could be used. This will provide clarity around the relative importance of potential roosting habitats assessed in the survey, and allow matching to defined roost habitat types in the Conservation Advice for this species (TSSC 2016).

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the locality, has not made a visit to observe the habitats available for bats, nor have we visited the specific project area on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme or other methods targeting specific species would help to resolve the presence of the possibilities in the project area.
9. The most reliable way of detecting the ghost bat with bat detectors is to place the equipment with the microphone facing into a potential cave roosting site. The echolocation calls of this species are of low amplitude, and therefore most detectable when a ghost bat flies close to the bat detector as it exits the underground structure. If there is uncertainty about whether ghost bats are present in a cave during the day, then video recordings can be a useful addition to the survey. The detection of ghost bats with bat detectors away from cave entrances is less reliable. Video recordings can also be used to determine colony size.
10. Predictions about whether the Pilbara leaf-nosed bat roosts within a particular surveyed cave (where a bat detector was placed at the entrance), or somewhere nearby, based on the time of first detection should be considered indicative only. If unambiguous confirmation of diurnal roosting of this species is required, this should be undertaken using the entrance barricade method that is described in DEWHA (2010).
11. This version of the document supersedes any previous version. Previous drafts are not authorised by us for submission to the regulator or the public domain.

References

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Table 1. Species identified in the present survey from all sites combined.

MEGADERMATIDAE	
Ghost bat	*Macroderma gigas*
RHINONYCTERIDAE	
Pilbara leaf-nosed bat	*Rhinonicteris aurantia*
EMBALLONURIDAE	
Yellow-bellied sheath-tailed bat	*Saccolaimus flaviventris*
Common sheath-tailed bat	*Taphozous georgianus*
VESPERTILIONIDAE	
Gould's wattled bat	*Chalinolobus gouldii*
Little broad-nosed bat	*Scotorepens greyii*
Finlayson's cave bat	*Vespadelus finlaysoni*
MOLOSSIDAE	
Greater northern free-tailed bat	*Chaerephon jobensis*

Table 2. Species identifications, with the degree of confidence indicated by a code. Date and recording unit number correlates with site; see *Table 1* for full species names.

			C. gouldii	*C. jobensis*	*M. gigas*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Date	**Latitude**	**Longitude**								
Swift 450007										
21/09/2021	-20.881148	118.382528	X	X	—	X	—	X	—	—
22/09/2021	-20.88115	118.382515	X	X	—	—	—	X	—	X
23/09/2021	-20.843273	118.549785	X	—	—	X	—	X	—	—
24/09/2021	-20.843272	118.54975	X	X	—	—	X	X	—	X
25/09/2021	-20.780892	118.531215	X	X	—	—	X	X	X	—
26/09/2021	-20.780782	118.5312	X	X	—	—	X	X	—	—
27/09/2021	-20.978165	117.879688	X	X	—	X	—	X	X	X
28/09/2021	-20.978163	117.879652	X	X	—	X	—	X	X	X
Swift 450083										
20/09/2021	-20.847027	118.50793	—	X	—	—	—	X	—	—
21/09/2021	-20.901538	118.39487	—	X	—	—	—	X	—	X
22/09/2021	-20.90154	118.394872	X	X	—	—	—	X	X	—
23/09/2021	-20.888717	118.195458	—	X	—	—	—	X	—	—
24/09/2021	-20.888715	118.195473	—	X	—	—	—	X	—	—
25/09/2021	-20.904543	118.200035	X	X	—	—	—	—	—	X
26/09/2021	-20.904512	118.20003	X	X	—	X	—	X	—	X
27/09/2021	-20.904512	118.20003	X	X	X	X	X	—	X	X
28/09/2021	-20.904512	118.20003	X	—	—	X	—	—	X	X
Swift 450085										
19/09/2021	-20.792578	118.503128	X	X	—	—	X	X	—	—
20/09/2021	-20.792593	118.503077	X	X	—	—	X	X	X	—
21/09/2021	-20.859425	118.43948	X	—	—	—	—	X	—	—
22/09/2021	-20.859458	118.439675	X	X	—	X	—	X	—	—
24/09/2021	-20.89763	118.168433	X	X	—	X	—	X	—	—
25/09/2021	-20.897768	118.16852	X	X	—	X	X	X	X	X
26/09/2021	-20.83758	118.432367	X	X	—	—	—	X	—	—
27/09/2021	-20.906557	118.340323	X	X	—	X	—	X	—	X
28/09/2021	-20.906577	118.340398	X	X	—	X	—	X	—	—

Definition of confidence level codes

— Not detected.

X Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

Table 3. Summary of detections of the Pilbara leaf-nosed bat.

Recording unit	Night of	No. passes	Time of first detection HH:MM:SS	Time of last detection HH:MM:SS	Sunset	End Civil Twilight	Begin Civil Twilight	Sunrise	Time since sunset HH MM SS	Time before sunrise HH MM SS
450007	21/09/2021	1	23:20:59	23:20:59	21/09/2021 18:03	21/09/2021 18:25	22/09/2021 5:35	22/09/2021 5:57	5H 17M 36S	6H 36M 42S
450007	23/09/2021	2	20:33:36	22:57:35	23/09/2021 18:03	23/09/2021 18:25	24/09/2021 5:33	24/09/2021 5:55	2H 29M 45S	6H 58M 10S
450007	27/09/2021	2709	18:41:11	05:16:27	27/09/2021 18:04	27/09/2021 18:26	28/09/2021 5:29	28/09/2021 5:51	36M 24S	35M 30S
450007	28/09/2021	2735	18:38:27	05:05:47	28/09/2021 18:05	28/09/2021 18:27	29/09/2021 5:28	29/09/2021 5:51	33M 25S	45M 13S
450083	26/09/2021	3	22:58:39	22:58:49	26/09/2021 18:04	26/09/2021 18:26	27/09/2021 5:30	27/09/2021 5:52	4H 54M 6S	6H 54M 5S
450083	27/09/2021	163	18:40:05	04:18:11	27/09/2021 18:04	27/09/2021 18:26	28/09/2021 5:29	28/09/2021 5:51	35M 18S	1H 33M 46S
450083	28/09/2021	209	18:47:55	04:26:11	28/09/2021 18:05	28/09/2021 18:27	29/09/2021 5:28	29/09/2021 5:51	42M 53S	1H 24M 49S
450085	22/09/2021	1	20:37:59	20:37:59	22/09/2021 18:03	22/09/2021 18:25	23/09/2021 5:34	23/09/2021 5:56	2H 34M 22S	9H 18M 44S
450085	24/09/2021	1	23:51:03	23:51:03	24/09/2021 18:04	24/09/2021 18:26	25/09/2021 5:32	25/09/2021 5:54	5H 46M 59S	6H 3M 45S
450085	25/09/2021	6	23:14:11	01:55:11	25/09/2021 18:04	25/09/2021 18:26	26/09/2021 5:31	26/09/2021 5:53	5H 9M 53S	3H 58M 40S
450085	27/09/2021	8	20:17:54	00:56:04	27/09/2021 18:04	27/09/2021 18:26	28/09/2021 5:29	28/09/2021 5:51	2H 13M 7S	4H 55M 53S
450085	28/09/2021	7	20:49:13	02:08:53	28/09/2021 18:05	28/09/2021 18:27	29/09/2021 5:28	29/09/2021 5:51	2H 44M 11S	3H 42M 7S

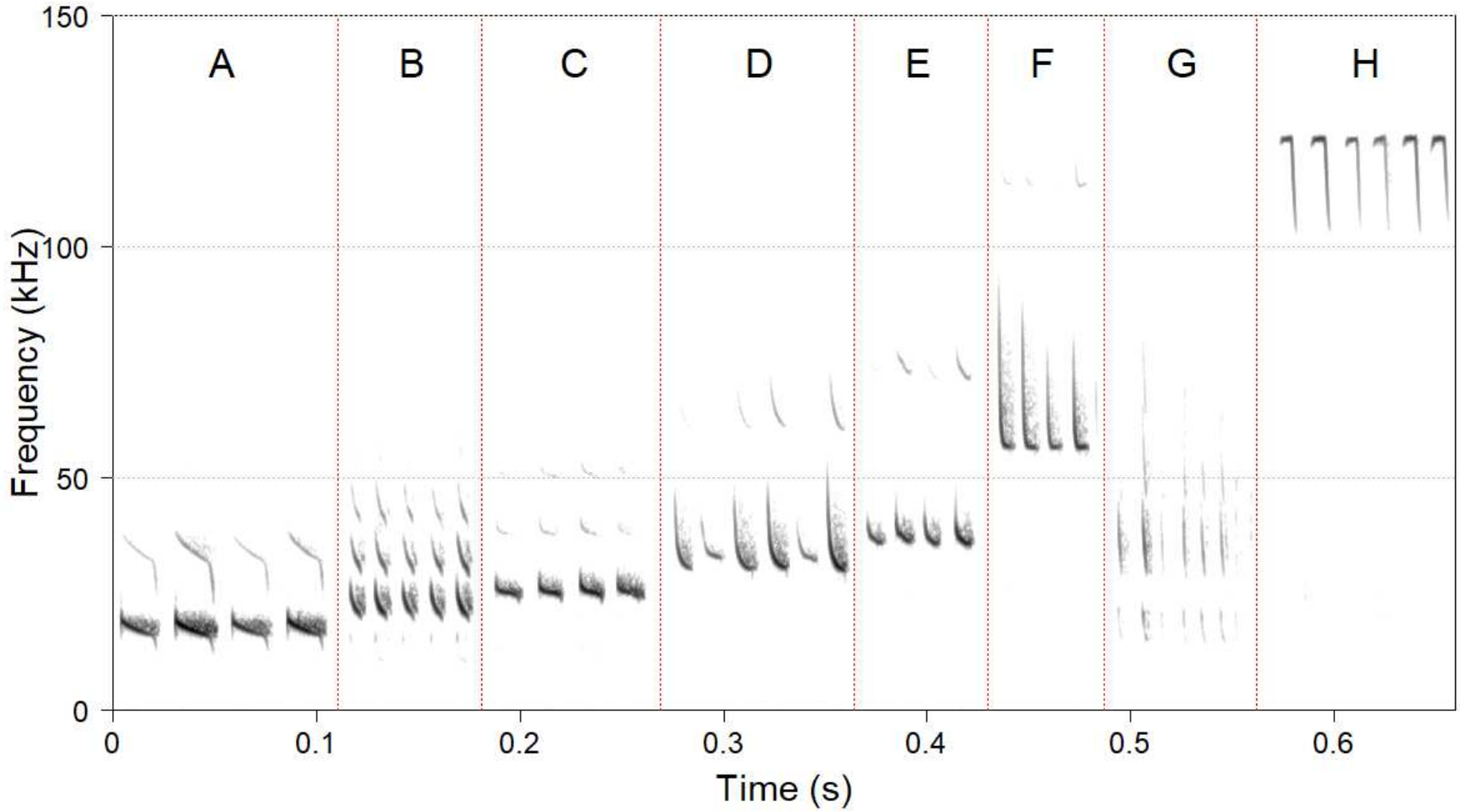

Figure 1. Representative echolocation call sequence portions of the species identified (**A**: *Chaerephon jobensis*; **B**: *Saccolaimus flaviventris*; **C**: *Taphozous georgianus*; **D**: *Chalinolobus gouldii*; **E**: *Scotorepens greyii*; **F**: *Vespadelus finlaysoni*; **G**: *Macroderma gigas*; **H**: *Rhinonicteris aurantia*; time between pulses has been compressed in A–G).

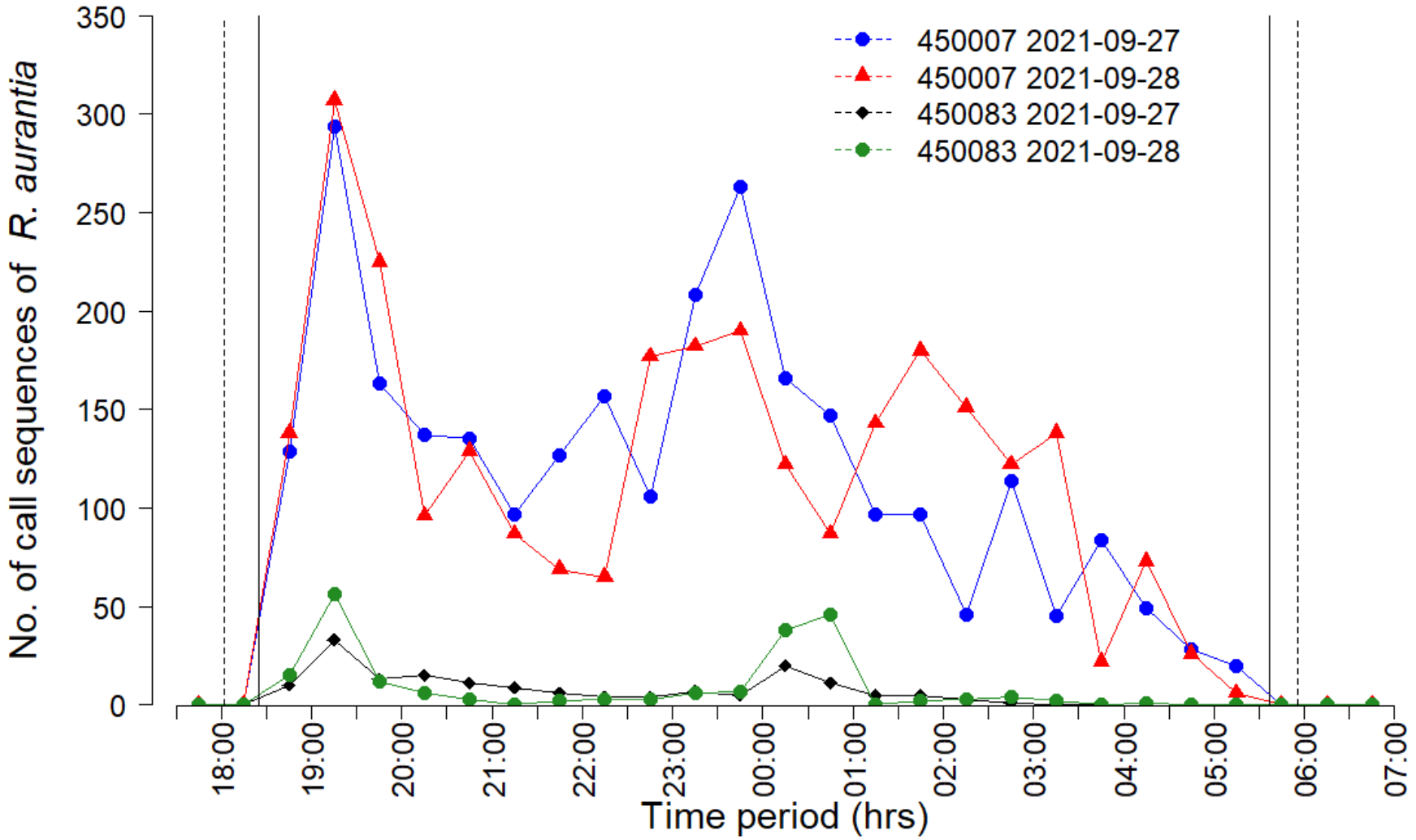

Figure 2. Activity pattern of the Pilbara leaf-nosed bat on the four survey nights with the highest levels of activity (number of bat passes (=WAV files) in 30-minute periods; designated from the date and serial number of the recording unit; dashed lines are times of sunset and sunrise; solid vertical lines are times of the end of civil twilight after sunset, and the beginning of civil twilight before dawn).

Acoustic analysis and bat call identification from Mallina, Western Australia

Prepared for **Western Wildlife Pty Ltd**

Version **21 August 2022**

SZ project reference **SZ601**

Prepared by **Dr Kyle Armstrong and Yuki Konishi**

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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2022). Acoustic analysis and bat call identification from Mallina, Western Australia. Unpublished report by Specialised Zoological for Western Wildlife Pty Ltd, 21 August 2022, project reference SZ601.

Summary

Bat identifications from acoustic recordings are provided from the Mallina project area, in the Pilbara region of Western Australia. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics.

Particular attention was given to the detection of the Threatened-listed Ghost Bat *Macroderma gigas* (Megadermatidae) and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Rhinonycteridae).

Nine species of bat were identified as being present (**Tables 1** and **2**).

Calls of the Ghost Bat were not observed in the dataset.

The Pilbara Leaf-nosed Bat was recorded at seven recording sites, with a total of 200 echolocation call sequences detected (**Table 3**). The records are mostly consistent with individuals out foraging away from diurnal roosts. However, one site (serial 642027; night 9/04/2022) might be relatively close to a diurnal roost in a cave or disused underground mine adit—activity was relatively high (114 passes), plus the times of first detection after sunset, and times of last detection before sunrise, were relatively close to periods of civil twilight.

Representative echolocation calls for each identification are illustrated (**Figure 1**), as recommended by the Australasian Bat Society (ABS 2006). Further details are available should verification be required.

Comments on identifications

Most species were identified unambiguously, but one call type has more than one possibility for its source. The single call sequence observed that was attributed to a species of long-eared bat *Nyctophilus* sp. could have derived from either the Lesser Long-eared Bat *N. geoffroyi* or the Pallid Long-eared Bat *N. daedalus*.

The Northern Coastal Free-tailed Bat *Ozimops cobourgianus* was identified on ten recording nights. This species has a call frequency similar to that of Gould's Wattled Bat *Chalinolobus gouldii*, but calls are generally of much lower bandwidth. If this identification is correct, it demonstrates that the Northern Coastal Free-tailed Bat can fly from coastal areas in mangal habitat, where it is likely to be more common, at least 50 km south through major river systems and adjacent areas.

Methods

The data provided were recorded in full spectrum WAV format with Titley Scientific Anabat Swift bat detectors (sampling rates 500 kHz, respectively, set to turn on automatically at sunset and off at sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong et al. 2021a,b) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (SCAN'R parameters) from each putative bat pulse. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language application that performed three tasks:

1. undertook a Discriminant Function Analysis on training data from representative calls from two datasets: encompassing all bat species in the Pilbara region; and calls from Pilbara cave-roosting bat species, including the Ghost Bat;

2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over ellipses representing one standard deviation of the variation for the defined call types;

3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition version 22.

Species were identified based on information in McKenzie and Bullen (2009) and the author's own unpublished material. Nomenclature follows Jackson and Groves (2015).

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.
9. The most reliable way of detecting the Ghost Bat with bat detectors is to place the equipment with the microphone facing into a potential cave roosting site. The echolocation calls of this species are of low amplitude, and therefore most detectable when a Ghost Bat flies close to the bat detector as it exits the underground structure. If there is uncertainty about whether Ghost Bats are present in a cave, then video recordings can be a useful addition to the survey. The detection of Ghost Bats with bat detectors away from cave entrances is less reliable.

References

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McKenzie, N.L. and Bullen, R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum* Supplement 78: 123–155.

Table 1. Species identified from all sites combined.

RHINONYCTERIDAE	
Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia*
EMBALLONURIDAE	
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Common Sheath-tailed Bat	*Taphozous georgianus*
VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Unidentified long-eared bat	*Nyctophilus* sp.
Little Broad-nosed Bat	*Scotorepens greyii*
Finlayson's Cave Bat	*Vespadelus finlaysoni*
MOLOSSIDAE	
Greater Northern Free-tailed Bat	*Chaerephon jobensis*
Northern Coastal Free-tailed Bat	*Ozimops cobourgianus*

Table 2. Species identifications, with the degree of confidence indicated by a code (see definitions next page; see *Table 1* for full species names).

		C. gouldii	*C. jobensis*	*Nyctophilus* sp.	*O. cobourgianus*	*R. aurantia*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Swift 642024										
15/03/2022	20.844575 S, 118.598982 E	X	X	.	.	.	.	X	.	.
16/03/2022	20.844575 S, 118.599017 E	X	.	.	.	.	X	X	X	.
17/03/2022	20.880675 S, 118.382402 E	.	.	.	.	X	.	X	.	.
18/03/2022	20.881160 S, 118.382445 E	.	.	.	.	.	.	X	.	.
19/03/2022	20.859198 S, 118.439658 E	.	X	.	X	.	.	X	.	.
20/03/2022	20.859428 S, 118.439905 E	.	X	.	.	.	X	X	.	.
21/03/2022	20.778113 S, 118.527668 E	X	X	.	.	.	X	X	X	.
22/03/2022	20.778207 S, 118.527760 E	X	X	.	.	.	X	X	.	.
23/03/2022	20.844587 S, 118.472658 E	.	X	.	.	.	.	X	X	.
24/03/2022	20.844490 S, 118.472602 E	X	.	.	X	.	.	X	X	.
3/04/2022	20.897757 S, 118.168372 E	X	X	.	.	X	X	X	X	X
4/04/2022	20.897862 S, 118.168392 E	X	X	.	X	.	X	X	X	X
5/04/2022	20.918903 S, 118.064647 E	.	.	.	X	.	.	X	X	X
6/04/2022	20.919182 S, 118.064645 E	X	.	.	X	.	.	X	X	X
7/04/2022	20.906255 S, 118.320895 E	X	.	.	X	.	X	X	X	.
8/04/2022	20.902795 S, 118.297753 E	X	X	.	.	.	.	X	.	.
9/04/2022	20.902795 S, 118.297753 E	X	X	.	.	.	X	X	X	X
10/04/2022	20.870343 S, 118.175445 E	X	X	.	.	X	.	X	.	X
11/04/2022	20.978482 S, 117.878697 E	X	X	.	.	X	X	.	X	X
12/04/2022	20.978482 S, 117.878728 E	X	X	.	.	X	.	X	X	X
Swift 642027										
15/03/2022	20.816352 S, 118.622775 E	X	X	.	.	.	X	.	X	X
16/03/2022	20.816517 S, 118.622873 E	X	X	.	.	.	.	X	X	X
17/03/2022	20.901787 S, 118.394992 E	X	X	.	X	.	.	X	.	.
18/03/2022	20.901202 S, 118.397125 E	X	.	.	.	.	.	X	.	.
19/03/2022	20.846955 S, 118.507730 E	X	X	.	X	.	X	X	X	.
20/03/2022	20.846920 S, 118.507717 E	X	X	.	.	.	.	X	.	.
21/03/2022	20.843283 S, 118.549790 E	.	X	.	.	.	X	X	X	.
22/03/2022	20.843305 S, 118.549803 E	X	X	.	.	.	.	X	.	X
23/03/2022	20.792557 S, 118.503317 E	X	X	.	.	.	X	.	X	.
24/03/2022	20.792823 S, 118.503142 E	X	.	.	.	.	X	X	.	.
3/04/2022	20.888765 S, 118.195545 E	X	X	.	.	.	X	X	.	.
4/04/2022	20.888802 S, 118.195128 E	X	X	.	.	X	X	X	.	X
5/04/2022	20.952813 S, 117.913123 E	X	X	.	.	.	X	X	.	X
6/04/2022	20.953282 S, 117.912128 E	X	.	.	X	.	X	.	X	X
7/04/2022	20.956872 S, 117.882740 E	X	.	.	.	.	.	X	X	X
8/04/2022	20.972568 S, 117.884730 E	X	X	.	.	.	.	X	X	X
9/04/2022	20.977972 S, 117.879508 E	X	X	NC	.	X	.	X	X	X
10/04/2022	20.897053 S, 118.214085 E	X	X	.	.	.	.	X	X	X
11/04/2022	20.907397 S, 118.192553 E	X	X	.	X	.	.	X	X	X
12/04/2022	20.907650 S, 118.192793 E	X	X	.	.	.	X	X	.	X

Definition of confidence level codes

‘.’ Not detected.

X Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

Table 3. Summary of detections of the Pilbara Leaf-nosed Bat.

Unit	Night of	Passes	Sunset	Dusk	Dawn	Sunrise	Time first detection	Time last detection	Time since sunset	Time until dawn
642024	17/03/2022	1	17/03/2022 18:21	17/03/2022 18:44	18/03/2022 5:48	18/03/2022 6:10	04:02:47	04:02:47	9H 40M 56S	2H 07M 36S
642024	3/04/2022	2	3/04/2022 18:06	3/04/2022 18:28	4/04/2022 5:53	4/04/2022 6:15	01:51:57	01:51:59	7H 45M 33S	4H 23M 15S
642024	10/04/2022	2	10/04/2022 18:00	10/04/2022 18:22	11/04/2022 5:54	11/04/2022 6:17	23:55:21	01:11:31	5H 55M 02S	5H 05M 46S
642024	11/04/2022	39	11/04/2022 17:59	11/04/2022 18:21	12/04/2022 5:55	12/04/2022 6:17	23:40:52	05:49:16	5H 41M 23S	28M 19S
642024	12/04/2022	41	12/04/2022 17:58	12/04/2022 18:20	13/04/2022 5:55	13/04/2022 6:17	22:14:25	05:27:53	4H 15M 46S	50M 00S
642027	4/04/2022	1	4/04/2022 18:05	4/04/2022 18:27	5/04/2022 5:53	5/04/2022 6:15	23:37:06	23:37:06	5H 31M 35S	6H 38M 25S
642027	9/04/2022	114	9/04/2022 18:01	9/04/2022 18:23	10/04/2022 5:54	10/04/2022 6:16	18:58:26	05:40:47	57M 16S	36M 12S

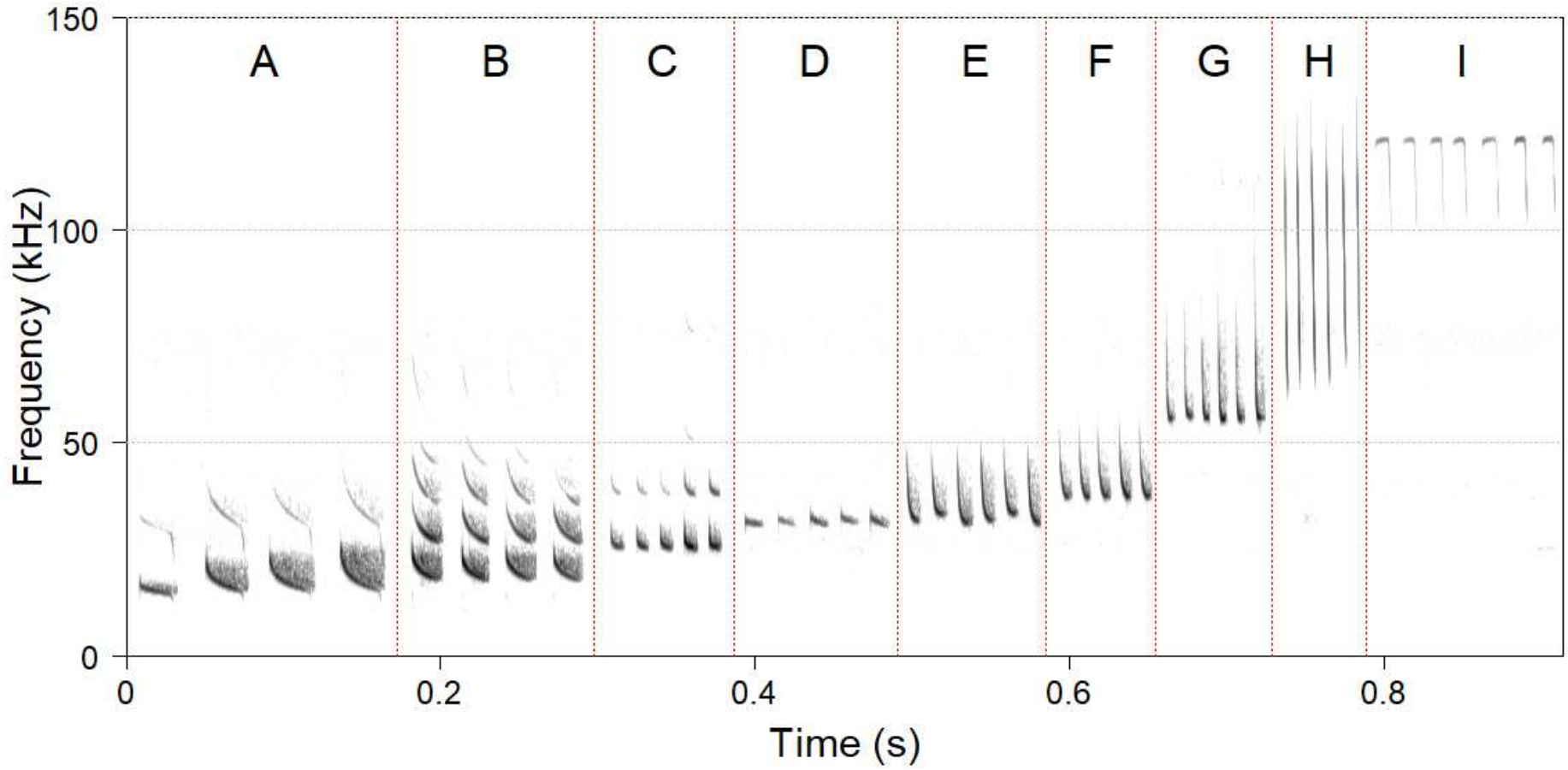

Figure 1. Representative echolocation call sequence portions of the species identified (**A**: *Chaerephon jobensis*; **B**: *Saccolaimus flaviventris*; **C**: *Taphozous georgianus*; **D**: *Ozimops cobourgianus*; **E**: *Chalinolobus gouldii*; **F**: *Scotorepens greyii*; **G**: *Vespadelus finlaysoni*; **H**: *Nyctophilus* sp.; **I**: *Rhinonicteris aurantia*; time between pulses has been compressed).

Appendix 11. Night Parrot Call Analysis

Results of acoustic surveys conducted for the Night Parrot (*Pezoporus occidentalis*) at the Mallina Gold Project

Report to:

Western Wildlife

Prepared by:

Nigel Jackett

Adaptive NRM

15 May 2022

1. Summary

During March and April 2022, autonomous recording units (ARUs) were deployed at the Mallina Gold Project, Western Australia, to survey for Night Parrots (*Pezoporus occidentalis*). Resulting acoustic data was analysed using signal parameters optimised for detecting Night Parrot calls. No Night Parrot calls were detected during the analysis.

2. Survey effort

Research in western Queensland has demonstrated Night Parrots occupy long-term stable roost sites for periods of up to several years. These long-term stable roost sites support both roosting and breeding. The birds also have predictable year-round calling periods at dusk and dawn (Murphy *et al.* 2017a; Leseberg *et al.* 2019). This ensures that if Night Parrots are roosting at a particular site, the likelihood of detecting them using ARUs is very high, provided the ARU is placed for a minimum of four nights in calm weather, and the recorder is set to record during the peak calling periods. During breeding, and following large rain events, calling is more frequent, extends throughout the night (Murphy *et al.* 2017a), and the likelihood of detection is increased. Preliminary results from research in central Western Australia suggest patterns of behaviour in that region are similar (Jackett *et al.* 2017).

Night Parrots are also known to call during the night at feeding and drinking sites (S. Murphy, N. Leseberg, N. Jackett unpubl. data). Anecdotal evidence suggests they may call when moving between these sites (N. Leseberg, N. Jackett, S. Murphy unpubl. data). However, the detection of birds away from roosting sites is likely to be a chance event given the large area over which birds range at night (Murphy *et al.* 2017b). Night Parrots are known to drink, and modelling suggests they may be reliant on free-standing water (or succulent food containing >55% water) during hot weather (Kearney *et al.* 2016). Birds have been detected in the Great Sandy Desert by focusing survey effort at water sources (J. Brown pers. comm.). It is likely this technique will be most effective during periods of water scarcity, when survey effort can focus on just a few possible locations.

The likelihood of detection is also influenced by the type of ARU being used. In calm conditions, Song Meter 4s are known to be capable of reliably detecting 95% of Night Parrot calls out to a range of around 205 m (Leseberg *et al.* 2021).

Western Wildlife conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in March and April 2022. Fourteen Song Meter 4 (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across 30 sites and recorded a combined total of 189.5 nights of data (Table 1). The analysed dataset comprised 2,127 sound files (wav format) totalling 886.7 GB. Each unit recorded continuously from sunset until sunrise (approx. 11.5 hours).

Table 1. Bioacoustic recordings analysed from the survey

Site	Project	Recording start date (PM)	Recording end date (AM)	Total recording nights	Nights with calm conditions
SM4 03	Hemi	19/03/22	25/03/22	6	6
SM4 06	Hemi	19/03/22	25/03/22	6	6
SM4 4552	Hemi	19/03/22	25/03/22	6	6
SM4 4605	Hemi	20/03/22	26/03/22	6	6
SM4 4896	Hemi	20/03/22	26/03/22	6	6
SM4 5263	Hemi	19/03/22	25/03/22	6	6
SM4 5263b	Hemi	25/03/22	31/03/22	6	6
SM4 5284	Hemi	19/03/22	25/03/22	6	6
SM4 5284b	Hemi	25/03/22	31/03/22	6	6
SM4 5285	Hemi	19/03/22	25/03/22	6	6
SM4 4888	Hemi/Haul Rd	20/03/22	26/03/22	6	6
SM4 5275	Hemi/Haul Rd	20/03/22	26/03/22	6	6
SM4 4896c	Haul Rd	06/04/22	13/04/22	7	7
SM4 5285c	Haul Rd	06/04/22	13/04/22	7	7
SM4 01	Hemi/Wingina	19/03/22	25/03/22	6	6
SM4 02	Wingina	19/03/22	25/03/22	6	6
SM4 04	Wingina	19/03/22	25/03/22	6	6
SM4 05	Wingina	19/03/22	25/03/22	6	6
SM4 03c	Toweranna	05/04/22	12/04/22	7	7
SM4 04c	Toweranna	05/04/22	12/04/22	7	7
SM4 05c	Toweranna	05/04/22	12/04/22	7	7
SM4 06c	Toweranna	05/04/22	12/04/22	7	7
SM4 4552c	Toweranna	06/04/22	13/04/22	7	7
SM4 4605c	Toweranna	05/04/22	12/04/22	7	7
SM4 4888c	Toweranna	05/04/22	12/04/22	7	7
SM4 5263c	Toweranna	05/04/22	12/04/22	7	7
SM4 5275c	Toweranna	05/04/22	07/04/22	2.5*	2.5
SM4 01c	Withnell	04/04/22	11/04/22	7	7
SM4 02c	Withnell	05/04/22	12/04/22	7	7
SM4 5284c	Withnell	06/04/22	13/04/22	7	7
			Total	189.5	189.5

* recording ended on 07/04/22 at 2300

3. Data analysis

The analysis was undertaken using the software Kaleidoscope Pro v5.4.6, targeting the frequency range of 1000 – 4000 Hz for which all known calls of the Night Parrot are distributed within (Leseberg *et al.* 2019). Searching for calls over a large frequency range such as this is likely to produce a high number of false-positive results due to many other bird species calling at similar frequencies but is a necessary procedure in order to capture the potential repertoire of Night Parrot.

Potential Night Parrot calls detected during the analysis were compared to a reference library comprising 897 Night Parrot calls from Western Australia. This library consists of calls recorded at sites where Night Parrots have been confirmed using visual means and is therefore considered of high reliability. The library also comprises multiple examples of all known call types from Western Australia (Leseberg *et al.* 2019).

Kaleidoscope Pro search parameters were optimised using a random selection of 250 Night Parrot call examples manually detected from both Great Sandy Desert and East Murchison datasets, of which 205 (82.0%) were automatically detected. Calls not detected were typically extremely faint. The probability of non-detection of a true-positive call was 18.0%; two true-positive calls was 3.2%; three true-positive calls was 0.6%; etc. Of the data tested, the median number of consecutive (spaced at <5 minutes apart) calls in a sequence when Night Parrots were recorded was 5 (1–34, n=29). The probability of at least one call being detected within a sequence of median length, assuming there was variation in the location of the source of the call, was >99.9%.

4. Survey results

A total of 28,553 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis.

The recordings were typically of a good quality, with only minor interference from wind gusts or insect noise. Heavy machinery noise and heavy vehicle noise were detected across all nights at sites SM4 4605 and SM4 5284b, respectively, which potentially masked any coinciding Night Parrot calls.

A total of 43 non-target species were detected during the analysis and are shown for each site in Appendix 1.

5. Conclusion

It is very unlikely a long-term stable Night Parrot roost exists within two hundred metres of any of the surveyed points where four or more non-windy recording nights were made. Additionally, it is unlikely that Night Parrots were foraging in proximity to these surveyed points during the survey. It is important to note that these results pertain specifically to that area immediately surrounding the survey points, and do not necessarily support conclusions about the presence or absence of Night Parrots in the wider landscape.

6. References

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Murphy, S. A., Silcock, J. L., Murphy, R., Reid, J., & Austin, J. J. (2017b). Movements and habitat use of the night parrot *Pezoporus occidentalis* in south-western Queensland. *Austral Ecology, 42*, 858–868.

Appendix 1a – Species detected during the analysis (Hemi / Haul Rd / Wingina)

Species	Hemi										Hemi / Haul Rd				Hemi / Wingina			
	03	06	4552	4605	4896	5263	5263b	5284	5284b	5285	4888	5275	4896c	5285c	01	02	04	05
Grey Teal											•						•	
Brown Quail			•	•	•	•	•		•	•	•	•	•	•	•	•	•	•
Crested Pigeon				•												•		
Black-eared Cuckoo											•							
Horsfield's Bronze Cuckoo		•	•	•	•	•	•	•		•	•	•			•	•	•	•
Pallid Cuckoo		•	•		•		•	•		•		•					•	•
Spotted Nightjar			•							•		•				•		
Australian Owlet-nightjar		•	•		•			•		•	•	•	•		•	•		•
Bush Stone-curlew		•					•		•	•	•	•	•		•		•	
Pied Stilt																		
Banded Lapwing			•															
Black-fronted Dotterel																		
Common Greenshank																		•
Australian Pratincole																		
Little Buttonquail		•	•	•	•	•		•	•	•	•		•	•	•		•	•
Australasian Darter											•							
Nankeen Night-Heron											•							
Eastern Barn Owl														•				
Barking Owl												•						
Southern Boobook											•		•					
Blue-winged Kookaburra											•	•	•			•		
Red-backed Kingfisher							•											
Rainbow Bee-eater			•		•	•						•						

Species	Hemi										Hemi / Haul Rd				Hemi / Wingina			
	03	06	4552	4605	4896	5263	5263b	5284	5284b	5285	4888	5275	4896c	5285c	01	02	04	05
Brown Falcon								•		•						•		
Falco sp.														•				
Galah													•			•		
Little Corella											•							
Cockatiel					•													
Australian Ringneck										•	•	•						
Budgerigar											•						•	
Purple-backed Fairywren																•		
White-winged Fairywren		•		•	•	•	•			•			•		•		•	
Yellow-throated Miner			•													•		
Singing Honeyeater		•	•		•		•	•		•			•	•	•	•	•	•
White-plumed Honeyeater						•					•	•	•					
Grey-crowned Babbler											•							
Black-faced Cuckooshrike											•							
Crested Bellbird											•							
Black-faced Woodswallow			•	•					•	•		•					•	
Pied Butcherbird		•														•	•	
Magpie-lark											•							
Torresian Crow		•			•	•			•			•	•			•		
Spinifexbird			•	•		•	•			•	•		•		•			•
Zebra Finch								•										
Total	0	9	12	7	10	8	8	7	5	13	20	13	12	4	8	13	11	8

Appendix 1b – Species detected during the analysis (Toweranna / Withnell)

Species	Toweranna									Withnell		
	03c	04c	05c	06c	4552c	4605c	4888c	5263c	5275c	01c	02c	5284c
Grey Teal											•	•
Brown Quail		•	•	•	•	•	•	•	•	•	•	•
Crested Pigeon											•	
Black-eared Cuckoo												
Horsfield's Bronze Cuckoo							•				•	•
Pallid Cuckoo							•					
Spotted Nightjar				•			•					
Australian Owlet-nightjar		•		•			•		•	•	•	•
Bush Stone-curlew			•	•	•	•		•			•	
Pied Stilt												•
Banded Lapwing												
Black-fronted Dotterel				•	•	•						
Common Greenshank												
Australian Pratincole				•							•	•
Little Buttonquail		•		•								
Australasian Darter												
Nankeen Night-Heron		•	•	•		•						•
Eastern Barn Owl						•			•	•		
Barking Owl												
Southern Boobook												
Blue-winged Kookaburra					•	•	•		•			
Red-backed Kingfisher												
Rainbow Bee-eater												

Species	Toweranna									Withnell		
	03c	04c	05c	06c	4552c	4605c	4888c	5263c	5275c	01c	02c	5284c
Brown Falcon							•					
Falco sp.								•				
Galah								•	•			
Little Corella		•	•	•	•	•			•	•		
Cockatiel												
Australian Ringneck												
Budgerigar												
Purple-backed Fairywren												
White-winged Fairywren						•						•
Yellow-throated Miner												
Singing Honeyeater		•	•		•	•	•	•		•	•	•
White-plumed Honeyeater							•					
Grey-crowned Babbler												
Black-faced Cuckooshrike						•	•					
Crested Bellbird												
Black-faced Woodswallow					•		•					
Pied Butcherbird												
Magpie-lark												
Torresian Crow		•	•	•	•	•	•					
Spinifexbird		•								•	•	•
Zebra Finch												
Total	0	8	6	10	8	11	12	4	6	6	9	10

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28-06-2024

Dear Jen,

Analysis of 96 nights of acoustic recording across 12 sites at HEMI during April 2024 presented no detection of Night Parrot (*Pezoporus occidentalis*) calls.

Conditions were gusty throughout the survey period. Machinery Noise was detected distantly at all sites. Both interferences may have masked some concurrent calls within those specific frequencies. These interferences are considered minimal and the recording quality was considered adequate for detection of Night Parrot vocal signals.

There is a very low likelihood that long-term stable Night Parrot roosts exist within two hundred metres of each recording point. It is also highly unlikely that Night Parrots foraged within the same areas during the survey. These statements pertain only to the areas within two hundred metres of each recording point and not the entire survey area.

A total of 33 non-target species were recorded. These are shown for each site in Appendix 1.

Regards,

Louis Masarei

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Appendix 1: Species detected during acoustic analyses

Common Name	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B
Pacific Black Duck *Anas superciliosa*							○					
Brown Quail *Synoicus ypsilophorus*	○											
Spotted Nightjar *Eurostopodus argus*					○				○			
Australian Owlet-nightjar *Aegotheles cristatus*							○					
Crested Pigeon *Ocyphaps lophotes*						○			○			
Bush Stone-curlew *Burhinus grallarius*			○		○		○				○	○
Banded Lapwing *Vanellus tricolor*											○	
Southern Boobook *Ninox boobook*									○			
Blue-winged Kookaburra *Dacelo leachii*						○	○				○	
Rainbow Bee-eater *Merops ornatus*	○	○	○	○						○		○
Nankeen Kestrel *Falco cenchroides*				○	○						○	
Brown Falcon *Falco berigora*						○			○			
Galah *Eolophus roseicapilla*							○	○				
Little Corella *Cacatua sanguinea*			○									
Australian Ringneck *Barnardius zonarius*	○	○								○		
Budgerigar *Melopsittacus undulatus*			○	○								
White-winged Fairywren *Malurus leucopterus*				○	○				○	○	○	○
Rufous-crowned Emu-wren *Stipiturus ruficeps*	○	○	○			○	○		○			
Singing Honeyeater *Gavicalis virescens*	○	○		○	○	○		○	○	○	○	○
White-plumed Honeyeater *Ptilotula penicillate*	○	○	○		○	○	○	○		○	○	○
Yellow-throated Miner *Manorina flavigula*	○		○	○			○					

Grey-crowned Babbler *Pomatostomus temporalis*					○							○
Black-faced Woodswallow *Artamus cinereus*	○											
Pied Butcherbird *Cracticus nigrogularis*								○				
Black-faced Cuckooshrike *Coracina novaehollandiae*	○		○	○	○	○	○	○				
Crested Bellbird *Oreoica gutturalis*						○	○	○	○			
Magpie-lark *Grallina cyanoleuca*	○	○	○			○	○	○				
Torresian Crow *Corvus orru*	○	○			○	○	○			○		○
Little Crow *Corvus bennetti*										○		
Tree Martin *Petrochelidon nigricans*	○											
Spinifexbird *Poodytes carteri*	○	○	○		○	○			○	○		
Painted Finch *Emblema pictum*	○		○	○	○	○	○				○	
Zebra Finch *Taeniopygia castanotis*	○			○	○		○	○				○