Central Pilbara Hub

Targeted Matters of National Environmental Significance Vertebrate Fauna Survey

Biologic Environmental Survey

Report to BHP WAIO

May 2023

Document Status				
Revision No.	Author	Review / Approved for Issue	Approved for Issue to	
			Name	Date
1	Andrew Hide, Debbie Gleeson, Verity Steptoe	Chris Knuckey, Ryan Ellis	Alice Taysom	29/08/2022
2	Debbie Gleeson	Chris Knuckey, Andrew Hide	Alice Taysom	31/10/2022
3	Penny Booshooft Brighton D'Rozario	Andrew Hide	Alice Taysom	23/12/2022
4	Verity Steptoe	Andrew Hide	Alice Taysom	11/05/2023

"IMPORTANT NOTE"

We have prepared this report for the sole purposes of BHP WAIO ("Client") for the specific purpose only for which it is supplied. This report is strictly limited to the Purpose and the facts and matters stated in it and does not apply directly or indirectly and will not be used for any other application, purpose, use or matter.

In preparing this report we have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request or enquiry were complete, accurate and up to date. Where we have obtained information from a government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware of any reason why any of the assumptions are incorrect.

This report is presented without the assumption of a duty of care to any other person (other than the Client) ("Third Party"). The report may not contain sufficient information for the purposes of a Third Party or for other uses. Without the prior written consent of Biologic:

a) This report may not be relied on by a Third Party; and

b) Biologic will not be liable to a Third Party for any loss, damage, liability, or claim arising out of or incidental to a Third Party publishing, using, or relying on the facts, content, opinions or subject matter contained in this report.

If a Third Party uses or relies on the facts, content, opinions or subject matter contained in this report with or without the consent of Biologic, Biologic disclaims all risk and the Third Party assumes all risk and releases and indemnifies and agrees to keep indemnified Biologic from any loss, damage, claim or liability arising directly or indirectly from the use of or reliance on this report.

In this note, a reference to loss and damage includes past and prospective economic loss, loss of profits, damage to property, injury to any person (including death) costs and expenses incurred in taking measures to prevent, mitigate or rectify any harm, loss of opportunity, legal costs, compensation, interest and any other direct, indirect, consequential or financial or other loss.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

BHP Western Australian Iron Ore (BHP WAIO) commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a desktop assessment and single season targeted vertebrate fauna survey of the Central Pilbara Hub (CPH). The CPH (hereafter referred to as the Study Area) is located approximately 80 kilometres (km) north-west of Newman and covers an area of approximately 60,000 hectares (ha).

The overarching objective of this assessment was to determine the presence, or likely presence, of significant species within the Study Area, with a specific focus on Matters of National Environmental Significance (MNES; i.e. species listed under the *Environment Protection and Biodiversity Conservation Act 1999*). MNES species targeted for this survey included:

- northern quoll (*Dasyurus hallucatus*) – Endangered;
- greater bilby (*Macrotis lagotis*) – Vulnerable;
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable;
- ghost bat (*Macroderma gigas*) – Vulnerable;
- night parrot (*Pezoporus occidentalis*) – Endangered;
- grey falcon (*Falco hypoleucos*) – Vulnerable; and
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable.

The field survey was undertaken by seven experienced zoologists over five separate trips, comprising two trips in November 2021 and three trips between April and May 2022. Species specific targeted sampling during the field survey comprised habitat and habitat feature (i.e. cave and water features) assessments, ultrasonic and acoustic sound recordings, camera trap transects, targeted searches and nocturnal searches.

Fauna Habitats

A total of 11 broad fauna habitat types were recorded and mapped across the Study Area, comprising Stony Plain (35.51%, 21,051.01 ha), Hillcrest/ Hillslope (23.89%, 14,160.00 ha), Drainage Area/ Floodplain (16.27%, 9,644.57 ha), Mulga Woodland (6.82%, 4,043.20 ha), Hardpan Plain (4.21%, 2,495.29 ha), Undulating Low Hills (3.34%, 1979.6 ha), Minor Drainage Line (2.77%, 1,639.45 ha), Gorge/ Gully (2.64%, 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha), Medium Drainage Line (0.61%, 362.20 ha) and Major Drainage Line (0.09%, 54.94 ha). The remaining 2.41% (1,428.48 ha) of the Study Area comprised Cleared/ Disturbed areas.

Of the 11 broad fauna habitats occurring within the Study Area, Gorge/ Gully, Breakaway/ Cliff, Major Drainage Line and Drainage Area/ Floodplain all provide critical habitat for MNES species, including northern quoll, ghost bat, Pilbara leaf-nosed bat, Pilbara olive python and grey falcon. These habitats provide critical breeding, roosting, foraging and dispersal habitat for some or all of the target species to various extents.

Northern Quoll

No evidence of northern quoll was recorded within the Study Area during the current survey. Sampling for northern quoll during the survey included a total of 1,503 camera trap nights on 21 camera trap transects and approximately 191 search hours over 70 targeted search transects.

The Study Area falls within the current distribution of the northern quoll. A total of 538 northern quoll records were identified within 50 km of the Study Area in the desktop assessment (BHP, 2022; DBCA, 2022b). The species has previously been recorded within the Study Area, from scats in Hillcrest/ Hillslope habitat at Camp Hill in 2011 and a live individual (BHP, 2022; Onshore & Biologic, 2011). Additionally, Astron (2019) recorded the northern quoll in an area approximately 8 km east of the Study Area: 14 times via motion camera detection images (10 records), scat recordings (three records) and trapping (one record). The scarcity of previous records within or close to the Study Area suggests the species is likely to occur at very low densities. Within the Study Area, the Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats meet the definition of critical habitat for the species. While Hillcrest/ Hillslope and Medium Drainage Line habitat represent supporting foraging and dispersal habitat for the species. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for northern quoll within the Study Area, the species is considered to highly likely to occur. However, due to the scarcity of contemporary records, this species is likely to occur at low densities and is unlikely to be reliant on the habitats within the Study Area for long-term persistence at a local scale or population abundance at a regional scale. The Study Area is unlikely to contain a 'population important for the long-term survival of the species', as defined by the Department of Environment (DoE (2013, 2016).

Greater Bilby

No evidence of greater bilby was recorded within the Study Area during the current survey. Sampling for greater bilby during the survey included 16 greater bilby targeted plot searches and two transects totalling 15 person search hours.

The Study Area falls within the western extent of the species' current distribution, whereby the species or species' habitat is likely to occur (DoE, 2022e). A total of 18 database search records of the greater bilby occur within 50 km of the Study Area (BHP, 2022; DBCA, 2022b). One previous record (unknown type of record) of the species is located within the Study Area, in the western extent of Mudlark Well from 1984; however, the location provided may be inaccurate given its historic date or that it is situated on a stony hill, which does not provide habitat. The next closest record occurs 14 km west, also from 1984. The nearest contemporary record is from the Fortescue Valley in 2020 with evidence of possible greater bilby diggings, located 37 km west of the Study Area, with all remaining records no earlier than 2013.

Drainage Area/ Floodplain habitat (9,644.57 ha) within the Study Area is considered marginal habitat for the greater bilby, as it often comprises heavy soils which provide low burrowing suitability and is therefore regarded as supporting habitat for the species. Although some areas of marginal habitat for the greater bilby occur within the Study Area, it is unlikely the species occurs due to the limited extent, and relative isolation, of habitat to other areas of suitable habitat as well as a lack of contemporary

records. Therefore, the Study Area is unlikely to support an 'important population' as defined by DoE (2013).

Pilbara Leaf-nosed Bat

Calls of Pilbara leaf-nosed bats were recorded at four locations during the current survey from 15 individual calls, located within Gorge/ Gully, Breakaway/ Cliff and Hillcrest/ Hillslope habitats. The timing of the calls recorded during the current survey indicated that the calls are likely to be representative of a foraging individual or individuals, which are unlikely to be habitually using a nearby cave as a diurnal roost. Sampling for the Pilbara leaf-nosed bat during the current survey included ultrasonic Song Meter recorders at 68 locations, for a total of 802 recording nights.

The Study Area is located at the eastern extent of the Pilbara leaf-nosed bat's distribution; whereby the species or species' habitat may occur (DoE, 2022b). The database search identified a total of 10 records within 10 km of the Study Area (with records from 2006 – 2018) and only one record occurred directly within the Study Area, a detection in 2013 (BHP, 2022; DBCA, 2022b). The Pilbara leaf-nosed bat has previously been recorded three times within the Study Area (Biologic, 2011e; Biota, 2013a; Onshore & Biologic, 2011).

No evidence of a Pilbara leaf-nosed bat diurnal roost caves was recorded within the Study Area during the current survey. A total of 34 caves were recorded within the Study Area, all of which represent potential nocturnal refuges only (Category 4) for the species, except three which had no usage.

The Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats within the Study Area represent critical Pilbara leaf-nosed bat habitat (Habitat Rating 4 (very high) as defined by Bat Call (2021b). Additionally, Stony Plain, Hillcrest/ Hillslope, Drainage Area/ Floodplain, Mulga Woodland, Undulating Low Hills, Minor Drainage Line and Medium Drainage Line all provide supporting habitat for the species (Habitat Rating 2 (low) as defined by Bat Call (2021b). The Study Area also contains water features likely to provide supporting foraging habitat for the Pilbara leaf-nosed bat. Given no roosting by the species has been recorded within or in the vicinity of the Study Area, habitats occurring are likely to only provide supporting foraging and/or dispersal habitat for the species.

The entire Pilbara represents one interbreeding population (TSSC, 2016c; Umbrello *et al.*, 2022), meeting the requirements of an 'important population' as defined by DoE (2013). Hence, the significance of occurrence used for this assessment was based on the presence/ absence of Category 1 and 2 (permanent diurnal) roosts and Category 3 (semi-permanent diurnal) roosts, as stipulated by Bat Call (2021b). Given the absence of a critical roost within, or in the immediate vicinity of the Study Area, it is unlikely that the Study Area represents a significant area for this species.

Ghost Bat

Ghost bat was recorded on 33 nights at four locations within the Study Area during the current survey. Sampling for ghost bat during the current survey included ultrasonic Song Meter recorders at 68 locations, for a total of 802 recording nights.

A total of 559 previous records of ghost bat occur within and surrounding the Study Area (within 50 km of the Study Area), including 115 records within the Study Area and a further 459 within 12 km (BHP,

2022; DBCA, 2022b). This includes 73 records from Mudlark Well, 40 records from Pineapple Hill and Camp Hill, two records within the MAC and Yandi Rail Corridor.

Within the Study Area, critical foraging habitat is provided by Stony Plain, Drainage Area/ Floodplain, Mulga Woodland, Minor Drainage Line, Medium Drainage Line, and Major Drainage Line when proximal (>12 km) to roosting caves. As suggested by Bat Call (2021a) these habitats represent "productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground" and/or contain "isolated trees and trees on the edge of thin thickets on the plains" and "trees along the edges of watercourse woodlands". Due to the locations of roosting caves within the Study Area and surrounds, these habitats within the entire extent of the Study Area can be considered critical foraging habitat. Undulating Low Hills and Gorge/ Gully habitats provide supporting foraging and dispersal habitat.

A population of ghost bats likely occurs within and surrounding the Study Area, forming part of a broader ghost bat population with high genetic diversity across the Pilbara region (Ottewell *et al.*, 2017), which is likely to be an important population. The population within the Study Area is likely to be considered 'important' as defined by DoE (2013) because it is likely to be a key source population for breeding given that five Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified and provide critical habitat. Furthermore, critical foraging habitat exists across the entire extent of the Study Area, supporting this important population, which would also be used by ghost bats from other Category 2 caves at South Flank.

Night Parrot

No evidence of night parrot was recorded within the Study Area during the current survey. Sampling for night parrot during the survey included acoustic recorders deployed at 35 locations, totalling 371 recording nights.

The distribution of the night parrot is very poorly understood in Western Australia; however, the Study Area occurs within the species' potential distribution, as currently mapped by DoEE (2019b). The nearest record of the night parrot to the Study Area is located approximately 50 km to the north-east, adjacent to the Cloudbreak Mine (FMG, 2021).

Habitat within the Study Area was considered marginal for the species, as there are limited instances of *Triodia* grasslands that are considered suitable (i.e. large, long-unburnt hummocks) for the species. Due to the close proximity of the recent night parrot record approximately 50 km to the north-east of the Study Area, this species is considered possible to occur within the Study Area; however, due to a lack of suitable habitat this use would be either intermittent or while transiting to other areas. It is unlikely that this would constitute a significant occurrence based on the definitions by DoE (2013).

Grey Falcon

No evidence of the grey falcon was recorded within the Study Area during the current survey. Sampling for this species within the Study Area included approximately 180 person hours of targeted searches undertaken at 60 sites during the current survey.

The Study Area is located within the current distribution of the grey falcon, where the species or species' habitat is likely to occur (DoE, 2022c). The desktop assessment returned ten records of the grey falcon, including near the Study Area (DBCA, 2022b; Ecologia, 1998c, 2004b; ENV, 2008a).

The Study Area contains habitat considered critical habitat for grey falcon, primarily within Major Drainage Line Habitat, and to a lesser extent, the Medium Drainage Line habitat, which provide potential breeding, foraging, and dispersal habitat for the species. The Stony Plain, Hillcrest/ Hillslope and Drainage Area/Floodplain habitat, may also provide supporting habitat for the species.

As the grey falcon is regarded as representing a single interbreeding population (Mullin *et al.*, 2020), grey falcon present in the Pilbara are suggested to represent part of an 'important population'. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for grey falcon within the Study Area, this species is considered to possibly occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale.

Pilbara Olive Python

No evidence of Pilbara olive python was recorded within the Study Area during the current survey. Sampling for the species within the Study Area included 70 diurnal searches (approximately 193 person search hours) and three nocturnal searches (comprising eight person search hours).

The Study Area is located within the current distribution of the Pilbara olive python, whereby the species or species' habitat is likely to occur (DoE, 2022d). The desktop assessment returned 64 records of the Pilbara olive python with four records within the Study Area (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008). A deceased (roadkill) Pilbara olive python was recorded 2.1 km outside of the boundary of the Study Area on 27th March 2022.

The Pilbara olive python is regularly encountered in the vicinity of rocky habitats (i.e. Gorge/ Gully and Breakaway/ Cliff habitats) and drainage systems (i.e. Major Drainage Lines), particularly where pooling water occurs (DSEWPaC, 2011b; Pearson, 1993). In the Hamersley region, the Pilbara olive python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011b; Pearson, 1993). Gorge/ Gully habitat, Breakaway/ Cliff and Major Drainage Line provide critical habitat within the Study Area for the species.

Although no evidence of the Pilbara olive python was recorded within the Study Area during the current survey, the species is notably cryptic and it is likely that a breeding population occurs within the Study Area based on the proximity of previous records and the presence of critical breeding and foraging habitat. Therefore, this population, if present, would be considered an 'important population' as defined by DoE (2013) supported by critical habitat within the Study Area.

Other Fauna of Significance

One non-target species of significance was identified during the current survey: the Western pebble-mound mouse (*Pseudomys chapmani*). This species was recorded on 135 occasions from secondary evidence (pebble-mounds).

1 INTRODUCTION

1.1 Background

BHP Western Australian Iron Ore (BHP WAIO) commissioned Biologic Environmental Survey Pty Ltd (Biologic) to undertake a desktop assessment and single season targeted vertebrate fauna survey of the Central Pilbara Hub (CPH). The CPH (hereafter referred to as the Study Area) is located approximately 80 kilometres (km) north-west of Newman and covers an area of approximately 60,000 hectares (ha). The Study Area comprises three separate areas (Figure 1.1):

- Pineapple Hill and Camp Hill;
- Mining Area C (MAC) to Yandi Rail Corridor; and
- Mudlark Well.

This assessment will provide local and contextual information that may inform future environmental approvals across the Study Area.

1.2 Survey Objectives

The overarching objective of this assessment was to determine the presence, or likely presence, of significant species within the Study Area, with a specific focus on Matters of National Environmental Significance (MNES; i.e. species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)). MNES species targeted for this survey included:

- northern quoll (*Dasyurus hallucatus*) – Endangered;
- greater bilby (*Macrotis lagotis*) – Vulnerable;
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable;
- ghost bat (*Macroderma gigas*) – Vulnerable;
- night parrot (*Pezoporus occidentalis*) – Endangered;
- grey falcon (*Falco hypoleucos*) – Vulnerable; and
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable.

1.3 Conformance

This assessment was carried out in a manner consistent with the following documents developed by the Western Australian Environmental Protection Authority (EPA), DBCA (formerly Department of Parks and Wildlife [DPaW]), the Department of Climate Change, Energy, the Environment and Water (DCCEEW - formerly the Department of Environment [DoE]), Department of Sustainability, Water, Population, and Communities [DSEWPaC] and Department of Environment, Water, Heritage and Arts [DEWHA]), relevant survey-specific license conditions and BHP WAIO:

- (BHP WAIO, 2022) Vertebrate Fauna Surveys in Western Australia Procedure (Document Number: SPR-IEN-EMS-012) Version: 9;
- BHP (2018) Biological survey spatial data requirements (SPR-IEN-EMS-015);

- DBCA (2017) Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia;
- DEWHA (2010a) Survey guidelines for Australia's threatened bats;
- DEWHA (2010b) Survey guidelines for Australia's threatened birds;
- DoE (2016) EPBC Act referral guideline for the endangered northern quoll (*Dasyurus hallucatus)*;
- DPaW (2017) Interim guidelines for the preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia;
- DoE (2013) Significant impact guidelines 1.1: Matters of National Environmental Significance;
- DSEWPaC (2011a) Survey guidelines for Australia's threatened mammals;
- DSEWPaC (2011b) Survey guidelines for Australia's threatened reptiles;
- EPA (2020b) Technical guidance: terrestrial vertebrate fauna surveys for environmental impact assessment;
- EPA (2020a) Statement of environmental principles, factors and objectives;
- TSSC (2016a) Conservation advice: *Macroderma gigas*, ghost bat;
- TSSC (2016c) Conservation advice: *Rhinonicteris aurantia* (Pilbara form), Pilbara leaf-nosed bat;
- TSSC (2016b) Conservation advice: *Macrotis lagotis*, Greater bilby;
- EPA (2016) Environmental factor guidelines – terrestrial fauna;
- TSSC (2008a) Approved conservation advice for *Liasis olivaceus barroni* (olive python – Pilbara subspecies); and
- TSSC (2008b) Approved conservation advice for *Pezoporus occidentalis*, night parrot.

660000
680000
700000
720000
7480000
7460000

Yandi Rail Spur Line
Yandi Rail Spur Line
Mining Area C Railway
MS1039
Yandicoogina Rail
Pineapple Hill
and Camp Hill
Yandicoogina Rail
Juna Downs Rd
Juna Downs Junction Rail
Packsaddle Rd
West Angelas Rail
West Angelas Rd
MAC to Yandi
Rail Corridor
MS1072
Great Northern Hwy
Karijini
National
Park
Mudlark Well

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail
- National Park
- Section 5(1)(g) Reserve

IBRA Region
- Pilbara

IBRA Subregion
- Chichester
- Fortescue
- Hamersley
- Roebourne

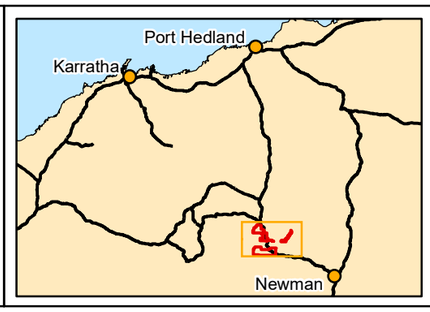
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 1.1: Study Area and regional context

2 EXISTING ENVIRONMENT

2.1 Biogeography

The Study Area is located within the Hamersley (PIL03) subregion of the Pilbara bioregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA; Thackway & Cresswell, 1995) (Figure 1.1). The Pilbara bioregion is characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges (Thackway & Cresswell, 1995). Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses (Bastin, 2008). The Hamersley subregion is characterised by mountainous areas of Proterozoic sedimentary ranges (ironstone ranges) and plateaux dissected by gullies and gorges (Kendrick, 2001). Vegetation comprises mulga low woodland over bunch grasses on fine-textured soils dominates in valley floors, while skeletal soils of the ranges are dominated by snappy gum (*Eucalyptus leucophloia*) over *Triodia brizoides* (Kendrick, 2001). Drainage is typically into the Fortescue River to the north, the Ashburton River to the south, or the Robe River to the west (Kendrick, 2001).

2.2 Climate

The Pilbara bioregion has a semi-desert to tropical climate, with rainfall occurring sporadically throughout the year, although mostly during summer (Thackway & Cresswell, 1995). Summer rainfall is usually the result of tropical low pressure systems and cyclonic activity in the region (Leighton, 2004). Winter rainfall is generally lighter and often associated with cold fronts moving north easterly across the state (Leighton, 2004). The average annual rainfall ranges from 200–350 mm, although there are significant fluctuations between years (BoM, 2022; McKenzie *et al.*, 2009).

2.3 Geology

The Hamersley subregion contains Proterozoic sedimentary ranges and gorges of basalt, shale and dolerite. This subregion also contains calcrete deposits (Kendrick, 2001). The Study Area occurs across six broad (1:500,000) geological units, Wittenoom Formation (A-HAd-kd), Brockman Iron Formation (P_-HAb-cib), Mount McRae Shale and Mount Sylvia Formation (A-HAu-xsl-ci), Weeli Wolli Formation (P-Haj-xci-od), Marra Mamba Iron Formation (A-HAm-cib) and Jeerinah Formation (A-FOj-xs-b) (Figure 2.1; Table 2.2). The two dominant formations of the Study Area are Wittenoom Formation (17,521.57 ha, 29.56%) and Brockman Iron Formation (17,413.61, 29.37%). The Wittenoom Formation is characterised by thinly bedded dolomite and dolomitic shale, with minor black chert, shale, banded iron formation and sandstone and the Brockman Iron Formation characterized by banded iron-formation, chert, mudstone, and siltstone.

Marra Mamba Iron Formation is the geology most predisposed to forming deep caves in the Pilbara suitable for use by ghost bats, while the larger hills of Brockman Iron Formation also form suitable caves (Armstrong & Anstee, 2000; Cramer *et al.*, 2022).

Table 2.1: Geology units within the Study Area

Unit Name	Geological unit	Description	Extent in Study Area	
			Ha	%
Wittenoom Formation	A-HAd-kd	Thinly bedded dolomite and dolomitic shale, with minor black chert, shale, banded iron formation and sandstone	17,521.57	29.56
Brockman Iron Formation	P_-HAb-cib	Banded iron-formation, chert, mudstone, and siltstone; metamorphosed	17,413.61	29.37
Mount McRae Shale and Mount Sylvia Formation	A-HAu-xsl-ci	Mudstone, siltstone, chert, banded iron-formation, and dolomite; metamorphosed	8,724.47	14.72
Weeli Wolli Formation	P_-HAj-xci-od	Banded iron-formation (commonly jaspilitic), mudstone, siltstone, and numerous dolerite sills; metamorphosed	7,635.96	12.88
Marra Mamba Iron Formation	A-HAm-cib	Chert, banded iron-formation, mudstone, and siltstone; minor carbonate; metamorphosed	7,173.29	12.10
Jeerinah Formation	A-FOj-xs-b	Siliciclastic sedimentary rocks, mafic volcanic rocks and minor felsic volcanic rocks; local carbonate rocks, chert, and dolerite sills	814.21	1.37
Total			**59,283.12**	**100**

2.4 Soils

The CSIRO (2009) Atlas of Australian Soils described and mapped the soils of Australia following Bettany *et al.* (1967). The Study Area occurs over three soil units, Fa13 (28,407.86 ha, 47.92%), Fb3 (18,716.32 ha, 31.57%) and Fa14 (12,157.83 ha, 20.51%) (Figure 2.2). The dominant soil type, Fa13, is characterised by ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5. 11) soils on the steeper slopes. Associated are (Dr2.33 and Dr2.32) (Bettany *et al.*, 1967).

The second most dominant soil type is Fb3, which is characterised by high-level valley plains set in extensive areas of unit Fa13. There are extensive areas of pisolitic limonite deposits: principal soils are deep earthy loams (Um5.52) along with small areas of (Gn2.12) soils (Bettany *et al.*, 1967). The remainder of the Study Area is soil type Fa14, characterised by steep hills and steeply dissected pediments on areas of banded jaspilite and chert along with shales, dolomite, and iron ore formations; some narrow winding valley plains: chief soils are shallow stony earthy loams (Um5.51) along with some (Uc5.11) soils on the steeper slopes. (Dr2.33 and Dr2.32) soils which occur on the pediments are more extensive than in unit Fa13. (Um5.52) and (Uf6.71) soils occur on the valley plains (Bettany *et al.*, 1967).

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
Juna Downs Rd
Juna Downs Junction Rail
Yandicoogina Rail
Packsaddle Rd
West Angelas Rail
West Angelas Rd
MS1072
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Bedrock Geology

- P_-HAw-fr; Woongarra Rhyolite
- P-HAj-xci-od; Weeli Wolli Formation
- P-HAb-cib; Brockman Iron Formation
- AP-HAu-xsl-ci; Mount McRae Shale and Mount Sylvia Formation
- A-HAd-kd; Wittenoom Formation
- A-HAm-cib; Marra Mamba Iron Formation
- A-FO-od; Fortescue Group
- A-FOj-xs-b; Jeerinah Formation

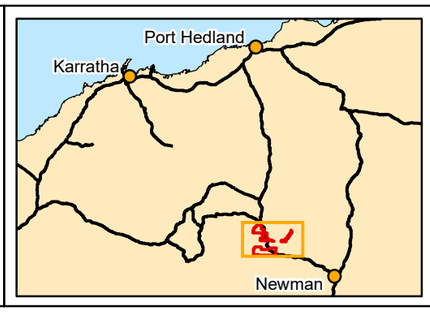
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.1: Broad Geology of the Study Area

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
MS1072
West Angelas Rd
Packsaddle Rd
Juna Downs Junction Rail
West Angelas Rail
Fb3
Fa13
Fa14
Fa15
Ja2
My55

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Soil Unit

- Fa13
- Fa14
- Fa15
- Fb3
- Ja2
- My55

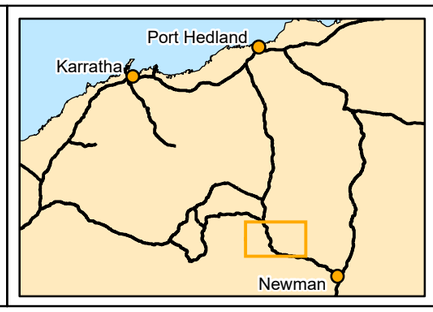
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.2: Soils of the Study Area

2.5 Land Systems

Payne *et al.* (1988) and Van Vreeswyk *et al*. (2004) classified and mapped the land systems of the Pilbara bioregion according to similarities in landform, soil, vegetation, geology and geomorphology. An assessment of land systems provides an indication of the diversity and distribution of fauna habitats present within the Study Area.

Eleven land systems occur within the Study Area, the dominant being the Boolgeeda land system, which covers approximately 51.08% (30,285.24 ha) of the Study Area (Figure 2.3; Table 2.2). The Boolgeeda land system is defined as “stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands” (van Vreeswyk *et al.*, 2004). The second most dominant is the Newman land system, covering approximately 32.26% (19,125.50 ha) of the Study Area, which is defined as “rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands”. The third most dominant system is the Wannamunna land system, accounting for 10.27% (6,091.12 ha) of the Study Area and characterised as “hardpan plains and internal drainage tracts supporting mulga shrublands and woodlands (and occasionally eucalypt woodlands)”. The remaining eight land systems account for the remaining 6.39% (3,782.17 ha) and include Platform, Robe, Egerton, McKay, Rocklea, Calcrete, River and Pindering (Figure 2.3; Table 2.2).

Of the eleven land systems occurring within the Study Area, the Newman land system contains the most significant habitats for many of the target MNES species. The rocky ridges and mountains associated with this land system can support important refugia and foraging habitats for Pilbara leaf-nosed bat, ghost bat, and northern quoll. The occurrence of this land system within the Study Area is however, patchily distributed throughout the area (Figure 2.3).

Table 2.2: Land systems of the Study Area

Land system	Land type	Description	Extent in Study Area	
			Area (ha)	%
Boolgeeda (Bgd)	Stony plains with spinifex grasslands	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	30,285.24	51.08
Newman (New)	Hills and ranges with spinifex grasslands	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	19,125.50	32.26
Wannamunna (Wnm)	Wash plains on hardpan with mulga shrublands	Hardpan plains and internal drainage tracts supporting mulga shrublands and woodlands (and occasionally eucalypt woodlands).	6,091.12	10.27
Platform (Pla)	Stony plains with spinifex grasslands	Dissected slopes and raised plains supporting hard spinifex grasslands.	3,020.89	5.10
Robe (Rob)	Mesas, breakaways and stony plains with spinifex grasslands	Low plateaux, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.	302.32	0.51
Egerton (Ege)	Stony plains with spinifex grasslands	Highly dissected hardpan plains supporting mulga shrublands and hard spinifex hummock grasslands.	197.68	0.33

Land system	Land type	Description	Extent in Study Area	
			Area (ha)	%
McKay (McK)	Hills and ranges with spinifex grasslands	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands.	86.60	0.15
Rocklea (Roc)	Hills and ranges with spinifex grasslands	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	81.74	0.14
Calcrete (Cal)	Calcrete plains with spinifex grasslands	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.	57.07	0.10
River (Riv)	River plains with grassy woodlands and tussock grasslands	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands	31.29	0.05
Pindering (Pdg)	Wash plains on hardpan with mulga shrublands	Gravelly hardpan plains supporting groved mulga shrublands with hard and soft spinifex.	4.58	0.01
Total			**59,284.03**	**100**

660000
680000
700000
720000
7480000
7460000

McKay System
Platform System
Pindering System
Calcrete System
Oakover System
Robe System
Yandi Rail Spur Line
Rocklea System
MS1039
Wannamunna System
Newman System
Yandicoogina Rail
Platform System
McKay System
River System
Boolgeeda System
Packsaddle Rd
Juna Downs Junction Rail
Juna Downs Rd
Yandicoogina Rail
Paraburdoo System
Elimunna System
Spearhole System
West Angelas Rail
Newman System
Mining Area C Railway
MS1072
Platform System
Oakover System
Calcrete System
Pindering System
Wannamunna System
Platform System
Egerton System
West Angelas Rd
Platform System
Newman System
Rocklea System
McKay System
Boolgeeda System
Jamindie System
Boolgeeda System
Egerton System
Great Northern Hwy
Rocklea System
Spearhole System
Newman System

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Land System

- Boolgeeda System
- Calcrete System
- Egerton System
- Elimunna System
- Jamindie System
- McKay System
- Newman System
- Oakover System
- Paraburdoo System
- Pindering System
- Platform System
- River System
- Robe System
- Rocklea System
- Spearhole System
- Wannamunna System

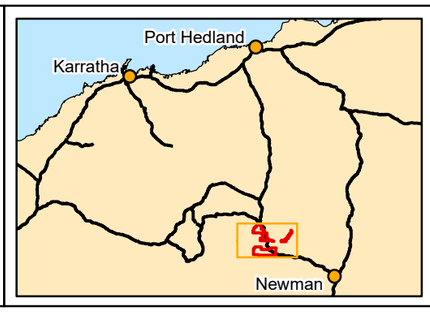
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.3: Land Systems of the Study Area

2.6 Surface Hydrology

Three major watercourses are located either within the Study Area (Marillana Creek, in the north-east) or in close proximity (Weeli Wolli Creek and Turee Creek East approximately 2 km to the south) (Figure 2.4). Yandicoogina Creek and numerous un-named tributaries of Marillana Creek also intersect the northern portion of the Study Area. The Marillana Creek flows in an easterly direction, running through the very north-eastern tip of the Study Area towards Yandicoogina Creek and Weeli Wolli Creek (approximately 8–13 km to the east of the Study Area). Marillana Creek and Yandicoogina Creek (flows to the north) are important sources of surface water runoff to Weeli Wolli Creek, which flows to the north and discharges into the Fortescue River Valley. Both Marillana Creek and Yandicoogina Creek typically only flow during the wet season following significant rainfall and are periodically subject to major flooding as a result of cyclonic weather events in the region. Marillana Creek and Yandicoogina Creek are also influenced by dewatering discharge from BHP WAIO's Yandi operations and Rio Tinto Iron Ore's Yandicoogina operations. Marillana Creek is a source of recharge to the Marillana Creek CID groundwater aquifer (WRC, 2003)

2.7 Pre-European Vegetation

Beard (1975) broadly (1:1,000,000) mapped the major structural vegetation types of Western Australia. Shepherd *et al.* (2002) reinterpreted and updated the vegetation association mapping to reflect the National Vegetation Information System (NVIS) standards (ESCAVI, 2003). This update also accounts for extensive clearing since Beard (1975) mapping.

Three vegetation associations occur within the Study Area (Table 2.3; Figure 2.5). The dominant vegetation association is HAMMERSLEY-18 which covers approximately 64.58% (38,286.11 ha) of the Study Area, followed by HAMMERSLEY-82, which covers approximately 34.24% (20,299.77 ha) of the Study Area. The remaining 1.18% (697.91 ha) of the Study Area is comprised of the HAMMERSLEY-29 association. The HAMMERSLEY-18 comprises of low Mulga woodland dominated by *Acacia aneura*.

Table 2.3: Vegetation associations within the Study Area

Vegetation Association	Description	Extent in Study Area	
		Area (ha)	%
HAMMERSLEY-18	Low woodland; mulga (*Acacia aneura*)	38,286.11	64.58
HAMMERSLEY-82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	20,299.77	34.24
HAMMERSLEY-29	Sparse low woodland; mulga, discontinuous in scattered groups	697.91	1.18
Total		**59,283.79**	**100**

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
Manillana Creek
Yandicoogina Creek
Juna Downs Rd
Juna Downs Junction Rail
Packsaddle Rd
West Angelas Rail
West Angelas Rd
MS1072
Weeli Wolli Creek
Pebble Mouse Creek
Weeli Wolli Creek

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Surface Hydrology

- Minor
- Major

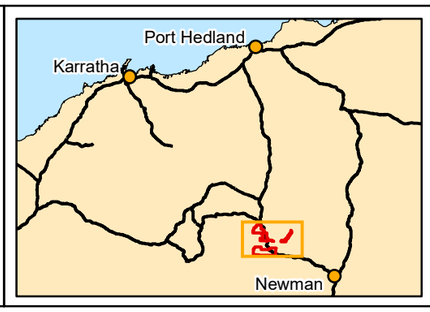
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.4: Surface hydrology of the Study Area

660000
680000
700000
720000
7480000
7460000

Juna Downs Rd
Juna Downs Junction Rail
Yandicoogina Rail
Packsaddle Rd
West Angelas Rail
Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
West Angelas Rd
MS1072
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Vegetation Association

- Hammersley 18
- Hammersley 29
- Hammersley 567
- Hammersley 82

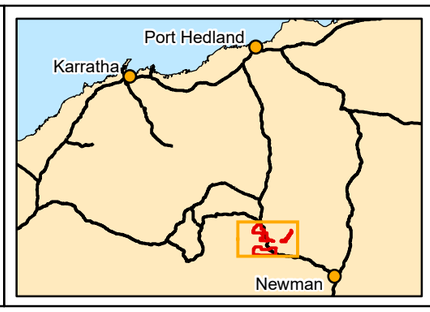
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 2.5: Pre-European vegetation assocations of the Study Area

2.8 Land Use and Tenure

The Study Area is located on two pastoral leases, the northern portion occurring on the Juna Downs Station and a small section in the north-east on Marillana Station. A small portion on the southern edge and eastern section occurs on vacant Crown Land, with the north-west section adjacent to Juna Downs Station, designated as Unallocated Crown Land. Karijini National Park is located immediately adjacent to the Study Area's western most boundary, with a small section of the Study Area located within the boundary of Karijini National Park (7.24 ha).

3 DESKTOP ASSESSMENT

3.1 Methods

A desktop assessment, comprising database searches and a literature review (Appendix A), was undertaken prior to the field survey. The purpose of the desktop assessment was to identify vertebrate fauna potentially occurring within the Study Area, with a focus on targeted MNES and other significant species.

3.1.1 Database Searches

Five fauna databases were searched (Table 3.1); three to obtain information on all species previously recorded (BHP, 2022; BirdLife Australia, 2022; DBCA, 2022a), one to identify species of significance previously recorded (DBCA, 2022b), and one to identify species of significance known or likely to occur within the region based on modelled distribution (DCCEEW, 2022).

Table 3.1: Details of database searches conducted

Database	Data Access/ Receival Date	Search Area
DBCA (2022a) NatureMap	14/03/2022	Approximate central point of the Study Area (-22.9600 S, 118.7700 E) with a 50 km buffer
DBCA (2022b) Threatened and Priority Fauna Database	14/03/2022	
BirdLife Australia (2022) Birdata	3/03/2022	
DCCEEW (2022) Protected Matters Search Tool	3/03/2022	
BHP (2022) BHP WAIO Fauna Records Database	24/05/2022	

3.1.2 Literature Review

A total of 79 assessments were reviewed, comprising 53 detailed surveys, six targeted surveys, 24 basic surveys and one desktop assessment (Table 3.2). Of the 79 assessments reviewed, 20 assessments overlapped with a portion of the Study Area, 28 assessments were within 10 km of the Study Area and the remaining 31 assessments were within 50 km (Table 3.2). Figure 3.1 illustrates the location of surveys conducted for BHP (BHP survey ID in Table 3.2) in relation to the Study Area.

Table 3.2: Literature sources used for the review

Report	BHP Survey ID	Survey Type	Distance from Study Area
Biologic (2019) Pineapple Hill Detailed Vertebrate Fauna Survey.	10216	Detailed	Within Study Area
Ecologia (1998a) Mining Area C Biological Survey.	336	Detailed	Within Study Area
ENV (2010a) Area C West NVCP Flora, Vegetation and Fauna Assessment.	374	Basic and detailed	Within Study Area
Onshore and Biologic (2011) Camp Hill Exploration Leases Level 2 Flora & Vegetation Survey and Level 1 Fauna Assessment.	381	Basic	Within Study Area
Biota (2013a) Area C West to Yandi level 2 Vertebrate Fauna Survey.	1070	Detailed	Within Study Area

Report	BHP Survey ID	Survey Type	Distance from Study Area
Biologic (2013a) Area C West Vertebrate Fauna Survey.	1086	Detailed	Within Study Area
Ecologia (2004b) Packsaddle Range Biological Survey.	357	Basic	Within Study Area
ENV (2008b) Area C West Fauna Assessment.	372	Detailed	Within Study Area
Biologic (2013d) Mudlark Vertebrate Fauna Survey.	1080	Detailed	Within Study Area
ENV (2009a) Munjina and Ministers North (Yandi Hub) Fauna Assessment.	423	Detailed	Within Study Area
Biologic (2011a) Area C and Surrounds Vertebrate Fauna Survey.	1008	Detailed	Within Study Area
Biologic (2017) Ministers North level 2 vertebrate fauna survey.	10082	Detailed	Within Study Area
Biologic (2011e) Southern Flank Vertebrate Fauna Study.	1021	Detailed	Within Study Area
Ecologia (2004a) Area C: Deposits D, E and F Biological Survey.	348	Detailed	Within Study Area
Outback Ecology (2010) Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey.	366	Detailed and basic	Within Study Area
Outback Ecology (2008) Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial Vertebrate Fauna Assessment.	344	Detailed	Within Study Area
Ecologia (2008b) Marillana Creek (Yandi) Iron Ore Mine Modification.	122	Detailed	Within Study Area
Biologic (2010) East Packsaddle Level 1 Vertebrate Fauna Study.	350	Targeted	Within Study Area
Biota (2010) Yandicoogina Junction South West and Oxbow Fauna Survey.	1187	Detailed	Within Study Area
Astron (2019) Hope Downs 2 Proposal Fauna Survey March 2019.	-	Detailed	Within Study Area
Biota (2009) Yandicoogina Targeted Northern Quoll survey.	-	Targeted	<1 km
Biologic (2018) Ministers North to Yandi Corridor Two Phase Targeted Fauna Survey.	10140	Targeted	<1 km
Ecologia (2005b) Mudlark Well Exploration Project Biological Survey.	421	Detailed	<1 km
Ecologia (2006c) Ministers North Biological Survey.	-	Basic	<1 km
Astron (2010) Packsaddle West Flora and Fauna Assessment.	-	Basic	<1 km
ENV (2008a) Area C Southern Flank Deposit Fauna Assessment.	-	Basic	<1 km
ecologia (1999) West Angelas Iron Ore Project Mine Access Road Corridor Vertebrate Fauna Assessment Survey.	-	Basic	~2 km
360 Environmental (2017) Upper Marillana and Munjina Baseline Vertebrate Fauna survey.	10084	Detailed	~2 km
HGM (1999) Marillana Creek Western Access Corridor - Biological Assessment.	-	Basic	~2 km
Ecologia (2008a) Area A and Additional Areas Level 2 Terrestrial Fauna Survey.	-	Detailed	~3 km

Report	BHP Survey ID	Survey Type	Distance from Study Area
ENV (2007a) Area C R-Deposit Fauna Assessment.	349	Detailed	~3 km
Bamford Consulting (2012b) Vertebrate Fauna Assessment of the Iron Valley Project Area	-	Detailed and targeted	~5 km
Biota (2014b) Yandi Billiards Targeted Northern Quoll Survey	-	Targeted	~5 km
Ecologia (1998c) West Angelas Iron Ore Project Vertebrate Fauna Assessment Survey	-	Detailed	~6 km
Ecologia (1997) Hope Downs Biological Survey	-	Detailed	~7 km
Ecologia (2014) Greater West Angelas Terrestrial Fauna Assessment	-	Detailed	~7 km
Ecologia (1998b) Weeli Wolli Creek Biological Assessment Survey.	101	Detailed	~8 km
Biologic (2011f) Yandi Vertebrate Fauna Review	-	Basic and targeted	~8 km
Biota (2012d) South Flank to Jinidi Level 2 Fauna Survey.	1093	Detailed	~9 km
Integrated Environmental (1980) An Ecological Appreciation of the West Angelas Environment, Western Australia 1979	-	Detailed	~9 km
Maunsell and Bamford Consulting (2003) Yandi Life of Mine Fauna and Flora	-	Basic	~9 km
Ecologia (2004c) Yandi Overland Conveyor and Stockyard Fauna and Flora Assessment	-	Flora survey with fauna desktop survey	~9 km
Biota (2005a) Fauna Habitats and Fauna Assemblage of Deposits E and F at West Angelas Survey	-	Detailed	~9 km
Biologic (2012) Jinidi to Mainline Vertebrate Fauna Survey.	1065	Detailed	~9 km
Biologic (2013e) Targeted conservation significant fauna survey- Karijini tenement E47/17	-	Basic targeted	~10 km
Bamford Consulting (2012a) Fauna Assessment Nyidinghu Iron Ore Project	-	Detailed	~10 km
Biota (2014a) Yandi Billiards Phase 1 Seasonal Fauna Survey	-	Detailed	~10 km
Ecologia (1995) Yandi Stage II Iron Ore Project: Biological Assessment Survey	-	Detailed	~10 km
ENV (2010b) Jinayri Access Road Vertebrate Fauna Survey.	499	Detailed	~11 km
Biologic (2011c) Barimunya Camp Vertebrate Fauna Survey	-	Basic	~12 km
Phoenix (2014) Terrestrial Fauna Survey for the Extension Project	-	Basic	~13 km
Ecologia (2006b) Marillana Terrestrial Vertebrate Fauna Survey.	408	Detailed	~13 km
Biologic (2013c) Marillana Vertebrate Fauna Survey.	1077	Detailed	~13 km
ENV (2008c) Jinayri Vertebrate Fauna Assessment.	1010	Detailed	~14 km
Biota (2013b) South Parmelia Vertebrate Fauna Survey.	1224	Detailed	~15 km
Biologic (2011b) Area C to Yandi Fauna Survey	-	Basic	~15 km

Report	BHP Survey ID	Survey Type	Distance from Study Area
Ecologia (2005c) Upper Marillana Exploration Project Biological Survey.	115	Basic	~15 km
ENV (2007d) Upper Marillana Exploration Lease Fauna Assessment	-	Basic	~16 km
Ecologia (2006a) Jirridi Terrestrial Vertebrate Fauna Survey.	497	Detailed	~16 km
ENV (2011) Upper Marillana and Munjina Flora, Vegetation and Fauna Assessment	-	Basic	~18 km
ENV (2010c) Jinayri Mining Lease Vertebrate Fauna Survey	-	Detailed	~19 km
Biota (2005c) Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas.	1242	Detailed	~19 km
Biota (2012b) Koodaideri Project Targeted Fauna Survey	-	Detailed	~20 km
Biota (2012a) Koodaideri Northern Extension Fauna Survey	-	Detailed	~20 km
Biota (2012c) Koodaideri Southern Infrastructure Corridor Fauna Survey	-	Detailed	~20 km
Rapallo (2012) Level 2 Fauna Survey and Targeted Northern Quoll Survey of the Lamb Creek	-	Detailed	~20 km
Biologic (2011d) Jinidi Vertebrate Fauna Survey	-	Basic	~21 km
Biota (2012c) Rapid Growth Project 5: M270SA Fauna Assessment	-	Basic	~22 km
ENV (2007c) Mindy North Exploration Lease Fauna Assessment.	411	Basic	~23 km
Ecologia (2005a) Mindy-Coondiner Exploration Project Biological Survey.	413	Basic	~24 km
Ecologia (2009) Marillana Iron Ore Project Vertebrate Fauna Assessment	-	Detailed	~24 km
Biota (2004) Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor	-	Detailed	~28 km
ENV (2009b) Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment	-	Basic	~33 km
Ninox (2009) A Vertebrate Fauna Survey of the Proposed Hope Downs 4 Mining Area, Near Newman, Western Australia.	1243	Detailed	~39 km
Biota (2002) Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate Fauna Survey	-	Detailed	~45 km
Biota (2008) Marandoo Mine Phase 2 Seasonal Fauna Survey	-	Detailed	~47 km
ENV (2007b) Coondiner and Mindy East Exploration Leases Fauna Assessment.	386	Detailed	~47 km
ENV (2008e) RGP5: Quarry 6 Fauna Assessment	-	Basic	~48 km
Bamford Consulting (2005) Fauna Survey of Proposed Iron Ore Mine, Cloud Break.	1166	Detailed and targeted	~49 km

650000 700000 750000 800000

7500000

7450000

Nanutarra Munjina Rd

Karijini Dr

Great Northern Hwy

1166
10084
423
115
408
1077
1065
1070
122
MS1039
411
10216
413
10140
122
1187
411
423
10082
381
1242
366
1086
357
354
499
348
336
344
101
MS1072
1008
386
413
349
1021
1010
372
374
1093
497
1224
372
421
1080
421
1243

Legend

- Study Area
- Approval Boundary
- State Road
- Rail

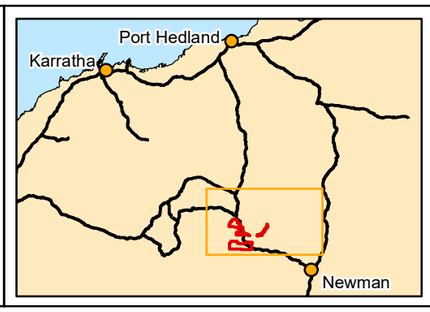
N

biologic Environmental Survey

Scale: 1:425,000

0 10 20 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 3.1: Previous fauna surveys within 50 km of the CPH Study Area

Legend

Year - Survey ID - Report Title

- 2019 - 10216 - Pineapple Hill Level 2 Vertebrate Fauna Survey
- 2017 - 10082 - Ministers North Level 2 Vertebrate Fauna Survey
- 2017 - 10084 - Upper Marillana and Munjina Baseline Vertebrate Fauna Survey
- 2017 - 10140 - Ministers North to Yandi Corridor Level 2 Vertebrate Fauna survey
- 2013 - 1224 - South Parmelia Level 2 Vertebrate Fauna survey
- 2013 - 1070 - Area C West to Yandi Level 2 Vertebrate Fauna
- 2013 - 1086 - Area C West Vertebrate Fauna Survey
- 2013 - 1080 - Mudlark Vertebrate Fauna Study
- 2013 - 1077 - Marillana Vertebrate Fauna Survey
- 2012 - 1093 - South Flank to Jinidi Level 2 Vertebrate Fauna Survey
- 2011 - 381 - Camp Hill Flora and Vegetation Survey Report and Fauna Assessment
- 2011 - 1021 - Southern Flank Vertebrate Fauna Study
- 2011 - 1008 - Area C and Surrounds Vertebrate Fauna Survey
- 2011 - 1065 - Jinidi to Mainline Vertebrate Fauna Survey
- 2010 - 499 - Jinayri Access Road Vertebrate Fauna Survey
- 2010 - 374 - Area C West NVCP Flora Vegetation and Fauna
- 2010 - 1187 - Yandicoogina Junction South West Oxbow Fauna Survey
- 2009 - 366 - Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna
- 2009 - 1243 - Fauna Survey of Proposed Hope Downs 4 Mining Area
- 2009 - 423 - Munjina and Minsters North (Yandi Hub) Fauna Assessment
- 2008 - 372 - Area C West Fauna
- 2008 - 344 - Area C Deposit A, D, P1 and P3 Vertebrate Fauna Survey Outback
- 2008 - 1010 - Jinayri Vertebrate Fauna Assessment
- 2008 - 122 - Marillana Creek (Yandi) Iron Ore Mine Modification Level 2 Fauna Survey
- 2007 - 386 - Coondiner and Mindy East Exploration Lease Fauna Assessment
- 2007 - 411 - Mindy North Exploration Lease Fauna Assessment
- 2007 - 349 - Area C Deposit R Fauna
- 2006 - 497 - Jirridi Terrestrial Fauna Survey
- 2006 - 408 - Marillana Terrestrial Vertebrate Fauna Survey
- 2005 - 115 - Upper Marillana Exploration Project Biological Survey
- 2005 - 421 - Mudlark Well Exploration Project Biological Survey
- 2005 - 1242 - Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas.
- 2005 - 413 - Minidy-Coondiner Exploration Project Biological Survey
- 2005 - 1166 - Fauna Survey of Proposed Iron Ore Mine Cloud Break
- 2004 - 357 - Area C Packsaddle Range Biological Survey
- 2004 - 348 - Area C Deposits D, E and F Biological Survey
- 2001 - 354 - Area C Packsaddle Vertebrate Fauna
- 1998 - 101 - Weeli Wolli Creek Biological Assessment Survey
- 1998 - 336 - Mining Area C Biological Survey

biologic Environmental Survey

3.2 Results

In addition to the seven target MNES species (Figure 3.2), a further 26 significant species were identified in the desktop assessment as having previously been recorded and/ or have the potential to occur within the Study Area (Figure 3.3). Overall, the 33 total significant species identified in the desktop assessment comprised 10 mammals, 15 birds and eight reptiles (Table 3.3; Appendix B). Of the 33 species, 15 have previously been recorded within the Study Area:

- northern quoll (*Dasyurus hallucatus*) – Endangered (EPBC/BC Act);
- ghost bat (*Macroderma gigas*) – Vulnerable (EPBC/BC Act);
- northern short-tailed mouse (*Leggadina lakedownensis*) – Priority 4 (DCBA);
- western pebble-mound mouse (*Pseudomys chapmani*) – Priority 4 (DCBA);
- Pilbara leaf-nosed bat (*Rhinonicteris aurantius* 'Pilbara form') – Vulnerable (EPBC/BC Act);
- letter-winged kite (*Elanus scriptus*) – Priority 4 (DCBA);
- eastern osprey (*Pandion haliaetus*) – Migratory (EPBC/BC Act);
- fork-tailed swift (*Apus pacificus*) – Migratory (EPBC/BC Act);
- grey falcon (*Falco hypoleucos*) – Vulnerable (EPBC/BC Act);
- peregrine falcon (*Falco peregrinus*) – Specially Protected (BC Act);
- wood sandpiper (*Tringa glareola*) – Migratory (EPBC/BC Act);
- common greenshank (*Tringa nebularia*) – Migratory (EPBC/BC Act);
- Pilbara barking gecko (*Underwoodisaurus seorsus*) – Priority 2 (DCBA);
- Pilbara olive python (*Liasis olivaceus* subsp. *barroni*) – Vulnerable (EPBC/BC Act); and
- Pilbara flat-headed blind-snake (*Anilios ganei*) – Priority 1 (DCBA).

The remaining 18 species have previously been recorded within a 50 km radius of the Study Area (Table 3.3). Several of these records may be inaccurate as the Study Area is outside of the distribution of the species of concern, e.g. north-western free-tailed bat, dwarf bearded dragon, Gunther's skink and lined soil-crevice skink (Table 3.3). The northern brushtail possum (*Trichosurus vulpecula* subsp. *arnhemensis*) (Vulnerable EPBC/BC Act) was previously recorded once (0.8 km outside of the Study Area, just south of the Camp Hill area). However, recent molecular analysis indicates that the population of the Pilbara region represents a different species to *Trichosurus vulpecula arnhemensis* (Biologic, 2021b).

In total, the desktop assessment identified 409 vertebrate fauna species, which have previously been recorded within or have the potential to occur within the Study Area, comprising 68 mammals, 181 birds, 149 reptiles and 11 amphibians.

Table 3.3: Species of significance with the potential to occur over the Study Area

Scientific Name	Common name	Conservation Status				Recorded within Study Area
		EPBC	BC	DBCA	IUCN	
Mammals						
Dasyuridae						
Dasycercus blythi	Brush-tailed mulgara			P4		
Dasyurus hallucatus	Northern quoll	EN	EN		EN	X
Sminthopsis longicaudata	Long-tailed dunnart			P4		
Megadermatidae						
Macroderma gigas	Ghost bat	VU	VU		VU	X
Molossidae						
Ozimops cobourgianus	North-western free-tailed bat			P1		
Muridae						
Leggadina lakedownensis	Northern short-tailed mouse			P4		X
Pseudomys chapmani	Western pebble-mound mouse			P4		X
Phalangeridae						
Trichosurus vulpecula subsp. arnhemensis	Northern brushtail possum	VU	VU			
Rhinonycteridae						
Rhinonicteris aurantius 'Pilbara form'	Pilbara leaf-nosed bat	VU	VU			X
Thylacomyidae						
Macrotis lagotis	Greater bilby	VU	VU		VU	
Birds						
Accipitridae						
Elanus scriptus	Letter-winged kite			P4	NT	X
Pandion haliaetus	Eastern osprey	MI	MI			X
Apodidae						
Apus pacificus	Fork-tailed swift	MI	MI			X
Ciconiidae						
Ephippiorhynchus asiaticus	Black-necked stork				NT	
Falconidae						
Falco hypoleucos	Grey falcon	VU	VU		VU	X
Falco peregrinus	Peregrine falcon		OS			X
Laridae						
Sterna caspia	Caspian tern	MI	MI			
Gelochelidon nilotica	Gull-billed tern	MI	MI			
Psittacidae						
Pezoporus occidentalis	Night parrot	EN	CR		EN	
Rostratulidae						
Rostratula australis	Australian Painted Snipe	EN	EN		EN	
Scolopacidae						
Calidris ferruginea	Curlew sandpiper	CR/MI	CR/MI		NT	

Scientific Name	Common name	Conservation Status				Recorded within Study Area
		EPBC	BC	DBCA	IUCN	
Tringa glareola	Wood sandpiper	MI	MI			X
Actitis hypoleucos	Common sandpiper	MI	MI			
Tringa nebularia	Common greenshank	MI	MI			X
Threskiornithidae						
Plegadis falcinellus	Glossy ibis	MI	MI			
Reptiles						
Agamidae						
Pogona minor minima	Dwarf bearded dragon		VU			
Carphodactylidae						
Underwoodisaurus seorsus	Pilbara barking gecko			P2		X
Pythonidae						
Liasis olivaceus subsp. *barroni*	Pilbara olive python	VU	VU			X
Scincidae						
Ctenotus uber subsp. *Johnstonei*	Spotted ctenotus			P2		
Cyclodomorphus branchialis	Gunther's skink		VU		NT	
Lerista macropisthopus remota	Unpatterned robust slider			P2		
Notoscincus butleri	Lined soil-crevice skink			P4		
Typhlopidae						
Anilios ganei	Pilbara Flat-headed Blind-snake			P1		X

550000 600000 650000 700000 750000 800000

7500000 7450000 7400000

Nanutarra Munjina Rd
Karijini Dr
Marble Bar Rd
Nanutarra Munjina Rd
Manuwarra Red Dog Hwy
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
Newman
Great Northern Hwy

BHP (2022)

Bird
- Grey falcon - VU

Mammal
- Northern quoll - EN
- Ghost bat - VU
- Greater bilby - VU
- Pilbara leaf-nosed bat - VU

Reptile
- Pilbara olive python - VU

DBCA (2022)

Bird
- Grey falcon - VU

Mammal
- Northern quoll - EN
- Ghost bat - VU
- Greater bilby - VU
- Pilbara leaf-nosed bat - VU

Reptile
- Pilbara olive python - VU

Legend

- Study Area
- Desktop Assessment Area
- State Road
- Rail

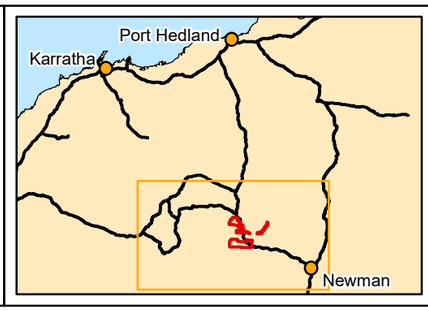
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 3.2: Targeted MNES fauna records from the desktop assessment

650000 700000 750000 800000 850000

7500000

7450000

7400000

Nanutarra Munjina Rd

Karijini Dr

Great Northern Hwy

Newman

BHP (2022)

Bird

- Common greenshank - MI
- Eastern osprey - MI
- Fork-tailed swift - MI
- Gull-billed tern - MI
- Wood sandpiper - MI
- Peregrine falcon - OS

Mammal

- Western pebble-mound mouse - P4

Reptile

- Pilbara flat-headed blind-snake - P1
- Pilbara barking gecko - P2

DBCA (2022)

Bird

- Letter-winged kite - P4
- Caspian tern - MI
- Common greenshank - MI
- Eastern osprey - MI
- Fork-tailed swift - MI
- Glossy ibis - MI
- Gull-billed tern - MI
- Southern giant petrel - MI
- Wood sandpiper - MI
- Peregrine falcon - OS

Mammal

- Brush-tailed mulgara - P4
- Northern short-tailed mouse - P4
- Western pebble-mound mouse - P4

Reptile

- Pilbara flat-headed blind-snake - P1
- Pilbara barking gecko - P2
- Unpatterned robust slider - P2

Legend

- Study Area
- Desktop Assessment Area
- State Road
- Rail

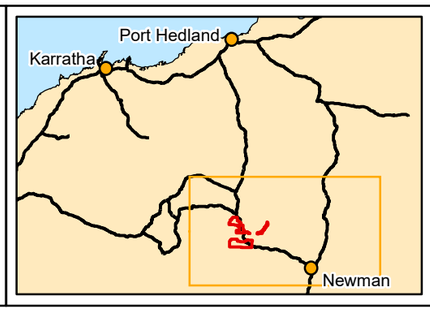
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 03/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 3.3: Additional significant fauna records from the desktop assessment

4 GENERAL FIELD METHODS

4.1 Survey Timing and Personnel

Due to the size of the Study Area, the field survey was undertaken over five separate field trips, with areas of focus during each trip determined by BHP WAIO survey priorities (Table 4.1, Figure 1.1). A helicopter was utilised to assist with sampling, particularly for the remote areas for 1-2 days during each field trip.

Table 4.1: Details of field surveys undertaken

Field trip #	Dates	Duration (days)	Area targeted
1	11th - 15th November 2021	5	Pineapple Hill
2	23rd - 28th November 2021	6	Pineapple Hill
3	4th - 13th April 2022	10	Within and surrounding the high priority survey areas within the MAC to Yandi rail corridor and Camp Hill area (northern areas)
4	27th April - 6th May 2022	10	Mudlark Well (southern section)
5	25th - 30th May 2022	6	Retrieval of any equipment not yet retrieved, as well as infill sampling, targeted searches and nocturnal searches throughout the Study Area

The field survey was led by Andrew Hide who has 16 years of experience undertaking fauna surveys, including surveys of a similar scope within the Pilbara region. The field personnel who contributed to the current field survey collectively have over 30 years of experience undertaking fauna surveys within the Pilbara region, including targeted surveys for the MNES that were the focus of this assessment (Table 4.2).

Table 4.2: Survey personnel and experience

Personnel	Position and Role	Qualification	Experience
Andrew Hide	Senior Zoologist	BSc (Hons) Natural Resource Management	16 years' EIA (consulting) 16 years' field survey 16 years' vertebrate zoology/ ecology
Thomas Rasmussen	Senior Zoologist		17 years' EIA (consulting) 17 years' field survey 17 years' vertebrate zoology/ ecology
Sam Lostrom	Senior Zoologist	BSc (Hons) Marine Biology and Zoology	5 years' EIA (consulting) 7 years' field survey 7 years' vertebrate zoology/ ecology
Andrew McCreery	Senior Zoologist	BSc (Hons) Environmental Science and Conservation Biology	9 years' EIA (consulting) 10 years' field survey

Personnel	Position and Role	Qualification	Experience
			10 years' vertebrate zoology/ ecology
Jari Cornelis	Zoologist	MSc Philosophy, BSc Zoology and Ecology	4 years' EIA (consulting) 5 years' field survey 5 years' vertebrate zoology/ ecology
Aleesha Turner	Zoologist	BSc Applied Science (Wildlife Biology) (Hons)	2 years' EIA (consulting) 3 years' field survey 3 years' vertebrate zoology/ ecology
Sam Edwards	Zoologist	BSc Environmental Management and Sustainability	1 years' EIA (consulting) 3 years' field survey 1 years' vertebrate zoology/ ecology
Georgina Mattner	Zoologist	BSc Animal Ecology	1 years' EIA (consulting) 5 years' field survey 1 years' vertebrate zoology/ ecology

The survey was conducted under the *Animal Welfare Act 2002*'s Licence to use animals for scientific purposes (License No. U244/2022-2024), administered through the Department of Primary Industries and Regional Development (DPIRD). This is enabled through Biologic's chosen Animal Ethics Committee (AEC), Murdoch University, under permit RW3354/21. DBCA Regulation 27 "Fauna Taking (Biological Assessment) Licence", issued to Chris Knuckey (licence number BA27000560). Under Section 40 of the BC Act, threatened species sampling was completed under a DBCA "Authorisation to Take or Disturbed Threatened Species" issued to Chris Knuckey (authorisation number TFA 2021-0138).

4.2 Climate and Weather

Current climatic data for the Study Area (MAC) was provided by BHP WAIO. Long-term climatic data is not available for the Study Area itself; however, long-term data is available from the Bureau of Meteorology (BoM) weather station at Newman Aero (Station 007176), located approximately 110 km north-west of the Study Area (BoM, 2022). The Newman Aero weather station is expected to provide the most accurate long-term average (LTA) dataset for climatic conditions experienced within the Study Area).

In the 6 months prior to the November 2021 and May 2022 surveys, minimum and maximum temperatures recorded at MAC were similar to the long-term averages for most months (Figure 4.1). Rainfall was generally below the long-term average in the months preceding the November 2021 survey but generally above average prior to the May 2022 surveys (Figure 4.1). In total, the rainfall received at MAC in the Study Area in the 12 months prior to the surveys (November 2020 to October 2021, 511.4 mm) was above the annual long-term average for the same period (314.5 mm), mainly due to unusually high rainfall caused by a tropical low recorded in February 2021. Observed maximum and minimum temperatures and total rainfall recorded during the survey are provided in Table 4.3.

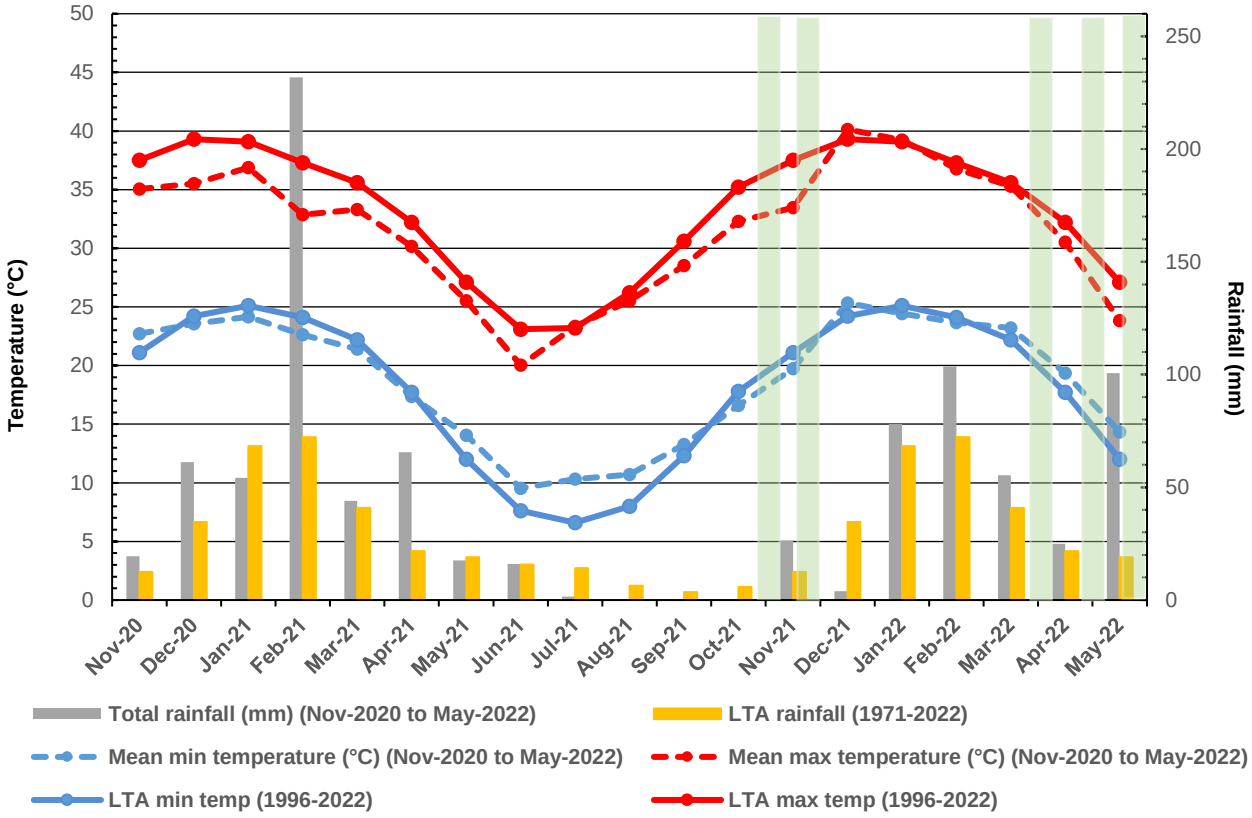


Figure 4.1: Long-term climatic data for Newman Airport (BoM, 2022) and current climatic data for MAC (data provided by BHP WAIO) with approximate survey timing of the five trips shown in green shaded box

Table 4.3: Climatic conditions recorded for MAC (data provided by BHP WAIO) during the surveys

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
Trip 1 – November 2021			
11/11/2021	15.0	28.8	0.0
12/11/2021	15.9	29.6	0.0
13/11/2021	17.8	31.2	0.0
14/11/2021	20.4	33.3	0.0
15/11/2021	19.8	35.1	0.0
Mean temp/ total rainfall	**17.78**	**31.6**	**0.0**
Trip 2 – November 2021			
23/11/2021	17.8	31.8	0.0
24/11/2021	20.1	32.0	0.0
25/11/2021	19.3	32.4	0.0
26/11/2021	19.4	32.6	0.0
27/11/2021	20.8	34.4	0.0
28/11/2021	23.3	35.7	0.0
Mean temp/ total rainfall	**20.1**	**33.2**	**0.0**

Date	Min. temp (°C)	Max. temp (°C)	Rainfall (mm)
Trip 3 – April 2022			
4/04/2022	20.1	33.2	0.8
5/04/2022	20.5	33.2	0.0
6/04/2022	20.6	31.5	0.0
7/04/2022	20.7	32.3	0.0
8/04/2022	21.4	33.5	0.0
9/04/2022	22.2	34.0	0.0
10/04/2022	18.2	34.0	0.0
11/04/2022	17.2	33.1	0.0
12/04/2022	15.8	32.1	0.0
13/04/2022	18.8	32.8	0.0
Mean temp/ total rainfall	**19.6**	**33.0**	**0.8**
Trip 4 – April/ May 2022			
27/04/2022	20.1	24.5	0.0
28/04/2022	16.2	22.4	11.2
29/04/2022	16.6	22.4	0.0
30/04/2022	17.0	21.9	0.0
1/05/2022	16.0	24.1	1.0
2/05/2022	16.6	26.5	0.0
3/05/2022	14.2	28.6	0.0
4/05/2022	18.2	27.5	0.0
5/05/2022	14.2	24.1	0.0
6/05/2022	13.2	24.6	0.0
Mean temp/ total rainfall	**16.2**	**24.7**	**12.2**
Trip 5 – May 2022			
25/05/2022	10.8	23.6	0.2
26/05/2022	13.3	25.5	0.0
27/05/2022	16.6	20.7	0.0
28/05/2022	16.4	23.0	1.0
29/05/2022	14.9	17.5	17.4
30/05/2022	9.0	16.2	6.0
Mean temp/ total rainfall	**13.5**	**21.1**	**24.6**

4.3 Habitat Assessments and Mapping

A total of 291 habitat assessments were undertaken in the field to define and delineate broad fauna habitats present and their suitability to species of significance. Habitat assessments were undertaken at all sampling locations and opportunistically where changes and/or variation in habitats occur to achieve representative coverage of the whole Study Area. Habitat assessments were conducted and attributes assessed using attribute terminology prescribed by BHP, which have been modified from the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009). The characteristics recorded during the habitat assessments were:

- site information, photo and location;
- landform: slope, relative inclination of slope, morphological type and landform type;
- vegetation: leaf litter %, wood litter, hollow bearing trees and dominant species;
- land surface: abundance and size of coarse fragments, rock outcropping, water bodies;
- substrate: bare ground, rock size, rock type, rock outcropping, soil texture and colour; and
- disturbance: time since last fire, evidence of weeds, grazing, or human disturbances.

Fauna habitat in the Study Area was mapped using the vertebrate fauna habitat assessments completed during the field surveys in conjunction with previously completed mapping, as well as high-resolution aerial imagery, vegetation, topographical, geology and soil mapping. Categories followed those defined by BHP WAIO (2022). Habitats were delineated and mapped across the Study Area at a scale of approximately 1:25,000.

4.4 Targeted Searching and Sampling

The methods used during the survey were specific to each targeted species and comprised:

- northern quoll camera traps and scat searches;
- Pilbara leaf-nosed bat and ghost bat ultrasonic recorders;
- Pilbara leaf-nosed bat and ghost bat roost searches;
- greater bilby plot searches;
- night parrot acoustic recorders; and
- Pilbara olive python searches.

Further discussion of the specific methods, as related to each of the target species, is provided in Section 6 (Figure 4.2).

4.5 Opportunistic Fauna Records

At all times while surveying, any opportunistic fauna observations within the Study Area were recorded, particularly of any significant species. These records included those from primary (i.e. direct observation of species) or secondary (e.g., burrows, scratching's, diggings and scats) evidence.

4.6 Assessment of Significance

4.6.1 Fauna Habitats

Habitat units were categorised as providing critical, supporting or nil habitat for MNES species confirmed or likely to occur. The categorisation of critical and supporting habitat followed that of BHP WAIO (2022). Due to differing habitat preferences of significant species (including habitat features and/or microhabitats), habitat significance was assessed on a species-by-species basis.

It should be noted that assessment of habitat significance applies only to habitat occurring within the Study Area, and therefore may not be representative of significance applied to the same habitat in other areas outside the Study Area. For example, a habitat within the Study Area may be deemed unsuitable due to the absence of certain habitat features and/ or suitable connecting habitat (e.g. wildlife movement corridors) which are required for the species persistence, despite the same habitat occurring outside the Study Area being considered of greater significance. The significance of habitats within the Study Area may also be influenced by other habitats occurring within the Study Area and more broadly, including areas adjacent to the Study Area, particularly if representative of critical habitat.

4.6.2 Significance of Species Occurrence

For the target species, an assessment was made on the significance of their occurrence based on the most relevant and prescriptive guidance documents relative to each species. For northern quoll the significance of occurrence was based on definitions of the DoE (2016), specifically whether the individuals present in the Study Area were representative of a “populations important for the long-term survival of the northern quoll”. These are populations that are:

- high density quoll populations, which occur in refuge-rich habitat critical to the survival of the species, including where cane toads are present;
- occurring in habitat that is free of cane toads and unlikely to support cane toads upon arrival i.e. granite habitats in WA, populations surrounded by desert and without permanent water; and/or
- subject to ongoing conservation or research actions i.e. populations being monitored by government agencies or universities or subject to reintroductions or translocation.

For the greater bilby, ghost bat and Pilbara olive python (species listed as vulnerable under the EPBC Act, but with no specific criteria to assess significance of occurrence), the significance of occurrence was based on criteria defined by DoE (2013), specifically whether their occurrence in the Study Area represented an ‘important population’. An ‘important population’ is a population that is necessary for a species’ long-term survival and recovery - this may include populations identified as such in recovery plans, and/or that are DoE (2013):

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

For the Pilbara leaf-nosed bat, the entire Pilbara is suggested to represent an 'important population' (TSSC, 2016c). Thus the significance of occurrence was based on the presence of Priority 1 and 2 refuges (Permanent Diurnal Roosts and Non-permanent Breeding Roosts) (TSSC, 2016c).

For the night parrot, the significance of occurrence was based on definitions by the DoE (2013), specifically the presence of a 'population'. A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area, including, but are not limited to:

- a geographically distinct regional population, or collection of local populations; or
- a population, or collection of local populations, that occurs within a particular bioregion.

660000 670000 680000 690000 700000

7480000

VPIH-005
VCPH-202
VCPH-203
VCPH-191
VCPH-190
VPIH-023
VPIH-020
VPIH-002
VPIH-021
VPIH-015
VPIH-016
VPIH-013
VPIH-012
VPIH-018
VCPH-204
VCPH-073
VCPH-205
VPIH-017
VPIH-001
VCPH-072
VPIH-010
VPIH-003
VPIH-022
VPIH-004
VPIH-007
VPIH-014
VPIH-009
VPIH-008
VCPH-206
VCPH-060
VPIH-024
VCPH-198
VPIH-011
VCPH-197
VCPH-057
VPIH-006
VCPH-071
VPIH-019
VPIH-025
VCPH-189
VPIH-026
VCPH-045
VCPH-004
VCPH-024
VCPH-044
VCPH-080
VCPH-081
VCPH-084
VCPH-043
VCPH-083
VCPH-079
VCPH-052
VCPH-029
VCPH-030
VCPH-042
VCPH-031
VCPH-006
VCPH-051
VCPH-032
VCPH-040
VCPH-036
VCPH-188
VCPH-033
VCPH-035
VCPH-038
VCPH-034
VCPH-039
VCPH-037
VCPH-047
VCPH-008
VCPH-048
VCPH-021
VCPH-050
VCPH-010
VCPH-070
VCPH-199
VCPH-192
VCPH-064
VCPH-176
VCPH-002
VCPH-082
VCPH-049
VCPH-028
VCPH-046
MS1072

Great Northern Hwy
Yandicoogina Rail
Packsaddle Rd
West Angelas Rail
West Angelas Rd

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Sampling Method

- Acoustic Recorder
- Bilby Plot
- Camera Trap
- Habitat Assessment
- Nocturnal Search
- Targeted Search
- Ultrasonic Recorder

N

biologic Environmental Survey

Scale: 1:110,000

0 2 4 6 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022

BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 4.2a: Vertebrate fauna sampling in the Study Area - Pineapple Hill and Camp Hill

700000
710000
720000
7480000
7470000

MS1039
VYAN-41
VYAN-31
Yandicoogina Rail
VCPH-013
VCPH-056
VCPH-054
VCPH-058
VCPH-026
VCPH-055
VCPH-001
VCPH-007
VCPH-022
VCPH-017
VCPH-027
VCPH-015
VCPH-062
VCPH-063
VCPH-061
VCPH-020
VCPH-003
VCPH-107
VCPH-023
VCPH-019
VCPH-009
VCPH-018
VCPH-059
VCPH-016
VCPH-014
VCPH-005
VCPH-025
West Angelas Rd
Mining Area C Railway
VCPH-011
VCPH-053
VCPH-012
MS1072
C Railway

Legend

- Study Area
- Approval Boundary
- Local Road
- Rail

Sampling Method

- Acoustic Recorder
- Bilby Plot
- Camera Trap
- Habitat Assessment
- Nocturnal Search
- Targeted Search
- Ultrasonic Recorder

N

biologic Environmental Survey

Scale: 1:80,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022

BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 4.2b: Vertebrate fauna sampling in the Study Area - MAC to Yandi Rail Corridor

670000 680000 690000

7450000

7440000

Great Northern Hwy

MS1072

VCPH-131 VCPH-180 VCPH-065 VCPH-195 VCPH-124 VCPH-123 VCPH-125 VCPH-130 VCPH-173 VCPH-158 VCPH-243 VCPH-121 VCPH-156 VCPH-087 VCPH-174 VCPH-157 VCPH-066 VCPH-155 VCPH-154 VCPH-179 VCPH-172 VCPH-068 VCPH-102 VCPH-101 VCPH-077 VCPH-171 VCPH-170 VCPH-128 VCPH-104 VCPH-148 VCPH-100 VCPH-152 VCPH-103 VCPH-099 VCPH-105 VCPH-151 VCPH-150 VCPH-153 VCPH-149 VCPH-146 VCPH-088 VCPH-098 VCPH-097 VCPH-078 VCPH-200 VCPH-067 VCPH-160 VCPH-133 VCPH-132 VCPH-120 VCPH-183 VCPH-119 VCPH-116 VCPH-181 VCPH-246 VCPH-248 VCPH-247 VCPH-245 VCPH-249 VCPH-201 VCPH-250 VCPH-244 VCPH-106 VCPH-129 VCPH-076 VCPH-178 VCPH-242 VCPH-224 VCPH-182 VCPH-232 VCPH-231 VCPH-220 VCPH-218 VCPH-085 VCPH-075 VCPH-147 VCPH-145 VCPH-139 VCPH-143 VCPH-137 VCPH-096 VCPH-093 VCPH-095 VCPH-141 VCPH-135 VCPH-094 VCPH-136 VCPH-134 VCPH-138 VCPH-089 VCPH-090 VCPH-086 VCPH-115 VCPH-114 VCPH-234 VCPH-113 VCPH-112 VCPH-233 VCPH-111 VCPH-175 VCPH-227 VCPH-207 VCPH-184 VCPH-185 VCPH-235 VCPH-186 VCPH-209 VCPH-230 VCPH-110 VCPH-228 VCPH-229 VCPH-108 VCPH-109 VCPH-069 VCPH-122 VCPH-144 VCPH-142 VCPH-140 VCPH-117 VCPH-127 VCPH-126 VCPH-193 VCPH-118 VCPH-196 VCPH-194 VCPH-251 VCPH-252 VCPH-177 VCPH-239 VCPH-253 VCPH-240 VCPH-241 VCPH-221 VCPH-187 VCPH-219 VCPH-217 VCPH-215 VCPH-222 VCPH-074 VCPH-223 VCPH-159 VCPH-168 VCPH-169 VCPH-092 VCPH-161 VCPH-162 VCPH-091 VCPH-163 VCPH-166 VCPH-165 VCPH-164 VCPH-167 VCPH-225

Legend

- Study Area
- Approval Boundary
- State Road
- Rail

Sampling Method

- Acoustic Recorder
- Bilby Plot
- Camera Trap
- Habitat Assessment
- Targeted Search
- Ultrasonic Recorder

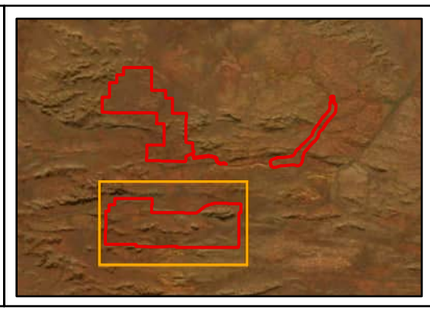
N

biologic Environmental Survey

Scale: 1:90,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 4.2c: Vertebrate fauna sampling in the Study Area - Mudlark Well

5 FAUNA HABITATS

5.1 Fauna Habitats of the Study Area

A total of 11 broad fauna habitat types were recorded and mapped across the Study Area, comprising in decreasing extent of occurrence: Stony Plain (35.51%, 21,051.01 ha), Hillcrest/ Hillslope (23.89%, 14,160.00 ha), Drainage Area/ Floodplain (16.27%, 9,644.57 ha), Mulga Woodland (6.82%, 4,043.20 ha), Hardpan Plain (4.21%, 2,495.29 ha), Undulating Low Hills (3.34%, 1,979.59 ha), Minor Drainage Line (2.77%, 1,639.45 ha), Gorge/ Gully (2.64%, 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha), Medium Drainage Line (0.61%, 362.20 ha) and Major Drainage Line (0.09%, 54.94 ha) (Figure 5.1). The remaining 2.41% (1,428.48 ha) of the Study Area comprised Cleared/ Disturbed areas. Descriptions of the distinguishing characteristics and the occurrence within the Study Area for each of these habitat types are presented in Table 5.1, and the data from on-site habitat assessments are presented in Appendix C.

Of the 11 broad fauna habitats occurring within the Study Area, Gorge/ Gully, Breakaway/ Cliff, Major Drainage Line and Drainage Area/ Floodplain all provide critical habitat for MNES species, including northern quoll, ghost bat, Pilbara leaf-nosed bat, Pilbara olive python and grey falcon (Table 5.1). These habitats provide critical breeding, roosting, foraging and dispersal habitat for some or all of the target species to various extents. Within these habitats, critical breeding, roosting, foraging and dispersal habitat for northern quoll, ghost bat, Pilbara leaf-nosed bat, and Pilbara olive python, occur particularly in areas with caves and overhangs (within Gorge/ Gully, Breakaway/ Cliff habitat) or where pooling water occurs for prolonged periods following rainfall events (within Major Drainage Line and Gorge/ Gully habitat). These habitats may be relied upon by these species for long-term survival within the Study Area, particularly when suitable caves and water features occur within these habitats. Major Drainage Line habitat provides the grey falcon with critical breeding, roosting and foraging habitat while supporting habitat is provided by Drainage Area/ Floodplain habitat (Table 5.1).

While Hillcrest/ Hillslope, Stony Plain, Mulga Woodland, Undulating Low Hills, Hardpan Plain, Medium Drainage Line and Minor Drainage Line habitat potentially provide foraging and dispersal habitat for ghost bat, Pilbara leaf-nosed bat and grey falcon this is dependent on the proximity of the habitat to other areas of critical habitat, particularly roosting habitat. Therefore, while the habitat may still be utilised, it is likely to be less frequent and is considered to only provide supporting foraging and dispersal habitat. None of the supporting habitats occurring within the Study Area are likely to be relied upon by any species for long-term survival within the Study Area or more broadly in the vicinity. All fauna habitats mapped that provide supporting habitat are broadly distributed and well represented across the Pilbara bioregion and surrounding regions, and therefore support fauna assemblages which are generally common and widespread. The condition of habitats within the Study Area was primarily Excellent to Good. The greatest disturbance was caused by grazing by cattle (*Bos taurus*), frequent fires and access tracks/ exploration activity; however, the overall level of disturbance was minimal.

Table 5.1: Broad fauna habitats occurring within the Study Area

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Stony Plain **21,051.01 ha** **35.51%**	Stony Plain comprise low-lying open plains and the rolling hills below upland areas, with very slight to no gradient. The substrate consists of gravel and pebbles, with vegetation dominated by *Triodia*, although scattered trees also occur. Vegetation within this habitat varied in composition but was generally dominated by scattered Mulga and *Acacia* forming an over-storey, with patches of various small to medium shrub species, over low hummock grasslands of *Triodia.* Scattered *Corymbia and Eucalyptus* are usually present.	Within the Study Area Stony Plain habitat is common throughout, particularly within Pineapple Hill and Mudlark Well, primarily at the base of the Hillcrest/ Hillslope habitat. Stony Plain is one of the most common and widespread habitat types within the Pilbara region. The vegetation and substrate which make up this habitat type are characteristic features of the region.	• **Critical habitat for:** ○ **Ghost bat** – foraging habitat where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal (~10 km) to roosting habitat	
Hillcrest/ Hillslope **14,160.00 ha** **23.89%**	The Hillcrest/ Hillslope habitat comprised a rocky substrate, often with exposed bedrock, on moderate to steep slopes leading into lower footslopes. This habitat was characterised by steep slopes with a high proportion of coarse fragments dominated by ironstone. These can contain cracks and crevices. Instances of Gorge/ Gully is contained within this habitat. This habitat is usually dominated by open *Eucalyptus* woodlands, *Acacia* and *Grevillea* scrublands and *Triodia* low hummock grasslands.	Within the Study Area Hillcrest/ Hillslope habitat is common and widespread throughout, it is of particularly high density within the northern portion of the MAC to Yandi Rail Corridor Area as well as from Mudlark Well. Hillcrest/ Hillslope habitat is common and widespread habitat types within the Pilbara region. The vegetation and substrate which make up this habitat type are characteristic features of the region.	• **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal (~10 km) to roosting habitat	
Drainage Area/ Floodplain **9,644.57 ha** **16.27%**	Lower lying plain often subjected to sheet flow following large rainfall events. Vegetation and substrates of this habitat was variable, often comprising scattered *Eucalyptus* over *Acacia* and/or *Grevillea* shrubs with an understory dominated by *Triodia* hummock grasses and/or mixed tussock grasses on alluvial substrates, often comprising heavy clays and gravel. Tussock grasses can be dominant within Drainage Area/ Floodplain habitat as a result of high rainfall events.	Within the Study Area Drainage Area/ Floodplain habitat occurs in high proportion within the Pineapple Hill Area with scattered areas throughout the MAC to Yandi Rail Corridor and Mudlark Well. This fauna habitat is common throughout the Pilbara bioregion. Across the region its structure and condition are variable as a result of rainfall events and disturbance (i.e. fire and cattle grazing).	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat ○ **Grey falcon** – where proximal to breeding habitat	
Mulga Woodland **4,043.20 ha** **6.82%**	Mulga Woodland habitat comprises stands of mulga (*Acacia aneura*) over clay or stony substrates. Differs from other plains by having a monoculture of mulga compared to a diversity of other *Acacia* species.	Within the Study Area Mulga Woodland habitat primarily occurs within low lowing areas, but also occurs within rocky areas, primarily occurs at Camp Hill and Mudlark Well. This habitat is relatively common throughout the Pilbara region, usually occurring in areas of drainage or sheet flow.	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Hardpan Plain **2,495.29 ha** **4.21%**	Hardpan Plain habitat comprised flat low lying clay based plain dominated by stands of mulga, with a high proportion of the substrate comprising bare soil. Often sparsely vegetated with large areas often void of vegetation.	Within the Study Area Hardpan Plain habitat occurs within low lowing areas, primarily at Camp Hill and Mudlark Well. This fauna habitat is common throughout parts of the Pilbara bioregion. Structure and condition is variable as a result of rainfall events and disturbance (i.e. fire and cattle grazing).	• **N/A**	
Undulating Low Hills **1,979.59 ha** **3.34%**	The Undulating Low Hills habitat comprises low hills and undulating stony plains of higher elevation than Stony Plain. The habitat supports hard spinifex with a mantle of gravel and larger rocks with occasional outcropping or minor breakaway. Vegetation is dominated by hard *Triodia* hummock grasslands with scattered *Eucalyptus* trees and *Acacia*, *Eremophila* and/or *Grevillea* shrubs.	Within the Study Area Undulating Low Hills habitat primarily occurs within the south-eastern portion of Mudlark Well. Undulating Low Hills habitat is a characteristic habitat type of the Pilbara region. Its occurrence throughout the region is widespread and common.	• **Supporting habitat for:** ○ **Ghost bat** – where proximal to roosting habitat ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat	
Minor Drainage Line **1,639.45 ha** **2.77%**	Minor Drainage Line habitat usually lacked a tall dense upper storey, but with a dense mid storey, including sparse *Eucalyptus* sp., and *Acacia* sp. over tussock grasses and *Triodia* sp. hummock grasses.	Within the Study Area Minor Drainage Line habitat is common throughout, primarily surrounding areas of higher elevation, particularly the Hillcrest/ Hillslope habitat. This fauna habitat is widespread throughout the Pilbara bioregion, though its structure and condition is variable as a result of rainfall events and susceptible to degradation from cattle grazing.	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Northern quoll** – where proximal to breeding habitat ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat ○ **Grey falcon** – where proximal to breeding habitat ○ **Pilbara olive python** – where proximal to breeding habitat	
Gorge/ Gully **1,564.61 ha** **2.64%**	Gorge/ Gully habitat was characterised by rugged, steep-sided valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are more open (but not as open as Minor Drainage Lines). Caves and rock pools are most often encountered in this habitat type. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred.	Within the Study Area Gorge/ Gully habitat occurs throughout, primarily within Mudlark Well. A reasonably common habitat in the Pilbara, usually associated with ranges; however, because this habitat type is narrow and linear, they only represent a small proportion of the total land area.	• **Critical habitat for:** ○ **Northern quoll** – critical breeding, denning, foraging and dispersal ○ **Pilbara leaf-nosed bat** – critical breeding, roosting, foraging and dispersal, when in range of appropriate roosting habitat ○ **Ghost bat** – critical breeding, roosting. ○ **Pilbara olive python** – critical breeding, denning, foraging and dispersal • **Supporting habitat for:** ○ **Ghost bat** - foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area)	

Habitat	Distinguishing habitat characteristics	Extent of habitat	Habitat for target MNES species	Photo
Breakaway/ Cliff **858.97 ha** **1.45%**	The Breakaway/ Cliff habitat comprised a single sided rock face, within the steep mid-upper slope comprising bare rock outcrops or cliffs. Does not comprise the entire slope.	Within the Study Area Breakaway/ Cliff habitat throughout, but primarily within Mudlark Well. A reasonably common habitat in the Pilbara, usually associated with ranges; however, because this habitat type is narrow and linear, they only represent a small proportion of the total land area.	• **Critical habitat for:** ○ **Northern quoll** – critical breeding, denning, foraging and dispersal ○ **Pilbara leaf-nosed bat** – critical breeding, roosting, foraging and dispersal, when in range of appropariate roosting habitat ○ **Pilbara olive python** – critical breeding, denning, foraging and dispersal	
Medium Drainage Line **362.20 ha** **0.61%**	Medium Drainage Line habitat comprised scattered *Eucalyptus* and *Acacias,* or mulga woodland, with an understory dominated by tussock grasses. The structure and condition of vegetation often varies seasonally, particularly following rainfall events. Vegetation condition often subject to heavy cattle grazing. This habitat type is prone to pooling and ponding in areas.	Within the Study Area Medium Drainage Line habitat occurs in discrete linear areas at Pineapple Hill, Camp Hill, and Mudlark Well. This fauna habitat is widespread throughout the Pilbara bioregion, though its structure and condition is variable as a result of rainfall events and susceptible to degradation from cattle grazing.	• **Critical habitat for:** ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area) • **Supporting habitat for:** ○ **Northern quoll** – where proximal to breeding habitat ○ **Pilbara leaf-nosed bat** – where proximal to roosting habitat ○ **Grey falcon** – where proximal to breeding habitat ○ **Pilbara olive python** – where proximal to breeding habitat	
Major Drainage Line **54.94 ha** **0.09%**	The Major Drainage Line habitat supported an upper story of relatively tall *Eucalyptus. The habitat* is prone to flooding and is more likely to retain water when inundated. The structure and condition of vegetation often varies seasonally, particularly following rainfall events. Vegetation condition often subject to heavy cattle grazing.	Within the Study Area the Major Drainage Line habitat occurs in discrete linear areas, comprised within the MAC to Yandi Rail Corridor. This fauna habitat is widespread throughout the Pilbara bioregion, though its structure and condition is variable as a result of rainfall events and susceptible to degradation from cattle grazing.	• **Critical habitat for:** ○ **Northern quoll** – critical foraging and dispersal ○ **Pilbara leaf-nosed bat** – critical foraging and dispersal ○ **Grey Falcon** – critical breeding, roosting, foraging and dispersal ○ **Pilbara olive python** – critical foraging and dispersal ○ **Ghost bat** –foraging where proximal (<12 km) to roosting habitat (entire extent in the Study Area)	
Cleared/ Disturbed **1,428.48 ha** **2.41%**	Cleared/ Disturbed areas include areas where the natural vegetation and microhabitats have been disrupted, usually devoid of native vegetation. This includes tracks, laydown areas, camps, major roads/ highways and historic, large-scale clearing.	Within the Study Area Cleared/ Disturbed areas are primarily restricted to discrete linear corridors, including roads and access tracks.	• **N/A**	No photo

660000 670000 680000 690000 700000

7480000

7470000

Great Northern Hwy

Yandicoogina Rail

Packsaddle Rd

West Angelas Rail

MS1072

West Angelas Rd

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Habitat Type

- Breakaway/ Cliff
- Cleared/ Disturbed
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hardpan Plain
- Hillcrest/ Hillslope
- Medium Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Stony Plain

N

biologic Environmental Survey

Scale: 1:110,000

0 2 4 6 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022

BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 5.1a: Fauna habitats in the Study Area - Pineapple Hill and Camp Hill

700000
710000
720000
7480000
7470000
MS1039
Yandicoogina Rail
MS1072
Mining Area C Railway
West Angelas Rd
Mining Area
C Railway

Legend

- Study Area
- Approval Boundary
- Local Road
- Rail

Habitat Type

- Breakaway/ Cliff
- Cleared/ Disturbed
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hillcrest/ Hillslope
- Major Drainage Line
- Minor Drainage Line
- Stony Plain

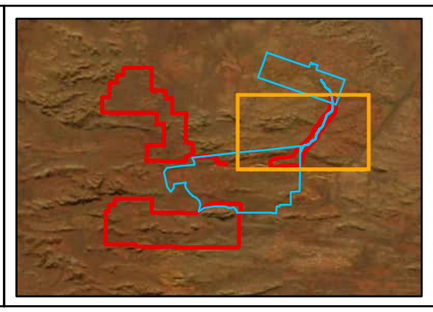
N

biologic Environmental Survey

Scale: 1:80,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 5.1b: Fauna habitats in the Study Area - MAC to Yandi Rail Corridor

670000
680000
690000
7450000
7440000
Great Northern Hwy
MS1072

Legend

- Study Area
- Approval Boundary
- State Road
- Rail

Habitat Type

- Breakaway/ Cliff
- Cleared/ Disturbed
- Drainage Area/ Floodplain
- Gorge/ Gully
- Hardpan Plain
- Hillcrest/ Hillslope
- Medium Drainage Line
- Minor Drainage Line
- Mulga Woodland
- Stony Plain
- Undulating Low Hills

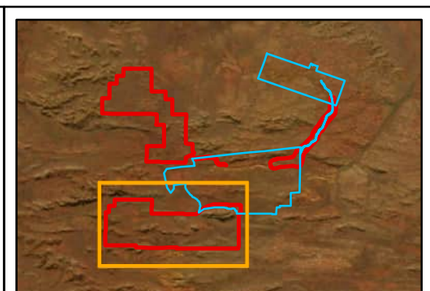
N

biologic Environmental Survey

Scale: 1:90,000

0 2 4 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 13/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 5.1c: Fauna habitats in the Study Area - Mudlark Well

5.2 Habitat Features of the Study Area

5.2.1 Caves

Caves can be important features within a landscape, particularly in arid zone systems, often providing stable microclimates, shelter and protection (Medellin *et al.*, 2017). A total of 34 caves are known within the Study Area, comprising: nine caves that are being currently monitored as part of the MS1072 Fauna Management Plan monitoring program; six caves previously assessed as having potential to support Pilbara leaf-nosed bat and ghost bat and 19 new caves identified and assessed during the current survey for suitability for Pilbara leaf-nosed bat and ghost bat (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *2023*, *in prep.*) (Table 5.2; Figure 5.2).

Underground refuges used by Pilbara leaf-nosed bat were categorised by Bat Call (2021b) into four categories as detailed further in Section 6.3.1. The caves were classified primarily as nocturnal refuge (Category 4) caves for Pilbara leaf-nosed bats, and none were assessed as likely or potentially suitable as Category 1, 2 or 3 (permanent or semi-permanent diurnal) roosts.

Caves and roosts used by ghost bats can be classified into four categories (Bat Call, 2021a) as detailed further in Section 6.4.1. Of the 34 caves occurring within the Study Area, five (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified as Category 2 roosts (maternity/ diurnal roost caves with regular occupancy for ghost bats) (Table 5.2). Three caves in the Study Area (CACW-01, CMUD-08 and CACW-11) were identified as Category 3 (diurnal roost caves with occasional occupancy) and 23 were identified as Category 4 (nocturnal roost caves with opportunistic usage) for ghost bats (Table 5.2). The remaining three caves recorded in the Study Area showed no evidence of usage by the ghost bat and are unlikely to be suitable for this species.

CMUD-01 and CMUD-10 are potential maternity roosts for ghost bat. CMUD-01 has a demonstrated presence of pregnant females across seven (out of eight) years of monitoring, making it the most consistently used cave by pregnant females of the caves monitored in the MS1072 Fauna Management Plan monitoring program (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *2023*, *in prep.*). Elevated progesterone levels were not recorded at CMUD-01 during the most recent monitoring in 2021-2022 (Biologic, in prep.-a). CMUD-10 has also demonstrated presence of pregnant females over six (out of eight) years of monitoring (Biologic, in prep.-a).

Of the 34 caves, 23 occur within Gorge/ Gully habitat, five within Breakaway/ Cliff habitat and six within Hillcrest/ Hillslope habitat. Cave searching survey effort was focussed on the areas of Gorge/ Gully habitat most likely to have the highest quality caves, therefore it is possible that not all caves have been located within the Study Area and additional caves may occur.

Table 5.2: Summary of caves recorded in Study Area

Cave ID	Previous Cave ID	Origin of data	Coordinates		Ghost Bat Significance	Pilbara Leaf-nosed Bat Significance
			Latitude	Longitude		
CMIN-01	-	Current survey	-22.8364	119.1238	Category 4	Category 4
CACW-02	-	Current survey	-22.8516	118.7906	No usage	No usage
CMIN-02	-	Current survey	-22.8049	119.1499	No usage	No usage
CMUD-03	-	Current survey	-23.0532	118.8123	Category 4	Category 4
CMUD-04	-	Current survey	-23.0385	118.6580	Category 4	Category 4
CMUD-05	-	Current survey	-23.0577	118.6216	Category 4	Category 4
CMUD-06	-	Current survey	-23.0579	118.6216	Category 4	Category 4
CMUD-07	-	Current survey	-23.0160	118.6501	Category 4	Category 4
CMUD-09	-	Current survey	-23.0816	118.6588	Category 4	Category 4
CMUD-11	-	Current survey	-23.0417	118.8685	Category 4	Category 4
CMUD-12	-	Current survey	-23.0396	118.8741	No usage	No usage
CMUD-13	-	Current survey	-23.0748	118.7932	Category 4	Category 4
CMUD-14	-	Current survey	-23.0669	118.7197	Category 4	Category 4
CMUD-15	-	Current survey	-23.0765	118.6262	Category 4	Category 4
CMUD-16	-	Current survey	-23.0756	118.6251	Category 4	Category 4
CMUD-17	-	Current survey	-23.0151	118.6891	Category 4	Category 4
CMUD-18	-	Current survey	-23.0476	118.9036	Category 4	Category 4
CMUD-19	-	Current survey	-23.0349	118.6186	Category 4	Category 4
CMUD-20	-	Current survey	-23.0354	118.6188	Category 4	Category 4
CMUD-01	M01	Monitoring	-23.0813	118.6607	Category 2	Category 4
CMUD-02	M02	Monitoring	-23.0715	118.634	Category 2	Category 4
CACW-01	ACW01	Monitoring	-22.8696	118.792	Category 3	Category 4
CMUD-08	ACW08	Monitoring	-23.0363	118.6605	Category 3	Category 4
CMUD-10	ACW10	Monitoring	-23.0284	118.7207	Category 2	Category 4
CACW-11	ACW11	Monitoring	-22.8701	118.7921	Category 3	Category 4
CACW-13	ACW13	Monitoring	-22.8698	118.7923	Category 4	Category 4
CACW-17	ACW17	Monitoring	-22.8415	118.7627	Category 4	Category 4
CACW-31	ACW31	Monitoring	-22.8649	118.7912	Category 2	Category 4

Cave ID	Previous Cave ID	Origin of data	Coordinates		Ghost Bat Significance	Pilbara Leaf-nosed Bat Significance
			Latitude	Longitude		
CMIN-03	ACY 1	Biologic (2011b)	-22.8740	119.1024	Category 2	Category 4
CPIN-02	CPIN-02	Biologic (2022)	-22.7704	118.7281	Category 4	Category 4
CPIN-03	CPIN-03	Biologic (2022)	-22.7956	118.6074	Category 4	Category 4
CPIN-04	CPIN-04	Biologic (2022)	-22.7954	118.6072	Category 4	Category 4
CPIN-05	CPIN-05	Biologic (2022)	-22.7961	118.6079	Category 4	Category 4
CPIN-20	CPIN-20	Biologic (2022)	-22.8084	118.6210	Category 4	Category 4

5.2.2 Water Features

Water sources are a limiting factor for many ecosystems (James *et al.*, 1995), particularly within arid-zone ecosystems such as the Pilbara (Burbidge *et al.*, 2010; Doughty *et al.*, 2011), and often represent areas of comparatively high ecological productivity (Murray *et al.*, 2003). Water features have varying levels of significance to the target species of this assessment. For northern quolls, water features can represent areas of high productivity, and therefore may contain a relatively high abundance of feeding resources (Braithwaite & Griffiths, 1994; Oakwood, 2000), when in suitable habitat (e.g., rocky habitats, and to a lesser degree, drainage lines). For Pilbara leaf-nosed bats, water features can provide significant drinking and foraging sources, and are a key component to 'gorges with pools' being recognised as the priority foraging habitat for the species (TSSC, 2016c). In the Hamersley region, the Pilbara olive python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011a; Pearson, 1993).

Six water features were recorded during the current survey (Table 5.3), comprising four river pools (located within Major Drainage Line habitat within Gorge/ Gully habitat), one waterhole (located within Gorge/ Gully habitat) and one livestock tank overflow (located within Drainage Area Floodplain habitat) (Table 5.3; Figure 5.2). Previously recorded water features have also been recorded along the Major Drainage Line habitat within the MAC to Yandi Rail Corridor (Biologic, 2020d). It is possible that additional water features occur within the Study Area, particularly within the Major Drainage Line, Medium Drainage Line and Gorge/ Gully habitat (Figure 5.2).

All of the waterholes recorded in the current survey were considered to provide significant foraging habitat for the northern quoll, Pilbara leaf-nosed bat and Pilbara olive python.

Table 5.3: Water features recorded in the Study Area during the current survey

Water Feature ID	Description	Coordinates		Habitat
		Latitude	Longitude	
WMIN-03	River pool	-22.8510	119.1150	Major Drainage Line Within Gorge/ Gully
WMUD-01	Waterhole	-23.0653	118.7074	Gorge/ Gully
WMIN-01	River pool	-22.8345	119.1314	Major Drainage Line Within Gorge/ Gully
WMIN-02	River pool	-22.8310	119.1336	Major Drainage Line Within Gorge/ Gully
WMIN-04	River pool	-22.8486	119.1111	Major Drainage Line Within Gorge/ Gully
WPIN-01	Livestock tank overflow	-22.7821	118.6602	Drainage Area Floodplain

660000
680000
700000
720000
740000
7480000
7460000

Yandicoogina Rail
Yandi Rail Spur Line
Mining Area C Railway
MS1039
CPIN-02
WPIN-01
CPIN-05
CPIN-03
CPIN-04
CPIN-20
CMIN-02
CACW-17
CACW-02
Packsaddle Rd
Yandicoogina Rail
CMIN-01
WMIN-02
WMIN-01
WMIN-04
WMIN-03
CACW-31
CACW-01
CACW-13
CACW-11
CMIN-03
West Angelas Rail
West Angelas Rd
MS1072
CMUD-17
CMUD-07
CMUD-19
CMUD-10
CMUD-08
CMUD-20
CMUD-04
CMUD-05
CMUD-12
CMUD-18
CMUD-03
CMUD-11
WMUD-01
CMUD-14
CMUD-06
CMUD-02
CMUD-13
CMUD-16
CMUD-01
CMUD-15
CMUD-09
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Habitat Feature

- Cave
- Water Feature

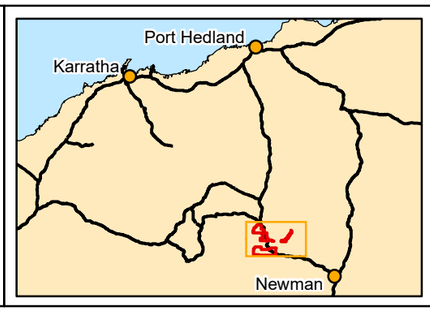
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 31/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 5.2: Fauna habitat features recorded in the Study Area

6 TARGET SPECIES

6.1 Northern Quoll (*Dasyurus hallucatus*)

6.1.1 Species Profile

The northern quoll is listed as Endangered under the EPBC Act and BC Act. The species was once widely distributed across northern Australia, however, it is now restricted to three isolated populations; the Pilbara, the Kimberley and Northern Territory, and Queensland (DoE, 2016). Northern quolls are opportunistic omnivores, consuming a wide range of invertebrates and small vertebrates also in addition to fruit, nectar, carrion and human refuse (Dunlop *et al.*, 2017).

As a result of facultative die-off, the abundance of the species is cyclical, and the annual reproduction is highly synchronised (Oakwood *et al.*, 2001). In the Pilbara, abundance is lowest toward the end of winter into early spring after the mating season, as a significant proportion of adult males die off and young have not yet begun to forage independently (Braithwaite & Griffiths, 1994; Oakwood, 2000). Conversely, the population density is thought to be highest in the summer months, prior to the mating season and when juveniles have begun foraging independently (Oakwood, 2000). Schmitt *et al.* (1989) reported relatively small home ranges in rugged habitat in the Kimberley (i.e. 2.3 ha for females and 1.8 ha for males), whereas in the western Pilbara, minimum activity areas (often used as an estimator of home range) are 75–443 ha for females and 5–1,109 ha for males (King, 1989). It should be noted here though that the method used to calculate minimum activity areas in this latter study can potentially overestimate home ranges (Burgman & Fox, 2003).

The northern quoll is both arboreal and terrestrial, inhabiting ironstone and sandstone ridges, scree slopes, granite boulders and outcrops, drainage lines, riverine habitats (Braithwaite & Griffiths, 1994; Oakwood, 2002), dissected rocky escarpments, open forest of lowland savannah and woodland (Oakwood, 2002, 2008). Rocky habitats tend to support higher densities, as they offer protection from predators and are generally more productive in terms of availability of resources (Braithwaite & Griffiths, 1994; Oakwood, 2000). Other microhabitat features important to the species include rock cover, proximity to permanent water, and time-since last fire (Woinarski *et al.*, 2008). Dens occur in a wide range of habitat features, including rock overhangs, tree hollows, hollow logs, termite mounds, goanna burrows and human dwellings/infrastructure, where individuals usually den alone (Oakwood, 2002; Woinarski *et al.*, 2008). At present, northern quolls are relatively common in the northern Pilbara region (generally within 150 km of the coast) but are much less common in southern and south-eastern parts of the region (Cramer *et al.*, 2016b).

The species has experienced a precipitous decline in much of its former range in northern Queensland and the Northern Territory in direct association with the spread of the cane toad, *Bufo marinus* (Braithwaite & Griffiths, 1994; Fitzsimons *et al.*, 2010). Other threats include predation from feral predators such as foxes and cats, inappropriate fire regimes, disease, habitat degradation through grazing and weed invasion, habitat destruction through mining and agriculture (Woinarski *et al.*, 2011). The potential invasion of the Pilbara by the cane toad is regarded as the most significant future threat

to the northern quoll in the Pilbara; however, there is little knowledge of the relative impact of the other key threats, and their interactive effects, currently and in the future (Cramer *et al.*, 2016b).

6.1.2 Previous Records

The Study Area falls within the current distribution of the northern quoll, whereby the species or species' habitat is likely to occur (DoE, 2022a). A total of 538 northern quoll records were identified within 50 km of the Study Area in the desktop assessment (BHP, 2022; DBCA, 2022b) (Figure 6.1). The vast majority of these records (475) occur in the vicinity of Koodaideri, approximately 21.5 km north of the Study Area. The scarcity of records elsewhere within the desktop assessment search area (50 km of Study Area) suggests that the species is patchily distributed and/or occurs at low abundance in the broader area. However, a higher number of records in the vicinity of Koodaideri may be partially due to greater survey effort in this area.

The species has previously been recorded within the Study Area, from scats in Hillcrest/ Hillslope habitat at Camp Hill in 2011 and a live individual (BHP, 2022; Onshore & Biologic, 2011) (Figure 6.1). Additionally, Astron (2019, 2020) recorded the northern quoll in an area approximately 8 to 20 km east of the Study Area: 16 times via motion camera detection images (10 records), scat recordings (five records) and trapping (one record). The scarcity of previous records within or close to the Study Area suggests the species is likely to occur at very low densities.

6.1.3 Survey Methods

Targeted Searches

Targeted searches for secondary northern quoll evidence (e.g., scats, remains and tracks) were conducted along 70 transects, equating to a total of approximately 193 person hours (Table 6.1).

Table 6.1: Targeted searches completed for northern quoll within the Study Area

Transect Name	Date	Habitat	Person hours
TCPH-003	8/04/2022	Major Drainage Line	4
TCPH-020	28/05/2022	Major Drainage Line	4
TCPH-022	6/04/2022	Major Drainage Line	6
TCPH-023	6/04/2022	Major Drainage Line	3
TCPH-025	7/04/2022	Gorge/ Gully	3
TCPH-026	8/04/2022	Breakaway/ Cliff	4
TCPH-027	8/04/2022	Gorge/ Gully	3
TCPH-035	8/04/2022	Breakaway/ Cliff	1
TCPH-041	9/04/2022	Medium Drainage Line	1.5
TCPH-042	10/04/2022	Gorge/ Gully	6
TCPH-046	9/04/2022	Gorge/ Gully	1
TCPH-051	10/04/2022	Gorge/ Gully	1.5
TCPH-052	10/04/2022	Gorge/ Gully	4
TCPH-056	10/04/2022	Gorge/ Gully	4
TCPH-063	10/04/2022	Gorge/ Gully	4
TCPH-081	12/04/2022	Gorge/ Gully	4

Transect Name	Date	Habitat	Person hours
TCPH-081	30/04/2022	Gorge/ Gully	3
TCPH-084	13/04/2022	Hillcrest/ Hillslope	1
TCPH-084	29/04/2022	Hillcrest/ Hillslope	1
TCPH-085	28/04/2022	Gorge/ Gully	2
TCPH-086	28/04/2022	Breakaway/ Cliff	5
TCPH-087	29/04/2022	Hillcrest/ Hillslope	1
TCPH-088	29/04/2022	Hillcrest/ Hillslope	1
TCPH-089	29/04/2022	Gorge/ Gully	1.5
TCPH-090	29/04/2022	Hillcrest/ Hillslope	2
TCPH-091	4/05/2022	Medium Drainage Line	3
TCPH-095	30/04/2022	Gorge/ Gully	6
TCPH-100	30/04/2022	Gorge/ Gully	5
TCPH-109	2/05/2022	Major Drainage Line	2
TCPH-117	1/05/2022	Gorge/ Gully	4
TCPH-123	1/05/2022	Gorge/ Gully	1.2
TCPH-125	1/05/2022	Gorge/ Gully	1
TCPH-127	1/05/2022	Gorge/ Gully	2
TCPH-128	5/05/2022	Gorge/ Gully	4
TCPH-129	5/05/2022	Gorge/ Gully	2
TCPH-130	2/05/2022	Gorge/ Gully	1
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5
TCPH-132	2/05/2022	Gorge/ Gully	2.5
TCPH-133	2/05/2022	Gorge/ Gully	2
TCPH-134	6/05/2022	Hillcrest/ Hillslope	1
TCPH-140	1/05/2022	Gorge/ Gully	2
TCPH-140	3/05/2022	Gorge/ Gully	9
TCPH-145	3/05/2022	Gorge/ Gully	2
TCPH-149	3/05/2022	Gorge/ Gully	4
TCPH-153	3/05/2022	Gorge/ Gully	2
TCPH-160	4/05/2022	Gorge/ Gully	4.5
TCPH-166	4/05/2022	Medium Drainage Line	2
TCPH-170	4/05/2022	Gorge/ Gully	2
TCPH-180	26/05/2022	Breakaway/ Cliff	1
TCPH-181	26/05/2022	Breakaway/ Cliff	2
TCPH-185	26/05/2022	Gorge/ Gully	4
TCPH-189	27/05/2022	Breakaway/ Cliff	2
TCPH-193	27/05/2022	Gorge/ Gully	4
TCPH-194	27/05/2022	Hillcrest/ Hillslope	1
TCPH-195	27/05/2022	Gorge/ Gully	1.5
TCPH-197	27/05/2022	Breakaway/ Cliff	2
TCPH-198	27/05/2022	Breakaway/ Cliff	2
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4
TCPH-209	28/05/2022	Gorge/ Gully	3
TCPH-229	28/05/2022	Gorge/ Gully	5.5

Transect Name	Date	Habitat	Person hours
TCPH-242	29/05/2022	Hillcrest/ Hillslope	3.5
TPIH-02	12/11/2021	Gorge/ Gully	3
TPIH-05	26/11/2021	Gorge/ Gully	0.66
TPIH-09	23/11/2021	Gorge/ Gully	2
TPIH-15	14/11/2021	Hillcrest/ Hillslope	0.5
TPIH-18	24/11/2021	Major Drainage Line	3
TPIH-20	25/11/2021	Gorge/ Gully	5
TPIH-21	25/11/2021	Gorge/ Gully	1
TPIH-25	29/11/2021	Hillcrest/ Hillslope	0.5
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5
Total			**193.26**

Camera Trap Transects

Twenty-one camera trap transects were deployed throughout the Study Area in suitable northern quoll breeding/ shelter habitat (e.g. Gorge/Gully), high quality foraging/ dispersal habitat (e.g., Major Drainage Line) or habitat directly adjacent to breeding/ shelter habitat (Table 6.1; Figure 6.2). Where possible, survey design and effort followed methods recommended by DoE (2016); however, due to the size of the Study Area, the number of cameras deployed at any given site were based on the extent of suitable habitat with an approximate spread of one camera every 50–100 meters (m). Cameras were deployed for between three and 22 consecutive nights, for a total of 1,503 camera trap sampling nights (Table 6.2).

Where possible, cameras were oriented to enable differentiation of individuals via spot patterning (following Hohnen *et al.*, 2012) and baited with universal bait mixture (comprising oats, peanut butter and sardines) contained within a non-reward receptacle (perforated and capped PVC pipe).

Table 6.2: Camera transects sampled for northern quoll within the Study Area

Site	Habitat	Deployment	Retrieval	Total Trap Nights
VCPH-020	Gorge/ Gully	6/04/2022	12/04/2022	50
VCPH-022	Gorge/ Gully	6/04/2022	28/04/2022	220
VCPH-023	Major Drainage Line	6/04/2022	28/04/2022	220
VCPH-025	Gorge/ Gully	7/04/2022	12/04/2022	50
VCPH-042	Gorge/ Gully	9/04/2022	30/04/2022	180
VCPH-046	Gorge/ Gully	25/05/2022	29/05/2022	20
VCPH-085	Gorge/ Gully	28/04/2022	2/05/2022	40
VCPH-086	Breakaway/ Cliff	28/04/2022	2/05/2022	40
VCPH-095	Breakaway/ Cliff	30/04/2022	4/05/2022	40
VCPH-100	Gorge/ Gully	30/04/2022	4/05/2022	40
VCPH-108	Medium Drainage Line	1/05/2022	6/05/2022	50

Site	Habitat	Deployment	Retrieval	Total Trap Nights
VCPH-132	Gorge/ Gully	2/05/2022	6/05/2022	40
VCPH-176	Medium Drainage Line	25/05/2022	29/05/2022	20
VCPH-180	Gorge/ Gully	26/05/2022	30/05/2022	40
VCPH-181	Breakaway/ Cliff	26/05/2022	30/05/2022	40
VCPH-185	Gorge/ Gully	26/05/2022	30/05/2022	40
VPIH-002	Gorge/ Gully	12/11/2021	28/11/2021	160
VPIH-008	Drainage Area/ Floodplain	13/11/2021	24/11/2021	22
VPIH-009	Gorge/ Gully	13/11/2021	24/11/2021	88
VPIH-015	Gorge/ Gully	14/11/2021	24/11/2021	100
VYAN-31	Major Drainage Line	15/05/2022	18/05/2022	3
Total				**1503**

600000 650000 700000 750000 800000

7500000

7450000

7400000

Nanutarra Munjina Rd

Karijini Dr

Manuwarra Red Dog Hwy

Tom Price

Tom Price Rd

Paraburdoo Rd

Paraburdoo

MS1039

MS1072

Marble Bar Rd

Newman

Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

Astron (2019)
Sampling Type
- Camera Trap
- Individual (alive)
- Scat

BHP (2022)
Sampling Type
- Camera Trap
- Individual (alive)
- Scat

DBCA (2022)
Sampling Type
- Camera Trap
- Individual (alive)
- Scat
- Specimen
- Unknown

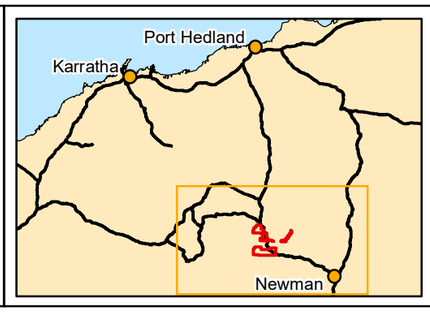
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 21/10/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.1: Previous northern quoll records in the Study Area and region

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1039
MS1072

Legend

Study Area
Approval Boundary
Local Road
State Road
Rail

Fauna Habitat
Critical
Supporting
Nil

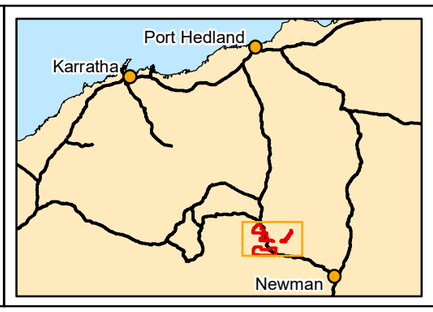
Sampling Method
Camera Trap (23)
Targeted Search (70)

N

biologic Environmental Survey

Scale: 1:220,000
0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.2: Northern quoll sampling locations and habitat in the Study Area

6.1.1 Survey Results

Targeted Searches

No evidence of northern quoll was recorded within the Study Area during the 193.26 person hours of targeted searches conducted for this species.

Camera Transects

No evidence of northern quoll was recorded at any of the 21 camera transects deployed within the Study Area over a total of 1,503 sampling nights.

6.1.2 Discussion

The Study Area falls within the current distribution of the northern quoll, whereby the species or species' habitat is likely to occur (DoE, 2022a). The species has previously been recorded within the Study Area, however, previous records of northern quolls in the Study Area are scarce and around a decade old (Biologic, 2011e, 2013d; Onshore & Biologic, 2011). In addition, no northern quolls or evidence of their occurrence was recorded during the current survey. Similarly, two previous targeted northern quoll surveys located within 5 km of the Study Area also recorded no evidence of the species (Biota, 2009, 2014a). However, Astron (2019) recorded the northern quoll in an area approximately 8 km east of the Study Area. These results suggest that northern quolls may be present in very low densities, or present only intermittently as a result of individuals moving from areas outside the Study Area. This is supported by the lack of records in the desktop assessment relative to the number of surveys completed in the area.

Critical habitat for the northern quoll, as defined by DoE (2016), includes rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines. Within the Study Area, the Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats meet the definition of critical habitat for the species (Figure 5.1; Figure 6.2). Supporting habitat for the northern quoll is provided by Minor Drainage Line and Medium Drainage Line habitat, where proximal to breeding habitat.

Given the presence of breeding, as well as foraging and dispersal, habitat suitable for northern quoll within the Study Area, this species is considered highly likely to occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale. Furthermore, the Study Area is unlikely to contain a 'population important for the long-term survival of the species', as defined by the DoE (2013, 2016).

6.2 Greater Bilby (*Macrotis lagotis*)

6.2.1 Species Profile

The greater bilby is listed as Vulnerable under the EPBC Act and BC Act. It is one of many Australian arid zone marsupial species that are within a 'critical weight range' (35 grams [g] to 5,500 g) considered significant based on the high risk of predation by introduced foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) (Johnson & Isaac, 2009). Greater bilbies are semi-fossorial and nocturnal, remaining in their burrows during the day and intermittently during the night for rest and refuge. Greater bilby populations naturally occur as scattered solitary individuals or small groups (Smythe & Philpott, 1968; Southgate, 1990a). They are regarded as having low site fidelity and high mobility (Southgate *et al.*, 2007); males regularly move three to five kilometres between burrows on consecutive days and have been recorded moving up to 15 km in a few weeks (Southgate & Possingham, 1995). This high mobility, together with low population density, ensures that the area of occupancy is often far less than the extent of occurrence. As greater bilbies are solitary in nature, lack territoriality and have large home ranges, it is likely that males adopt a roving strategy to find receptive females, consistent with an overlapping promiscuous mating system (Miller *et al.*, 2010).

Populations of greater bilby exist in the Pilbara bioregion (particularly within the Chichester subregion, along the Fortescue River and north-east to Goldsworthy and Shay Gap), in the Dampier bioregion (along 80 Mile Beach north to Beagle Bay) and in the Central Kimberley and Ord-Victoria Plains bioregions south of the Fitzroy and Margaret Rivers (Southgate, 1990a). The species' distribution within the Pilbara region is highly fragmented (Cramer *et al.*, 2017).

Greater bilbies occupy three major vegetation types - open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate, 1990b). Laterite and rock feature substrates are an important part of greater bilby habitat as they support shrub species, such as *Acacia kempeana, A. hilliana* and *A. rhodophylla*, which have root-dwelling larvae prone to supporting a constant food source (Dziminski & Carpenter, 2017; Southgate *et al.*, 2007). These habitats also contain spinifex hummocks, which are quite uniform and discrete, providing runways between hummocks and enabling easier movement and foraging (Southgate *et al.*, 2007). Minimal ground cover is a common feature in greater bilby habitats, as it allows easy foraging (Dawson *et al.*, 2018). Habitat within the Pilbara bioregion seems to consist mostly of spinifex sand plain associated with major drainage line sandy terraces. In general, the distribution of greater bilbies can be limited by the availability of suitable burrowing habitat, such as dunes where burrow excavation is easier (Moseby & O'Donnell, 2003), and are not found in predominantly rocky areas or mountains where they would be unable to dig suitable burrow systems or dig for food.

6.2.2 Previous Records

The Study Area falls within the western extent of the current distribution of the greater bilby, whereby the species or species' habitat is likely to occur (DoE, 2022e). The desktop assessment identified 18 previous records of the species within 50 km of the Study Area (BHP, 2022; DBCA, 2022b) (Figure 6.3). One previous record of the species is located within the Study Area, in the western extent of Mudlark Well from 1984; however, the location provided may be inaccurate given that it is situated on a stony hill, which does not provide habitat. This record also may be of a misidentified goanna burrow. The next closest record occurs 14 km west, also from 1984. The most contemporary record (2020) is from the Fortescue Valley, located 37 km west of the Study Area; however, this record was of possible greater bilby diggings so may be inaccurate. Integrated Environmental (1980) recorded the greater bilby 8.7 km from the Study Area, however, this record is historic.

6.2.1 Survey Methods

Greater Bilby Plots Searches

Greater bilby sampling within the Study Area comprised 2 hectare (ha) survey plots (greater bilby plots) distributed within areas of suitable habitat across the Study Area, in accordance with survey guidelines for the species (DBCA, 2017). Each greater bilby plot was subjected to targeted searches for a minimum of 18 minutes and comprised searches for secondary evidence for the species, including burrows, diggings, tracks and scats, as described by Southgate *et al.* (2019). Due to the size of the Study Area, plot searches were supplemented with additional linear transect searches in areas of suitable habitat (as recommended by (DBCA, 2017)).

Overall, a total of 16 greater bilby plots, and two transects were sampled for the greater bilby within the Study Area. Each plot was searched for between 0.3 and 1 person hour, equating to a total of 15 person hours of targeted sampling (Table 6.3; Figure 6.4).

Table 6.3: Greater bilby sampling locations within the Study Area

Transect Name	Date	Habitat	Sampling Method	Person hours
TCPH-010	5/04/2022	Mulga Woodland	Plot	1
TCPH-036	8/04/2022	Mulga Woodland	Transect	1
TCPH-037	8/04/2022	Hardpan Plain	Plot	1
TCPH-047	12/04/2022	Hardpan Plain	Transect	1
TCPH-059	10/04/2022	Drainage Area/ Floodplain	Plot	0.3
TCPH-064	11/04/2022	Mulga Woodland	Plot	1
TCPH-101	30/04/2022	Drainage Area/ Floodplain	Plot	0.4
TCPH-102	30/04/2022	Drainage Area/ Floodplain	Plot	0.3
TCPH-171	4/05/2022	Hardpan Plain	Plot	1
TCPH-173	5/05/2022	Hardpan Plain	Plot	0.5
TCPH-174	5/05/2022	Mulga Woodland	Plot	1
TCPH-192	27/05/2022	Mulga Woodland	Plot	1.5
TCPH-199	27/05/2022	Mulga Woodland	Plot	1.5

Transect Name	Date	Habitat	Sampling Method	Person hours
TCPH-201	27/05/2022	Mulga Woodland	Plot	1
TCPH-231	28/05/2022	Drainage Area/ Floodplain	Plot	0.5
TCPH-232	28/05/2022	Hardpan Plain	Plot	0.5
TCPH-243	29/05/2022	Hardpan Plain	Plot	0.7
TCPH-249	29/05/2022	Mulga Woodland	Plot	0.8
Total				**15**

600000
650000
700000
750000
800000
7500000
7450000
7400000
Nanutarra Munjina Rd
Nanutarra Munjina Rd
Manuwarra Red Dog Hwy
Karijini Dr
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1089
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

BHP (2022) Sampling Type

- Burrow (inactive)
- Digging

DBCA (2022) Sampling Type

- Burrow

- Camera Trap
- Digging
- Unknown

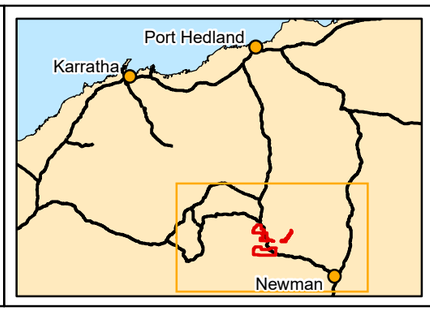
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.3: Previous greater bilby records in the Study Area and region

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
MS1039
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1072

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Sampling Method

- Bilby Plot
- Targeted Search (20)

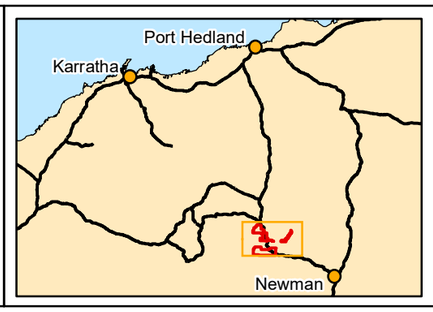
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.4: Greater bilby sampling locations in the Study Area

6.2.1 Survey Results

Greater Bilby Plots Searches

No evidence of greater bilby (tracks, scats, diggings, or burrows) was recorded within the Study Area during the 15-person hours of targeted searches for this species.

6.2.2 Discussion

Although the Study Area is located within the western extent of the current distribution of the greater bilby, where the species or species' habitat is likely to occur (DoE, 2022e), no greater bilbies or evidence of their occurrence was recorded during the current survey. Furthermore, the records of the greater bilby within or near the Study Area are either likely to be inaccurate (e.g. incorrect coordinates provided) or are historic.

Extant populations of the greater bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils (Southgate, 1990b). Within the Pilbara region, the species is often recorded within spinifex sandplains associated with paleo-drainage lines and perched drainage lines where the substrate of sand, soil, sandy clay, or sandy gravel is suitable for burrowing (Dziminski & Carpenter, 2017). Within these sandplain habitats, there is also an association with particular *Acacia* spp. containing root dwelling larvae that the species use for food resources (Dziminski & Carpenter, 2017). Outside of the Pilbara, the species has also been recorded within Mulga Woodland habitat (Southgate, 1990b).

Within the Study Area, only marginally suitable habitat was identified for greater bilby, present in areas with higher concentrations of sand, primarily within the Drainage Area/ Floodplain habitat. The Drainage Area/ Floodplain habitat (9,644.57 ha) often comprises heavy soils which provide low burrowing suitability and is therefore regarded as supporting habitat for the species. Sampling for greater bilby was also completed within Mulga Woodland and Hardpan Plain habitat; however, this habitat was considered low suitability for the species, also due to the low burrowing suitability. It is considered unlikely that the greater bilby occurs within the Study Area due to the lack of critical habitat (e.g. sandplains) and because any areas of supporting habitat were isolated and relatively small. This is supported by the lack of contemporary records in the vicinity of the Study Area. Therefore, the Study Area is unlikely to support an 'important population' as defined by DoE (2013).

6.3 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)

6.3.1 Species Profile

The Pilbara leaf-nosed bat is listed as Vulnerable under the EPBC Act and the BC Act. Within the Pilbara, the species is recognised as a geographically isolated population (or form) of the orange leaf-nosed bat, distributed across northern Australia and separated from the Pilbara population by approximately 400 km of the Great Sandy Desert (Armstrong, 2001). The Pilbara population is regarded as representing a single interbreeding population comprising multiple colonies (TSSC, 2016c; Umbrello *et al.*, 2022). Currently, there are 48 confirmed permanent diurnal categories 1 and 2 roost sites (17 of known location and 31 yet to be found) throughout the Pilbara region (Bat Call, 2021b).

Pilbara leaf-nosed bats typically roost in undisturbed caves, deep fissures or abandoned mine shafts (Armstrong, 2000, 2001). The species' limited ability to conserve heat and water (Baudinette *et al.*, 2000) means they require warm (28–32ºC) and very humid (85–100%) roost sites to persist in arid and semi-arid climates (Armstrong, 2001; Churchill, 1991). Roost sites with such attributes are relatively uncommon in the Pilbara and the limiting factor of the species' distribution (Armstrong, 2001). During the dry season (June to November), individuals are believed to aggregate in roosts that provide a suitably warm, humid microclimate (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). While in the wet season (December to May), when conditions are generally wetter and more humid, individuals typically disperse roosting in seasonally suitable features (Armstrong, 2000, 2001; Bullen & McKenzie, 2011). Bat Call (2021b) categorised underground refuges used by the species into four categories:

- **Permanent diurnal (Categories 1 and 2) roosts** – critical habitat that is essential for the daily and long-term survival of the Pilbara leaf-nosed bat. Category 1 are maternity roosts where seasonal presence of young is proven. Category 2 are occupied year-round but without the proven presence of young.
- **Semi-permanent diurnal (Category 3) roosts** – critical habitat that is essential for the long-term survival of the Pilbara leaf-nosed bat. Used diurnally during some part of the year, but not occupied year-round. May be used during the breeding cycle and may facilitate long distance dispersal in the region, particularly in autumn. Often associated with nearby Category 1 or 2 permanent roost as a 'satellite' roost, that together make up a colony.
- **Nocturnal refuge (Category 4)** – not considered critical but important for persistence in the local area). Are occupied or entered at night for resting, feeding or other purposes, with perching not a requirement. Includes most moderately deep caves and shallow abandoned mines.

Foraging sites surrounding known or suspected roosts can be critical to the survival of the species as the species forages within the vicinity of roost caves and more broadly along waterbodies with suitable fringing vegetation supporting prey species (TSSC, 2016c). The species is predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016a) in the dry season and up to 50 km during the wet season (Bullen, 2013). Bat Call (2021b) categorised foraging habitat into five Habitat Ratings:

- **Habitat Rating 5 (outside a diurnal roost)** – Pilbara leaf-nosed bats are present permanently and will be detected nightly. Areas immediately outside a diurnal roost entrance.
- **Habitat Rating 4 (very high)** – Pilbara leaf-nosed bats are very likely to forage and/or drink if in range of a roost. Includes deep gorges.
- **Habitat Rating 3 (high)** – Pilbara leaf-nosed bats are likely to forage if in range of a roost. May be detected passing along creek lines, vegetation lines, rock faces or foraging in the most productive areas. Includes deep gorges.
- **Habitat Rating 2 (moderate)** – Pilbara leaf-nosed bats may occasionally forage due to presence of suitable vegetation, seasonal water and may also use areas as a flyway.
- **Habitat Rating 1 (low)** – Pilbara leaf-nosed bats are unlikely to forage but may traverse while crossing to more productive areas.
- **Habitat Rating 0 (poor)** – Pilbara leaf-nosed bats are unlikely to be detected. Includes bare open ground (e.g., salt and clay pans without vegetation and bare mesa and ridgeline tops).

6.3.2 Previous Records

The Study Area is located at the eastern extent of the current distribution of the Pilbara leaf-nosed bat, whereby the species or species' habitat may occur (DoE, 2022b). The database search identified a total of 1,314 records of Pilbara leaf-nosed bat occur within 50 km of the Study Area (Figure 6.5), however a significant portion of these records (97.4%, 1,281 records) originate from a single location within the Koodaideri locality, approximately 25.5 km north of the Study Area (BHP, 2022; DBCA, 2022b). Of the remaining records, only 10 occur with 10 km of the Study Area (with records from 2006 – 2018) and only one record occurred directly within the Study Area, a detection in 2013 (BHP, 2022; DBCA, 2022b).

The Pilbara leaf-nosed bat has previously been recorded three times within the Study Area (Biologic, 2011e; Biota, 2013a; Onshore & Biologic, 2011). Additionally, ENV (2007a) recorded the species approximately 3.5 km away from the Study Area while Ecologia (2014) recorded the species multiple times foraging approximately 7 km away from the Study Area. In 2008, Biota (2013a) recorded one call of a Pilbara leaf-nosed bat at one location within the Study Area and concluded that the call probably represented a foraging individual and that it was unlikely to be using a nearby cave as a diurnal roost. The other previous records from the Study Area were made by Biologic (2011e) in 2011 and Onshore and Biologic (2011) in 2010; both of which were from a single call deemed likely to be indicative of a transient individual originating from another area. The nearest permanent diurnal roost is believed to be the East Turee Creek roost, a yet to be located roost, located in the south-east corner of Karijini National Park, approximately 20 km west of the western edge of the Study Area (Bat Call, 2021b). The next nearest permanent diurnal roost, the Kalgan Creek roost, is located approximately 50 km east of the eastern extent of the Study Area.

6.3.3 Survey Methods

Targeted Searches

Targeted searches were undertaken at 67 locations across the Study Area on foot to determine the presence and extent of any prospective roosting habitat (i.e. caves) likely to be utilised by Pilbara leaf-

nosed bats and/or ghost bats (Table 6.4; Figure 6.6). Where suitable caves or overhangs that may be utilised by the species were located, detailed cave assessments and searches were undertaken to search for evidence of occurrence and determine the likely use of the cave as a roost site. Where a cave was not deemed safe for entry, efforts were made to assess the cave without entering. Approximately 186 hours of search effort to find potential night or day roost sites was undertaken (Table 6.4; Figure 6.6).

Table 6.4: Targeted searches completed for Pilbara leaf-nosed bat and ghost bat within the Study Area

Transect Name	Date	Habitat	Person hours
TPIH-02	12/11/2021	Gorge/ Gully	3
TPIH-15	14/11/2021	Hillcrest/ Hillslope	0.5
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5
TPIH-09	23/11/2021	Gorge/ Gully	2
TPIH-18	24/11/2021	Major Drainage Line	3
TPIH-20	25/11/2021	Gorge/ Gully	5
TPIH-21	25/11/2021	Gorge/ Gully	1
TPIH-05	26/11/2021	Gorge/ Gully	0.66
TPIH-25	29/11/2021	Hillcrest/ Hillslope	0.5
TCPH-022	6/04/2022	Major Drainage Line	6
TCPH-023	6/04/2022	Major Drainage Line	3
TCPH-025	7/04/2022	Gorge/ Gully	3
TCPH-026	8/04/2022	Breakaway/ Cliff	4
TCPH-035	8/04/2022	Breakaway/ Cliff	1
TCPH-027	8/04/2022	Gorge/ Gully	3
TCPH-003	8/04/2022	Major Drainage Line	4
TCPH-046	9/04/2022	Gorge/ Gully	1
TCPH-042	10/04/2022	Gorge/ Gully	6
TCPH-051	10/04/2022	Gorge/ Gully	1.5
TCPH-052	10/04/2022	Gorge/ Gully	4
TCPH-056	10/04/2022	Gorge/ Gully	4
TCPH-063	10/04/2022	Gorge/ Gully	4
TCPH-081	12/04/2022	Gorge/ Gully	4
TCPH-084	13/04/2022	Hillcrest/ Hillslope	1
TCPH-086	28/04/2022	Breakaway/ Cliff	5
TCPH-085	28/04/2022	Gorge/ Gully	2
TCPH-089	29/04/2022	Gorge/ Gully	1.5
TCPH-084	29/04/2022	Hillcrest/ Hillslope	1
TCPH-087	29/04/2022	Hillcrest/ Hillslope	1
TCPH-088	29/04/2022	Hillcrest/ Hillslope	1
TCPH-090	29/04/2022	Hillcrest/ Hillslope	2
TCPH-081	30/04/2022	Gorge/ Gully	3
TCPH-095	30/04/2022	Gorge/ Gully	6
TCPH-100	30/04/2022	Gorge/ Gully	5

Transect Name	Date	Habitat	Person hours
TCPH-117	1/05/2022	Gorge/ Gully	4
TCPH-123	1/05/2022	Gorge/ Gully	1.2
TCPH-125	1/05/2022	Gorge/ Gully	1
TCPH-127	1/05/2022	Gorge/ Gully	2
TCPH-140	1/05/2022	Gorge/ Gully	2
TCPH-130	2/05/2022	Gorge/ Gully	1
TCPH-132	2/05/2022	Gorge/ Gully	2.5
TCPH-133	2/05/2022	Gorge/ Gully	2
TCPH-109	2/05/2022	Major Drainage Line	2
TCPH-140	3/05/2022	Gorge/ Gully	9
TCPH-145	3/05/2022	Gorge/ Gully	2
TCPH-149	3/05/2022	Gorge/ Gully	4
TCPH-153	3/05/2022	Gorge/ Gully	2
TCPH-160	4/05/2022	Gorge/ Gully	4.5
TCPH-170	4/05/2022	Gorge/ Gully	2
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5
TCPH-128	5/05/2022	Gorge/ Gully	4
TCPH-129	5/05/2022	Gorge/ Gully	2
TCPH-134	6/05/2022	Hillcrest/ Hillslope	1
TCPH-180	26/05/2022	Breakaway/ Cliff	1
TCPH-181	26/05/2022	Breakaway/ Cliff	2
TCPH-185	26/05/2022	Gorge/ Gully	4
TCPH-189	27/05/2022	Breakaway/ Cliff	2
TCPH-197	27/05/2022	Breakaway/ Cliff	2
TCPH-198	27/05/2022	Breakaway/ Cliff	2
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4
TCPH-193	27/05/2022	Gorge/ Gully	4
TCPH-195	27/05/2022	Gorge/ Gully	1.5
TCPH-194	27/05/2022	Hillcrest/ Hillslope	1
TCPH-209	28/05/2022	Gorge/ Gully	3
TCPH-229	28/05/2022	Gorge/ Gully	5.5
TCPH-020	28/05/2022	Major Drainage Line	4
TCPH-242	29/05/2022	Hillcrest/ Hillslope	3.5
Total			**186.76**

Ultrasonic Recorders

Overnight recordings of bat echolocation calls were undertaken with Song Meter (SM; Wildlife Acoustics Inc.) ultrasonic bat recorders at 70 sites within the Study Area during the survey (Table 6.5; Figure 6.6). Sampling at each location focussed on habitat features of potential significance (i.e. water features or potential caves) and habitat or habitat features most likely to support the species (i.e. foraging and dispersal corridors provided by Major Drainage Line habitat). Recorders were deployed for between two and 133 consecutive nights at each site, resulting in a total of 802 recording nights (Table 6.5; Figure 6.6).

The audio settings used for the SM units followed the manufacturer's recommendations (Wildlife Acoustics, 2011, 2017) and were set to account for all species known to occur within the region (McKenzie & Bullen, 2009). All recordings were analysed by Robert Bullen of Bat Call WA for the presence of Pilbara leaf-nosed bat and ghost bat calls only.

Table 6.5: Ultrasonic sampling locations within the Study Area

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-003	Major Drainage Line	5/04/2022	9/04/2022	4
VCPH-012	Drainage Area/ Floodplain	5/04/2022	9/04/2022	4
VCPH-013	Gorge/ Gully	6/04/2022	9/04/2022	3
VCPH-014	Stony Plain	6/04/2022	6/04/2022	3
VCPH-015	Major Drainage Line	6/04/2022	9/04/2022	3
VCPH-016	Minor Drainage Line	6/04/2022	9/04/2022	3
VCPH-017	Major Drainage Line	6/04/2022	9/04/2022	3
VCPH-018	Breakaway/ Cliff	6/04/2022	28/04/2022	25
VCPH-019	Gorge/ Gully	6/04/2022	9/04/2022	3
VCPH-020	Gorge/ Gully	6/04/2022	12/04/2022	6
VCPH-027	Gorge/ Gully	8/04/2022	28/04/2022	20
VCPH-041	Medium Drainage Line	9/04/2022	13/04/2022	4
VCPH-042	Gorge/ Gully	9/04/2022	30/04/2022	20
VCPH-043	Gorge/ Gully	9/04/2022	13/04/2022	4
VCPH-044	Minor Drainage Line	9/04/2022	12/04/2022	3
VCPH-045	Minor Drainage Line	9/04/2022	12/04/2022	3
VCPH-046	Gorge/ Gully	9/04/2022	12/04/2022	3
VCPH-048	Mulga Woodland	9/04/2022	12/04/2022	3
VCPH-049	Minor Drainage Line	9/04/2022	12/04/2022	3
VCPH-053	Minor Drainage Line	10/04/2022	28/04/2022	18
VCPH-063	Gorge/ Gully	10/04/2022	28/04/2022	18
VCPH-079	Stony Plain	12/04/2022	29/04/2022	17
VCPH-081	Gorge/ Gully	12/04/2022	30/04/2022	17
VCPH-082	Hillcrest/ Hillslope	13/04/2022	29/04/2022	16
VCPH-084	Gorge/ Gully	13/04/2022	29/04/2022	16
VCPH-085	Gorge/ Gully	28/04/2022	2/05/2022	4
VCPH-087	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-088	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-089	Gorge/ Gully	29/04/2022	2/05/2022	3

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-090	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-091	Breakaway/ Cliff	29/04/2022	2/05/2022	3
VCPH-092	Drainage Area/ Floodplain	29/04/2022	2/05/2022	3
VCPH-093	Gorge/ Gully	29/04/2022	2/05/2022	3
VCPH-094	Breakaway/ Cliff	29/04/2022	2/05/2022	3
VCPH-108	Medium Drainage Line	1/05/2022	6/05/2022	5
VCPH-128	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-129	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-130	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-131	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-132	Gorge/ Gully	2/05/2022	6/05/2022	4
VCPH-133	Gorge/ Gully	2/05/2022	5/05/2022	3
VCPH-138	Gorge/ Gully	3/05/2022	6/05/2022	3
VCPH-140	Breakaway/ Cliff	3/05/2022	26/05/2022	20
VCPH-143	Gorge/ Gully	3/05/2022	6/05/2022	3
VCPH-177	Minor Drainage Line	25/05/2022	29/05/2022	4
VCPH-178	Stony Plain	26/05/2022	29/05/2022	3
VCPH-179	Hardpan Plain	26/05/2022	29/05/2022	3
VCPH-180	Gorge/ Gully	26/05/2022	30/05/2022	4
VCPH-181	Breakaway/ Cliff	26/05/2022	30/05/2022	4
VCPH-182	Hardpan Plain	26/05/2022	29/05/2022	3
VCPH-183	Stony Plain	26/05/2022	29/05/2022	3
VCPH-184	Drainage Area/ Floodplain	26/05/2022	29/05/2022	3
VCPH-185	Gorge/ Gully	26/05/2022	30/05/2022	4
VCPH-186	Undulating Low Hills	26/05/2022	29/05/2022	3
VCPH-187	Drainage Area/ Floodplain	26/05/2022	29/05/2022	3
VCPH-188	Stony Plain	26/05/2022	29/05/2022	3
VPIH-001	Drainage Area/ Floodplain	11/11/2021	24/11/2021	13
VPIH-003	Drainage Area/ Floodplain	12/11/2021	24/11/2021	12
VPIH-004	Drainage Area/ Floodplain	12/11/2021	15/11/2021	3
VPIH-005	Gorge/ Gully	12/11/2021	24/11/2021	12
VPIH-006	Stony Plain	12/11/2021	24/11/2021	12
VPIH-008	Drainage Area/ Floodplain	23/11/2021	28/11/2021	4
VPIH-016	Stony Plain	24/11/2021	26/11/2021	2
VPIH-017	Medium Drainage Line	24/11/2021	28/11/2021	4
VPIH-023	Gorge/ Gully	27/11/2021	9/04/2022	133
VPIH-024	Gorge/ Gully	27/11/2021	9/04/2022	133
VPIH-025	Gorge/ Gully	29/11/2021	9/04/2022	131
VYAN-31	Major Drainage Line	15/05/2022	18/05/2022	3
Total				**802**

600000
650000
700000
750000
800000
7500000
7450000
7400000
Nanutarra Munjina Rd
Karijini Dr
Manuwarra Red Dog Hwy
Tom Price
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

BHP (2022) Sampling Type

- Unknown

DBCA (2022) Sampling Type

- Acoustic Recorder
- Secondary Evidence
- Specimen
- Ultrasonic Call
- Unknown

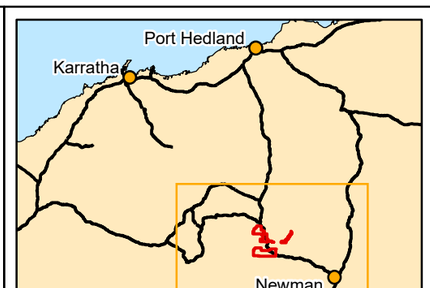
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.5: Previous Pilbara leaf-nosed bat records in the Study Area and region

660000
680000
700000
720000
7480000
7460000

MS1039
MS1072
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Targeted Search (67)
- Ultrasonic Recorder (68)

Record

Pilbara leaf-nosed bat - VU

- Ultrasonic Recorder (6)

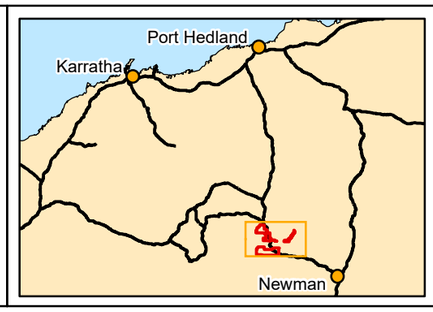
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.6: Pilbara leaf-nosed bat sampling locations, records and habitat in the Study Area

6.3.4 Survey Results

Calls of Pilbara leaf-nosed bats were recorded at four locations during the current survey (from 15 individual calls) within Gorge/ Gully, Hillcrest/ Hillslope and Breakaway/ Cliff habitats (Table 6.6). These locations were all close to caves or moderate to major outcropping (Table 6.6).

Table 6.6: Pilbara leaf-nosed bat recorded within the Study Area

Site	Habitat feature	Habitat	Date	Calls
VCPH-128	Major outcropping	Gorge/ Gully	2/05/2022	1 call (at 2011)
VCPH-133	Cave	Hillcrest/ Hillslope	2/05/2022	9 calls (between 2330 and 0454)
VCPH-130	Moderate outcropping	Gorge/ Gully	3/05/2022	1 call (2159)
VCPH-140	Cave	Breakaway/ Cliff	19/05/2022	4 calls (2130)

No evidence of a Pilbara leaf-nosed diurnal roost caves was recorded within the Study Area during the current survey. A total of 34 caves were recorded within the Study Area, all of which represent potential nocturnal refuges only (Category 4) for the species, except three which had no usage (Table 5.2). Nocturnal roost caves recorded within the Study Area are likely to be intermittently used by foraging and dispersing individuals from diurnal roost(s) located outside the Study Area.

6.3.5 Discussion

The Pilbara leaf-nosed bat was recorded more times within the Study Area during the current survey than any of the previous studies (Biologic, 2011e; Biota, 2013a; Onshore & Biologic, 2011); however, the number of calls was still very low compared to earlier studies. The timing of the calls recorded during the current survey indicated that the calls are likely to be representative of a foraging individual or individuals, which are unlikely to be habitually using a nearby cave as a diurnal roost. This is consistent with previous studies.

The nearest known permanent diurnal roost for this species (East Turee Creek roost) is located approximately 20 km west of the western edge of the Study Area (Bat Call, 2021b). Pilbara leaf-nosed bats are predicted to travel up to 20 km from roost caves during nightly foraging (Cramer *et al.*, 2016a); however, seasonal variation is known to occur, with foraging occurring up to 20 km in the dry season and up to 50 km during the wet season (Bullen, 2013). Long-distance movements by the species have also been recorded, with a single monitored individual recorded from two roost caves located 170 km from each other approximately 12 months apart (Bullen & Reiffer, 2019), suggesting the species may forage and/or disperse over greater distances than previously thought. Given this, it is possible that the Pilbara leaf-nosed bats occasionally recorded in the Study Area may have originated from the East Turee Creek roost. It is also possible that these Pilbara leaf-nosed bats may originate from an undiscovered roost site near the Study Area.

The Gorge/ Gully (2.64%, 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha) and Major Drainage Line (0.09%, 54.94 ha) habitats within the Study Area represent critical Pilbara leaf-nosed bat habitat. These habitats provide potential roosting, foraging and dispersal habitat for the species, and also tend to contain important habitat features for the species, such as nocturnal refuges and water features. As such these habitats represent a Habitat Rating 4 (very high) as defined by (Bat Call, 2021b).

Additionally, Stony Plain, Hillcrest/ Hillslope, Drainage Area/ Floodplain, Mulga Woodland, Undulating Low Hills, Minor Drainage Line and Medium Drainage Line all provide supporting habitat for the species. As such these habitats represent a Habitat Rating 2 (low) as defined by (Bat Call, 2021b). The Study Area also contains water features likely to provide supporting foraging habitat for the Pilbara leaf-nosed bat. These water features would provide supporting habitat rather than critical habitat because they are not permanent and are situated further than 8.7 km from the nearest roost.

The results of this survey support the desktop findings by Biologic (2020e), which demonstrated that the Pilbara leaf-nosed bat is relatively scarce within the broader Newman area. This is likely due to the limited occurrence of potential roosting habitat in the vicinity of the Study Area. The scarcity of records in the broader vicinity of the Study Area suggests the Pilbara leaf-nosed bat is relatively uncommon in the area and its occurrence may be restricted to foraging and/or dispersal events only.

The Pilbara population is regarded as representing a single interbreeding population (TSSC, 2016c; Umbrello *et al.*, 2022). Thus, the entire population of Pilbara leaf-nosed bat present in the Pilbara is suggested to represent an 'important population'. Hence, the significance of occurrence used for this assessment was based on the presence/ absence of Category 1 and 2 (permanent diurnal) roosts and Category 3 (semi-permanent diurnal) roosts, as stipulated by (Bat Call, 2021b). Given the absence of a critical roost within, or in the immediate vicinity of, the Study Area, it is unlikely that the Study Area represents a significant area for this species.

6.4 Ghost Bat (*Macroderma gigas*)

6.4.1 Species Profile

The ghost bat is listed as Vulnerable under the EPBC Act and the BC Act. The species occurs in disjunct colonies across northern Australia (TSSC, 2016a). In the Pilbara region, the species occurs in all four subregions. The Pilbara population is estimated to comprise between 1,300 and 2,000 individuals (TSSC, 2016a). The largest population occurs within the Chichester subregion (estimated at approximately 1,500 individuals) where known populations are largely restricted to disused mines (TSSC, 2016a).

The distribution of ghost bats in the Pilbara is determined by the presence of suitable roosting sites. Natural roosts generally comprise deep, complex caves beneath bluffs or low rounded hills (Armstrong & Anstee, 2000). Centralised breeding sites in the Pilbara are largely restricted to abandoned mines in the Chichester Ranges; however, there are also a number of smaller maternity roosts in the Chichester and Hamersley Ranges (Armstrong & Anstee, 2000). Based on available data, breeding has been documented in natural caves at Mining Area C, Mt Brockman and West Angeles in the Hamersley sub-

region, and at Callawa and Tambrey Station in the Chichester subregion (Armstrong & Anstee, 2000). Ghost bats are known to move between a number of caves seasonally, or as dictated by weather conditions, and require a range of cave sites (Hutson *et al.*, 2001). Outside the breeding season, male bats are known to disperse widely, most likely during the wet season when conditions would allow bats to use caves that would otherwise not be suitable (Worthington-Wilmer *et al.*, 1994). Genetic studies indicate that females are likely to stay close to the maternity roosts (Worthington-Wilmer *et al.*, 1994).

Caves and roosts used by the species can be classified into four categories (Bat Call, 2021a):

- **Category 1 maternity/ diurnal roost sites with permanent ghost bat occupancy**: Maternity/ diurnal roost caves with permanent ghost bat occupancy. There are several documented permanent roost caves and underground mines in northern Australia. These may be abandoned underground mines;
- **Category 2 maternity/ diurnal roost caves with regular occupancy**: Maternity/ Diurnal roost caves with regular (but not continuous) ghost bat occupancy that is capable of supporting one or more reproducing females and their habitat. These may be abandoned underground mines;
- **Category 3 diurnal roost caves with occasional occupancy**: There are many caves and adits where one to a few ghost bats roost occasionally, or rarely; and
- **Category 4 nocturnal roost caves with opportunistic usage**: shallow caves, shelters and deep overhangs that support opportunistic usage for resting and feeding.

Foraging habitat for ghost bats is classified as occurring within 12 km radius of these categorised caves (Bat Call, 2021a) or 1,200 ha of habitat surrounding each of these caves. The habitat includes:

- productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground;
- isolated trees and trees on the edge of thin thickets on the plains;
- trees along the edges of watercourse woodlands; and
- gully or gorge system that opens onto a plain or riparian line.

Historically, ghost bats were documented to have a short-range foraging strategy of up to 3 km (average 1.9 km), with vantage points changing approximately every 15 minutes, and average foraging areas of 61 ha having been recorded in the Northern Territory (Tidemann *et al.*, 1985). However, recent studies using VHF tracking and GPS/satellite tracking technologies show that ghost bats, both male and female, forage over much larger areas up to 12 km from their diurnal roost (Augusteyn *et al.*, 2018; Bat Call, 2021a). It also appears that bats generally return to the same area each night (Tidemann *et al.*, 1985), although it has been suggested that ghost bats in the arid zone are semi-transient through most areas and will readily travel large distances (>4 km) (Biologic, 2020c). Ghost bats have a ‘sit and inspect’ foraging strategy; whereby they hang on a perch and visually inspect their surroundings for movement. Once their prey is detected it may be captured in the air, gleaned (i.e. taken from the surface of a substrate by a flying bat) from the ground or vegetation, or dropped on from a perch (Boles, 1999).

Recent studies at BHP WAIO's South Flank mine have physically observed a ghost bat exiting a cave and moving immediately towards broad drainage plains, comprising of Mulga Woodland and Major Drainage Line (Biologic, 2020c). Such areas are often highly productive and comprise an abundance of foraging structures (Biologic, 2020c).

6.4.2 Previous Records

The Study Area falls within the current distribution of the ghost bat, whereby the species or species' habitat is likely to occur (DoE, 2022b). In Western Australia, the species has experienced a significant north-westward distribution contraction, presumably associated with increasing aridity (TSSC, 2016a). Numerous caves regarded as important for ghost bats are known to occur near the Study Area, at South Flank and West Angelas.

A total of 559 records of ghost bat occur within 50 km of the Study Area (Figure 6.7), with 115 records occurring within the Study Area (BHP, 2022; DBCA, 2022b). This includes 73 records from Mudlark Well, 40 from Pineapple Hill and Camp Hill, two records within the MAC to Yandi Rail Corridor. Of the total ghost bat records, 459 occur within 12 km of the Study Area (classified foraging range), with all records occurring between 2005 and 2019 (BHP, 2022; DBCA, 2022b).

Other than long-term ghost bat monitoring studies currently being completed around the South Flank area, which monitors four Category 2 and three Category 3 roosts in the Study Area (Biologic, *2023*), the majority of ghost bat records within the Study Area are around a decade old (up until 2014) (Table 6.7).

Table 6.7: Ghost bat previously recorded in and near the Study Area

Report	Records
Biologic (2019)	Recorded the ghost bat 13 times (11 times from scats collected from caves, once from direct observation of two individuals within a cave and once from ultrasonic recorder) all within Gorge/ Gully and Hillcrest/ Hillslope habitats within the Pineapple Hills tenements Study Area. Scats were also recorded at 12 of the caves; five of these are located in the Study Area (CPIN-02, CPIN-03, CPIN-04, CPIN-05 and CPIN-20) (Figure 5.2).
Biologic (2013a)	Recorded at 35 wide-spread locations at Area C West in 2011. A confirmed maternity roost at South Flank.
(Onshore & Biologic, 2011)	Camp Hill, also located within the Study Area, has suitable caves and overhangs and scats were recorded in 2010 from a number of locations, suggesting that this species may be resident in this area.
Biologic (2011a)	20 confirmed ghost bat roosts based on the presence of scats and observed a total of 18 individual ghost bats at two caves.
Biologic (2011e)	Observed seven individual ghost bats at two cave locations and identified 16 ghost bat roosts by the presence of ghost bat scats.
Biologic (2010)	18 individual ghost bats and recorded scats in one cave.

Report	Records
Outback Ecology (2010)	Ghost bat scats in Gorge/ Gully habitat.

6.4.3 Survey Methods

Targeted Searches

Targeted searches were undertaken at 67 locations across the Study Area on foot to determine the presence and extent of any prospective roosting habitat (i.e. caves) likely to be utilised by ghost bats and/or Pilbara leaf-nosed bats (Table 6.4; Figure 6.8). Where suitable caves or overhangs that may be utilised by the species were located, detailed cave assessments were undertaken to search for evidence of occurrence and determine the likely use of the cave as a roost site. Where a cave was not deemed safe for entry, efforts were made to assess the cave without entering. Approximately 186.78 hours of search effort to find potential night or day roost sites was undertaken (Table 6.4; Figure 6.8).

Ultrasonic Recorders

Overnight recordings of bat echolocation calls were undertaken with Song Meter (SM; Wildlife Acoustics Inc.) ultrasonic bat recorders at 68 sites within the Study Area during the survey (Table 6.5; Figure 6.8). Sampling at each location focussed on habitat features of potential significance (i.e. water features or potential caves) and habitat or habitat features most likely to support the species (i.e. foraging and dispersal corridors). Recorders were deployed for between two and 133 consecutive nights at each site, resulting in a total of 802 recording nights (Table 6.5; Figure 6.8).

The audio settings used for the SM units followed the manufacturer's recommendations (Wildlife Acoustics, 2011, 2017) and were set to account for all species known to occur within the region (McKenzie & Bullen, 2009). All recordings were analysed by Robert Bullen of Bat Call WA for the presence of ghost bat and Pilbara leaf-nosed bat calls only.

600000 650000 700000 750000 800000

7500000 7450000 7400000

Nanutarra Murrjina Rd
Manuwarra Red Dog Hwy
Tom Price
Karijini Dr
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Approval Boundary
- Desktop Assessment Area
- State Road
- Rail

BHP (2022)
Sampling Type
- Camera Trap
- Ultrasonic Recorder
- Unknown
- Scat

DBCA (2022)
Sampling Type
- Acoustic Recorder
- Individual (alive)
- Individual (dead)
- Scat
- Specimen
- Unknown

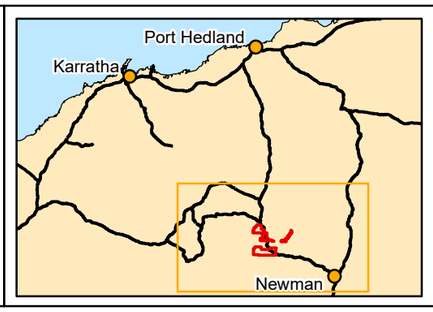
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.7: Previous ghost bat records in the Study Area and region

660000
680000
700000
720000
7480000
7460000

MS1039
MS1072
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Targeted Search (67)
- Ultrasonic Recorder (68)

Record

Ghost bat - VU

- Ultrasonic Recorder (32)

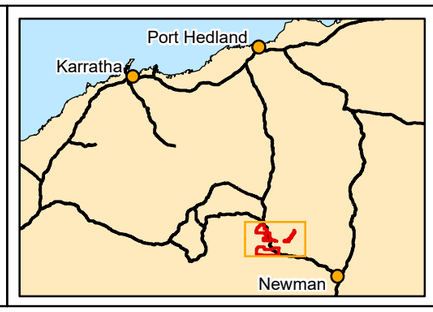
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 22/12/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.8: Ghost bat sampling locations, records and habitat in the Study Area

6.4.4 Survey Results

Ghost bats were recorded from echolocation calls at four locations on 33 nights, which were all close to caves or major outcropping (Table 6.8). Calls were recorded from VPIH-23 on 29 nights, VPIH-24 on two nights, VCPH-042 on two nights, and VCPH-046 on a single night (Table 6.8). The number of calls recorded during a given night at VPIH-23 ranged between one and ten (Table 6.8).

Of the 34 caves occurring within the Study Area, five (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified as Category 2 roosts (maternity/ diurnal roost caves with regular occupancy for ghost bats) (Table 5.2). Three caves in the Study Area (CACW-01, CMUD-08 and CACW-11) were identified as Category 3 (diurnal roost caves with occasional occupancy) and 23 were identified as Category 4 (nocturnal roost caves with opportunistic usage) for ghost bats (Table 5.2). The remaining three caves recorded in the Study Area showed no evidence of usage by the ghost bat and are unlikely to be suitable for this species. No scat evidence was recorded from any caves during the current survey.

Unlike the majority of microbats, ghost bats are proficient in navigating and hunting visually without needing to constantly echolocate (Strahan, 2004). For this reason, it is difficult and inaccurate to rely solely on ultrasonic and acoustic recordings of the species to infer absence and/or activity, and therefore very possible the species went undetected at other sampling sites during the survey.

Table 6.8: Ghost bats recorded within the Study Area

Site	Habitat feature	Habitat	Date	Records (calls)
VCPH-046	Major outcropping	Gorge/ Gully	9/04/2022	1
VCPH-042	Cave	Gorge/ Gully	12/04/2022	1
			3/05/2022	1
VPIH-23	Cave	Gorge/ Gully	27/11/2021	5
			28/11/2021	6
			29/11/2021	5
			3/12/2021	5
			7/12/2021	2
			12/12/2021	2
			28/12/2021	2
			7/01/2022	5
			14/01/2022	2
			15/01/2022	4
			20/01/2022	2
			12/02/2022	3
			3/03/2022	10
			7/03/2022	3
			19/03/2022	6
			24/03/2022	1
			25/03/2022	3
			26/03/2022	1
			27/03/2022	1
			28/03/2022	1
			31/03/2022	1
			1/04/2022	1
			2/04/2022	1
			3/04/2022	3
			4/04/2022	3
			5/04/2022	2
			6/04/2022	2
			7/04/2022	2
			8/04/2022	1
VPIH-24	Cave	Gorge/ Gully	28/11/2021	1
			10/02/2022	2

6.4.5 Discussion

The results of the current and previous surveys have confirmed ghost bat occurrence within the Study Area. Based on previous records, the Study Area is likely to be an important area to the ghost bat, based on the presence of critical and supporting habitats. Of the 34 caves occurring within the Study Area, 23 are located within Gorge/ Gully habitat, five within Breakaway/ Cliff habitat and six within Hillcrest/ Hillslope Habitat (Table 5.2; Figure 6.8). Within the Study Area, Gorge/ Gully habitat (2.64%, 1,564.61 ha) often contains important habitat features such as overhangs and caves. Due to the size of the Study Area, it was not feasible to search the entire extent of these habitat types, therefore it is possible additional undiscovered caves occur within the Study Area.

Ghost bats will often forage broadly across habitats, often utilising drainage lines and other habitats where prey species are likely to be most abundant (Richards *et al.*, 2008; Tidemann *et al.*, 1985). Recent studies of ghost bat home range and foraging behaviour in the Pilbara region have identified Drainage Area/ Floodplain, Gorge/ Gully, and Minor Drainage Line as important foraging habitats for the species (Biologic, 2020c). Within the Study Area it is considered that critical foraging habitat is provided by Stony Plain (35.51%, 21,051.01 ha), Drainage Area/ Floodplain (16.27%, 9,644.57 ha), Mulga Woodland (6.82%, 4,043.20 ha), Minor Drainage Line (2.77%, 1,639.45 ha), Medium Drainage Line (0.61%, 362.20 ha), and Major Drainage Line (0.09%, 54.94 ha) when proximal (>12 km) to roosting caves. As suggested by Bat Call (2021a) these habitats represent “productive plain areas with thin mature woodland over patchy or clumped tussock or hummock grass (*Triodia* spp.) on sand or stony ground” and/or contain “isolated trees and trees on the edge of thin thickets on the plains” and “trees along the edges of watercourse woodlands”. Due to the locations of roosting caves within the Study Area and surrounds, these habitats within the entire extent of the Study Area can be considered critical foraging habitat. Undulating Low Hills and Gorge/ Gully habitats provide supporting foraging and dispersal habitat. The suitability of this habitat, is however, variable depending particular characteristics of the habitat, including the abundance of foraging structures (tree perches) and density of understory vegetation present.

A population of ghost bats likely occurs within and surrounding the Study Area, forming part of a broader ghost bat population with high genetic diversity across the Pilbara region (Ottewell *et al.*, 2017), which is likely to be an important population. The population within the Study Area is likely to be considered ‘important’ as defined by DoE (2013) because it is likely to be a key source population for breeding given that five Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified and provide critical habitat. Furthermore, critical foraging habitat exists across the entire extent of the Study Area and would be used by ghost bats that use other High Value Caves at South Flank detailed in Biologic (*in prep.*).

CMUD-01 has evidence of utilisation by pregnant females with elevated progesterone (> 970 ng/g) detected in scats across seven (out of eight) consecutive years of monitoring (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *in prep.-a*, *in prep.-b)* making it the most consistently used cave by pregnant females of the caves monitored in the MS1072 Fauna Management Plan monitoring program (Biologic, *2023*). This result indicates that CMUD-01 is a potential maternity roost. Elevated progesterone levels

were not recorded at CMUD-01 during the most recent monitoring in 2021-2022 (Biologic, *in prep.*). CMUD-10 has also demonstrated evidence of utilisation by pregnant females over six (out of eight) years of monitoring (Biologic, *in prep.*).

6.5 Night Parrot (*Pezoporus occidentalis*)

6.5.1 Species Profile

The night parrot is an elusive, nocturnal ground dwelling parrot listed as Critically Endangered under the BC Act and Endangered under the EPBC Act. The species inhabits arid and semi-arid areas that comprise dense, low vegetation (DPaW, 2017). Based on accepted records, the species' habitat consists of *Triodia* grasslands in stony or sandy environments (McGilp, 1931; North, 1898; Whitlock, 1924; Wilson, 1937), and of samphire and chenopod shrublands, including genera such as *Atriplex*, *Bassia* and *Maireana*, on floodplains and claypans, as well as on the margins of salt lakes, creeks or other sources of water (McGilp, 1931; Wilson, 1937). The current interim guidelines for preliminary surveys of night parrot in Western Australia suggest the species requires old-growth spinifex (*Triodia*) (often more than 50 years' unburnt) for roosting and nesting (DPaW, 2017).

Although little is known about foraging sites, habitats that comprise various grasses and herbs are thought to be suitable. Foraging habitat is not necessarily within or adjacent to roosting habitat as the night parrot has been known to fly up to 40 km in a single night to forage (Murphy *et al.*, 2017). It is assumed that the species may fly cumulative distances of up to 100 km per night during productive seasons and considerably greater than 100 km per night during drought conditions between roosting habitat and foraging habitat (Night Parrot Recovery Team, 2017). *Triodia* is likely to provide a good seasonal food resource, particularly in times of mass flowering and seeding. The succulent *Sclerolaena* and other succulent chenopods also provides a source of food and moisture throughout the year, and are also likely to provide significant habitat (DPaW, 2017). As such, foraging areas include highly productive and floristically diverse alluvial habitats, stony herb fields, sparse ironstone pavements, and quaternary sand drifts and ridges (Night Parrot Recovery Team, 2017). Foraging habitat is likely to be more important when it occurs adjacent to or within approximately 10 km of suitable roosting habitat (DPaW, 2017). During dispersal, or nomadic movements, night parrots may travel distances in the order of several hundred kilometres.

The distribution of the night parrot is very poorly understood. The small number of confirmed or verifiable records prevents the population size from being assessed with any accuracy; however, the population size is speculatively estimated to consist of approximately 50 breeding birds that occur in five subpopulations. The largest of these subpopulations is estimated, with low reliability, to consist of 20 breeding birds (Garnett & Crowley, 2000).

6.5.2 Previous Records

The distribution of the night parrot is very poorly understood in Western Australia; however, the Study Area occurs within the species' potential distribution, as currently mapped by DoEE (2019b). The nearest record of the night parrot to the Study Area is located approximately 50 km to the north-east,

adjacent to the Cloudbreak mine (FMG, 2021) (Table 6.9). This record currently represents the most recent documented record of the species in Western Australia and was the first to provide evidence of the night parrot persisting in suitable habitat areas adjacent to active mining operations. This follows on from an earlier record in the same area of three individuals sighted at dusk in Mulga woodland near a permanent water soak in 2005 (Davis & Metcalf, 2008) (Table 6.9). That site is heavily degraded from cattle and lacks understory within a larger area; however, larger patches of old-growth *Triodia* grasslands occur in the vicinity along the peripherals of the Fortescue Marsh and chenopod shrublands occur throughout the marsh itself. Another recent record, Kanyirninpa Jukurrpa rangers recorded night parrot calls at two locations on Martu country in 2020 (Michelmore & Birch, 2020).

The night parrot is assumed to be able to travel large distances (up to 100 km per night or more) between roosting habitat and foraging habitat (Night Parrot Recovery Team, 2017). Any night parrots occurring near the Cloudbreak mine (Davis & Metcalf, 2008; FMG, 2021) could potentially use the Study Area as only 50 km separates these two areas. It should also be noted that the night parrot is especially cryptic and rare in occurrence and therefore difficult to record so the records to date may underestimate the occurrence of the species.

Table 6.9: Previous records of night parrot within Western Australia

Location	Date of Observation	Source	Distance from Study Area	Recorded Habitat Type	Other Comments
Minga Well, south of Cloudbreak mine site	12/04/2005	Davis and Metcalf (2008)	~50 km north-east	Mulga woodland. No understorey	Permanent water soak. 3 individuals observed at dusk in a targeted survey
Adjacent to Cloudbreak Mine	~2021 (exact date not given)	(FMG, 2021)	~50 km north-east	Not noted but located near Fortescue Marsh	Adjacent to mining operations
Moojarri Well	~2005 (exact date not noted)	Biota (2005b)	~44 km north north-east	Not noted	Unconfirmed Biota record between Fortescue Marsh and FMG Stage B Rail Corridor
Vacant crown land	15/07/1970	DBCA (2022a)	Undisclosed location	Spinifex grassland (Spinifex and scattered gums) Crest/summit.	Four individuals observed
Martu country (Great Sandy and Little Sandy Deserts)	~2020 (exact date not provided)	Michelmore and Birch (2020)	Undisclosed location	Salt lake system	Acoustic recording
Matuwa (Lorna Glen)	24/11/2009 05/12/2009	Hamilton *et al.* (2017)	~450 km south-east	Lake system-native and introduced grasses, samphire,	One individual each night

Location	Date of Observation	Source	Distance from Study Area	Recorded Habitat Type	Other Comments
				sedges, chenopods. Thick *Eremophila*, Mulga and grasses	
East Murchison	March 2017	Night Parrot Recovery Team (2017), Jackett *et al.* (2017)	Undisclosed location	Spinifex hummock grassland on sandy substrate, encompassed by mulga woodland and a breakaway, separated from the *Triodia* by an open plain of samphire	Living individuals and an active nest

6.5.3 Survey Methods

Acoustic Recorders

Song Meter (SM; Wildlife Acoustics Inc.) acoustic recorders were deployed at 36 sites during the field survey within habitat considered the most appropriate (Table 6.10, Figure 6.9). In an effort to target night parrot, acoustic recorders were deployed in habitat that best meets the description of potential roosting and nesting habitat as recommended by DPaW (2017), stands of large old-growth spinifex (*Triodia* spp.), often 50 years unburn, often forming mosaics with chenopods shrublands. Song Meters were deployed for between one and 20 consecutive nights each, for a total of 371 recording nights. Sampling at 31 of the locations met the recommended sampling period of six consecutive nights (DPaW, 2017). Acoustic recordings were analysed for night parrot calls by specialist Nigel Jackett.

Table 6.10: Night parrot acoustic sampling locations within the Study Area

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-001	Stony Plain	5/04/2022	11/04/2022	6
VCPH-002	Stony Plain	5/04/2022	11/04/2022	6
VCPH-004	Drainage Area/ Floodplain	5/04/2022	11/04/2022	6
VCPH-005	Hillcrest/ Hillslope	5/04/2022	11/04/2022	6
VCPH-006	Stony Plain	5/04/2022	11/04/2022	6
VCPH-007	Hillcrest/ Hillslope	5/04/2022	11/04/2022	6
VCPH-008	Drainage Area/ Floodplain	5/04/2022	11/04/2022	6
VCPH-009	Hillcrest/ Hillslope	5/04/2022	11/04/2022	6
VCPH-011	Stony Plain	5/04/2022	11/04/2022	6
VCPH-020	Gorge/ Gully	6/04/2022	12/04/2022	6
VCPH-021	Drainage Area/ Floodplain	6/04/2022	13/04/2022	7
VCPH-024	Stony Plain	7/04/2022	13/04/2022	6
VCPH-065	Stony Plain	11/04/2022	1/05/2022	20
VCPH-066	Stony Plain	11/04/2022	1/05/2022	20
VCPH-067	Stony Plain	11/04/2022	1/05/2022	20
VCPH-068	Stony Plain	11/04/2022	1/05/2022	20
VCPH-069	Stony Plain	11/04/2022	1/05/2022	20

Site	Habitat	Deployment	Retrieval	Sampling Nights
VCPH-070	Mulga Woodland	11/04/2022	1/05/2022	20
VCPH-074	Stony Plain	11/04/2022	13/04/2022	2
VCPH-075	Stony Plain	11/04/2022	30/04/2022	19
VCPH-076	Hillcrest/ Hillslope	11/04/2022	1/05/2022	20
VCPH-077	Drainage Area/ Floodplain	11/04/2022	1/05/2022	20
VCPH-080	Hillcrest/ Hillslope	12/04/2022	13/04/2022	1
VCPH-081	Gorge/ Gully	12/04/2022	30/04/2022	18
VCPH-082	Hillcrest/ Hillslope	30/04/2022	6/05/2022	6
VCPH-175	Stony Plain	6/05/2022	26/05/2022	20
VPIH-007	Stony Plain	13/11/2021	24/11/2021	11
VPIH-008	Drainage Area/ Floodplain	13/11/2021	24/11/2021	11
VPIH-010	Stony Plain	13/11/2021	24/11/2021	11
VPIH-011	Drainage Area/ Floodplain	13/11/2021	24/11/2021	11
VPIH-012	Hardpan Plain	24/11/2021	26/11/2021	2
VPIH-013	Drainage Area/ Floodplain	13/11/2021	24/11/2021	11
VPIH-014	Stony Plain	13/11/2021	24/11/2021	11
VPIH-019	Stony Plain	23/11/2021	26/11/2021	3
VPIH-026	Stony Plain	25/11/2021	26/11/2021	1
Total				**371**

660000
680000
700000
720000
7480000
7460000

Great Northern Hwy
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1039
MS1072

Legend

Study Area
Approval Boundary
Local Road
State Road
Rail

Sampling Method

Acoustic Recorder (36)

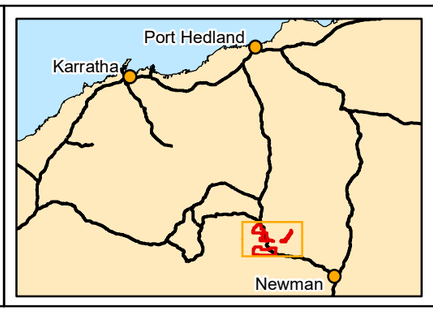
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.9: Night parrot sampling locations in the Study Area

6.5.4 Survey Results

Acoustic Recorders

No night parrots were recorded during the current survey from the 371 recording nights at 35 acoustic recording sites. Sampling resulted in a total of 678 non-target records, comprising 37 bird species.

6.5.5 Discussion

No evidence of occurrence of night parrot was recorded within the Study Area during the current survey, including from targeted acoustic recorders deployed in areas of habitat considered possibly suitable for the species. Habitat within the Study Area was considered marginal for the species, as there are limited instances of *Triodia* grasslands that are considered suitable (i.e. large, long-unburnt hummocks) for the species; however, the occurrence of these habitats is often small in size with no connectivity to other areas of suitable nesting and/or foraging habitat within or in the vicinity of the Study Area. These instances occur within Stony Plain (35.51%, 2,1051.0 ha) and Drainage Area/ Floodplain 16.27% (9,644.57 ha) habitats of the Study Area. Additionally, there is a lack of neighbouring ephemeral freshwater sources and foraging habitat (i.e. succulent chenopod shrubs). This type of foraging habitat is widespread at the Fortescue Marsh, which is located near the recent night parrot record approximately 50 km to the north-east of the Study Area.

Little is known about the species' habitat preferences and occurrence, particularly within the Pilbara region, and thus the extent of which the Study Area may still provide habitat for the species is unknown. Due to the close proximity of the recent night parrot record approximately 50 km to the north-east of the Study Area, this species is considered possible to occur within the Study Area; however, due to a lack of suitable habitat this use would be either intermittent or while transiting to other areas. It is unlikely that this would constitute a significant occurrence based on the definitions by DoE (2013).

6.6 Grey Falcon (*Falco hypoleucos*)

6.6.1 Species Profile

The grey falcon is listed as Vulnerable under the EPBC Act and BC Act and are widely distributed over the northern parts of Australia's arid and semi-arid zone (Mullin *et al.*, 2020). Climate characteristics appear to play a crucial role in this species' distribution (Schoenjahn *et al.*, 2019), perhaps because these birds rely on low levels of relative humidity for efficient evaporative cooling (Schoenjahn *et al.*, 2022). Recent estimates suggest the grey falcon comprises a single, widely distributed interbreeding population (although there may be weak population structure between breeding grounds in the east and west of Australia) with around 1,415 females (Mullin *et al.*, 2020). The Pilbara is thought to potentially be a stronghold of the grey falcon (Sutton, 2010).

Grey falcons do not appear to be associated with particular vegetation types (Schoenjahn *et al.*, 2019); they often sit motionless in the canopies of trees or dead branches of eucalypts (Falkenberg, 2010). The species tends to prefer sparsely-treed, open plains and creek lines for hunting (Olsen & Olsen, 1986).

Breeding takes place between mid to late winter and the end of spring (i.e. June to November) (Schoenjahn *et al.*, 2019). Breeding habitat for this species has been observed to be riparian habitat as well as other productive 'oases' within an arid environment, though not necessarily immediately adjacent to waterholes (Sutton, 2010). Nesting often occurs in the abandoned nest of a raptor or corvid in trees or tall infrastructure such as power line towers or communications towers (Olsen & Olsen, 1986; Schoenjahn *et al.*, 2019). Within the Pilbara, grey falcon nests (made using disused stick nests of crows) were observed in two riparian eucalypts (*Eucalyptus coolabah* and *E. camaldulensis*; 23 km apart) on a dry river bed (Sutton, 2010). Ten years later, the area had a lot of scrubby regrowth and the grey falcons were absent (Sutton, 2010). Above-average rainfall in the first half of the year may encourage breeding if summer rainfall triggers growth of seed grasses which in turn increases abundance of granivorous birds which the species prey on (Sutton, 2010).

Grey falcons have an almost exclusive diet of birds (e.g. budgerigars (*Melopsittacus undulatus*), pigeons, doves and zebra finches (*Taeniopygia guttata*)) but can, under unusual circumstances, include non-avian foods (e.g. small mammals) (Schoenjahn, 2013). Whether grey falcons scavenge carrion at all has been disputed, although they do have a tendency to consume their prey on the ground, sometimes by the side of roads and tracks (Schoenjahn, 2018).

Modelling by Runge *et al.* (2014) estimated the minimum range size for this species as 882,558 km^2. Recent research has shown that the grey falcon is a 'reluctant nomad'; only if conditions become a risk to their survival are they likely to move on and then, when they do, they move no further than necessary (Schoenjahn, 2018). The grey falcon tends to stay and forego breeding rather than search for more favourable conditions (Schoenjahn, 2018). In general, this species tends to keep physical activity levels lows (Schoenjahn *et al.*, 2022).

6.6.2 Previous Records

Ten records of grey falcon within 50 km of the Study Area were identified in the desktop assessment (Figure 6.10) (BHP, 2022; DBCA, 2022b). The most proximate record of the species to the Study Area includes a 2004 record of an individual observed in the Packsaddle range, just outside the Study Area (Ecologia, 2004b), multiple of observations of an individual foraging from the same day located approximately 0.8–1.7 km north of Mudlark Well of in 2008 (DBCA, 2022b; ENV, 2008a) and a record of two birds observed approximately 0.5 km south of Mudlark Well in 1997 (Ecologia, 1998c). All remaining records from the desktop assessment are located to the north of the Study Area and are no closer than 27 km.

6.6.3 Survey Methods

Targeted Searching

A total of 60 targeted searches were undertaken within the Study Area that included concurrent searching for grey falcon, undertaken within Major Drainage Line, Minor Drainage Line, Gorge/ Gully and Breakaway/ Cliff habitats (Table 6.11; Figure 6.11). Searches focused on observing active individuals and/or secondary evidence such as nests, feathers or eggs. A total of 180.7 person hours of targeted searches were undertaken within the Study Area (Table 6.11). Opportunistic searches for grey falcon were also undertaken whilst undertaking sampling for other target species and traversing the Study Area.

Table 6.11: Targeted searches completed for grey falcon within the Study Area

Transect ID	Date	Habitat	Person Hours
TPIH-02	12/11/2021	Gorge/ Gully	3
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5
TPIH-09	23/11/2021	Gorge/ Gully	2
TPIH-18	24/11/2021	Major Drainage Line	3
TPIH-20	25/11/2021	Gorge/ Gully	5
TPIH-21	25/11/2021	Gorge/ Gully	1
TPIH-05	26/11/2021	Gorge/ Gully	0.66
TCPH-022	6/04/2022	Major Drainage Line	6
TCPH-023	6/04/2022	Major Drainage Line	3
TCPH-025	7/04/2022	Gorge/ Gully	3
TCPH-026	8/04/2022	Breakaway/ Cliff	4
TCPH-035	8/04/2022	Breakaway/ Cliff	1
TCPH-027	8/04/2022	Gorge/ Gully	3
TCPH-003	8/04/2022	Major Drainage Line	4
TCPH-046	9/04/2022	Gorge/ Gully	1
TCPH-041	9/04/2022	Medium Drainage Line	1.5
TCPH-042	10/04/2022	Gorge/ Gully	6
TCPH-051	10/04/2022	Gorge/ Gully	1.5
TCPH-052	10/04/2022	Gorge/ Gully	4
TCPH-056	10/04/2022	Gorge/ Gully	4
TCPH-063	10/04/2022	Gorge/ Gully	4

Transect ID	Date	Habitat	Person Hours
TCPH-081	12/04/2022	Gorge/ Gully	4
TCPH-086	28/04/2022	Breakaway/ Cliff	5
TCPH-085	28/04/2022	Gorge/ Gully	2
TCPH-089	29/04/2022	Gorge/ Gully	1.5
TCPH-081	30/04/2022	Gorge/ Gully	3
TCPH-095	30/04/2022	Gorge/ Gully	6
TCPH-100	30/04/2022	Gorge/ Gully	5
TCPH-117	1/05/2022	Gorge/ Gully	4
TCPH-123	1/05/2022	Gorge/ Gully	1.2
TCPH-125	1/05/2022	Gorge/ Gully	1
TCPH-127	1/05/2022	Gorge/ Gully	2
TCPH-140	1/05/2022	Gorge/ Gully	2
TCPH-130	2/05/2022	Gorge/ Gully	1
TCPH-132	2/05/2022	Gorge/ Gully	2.5
TCPH-133	2/05/2022	Gorge/ Gully	2
TCPH-109	2/05/2022	Major Drainage Line	2
TCPH-140	3/05/2022	Gorge/ Gully	9
TCPH-145	3/05/2022	Gorge/ Gully	2
TCPH-149	3/05/2022	Gorge/ Gully	4
TCPH-153	3/05/2022	Gorge/ Gully	2
TCPH-160	4/05/2022	Gorge/ Gully	4.5
TCPH-170	4/05/2022	Gorge/ Gully	2
TCPH-091	4/05/2022	Medium Drainage Line	3
TCPH-166	4/05/2022	Medium Drainage Line	2
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5
TCPH-128	5/05/2022	Gorge/ Gully	4
TCPH-129	5/05/2022	Gorge/ Gully	2
TCPH-180	26/05/2022	Breakaway/ Cliff	1
TCPH-181	26/05/2022	Breakaway/ Cliff	2
TCPH-185	26/05/2022	Gorge/ Gully	4
TCPH-189	27/05/2022	Breakaway/ Cliff	2
TCPH-197	27/05/2022	Breakaway/ Cliff	2
TCPH-198	27/05/2022	Breakaway/ Cliff	2
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4
TCPH-193	27/05/2022	Gorge/ Gully	4
TCPH-195	27/05/2022	Gorge/ Gully	1.5
TCPH-209	28/05/2022	Gorge/ Gully	3
TCPH-229	28/05/2022	Gorge/ Gully	5.5
TCPH-020	28/05/2022	Major Drainage Line	4
Total			**180.76**

600000
650000
700000
750000
800000
7500000
7450000
7400000
Nanutarra Wmjina Rd
Manuwarra Red Dog Hwy
Tom Price
Karijini Dr
Tom Price Rd
Paraburdoo Rd
Paraburdoo
MS1039
MS1072
Great Northern Hwy
Marble Bar Rd
Newman

Legend

- Study Area
- Desktop Assessment Area
- Approval Boundary
- State Road
- Rail

BHP (2022)
Sampling Type
- Individual (alive)

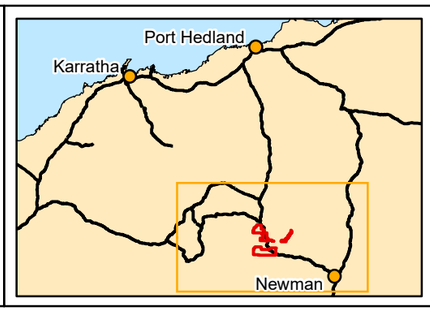
DBCA (2022)
Sampling Type
- Individual (alive)
- Unknown

N

biologic Environmental Survey

Scale: 1:700,000
0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO
CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.10: Previous grey falcon records in the Study Area and region

660000
680000
700000
720000
7480000
7460000
Great Northern Hwy
MS1039
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1072
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Targeted Search (57)

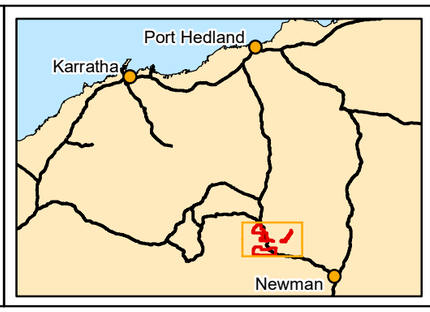
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.11: Grey falcon sampling locations and habitat in the Study Area

6.6.4 Survey Results

No grey falcon or evidence of the species' occurrence was recorded within the Study Area during the 180.7 person hours of targeted searches undertaken at 60 sites during the current survey.

6.6.5 Discussion

Although the Study Area is located within the current distribution of the grey falcon, where the species or species' habitat is likely to occur (DoE, 2022c), no grey falcons or evidence of their occurrence was recorded during the current survey. However, this species has been previously recorded near the Study Area on multiple occasions (DBCA, 2022b; Ecologia, 1998c, 2004b; ENV, 2008a) (Figure 6.10).

The Study Area contains habitat considered critical habitat for grey falcon, primarily within Major Drainage Line Habitat (62.4 ha, 0.11%), and to a lesser extent the Medium Drainage Line habitat (362.20 ha, 0.61%), which provide potential breeding (in the form of mature eucalypts present), foraging, and dispersal habitat for the species. The Stony Plain (2,1051.0 ha, 35.51%), Hillcrest/ Hillslope (1,4162.4 ha, 23.89 %) and Drainage Area/Floodplain (9,644.57 ha, 16.27%) habitat, may also provide supporting habitat for the species.

The grey falcon is regarded as representing a single interbreeding population (Mullin *et al.*, 2020) and the Pilbara thought to be a stronghold (Sutton, 2010). Thus, any grey falcon present in the Pilbara are suggested to represent part of an 'important population'. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for grey falcon within the Study Area, this species is considered to possibly occur. The species' occurrence within the Study Area is likely to be dependent on the proximity of nesting habitat such as mature eucalypts and infrastructure such as communication and powerline towers, which are present in parts of the Study Area associated with existing mining operations and/or infrastructure projects. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale.

6.7 Pilbara Olive Python (*Liasis olivaceus* subsp. *barroni*)

6.7.1 Species Profile

The Pilbara olive python is listed as Vulnerable under the EPBC Act and the BC Act. The species is Western Australia's largest snake, averaging 2.5 metres (m), with records up to 4.5 m (Bush & Maryan, 2011; Cogger, 2014). The species has a dull olive-brown upper surface and is pale cream below (Burbidge, 2004; Cogger, 2014). This species is endemic to the Pilbara and northern parts of the Gascoyne bioregions, distributed from Burrup Peninsula, Ord Ranges and Meentheena south to Nanutarra and Newman in the Pilbara, with an isolated population occurring at Mt Augustus in the Gascoyne region (Bush & Maryan, 2011; Storr *et al.*, 2002).

This species is primarily nocturnal and tends to shelter amongst rocky habitats, in small caves or under vegetation during the day. During summer months they will emerge from daytime shelters soon after dark and continue to move until the early hours of the morning (DSEWPaC, 2011b). In the winter months, the species is primarily nocturnal, although adult pythons can sometimes be found basking in the morning sun (DSEWPaC, 2011b). The breeding season of the Pilbara olive python takes place in the cooler months, which extends from June to August and males will travel up three kilometres in search of a mate (DSEWPaC, 2011b). The species is a well-adapted opportunistic ambush predator and common prey items include rock-wallabies, small euros, fruit bats, waterbirds, doves/pigeons and is also likely to include instances of northern quoll and other small mammals (Ellis, 2013; Ellis & Johnstone, 2016; Pearson, 2007; Pearson, 2003; TSSC, 2008a).

The species commonly inhabits moist areas such as gorges, rivers, pools and surrounding hills, but can be found in a range of habitats (Burbidge, 2004; DSEWPaC, 2011b). In the Hamersley region, the Pilbara olive python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011b; Pearson, 1993). The species is likely to be attracted to these areas due to the productivity and abundance of suitably-sized prey (Pearson, 2003).

6.7.2 Previous Records

The Study Area is located within the current distribution of the Pilbara olive python, whereby the species or species' habitat is likely to occur (DoE, 2022d). Pilbara olive pythons are known to occur across the Pilbara bioregion, particularly within the Hamersley subregion, and are most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (DSEWPaC, 2011b; Pearson, 1993). The desktop assessment returned 64 records of the species, including on four occasions within the Study Area (Figure 6.12) (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008).

Within the Study Area, the most recent record was a scat within Gorge/ Gully habitat of Pineapple Hill (Biologic, 2019), where it was thought to occur as a resident based on the presence of critical habitat likely to support the species. Additionally, a dead individual was previously located within Gorge/ Gully habitat at Area C in 2008 (Outback Ecology, 2008) and a live individual within Major Drainage Line at Area C West in 2011 Biologic (2013a). A deceased (roadkill) Pilbara olive python was recorded 2.1 km outside of the boundary of the Study Area.

6.7.1 Survey Methods

Targeted Searching

Diurnal searches for the Pilbara olive python were conducted along 70 transects within suitable habitat during the field survey (Figure 6.13; Table 6.12). Searches focused on observing active individuals and/or secondary evidence such as scats, sloughs or remains. A total of approximately 193 person hours of targeted diurnal searches and eight person hours of nocturnal searches were undertaken within the Study Area (Table 6.12).

Table 6.12: Targeted searches completed for Pilbara olive python within the Study Area

Transect Name	Date	Habitat	Diurnal Searches (Person hours)	Nocturnal Searches (Person hours)
TPIH-02	12/11/2021	Gorge/ Gully	3	-
TPIH-15	14/11/2021	Hillcrest/ Hillslope	0.5	-
VPIH-08	23/11/2021	Breakaway/ Cliff	1.5	-
VPIH-013	13/11/201	Drainage Area/ Floodplain	-	2
VPIH-015	23/11/2021	Gorge/ Gully	-	2
VCPH-020	28/05/2022	Gorge/ Gully	-	4
TPIH-09	23/11/2021	Gorge/ Gully	2	-
TPIH-18	24/11/2021	Major Drainage Line	3	-
TPIH-20	25/11/2021	Gorge/ Gully	5	-
TPIH-21	25/11/2021	Gorge/ Gully	1	-
TPIH-05	26/11/2021	Gorge/ Gully	0.66	-
TPIH-25	29/11/2021	Hillcrest/ Hillslope	0.5	-
TCPH-022	6/04/2022	Major Drainage Line	6	-
TCPH-023	6/04/2022	Major Drainage Line	3	-
TCPH-025	7/04/2022	Gorge/ Gully	3	-
TCPH-026	8/04/2022	Breakaway/ Cliff	4	-
TCPH-035	8/04/2022	Breakaway/ Cliff	1	-
TCPH-027	8/04/2022	Gorge/ Gully	3	-
TCPH-003	8/04/2022	Major Drainage Line	4	-
TCPH-046	9/04/2022	Gorge/ Gully	1	-
TCPH-041	9/04/2022	Medium Drainage Line	1.5	-
TCPH-042	10/04/2022	Gorge/ Gully	6	-
TCPH-051	10/04/2022	Gorge/ Gully	1.5	-
TCPH-052	10/04/2022	Gorge/ Gully	4	-
TCPH-056	10/04/2022	Gorge/ Gully	4	-
TCPH-063	10/04/2022	Gorge/ Gully	4	-
TCPH-081	12/04/2022	Gorge/ Gully	4	-
TCPH-084	13/04/2022	Hillcrest/ Hillslope	1	-
TCPH-086	28/04/2022	Breakaway/ Cliff	5	-
TCPH-085	28/04/2022	Gorge/ Gully	2	-
TCPH-089	29/04/2022	Gorge/ Gully	1.5	-
TCPH-084	29/04/2022	Hillcrest/ Hillslope	1	-
TCPH-087	29/04/2022	Hillcrest/ Hillslope	1	-
TCPH-088	29/04/2022	Hillcrest/ Hillslope	1	-

Transect Name	Date	Habitat	Diurnal Searches (Person hours)	Nocturnal Searches (Person hours)
TCPH-090	29/04/2022	Hillcrest/ Hillslope	2	-
TCPH-081	30/04/2022	Gorge/ Gully	3	-
TCPH-095	30/04/2022	Gorge/ Gully	6	-
TCPH-100	30/04/2022	Gorge/ Gully	5	-
TCPH-117	1/05/2022	Gorge/ Gully	4	-
TCPH-123	1/05/2022	Gorge/ Gully	1.2	-
TCPH-125	1/05/2022	Gorge/ Gully	1	-
TCPH-127	1/05/2022	Gorge/ Gully	2	-
TCPH-140	1/05/2022	Gorge/ Gully	2	-
TCPH-130	2/05/2022	Gorge/ Gully	1	-
TCPH-132	2/05/2022	Gorge/ Gully	2.5	-
TCPH-133	2/05/2022	Gorge/ Gully	2	-
TCPH-109	2/05/2022	Major Drainage Line	2	-
TCPH-140	3/05/2022	Gorge/ Gully	9	-
TCPH-145	3/05/2022	Gorge/ Gully	2	-
TCPH-149	3/05/2022	Gorge/ Gully	4	-
TCPH-153	3/05/2022	Gorge/ Gully	2	-
TCPH-160	4/05/2022	Gorge/ Gully	4.5	-
TCPH-170	4/05/2022	Gorge/ Gully	2	-
TCPH-091	4/05/2022	Medium Drainage Line	3	-
TCPH-166	4/05/2022	Medium Drainage Line	2	-
TCPH-131	5/05/2022	Breakaway/ Cliff	2.5	-
TCPH-128	5/05/2022	Gorge/ Gully	4	-
TCPH-129	5/05/2022	Gorge/ Gully	2	-
TCPH-134	6/05/2022	Hillcrest/ Hillslope	1	-
TCPH-180	26/05/2022	Breakaway/ Cliff	1	-
TCPH-181	26/05/2022	Breakaway/ Cliff	2	-
TCPH-185	26/05/2022	Gorge/ Gully	4	-
TCPH-189	27/05/2022	Breakaway/ Cliff	2	-
TCPH-197	27/05/2022	Breakaway/ Cliff	2	-
TCPH-198	27/05/2022	Breakaway/ Cliff	2	-
TCPH-200	27/05/2022	Breakaway/ Cliff	6.4	-
TCPH-193	27/05/2022	Gorge/ Gully	4	-
TCPH-195	27/05/2022	Gorge/ Gully	1.5	-
TCPH-194	27/05/2022	Hillcrest/ Hillslope	1	-
TCPH-209	28/05/2022	Gorge/ Gully	3	-
TCPH-229	28/05/2022	Gorge/ Gully	5.5	-
TCPH-020	28/05/2022	Major Drainage Line	4	-
TCPH-242	29/05/2022	Hillcrest/ Hillslope	3.5	-
Total			**193.26**	**8**

600000 650000 700000 750000 800000

7500000 7450000 7400000

Nanutarra Munjina Rd

Nanutarra Munjina Rd

Manuwarra Red Dog Hwy

Karijini Dr

Tom Price

Tom Price Rd

Paraburdoo Rd

Paraburdoo

MS1039

MS1072

Marble Bar Rd

Great Northern Hwy

Newman

Legend

- Study Area
- Desktop Assessment Area
- Approval Boundary
- State Road
- Rail

BHP (2022)

Sampling Type

- Camera Trap
- Scat
- Unknown

DBCA (2022)

Sampling Type

- Individual (alive)
- Individual (dead)

- Secondary Evidence
- Specimen
- Unknown

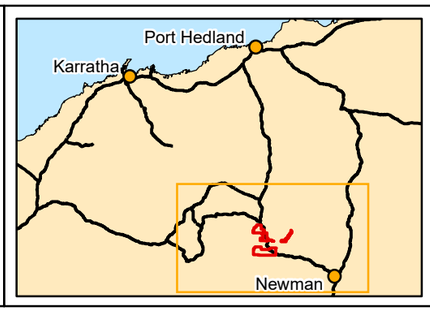
N

biologic Environmental Survey

Scale: 1:700,000

0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 05/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.12: Previous Pilbara olive python records in the Study Area and region

660000
680000
700000
720000
7480000
7460000
Packsaddle Rd
West Angelas Rd
Great Northern Hwy
MS1039
MS1072

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Supporting
- Nil

Sampling Method

- Nocturnal Search (3)
- Targeted Search (70)

Record

Pilbara olive python - VU

- Individual (dead) (1)

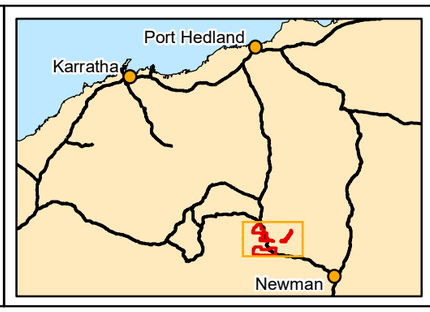
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.13: Pilbara olive python sampling locations, records and habitat in the Study Area

6.7.2 Survey Results

Targeted Searching

No Pilbara olive python or evidence of the species' occurrence was recorded within the Study Area during approximately 201 person hours of diurnal and nocturnal targeted searches during the current survey. However, one deceased individual was recorded approximately 2.1 km outside of the boundary of the Study Area, to the southeast of the Camp Hill area on the 27th March 2022 (Figure 6.13).

6.7.3 Discussion

Although the Study Area is located within the current distribution of the Pilbara olive python, whereby the species or species' habitat is likely to occur (DoE, 2022d), no Pilbara olive pythons were recorded within the Study Area . However, Pilbara olive python are a cryptic species and can be difficult to detect through targeted searches alone. Additionally, the current survey was partially undertaken during the cooler months when the species is less active, and this could have affected the results. A deceased (roadkill) Pilbara olive python was recorded 2.1 km outside of the boundary of the Study Area. Critical habitat likely to support the species occurs within Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats of the Study Area. Furthermore the Pilbara olive python has been previously recorded within the Study Area on four occasions (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008), indicating that the Study Area is utilised by the species.

The Pilbara olive python is regularly encountered in the vicinity of rocky habitats (i.e. Gorge/ Gully and Breakaway/ Cliff habitats) and drainage systems (i.e. Major Drainage Lines), particularly areas with permanent and/ or semi-permanent water features (DSEWPaC, 2011b; Pearson, 1993). Gorge/ Gully habitat (2.64% 1,564.61 ha), Breakaway/ Cliff (1.45%, 858.97 ha) and Major Drainage Line (0.09%, 54.94 ha) provide critical potential breeding and dispersal/ foraging habitat for the species within the Study Area (Figure 6.13).

Although not considered critical habitat, Medium Drainage Line habitat (0.61%, 362.20 ha) still provides supporting breeding and foraging habitat for this species within the Study Area, particularly in areas where these habitats provide connectivity between areas of critical (i.e. Gorge/ Gully) habitat, as well as areas prone to pooling and ponding (Figure 5.1). Minor Drainage Line habitat may also be supporting habitat to the species in areas that are prone to pooling and ponding, particularly following large rainfall events, and providing dispersal corridors throughout the landscape (Figure 5.1). The Pilbara olive python may occur throughout the Study Area in these habitats, particularly where they facilitate connectivity between critical habitats.

A total of six water features were recorded in the Study Area, located within Major Drainage Line and Gorge/ Gully habitat (as well as Drainage Area/ Floodplain associated with a cattle watering point: WPIN-01). For Pilbara olive pythons in particular, these water features can often act as critical foraging locations and for that reason the species is more often than not, associated with such features, particularly within rocky habitats, but also, to a lesser degree within Major Drainage Line and Medium Drainage Line habitats where suitable vegetation cover is present (Pearson, 1993). WPIN-01 is not

located near critical habitat (the closest supporting habitat is Medium Drainage Line habitat, 500 m away) and is therefore unlikely to provide good habitat for Pilbara olive pythons.

Although no evidence of the Pilbara olive python was found within the Study Area during the current survey, it is likely that a population occurs within the Study Area based on previous records within and in the vicinity of the Study Area and the presence of critical breeding and foraging habitat. This population, if present, would be considered an 'important population' as defined by DoE (2013).

6.8 Other Fauna of Significance

One non-target species of significance was identified during the current survey: the Western pebble-mound mouse (*Pseudomys chapmani*).

Western pebble-mound mouse

Western pebble mound mouse has previously been recorded on 3053 occasions within 50 km of the Study Area; 311 of these records were within the Study Area. The species has most frequently been associated with undulating lower slopes and foot slopes within the Study Area (Onshore & Biologic, 2011), with records indicating the species occurs as a resident throughout a large portion of the Study Area.

During the current survey, western pebble-mound mouse was recorded a total of 137 times from secondary evidence (pebble-mounds), comprising 70 active mounds, 20 recently inactive mounds, 46 inactive mounds and one inactive burrow (Appendix F; Figure 6.14).

660000
680000
700000
720000
7480000
7460000
Great Northern Hwy
MS1039
Juna Downs Rd
Packsaddle Rd
West Angelas Rd
MS1072
Great Northern Hwy

Legend

- Study Area
- Approval Boundary
- Local Road
- State Road
- Rail

Fauna Habitat

- Critical
- Nil

Significant Species

Western pebble-mound mouse (P4)

- Mound (active) (70)
- Mound (inactive) (47)
- Mound (recently inactive) (20)

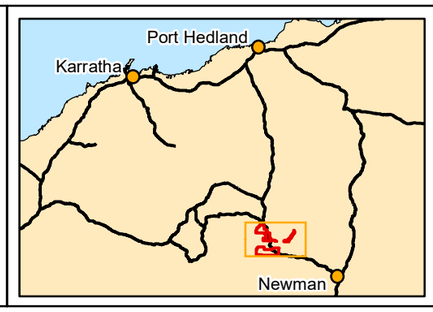
N

biologic Environmental Survey

Scale: 1:220,000

0 3 6 9 Km

Coordinate System: GDA2020 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA2020 Created 06/10/2022



BHP WAIO

CPH Targeted MNES Vertebrate Fauna Survey

Figure 6.14: Other significant species records and habitat in the Study Area during the current survey

6.9 Constraints and Limitations

The (EPA, 2020b) outlines several potential limitations to vertebrate fauna surveys. These aspects are assessed and discussed in Table 6.13 below. No major limitations or constraints were identified for the survey.

Table 6.13: Survey constraints and limitations

Potential limitation or constraint	Constraint	Applicability to this survey
Sources/availability of data and information (recent or historic) and availability of contextual information	No	A significant amount of survey work has been undertaken within the Study Area and in the surrounding region, and most of these previous survey results were available for review.
Competency/ experience of the survey team	No	The field personnel involved in the survey are experienced in undertaking fauna surveys of similar nature, including with the significant species targeted during the survey. Technical personnel with relevant expertise assisted with analysis of ultrasonic recordings (Bob Bullen) and analysis of acoustic recordings (Nigel Jackett).
Scope (faunal groups sampled and whether any constraints affect this)	No	The scope was a targeted fauna survey and was conducted within that framework (EPA, 2020b).
		Northern quoll –The species was sampled following survey guidelines in relation to survey design and effort, site coverage, and detectability (DoE, 2016). A total of 21 camera trap transects were set during this assessment (resulting in 1,503 sampling nights). Targeted searches were undertaken for secondary evidence (e.g., scats).
		Greater bilby – Sampling consisted of targeted greater bilby plots and opportunistic records.
		Pilbara leaf-nosed bat – Sampling consisted of ultrasonic recorders (802 sampling nights) and targeted searches for roosts. Ultrasonic detectors were placed at significant habitat areas including water features where possible.
		Ghost bat – Sampling consisted of ultrasonic recorders (802 sampling nights) and targeted searches for potential roosts. Ultrasonic recorders were placed at significant habitat areas (i.e. water features and/or likely foraging/ dispersal habitats). Ultrasonic recorders are not always successful in capturing present ghost bats; however, this method was supplemented with targeted searches for roosts and any associated secondary evidence.
		Night parrot – Sampling consisted of acoustic recorders at 35 locations containing the best habitat present within the Study Area, resulting in 371 sampling nights. The recorders were deployed for a minimum of six nights at 31 of the locations in accordance with the night parrot survey guidelines (DPaW, 2017). The acoustic detectors range is only ~300 metres (DPaW, 2017), but due to the limited night parrot habitat present within the area, it is considered adequate coverage. Conditions during the recording period was generally good, with limited rain and low winds whilst recorders were deployed.
		Pilbara olive python – Targeted diurnal and nocturnal searches were undertaken in potential habitat for active individuals, scats, and water features likely to support the species.

Potential limitation or constraint	Constraint	Applicability to this survey
Timing, weather, and season	Partial	Field surveys occurred over appropriate or optimal periods for sampling the target species, with the exception of the Pilbara olive python. Most of the targeted searches for this species were undertaken during the cooler months when the species is less active, and this could have affected the results. No other weather or seasonality constraints or limitations were identified during the surveys.
Disturbances (e.g., fire or flood)	No	Disturbances in the Study Area included past frequent fire, access tracks, weed invasion, cattle grazing and mining exploration. However, no temporary disturbance impinged on the results of this assessment.
Proportion of fauna identified	No	All fauna observed during the field surveys were identified to species level. Species identification of fauna recorded via camera traps and Song Meter ultrasonic recorders were able to be accurately identified with the assistance of technical personnel with relevant expertise.
Adequacy of the survey intensity and proportion of the survey achieved	No	A targeted survey was undertaken across the Study Area to assist with decisions on future environmental approvals. The sampling methods and survey intensity was high and focussed on the species of interest.
Remoteness or access issues	No	The majority of the Study Area was accessible either by vehicle or on foot, thus the sampling techniques used in these areas during this survey were unconstrained by accessibility or remoteness.
Problems with data and analysis, including sampling bias	No	No limitations with data collection and/or analysis were encountered during the field survey or during subsequent analysis.

7 CONCLUSION

The overarching objective of this assessment was to determine the presence, or likely presence, of significant species within the Study Area, with a specific focus on MNES species. The targeted MNES species for the survey comprised the northern quoll, greater bilby, Pilbara leaf-nosed bat, ghost bat, night parrot, grey falcon and Pilbara olive python.

7.1 Northern Quoll

The species has previously been recorded within the Study Area, however, previous records of northern quolls in the Study Area are scarce and around a decade old (Biologic, 2011e, 2013d; Onshore & Biologic, 2011). In addition, no northern quolls or evidence of their occurrence was recorded during the current survey. Similarly, two previous targeted northern quoll surveys located within 5 km of the Study Area also recorded no evidence of the species (Biota, 2009, 2014a). However, Astron (2019) recorded the northern quoll in an area approximately 8 km east of the Study Area. These results suggest that northern quolls may be present in very low densities, or present only intermittently as a result of individuals moving from areas outside the Study Area. This is supported by the lack of records in the desktop assessment relative to the number of surveys completed in the area.

Critical habitat for the northern quoll, as defined by DoE (2016), includes rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines. Within the Study Area, the Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats meet the definition of critical habitat for the species (Figure 5.1; Figure 6.2). Supporting habitat for the northern quoll is provided by Minor Drainage Line and Medium Drainage Line habitat, where proximal to breeding habitat. Given the presence of breeding, as well as foraging and dispersal, habitat suitable for northern quoll within the Study Area, this species is considered highly likely to occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale. Furthermore, the Study Area is unlikely to contain a ‘population important for the long-term survival of the species’, as defined by the DoE (2013, 2016).

7.2 Greater Bilby

No evidence of greater bilby was recorded within the Study Area during the current survey. Although the Study Area is located within the western extent of the current distribution of the greater bilby, where the species or species’ habitat is likely to occur (DoE, 2022e), there are limited previous records of the species occurrence within or surrounding the Study Area (Figure 6.3). One previous record of the species is located within the Study Area, in the western extent of Mudlark Well from 1984; however, the location provided may be inaccurate given that it is situated on a stony hill, which does not provide habitat.

Critical habitat for the species does not occur within the Study Area, with only marginal habitat occurring in Drainage Area/ Floodplain habitat where patches of sandy substrate occur. However, it is unlikely the species occurs in the Study Area due to the limited extent, and relative isolation, of habitat to other areas of suitable habitat as well as a lack of contemporary records. Therefore, the Study Area is unlikely to support an ‘important population’ as defined by DoE (2013).

7.3 Pilbara Leaf-nosed Bat

Calls of Pilbara leaf-nosed bats were recorded at four locations during the current survey from 15 individual calls, located within Gorge/ Gully, Breakaway/ Cliff and Hillcrest/ Hillslope habitats. No evidence of a Pilbara leaf-nosed diurnal roost caves was recorded within the Study Area during the current survey. A total of 34 caves were recorded within the Study Area, all of which represent potential nocturnal refuges only (Category 4) for the species, except for three which had no usage.

The Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats within the Study Area represent critical Pilbara leaf-nosed bat habitat (Habitat Rating 4 (very high) as defined by (Bat Call, 2021b)). Additionally, Stony Plain, Hillcrest/ Hillslope, Drainage Area/ Floodplain, Mulga Woodland, Undulating Low Hills, Minor Drainage Line and Medium Drainage Line all provide supporting habitat for the species (Habitat Rating 2 (low) as defined by (Bat Call, 2021b)). The Study Area also contains water features likely to provide supporting foraging habitat for the Pilbara leaf-nosed bat. Given no roosting by the species has been recorded within or in the vicinity of the Study Area, habitats occurring are likely to only provide supporting foraging and/or dispersal habitat for the species.

The entire Pilbara represents one interbreeding population (TSSC, 2016c; Umbrello *et al.*, 2022), meeting the requirements of an 'important population' as defined by DoE (2013). Hence, the significance of occurrence used for this assessment was based on the presence/ absence of Category 1 and 2 (permanent diurnal) roosts and Category 3 (semi-permanent diurnal) roosts, as stipulated by (Bat Call, 2021b). Given the absence of a critical roost within, or in the immediate vicinity of, the Study Area, it is unlikely that the Study Area represents a significant area for this species.

7.4 Ghost Bat

Ghost bat was recorded on 33 nights at four locations within the Study Area during the current survey. Previous records of the species within and surrounding the Study Area are extensive, with a total of 559 occurring within 50 km of the Study Area, including 115 records within the Study Area and a further 459 within 12 km (BHP, 2022; DBCA, 2022b).

Within the Study Area, critical foraging habitat is provided by Stony Plain, Drainage Area/ Floodplain, Mulga Woodland, Minor Drainage Line, Medium Drainage Line, and Major Drainage Line when proximal (>12 km) to roosting caves. Due to the locations of roosting caves within the Study Area and surrounds, these habitats within the entire extent of the Study Area can be considered critical foraging habitat. Undulating Low Hills and Gorge/ Gully habitats provide supporting foraging and dispersal habitat.

A population of ghost bats likely occurs within and surrounding the Study Area, forming part of a broader ghost bat population with high genetic diversity across the Pilbara region (Ottewell *et al.*, 2017), which is likely to be an important population. The population within the Study Area is likely to be considered 'important' as defined by DoE (2013) because it is likely to be a key source population for breeding given that five Category 2 (maternity/ diurnal roost caves with regular occupancy for ghost bats) roosts (CMUD-01, CMUD-02, CMUD-10, CMIN-03 and CACW-31) were identified and provide critical habitat. Furthermore, critical foraging habitat exists across the entire extent of the Study Area and would be

used by ghost bats that use other High Value Caves at South Flank detailed in Biologic (*in prep.*). CMUD-01 has shown presence of pregnant females across seven (out of eight) years of monitoring, making it the most consistently used cave by pregnant females monitored in the MS1072 Fauna Management Plan program (Biologic, 2013b, 2015, 2020a, 2020b, 2021a, *in prep.-a*, *in prep.-b),* indicating that CMUD-01 is a potential maternity roost. Elevated progesterone levels were not recorded at CMUD-01 during the most recent monitoring in 2021-2022 (Biologic, *in prep.*). CMUD-10 has also demonstrated presence of pregnant females during six (out of eight) of the monitoring years (Biologic, *in prep.*). Furthermore, critical foraging habitat exists across the entire extent of the Study Area and this foraging habitat would likely be used by ghost bats from other High Value Caves at South Flank detailed in Biologic (*in prep.*).

7.5 Night Parrot

No evidence of night parrot was recorded within the Study Area during the current survey, despite targeted sampling involving Song Meter acoustic recorders, as outlined in DPaW (2017). The nearest record of the night parrot to the Study Area is located approximately 50 km to the north-east, adjacent to the Cloudbreak Mine (FMG, 2021).

Little is known about the species' habitat preferences and occurrence, particularly within the Pilbara region, and thus the extent of which the Study Area may still provide habitat for the species is unknown. However, habitat within the Study Area was considered marginal for the species, as per the survey guidelines (DPaW, 2017), as there are limited instances of *Triodia* grasslands that are considered suitable (i.e. large, long-unburnt hummocks) for night parrot. On occasion suitable habitat did occur; however, the occurrences of these habitats was often small in size with no connectivity to other areas of suitable nesting and/or foraging habitat within or in the vicinity of the Study Area. These instances occur within Stony Plain (35.51%, 2,1051.0 ha) and Drainage Area/ Floodplain 16.27% (9,644.57 ha) habitats of the Study Area.

Due to the close proximity of the recent night parrot record approximately 50 km to the north-east of the Study Area, this species is considered possible to occur within the Study Area; however, due to a lack of suitable habitat this use would be either intermittent or while transiting to other areas. It is unlikely that this would constitute a significant occurrence based on the definitions by DoE (2013).

7.6 Grey Falcon

No evidence of grey falcon was recorded within the Study Area during this assessment. Although the Study Area falls within the current distribution of the grey falcon, whereby the species or species habitat may occur (DoEE, 2019a), there are limited records of the species within or surrounding the Study Area (Table 3.2; Appendix A; Appendix B). The Study Area contains habitat considered critical habitat for grey falcon and includes the Major Drainage Line Habitat (62.4 ha, 0.11%) and to a lesser extent the Medium Drainage Line habitat (362.20 ha, 0.61%) as these habitats provide potential breeding (in presence of mature eucalypts), foraging, and dispersal habitat for the species.

As the grey falcon is regarded as representing a single interbreeding population (Mullin *et al.*, 2020), grey falcon present in the Pilbara are suggested to represent part of an 'important population'. Given

the presence of breeding, as well as foraging and dispersal, habitat suitable for grey falcon within the Study Area, this species is considered to possibly occur. However, due to the scarcity of contemporary records, this species is unlikely to be reliant on the habitats within the Study Area for long-term survival on a local or regional scale.

7.7 Pilbara Olive Python

No evidence of Pilbara olive python was recorded within the Study Area during this assessment, despite 193.26 hours of targeted searches. However, one record of a deceased (roadkill) individual was recorded just outside the Study Area boundary on 27th March 2022. The Study Area falls within the current distribution of the Pilbara olive python, whereby the species or species habitat is likely to occur (DoE, 2022d). Pilbara olive python has been previously recorded in the Study Area four times (Biologic, 2013a, 2013d, 2019; Outback Ecology, 2008). Critical habitat for the Pilbara olive python occurs within the Study Area, and includes Gorge/ Gully, Breakaway/ Cliff and Major Drainage Line habitats (Figure 6.13).

Although no evidence of the Pilbara olive python was recorded within the Study Area during the current survey, the species is notably cryptic and it is likely that a breeding population occurs within the Study Area based on the proximity of previous records and the presence of critical breeding and foraging habitat. Therefore, this population, if present, would be considered an ‘important population’ as defined by DoE (2013) supported by critical habitat within the Study Area.

8 REFERENCES

360 Environmental. (2017). *Upper Marillana and Munjina baseline vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. 360 Environmental Pty Ltd, West Leederville, WA.

Armstrong, K. N. (2000). Roost microclimates of the bat *Rhinonicteris aurantius* in a limestone cave in Geike Gorge, Western Australia. *Australian Mammalogy, 22*, 69-70. doi:https://doi.org/10.1071/AM00069

Armstrong, K. N. (2001). The distribution and roost habitat of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia. *Wildlife Research, 28*, 95–104. doi:https://doi.org/10.1071/WR00011

Armstrong, K. N., & Anstee, S. D. (2000). The ghost bat in the Pilbara: 100 years on. *Australian Mammalogy, 22*, 93–101. doi:https://doi.org/10.1071/AM00093

Astron. (2010). *Packsaddle West flora and fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. Astron Environmental Services, Perth, WA.

Astron. (2019). *Hope Downs 2 Proposal fauna survey*. Unpublished report prepared for Rio Tinto. Astron Environmental Services, Perth, WA.

Astron. (2020). *Hope Downs 2 Proposal Survey Area: Ghost Bat Cave Characteristics, February/March 2020*.

Augusteyn, J., Hughes, J., Armstrong, G., Real, K., & Pacioni, C. (2018). Tracking and tracing central Queensland's *Macroderma* – determining the size of the Mount Etna ghost bat population and potential threats. *Australian Mammalogy, 40*(2). doi:https://doi.org/10.1071/AM16010

Bamford Consulting. (2005). *Fauna survey of proposed iron ore mine, Cloud Break*. Unpublished report prepared for Fortescue Metals Group Ltd. Bamford Consulting Ecologists, Kingsley, WA.

Bamford Consulting. (2012a). *Fauna assessment Nyidinghu Iron Ore Project*. Unpublished report prepared for Fortescue Metals Group. Bamford Consulting Ecologists, Kingsley, WA.

Bamford Consulting. (2012b). *Vertebrate fauna assessment of the Iron Valley Project Area*. Unpublished report prepared for Iron Ore Holdings Ltd. Bamford Consulting Ecologists, Kingsley, WA.

Bastin, G. (2008). *Rangelands 2008 - Taking the pulse*. Canberra, Australian Capital Territory: National Land & Water Resources Audit.

Bat Call. (2021a). *A review of ghost bat ecology, threats and survey requirements*. Report prepared for the Department of Agriculture, Water and the Environment. Canberra.

Bat Call. (2021b). *A review of Pilbara leaf-nosed bat ecology, threats and survey requirements*. Report prepared for the Department of Agriculture, Water and the Environment. Canberra.

Baudinette, R. V., Churchill, S. K., Christian, K. A., Nelson, J. E., & Hudson, P. J. (2000). Energy, water balance and the roost microenvironment in three Australian cave-dwelling bats (Microchiroptera). *Journal of Comparative Physiology B, 170*(5), 439-446. doi:http://10.1007/s003600000121

Beard, J. S. (1975). *The vegetation of the Nullarbor Area: 1:1,000,000 vegetation series, map and explanatory notes to sheet 4*. Nedlands, Western Australia: University of Western Australia Press.

Bettany, E., Churchward, H. M., & McArthur, W. M. (1967). *Atlas of Australian soils*. Melbourne, Victoria: CSIRO Australia and Melbourne University Press.

BHP. (2018). *Biodiversity Survey Spatial Data Requirements Procedure*. BHP Billiton Iron Ore, Perth, WA.

BHP. (2022). *BHP fauna records database (custom search)*.

BHP WAIO. (2022). *Vertebrate fauna surveys in Western Australia procedure*. Unpublished procedure prepared by BHP Billiton Iron Ore. BHP Billiton Iron Ore, Perth, WA.

Biologic. (2010). *East Packsaddle Level 1 vertebrate fauna study*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2011a). *Area C and surrounds vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2011b). *Area C to Yandi fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey, Subiaco, WA.

Biologic. (2011c). *Barimunya Camp vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2011d). *Jinidi vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2011e). *Southern Flank vertebrate fauna study*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2011f). *Yandi vertebrate fauna review*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey, Subiaco, WA.

Biologic. (2012). *Jinidi to Mainline vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2013a). *Area C West vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2013b). *Central Pilbara Ghost Bat population and roost assessment*. Biologic Environmental Survey,

Biologic. (2013c). *Marillana vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey, Subiaco, WA.

Biologic. (2013d). *Mudlark vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore.

Biologic. (2013e). *Targeted conservation significant fauna survey- Karijini tenement E47/17*. Biologic Environmental Survey,

Biologic. (2015). *Central Pilbara ghost bat population and roost assessment: 2014*. Unpublished report prepared for BHP Biliton Iron Ore. Biologic Environmental Survey, Subiaco, WA.

Biologic. (2017). *Ministers North level 2 vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2018). *Ministers North to Yandi Corridor two phase targeted fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2019). *Pineapple Hill Detailed vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biologic Environmental Survey,

Biologic. (2020a). *Central Pilbara ghost bat monitoring 2017-2018*. Unpublished report prepared for BHP WAIO.

Biologic. (2020b). *Central Pilbara ghost bat monitoring 2018-2019*. Unpublished report prepared for BHP WAIO. Biologic Environmental Survey, East Perth, WA.

Biologic. (2020c). *Developments in knowledge of ghost bat home range and foraging areas, and its application at Mining Area C - South Flank*. Unpublished report prepared for BHP Western Australian Iron Ore. Biologic Environmental Survey, East Perth, WA.

Biologic. (2020d). *Ministers North: Yandicoogina Creek Aquatic Ecosystem Surveys*. Unpublished report for BHP WAIO. Biologic Environmental Survey, East Perth, WA.

Biologic. (2020e). *Western Ridge targeted vertebrate fauna survey*. Unpublished report prepared for BHP Western Australian Iron Ore. Biologic Environmental Survey, East Perth, WA.

Biologic. (2021a). *Central Pilbara Ghost Bat Monitoring 2018-2019*. Unpublished report prepared for BHP WAIO.

Biologic. (*2023*). *Central Pilbara Ghost Bat Monitoring: 2020 - 2021*. Unpublished report prepared for BHP Western Australian Iron Ore. Biologic Environmental Survey,

Biologic. (*in prep.*). *Central Pilbara Ghost Bat Monitoring 2021 - 2022*. Biologic Environmental Survey,

Biologic, Environmental Survey. (2021b). *Pilbara Brushtail Possum Molecular Systematics Analysis*. Unpublished report prepared for BHP Western Australian Iron Ore.

Biologic, Environmental Survey. (2022). *Pineapple Hill Level 2 Vertebrate Fauna Survey*.

Biota. (2002). *Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate fauna survey*. Unpublished report prepared for Hope Downs Management Services. Biota Environmental Sciences, Leederville, WA.

Biota. (2004). *Fauna habitats and fauna assemblage of the proposed FMG Stage A Rail Corridor*. Unpublished report prepared for Fortescue Metals Group. Biota Environmental Sciences, Leederville, WA.

Biota. (2005a). *Fauna habitats and fauna assemblage of Deposits E and F at West Angelas*. Unpublished report prepared for Robe River Iron Associates. Biota Environmental Sciences, Leederville, WA.

Biota. (2005b). *Fauna habitats and fauna assemblage of the FMG stage B rail corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas mine areas*. Biota Environmental Sciences, Leederville, WA.

Biota. (2005c). *Fauna habitats and fauna assemblage of the proposed FMG Stage B Rail Corridor and Ore Bodies*. Unpublished report prepared for Fortescue Metals Group Limited. Biota Environmental Sciences, Leederville, WA.

Biota. (2008). *Marandoo Mine Phase 2 Seasonal Fauna Survey*. Unpublished report prepared for Rio Tinto. Biota Environmental Sciences, Leederville, WA.

Biota. (2009). *Yandicoogina targeted northern quoll survey*. Unpublished report prepared for Rio Tinto Iron Ore. Biota Environmental Sciences, Leederville, WA.

Biota. (2010). *Yandicoogina Junction South West and Oxbow fauna survey*. Unpublished report prepared for Rio Tinto Iron Ore. Biota Environmental Sciences, Leederville, WA.

Biota. (2012a). *Koodaideri northern extension fauna survey*. Unpublished report prepared for Rio Tinto. Biota Environmental Sciences, Leederville, WA.

Biota. (2012b). *Koodaideri Project targeted fauna survey*. Unpublished report prepared for Rio Tinto Iron Ore. Biota Environmental Sciences, Leederville, WA.

Biota. (2012c). *Koodaideri Southern Infrastructure Corridor fauna survey*. Unpublished report prepared for Rio Tinto Iron Ore. Biota Environmental Sciences, Leederville, WA.

Biota. (2012d). *South Flank to Jinidi level 2 vertebrate fauna survey.* Unpublished report prepared for BHP Biliton Iron Ore. Biota Environmental Sciences, Leederville, WA.

Biota. (2013a). *Area C West to Yandi level 2 vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Biota Environmental Sciences, Leederville, WA.

Biota. (2013b). *South Parmelia Level 2 vertebrate fauna survey*. Unpublished report prepared for BHP Biliton Iron Ore.

Biota. (2014a). *Yandi Billiards phase 1 seasonal fauna survey*. Unpublished report prepared for Rio Tinto Iron Ore. Biota Environmental Sciences, Leederville, WA.

Biota. (2014b). *Yandi Billiards targeted northern quoll survey*. Unpublished report prepared for Rio Tinto Iron Ore. Biota Environmental Sciences, Leederville, WA.

BirdLife Australia. (2022). Birdata (custom search). http://www.birdata.com.au/custom.vm

Boles, W. E. (1999). Avian prey of the Australian ghost bat *Macroderma gigas* (Microchiroptera: Megadermatidae): Prey characteristics and damage from predation. *Australian Zoologist, 31*(1), 82-91.

BoM, Bureau of Meteorology. (2022). Climate Data Online. Retrieved 2022 http://www.bom.gov.au./climate/data/index.shtml

Braithwaite, R. W., & Griffiths, A. D. (1994). Demographic variation and range contraction in the northern quoll, *Dasyurus hallucatus (Marsupialia: Dasyuridae)*. *Wildlife Research, 21*, 203-217.

Bullen, R. D. (2013). *Pilbara leaf-nosed bat (Rhinonicteris aurantia); summary of current data on distribution, energetics, threats*. Paper presented at the Pilbara Leaf-nosed Bat workshop, Kensington, Western Australia.

Bullen, R. D., & McKenzie, N. L. (2011). Recent developments in studies of the community structure, foraging ecology and conservation of Western Australian bats. In B. Law, P. Eby, D. Lunney, & L. Lumsden (Eds.), *The Biology and Conservation of Australasian Bats* (pp. 31-43). Mosman, New South Wales: Royal Zoological Society of NSW.

Bullen, R. D., & Reiffer, S. (2019). A record of movement of a Pilbara leaf-nosed bat between distant diurnal roosts using PIT tags. *Australian Mammalogy, 42*(4), 119-121. doi:https://doi.org/10.1071/AM18054

Burbidge, A. A. (2004). *Threatened Animals of Western Australia*. Kensington, Western Australia: Department of Conservation and Land Management.

Burbidge, A. H., Johnstone, R. E., & Pearson, D. J. (2010). Birds in a vast arid upland: avian biogeographical patterns in the Pilbara region of Western Australia. *Records of the Western Australian Museum Supplement, 78*, 247-270.

Burgman, M., & Fox, J. C. (2003). Bias in species range estimates from minimum convex polygons: implications for conservation and options for improved planning. *Animal Conservation, 6*, 19-28. doi:http://doi.org/10.1017/S1367943003003044

Bush, B., & Maryan, B. (2011). *Field guide to snakes of the Pilbara, Western Australia*. Perth, Western Australia: Western Australian Museum.

Churchill, S. K. (1991). Distribution, abundance and roost selection of the orange horseshoe-bat, *Rhinonycteris aurantius*, a tropical cave-dweller. *Wildlife Research, 18*, 343-353.

Cogger, H. G. (2014). *Reptiles and amphibians of Australia* (Seventh ed.). Collingwood, Victoria: CSIRO Publishing.

Cramer, V. A., Armstrong, K. N., Bullen, R. D., Cross, S. A., Lesley, G., Hanrahan, N., Knuckey, C. G., Ottewell, K., Reiffer, S., Ruykys, L., Shaw, R. E., Thavornkanlapachai, R., Thompson, S. A., Wild, S., & Van Leeuwen, S. (2022). Research priorities for the ghost bat (Macroderma gigas) in the Pilbara region of Western Australia. *Australian Mammalogy*.

Cramer, V. A., Armstrong, K. N., Bullen, R. D., Ellis, R., Gibson, L. A., McKenzie, N. L., O'Connell, M., Spate, A., & van Leeuwen, S. (2016a). Research priorities for the Pilbara leaf-nosed bat (*Rhinonicteris aurantia* Pilbara form). *Australian Mammalogy, 38*(2), 149-157. doi:https://doi.org/10.1071/AM15012

Cramer, V. A., Dunlop, J., Davis, R. A., Ellis, R., Barnett, B., Cook, A., Morris, K., & van Leeuwen, S. (2016b). Research priorities for the northern quoll (*Dasyurus hallucatus*) in the Pilbara region of Western Australia. *Australian Mammalogy, 38*(2), 135-148. doi:https://doi.org/10.1071/AM15005

Cramer, V. A., Dziminski, M. A., Southgate, R., Carpenter, F. M., Ellis, i. R. J., & van Leeuwen, S. (2017). A conceptual framework for habitat use and research priorities for the greater bilby

(*Macrotis lagotis*) in the north of Western Australia. *Australian Mammalogy, 39*(2), 137-151. doi:https://doi.org/10.1071/AM16009

CSIRO, Commonwealth Scientific and Industrial Research Organisation. (2009). *Australian soil and land survey field handbook* (Third ed.). Collingwood, Australia: CSIRO Publishing.

Davis, R. A., & Metcalf, B. M. (2008). The night parrot (*Pezoporus occidentalis*) in northern Western Australia: a recent sighting from the Pilbara region. *Emu - Austral Ornithology, 108*(3), 233-236. doi:http://dx.doi.org/10.1071/MU07058

Dawson, S., Adams, P. J., Moseby, K. E., Waddington, K. I., Kobryn, H., Bateman, P. W., & Fleming, P. A. (2018). Peak hour in the bush: linear anthropogenic clearings funnel predator and prey species. *Austral Ecology, 43*, 159–171.

DBCA, Department of Biodiversity, Conservation and Attractions. (2017). *Guidelines for surveys to detect the presence of bilbies and assess the importance of habitat in Western Australia*. Department of Biodiversity, Conservation and Attractions, Kensington, WA.

DBCA, Department of Biodiversity, Conservation and Attractions. (2022a). NatureMap: Mapping Western Australia's biodiversity (custom search). Retrieved 2022 http://naturemap.dec.wa.gov.au./default.aspx

DBCA, Department of Biodiversity, Conservation and Attractions. (2022b). Threatened and Priority Fauna database (custom search). https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals

DCCEEW, Department of Climate Change, Energy, the Environment and Water. (2022). Protected Matters Search Tool (custom search). Retrieved 2022 www.environment.gov.au/erin/ert/epbc/index.html

DEWHA, Department of Environment, Water, Heritage and the Arts. (2010a). *Survey guidelines for Australia's threatened bats*. Canberra, Australian Capital Territory: Department of Environment, Water, Heritage and the Arts.

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

DoE, Department of the Environment. (2013). *Matters of national environmental significance: significant impact guidelines*. Department of the Environment, Canberra.

DoE, Department of the Environment. (2016). *EPBC Act referral guideline for the endangered northern quoll Dasyurus hallucatus*. Canberra, Australian Capital Territory: Department of the Environment.

DoE, Department of the Environment. (2022a). *Dasyurus hallucatus* in Species Profile and Threats Database. https://www.environment.gov.au/sprat

DoE, Department of the Environment (2022b). *Macroderma gigas* in Species Profile and Threats Database. Retrieved 20/07/22 https://www.environment.gov.au/sprat

DoE, D. o. t. E. (2022c). *Falco hypoleucos* in Species Profile and Threats Database. Retrieved Tue, 23 Aug 2022 https://www.environment.gov.au/sprat

DoE, D. o. t. E. (2022d). *Liasis olivaceus barroni* in Species Profile and Threats Database. Retrieved 20/07/2022 https://www.environment.gov.au/sprat

DoE, D. o. t. E. (2022e). *Macrotis lagotis* in Species Profile and Threats Database. https://www.environment.gov.au/sprat

DoEE, Department of the Environment and Energy. (2019a). *Australia - Species of national environmental significance database (public grids)*. Retrieved from: http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B337B05B6-254E-47AD-A701-C55D9A0435EA%7D

DoEE, Department of the Environment and Energy. (2019b). Species profile and threats database. from Department of the Environment and Energy http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Doughty, P., Rolfe, J. K., Burbidge, A. H., Pearson, D. J., & Kendrick, P. G. (2011). Herpetological assemblages of the Pilbara biogeographic region, Western Australia: ecological associations, biogeographic patterns and conservation. *Records of the Western Australian Museum, Supplement, 78*, 315-341.

DPaW, Department of Parks and Wildlife. (2017). *Interim guideline for preliminary surveys of night parrot (Pezoporus occidentalis) in Western Australia*. Department of Parks and Wildlife, Kensington, Western Australia.

DSEWPaC, Department of Sustainability, Environment, Water, Population and Communities. (2011a). *Survey guidelines for Australia's threatened mammals*. Canberra, Australian Capital Territory: Department of Sustainability, Environment, Water, Population and Communities.

DSEWPaC, Department of Sustainability, Environment, Water, Population and Communities. (2011b). *Survey guidelines for Australia's threatened reptiles*. Canberra, Australian Capital Territory: Department of Sustainability, Environment, Water, Population and Communities.

Dunlop, J. A., Rayner, K., & Doherty, T. S. (2017). Dietary flexibility in small carnivores: a case study on the endangered northern quoll, *Dasyurus hallucatus*. *Journal of Mammalogy, 98*(3), 858-866. doi:https://10.1093/jmammal/gyx015

Dziminski, M. A., & Carpenter, F. (2017). *The conservation and management of the bilby (Macrotis lagotis) in the Pilbara: Progress Report 2017*. Department of Parks and Wildlife., Perth, Western Australia.

Ecologia. (1995). *Yandi stage II iron ore project: Biological assessment survey*. Unpublished report prepared for BHP Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (1997). *Hope Downs biological survey*. Unpublished report prepared for Hancock Prospecting. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (1998a). *Mining Area C biological survey*. Unpublished report prepared for BHP Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (1998b). *Weeli Wolli creek biological assessment survey*. Unpublished report prepared for BHP Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (1998c). *West Angelas iron ore project vertebrate fauna assessment survey*. Unpublished report prepared for Robe River Mining Company. ecologia Environmental Consultants, West Perth, WA.

ecologia. (1999). *West Angeles iron ore project mine access road corridor vertebrate fauna assessment survey*. Unpublished report prepared for Robe River Mining Company. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2004a). *Area C: Deposits D, E and F biological survey*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2004b). *Packsaddle Range biological survey*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2004c). *Yandi overland conveyor and stockyard fauna and flora assessment*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2005a). *Mindy-Coondiner exploration project biological survey*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2005b). *Mudlark Well exploration project biological survey*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2005c). *Upper Marillana Exploration Project biological survey*. Unpublished report prepared for BHP Biliton Iron Ore.

Ecologia. (2006a). *Jirridi terrestrial vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2006b). *Marillana terrestrial vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2006c). *Ministers North biological survey*. Unpublished report prepared for BHP Billiton Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2008a). *Area A and additional areas level 2 terrestrial fauna survey*. Unpublished report prepared for United Minerals Corporation. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2008b). *Marillana Creek (Yandi) iron ore mine modification - Level 2 fauna survey*. Unpublished report prepared for Kellogg, Brown and Root. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2009). *Marillana iron ore project vertebrate fauna assessment*. Unpublished report prepared for Brockman Resources. ecologia Environmental Consultants, West Perth, WA.

Ecologia. (2014). *Greater West Angelas terrestrial fauna assessment*. Unpublished report prepared for Rio Tinto Iron Ore. ecologia Environmental Consultants, West Perth, WA.

Ellis, R. J. (2013). *Liasis olivaceus barroni* (Pilbara olive python) Diet. *Herpetological Review, 44*(4), 693.

Ellis, R. J., & Johnstone, R. E. (2016). *Liasis olivaceus barroni* (Pilbara olive python). Diet. *Herpetological Review, 47*(4), 685.

ENV. (2007a). *Area C R-Deposit fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. ENV Australia, Perth, WA.

ENV. (2007b). *Coondiner and Mindy East exploration leases fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. ENV Australia, Perth, WA.

ENV. (2007c). *Mindy North Exploration Lease fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. ENV Australia, Perth, WA.

ENV. (2007d). *Upper Marillana Exploration Lease fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. ENV Australia, Perth, WA.

ENV. (2008a). *Area C Southern Flank deposit fauna assessment*. Unpublished report prepared for BHP Biliton Iron Ore. ENV Australia, Perth, WA.

ENV. (2008b). *Area C West fauna assessment*. Unpublished report prepared for BHP Biliton Iron Ore. ENV Australia, Perth, WA.

ENV. (2008c). *Jinayri vertebrate fauna assessment*. Unpublished report for BHP Billiton Iron Ore. ENV Australia, Perth, WA.

ENV. (2008d). *Rapid growth project 5: M270SA fauna assessment*. Unpublished report prepared for Calibre Engenium Join Venture. ENV Australia, Perth, WA.

ENV. (2008e). *RGP5: Quarry 6 fauna assessment*. Unpublished report prepared for Calibre Engenium Joint Venture. ENV Australia, Perth, WA.

ENV. (2009a). *Munjina and Ministers North (Yandi Hub) fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. ENV Australia, Perth, WA.

ENV. (2009b). *Newman to Yandi transmission line terrestrial vertebrate fauna assessment*. Unpublished report prepared for BHP Biliton Iron Ore. ENV Australia, Perth, WA.

ENV. (2010a). *Area C West NVCP Flora, Vegetation and Fauna Assessment*. Unpublished report to BHP Billiton Iron Ore Pty Ltd. ENV Australia,

ENV. (2010b). *Jinayri Access Road vertebrate fauna survey*. Unpublished report to BHP Billiton Iron Ore Pty Ltd, Peth Western Australia. ENV Australia, Perth, WA.

ENV. (2010c). *Jinayri Mining Lease vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore Pty Ltd. ENV Australia, Perth, WA.

ENV. (2011). *Upper Marillana and Munjina flora, vegetation and fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. ENV Australia, Perth, WA.

EPA, Environmental Protection Authority. (2016). *Environmental factor guideline: Terrestrial fauna*. Perth, Western Australia: Environmental Protection Authority.

EPA, Environmental Protection Authority. (2020a). *Statement of Environmental Principles, Factors and Objectives*. Perth, Western Australia: Environmental Protection Authority.

EPA, Environmental Protection Authority. (2020b). *Technical guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment*. Western Australia: Environmental Protection Authority.

ESCAVI, Executive Steering Committee for Australian Vegetation Information. (2003). *Australian vegetation attribute manual: National vegetation information system (version 6.0)*. Canberra, Australian Capital Territory: ESCAVI, Executive Steering Committee for Australian Vegetation Information.

Falkenberg, D. (2010). Aspects of the ecology of the Grey Falcon *Falco hypoleucos* in the South Australian arid zone. *Corella, 35*(1), 23-28.

Fitzsimons, J., Legge, S., Traill, B., & Woinarski, J. (2010). *Into oblivion? The disappearing native mammals of northern Australia*. Melbourne, Victoria. http://www.australianwildlife.org/images/file/Into_Oblivion_-_Nth_Aus_Mammal_Decline_Report.pdf

FMG, Fortescue Metals Group. (2021, 25 June 2021). Fortecue research confirms endangered night parrot co-existing with mining. Retrieved from https://www.fmgl.com.au/isobar-development/blog-preview-page/our-stories/2021/06/25/fortescue-research-confirms-endangered-night-parrot-co-existing-with-mining

Garnett, S., & Crowley, G. (2000). *The action plan for Australian birds 2000* (1st ed.). Canberra, Australian Capital Territory: Environment Australia and the Royal Australia Ornithologists Union.

Hamilton, N. A., Onus, M., Withnell, B., & Withnell, K. (2017). Recent sightings of the Night Parrot *Pezoporus occidentalis* from Matuwa (Lorna Glen) and Milrose Station in Western Australia. *Australian Field Ornithology, 34*, 71-75.

HGM, Halpern Glick Maunsell. (1999). *Marillana Creek Western Access Corridor - Biological assessment*. Unpublished report prepared for BHP Iron Ore Pty Ltd. Halpern Glick Maunsell, Perth, WA.

Hohnen, R., Ashby, J., Tuft, K., & McGregor, H. (2012). Individual identification of northern quolls (*Dasyurus hallucatus*) using remote cameras. *Australian Mammalogy, 35*(2), 131-135. doi:http://dx.doi.org/10.1071/AM12015

Hutson, A. M., Mickelburgh, S. P., & Racet, P. A. (2001). *Microchiropteran bats: global status survey and conservation action plan*: IUCN.

Integrated Environmental. (1980). *An ecological appreciation of the West Angelas environment, Western Australia 1979*. Unpublished report prepared for Cliffs International Inc. Integrated Environmental Services, South Perth, WA.

Jackett, N. A., Greatwich, B. R., Swann, G., & Boyle, A. (2017). A nesting record and vocalisations of the night parrot *Pezoporus occidentalis* from the East Murchison, Western Australia. *Australian Field Ornithology, 34*, 144-150.

James, C. D., Landsberg, J., & Morton, S. R. (1995). Ecological functioning in arid Australia and research to assist conservation of biodiversity. *Pacific Conservation Biology, 2*, 126-142.

Johnson, C. N., & Isaac, J. L. (2009). Body mass and extinction risk in Australian marsupials: The 'Critical Weight Range' revisited. *Austral Ecology, 34*(1), 35-40. doi:http://doi.org/10.1111/j.1442-9993.2008.01878.x

Kendrick, P. (2001). Pilbara 3 (PIL3 - Hamersley subregion). In J. May & N. McKenzie (Eds.), *A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002* (pp. 568-580). Kensington, Western Australia: Department of Conservation and Land Management.

King, D. R. (1989). An assessment of the hazard posed to northern quolls (*Dasyurus hallucatus*) by aerial baiting with 1080 to control dingoes. *Australian Wildlife Research, 16*(5), 569-574.

Leighton, K. A. (2004). Climate. In A. M. E. van Vreeswyk, A. L. Payne, K. A. Leighton, & P. Hennig (Eds.), *An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No. 92*. Perth, Western Australia: Western Australian Department of Agriculture.

Maunsell, & Bamford Consulting. (2003). *Yandi life of mine fauna and flora*. Unpublished report prepared for BHP Billiton Iron Ore. Maunsell and Bamford Consulting Ecologists, Kingsley, WA.

McGilp, J. N. (1931). *Geopsittacus occidentalis*, night parrot. *South Australian Ornithologist, 11*, 68-70.

McKenzie, N. L., & 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.

McKenzie, N. L., van Leeuwen, S., & Pinder, A. M. (2009). Introduction to the Pilbara biodiversity survey, 2002-2007. *Records of the Western Australian Museum Supplement, 78*, 3-89.

Medellin, R. A., Wiederholt, R., & Lopez-Hoffman, L. (2017). Conservation relevance of bat caves for biodiversity and ecosystem services. *Biological Conservation, 211*(Part B), 45-50. doi:https://doi.org/10.1016/j.biocon.2017.01.012

Michelmore, K., & Birch, L. (2020). Night parrot located by KJ rangers on Martu country in the Pilbara. Retrieved from https://www.abc.net.au/news/2020-08-21/elusive-night-parrot-discovered-in-the-pilbara/12581900

Miller, E. J., Eldridge, M. D. B., Thomas, N., Marlow, N., & Herbert, C. A. (2010). The genetic mating system, male reproductive success and lack of selection on male traits in the greater bilby. *Australian Journal of Zoology, 58*(2), 113-120. doi:http://dx.doi.org/10.1071/ZO09092

Moseby, K. E., & O'Donnell, E. (2003). Reintroduction of the greater bilby, *Macrotis lagotis* (Reid) (Marsupialia: Thylacomyidae), to northern South Australia: survival, ecology and notes on reintroduction protocols. *Wildlife Research, 30*(1), 15-27.

Mullin, D. W., McCulloch, G. A., Schoenjahn, J., & Walter, G. H. (2020). Phylogeography of the rare Australian endemic grey falcon *Falco hypoleucos*: implications for conservation. *Bird Conservation International, in press*, 1–9. doi:10.1017/S0959270920000106

Murphy, S. A., Silcock, J., Murphy, R., Reid, J., & Austin, J. J. (2017). Movements and habitat use of the night parrot *Pezoporus occidentalis* in south-western Queensland. *Austral Ecology, 42*(7), 858-868. doi:https://doi.org/10.1111/aec.12508

Murray, B. R., Zeppel, M. J. B., Hose, G. C., & Eamus, D. (2003). Groundwater-dependent ecosystems in Australia: It's more than just water for rivers. *Ecological Management & Restoration, 4*(2), 110-113. doi:https://doi.org/10.1046/j.1442-8903.2003.00144.x

National Committee on Soil and Terrain. (2009). *Australian soil and land survey field handbook* (Third ed.). Collingwood, Victoria: CSIRO Publishing.

Night Parrot Recovery Team. (2017). Leading night parrot conservation. Retrieved from https://nightparrot.com.au/

Ninox. (2009). *A fauna survey of the proposed Hope Downs 4 Mining Area, near Newman, Western Australia*. Unpublished report prepared for Mattiske Consulting on behalf of Pilbara Iron Company. Ninox Wildlife Consulting, Albany, WA.

North, A. J. (1898). List of birds collected by the Calvert Exploring Expedition in Western Australia. *Transactions of the Royal Society of South Australia, 22*, 125-192.

Oakwood, M. (2000). Reproduction and demography of the northern quoll, *Dasyurus hallucatus*, in the lowland savanna of northern Australia. *Australian Journal of Zoology, 48*, 519–539. doi:https://doi.org/10.1071/ZO00028

Oakwood, M. (2002). Spatial and social organization of a carnivorous marsupial *Dasyurus hallucatus (Marsupialia: Dasyuridae)*. *Journal of Zoology, 257*, 237-248.

Oakwood, M. (2008). Northern quoll *Dasyurus hallucatus*. In R. Strahan (Ed.), *The Mammals of Australia* (3rd ed.). Sydney: Reed New Holland.

Oakwood, M., Bradley, A. J., & Cockburn, A. (2001). Semelparity in a large marsupial. *Proceedings of the Royal Society B, 268*(1465), 407-411.

Olsen, P. D., & Olsen, J. (1986). Distribution, status, movement and breeding of the grey falcon *Falco hypoleucos*. *Emu - Austral Ornithology, 86*(1), 47-51.

Onshore, & Biologic. (2011). *Camp Hill exploration leases level 2 flora & vegetation survey and level 1 fauna assessment*. Unpublished report prepared for BHP Billiton Iron Ore. Onshore Environmental Consultants & Biologic Environmental Survey, Yallingup, WA.

Ottewell, K., McArthur, S., van Leeuwen, S., & Byrne, M. (2017). *Population genetics of the ghost bat (Macroderma gigas) in the Pilbara bioregion*. Unpublished report prepared for Biologic Environmental Survey. Department of Biodiversity, Conservation and Attractions, Kensington, WA.

Outback Ecology. (2008). *Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial vertebrate fauna assessment*. Unpublished report prepared for BHP. Outback Ecology Services, Jolimont, WA.

Outback Ecology. (2010). *Area C to Jinayri to Mount Newman Railway terrestrial vertebrate fauna survey*. Unpublished report prepared for BHP Billiton Iron Ore. Outback Ecology Services, Jolimont, WA.

Payne, A. L., Mitchell, A. A., & Holman, W. F. (1988). *An inventory and condition survey of rangelands in the Ashburton River catchment, Western Australia*. Western Australian Department of Agriculture, South Perth, Western Australia.

Pearson, D. (2007). Pilbara olive python *Liasis olivaceus barroni* (Smith, 1981). In M. Swan (Ed.), *Keeping and Breeding Australian Pythons* (pp. 174-181). Lilydale, Vic.: Mike Swan Herp Books.

Pearson, D. J. (1993). Distribution, status and conservation of pythons in Western Australia. In D. Lunney & D. Ayers (Eds.), *Herpetology in Australia: A diverse discipline* (pp. 383-395). Sydney, New South Wales: Royal Zoological Society of NSW.

Pearson, D. J. (2003). Giant pythons of the Pilbara. *Landscope, 19*(1), 32-39.

Phoenix. (2014). *Terrestrial fauna survey for the extension project*. Unpublished report prepared for Australian Aboriginal Mining Corporation. Phoenix Environmental Sciences, Balcatta, WA.

Rapallo. (2012). *Level 2 fauna survey and targeted northern quoll survey of the Lamb Creek*. Unpublished report prepared for Process Minerals International. Rapallo Environmental, Subiaco, WA.

Richards, G. C., Hand, S., Armstrong, K. N., & Hall, L. S. (2008). Ghost bat. In S. van Dyck & R. Strahan (Eds.), *Mammals of Australia* (Third ed.). Sydney, New South Wales: Reed New Holland.

Runge, C., Tulloch, A., Hammill, E., Possingham, H., & Fuller, R. (2014). Geographic range size and extinction risk assessment in nomadic species. *Conservation Biology, 29*(3), 865-876. doi:10.1111/cobi.12440

Schmitt, L., Bradley, A., Kemper, C., Kitchener, D., Humphreys, W., & How, R. (1989). Ecology and physiology of the northern quoll, *Dasyurus hallucatus* (Marsupialia, Dasyuridae), at Mitchell Plateau, Kimberley, Western Australia. *Journal of Zoology, 217*(4), 539-558.

Schoenjahn, J. (2013). A hot environment and one type of prey: investigating why the Grey Falcon (*Falco hypoleucos*) is Australia's rarest falcon. *Emu - Austral Ornithology, 113*(1), 19-25.

Schoenjahn, J. (2018). *Adaptations of the rare endemic Grey Falcon Falco hypoleucos that enable its permanent residence in the arid zone of Australia.* The University of Queensland,

Schoenjahn, J., Pavey, C., & Walter, G. (2022). Low activity levels are an adaptation to desert-living in the Grey Falcon, an endotherm that specializes in pursuing highly mobile prey. *Journal of Thermal Biology, 103*. doi:https://doi.org/10.1016/j.jtherbio.2021.103108

Schoenjahn, J., Pavey, C. R., & Walter, G. H. (2019). Ecology of the grey falcon *Falco hypoleucos* – current and required knowledge. *Emu - Austral Ornithology, 120*(1), 1–9. doi:https://doi.org/10.1080/01584197.2019.1654393

Shepherd, D. P., Beeston, G. R., & Hopkins, A. J. M. (2002). *Native vegetation in Western Australia: Extent, type and status*. Perth, Western Australia: Western Australian Department of Agriculture.

Smythe, D. R., & Philpott, C. M. (1968). A field study of the rabbit bandicoot *Macrotis lagotis* Reid (Marsupalia), from central Western Australia. *Transactions of the Royal Society of South Australia, 92*, 3-14.

Southgate, R. (1990a). Distribution and abundance of the greater bilby *Macrotis lagotis* Reid (Marsupialia: Peramelidae). In J. H. Seeback, P. R. Brown, R. L. Wallis, & C. M. Kemper (Eds.), *Bandicoots and Bilbies* (pp. 293-302): Surrey Beatty & Sons.

Southgate, R. (1990b). Habitat and diet of the greater bilby *Macrotis lagotis* (Marsupialia: Peramelidae). In J. H. Seeback, P. R. Brown, R. L. Wallis, & C. M. Kemper (Eds.), *Bandicoots and Bilbies* (pp. 303-309): Surrey Beatty & Sons.

Southgate, R., Dziminski, M. A., Paltridge, R., Schubert, A., & Gaikhorst, G. (2019). Verifying bilby presence and the systematic sampling of wild populations using sign-based protocols – with notes on aerial and ground survey techniques and asserting absence. *Australian Mammalogy, 41*(1). doi:https://doi.org/10.1071/AM17028

Southgate, R., Paltridge, R., Masters, P., & Carthew, S. (2007). Bilby distribution and fire: a test of alternative models of habitat suitability in the Tanami Desert, Australia. *Ecography, 30*(6), 759-776. doi:10.1111/j.2007.0906-7590.04956.x

Southgate, R., & Possingham, H. (1995). Modelling the reintroduction of the Greater Bilby *Macrotis lagotis* using the metapopulation model analysis of the likelihood of extinction (ALEX). *Biological Conservation, 73*, 151-160.

Storr, G. M., Smith, L. A., & Johnstone, R. E. (2002). *Snakes of Western Australia* (Revised ed.). Perth, Western Australia: Western Australian Museum.

Strahan, R. (2004). *The Mammals of Australia* (Revised Edition ed.): Reed Books, Chatswood, NSW.

Sutton, A. (2010). Aspects of the biology of the Grey Falcon *Falco hypoleucos* in the Pilbara region of Western Australia. *Corella, 10*(35), 11-15.

Thackway, R., & Cresswell, I. D. (1995). *An Interim Biogeographical Regionalisation for Australia*. Canberra, ACT: Australian Nature Conservation Agency.

Tidemann, C. R., Priddel, D. M., Nelson, J. E., & Pettigrew, J. D. (1985). Foraging behaviour of the Australian ghost bat *Macroderma gigas* (Microchiroptera: Megadermatidae). *Australian Journal of Zoology, 33*(5), 705-713. doi:http://dx.doi.org/10.1071/ZO9850705

TSSC, Threatened Species Scientific Committee. (2008a). *Approved conservation advice for Liasis olivaceus barroni (Olive Python – Pilbara subspecies)*. Commonwealth of Australia, Canberra, ACT.

TSSC, Threatened Species Scientific Committee. (2008b). *Approved conservation advice for night parrot Pezoporus occidentalis*. Department of the Agriculture, Water and the Environment, Canberra, ACT.

TSSC, Threatened Species Scientific Committee. (2016a). *Conservation advice: Macroderma gigas, ghost bat*. Commonwealth of Australia, Canberra, ACT.

TSSC, Threatened Species Scientific Committee. (2016b). *Conservation advice: Macrotis lagotis, greater bilby*. Department of the Agriculture, Water and the Environment, Canberra, ACT.

TSSC, Threatened Species Scientific Committee. (2016c). *Conservation advice: Rhinonicteris aurantia (Pilbara form), Pilbara leaf-nosed bat*. Commonwealth of Australia, Canberra, ACT.

Umbrello, L., Bullen, R. D., Shaw, R. E., McArthur, S., Byrne, M., van Leeuwen, S., & Ottewell, K. (2022). Extensive gene flow in a threatened bat (Rhinonicteris aurantia) in an arid landscape. *Global Ecology and Conservation*, e02154. doi:https://doi.org/10.1016/j.gecco.2022.e02154

van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A., & Hennig, P. (2004). *An inventory and condition survey of the Pilbara region, Western Australia*. South Perth, Western Australia: Western Australian Department of Agriculture.

Whitlock, F. L. (1924). Journey to central Australia in search of the night parrot. *Emu - Austral Ornithology, 23*, 248-281.

Wildlife Acoustics, Inc. (2011). *Song meter SM2BAT+ ultrasonic recorder*. Wildlife Acoustics Inc., Massachusetts, United States of America.

Wildlife Acoustics, Inc. (2017). *Song Meter SM4BAT FS bioacoustics recorder user guide*. Wildlife Acoustics Inc., Massachusetts, United States of America.

Wilson, H. (1937). Notes on the night parrot, with references to recent occurrences. *Emu - Austral Ornithology, 37*(2), 79-87.

Woinarski, J. C. Z., Legge, S., Fitzsimons, J. A., Traill, B. J., Burbidge, A. A., Fisher, A., Firth, R. S. C., Gordon, I. J., Griffiths, A. D., Johnson, C. N., McKenzie, N. L., Palmer, C., Radford, I., Rankmore, B., Ritchie, E. G., Ward, S., & Ziembicki, M. (2011). The disappearing mammal fauna of northern Australia: context, cause, and response. *Conservation Letters, 4*(3), 192-201. doi:10.1111/j.1755-263X.2011.00164.x

Woinarski, J. C. Z., Oakwood, M., Winter, J., Burnett, S., Milne, D., Foster, P., Myles, H., & Holmes, B. (2008). *Surviving the toads: Patterns of persistence of the northern quoll Dasyurus hallucatus in Queensland*. Report to the Australian Government's Natural Heritage Trust. http://www.nt.gov.au/nreta/wildlife/programs/quoll/pdf/qld_quolls_finalreport.pdf

Worthington-Wilmer, J., Moritz, C., Hall, L., & Toop, J. (1994). Extreme population structuring in the threatened ghost bat, *Macroderma gigas*: evidence from mitochondrial DNA. *Proceedings of the Royal Society B, 257*, 193-198.

WRC. (2003). *Mine Void Water Resource Issues in Western Australia*. Water and Rivers Commission,

9 APPENDICES

Appendix A – Summary of Literature Review

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
1. Biologic (2019)	Project: Pineapple Hill Detailed Vertebrate Fauna Survey. 10216 Client: BHP Survey date: Phase 1: 26th April – 6th May 2019 Phase 2: 28th August – 9th September 2019 Survey type: Two phase Detailed survey Experience: Senior Zoologist x 4 Ecologist	Within Study Area	• Active searching • Targeted searches • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal Surveys • Bat echolocation recording • Acoustic recording • Motion sensitive cameras • Cave assessments • Remotely piloted aircraft searches • Opportunistic observations • Secondary evidence	• Stony Plain • Drainage Area/Floodplain • Hillcrest/slope • Gorge/gully • Major drainage line • Mulga Woodland • Minor drainage line	129 vertebrate species • 19 native mammals • 4 introduced mammals • 73 birds • 33 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
2. Ecologia (1998a)	Project: Mining Area C Biological Survey. 336 Client: BHP Survey date: 14th – 30th April 1997 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x 4 Research assistant	Within Study Area	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Mist netting • Opportunistic observations • Secondary evidence	• Medium drainage line • Gorge/gully • Hillcrest/slope • Mulga woodland • Acacia shrubland	143 vertebrate species • 17 native mammals • 4 introduced mammals • 78 birds • 43 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Pre bat echolocation and motion sensitive camera use.
3. ENV (2010a)	Project: Area C West NVCP Flora, Vegetation and Fauna Assessment. 374 Client: BHP Survey date: 22nd – 31st March 2010 15th August – 4th September 2007 Survey type: 2010 - Basic fauna assessment 2007 – Detailed fauna survey Experience: Senior biologist x2 Biologist x2 Field assistant	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Avifauna census • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Breakaway • Stony plain • Alluvial plain	2007 113 vertebrate species • 18 native mammals • 0 introduced mammals • 72 birds • 32 reptiles • 1 amphibian 2010 72 vertebrate species • 9 native mammals • 0 introduced mammals • 46 birds • 17 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
4. Onshore and Biologic (2011)	Project: Camp Hill Exploration Leases Level 2 Flora & Vegetation Survey and Level 1 Fauna Assessment. 381 Client: BHP Survey date: 2nd – 15th August 2010 Survey type: Basic fauna survey Experience: Senior Zoologist Zoologist	Within Study Area	• Active searching • Targeted transects • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Medium drainage area • Gorge/gully • Hillcrest/slope • Basalt plain • Sand/ stony plain	89 vertebrate species • 13 native mammals • 4 introduced mammals • 60 birds • 12 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Cooler temperatures and continuing dry conditions may have inhibited reptile and amphibian activity.
5. Biota (2013a)	Project: Area C West to Yandi level 2 Vertebrate Fauna Survey. 1070 Client: BHP Survey date: Phase 1: 25th May – 2nd June 2011 Phase 2: 7th – 15th September 2011 Phase 3: 5th – 8th February 2012 Survey type: Three Phase Detailed fauna survey Experience: Senior Zoologist Zoologist Ecologist	Within Study Area	• Active searching • Targeted searching • Systematic trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gullies • Stony and Loamy Plains • Major Creeks • Minor Creeks • Hillcrest/slopes calcrete Plain • Mulga Plain	172 vertebrate species • 24 native mammals • 4 introduced mammals • 84 birds • 57 reptiles • 3 amphibians	Threatened: • Pilbara leaf-nosed bat (Rhinonicteris aurantia) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Common greenshank (*Tringa nebularia*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	No motion sensitive cameras.
6. Biologic (2013a)	Project: Area C West Vertebrate Fauna Survey. 1086 Client: BHP Survey date: Phase 1: 18th April – 1st May; 8th – 21st May 2011 Phase 2: 12th – 25th September; 3rd – 14th October 2011 Nocturnal survey: 19th – 22nd January 2012 Survey type: Two phase Detailed baseline fauna surveys Experience: Principal Zoologist/ecologist x2 Senior Zoologist x 4 Zoologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Motion sensitive cameras • Bat echolocation recording • Avifauna census • Nocturnal survey • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope • Sandy/stony plain • Basalt Gilgi rocky plain	213 vertebrate species • 26 native mammals • 5 introduced mammals • 100 birds • 79 reptiles • 3 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Northern short-tailed mouse (*Leggadina lakedownensis*) Migratory: • Wood sandpiper (*Tringa glareola*) Other significant: • Peregrine falcon (*Falco peregrinus*)	
7. Ecologia (2004b)	Project: Packsaddle Range Biological Survey. 357 Client:	Within Study Area	• Active searching • Avifauna census • Bat echolocation recording	• Medium drainage line • Gorge/gully • Mulga woodland • Eucalypt woodland	88 vertebrate species • 10 native mammals • 1 introduced mammals	Threatened: • Grey falcon (*Falco hypoleucos*) Priority:	No trapping or motion sensitive camera use.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	BHP <u>Survey date:</u> 5th - 10th May 2004 <u>Survey type:</u> Basic fauna survey <u>Experience:</u> Senior Zoologist Herpetologist Zoologist Research assistant		• Opportunistic observations • Secondary evidence	• Valley plain	• 56 birds • 20 reptiles • 0 amphibian	• Western pebble-mound mouse (*Pseudomys chapmani*)	
8. ENV (2008b)	<u>Project:</u> Area C West Fauna Assessment. 372 <u>Client:</u> BHP <u>Survey date:</u> 15th August – 4th September 2007 <u>Survey type:</u> Detailed fauna survey <u>Experience:</u> N/A	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Breakaway • Stony plain	<u>126 vertebrate species</u> • 17 native mammals • 2 introduced mammals • 72 birds • 34 reptiles • 1 amphibian	<u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*)	
9. Biologic (2013d)	<u>Project:</u> Mudlark Vertebrate Fauna Survey. 1080 <u>Client:</u> BHP <u>Survey date:</u> Phase 1: 12th – 19th May and 31st May – 11th June 2011 Phase 2: 6th – 15th October 2011 and 18th – 28th May 2012 Phase 3: 19th – 22nd January 2012 <u>Survey type:</u> Three phase Detailed fauna survey <u>Experience:</u> Senior Zoologist x5 Principle Zoologist x2 Zoologist	Within Study Area	• Active searching • Targeted searches • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal Surveys • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Hillcrest/slope • Gorge/gully • Major drainage line • Stony Plain • Mulga12	<u>178 vertebrate species</u> • 21 native mammals • 4 introduced mammals • 80 birds • 70 reptiles • 3 amphibians	<u>Threatened:</u> • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) <u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
10. ENV (2009a)	Project: Munjina and Ministers North (Yandi Hub) Fauna Assessment. 423 Client: BHP Survey date: 21st November – 2nd December 2007 Survey type: Detailed fauna survey Experience: Senior Zoologist/Ornithologist Zoologist x4 Taxonomist	Within Study Area	• Active searching • Systematic trapping – pitfall, funnel, Elliott, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations Secondary evidence	• Minor Drainage Line • Gorge/gully • Hillcrest/slope • Riverine • Breakaway • Alluvial Plain	134 vertebrate species • 15 native mammals • 6 introduced mammals • 66 birds • 45 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Fires just prior to the field survey reduced survey efforts in the Minister's North site.
11. Biologic (2011a)	Project: Area C and Surrounds Vertebrate Fauna Survey. 1008 Client: BHP Survey date: Phase 1: 5th – 18th October 2009 Phase 2: 20th March – 1st May 2010 Survey type: Two phase Detailed survey Experience: Principal Zoologist Senior Zoologist x 3 Herpetologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Hair traps • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope • Calcrete plain • Sandplain	166 vertebrate species • 22 native mammals • 4 introduced mammals • 76 birds • 60 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind snake (*Anilios ganei*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other significant: • Peregrine falcon (*Falco peregrinus*) • Pilbara barking gecko (*Underwoodisaurus seorsus*)	
12. Biologic (2017)	Project: Ministers North level 2 vertebrate fauna survey. 10082 Client: BHP Survey date: Phase 1: 15th – 26th October 2016 Phase 2: 3rd – 13th April 2017 Survey type: Two phase Detailed survey Experience: Principal Zoologist Senior Zoologist x 3	Within Study Area	• Active searching • Targeted transects • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal surveys • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope	119 vertebrate species • 15 native mammals • 2 introduced mammals • 54 birds • 45 reptiles • 3 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Heavy rainfall during stage two survey resulted in site access issues and three sites (1,2,7) were changed (bringing the total number of sites to 10).

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
13. Biologic (2011e)	Project: Southern Flank Vertebrate Fauna Study. 1021 Client: BHP Survey date: Phase 1: 7th – 19th April 2010 Phase 2: 23rd August – 4th September 2010 Survey type: Two Phase Detailed fauna survey Experience: Principal Zoologist Principal Ecologist Senior Zoologist x 2 Herpetologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Motion sensitive cameras • Hair traps • Bat echolocation recording • Nocturnal surveys • Avifauna census • Opportunistic observations • Secondary evidence	• Major drainage line • Mulga • Gorge/gully • Hillcrest/slope • Stony plain • Sandy areas • Coolabah-Lignum	161 vertebrate species • 26 native mammals • 7 introduced mammals • 68 birds • 58 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*) • Pilbara barking gecko (*Underwoodisaurus seorsus*) Other significant: • Peregrine falcon (*Falco peregrinus*)	
14. Ecologia (2004a)	Project: Area C: Deposits D, E and F Biological Survey. 348 Client: BHP Survey date: 28th May – 7th June 2004 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x 4 Biologist Research assistant	Within Study Area	• Active searching • Systematic trapping – pitfall, funnel, Elliott • Avifauna census • Nocturnal surveys • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Mulga woodland • Mallee woodland	104 vertebrate species • 16 native mammals • 1 introduced mammals • 55 birds • 32 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
15. Outback Ecology (2010)	Project: Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey. 366 Client: BHP Survey date: Phase 1: 20th October – 1st November 2008 Phase 2: 5th – 29th March 2009 Recon: 8th – 12th October 2008 Survey type: Two Phase Detailed fauna survey and reconnaissance survey Experience: Senior Zoologist Zoologist x6 Biologist	Within Study Area	• Active searching • Systematic trapping – pitfall, funnel, Elliott, cage • Targeted survey • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Drainage Line • Gorge/gully • Hillcrest/slope • Riverine • Sand and Stony Plain • Alluvial Plain • Mulga Woodland	204 vertebrate species • 20 native mammals • 6 introduced mammals • 95 birds • 76 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*) Migratory: • Eastern osprey (*Pandion haliaetus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
16. Outback Ecology (2008)	Project: Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial Vertebrate Fauna Assessment. 344 Client: BHP Survey date: 17th – 31st March 2008 Survey type: Detailed Fauna survey Experience: Zoologist x 3	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Nocturnal survey • Avifauna census • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Gorge/gully • Hillcrest/slope	100 vertebrate species • 8 native mammals • 3 introduced mammals • 61 birds • 26 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	
17. Ecologia (2008b)	Project: Marillana Creek (Yandi) Iron Ore Mine Modification. 122 Client: Kellogg, Brown and Root Pty Ltd Survey date: 19th - 30th March 2008 Survey type: Single phase, Detailed survey Experience: Senior Zoologist Zoologist x3	Within Study Area	• Systematic trapping – pitfall, Elliott, cage, funnel • Active searching • Targeted searching • Avifauna census • Bat echolocation recording • Nocturnal survey • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Hillslope • Stony Plain • Creek Line • Outwash and Valley Plain	116 vertebrate species • 16 native mammals • 3 introduced mammals • 60 birds • 37 reptiles • 3 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Single phase survey. Reduced ANABAT usage due to rain.
18. Biologic (2010)	Project: East Packsaddle Level 1 Vertebrate Fauna Study. 350 Client: BHP Survey date: Phase 1: 5th – 18th October 2009 Phase 2: 20th March – 1st April 2009 Survey type: Two Phase targeted fauna survey Experience: Senior Zoologist x3 Principal Zoologist Herpetologist	Within Study Area	• Active searching • Targeted searching – transects • Trapping – not specified • Hair trap • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary Evidence	• Mulga Association • Gorge/gully • Hillcrest/slope • Major Drainage Line • Drainage Area • Valley and Calcrete Plain • Sandplain	110 vertebrate species • 17 native mammals • 2 introduced mammals • 48 birds • 39 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Eastern osprey (*Pandion haliaetus*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
19. Biota (2010)	Project: Yandicoogina Junction South West and Oxbow Fauna Survey. 1187 Client: RITO Survey date: 5th – 12th July 2008 Survey type: Detailed fauna survey Experience: Principal Zoologist Senior Zoologist Zoologist	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Major drainage line • Minor drainage line • Hillcrest/slope • Stony plain and valley floors • Rocky breakaways and screes	72 vertebrate species • 10 native mammals • 2 introduced mammals • 46 birds • 14 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Single season survey. Sections of site inaccessible by car however, fauna habitats surrounding still representative of the area as a whole. No nocturnal surveys.
20. Astron (2019)	Project: Hope Downs 2 Proposal Fauna Survey March 2019 Client: RITO Survey date: Phase 1: 21 November to 2 December 2017 Phase 2: 18 to 27 May 2018 Phase 3: 8 to 18 March 2019 Survey type: Detailed fauna survey Experience: All technical survey personnel have over five years of experience conducting Level 2 vertebrate fauna surveys	Within Study Area	• Active searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Motion sensitive cameras • Bat echolocation recording • Night parrot survey • Targeted searches • Nocturnal spotlighting	• Minor drainage line • Gorge/gully • Breakaway • Rocky hill • Low hill and slopes • Alluvial plain • Mulga woodland • Stony plain	174 vertebrate species • 26 native mammals • 7 introduced mammals • 84 birds • 55 reptiles • 2 amphibians	Threatened: • Northern quoll (*Dasyurus hallucatus*) • Ghost bat (*Macroderma gigas*) • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Rainfall in the three months preceding Phase 2 and Phase 3 was below average, this led to potentially dry unfavorable conditions for vertebrate fauna sampling.
21. Biota (2009)	Project: Yandicoogina Targeted Northern Quoll survey Client: RITO Survey date: 6th – 12th October 2009 Survey type: Targeted fauna survey Experience: Unknown	<1km	• Active searching • Targeted searching – transects			None	
22. Biologic (2018)	Project: Ministers North to Yandi Corridor Two Phase Targeted Fauna Survey. 10140 Client: BHP	<1km	• Active searching • Targeted searching – transects • Trapping – small and large Elliott • Avifauna census	• Basalt Outcrop • Breakaway/Cliff • Gorge/gully • Hillcrest/slope • Minor Drainage Line • Major Drainage Line	94 vertebrate species • 15 native mammals • 2 introduced mammals • 54 birds • 23 reptiles • 0 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specially protected:	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	Survey date: Phase 1: 9th – 13th October 2017 Phase 2: 15th – 23rd June 2018 Survey type: Two Phase targeted fauna survey Experience: Senior Zoologist x3 Zoologist		• Bat echolocation recording • Acoustic recording • Motion sensitive cameras • Opportunistic observations • Secondary Evidence	• Drainage Area/ Floodplain		• Peregrine falcon (*Falco peregrinus*)	
23. Ecologia (2005b)	Project: Mudlark Well Exploration Project Biological Survey. 421 Client: BHP Survey date: 18th – 23rd August 2005 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x2	<1km	• Active searching • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Medium drainage area • Gorge/gully • Hillcrest/slope • Sand/ stony plain	56 vertebrate species • 7 native mammals • 1 introduced mammals • 30 birds • 19 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No nocturnal surveying undertaken due to low temperatures.
24. Ecologia (2006c)	Project: Ministers North Biological Survey. Client: BHP Survey date: 10th – 14th May 2006 Survey type: Basic fauna survey Experience: Senior Zoologist Zoologist	<1km	• Active searching • Avifauna census • Bat echolocation recording • Night survey • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope	71 vertebrate species • 10 native mammals • 0 introduced mammals • 42 birds • 18 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No trapping done.
25. Astron (2010)	Project: West Packsaddle Flora and Fauna Assessment Client: BHP Survey date: 10th – 19th April 2010 Survey type: Basic fauna survey Experience: Principal Zoologist	<1km	• Active searching • Targeted transects • Avifauna census • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Gorge/gully • Rocky ridges and cliff faces	87 vertebrate species • 13 native mammals • 0 introduced mammals • 60 birds • 14 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Northern brushtail possum (*Trichosurus vulpecula arnhemensis*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
26. ENV (2008a)	Project: Area C Southern Flank Deposit Fauna Assessment. Client: BHP Survey date: 30th January – 6th February 2007 Survey type: Basic fauna survey Experience: Senior zoologist Zoologist	<1km	• Active searching • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Alluvial plain	100 vertebrate species • 13 native mammals • 4 introduced mammals • 56 birds • 23 reptiles • 4 amphibians	Threatened: • Grey falcon (*Falco hypoleucos*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
27. ecologia (1999)	Project: West Angelas Iron Ore Project Mine Access Road Corridor Vertebrate Fauna Assessment Survey Client: Robe River Mining Company Survey date: 3rd – 9th August 1999 Survey type: Basic fauna survey Experience: Senior Zoologist x3 Zoologist Ecologist	1.7km	• Active searching • Trapping – pitfall, Elliott • Nocturnal surveys • Mist netting • Avifauna census • Opportunistic observations • Secondary evidence	• Mulga steppe • mulga grassland • eucalypt steppe	82 vertebrate species • 8 native mammals • 1 introduced mammals • 51 birds • 22 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
28. 360 Environmental (2017)	Project: Upper Marillana and Munjina Baseline Vertebrate Fauna survey. 10084 Client: BHP Survey date: 30th March – 9th April 2017 Survey type: Detailed survey Experience: Unknown	1.8km	• Systematic trapping – pitfall, Elliott, funnel, cage • Active searching • Avifauna census • Motion sensitive cameras • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Mulga Woodland • Drainage Line • Hill Crest/ Slope • Stony Plain	126 vertebrate species • 15 native mammals • 4 introduced mammals • 77 birds • 28 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
29. HGM (1999)	Project: Marillana Creek Western Access Corridor - Biological Assessment. Client: BHP Survey date: 23rd – 30th April 1999 Survey type: Opportunistic fauna survey Experience: Unknown	2.1km	• Active searching • Opportunistic observations • Secondary evidence	• Minor drainage line • Riverine • Alluvial plains • Hillcrest/slope • Mulga woodland	50 vertebrate species • 5 native mammals • 1 introduced mammals • 42 birds • 1 reptile • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Opportunistic survey only.
30. Ecologia (2008a)	Project: Area A and Additional Areas Level 2 Terrestrial Fauna Survey. Client: United Minerals Corporation Survey date: Phase 1: 22nd May – 3rd June 2008 Phase 2: 29th September – 10th October 2008 Survey type: Two Phase Detailed fauna survey Experience: Senior Zoologist Zoologist x 4	3.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, funnel, Elliott, cage • Avifauna census • Nocturnal surveys • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Degraded Mulga Woodland • Spinifex Plain • Spinifex Hillslope • Mulga woodland • Acacia Shrubland • Cracking Clay	135 vertebrate species • 19 native mammals • 3 introduced mammals • 70 birds • 41 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	
31. ENV (2007a)	Project: Area C R-Deposit Fauna Assessment. 349 Client: BHP Survey date: 22nd – 27th November 2006 Survey type: Detailed fauna survey Experience: Senior Biologist/Ornithologist Ornithologist Herpetologist Biologist Taxonomist	3.5km	• Active searching • Systematic trapping – pitfall, funnel, Elliott, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope • Ridges/range crests • Riverine areas • breakaways • flood plains/ valley plains	183 vertebrate species • 28 native mammals • 0 introduced mammals • 89 birds • 64 reptiles • 1 amphibian	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*)	Fire swept through sampling sites on the 24th of November, damaging traps, reducing site access and reducing length of survey time.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
32. Bamford Consulting (2012b)	Project: Vertebrate Fauna Assessment of the Iron Valley Project Area. Client: Iron Ore Holdings Ltd. Survey date: Phase 1: 9th – 19th May 2011 Phase 2: 29th – 30th September 2011 Survey type: Two phase Detailed targeted fauna survey Experience: Senior Zoologist x3 Zoologist x8	~5km	• Active searching • Targeted searching • Elliott trapping • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Alluvial and Flood Plain • Rocky Hillcrest/Slopes • Drainage Line • Stony Plain	97 vertebrate species • 11 native mammals • 2 introduced mammals • 58 birds • 25 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
33. Biota (2014b)	Project: Yandi Billiards Targeted Northern Quoll Survey Client: RTIO Survey date: 5th – 13th August 2014 Survey type: Targeted fauna survey Experience: Zoologist x2	~5km	• Targeted searching • Systematic trapping – cage and large Elliott • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations Secondary evidence	• Alluvial and Flood Plain • Hillcrest/Slopes • Major Drainage Line • Minor Drainage Line • Cave/Overhang	10 vertebrate species • 5 native mammals • 1 introduced mammals • 3 birds • 1 reptile • 0 amphibians		Unconfirmed northern quoll scat found (Molecular results inconclusive)
34. Ecologia (1998c)	Project: West Angelas Iron Ore Project Vertebrate Fauna Assessment Survey. Client: Robe River Mining Company Survey date: Phase 1: 10th June – 10th July 1997 Phase Two: 18th – 3rd October 1997 Survey type: Two phase Detailed fauna survey Experience: Not listed	5.6km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Mist netting • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope/ridges • Major creek line • Valley floor/Outwash valley • Mulga woodland • Eucalyptus woodland • Acacia shrubland • Spinifex steppe	West Angelas mine area: 119 vertebrate species • 19 native mammals • 2 introduced mammals • 70 birds • 27 reptiles • 1 amphibian Rail Corridor: 195 vertebrate species • 19 native mammals • 4 introduced mammals • 108 birds • 60 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Grey falcon (*Falco hypoleucos*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Pre bat echolocation and motion sensitive cameras

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
35. Ecologia (1997)	Project: Hope Downs Biological Survey. Client: Hancock Prospecting Pty Ltd. Survey date: Phase 1: 18th August – 10th September 1993 Phase Two: 19th – 30th April 1994 Survey type: Two phase Detailed fauna survey Experience: Senior Zoologist Zoologist x4 Research assistant	6.6km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Avifauna census • Opportunistic observations • Secondary evidence	• Minor drainage line • Gorge/gully • Hillcrest/slope/ridges • Major creek lines • outwash plains/ valley plains	158 vertebrate species • 20 native mammals • 4 introduced mammals • 88 birds • 45 reptiles • 1 amphibian	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Pre bat echolocation and motion sensitive cameras
36. Ecologia (2014)	Project: Greater West Angelas Terrestrial Fauna Assessment. Client: RTIO Survey date: Phase 1: 26th September – 6th October 2012 Phase Two: 18th – 27th March 2013 Survey type: Two phase Detailed fauna survey Experience: Senior Zoologist Zoologist x4 Research assistant	7km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Nocturnal surveys • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary evidence	• Major drainage line • Gorge/gully • Hillcrest/slope/ridges • Mixed Acacia woodland • Mesa top • Cracking clay • Foot slope or plain	169 vertebrate species • 23 native mammals • 2 introduced mammals • 80 birds • 64 reptiles • 0 amphibians	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other significant: • Pilbara barking gecko (*Underwoodisaurus seorsus*)	
37. Ecologia (1998b)	Project: Weeli Wolli Creek Biological Assessment Survey. 101 Client: BHP Survey date: 9th – 16th August 1999 Survey type: Detailed fauna survey Experience: Senior Zoologist x2 Zoologist x3 Ecologist	8.2km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Colluvial Flats • Melaleuca Forest • Creek Line • Acacia Thicket • Calcrete Gully • Shrub Steppe	135 vertebrate species • 14 native mammals • 3 introduced mammals • 85 birds • 30 reptiles • 3 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Pre bat echolocation use and motion sensitive cameras.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
38. Biologic (2011f)	Project: Yandi Vertebrate Fauna Review. Client: BHP Survey date: 9th - 17th December 2010 Survey type: Basic survey and Targeted Experience: Senior Ecologist Senior Zoologist	8.3km	• Targeted searching – transects and caves • Active searching • Motion sensitive cameras • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Mulga Woodland • Major Drainage Line • Hill Crests and Slopes • Boulder Piles • Sandplain	75 vertebrate species • 7 native mammals • 1 introduced mammal • 53 birds • 12 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
39. Biota (2012d)	Project: South Flank to Jinidi Level 2 Fauna Survey. 1093 Client: BHP Survey date: Phase 1:11th – 20th April 2011 Phase 2: 2nd – 11th November 2011 Phase 3: 31st January – 3rd February 2012 Survey type: Three Phase Detailed fauna survey Experience: Senior Zoologist x3 Zoologist x8	8.6km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel • Avifauna census • Bat echolocation recording • Harp trapping • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Hilly Areas • Calcrete Plain • Creeks with shrubland/hummock grasslands • Mulga Plains • Stony/Loamy Plains • Major Creeks • Gorge and Breakaway	173 vertebrate species • 24 native mammals • 2 introduced mammals • 79 birds • 63 reptiles • 5 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Parts of the study area were inaccessible by vehicle and were surveyed on foot only.
40. Integrated Environmental (1980)	Project: An Ecological Appreciation of the West Angelas Environment, Western Australia 1979. Client: Cliffs International Inc. Survey date: 1978/79 Survey type: Detailed fauna surveys Experience: Senior Ecologist Zoologist	8.7km	• Active searching • Systematic trapping – pitfall, funnel, Elliott and break back traps • Avifauna census • Nocturnal surveys • Mist netting • Opportunistic observations • Secondary evidence	• Major drainage line • Gorge/gully • Hillcrest/slope/ridges • Mulga woodland • Eucalyptus woodland • Stony plain	125 vertebrate species • 18 native mammals • 3 introduced mammals • 64 birds • 48 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Grey falcon (*Falco hypoleucos*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Western pebble-mound mouse (*Pseudomys chapmani*) first described from this survey.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
41. Maunsell and Bamford Consulting (2003)	Project: Yandi Life of Mine Fauna and Flora Client: BHP Survey date: 23rd - 28th September 2003 Survey type: Basic survey Experience: Ecologist x2	8.9km	• Opportunistic observations • Nocturnal surveys • Bat echolocation recording	• Creek Line • Low Hills and mesas • Mulga Woodland • Major Drainage Line	80 vertebrate species • 2 native mammals • 2 introduced mammal • 69 birds • 7 reptiles • 0 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
42. Ecologia (2004c)	Project: Yandi Overland Conveyor and Stockyard Fauna and Flora Assessment. Client: BHP Survey date: 18th-19th October 2004 Survey type: Flora survey with fauna desktop survey Experience: Biologist	9.2km	• Opportunistic observations	• Creek Line • Drainage Line • Acacia shrubland • Rocky hillslope	• 1 native mammal	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Survey conducted to target rare and priority flora and weed species with opportunistic fauna sighting recorded only, no active fauna field component. Three active pebble mounds were recorded in the Yandi Stockyard survey area.
43. Biota (2005a)	Project: Fauna Habitats and Fauna Assemblage of Deposits E and F at West Angelas Survey. Client: Robe River Iron Associates Survey date: 4th – 12th May 2004 Survey type: Detailed fauna survey Experience: Zoologist x3 Ecologist x1	9.4km	• Active searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Broad colluvial valleys dominated by Acacia • Hillcrest/slope • Stony plain and valley floors • Incised gullies and creeks	98 vertebrate species • 12 native mammals • 2 introduced mammals • 47 birds • 37 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No motion sensitive cameras.
44. Biologic (2012)	Project: Jinidi to Mainline Vertebrate Fauna Survey. 1065 Client: BHP Survey date: Phase 1: 28th March – 10th April 2011 Phase 2: 22nd August- 3rd September 2011 Survey type: Two phase Detailed fauna survey	9.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations	• Gorge/gully • Hillcrest/slope • Drainage Area • Dune • Sandplain • Grassland • Mulga • Major Drainage Line	197 vertebrate species • 27 native mammals • 4 introduced mammals • 89 birds • 73 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	Experience: Zoologists		• Secondary Evidence				
45. Biologic (2013e)	Project: Targeted conservation significant fauna survey- Karijini tenement E47/17. Client: BHP Survey date: 17th- 25th June 2013 Survey type: Basic targeted fauna assessment Experience: Senior Zoologist x 5	9.8km	• Active searching • Motion sensitive cameras • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Major drainage line • Drainage area • Gorge/gully • Hillcrest/slope • Stony plain	23 vertebrate species • 6 native mammals • 0 introduced mammals • 13 birds • 4 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other significant: • Peregrine falcon (*Falco peregrinus*)	Four days of rainfall and lower than long-term average temperatures disrupted survey period.
46. Bamford Consulting (2012a)	Project: Fauna Assessment Nyidinghu Iron Ore Project. Client: Fortescue Metals Group Ltd. Survey date: Phase 1: 7th – 17th April 2011 Phase 2: 16th – 24th June 2011 Survey type: Two phase Detailed fauna assessment Experience: Senior Zoologist x2 Zoologist x8	~10km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Bat echolocation recording • Avifauna census • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Alluvial and Flood Plain • Creekline • Rocky Hillcrest/Slopes • Drainage Line • Stony Plain	110 vertebrate species • 6 native mammals • 1 introduced mammals • 56 birds • 45 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	
47. Biota (2014a)	Project: Yandi Billiards Phase 1 Seasonal Fauna Survey. Client: RTIO Survey date: Phase 1: 8th – 18th March 2014 Survey type: Two Phase Detailed fauna survey Experience: Zoologist #	~10km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Audio recordings for birds and amphibians • Opportunistic observations Secondary evidence	• Alluvial Plain • Floodplain • Hillcrest/Slopes • Major Drainage Line • Minor Alluvial Fans • Mulga Woodlands • Pediment Slope	155 vertebrate species • 19 native mammals • 2 introduced mammals • 78 birds • 54 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Brush-tailed mulgara (*Dasycercus blythi*) Migratory: • Fork-tailed swift (*Apus pacificus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
48. Ecologia (1995)	Project: Yandi Stage II Iron Ore Project: Biological Assessment Survey. Client: BHP Survey date: 14th May – 8th June 1995 Survey type: Single phase Detailed survey Experience: Senior Zoologist x 2 Zoologist Research Assistant Field Assistant	10.1km	• Active searching • Systematic trapping – pitfall, Elliott • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Riverine • Drainage Gully • Colluvial Flat • Outwash Flat • Scree Slope • Mesa Top	154 vertebrate species • 16 native mammals • 4 introduced mammals • 81 birds • 47 reptiles • 3 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specialy protected: • Peregrine falcon (*Falco peregrinus*)	No cage or funnel trapping. Pre bat echolocation recording.
49. ENV (2010b)	Project: Jinayri Access Road Vertebrate Fauna Survey. 499 Client: BHP Survey date: 20th – 30th May 2009 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x3 Field assistant	10.8km	• Active searching • Targeted trapping – pitfall, funnel, Elliott, cage • Avifauna census • Nocturnal survey • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Gorge • Hill Top • Scree Slope • Minor Drainage Line • Breakaway • Alluvial Plain • Riverine	92 vertebrate species • 12 native mammals • 3 introduced mammals • 47 birds • 28 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
50. Biologic (2011c)	Project: Barimunya Camp Vertebrate Fauna Survey. Client: BHP Survey date: 29th April 2011 Survey type: Basic baseline fauna survey Experience: Senior Ecologist Zoologist	11.9km	• Active searching • Targeted searching • Opportunistic observations • Secondary Evidence	• Drainage Line • Alluvial Slope • Hillcrest/slope	21 vertebrate species • 1 native mammals • 0 introduced mammal • 17 birds • 3 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
51. Phoenix (2014)	Project: Terrestrial Fauna Survey for the Extension Project. Client: AAMC Survey date: 27th March - 5th April 2014 Survey type: Basic survey Experience: Unknown	13km	• Active searching • Targeted searching • Motion sensitive cameras • Bat echolocation recording • Opportunistic observations • Secondary Evidence	• Hummock and Tussock Grassland • Open and Closed Shrubland • Hillcrest and Slopes • Minor Creek and Drainage Line • Gorge/Gullies	78 vertebrate species • 10 native mammals • 4 introduced mammals • 32 birds • 29 reptiles • 3 amphibians	Threatened: • Pilbara leaf-nosed bat (Rhinonicteris aurantia) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
52. Ecologia (2006b)	Project: Marillana Terrestrial Vertebrate Fauna Survey. 408 Client: Brockman Resources Ltd. Survey date: Phase 1: 2nd – 9th October 2005 Phase 2: 10th – 17th March 2006 Survey type: Two Phase Detailed survey Experience: Senior Zoologist x3 Zoologist	13.5km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Ridge Top and Scree Slope • Minor Drainage Gully • Stony Plain • Alluvial Plain • Mesa Top	118 vertebrate species • 18 native mammals • 2 introduced mammals • 56 birds • 42 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Access restriction phase one. Reduced reptile activity due to rain during phase two.
53. Biologic (2013c)	Project: Marillana Vertebrate Fauna Survey. 1077 Client: BHP Survey date: Phase 1: 7th – 20th March 2011 Phase 2: 1st – 14th August 2011 Survey type: Two phase Detailed fauna survey Experience: Senior Zoologist x4 Principal Zoologist Herpetologist	13.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Gorge/gully • Hillcrest/slope • Sandy Areas • Sand Dunes • Mulga Woodland • Minor Drainage Line • Major Drainage Line	175 vertebrate species • 25 native mammals • 5 introduced mammal • 77 birds • 66 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) • Northern quoll (Dasyurus hallucatus) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind snake (*Anilios ganei*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other significant: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
54. ENV (2008c)	Project: Jinayri Vertebrate Fauna Assessment. 1010 Client: BHP Survey date: 5th – 18th March 2008 Survey type: Detailed survey Experience: Zoologist(s)	13.8km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Gorge • Breakaways • Alluvial Plains • Hill Top • Scree Slope	153 vertebrate species • 22 native mammals • 5 introduced mammals • 65 birds • 60 reptiles • 1 amphibian	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*)	
55. Biota (2013b)	Project: South Parmelia Vertebrate Fauna Survey. 1224 Client: BHP Survey date: Phase 1: 11th – 20th April 2011 Phase 2: 2nd – 11th November 2011 Nocturnal Survey: 1st – 4th February 2012 Survey type: Twp phase Detailed fauna survey Experience: Senior Zoologist x4 Zoologist x7	14.7km	• Active searching • Targeted searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Undulating Low Hills • Flood and Colluvial Plains • Minor Drainage • Rocky Gorges/gullies • Calcrete Plains • Major Drainage Line	138 vertebrate species • 20 native mammals • 1 introduced mammals • 71 birds • 43 reptiles • 4 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
56. Biologic (2011b)	Project: Area C to Yandi Fauna Survey. Client: BHP Survey date: 13th – 20th September 2011 Survey type: Basic fauna survey Experience: Senior Zoologist Principle Zoologist	~15km	• Active searching • Targeted searching – transects • Avifauna census • Bat echolocation recording • Motion sensitive cameras • Opportunistic observations • Secondary Evidence	• Gorge/gully • Hillcrest/slope • Minor Drainage Line • Major Drainage Line • Valley	74 vertebrate species • 13 native mammals • 3 introduced mammals • 47 birds • 10 reptiles • 1 amphibian	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
57. Ecologia (2005c)	Project: Upper Marillana Exploration Project Biological Survey. 115 Client: BHP Survey date: 13th – 20th April 2005 Survey type: Basic survey Experience: Senior Zoologist Zoologist x2	15km	• Active searching • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Stony Plain • Low Ridge Line • Mulga Sandplain • Drainage Line	69 vertebrate species • 11 native mammals • 5 introduced mammals • 37 birds • 16 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	Ghost bat recorded adjacent to Study Area at Marillana Creek waterhole.
58. ENV (2007d)	Project: Upper Marillana Exploration Lease Fauna Assessment. Client: BHP Survey date: 5th – 11th May 2007 Survey type: Basic fauna survey Experience: Ornithologist Taxonomist Biologist	15.8km	• Active searching • Bat echolocation recording • Avifauna census • Nocturnal survey • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Hillcrest/slope • Sand Plain • Flood Plain	118 vertebrate species • 14 native mammals • 5 introduced mammals • 79 birds • 18 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No motion sensitive cameras used.
59. Ecologia (2006a)	Project: Jirridi Terrestrial Vertebrate Fauna Survey. 497 Client: BHP Survey date: Phase 1: 17th – 31st October 2005 Phase 2: 27th March – 5th April 2006 Survey type: Two Phase Detailed survey Experience: Senior Zoologist x 3 Zoologist x3	16.4km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Ridge top and Scree Slope • Minor Drainage Gully • Stony Plain • Alluvial Plain • Rocky Scree Slope • Mesa Top	142 vertebrate species • 18 native mammals • 4 introduced mammals • 70 birds • 48 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
60. ENV (2011)	Project: Upper Marillana and Munjina Flora, Vegetation and Fauna Assessment. Client: BHP Survey date: 31st August – 10th September 2010 Survey type: Basic fauna survey Experience: Senior Zoologist Ornithologist Zoologist Biologist	17.7km	• Active searching • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Hillcrest/slope • Riverine • Stony Plain • Alluvial Plain	134 vertebrate species • 2 native mammals • 4 introduced mammals • 35 birds • 5 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	No trapping, bat echolocation recording, or motion sensitive cameras used.
61. ENV (2010c)	Project: Jinayri Mining Lease Vertebrate Fauna Survey. Client: BHP Survey date: 5th – 18th March 2008 Survey type: Detailed survey Experience: Senior Zoologist Zoologist x3 Ornithologist x2 Biologist Field Assistant x3	18.9km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Breakaways • Alluvial Plains • Hillcrest/slope	149 vertebrate species • 22 native mammals • 4 introduced mammals • 65 birds • 57 reptiles • 1 amphibian	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind-snake (*Anilios ganei*)	
62. Biota (2005c)	Project: Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas. 1242 Client: FMG Survey date: Phase 1: 20th March – 7th April 2004 Phase 2: 21st June – 16th July 2004 Survey type: Twp phase Detailed fauna survey Experience: Zoologist x7	18.9km	• Active searching • Targeted searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Low Hills • Stony Plains • Minor creekline and Floodplains • Mulga Wooldlands • Sandy Plains • Cracking Clays • Colluvial Fans	175 vertebrate species • 20 native mammals • 6 introduced mammals • 105 birds • 42 reptiles • 2 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
63. Biota (2012b)	Project: Koodaideri Project Targeted Fauna Survey. Client: RTIO Survey date: 19th – 27th July 2011 Survey type: Detailed targeted fauna survey Experience: Senior Zoologist Zoologist x3	~20km	• Active searching • Targeted searching • Targeted trapping – medium and large Elliott • Bat echolocation recording • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/Slopes • Drainage Lines • Alluvial Plains	16 vertebrate species • 8 native mammals • 2 introduced mammals • 0 birds • 6 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
64. Biota (2012a)	Project: Koodaideri Northern Extension Fauna Survey. Client: RTIO Survey date: 10th – 20th October 2011 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist x3	~20km	• Active searching • Targeted searching • Targeted trapping – pitfall, funnel, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/Slopes • Drainage Lines • Alluvial Plains • Stony Plain • Calcrete Plain	87 vertebrate species • 15 native mammals • 1 introduced mammals • 31 birds • 40 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
65. Biota (2012c)	Project: Koodaideri Southern Infrastructure Corridor Fauna Survey. Client: RTIO Survey date: Phase 1: 3rd – 13th May 2011 Phase 2: 15th – 25th November 2011 Phase 3: 2nd – 10th May 2012 Survey type: Three phase Detailed fauna survey Experience: Zoologist x12	~20km	• Active searching • Targeted searching • Systematic trapping – pitfall, funnel, Elliott • Bat echolocation recording • Harp trapping • Avifauna census • Motion sensitive cameras • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/Slopes • Drainage Lines • Alluvial Plains	166 vertebrate species • 23 native mammals • 4 introduced mammals • 76 birds • 61 reptiles • 2 amphibians	Threatened: • Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) • Blind snake (*Anilios ganei*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
66. Rapallo (2012)	Project: Level 2 Fauna Survey and Targeted Northern Quoll Survey of the Lamb Creek. Client: Process Minerals International Pty Ltd. Survey date: Phase 1: 19th – 20th March 2012 Phase 2: 26th – 12th April 2012 Survey type: Two phase Detailed fauna survey Experience: Senior Ecologist Ecologist x5 Field assistant x2	~20km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Bat echolocation recording • Harp trapping • Motion sensitive cameras • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Gorge/gully • Hillcrest/slope • Minor Drainage Line • Alluvial/flood Plain • Stony/sandy Plain	158 vertebrate species • 19 native mammals • 3 introduced mammals • 76 birds • 58 reptiles • 2 amphibians	Threatened: • Pilbara olive python (*Liasis olivaceus subsp. barroni*) • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	
67. Biologic (2011d)	Project: Jinidi Vertebrate Fauna Survey. Client: BHP Survey date: 14th - 20th March 2011 6th – 10th April 2011 Survey type: Basic fauna survey Experience: Zoologist x2	21km	• Active searching • Targeted searching – transects • Bat echolocation recording • Opportunistic observations • Secondary Evidence	• Gorge/gully • Hillcrest/slope • Drainage Area • Calcrete Plain • Mulga • Major Drainage Line	92 vertebrate species • 12 native mammals • 3 introduced mammals • 59 birds • 16 reptiles • 2 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) • Pilbara olive python (*Liasis olivaceus subsp. barroni*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: • Fork-tailed swift (*Apus pacificus*)	
68. ENV (2008d)	Project: Rapid Growth Project 5: M270SA Fauna Assessment. Client: Calibre Engenium Joint Venture Survey date: 21st, 22nd and 25th May 2008 Survey type: Basic fauna survey Experience: Senior Zoologist/Ornithologist Zoologist x2	21.8km	• Active searching • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Rocky Hill • Stony Plain	10 vertebrate species • 1 native mammals • 0 introduced mammal • 6 birds • 3 reptiles • 0 amphibians		No bat echolocation recording or use of motion sensitive cameras

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
69. ENV (2007c)	Project: Mindy North Exploration Lease Fauna Assessment. 411 Client: BHP Survey date: 18th – 24th April 2007 13th -20th April 2007 Survey type: Basic survey Experience: Biologist Ornithologist Taxonomist	23.3km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Riverine • Floodplain • Hillcrest/slope	101 vertebrate species • 6 native mammals • 1 introduced mammal • 57 birds • 37 reptiles • 0 amphibians		Trapping grids were opened within the Coondiner exploration lease, during the same period, to supplement the opportunistic searches.
70. Ecologia (2005a)	Project: Mindy-Coondiner Exploration Project Biological Survey. 413 Client: BHP Survey date: 7th – 11th November 2005 Survey type: Basic survey Experience: Biologist Zoologist	23.6km	• Active searching • Avifauna census • Opportunistic observations • Secondary evidence	• Minor Drainage Gully • Mulga Sandplain	39 vertebrate species • 5 native mammals • 0 introduced mammals • 29 birds • 0 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
71. Ecologia (2009)	Project: Marillana Iron Ore Project Vertebrate Fauna Assessment. Client: Brockman Resources Ltd. Survey date: Phase 1: 25th April – 7th May 2008 Phase 2: 30th August – 10th September 2008 Survey type: Two Phase Detailed survey Experience: Senior Zoologist Zoologist x7	24km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Sandy Spinifex Grassland • Stony Spinifex Plain • Creekline • Longitudinal Sand Dune • Mulga Woodland	152 vertebrate species • 23 native mammals • 4 introduced mammals • 82 birds • 43 reptiles • 0 amphibians	Threatened: • Ghost bat (*Macroderma gigas*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Migratory: Fork-tailed swift (*Apus pacificus*)	Potential suitable habitat for night parrots but no acoustic recording equipment used.

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
72. Biota (2004)	Project: Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor. Client: FMG Survey date: 20th March – 7th April 2004 Survey type: Detailed fauna survey Experience: Senior Zoologist Zoologist	27.8km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott • Avifauna census • Bat echolocation recording • Opportunistic observations • Secondary evidence	• Stony Plain • Sandy Plain • Mulga Woodland • Drainage Line • Creekline • Hilcrest/slope	178 vertebrate species • 25 native mammals • 5 introduced mammals • 84 birds • 58 reptiles • 6 amphibians	Priority: • Northern short-tailed mouse (*Leggadina lakedownensis*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	Rainfall events during the survey resulted in some trap sites being closed early, and limited access to sites.
73. ENV (2009b)	Project: Newman to Yandi Transmission Line Terrestrial Vertebrate Fauna Assessment. Client: Worley Parsons and BHP Survey date: 7th – 16th May 2009 Survey type: Basic fauna survey Experience: Senior Zoologist Zoologist	33.3km	• Active searching • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Riverine • Alluvial Plain • Hillcrest/slope • Stony Plain • Gorge/gully	78 vertebrate species • 8 native mammals • 2 introduced mammal • 59 birds • 9 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*)	
74. Onshore Environmental Consultants and Biologic Environmental Survey (2011).	Project: South Parmelia Exploration Leases. Client: BHP	~35km	• Active searching •	• Medium drainage area •	vertebrate species • 13 native mammals • 4 introduced mammals • 60 birds • 12 reptiles • 0 amphibians		
75. Ninox (2009)	Project: A Vertebrate Fauna Survey of the Proposed Hope Downs 4 Mining Area, Near Newman, Western Australia. 1243 Client: Mattiske Consulting Pty Ltd. Survey date: Phase 1: 6th – 13th May 2008 Phase 2: 12th – 18th September 2008 Survey type: Two Phase Detailed survey Experience: Senior Zoologist x2 Zoologist	39km	• Active searching • Systematic trapping – pitfall, Elliott, funnel, cage • Avifauna census • Bat echolocation recording • Harp trapping • Opportunistic observations • Secondary evidence	• Ridge and Range • Rocky Hill/gully • Creekline • Spinifex with Eucalyptus • Mulga Groves • Stony Plain	112 vertebrate species • 16 native mammals • 1 introduced mammal • 66 birds • 29 reptiles • 0 amphibians	Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	
76. Biota (2002)	Project:	45.5km	• Active searching • Targeted searching	• Stony Plain • Mulga Woodland • Alluvial Plain	239 vertebrate species • 30 native mammals	Threatened: • Ghost bat (*Macroderma gigas*) • Woma (*Aspidites ramsayi*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
	Proposed Hope Downs Rail Corridor from Weeli Wolli Siding to Port Hedland - Vertebrate Fauna Survey. <u>Client:</u> BHP <u>Survey date:</u> Phase 1: 25th May – 2nd June 2001 Phase 2: 7th – 15th September 2001 Phase 3: 5th – 8th February 2002 <u>Survey type:</u> Three Phase Detailed fauna survey <u>Experience:</u> Senior Zoologist Zoologist		• Systematic trapping – pit, Elliott • Avifauna census • Bat echolocation recording • Harp trapping and Mist netting • Nocturnal surveys • Opportunistic observations • Secondary evidence		• 5 introduced mammals • 125 birds • 73 reptiles • 6 amphibians	• Northern quoll (*Dasyurus hallucatus*) • Greater bilby (*Macrotis lagotis*) <u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*) • Northern short-tailed mouse (*Leggadina lakedownensis*) • Spotted ctenotus (*Ctenotus uber subsp. Johnstonei*) <u>Other specialy protected:</u> • Peregrine falcon (*Falco peregrinus*)	
77. Biota (2008)	<u>Project:</u> Marandoo Mine Phase 2 Seasonal Fauna Survey. <u>Client:</u> RTIO <u>Survey date:</u> Phase 1: 1st – 11th March 2007 and 10th – 15th April 2007 Phase 2: 6th – 12th November 2007 <u>Survey type:</u> Two Phase Detailed fauna survey <u>Experience:</u> Zoologist x7	47.3km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott • Avifauna census • Bat echolocation recording • Harp trapping • Opportunistic observations • Secondary evidence	• Minor Drainage Line • Stony Hillslope • Plain • Rocky Gorge	<u>125 vertebrate species</u> • 17 native mammals • 3 introduced mammals • 54 birds • 48 reptiles • 3 amphibians	<u>Threatened:</u> • Ghost bat (*Macroderma gigas*) • Northern quoll (*Dasyurus hallucatus*) <u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*)	Phase 1 broken into two surveys due to rainfall from tropical cyclone. No funnel traps used due to high temperatures.
78. ENV (2007b)	<u>Project:</u> Coondiner and Mindy East Exploration Leases Fauna Assessment. 386 <u>Client:</u> BHP <u>Survey date:</u> 13th – 20th April 2007 <u>Survey type:</u> Detailed fauna survey <u>Experience:</u> Senior Zoologist/Ornithologist Biologist x3 Ornithologist Taxonomist	47.3km	• Active searching • Avifauna census • Systematic trapping – Elliott, cage, funnel, pitfall • Bat echolocation recording • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Floodplain • Ridge Crest • Gorge/gully • Breakaway • Scree Slope	<u>125 vertebrate species</u> • 13 native mammals • introduced mammal • 73 birds • 37 reptiles • 1 amphibian	<u>Priority:</u> • Western pebble-mound mouse (*Pseudomys chapmani*)	

Reference	Survey details	Proximity to Study Area	Survey methods	Significant species habitat	Vertebrate fauna assemblage found (summary of species richness)	Significant species	Survey limitations/notes
79. ENV (2008e)	Project: RGP5: Quarry 6 Fauna Assessment. Client: Calibre Engenium Joint Venture Survey date: 24th – 26th May 2008 Survey type: Basic fauna survey Experience: Senior Zoologist/Ornithologist Zoologist x2	48.5km	• Active searching • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary Evidence	• Minor Drainage Line • Plain • Low Rise Floodplain • Cleared/regenerating Area	11 vertebrate species • 0 native mammals • 0 introduced mammal • 9 birds • 2 reptiles • 0 amphibians		
80. Bamford Consulting (2005)	Project: Fauna Survey of Proposed Iron Ore Mine, Cloud Break. 1166 Client: Fortescue Metals Group Ltd. Survey date: Phase 1: 7th – 17th April 2005 Phase 2: 18th – 29th May 2005 Survey type: Two phase Detailed fauna survey and targeted Experience: Senior Zoologist x3 Zoologist x4	49.5km	• Active searching • Targeted searching • Systematic trapping – pitfall, Elliott, funnel, cage • Bat echolocation recording • Mist netting • Avifauna census • Nocturnal surveys • Opportunistic observations • Secondary evidence	• Acacia Woodland • Scattered Eucalypt Woodland • Spinifex and Hummock Grassland • Stony Plain • Rocky hills/slopes • Riverbed/drainage area	153 vertebrate species • 20 native mammals • 5 introduced mammals • 99 birds • 28 reptiles • 1 amphibian	Endangered: • Night parrot (*Pezoporus occidentalis*) Threatened: • Grey falcon (*Falco hypoleucos*) Priority: • Western pebble-mound mouse (*Pseudomys chapmani*) Other specially protected: • Peregrine falcon (*Falco peregrinus*)	

Appendix B – Significant Vertebrate Fauna Recorded in the Desktop Assessment and Field Survey

Species		Conservation Status				Database review					Literature review																																				
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA**	**IUCN**	**NatureMap (40 km)**	**EPBC (40km)**	**DBCA T&P (50 km)**	**ALA (50 km)**	**Birdlife (10km)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**
DASYURIDAE																																															
Dasycercus blythi	Brush-tailed mulgara			*P4*		•		•																																	•						
Dasyurus hallucatus	Northern quoll	*EN*	*EN*		*EN*	•	•	•						•					•				•																				•				
Sminthopsis longicaudata	Long-tailed dunnart			*P4*		•																																									
MEGADERMATIDAE																																															
Macroderma gigas	Ghost bat	*VU*	*VU*		*VU*	•	•	•			•			•		•			•		•		•		•			•						•													
MOLOSSIDAE																																															
Ozimops cobourgianus	North-western free-tailed bat			*P1*																																											
MURIDAE																																															
Leggadina lakedownensis	Northern short-tailed mouse			*P4*		•		•			•					•																											•				
Notomys longicaudatus	Long-tailed hopping-mouse, koolawa	*EX*	*EX*		*EX*			•																																							
Pseudomys chapmani	Western pebble-mound mouse			*P4*		•		•			•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•		•	•	•		•	•	•	•	•	•	•		•	•	•	•	•
PHALANGERIDAE																																															
Trichosurus vulpecula subsp. arnhemensis	Northern brushtail possum	*VU*	*VU*																															•													
RHINONYCTERIDAE																																															
Rhinonicteris aurantia	Pilbara leaf-nosed bat	*VU*	*VU*			•																	•																	•					•		
THYLACOMYIDAE																																															
Macrotis lagotis	Greater bilby	*VU*	*VU*		*VU*	•	•	•																																							
ACCIPITRIDAE																																															
Elanus scriptus	Letter-winged kite			*P4*	*NT*	•		•																																							
Pandion haliaetus	Eastern osprey	*MI*	*MI*			•																			•																						
APODIDAE																																															
Apus pacificus	Fork-tailed swift	*MI*	*MI*			•		•		•									•		•					•																			•		•
CICONIIDAE																																															
Ephippiorhynchus asiaticus	Black-necked stork				*NT*																																										
FALCONIDAE																																															
Falco hypoleucos	Grey falcon	*VU*	*VU*		*VU*	•	•	•									•																		•								•				
Falco peregrinus	Peregrine falcon		*OS*			•		•		•		•			•	•			•		•		•								•								•							•	
LARIDAE																																															
Gelochelidon nilotica	Gull-billed tern	*MI*	*MI*					•																																							
Sterna caspia	Caspian tern	*MI*	*MI*							•																																					
PETROICIDAE																																															
Melanodryas cucullata	Hooded robin					•				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•
PSITTACIDAE																																															
Pezoporus occidentalis	Night parrot	*EN*	*CR*		*EN*		•																																								

Species		Conservation Status				Database review					Literature review																																				
Scientific Name	Common Name	EPBC Act	BC Act	DBCA	IUCN	NatureMap (40 km)	EPBC (40km)	DBCA T&P (50 km)	ALA (50 km)	Birdlife (10km)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
ROSTRATULIDAE																																															
Rostratula australis	Australian painted snipe	*EN*	*EN*		*EN*		•																																								
SCOLOPACIDAE																																															
Calidris ferruginea	Curlew sandpiper	*CR/ MI*	*CR/ MI*		*NT*		•																																								
Tringa glareola	Wood sandpiper	*MI*	*MI*													•																															
Actitis hypoleucos	Common sandpiper	*MI*	*MI*																																												
Tringa nebularia	Common greenshank	*MI*	*MI*			•		•							•																																
THRESKIORNITHIDAE																																															
Plegadis falcinellus	Glossy ibis	*MI*	*MI*			•																																									
AGAMIDAE																																															
Pogona minor minima	Dwarf bearded dragon		*VU*																																												
CARPHODACTYLIDAE																																															
Underwoodisaurus seorsus	Pilbara barking gecko			*P2*		•		•								•	•				•		•					•																	•		
ELAPIDAE																																															
Simoselaps anomalus	Desert banded snake																																														
PYTHONIDAE (PREVIOUSLY BOIDAE)																																															
Liasis olivaceus subsp. barroni	Pilbara olive python	*VU*	*VU*			•					•					•			•							•																					•
SCINCIDAE																																															
Ctenotus uber subsp. johnstonei	Spotted ctenotus			*P2*																																				•								
Cyclodomorphus branchialis	Gunther's skink		*VU*		*NT*																																										
Lerista macropisthopus remota	Unpatterned robust slider (Robertson Range)			*P2*		•																																									
Notoscincus butleri	Lined soil-crevice skink			*P4*																																								•				
TYPHLOPIDAE																																															
Anilios ganei	Blind-snake			*P1*		•		•											•		•		•		•															•						•	

Species		Conservation Status				Literature review																																									
Scientific Name	Common Name	EPBC Act	BC Act	DBCA	IUCN	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
DASYURIDAE																																															
Dasycercus blythi	Brush-tailed mulgara			*P4*										•																									•								
Dasyurus hallucatus	Northern quoll	*EN*	*EN*		*EN*															•													•						•				•	•			
Sminthopsis longicaudata	Long-tailed dunnart			*P4*																																											
MEGADERMATIDAE																																															
Macroderma gigas	Ghost bat	*VU*	*VU*		*VU*	•	•				•	•								•	•	•	•	•		•		•					•	•										•			
MOLOSSIDAE																																															
Ozimops cobourgianus	North-western free-tailed bat			*P1*			•																																								
MURIDAE																																															
Leggadina lakedownensis	Northern short-tailed mouse			*P4*																									•										•				•				
Notomys longicaudatus	Long-tailed hopping-mouse, koolawa	*EX*	*EX*		*EX*																																										
Pseudomys chapmani	Western pebble-mound mouse			*P4*		•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•		•		•	•	•	•			•
PHALANGERIDAE																																															
Trichosurus vulpecula subsp. arnhemensis	Northern brushtail possum	*VU*	*VU*																																												
RHINONYCTERIDAE																																															
Rhinonicteris aurantia	Pilbara leaf-nosed bat	*VU*	*VU*															•			•							•																			
THYLACOMYIDAE																																															
Macrotis lagotis	Greater bilby	*VU*	*VU*		*VU*		•																																				•				•
ACCIPITRIDAE																																															
Elanus scriptus	Letter-winged kite			*P4*	*NT*																																										
Pandion haliaetus	Eastern osprey	*MI*	*MI*																																												
APODIDAE																																															
Apus pacificus	Fork-tailed swift	*MI*	*MI*										•	•						•						•			•				•	•					•								
CICONIIDAE																																															
Ephippiorhynchus asiaticus	Black-necked stork				*NT*																																		•								
FALCONIDAE																																															
Falco hypoleucos	Grey falcon	*VU*	*VU*		*VU*		•																																•								•
Falco peregrinus	Peregrine falcon		*OS*									•	•		•					•									•			•							•			•	•				•
LARIDAE																																															
Gelochelidon nilotica	Gull-billed tern	*MI*	*MI*										•																																		
Sterna caspia	Caspian tern	*MI*	*MI*																																												
PETROICIDAE																																															
Melanodryas cucullata	Hooded robin					•	•	•		•	•		•		•	•			•	•	•	•			•	•	•	•	•			•	•	•				•	•	•	•	•	•	•	•	•	•
PSITTACIDAE																																															
Pezoporus occidentalis	Night parrot	*EN*	*CR*		*EN*																																										•

Species		Conservation Status				Literature review																																									
Scientific Name	**Common Name**	**EPBC Act**	**BC Act**	**DBCA**	**IUCN**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**
ROSTRATULIDAE																																															
Rostratula australis	Australian painted snipe	*EN*	*EN*		*EN*																																										
SCOLOPACIDAE																																															
Calidris ferruginea	Curlew sandpiper	*CR/ MI*	*CR/ MI*		*NT*																																										
Tringa glareola	Wood sandpiper	*MI*	*MI*																																												
Actitis hypoleucos	Common sandpiper	*MI*	*MI*					•																																							
Tringa nebularia	Common greenshank	*MI*	*MI*																																												
THRESKIORNITHIDAE																																															
Plegadis falcinellus	Glossy ibis	*MI*	*MI*																																												
AGAMIDAE																																															
Pogona minor minima	Dwarf bearded dragon		*VU*																										•																		
CARPHODACTYLIDAE																																															
Underwoodisaurus seorsus	Pilbara barking gecko			*P2*		•																																									
ELAPIDAE																																															
Simoselaps anomalus	Desert banded snake																																												•				
PYTHONIDAE (PREVIOUSLY BOIDAE)																																															
Liasis olivaceus subsp. barroni	Pilbara olive python	*VU*	*VU*					•			•	•	•	•	•					•													•	•							•						
SCINCIDAE																																															
Ctenotus uber subsp. johnstonei	Spotted ctenotus			*P2*																																		•	•				•				
Cyclodomorphus branchialis	Gunther's skink		*VU*		*NT*		•								•																																
Lerista macropisthopus remota	Unpatterned robust slider			*P2*																																											
Notoscincus butleri	Lined soil-crevice skink			*P4*																																											
TYPHLOPIDAE							•																																								
Anilios ganei	Pilbara flat-headed blind-snake			*P1*																•	•											•															

Appendix C – Vertebrate Fauna Habitat Assessments

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-001	-22.8171	119.1452	05/04/2022	Stony Plain	Stony Plain	South/ West	Low	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-002	-22.9131	118.7276	05/04/2022	Stony Plain	Stony Plain	South/ West	Low	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Eucalypt Woodland	Minor Outcropping	Ironstone	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-003	-22.8510	119.1150	05/04/2022	Major Drainage Line	Gorge	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Pooling	1	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-004	-22.8198	118.7462	05/04/2022	Drainage Area/ Floodplain	Sandy/ Stony Plain	North/ West	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-005	-22.8934	119.0668	05/04/2022	Hillcrest/ Hillslope	Stony Plain	Flat	Low	Small Rocks (11-20cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam Sandy	Few Small Patches	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-006	-22.8686	118.7652	05/04/2022	Stony Plain	Stony Plain	East	Low	Pebbles (5-10cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Limited Outcropping	Ironstone	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-007	-22.8299	119.1231	05/04/2022	Hillcrest/ Hillslope	Gully	North	Moderate	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-008	-22.8881	118.8109	05/04/2022	Drainage Area/ Floodplain	Stony Plain	Sout h/ East	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Many Small Patches	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-009	-22.8654	119.1004	05/04/2022	Hillcrest/ Hillslope	Stony Plain	Nort h/ East	Low	Small Rocks (11-20cm)	Scarce	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-010	-22.9030	118.7277	05/04/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Many Large Patches	Few Large Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Light Clay	Many Large Patches	Prone to Flooding	0	0.4	Cattle Grazing	Old (6+ yr)		-
VCPH-011	-22.9123	119.0533	05/04/2022	Stony Plain	Stony Plain	Nort h/ West	Low	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Limited Outcroppin g	BIF	Sandy Clay Loam	Scarce	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-012	-22.9133	119.0734	05/04/2022	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Negligible	-	Clay Loam Sandy	Many Small Patches	None	0	1	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-013	-22.8059	119.1424	06/04/2022	Gorge/ Gully	Gully	West	Stee p	Small Rocks (11-20cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcroppin g	Shal e	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-014	-22.8859	119.0830	06/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-015	-22.8345	119.1313	06/04/2022	Major Drainage Line	Drainage Area/ Floodplain	North/ West	Moderate	Boulders (>61cm)	Few Small Patches	Few Large Patches	Eucalypt Woodland, Tussock Grassland, *Spinifex* Hummock Grassland	Extensive Outcropping	Ironstone	Light Clay	Few Small Patches	Prone to Pooling	1	0.8	None Discernible	Old (6+ yr)		-
VCPH-016	-22.8847	119.0842	06/04/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-017	-22.8310	119.1336	06/04/2022	Major Drainage Line	Drainage Area/ Floodplain	East	Moderate	Boulders (>61cm)	Few Small Patches	Few Large Patches	Eucalypt Woodland, Tussock Grassland, *Spinifex* Hummock Grassland	Major Outcropping	Ironstone	Light Clay	Few Small Patches	Prone to Pooling	2	0.8	None Discernible	Old (6+ yr)		-
VCPH-018	-22.8685	119.0957	06/04/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-019	-22.8562	119.1166	06/04/2022	Gorge/ Gully	Gorge	South/ West	Steep	Large Rocks (21-60cm)	Scarce	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Clay Loam	Scarce	Prone to Flooding	0	1	None Discernible	Old (6+ yr)		Cliff face, water availability in drainage line below.

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-020	-22.8486	119.1111	06/04/2022	Gorge/ Gully	Gorge	Flat	Flat	Boulders (>61cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Permanent	0	1	None Discernible	Old (6+ yr)		-
VCPH-021	-22.8927	118.7977	07/04/2022	Drainage Area/ Floodplain	Sand Plain	Flat	Flat	Negligible	Few Large Patches	Scarce	*Spinifex* Hummock Grassland, *Acacia* Shrubland, Tussock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	0	0.6	Cattle Grazing	Old (6+ yr)		-
VCPH-022	-22.8314	119.1311	06/04/2022	Gorge/ Gully	Gorge	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-023	-22.8545	119.1169	06/04/2022	Major Drainage Line	Gorge	Flat	Flat	Large Rocks (21-60cm)	Few Small Patches	Many Large Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	None Discernible	Old (6+ yr)		-
VCPH-024	-22.8286	118.7736	07/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-025	-22.8980	119.0722	07/04/2022	Gorge/ Gully	Gorge	West	Steep	Large Rocks (21-60cm)	Scarce	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-026	-22.8116	119.1451	08/04/2022	Gorge/ Gully	Gully	North	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-027	-22.8355	119.1221	08/04/2022	Gorge/ Gully	Gorge	North	Very Steep	Boulders (>61cm)	Scarce	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-028	-22.9093	118.8539	08/04/2022	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	0.6	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-029	-22.8594	118.7656	08/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-030	-22.8598	118.7705	08/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-031	-22.8688	118.7579	08/04/2022	Stony Plain	Undulating Low Hills	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-032	-22.8808	118.7486	08/04/2022	Breakaway/ Cliff	Breakaway	West	Steep	Boulders (>61cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-033	-22.8827	118.7487	08/04/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-034	-22.8842	118.7539	08/04/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-035	-22.8829	118.7748	08/04/2022	Breakaway/ Cliff	Breakaway	South	Moderate	Large Rocks (21-60cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-036	-22.8819	118.7844	08/04/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Scarce	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	Weed Invasion	Old (6+ yr)		-
VCPH-037	-22.8856	118.7826	08/04/2022	Hardpan Plain	Drainage Area/ Floodplain	Flat	Flat	Negligible	Evenly Spread	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-038	-22.8850	118.7837	08/04/2022	Mulga Woodland	Drainage Area/ Floodplain	Flat	Flat	Negligible	Many Small Patches	Many Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-039	-22.8844	118.7802	08/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-040	-22.8822	118.7774	08/04/2022	Hillcrest/ Hillslope	Hillslope	East	Low	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-041	-22.9045	118.7240	09/04/2022	Medium Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Small Patches	Mulga Woodland, Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible	-	Clay Loam	Few Large Patches	Permanent	5	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-042	-22.8652	118.7912	09/04/2022	Gorge/ Gully	Gorge	South	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	*Spinifex* Hummock Grassland, Tussock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-043	-22.8472	118.7582	09/04/2022	Gorge/ Gully	Gully	South	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-044	-22.8295	118.7704	09/04/2022	Minor Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Large Patches	Mulga Woodland, Tussock Grassland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	1	0.6	Weed Invasion	Old (6+ yr)		-
VCPH-045	-22.8194	118.7506	09/04/2022	Minor Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland, Scattered Eucalypts	Negligible	-	Clay Loam	Few Small Patches	Prone to Pooling	3	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-046	-22.9220	118.8763	09/04/2022	Gorge/ Gully	Gully	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Few Small Patches	None	1	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-047	-22.8902	118.7928	09/04/2022	Hardpan Plain	Drainage Area/ Floodplain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Scarce	*Acacia* Shrubland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-048	-22.8916	118.7871	09/04/2022	Mulga Woodland	Drainage Area/ Floodplain	Flat	Flat	Negligible	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-049	-22.9116	118.8386	09/04/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Flooding	0	0.8	None Discernible	Old (6+ yr)		-

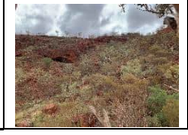
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-050	-22.9052	118.7135	09/04/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Many Large Patches	Scarce	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Large Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-051	-22.8700	118.7919	10/04/2022	Gorge/ Gully	Gorge	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-052	-22.8506	118.7919	10/04/2022	Gorge/ Gully	Gorge	North	Steep	Boulders (>61cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-053	-22.9158	119.0305	10/04/2022	Minor Drainage Line	Minor Drainage Line	South	Low	Gravel (1-4cm)	Many Small Patches	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland, Scattered Eucalypts	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	0.6	Mining Exploration	Old (6+ yr)		-
VCPH-054	-22.8083	119.1531	10/04/2022	Gorge/ Gully	Gorge	Flat	Moderate	Large Rocks (21-60cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-055	-22.8111	119.1529	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	South	Low	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

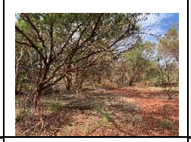
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-056	-22.8049	119.1499	10/04/2022	Gorge/ Gully	Gully	South	Steep	Large Rocks (21-60cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-057	-22.8053	118.7125	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	South/ West	Moderate	Small Rocks (11-20cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-058	-22.8075	119.1495	10/04/2022	Gorge/ Gully	Gorge	North	Low	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-059	-22.8856	119.0746	05/04/2022	Drainage Area/ Floodplain	Sand Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sand	Evenly Spread	None	0	0.8	Mining Exploration	Old (6+ yr)		-
VCPH-060	-22.7872	118.6798	10/04/2022	Drainage Area/ Floodplain	Hillslope	North	Moderate	Pebbles (5-10cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Evenly Spread	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		Stony rise with patchy fire, some long unburnt
VCPH-061	-22.8458	119.1122	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-062	-22.8394	119.1208	10/04/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	North	Steep	Small Rocks (11-20cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-063	-22.8426	119.1160	10/04/2022	Gorge/ Gully	Medium Drainage Line	South	Steep	Large Rocks (21-60cm)	Many Small Patches	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-064	-22.9026	118.7568	11/04/2022	Mulga Woodland	Sand Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Many Large Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-065	-23.0247	118.6427	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Clay Loam	Scarce	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-066	-23.0391	118.6769	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-067	-23.0789	118.6668	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-068	-23.0420	118.7365	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-069	-23.0282	118.9216	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible	-	Clay Loam	Scarce	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-070	-22.9021	118.7582	11/04/2022	Mulga Woodland	Sand Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Light Clay	Many Large Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-071	-22.8055	118.6941	11/04/2022	Breakaway/ Cliff	Cliff	Sout h/ West	Cliff	Large Rocks (21-60cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcroppin g	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-072	-22.7673	118.6481	11/04/2022	Drainage Area/ Floodplain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Large Patches	None	0	0.6	Frequent Fire	Moderate (3 to 5 yr)		Stony spinifex plain with scattered shrubs
VCPH-073	-22.7625	118.6501	11/04/2022	Drainage Area/ Floodplain	Medium Drainage Line	West	Low	Pebbles (5-10cm)	Evenly Spread	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clayey Sand	Evenly Spread	Prone to Flooding	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		Patchy fire
VCPH-074	-23.0882	118.8551	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-075	-23.0930	118.8109	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Mining Exploration	Moderate (3 to 5 yr)		-
VCPH-076	-23.0910	118.7173	11/04/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Low	Small Rocks (11-20cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-077	-23.0540	118.6695	11/04/2022	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-078	-23.0710	118.6742	11/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-079	-22.8468	118.7901	12/04/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clay Loam	Scarce	None	3	0.8	None Discernible	Old (6+ yr)		-
VCPH-080	-22.8383	118.7541	12/04/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-081	-22.8404	118.7561	11/04/2022	Gorge/ Gully	Gorge	South	Moderate	Small Rocks (11-20cm)	Scarce	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	Prone to Pooling	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-082	-22.9137	118.7853	13/04/2022	Hillcrest/ Hillslope	Gully	South/ East	Moderate	Small Rocks (11-20cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Clay Loam	Scarce	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-083	-22.8476	118.7650	13/04/2022	Stony Plain	Undulating Low Hills	East	Low	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-084	-22.8428	118.7504	13/04/2022	Gorge/ Gully	Gorge	East	Moderate	Small Rocks (11-20cm)	Scarce	Many Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-085	-23.1060	118.8094	28/04/2022	Gorge/ Gully	Gorge	West	Moderate	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	1	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-086	-23.0442	118.8541	28/04/2022	Breakaway/ Cliff	Gorge	South	Steep	Boulders (>61cm)	None Discernible	Few Small Patches	*Spinifex* Hummock Grassland, Eucalypt Woodland	Major Outcropping	BIF	Clay Loam	None Discernible	None	1	0.6	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-087	-23.0292	118.7122	29/04/2022	Gorge/ Gully	Gorge	North	Moderate	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-088	-23.0644	118.7429	29/04/2022	Gorge/ Gully	Gorge	South	Steep	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-089	-23.0403	118.8516	29/04/2022	Gorge/ Gully	Gorge	South/ West	Very Steep	Large Rocks (21-60cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Extensive Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-
VCPH-090	-23.0374	118.8401	29/04/2022	Gorge/ Gully	Gorge	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Pooling	1	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-091	-23.0964	118.9056	29/04/2022	Breakaway/ Cliff	Major Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Clay Loam	Many Small Patches	Prone to Pooling	3	0.8	Weed Invasion	Old (6+ yr)		Buffel common. Recent burn where outcropping is minimal but long unburned elsewhere
VCPH-092	-23.0968	118.8454	29/04/2022	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	Tussock Grassland, *Acacia* Shrubland, Mulga Woodland	Negligible	-	Light Clay	Few Small Patches	None	1	0.6	Cattle Grazing, Weed Invasion and Road/ Access Track	Old (6+ yr)		-
VCPH-093	-23.0685	118.8181	29/04/2022	Gorge/ Gully	Gorge	South/ West	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland, *Acacia* Shrubland	Major Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		Recent burning surrounds

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-094	-23.0532	118.8123	29/04/2022	Breakaway/ Cliff	Ironstone Outcrops	North/ East	Moderate	Small Rocks (11-20cm)	Few Small Patches	Scarce	Mulga Woodland, Tussock Grassland	Moderate Outcropping	BIF	Clay Loam	Few Small Patches	None	0	0.6	Cattle Grazing	Old (6+ yr)		-
VCPH-095	-23.0722	118.8226	30/04/2022	Breakaway/ Cliff	Breakaway	South	Very Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-096	-23.0650	118.8211	30/04/2022	Gorge/ Gully	Gorge	West	Very Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-097	-23.0690	118.7791	30/04/2022	Stony Plain	Stony Plain	North	Low	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-098	-23.0677	118.7691	30/04/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-099	-23.0634	118.6912	30/04/2022	Minor Drainage Line	Minor Drainage Line	North	Low	Pebbles (5-10cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Clayey Sand	Few Small Patches	Prone to Pooling	0	0.8	Mining Exploration	Old (6+ yr)		-
VCPH-100	-23.0609	118.7099	30/04/2022	Gorge/ Gully	Gorge	North	Very Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-101	-23.0480	118.7424	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	*Spinifex* Hummock Grassland, Mulga Woodland	Negligible	-	Light Clay	Many Large Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-102	-23.0475	118.7359	30/04/2022	Drainage Area/ Floodplain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-103	-23.0567	118.7365	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-104	-23.0581	118.7162	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-105	-23.0617	118.7000	30/04/2022	Stony Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Light Clay	Few Small Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-106	-23.0935	118.6942	01/05/2022	Hillcrest/ Hillslope	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-107	-22.8504	119.1197	06/04/2022	Major Drainage Line	Major Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Pooling	5	1	None Discernible	Old (6+ yr)		-
VCPH-108	-23.0285	118.9135	01/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Limited Outcropping	BIF	Sandy Loam	Many Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-109	-23.0298	118.9094	01/05/2022	Gorge/ Gully	Gorge	East	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-110	-23.0231	118.9118	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-111	-23.0198	118.9084	01/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-112	-23.0168	118.8981	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-

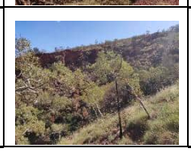
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-113	-23.0164	118.8845	01/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-114	-23.0174	118.8662	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-115	-23.0175	118.8582	01/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Flooding	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-116	-23.0922	118.6951	01/05/2022	Gorge/ Gully	Gorge	South	Moderate	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-117	-23.0461	118.9093	01/05/2022	Breakaway/ Cliff	Ironstone Outcrops	East	Moderate	Small Rocks (11-20cm)	Scarce	Many Small Patches	*Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-118	-23.0467	118.9072	01/05/2022	Breakaway/ Cliff	Ironstone Outcrops	East	Moderate	Large Rocks (21-60cm)	Scarce	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-119	-23.0864	118.6868	01/05/2022	Drainage Area/ Floodplain	Sand Plain	Flat	Flat	Negligible	Many Large Patches	Many Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Loam	Many Large Patches	None	0	1	Frequent Fire	Old (6+ yr)		-
VCPH-120	-23.0857	118.6838	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-121	-23.0335	118.6869	01/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Scarce	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Flooding	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-122	-23.0396	118.8660	01/05/2022	Breakaway/ Cliff	Gorge	North/ East	Steep	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-123	-23.0369	118.6570	01/05/2022	Gorge/ Gully	Gully	South/ East	Steep	Large Rocks (21-60cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Clay Loam	Scarce	None	0	0.6	None Discernible	Old (6+ yr)		-
VCPH-124	-23.0366	118.6479	01/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	1	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-125	-23.0376	118.6475	01/05/2022	Gorge/ Gully	Gully	South/ East	Moderate	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Moderate Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-126	-23.0456	118.9146	01/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	East	Moderate	Pebbles (5-10cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-127	-23.0424	118.9135	01/05/2022	Breakaway/ Cliff	Gorge	South/ West	Steep	Small Rocks (11-20cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-128	-23.0590	118.6237	02/05/2022	Gorge/ Gully	Gorge	South/ East	Moderate	Large Rocks (21-60cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-129	-23.0937	118.7026	02/05/2022	Gorge/ Gully	Gully	South	Steep	Large Rocks (21-60cm)	None Discernible	Few Large Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-130	-23.0383	118.6552	02/05/2022	Gorge/ Gully	Breakaway	North	Steep	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-131	-23.0170	118.6490	02/05/2022	Gorge/ Gully	Gully	South	Steep	Large Rocks (21-60cm)	Scarce	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-132	-23.0870	118.6405	02/05/2022	Gorge/ Gully	Gorge	South	Very Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-133	-23.0815	118.6608	02/05/2022	Gorge/ Gully	Gorge	North/ East	Steep	Large Rocks (21-60cm)	None Discernible	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-134	-23.0323	118.8336	03/05/2022	Stony Plain	Stony Plain	North/ West	Low	Pebbles (5-10cm)	Scarce	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Scarce	None	0	0.6	Road/ Access Track	Recent (0 to 2 yr)		Patchy recent burn
VCPH-135	-23.0463	118.8309	03/05/2022	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-136	-23.0508	118.8236	03/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-137	-23.0662	118.8065	03/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-138	-23.0332	118.8385	03/05/2022	Gorge/ Gully	Footslope	North/ West	Steep	Small Rocks (11-20cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-139	-23.0701	118.8124	03/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-140	-23.0417	118.8684	03/05/2022	Breakaway/ Cliff	Gorge	South/ West	Steep	Large Rocks (21-60cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-141	-23.0822	118.8164	03/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-142	-23.0408	118.8755	03/05/2022	Gorge/ Gully	Gorge	North/ West	Moderate	Boulders (>61cm)	Scarce	Many Small Patches	Scattered Eucalypts	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	Prone to Pooling	4	1	None Discernible	Old (6+ yr)		-
VCPH-143	-23.0755	118.8043	03/05/2022	Gorge/ Gully	Gully	South/ East	Steep	Boulders (>61cm)	None Discernible	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Clay Loam	None Discernible	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-144	-23.0396	118.8741	03/05/2022	Gorge/ Gully	Gorge	North/ West	Moderate	Boulders (>61cm)	Scarce	Many Small Patches	Scattered Eucalypts	Extensive Outcropping	BIF	Sandy Clay Loam	Scarce	Prone to Pooling	2	1	None Discernible	Old (6+ yr)		-
VCPH-145	-23.0726	118.7952	03/05/2022	Hillcrest/ Hillslope	Footslope	North	Low	Pebbles (5-10cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Scarce	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-146	-23.0652	118.7555	03/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-147	-23.0751	118.7935	03/05/2022	Breakaway/ Cliff	Gully	North	Steep	Boulders (>61cm)	Scarce	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Moderate (3 to 5 yr)		-
VCPH-148	-23.0579	118.7215	03/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-149	-23.0674	118.7169	03/05/2022	Gorge/ Gully	Gully	West	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	2	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-150	-23.0662	118.7197	03/05/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	West	Steep	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

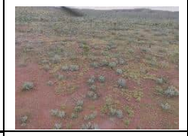
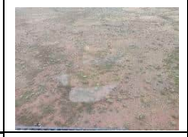
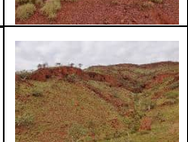
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-151	-23.0649	118.7202	03/05/2022	Gorge/ Gully	Gully	West	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	2	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-152	-23.0587	118.7148	03/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-153	-23.0671	118.6946	03/05/2022	Gorge/ Gully	Gorge	West	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	1	0.8	Frequent Fire	Old (6+ yr)		-
VCPH-154	-23.0377	118.7311	03/05/2022	Stony Plain	Stony Plain	South	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-155	-23.0359	118.7138	03/05/2022	Stony Plain	Stony Plain	South	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-156	-23.0328	118.6990	03/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Moderate	Small Rocks (11-20cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-157	-23.0352	118.6983	03/05/2022	Mulga Woodland	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Limited Outcropping	BIF	Light Clay	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-158	-23.0266	118.7039	03/05/2022	Stony Plain	Stony Plain	South	Low	Pebbles (5-10cm)	Few Small Patches	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-159	-23.0921	118.8676	04/05/2022	Minor Drainage Line	Medium Drainage Line	North/ West	Low	Gravel (1-4cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Clay Loam	Few Small Patches	Prone to Flooding	0	0.6	Road/ Access Track	Old (6+ yr)		-
VCPH-160	-23.0838	118.6219	04/05/2022	Gorge/ Gully	Gorge	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Extensive Outcropping	BIF	Clay Loam	Scarce	None	0	1	None Discernible	Old (6+ yr)		-

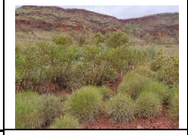
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-161	-23.0889	118.9101	04/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Negligible	-	Sandy Loam	Many Small Patches	Prone to Flooding	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-162	-23.0896	118.9138	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-163	-23.0994	118.9219	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-164	-23.1018	118.9203	04/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-165	-23.1009	118.9105	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-166	-23.1007	118.9013	04/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Large Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Moderate Outcropping	BIF	Silty Loam	Many Large Patches	Prone to Flooding	2	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-167	-23.1047	118.9028	04/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Small Rocks (11-20cm)	Scarce	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-168	-23.0962	118.8878	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-169	-23.0943	118.8738	04/05/2022	Undulating Low Hills	Undulating Low Hills	South	Low	Pebbles (5-10cm)	Scarce	None Discernible	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Scarce	None	0	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-170	-23.0574	118.6345	04/05/2022	Gorge/ Gully	Gorge	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-

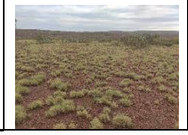
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-171	-23.0571	118.6769	04/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-172	-23.0442	118.6837	04/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-173	-23.0236	118.6978	05/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Gravel (1-4cm)	Many Large Patches	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Large Patches	Prone to Flooding	0	0.8	Road/ Access Track	Old (6+ yr)		-
VCPH-174	-23.0383	118.6805	05/05/2022	Hardpan Plain	Sandy/ Stony Plain	Flat	Flat	Gravel (1-4cm)	Many Small Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Flooding	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-175	-23.0197	118.8665	06/05/2022	Stony Plain	Stony Plain	North	Low	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.6	Mining Exploration	Old (6+ yr)		-
VCPH-176	-22.9062	118.7242	26/05/2022	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Pebbles (5-10cm)	Many Small Patches	Many Small Patches	*Acacia* Shrubland, Eucalypt Woodland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	Prone to Pooling	0	0.6	Weed Invasion	Old (6+ yr)		-
VCPH-177	-23.0545	118.8860	25/05/2022	Minor Drainage Line	Minor Drainage Line	West	Low	Gravel (1-4cm)	Scarce	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	CID	Clay Loam	Scarce	Prone to Pooling	1	0.8	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-178	-23.0977	118.7020	26/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Scarce	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-179	-23.0427	118.6814	26/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Flooding	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-180	-23.0133	118.6869	26/05/2022	Gorge/ Gully	Gully	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Extensive Outcropping	Conglomerate	Clay Loam	Scarce	Scarce	0	1	None Discernible	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-181	-23.0901	118.7062	26/05/2022	**Breakaway/ Cliff**	Breakaway	North / East	Mode rate	Large Rocks (21-60cm)	Scarce	Scarce	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	Moderate Outcropping	BIF	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-182	**-23.0969**	**118.7851**	**26/05/2022**	**Hardpan Plain**	**Hardpan Plain**	**Flat**	**Flat**	**Negligible**	**Evenly Spread**	**Few Small Patches**	**Mulga Woodland, Tussock Grassland**	**Negligible**	**-**	**Clay Loam**	**Evenly Spread**	**Prone to Flooding**	**0**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-183	**-23.0857**	**118.6830**	**26/05/2022**	**Stony Plain**	**Stony Plain**	**Sout h**	**Low**	**Pebbles (5-10cm)**	**Scarce**	**Few Small Patches**	***Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Negligible**	**-**	**Clay Loam**	**Scarce**	**None**	**0**	**0.8**	**None Discernible**	**Moderate (3 to 5 yr)**		-
VCPH-184	**-23.0236**	**118.8872**	**26/05/2022**	**Drainage Area/ Floodplain**	**Drainage Area/ Floodplain**	**Nort h**	**Low**	**Pebbles (5-10cm)**	**Few Small Patches**	**Few Small Patches**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Minor Outcroppin g**	**BIF**	**Clay Loam**	**Few Small Patches**	**Prone to Flooding**	**1**	**0.8**	**None Discernible**	**Old (6+ yr)**		-
VCPH-185	**-23.0261**	**118.8710**	**26/05/2022**	**Gorge/ Gully**	**Gully**	**Nort h**	**Mod erate**	**Pebbles (5-10cm)**	**Scarce**	**Few Small Patches**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Major Outcroppin g**	**BIF**	**Clay Loam**	**Scarce**	**None**	**3**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-186	**-23.0269**	**118.8513**	**26/05/2022**	**Undulating Low Hills**	**Undulating Low Hills**	**East**	**Low**	**Pebbles (5-10cm)**	**Scarce**	**Scarce**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Limited Outcroppin g**	**CID**	**Clay Loam**	**Scarce**	**None**	**4**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-187	**-23.0788**	**118.8579**	**26/05/2022**	**Drainage Area/ Floodplain**	**Stony Plain**	**Flat**	**Flat**	**Gravel (1-4cm)**	**Evenly Spread**	**Few Small Patches**	**Mulga Woodland**	**Negligible**	**-**	**Clay Loam**	**Evenly Spread**	**None**	**0**	**0.8**	**Cattle Grazing**	**Old (6+ yr)**		-
VCPH-188	**-22.8818**	**118.8084**	**26/05/2022**	**Stony Plain**	**Stony Plain**	**Flat**	**Flat**	**Gravel (1-4cm)**	**Few Small Patches**	**Few Small Patches**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Negligible**	**-**	**Clay Loam**	**Few Small Patches**	**None**	**0**	**0.8**	**Mining Exploration**	**Moderate (3 to 5 yr)**		-
VCPH-189	**-22.8095**	**118.7112**	**27/05/2022**	**Breakaway/ Cliff**	**Breakaway**	**Sout h**	**Stee p**	**Large Rocks (21-60cm)**	**Few Small Patches**	**Many Small Patches**	***Acacia* Shrubland, *Spinifex* Hummock Grassland**	**Moderate Outcroppin g**	**BIF**	**Sandy Loam**	**Few Small Patches**	**None**	**0**	**1**	**None Discernible**	**Old (6+ yr)**		-
VCPH-190	**-22.7357**	**118.7097**	**27/05/2022**	**Stony Plain**	**Stony Plain**	**Flat**	**Flat**	**Pebbles (5-10cm)**	**Few Small Patches**	**Scarce**	**Scattered Eucalypts, *Spinifex* Hummock Grassland**	**Negligible**	**-**	**Sandy Clay Loam**	**Few Small Patches**	**None**	**0**	**0.8**	**Frequent Fire**	**Old (6+ yr)**		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-191	-22.7339	118.7098	27/05/2022	Mulga Woodland	Medium Drainage Line	Flat	Flat	Negligible	Many Large Patches	Many Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Many Large Patches	Prone to Pooling	0	0.8	Frequent Fire	Old (6+ yr)		-
VCPH-192	-22.9032	118.7439	10/04/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Many Large Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Many Large Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-193	-23.0465	118.9035	27/05/2022	Gorge/ Gully	Gorge	South	Steep	Large Rocks (21-60cm)	Few Small Patches	Many Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-194	-23.0512	118.9018	27/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Small Rocks (11-20cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Moderate Outcropping	Conglomerate	Sandy Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-195	-23.0349	118.6186	27/05/2022	Gorge/ Gully	Gorge	North	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	Conglomerate	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-196	-23.0499	118.9026	27/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	South	Moderate	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-197	-22.8052	118.6949	27/05/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	North	Steep	Large Rocks (21-60cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Moderate Outcropping	BIF	Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-198	-22.7967	118.6913	27/05/2022	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	North	Steep	Large Rocks (21-60cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Major Outcropping	BIF	Clay Loam	None Discernible	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-199	-22.8981	118.7781	27/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-200	-23.0733	118.6925	27/05/2022	Breakaway/ Cliff	Breakaway	South	Cliff	Boulders (>61cm)	None Discernible	Few Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Clay Loam	None Discernible	None	5	0.8	Mining Exploration	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-201	-23.0885	118.7284	27/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-202	-22.7272	118.6606	27/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-203	-22.7335	118.6680	27/05/2022	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-204	-22.7501	118.6955	27/05/2022	Undulating Low Hills	Undulating Low Hills	West	Low	Small Rocks (11-20cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-205	-22.7611	118.6981	27/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-206	-22.7829	118.6941	27/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-207	-23.0229	118.8673	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-208	-23.0238	118.8667	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-209	-23.0276	118.8673	28/05/2022	Gorge/ Gully	Gorge	North	Steep	Large Rocks (21-60cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Major Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-210	-23.0261	118.8689	28/05/2022	Hillcrest/ Hillslope	Undulating Low Hills	North	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Limited Outcropping	BIF	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

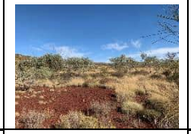
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-211	-23.0246	118.8654	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-212	-23.0237	118.8644	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-213	-23.0240	118.8613	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-214	-23.0240	118.8594	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-215	-23.0819	118.8926	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-216	-23.0206	118.8637	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-217	-23.0790	118.8718	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-218	-23.1008	118.8129	28/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-219	-23.0780	118.8836	28/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Gravel (1-4cm)	Many Small Patches	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Many Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-220	-23.1026	118.8023	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-

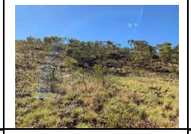
Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-221	-23.0712	118.8543	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-222	-23.0896	118.8480	28/05/2022	Stony Plain	Hardpan Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Tussock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-223	-23.0950	118.8354	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-224	-23.0885	118.7918	28/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-225	-23.0835	118.8338	28/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Road/ Access Track	Moderate (3 to 5 yr)		-
VCPH-226	-23.0205	118.8846	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-227	-23.0214	118.8836	28/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-228	-23.0263	118.8979	28/05/2022	Gorge/ Gully	Gully	North	Low	Gravel (1-4cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Minor Outcropping	BIF	Clay Loam	Scarce	None	4	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-229	-23.0290	118.8980	28/05/2022	Hillcrest/ Hillslope	Hillslope	North/ West	Very Steep	Boulders (>61cm)	None Discernible	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Extensive Outcropping	BIF	Clay Loam	None Discernible	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-230	-23.0196	118.8984	28/05/2022	Stony Plain	Stony Plain	North	Low	Gravel (1-4cm)	Many Small Patches	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Many Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-231	-23.1031	118.7768	28/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-232	-23.1002	118.7854	26/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Evenly Spread	Prone to Flooding	0	1	None Discernible	Old (6+ yr)		-
VCPH-233	-23.0195	118.8878	28/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-234	-23.0160	118.8754	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-235	-23.0228	118.8554	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-236	-23.0247	118.8557	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-237	-23.0254	118.8544	29/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Eucalypt Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	Prone to Pooling	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-238	-23.0258	118.8530	29/05/2022	Stony Plain	Undulating Low Hills	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-239	-23.0582	118.8841	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-
VCPH-240	-23.0652	118.8902	29/05/2022	Stony Plain	Stony Plain	Flat	Low	Pebbles (5-10cm)	Few Small Patches	Scarce	*Acacia* Shrubland, Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	0.8	Frequent Fire	Moderate (3 to 5 yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-241	-23.0679	118.8918	29/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Few Small Patches	Few Small Patches	*Acacia* Shrubland, Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Sandy Clay Loam	Few Small Patches	None	0	1	None Discernible	Old (6+ yr)		-
VCPH-242	-23.1009	118.7020	29/05/2022	Breakaway/ Cliff	Breakaway	North	Moderate	Boulders (>61cm)	Scarce	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Moderate Outcropping	CID	Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-243	-23.0274	118.6893	29/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Medium Heavy Clay	Evenly Spread	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-244	-23.0879	118.7670	29/05/2022	Cleared/ Disturbed	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Scarce	*Acacia* Shrubland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.6	Mining Exploration	Old (6+ yr)		-
VCPH-245	-23.0839	118.7482	29/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	Tussock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-246	-23.0778	118.7325	29/05/2022	Stony Plain	Stony Plain	Flat	Flat	Pebbles (5-10cm)	Scarce	Few Small Patches	Tussock Grassland, *Acacia* Shrubland	Negligible	-	Clay Loam	Scarce	None	0	0.8	None Discernible	Moderate (3 to 5 yr)		-
VCPH-247	-23.0823	118.7317	29/05/2022	Hardpan Plain	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Tussock Grassland	Negligible	-	Medium Heavy Clay	Evenly Spread	None	0	0.8	Cattle Grazing	Old (6+ yr)		-
VCPH-248	-23.0805	118.7331	29/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-249	-23.0859	118.7305	27/05/2022	Mulga Woodland	Hardpan Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	Mulga Woodland	Negligible	-	Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VCPH-250	-23.0884	118.7335	29/05/2022	Mulga Woodland	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Large Patches	Few Small Patches	Mulga Woodland, Tussock Grassland	Negligible	-	Clay Loam	Few Large Patches	None	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VCPH-251	-23.0516	118.8597	30/05/2022	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	None	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-252	-23.0554	118.8719	30/05/2022	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Scarce	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	Prone to Flooding	0	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VCPH-253	-23.0567	118.8769	30/05/2022	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Few Small Patches	Few Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland	Negligible	-	Clay Loam	Few Small Patches	None	1	0.6	Frequent Fire	Recent (0 to 2 yr)		-
VPIH-01	-22.7640	118.5966	11/11/2021	Drainage Area/ Floodplain	Sandy/ Stony Plain	Flat	Flat	Negligible	Evenly Spread	Many Large Patches	*Acacia* Shrubland, Scattered Eucalypts, Tussock Grassland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-02	-22.7449	118.5839	12/11/2021	Gorge/ Gully	Gorge	Sout h/ East	Mod erate	Boulders (>61cm)	Few Large Patches	Many Large Patches	Scattered Eucalypts	Extensive Outcroppin g	BIF	Clay Loam	Few Large Patches	Prone to Pooling	10	1	None Discernible	Old (6+ yr)		-
VPIH-03	-22.7756	118.5850	12/11/2021	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Negligible	Evenly Spread	Many Small Patches	Eucalypt Woodland, Tussock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-04	-22.7751	118.6330	12/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-05	-22.7208	118.6935	12/11/2021	Gorge/ Gully	Gully	Nort h	Mod erate	Small Rocks (11-20cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Eucalypt Woodland	Minor Outcroppin g	BIF	Silty Clay Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-06	-22.8029	118.7529	12/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Tussock Grassland, *Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-07	-22.7703	118.7010	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VPIH-08	-22.7821	118.6602	13/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	*Spinifex* Hummock Grassland, Tussock Grassland, *Acacia* Shrubland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-09	-22.7864	118.5806	13/11/2021	Gorge/ Gully	Gully	Sout h/ East	Mod erate	Boulders (>61cm)	Scarce	Many Small Patches	Eucalypt Woodland, *Spinifex* Hummock Grassland	Major Outcroppin g	BIF	Clay Loam	Scarce	Scarce	3	0.8	None Discernible	Old (6+ yr)		-
VPIH-10	-22.7720	118.6083	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-11	-22.8006	118.6525	13/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Negligible	Evenly Spread	Few Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-12	-22.7474	118.6760	24/11/2021	Hardpan Plain	Hardpan Plain	Flat	Flat	Pebbles (5-10cm)	Many Large Patches	Few Large Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Negligible		Clay Loam	Many Large Patches	None	0	0.8	Road/ Access Track	Old (6+ yr)		-
VPIH-13	-22.7472	118.6515	13/11/2021	Drainage Area/ Floodplain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-14	-22.7734	118.7467	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Tussock Grassland,*Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-15	-22.7482	118.6333	14/11/2021	Gorge/ Gully	Gully	Sout h/ East	Stee p	Large Rocks (21-60cm)	Scarce	Scarce	Eucalypt Woodland, Tussock Grassland	Moderate Outcroppin g	BIF	Clay Loam	Scarce	Scarce	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-16	-22.7479	118.6429	13/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Many Small Patches	*Spinifex* Hummock Grassland, *Acacia* Shrubland	Negligible		Sandy Clay Loam	Evenly Spread	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-17	-22.7661	118.5847	24/11/2021	Medium Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Pebbles (5-10cm)	Evenly Spread	Few Small Patches	Eucalypt Woodland, Tussock Grassland	Negligible		Clay Loam	Evenly Spread	Prone to Flooding	6	0.8	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VPIH-18	-22.7511	118.6809	24/11/2021	Medium Drainage Line	Medium Drainage Line	Flat	Flat	Small Rocks (11-20cm)	Many Small Patches	Many Small Patches	Scattered Eucalypts, *Spinifex* Hummock Grassland, Tussock Grassland	Minor Outcropping	BIF	Sandy Clay Loam	Many Small Patches	Prone to Flooding	5	0.6	None Discernible	Old (6+ yr)		-
VPIH-19	-22.8064	118.7418	23/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	*Acacia* Shrubland, Tussock Grassland, *Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-
VPIH-20	-22.7405	118.5952	25/11/2021	Gorge/ Gully	Gorge	South	Steep	Negligible	Scarce	Few Small Patches	-	Extensive Outcropping	BIF	Clay Loam	Scarce	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-
VPIH-21	-22.7507	118.6042	25/11/2021	Gorge/ Gully	Gully	South	Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts, Tussock Grassland	Major Outcropping	BIF	Silty Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-22	-22.7763	118.6143	25/11/2021	Gorge/ Gully	Gully	West	Moderate	Large Rocks (21-60cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Moderate Outcropping	BIF	Silty Clay Loam	Scarce	None	0	0.6	None Discernible	Moderate (3 to 5 yr)		-
VPIH-23	-22.7382	118.6259	27/11/2021	Gorge/ Gully	Gully	East	Steep	Boulders (>61cm)	Scarce	Many Small Patches	Tussock Grassland, *Spinifex* Hummock Grassland, Scattered Eucalypts, *Acacia* Shrubland	Major Outcropping	BIF	Silty Loam	Scarce	Scarce	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-24	-22.7953	118.6074	27/11/2021	Gorge/ Gully	Gully	East	Steep	Boulders (>61cm)	Scarce	Few Small Patches	*Spinifex* Hummock Grassland, Scattered Eucalypts	Major Outcropping	BIF	Silty Loam	Scarce	None	0	0.8	None Discernible	Old (6+ yr)		-
VPIH-25	-22.8137	118.5848	29/11/2021	Gorge/ Gully	Gorge	North	Steep	Boulders (>61cm)	Few Small Patches	Many Large Patches	-	Extensive Outcropping	BIF	Clay Loam	Few Small Patches	Prone to Pooling	0	1	None Discernible	Old (6+ yr)		-
VPIH-26	-22.8093	118.7542	25/11/2021	Stony Plain	Stony Plain	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Few Small Patches	Mulga Woodland, *Spinifex* Hummock Grassland	Negligible		Silty Clay Loam	Evenly Spread	None	0	0.6	Road/ Access Track	Old (6+ yr)		-

Site ID	Location		Date	Habitat type	Landform	Aspect	Slope	Ground cover (%)				Outcropping		Soil		Water presence	Hollow count	Veg condition	Disturbances	Time since last fire (years)	Photo	Notes
	Latitude	Longitude						Rocks	Bare soil	Leaf litter	Perennial vegetation	Extent	Rock type	Type	Availablility							
VYAN-31	-22.7864	119.1484	15/05/2022	Major Drainage Line	Major Drainage Line	Flat	Flat	Gravel (1-4cm)	Evenly Spread	Evenly Spread	Eucalypt Woodland	Negligible		Clay Loam	Evenly Spread	Permanent	20	1	Dewatering	Old (6+ yr)		-
VYAN-41	-22.7791	119.1446	16/05/2022	Hillcrest/ Hillslope	Hillslope	North	Low	Gravel (1-4cm)	Scarce	Scarce	*Spinifex* Hummock Grassland	Limited Outcropping	BIF	Clay Loam	Scarce	None	0	1	Mining Dust/Noise	Old (6+ yr)		-

Appendix D – Fauna Species Recorded During the Current Survey

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Birds					
Acanthizidae					
Acanthiza uropygialis	Chestnut-rumped thornbill				•
Acanthiza apicalis	Inland thornbill	•			•
Gerygone fusca	Western gerygone				•
Smicrornis brevirostris	Weebill	•			•
Accipitridae					
Aquila audax	Wedge-tailed eagle			•	
Elanus caeruleus subsp. axillaris	Black-shouldered kite				•
Haliastur sphenurus	Whistling kite				•
Lophoictinia isura	Square-tailed kite				•
Hamirostra melanosternon	Black-breasted buzzard				•
Milvus migrans	Black kite				•
Aegothelidae					
Aegotheles cristatus	Australian owlet-nightjar	•			•
Alaudidae					
Mirafra javanica	Horsfield's bushlark				•
Alcedinidae					
Dacelo leachii	Blue-winged kookaburra	•			•
Todiramphus pyrrhopygius	Red-backed kingfisher	•			•
Todiramphus sanctus	Sacred kingfisher				•
Anatitdae					
Anas gracilis	Grey teal	•			•
Artamidae					
Artamus cinereus	Black-faced woodswallow				•
Artamus minor	Little woodswallow				•
Artamus personatus	Masked woodswallow				•
Cracticus tibicen	Australian Magpie	•		•	•
Burhinidae					
Burhinus grallarius	Bush stone-curlew	•			
Cacatuidae					
Cacatua sanguinea	Little corella	•			•
Cacatua roseicapilla	Galah	•			•
Nymphicus hollandicus	Cockatiel				•
Campephagidae					
Coracina maxima	Ground cuckoo-shrike				•
Coracina novaehollandiae	Black-faced cuckoo-shrike				•

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Caprimulgidae					
Eurostopodus argus	Spotted nightjar	•			
Columbidae					
Geopelia cuneata	Diamond dove				•
Geopelia placida	Peaceful dove				•
Geophaps plumifera	Spinifex pigeon				•
Ocyphaps lophotes	Crested pigeon			•	•
Corvidae					
Corvus bennetti	Little crow				•
Corvus orru	Torresian crow	•		•	•
Cracticidae					
Cracticus nigrogularis	Pied butcherbird	•		•	•
Cracticus torquatus	Grey butcherbird	•			•
Cuculidae					
Chrysococcyx basalis	Horsfield's bronze cuckoo	•			
Chrysococcyx osculans	Black-eared cuckoo	•			
Cacomantis pallidus	Pallid cuckoo	•			•
Dicaeidae					
Dicaeum hirundinaceum	Mistletoe bird				•
Estrildidae					
Emblema pictum	Painted finch	•			•
Taeniopygia guttata	Zebra finch				•
Falconidae					
Falco berigora	Brown falcon	•			•
Falco cenchroides	Nankeen kestrel				•
Falco longipennis	Australian hobby				•
Locustellidae					
Cincloramphus mathewsi	Rufous songlark			•	•
Eremiornis carteri	Spinifexbird	•			•
Maluridae					
Amytornis striatus	Striated grasswren				•
Malurus assimilis subsp. assimilis	Purple-backed fairy-wren	•			•
Malurus leucopterus	White-winged fairy-wren	•			•
Stipiturus ruficeps	Rufous-crowned emu-wren	•			
Meliphagidae					
Acanthagenys rufogularis	Spiny-cheeked honeyeater	•			•
Epthianura tricolor	Crimson chat				•

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Gavicalis virescens subsp. virescens	Singing honeyeater	•		•	•
Lichmera indistincta	Brown honeyeater				•
Manorina flavigula	Yellow-throated miner				•
Ptilotula keartlandi	Grey-headed honeyeater	•			•
Ptilotula penicillata	White-plumed honeyeater				•
Meropidae					
Merops ornatus	Rainbow bee-eater				•
Oreoicidae					
Oreoica gutturalis	Crested bellbird	•			•
Otididae					
Ardeotis australis	Australian bustard				•
Pachycephalidae					
Colluricincla harmonica	Grey shrike-thrush			•	•
Pachycephala rufiventris	Rufous whistler	•			•
Pardalotidae					
Pardalotus rubricatus	Red-browed pardalote				•
Petroicidae					
Melanodryas cucullata	Hooded robin	•			•
Petroica goodenovii	Red-capped robin				•
Phasianidae					
Synoicus ypsilophora	Brown quail	•			•
Pomatostomidae					
Pomatostomus superciliosus	White-browed babbler				•
Pomatostomus temporalis	Grey-crowned babbler				•
Psittacidae					
Barnardius zonarius	Australian ringneck/ Port Lincoln parrot				•
Melopsittacus undulatus	Budgerigar	•			•
Ptilinorhynchidae					
Ptilonorhynchus maculatus subsp. guttatus	Western bowerbird				•
Rhipiduridae					
Rhipidura albiscapa	Grey fantail				•
Rhipidura leucophrys	Willie wagtail	•		•	•
Strigidae					
Ninox boobook	Boobook owl	•			•
Ninox connivens	Barking owl	•			
Turnicidae					
Turnix velox	Little button quail	•		•	•

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Tytonidae					
Tyto javanica	Eastern barn owl	•			
Mammals					
Bovidae					
Bos taurus	European cattle			•	•
Canidae					
Canis familiaris	Dingo, dog			•	•
Dasyuridae					
Ningaui timealeyi	Pilbara ningaui			•	
Pseudomys chapmani	Western pebble-mound mouse				•
Pseudantechinus woolleyae	Woolley's pseudantechinus			•	
Felidae					
Felis catus	Domestic cat			•	•
Emballonuridae					
Taphozous georgianus	Common sheath-tailed bat				•
Leporidae					
Oryctolagus cuniculus	European rabbit				•
Macropodidae					
Osphranter robustus	Euro, biggada			•	•
Osphranter rufus	Red kangaroo			•	•
Petrogale rothschildi	Rothschild's rock-wallaby			•	•
Megadermatidae					
Macroderma gigas	Ghost bat **– Vulnerable***		•		
Molossidae					
Austronomus australis	White-striped free-tailed bat		•		
Chaerephon jobensis colonicus	Greater northern free-tailed bat		•		
Ozimops lumsdenae	Northern free-tailed bat		•		
Muridae					
Zyzomys argurus	Common rock-rat			•	
Rhinonycteridae					
Rhinonicteris aurantia Pilbara form	Pilbara leaf-nosed bat **- Vulnerable**		•		
Tachyglossidae					
Tachyglossus aculeatus subsp. acanthion	Short-beaked echidna			•	
Vespertilionidae					
Chalinolobus gouldii	Gould's wattled bat		•		
Nyctophilus geoffroyi subsp. geoffroyi	Lesser long-eared bat		•		
Scotorepens greyii	Little broad-nosed bat		•		

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Vespadelus finlaysoni	Finlayson's cave-bat		•		•
Reptiles					
Agamidae					
Ctenophorus caudicinctus	Western ring-tailed dragon				•
Ctenophorus isolepis	Central military dragon				•
Gowidon longirostris	Long-nosed dragon			•	•
Pogona minor subsp. minor	Dwarf bearded dragon				•
Diplodactylidae					
Oedura fimbria	Western marbled velvet gecko				•
Elapidae					
Demansia psammophis subsp. cupreiceps	Yellow-faced whipsnake				•
Furina ornata	Moon snake				•
Pseudechis australis	Mulga snake				•
Pseudonaja mengdeni	Western brown snake				•
Vermicella snelli	Pilbara bandy bandy				•
Gekkonidae					
Heteronotia binoei	Binoe’s gecko				•
Myobatrachidae					
Pseudophryne douglasi	Gorge toadlet				•
Pelodryadidae					
Litoria rubella	Little red tree frog				•
Lialis burtonis	Burton's legless lizard				•
Pythonidae					
Antaresia childreni	Children’s python				•
*Liasis olivaceus subsp. barroni**	Pilbara olive python				•
Scincidae					
Cryptoblepharus ustulatus	Russet snake-eyed skink				•
Ctenotus inornatus	-				•
Ctenotus pantherinus	Leopard skink				•
Ctenotus rubicundus	Ruddy ctenotus				•
Lerista flammicauda	Pilbara flame-tailed slider				•
Menetia greyii	Common dwarf skink				•
Varanidae					
Varanus acanthurus	Spiny-tailed goanna			•	
Varanus giganteus	Perentie			•	
Varanus gouldii	Bungarra			•	

Scientific name	Vernacular	Sampling Method			
		Acoustic	Ultrasonic	Camera Trap	Opp/ Targeted
Varanus hamersleyensis	Southern Pilbara rock goanna				•
Varanus tristis	Racehorse goanna			•	•
Total		**39**	**9**	**7**	**54**

* Located just outside Study Area

Appendix E – Night Parrot Acoustic Analysis Report

Results of acoustic surveys conducted for the Night Parrot (*Pezoporus occidentalis*) at Central Pilbara Hub – April/May 2022

Report to:

Biologic Environmental Survey

Prepared by:

Nigel Jackett

Adaptive NRM

18 July 2022

1. Summary

During April and May 2022, autonomous recording units (ARUs) were deployed at Central Pilbara Hub, 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).

Biologic Environmental Survey conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in April and May 2022. Thirteen Song Meter Mini (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across 24 sites and recorded a combined total of 206 nights of data (Table 1). The analysed dataset comprised 2,289 sound files (wav format) totalling 366.5 GB. Each unit recorded continuously from sunset until sunrise (approx. 12 hours).

Table 1. Bioacoustic recordings analysed from the Central Pilbara Hub surveys

Site	Recording start date (PM)	Recording end date (AM)	Total recording nights	Nights with calm conditions
VCPH-01	05/04/22	11/04/22	6	6
VCPH-02	05/04/22	11/04/22	6	6
VCPH-04	05/04/22	06/04/22	1	1
VCPH-05	05/04/22	11/04/22	6	6
VCPH-06	05/04/22	11/04/22	6	6
VCPH-07	05/04/22	11/04/22	6	5
VCPH-08	05/04/22	11/04/22	6	4
VCPH-09	05/04/22	11/04/22	6	6
VCPH-11	05/04/22	11/04/22	6	6
VCPH-19	06/04/22	12/04/22	6	6
VCPH-20	07/04/22	13/04/22	6	6
VCPH-22	07/04/22	13/04/22	6	6
VCPH-50	11/04/22	28/04/22	17	15
VCPH-52	11/04/22	28/04/22	17	16
VCPH-54	11/04/22	16/04/22	5	5
VCPH-56	11/04/22	29/04/22	18	17
VCPH-58	11/04/22	28/04/22	17	15
VCPH-60	11/04/22	25/04/22	14	14
VCPH-73	11/04/22	13/04/22	2	2
VCPH-73	30/04/22	06/05/22	6	6
VCPH-75	11/04/22	23/04/22	12	11
VCPH-77	11/04/22	28/04/22	17	16
VCPH-79*	11/04/22	11/04/22	0	0
VCPH-81	12/04/22	13/04/22	1	1
VCPH-175	06/05/22	19/05/22	13	12
* recordings end first evening		Total	206	194

3. Data analysis

The analysis was undertaken using the software Kaleidoscope Pro v5.4.2, 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 65,482 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis.

Recording conditions were considered good, with minimal noise interference from wind across most sites. Occasional noise interference from heavy machinery was detected at sites VCPH-20 and VCPH-22, and constant calls from *Uperoleia saxatilis* was detected at site VCPH-19. Noise interference at these sites may have masked any coinciding Night Parrot calls.

A total of 37 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

Jackett, N. A., Greatwich, B. R., Swann, G., & Boyle, A. (2017). A nesting record and vocalisations of the Night Parrot *Pezoporus occidentalis* from the East Murchison, Western Australia. *Australian Field Ornithology, 34*, 144–150.

Kearney, M. R., Porter, W. P., & Murphy, S. A. (2016). An estimate of the water budget for the endangered night parrot of Australia under recent and future climates. *Climate Change Responses, 3*, 14-31.

Leseberg, N. P., Murphy, S. A., Jackett, N. A., Greatwich, B. R., Brown, J., Hamilton, N., Joseph, L., & Watson, J. E. M. (2019). Descriptions of known vocalisations of the Night Parrot *Pezoporus occidentalis*. *Australian Field Ornithology*, 79-88.

Leseberg, N. P., Venables, W. N., Murphy, S. A., Jackett, N. A., & Watson, J. E. M. (2021). Accounting for both automated recording unit detection space and signal recognition performance in acoustic surveys: A protocol applied to the cryptic and critically endangered Night Parrot (*Pezoporus occidentalis*). *Austral Ecology*.

Murphy, S. A., Austin, J. J., Murphy, R. K., Silcock, J., Joseph, L., Garnett, S. T., Leseberg, N. P., Watson, J. E. M., & Burbidge, A. H. (2017a). Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. *Emu - Austral Ornithology, 117*(2), 107–113.

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 1 – Species detected during the analysis

Species	Site VCPH-																							
	1	2	4	5	6	7	8	9	11	19	20	22	50	52	54	56	58	60	73	75	77	79	81	175
Grey Teal *Anas gracilis*																			•					
Brown Quail *Coturnix ypsilophora*	•	•			•		•	•						•	•	•	•	•		•	•			
Black-eared Cuckoo *Chalcites osculans*						•										•	•		•					•
Horsfield's Bronze Cuckoo *Chalcites basalis*	•	•		•	•	•	•	•	•		•		•	•	•	•	•	•	•	•	•			•
Pallid Cuckoo *Heteroscenes pallidus*			•	•		•		•	•		•		•	•		•	•	•	•	•	•			•
Spotted Nightjar *Eurostopodus argus*		•		•	•								•	•							•			
Australian Owlet-nightjar *Aegotheles cristatus*	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•		•	•
Bush Stone-curlew *Burhinus grallarius*		•														•		•						
Little Buttonquail *Turnix velox*				•	•	•			•				•	•		•		•	•	•	•			•
Eastern Barn Owl *Tyto javanica*		•	•					•						•		•		•						
Barking Owl *Ninox connivens*	•																							
Boobook Owl *Ninox boobook*		•	•					•		•					•	•				•	•			
Blue-winged Kookaburra *Dacelo leachii*																								•
Red-backed Kingfisher *Todiramphus pyrrhopygius*		•							•				•				•			•				
Brown Falcon *Falco berigora*									•				•		•	•						•		
Galah *Eolophus roseicapilla*													•	•		•								
Little Corella *Cacatua sanguinea*																•								
Budgerigar *Melopsittacus undulatus*	•	•												•		•				•	•			
Rufous-crowned Emu-wren *Stipiturus ruficeps*																			•					

Species	Site VCPH-																							
	1	2	4	5	6	7	8	9	11	19	20	22	50	52	54	56	58	60	73	75	77	79	81	175
Purple-backed Fairywren *Malurus assimilis*																			•					
White-winged Fairywren *Malurus leucopterus*	•							•			•		•	•		•								
Spiny-cheeked Honeyeater *Acanthagenys rufogularis*		•			•		•				•		•	•	•	•		•	•	•	•	•		
Singing Honeyeater *Gavicalis virescens*		•			•		•		•		•		•	•	•	•			•	•		•		•
Grey-headed Honeyeater *Ptilotula keartlandi*					•																			•
Inland Thornbill *Acanthiza apicalis*																			•					
Weebill *Smicrornis brevirostris*																			•					
Crested Bellbird *Oreoica gutturalis*																			•			•		
Rufous Whistler *Pachycephala rufiventris*													•									•		
Grey Butcherbird *Cracticus torquatus*													•					•						
Pied Butcherbird *Cracticus nigrogularis*					•								•						•					•
Australian Magpie *Gymnorhina tibicen*						•							•			•	•	•						•
Willie Wagtail *Rhipidura leucophrys*		•			•	•	•	•					•	•	•	•	•	•	•	•	•	•	•	•
Torresian Crow *Corvus orru*																			•					
Hooded Robin *Melanodryas cucullata*		•						•						•										
Horsfield's Bush Lark *Mirafra javanica*														•		•								
Spinifexbird *Poodytes carteri*	•	•	•		•		•	•	•		•				•		•				•			•
Painted Finch *Emblema pictum*				•																				
Total	7	14	5	6	11	7	7	10	8	2	6	0	16	15	9	19	9	11	16	11	11	6	2	12

Results of acoustic surveys conducted for the Night Parrot (*Pezoporus occidentalis*) at Pineapple Hill

Report to:

Biologic Environmental Survey

Prepared by:

Nigel Jackett

Adaptive NRM

12 May 2022

1. Summary

During November 2021, autonomous recording units (ARUs) were deployed at Pineapple Hill, 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).

Biologic Environmental Survey conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in November 2021. Five Song Meter Mini (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across seven sites and recorded a combined total of 38.25 nights of data (Table 1). The analysed dataset comprised 421 sound files (wav format) totalling 133.6 GB. Each unit recorded continuously from sunset until sunrise (approx. 12 hours).

Table 1. Bioacoustic recordings analysed from the Pineapple Hill survey

Site	Recording start date (PM)	Recording end date (AM)	Total recording nights	Nights with calm conditions
VPIN-07	13/11/21	17/11/21	4	4
VPIN-08	13/11/21	21/11/21	8.25	8.25
VPIN-10	13/11/21	19/11/21	6	6
VPIN-13	13/11/21	24/11/21	11	11
VPIN-14	13/11/21	19/11/21	6	6
VPIN-19	24/11/21	26/11/21	2	2
VPIN-26	25/11/21	26/11/21	1	1
		Total	38.25	38.25

3. Data analysis

The analysis was undertaken using the software Kaleidoscope Pro v5.4.2, 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 46,385 Kaleidoscope detections were manually assessed for Night Parrot vocalisations. No calls attributable to Night Parrots were detected during the analysis.

The recordings were of excellent quality, with minimal interference from wind or insects. Site VPIN-08 had near-constant background water noise, which may have masked any Night Parrot vocalisations had they been recorded.

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

Jackett, N. A., Greatwich, B. R., Swann, G., & Boyle, A. (2017). A nesting record and vocalisations of the Night Parrot *Pezoporus occidentalis* from the East Murchison, Western Australia. *Australian Field Ornithology, 34*, 144–150.

Kearney, M. R., Porter, W. P., & Murphy, S. A. (2016). An estimate of the water budget for the endangered night parrot of Australia under recent and future climates. *Climate Change Responses, 3*, 14-31.

Leseberg, N. P., Murphy, S. A., Jackett, N. A., Greatwich, B. R., Brown, J., Hamilton, N., Joseph, L., & Watson, J. E. M. (2019). Descriptions of known vocalisations of the Night Parrot *Pezoporus occidentalis*. *Australian Field Ornithology*, 79-88.

Leseberg, N. P., Venables, W. N., Murphy, S. A., Jackett, N. A., & Watson, J. E. M. (2021). Accounting for both automated recording unit detection space and signal recognition performance in acoustic surveys: A protocol applied to the cryptic and critically endangered Night Parrot (*Pezoporus occidentalis*). *Austral Ecology*.

Murphy, S. A., Austin, J. J., Murphy, R. K., Silcock, J., Joseph, L., Garnett, S. T., Leseberg, N. P., Watson, J. E. M., & Burbidge, A. H. (2017a). Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. *Emu - Austral Ornithology, 117*(2), 107–113.

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 F – Records of Western Pebble Mound Mouse During Current Survey

Date	Latitude	Longitude	Observation	Habitat Type
25/11/2021	-22.7769	118.7186	Mound (inactive)	Stony Plain
8/04/2022	-22.8157	119.1440	Mound (active)	Cleared/ Disturbed
8/04/2022	-22.8155	119.1450	Mound (active)	Stony Plain
8/04/2022	-22.8151	119.1469	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8151	119.1467	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8149	119.1479	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8108	119.1462	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8827	118.7774	Mound (active)	Hillcrest/ Hillslope
8/04/2022	-22.8155	119.1445	Mound (recently inactive)	Stony Plain
8/04/2022	-22.8150	119.1466	Mound (recently inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8631	118.7863	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8481	118.7967	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8473	118.7923	Mound (active)	Stony Plain
10/04/2022	-22.8463	118.7856	Mound (active)	Stony Plain
10/04/2022	-22.8091	119.1482	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8635	118.7952	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8632	118.7947	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8591	118.7922	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8590	118.7867	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8590	118.7931	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8581	118.7901	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8499	118.7922	Mound (active)	Hillcrest/ Hillslope
10/04/2022	-22.8479	118.7880	Mound (active)	Stony Plain
10/04/2022	-22.8605	118.7854	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8465	118.7860	Mound (inactive)	Stony Plain
10/04/2022	-22.8663	118.7893	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8626	118.7861	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8589	118.7919	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8585	118.7875	Mound (inactive)	Hillcrest/ Hillslope
10/04/2022	-22.8498	118.7923	Mound (inactive)	Hillcrest/ Hillslope
11/04/2022	-23.0911	118.7179	Mound (inactive)	Hillcrest/ Hillslope
12/04/2022	-22.8659	118.7892	Mound (active)	Hillcrest/ Hillslope
12/04/2022	-22.8385	118.7555	Mound (active)	Hillcrest/ Hillslope
13/04/2022	-22.8480	118.7633	Mound (recently inactive)	Stony Plain
28/04/2022	-23.0441	118.8525	Mound (active)	Hillcrest/ Hillslope
28/04/2022	-23.0441	118.8530	Mound (inactive)	Hillcrest/ Hillslope
28/04/2022	-23.0438	118.8516	Mound (recently inactive)	Hillcrest/ Hillslope
29/04/2022	-23.0716	118.8183	Mound (active)	Hillcrest/ Hillslope
29/04/2022	-23.0547	118.8132	Mound (active)	Hillcrest/ Hillslope
29/04/2022	-22.9167	118.7860	Mound (active)	Stony Plain
29/04/2022	-22.8430	118.7467	Mound (recently inactive)	Hillcrest/ Hillslope
29/04/2022	-22.8381	118.7529	Mound (recently inactive)	Hillcrest/ Hillslope
30/04/2022	-23.0694	118.7792	Mound (active)	Stony Plain

Date	Latitude	Longitude	Observation	Habitat Type
30/04/2022	-23.0716	118.8183	Mound (inactive)	Hillcrest/ Hillslope
30/04/2022	-23.0601	118.7096	Mound (inactive)	Hillcrest/ Hillslope
30/04/2022	-22.8385	118.7549	Mound (inactive)	Hillcrest/ Hillslope
1/05/2022	-23.0474	118.9138	Mound (active)	Minor Drainage Line
1/05/2022	-23.0274	118.9141	Mound (inactive)	Hillcrest/ Hillslope
1/05/2022	-23.0268	118.9226	Mound (inactive)	Stony Plain
2/05/2022	-23.0177	118.6490	Mound (active)	Hillcrest/ Hillslope
2/05/2022	-23.0274	118.9141	Mound (inactive)	Hillcrest/ Hillslope
2/05/2022	-23.0695	118.8153	Mound (recently inactive)	Hillcrest/ Hillslope
3/05/2022	-23.0446	118.8656	Mound (active)	Stony Plain
3/05/2022	-23.0326	118.8378	Mound (active)	Hillcrest/ Hillslope
3/05/2022	-23.0639	118.6941	Mound (inactive)	Stony Plain
3/05/2022	-23.0438	118.8660	Mound (inactive)	Stony Plain
3/05/2022	-23.0325	118.8346	Mound (inactive)	Minor Drainage Line
3/05/2022	-23.0322	118.8377	Mound (inactive)	Stony Plain
3/05/2022	-23.0458	118.8649	Mound (recently inactive)	Minor Drainage Line
4/05/2022	-23.0837	118.6220	Mound (inactive)	Hillcrest/ Hillslope
4/05/2022	-23.0597	118.7096	Mound (recently inactive)	Hillcrest/ Hillslope
5/05/2022	-23.0159	118.6468	Mound (active)	Hillcrest/ Hillslope
5/05/2022	-23.0376	118.6548	Mound (inactive)	Hillcrest/ Hillslope
6/05/2022	-23.0328	118.8382	Mound (active)	Hillcrest/ Hillslope
16/05/2022	-22.7806	119.1444	Mound (recently inactive)	Hillcrest/ Hillslope
25/05/2022	-23.0608	118.8837	Mound (active)	Stony Plain
26/05/2022	-23.0226	118.8716	Mound (active)	Stony Plain
26/05/2022	-23.0259	118.8508	Mound (inactive)	Stony Plain
26/05/2022	-23.0237	118.8716	Mound (inactive)	Stony Plain
26/05/2022	-23.0227	118.8869	Mound (inactive)	Minor Drainage Line
26/05/2022	-23.0218	118.8713	Mound (inactive)	Stony Plain
26/05/2022	-23.0210	118.8711	Mound (inactive)	Stony Plain
26/05/2022	-23.0189	118.8710	Mound (inactive)	Stony Plain
26/05/2022	-23.0182	118.8712	Mound (inactive)	Minor Drainage Line
26/05/2022	-23.0877	118.7071	Mound (recently inactive)	Hillcrest/ Hillslope
26/05/2022	-23.0872	118.7009	Mound (recently inactive)	Hillcrest/ Hillslope
26/05/2022	-23.0870	118.7072	Mound (recently inactive)	Hillcrest/ Hillslope
26/05/2022	-23.0127	118.6859	Mound (recently inactive)	Hillcrest/ Hillslope
27/05/2022	-22.7990	118.6906	Mound (active)	Hillcrest/ Hillslope
28/05/2022	-23.0235	118.8633	Burrow (inactive)	Stony Plain
28/05/2022	-23.0244	118.8648	Mound (active)	Stony Plain
28/05/2022	-23.0242	118.8978	Mound (active)	Hillcrest/ Hillslope
28/05/2022	-23.0221	118.8981	Mound (active)	Stony Plain
28/05/2022	-23.0209	118.8985	Mound (active)	Stony Plain
28/05/2022	-23.0205	118.9045	Mound (active)	Stony Plain
28/05/2022	-23.0203	118.9041	Mound (active)	Stony Plain
28/05/2022	-23.0202	118.9041	Mound (active)	Stony Plain
28/05/2022	-23.0199	118.8984	Mound (active)	Stony Plain

Date	Latitude	Longitude	Observation	Habitat Type
28/05/2022	-23.0192	118.8983	Mound (active)	Minor Drainage Line
28/05/2022	-23.0187	118.8998	Mound (active)	Stony Plain
28/05/2022	-23.0184	118.8983	Mound (active)	Stony Plain
28/05/2022	-23.0174	118.8988	Mound (active)	Stony Plain
28/05/2022	-23.0196	118.8990	Mound (active)	Stony Plain
28/05/2022	-23.0216	118.9052	Mound (active)	Stony Plain
28/05/2022	-23.0212	118.9048	Mound (active)	Stony Plain
28/05/2022	-23.0209	118.9039	Mound (active)	Stony Plain
28/05/2022	-23.0208	118.9038	Mound (active)	Minor Drainage Line
28/05/2022	-23.0198	118.9015	Mound (active)	Stony Plain
28/05/2022	-23.0196	118.9000	Mound (active)	Stony Plain
28/05/2022	-23.0245	118.8648	Mound (inactive)	Stony Plain
28/05/2022	-23.0240	118.8611	Mound (inactive)	Minor Drainage Line
28/05/2022	-23.0240	118.8645	Mound (inactive)	Stony Plain
28/05/2022	-23.0239	118.8609	Mound (inactive)	Stony Plain
28/05/2022	-23.0237	118.8633	Mound (inactive)	Stony Plain
28/05/2022	-23.0236	118.8625	Mound (inactive)	Minor Drainage Line
28/05/2022	-23.0204	118.9021	Mound (inactive)	Stony Plain
28/05/2022	-23.0193	118.9026	Mound (inactive)	Stony Plain
28/05/2022	-23.0200	118.9025	Mound (inactive)	Stony Plain
28/05/2022	-23.0239	118.8622	Mound (recently inactive)	Stony Plain
28/05/2022	-23.0207	118.8637	Mound (recently inactive)	Stony Plain
28/05/2022	-23.0202	118.8647	Mound (recently inactive)	Stony Plain
29/05/2022	-23.1009	118.7020	Mound (active)	Hillcrest/ Hillslope
29/05/2022	-23.0984	118.7026	Mound (active)	Stony Plain
29/05/2022	-23.0651	118.8902	Mound (active)	Stony Plain
29/05/2022	-23.0650	118.8919	Mound (active)	Stony Plain
29/05/2022	-23.0645	118.8919	Mound (active)	Stony Plain
29/05/2022	-23.0587	118.8840	Mound (active)	Stony Plain
29/05/2022	-23.0583	118.8826	Mound (active)	Stony Plain
29/05/2022	-23.0556	118.8849	Mound (active)	Stony Plain
29/05/2022	-23.0264	118.8518	Mound (active)	Minor Drainage Line
29/05/2022	-23.0236	118.8556	Mound (active)	Stony Plain
29/05/2022	-23.0219	118.8846	Mound (active)	Stony Plain
29/05/2022	-23.0214	118.8840	Mound (active)	Stony Plain
29/05/2022	-23.0208	118.8849	Mound (active)	Stony Plain
29/05/2022	-23.0203	118.8870	Mound (active)	Stony Plain
29/05/2022	-23.0597	118.8836	Mound (inactive)	Stony Plain
29/05/2022	-23.0573	118.8828	Mound (inactive)	Stony Plain
29/05/2022	-23.0251	118.8556	Mound (inactive)	Stony Plain
29/05/2022	-23.0218	118.8873	Mound (inactive)	Drainage Area/ Floodplain
29/05/2022	-23.0208	118.8841	Mound (inactive)	Stony Plain
29/05/2022	-23.0198	118.8875	Mound (inactive)	Stony Plain
29/05/2022	-23.0214	118.8843	Mound (recently inactive)	Stony Plain
30/05/2022	-23.0245	118.8704	Mound (active)	Stony Plain

Date	Latitude	Longitude	Observation	Habitat Type
30/05/2022	-23.0257	118.8710	Mound (inactive)	Hillcrest/ Hillslope
30/05/2022	-23.0239	118.8698	Mound (inactive)	Stony Plain
30/05/2022	-23.0218	118.8681	Mound (recently inactive)	Stony Plain
30/05/2022	-23.0195	118.8663	Mound (recently inactive)	Stony Plain

Ministers North

Level 2 Vertebrate Fauna Survey

Biologic Environmental Survey

BHP Iron Ore Pty Ltd

October 2017

MINISTERS NORTH TWO SEASON LEVEL 2 VERTEBRATE FAUNA SURVEY

DOCUMENT STATUS				
Rev. No.	Author	Review / Approved for Issue	Approved for Issue to	
			Name	Date
1	Claire Brooks	Breanne Menezies Morgan O'Connell	Tanya Carroll	12/09/17
2	Chris Knuckey	Brad Durrant	Tanya Carroll	13/10/17
3	Brad Durrant	Morgan O'Connell	Tanya Carroll	25/10/17

Contents

Appendices

Tables

Plates

Figures

Executive Summary

BHP Iron Ore Pty Ltd (BHP Iron Ore) commissioned Biologic Environmental Survey (Biologic) to undertake a two season Level 2 vertebrate fauna survey within the Ministers North Study Area, tenement E47/628-1 (hereafter referred to as the Study Area). The Study Area is located approximately 90 km north west of the town of Newman in the Pilbara region of Western Australia, and covers an area of approximately 3028 hectares (ha).

The field surveys were undertaken from 15 – 26 October 2016 and 3 – 13 April 2017. Survey methods included targeted and nocturnal searches along transects; dry pitfalls and Elliott traps at seven (7) sites, with trapping at an additional three (3) sites following rain, SM2BAT+ recorders at 28 locations, motion cameras at 26 locations, and opportunistic sightings. Habitat assessments were conducted at every trapping site/ motion camera/ bat recorder/ nocturnal transect location, as well at standalone habitat assessment locations (for a total of 73 habitat assessments) according to BHP Iron Ore guidelines.

Based upon previous survey records, fauna databases, and current knowledge of species distributions and habitat preferences, approximately 319 fauna species are thought to potentially occur in the local area surrounding the Study Area (within approximately 40 km). Of these, 25 species are regarded as conservation significant (*i.e.* species listed under relevant state and federal legislation, by International Union for the Conservation of Nature [IUCN], by the Department of Biodiversity, Conservation and Attractions [DBCA]), or regarded as being of local significance.

The survey recorded 116 vertebrate fauna species from the Study Area, comprising 17 mammal species, 54 bird species, 43 reptile species, and two (2) amphibians. Two (2) conservation significant species have been recorded within the Study Area, comprising:

- Rainbow Bee-eater, *Merops ornatus* (Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act*) Migratory, Wildlife Conservation Act 1950 (*WC Act*) Schedule 5 – recorded from two sites during the current survey in suitable breeding habitat in the banks in Major Drainage Line habitat. A nest was found at one of these sites. Suitable foraging habitat exists throughout the Study Area; and
- Western Pebble-mound Mouse, *Pseudomys chapmani* (DBCA Priority 4) – The species was recorded on six occasions, including three direct captures and three records of active mounds. Four of the records were from the Hillcrest/ Hillslope habitat type and the remaining two were recorded from Minor Drainage Line habitat.

One locally significant species was recorded from the Study Area during the current survey, the Chocolate Wattled Bat (*Chalinolobus morio*). This species was recorded from two sites within Gorge/Gully and Major Drainage Line habitats.

An additional seven (7) species of conservation significant fauna are considered to potentially occur within the Study Area, based on previous survey records, fauna databases and habitats present; comprising:

- Ghost Bat, *Macroderma gigas* (*EPBC Act* Vulnerable, IUCN Vulnerable, *WC Act* Schedule 3) – recorded adjacent to the Study Area during a previous survey (Biologic 2010) and suitable foraging habitat is present in the Study Area;
- Pilbara Leaf-nosed Bat, *Rhinonicteris aurantia,* (*EPBC Act* Vulnerable, *WC Act* Schedule 3) – may possibly utilise a foraging range that extends over the Study Area;
- Barn Swallow, *Hirundo rustica* (*EPBC Act* Migratory, *WC Act* Schedule 5) – considered likely to occur occasionally, based on generalist habitat requirements;
- Peregrine Falcon, *Falco peregrinus* (*WC Act* Schedule 7) – may possibly occur occasionally, based on generalist feeding habitat requirements and the presence of potential breeding habitat along cliff faces in the Study Area;
- Fork-tailed Swift, *Apus pacificus* (*EPBC Act* Migratory, *WC Act* Schedule 5) – considered likely to occur occasionally in the skies above the Study Area;
- Pilbara Olive Python (*EPBC Act* Vulnerable, *WC Act* Schedule 3) – considered likely to occur in Gorge/Gully and Major Drainage Line habitats based on the species' habitat requirements and local area records; and
- Pilbara Flat-headed Blind Snake, *Anilios ganei* (DBCA Priority 1) – may possibly occur occasionally in any of the habitats throughout the Study Area.

Based on the habitat assessments conducted, the Study Area was classified into four (4) broad habitat types, with an additional unit mapped for 'Disturbed' areas. Habitats of greatest significance were Major Drainage Lines and Gorge/Gully habitats based on the conservation significant species that they potentially support. These habitats extend throughout the Study Area and the immediate surrounding area beyond the Study Area boundaries.

1 Introduction

BHP Iron Ore Pty Ltd (BHP Iron Ore) commissioned Biologic Environmental Survey (Biologic) to undertake a two season Level 2 vertebrate fauna survey within the Ministers North Study Area, tenement E47/628-1 (hereafter referred to as the Study Area). The Study Area is located approximately 90 km north west of the town of Newman in the Pilbara region of Western Australia (Figure 1.1), and covers an area of approximately 3028 hectares (ha).

The vertebrate fauna assessment will be used to inform future environmental approvals across the area, and this survey report is a general report not assessing any specific development proposed by BHP Iron Ore.

This report provides:

a) a contemporary review and assessment of:

1. Vertebrate fauna within the Study Area, based on consolidated data from all available surveys intercepting the Study Area;
2. The conservation values of fauna occurring (or likely to occur) in the Study Area based on state and federal legislation, threatened species lists, and international agreements;
3. Fauna habitats in the Study Area, and their significance, evaluated using BHP Iron Ore guidelines; and
4. Extent of fauna habitats in the Study Area (mapping), indicating areas of suitable habitat for the conservation significant species and locations of any significant habitat features (*e.g.* caves and waterbodies);

b) an inventory of:

5. Species recorded from the Study Area and those that are likely to occur in the area based on habitats present, previous fauna surveys and database results;
6. Characteristics of assessed habitats; and
7. Locations of conservation significant fauna reported within the Study Area.

500000 600000 700000 800000 900000 1000000

7700000 7600000 7500000 7400000

Port Operations
PORT HEDLAND
DAMPIER
SHAY GAP
MARBLE BAR
TOM PRICE
Yandi
Marillana
Mining Area C
Jinidi
South Flank
Mt Whaleback
NEWMAN
Jimblebar

Pindanland
Roebourne
Chichester
Hamersley
Ashburton
Fortescue
Rudall
Trainor
Augustus

Yandi
Ministers North
Mining Area C

Legend

- Pilbara Towns
- Major Roads
- Pilbara Rail
- Study Area

IBRA sub-region

- Ashburton
- Augustus
- Chichester
- Fortescue
- Hamersley
- Mackay
- McLarty
- Pindanland
- Roebourne
- Rudall
- Trainor

Mining locations

- Exploration
- Operations

N

1:1,600,000

0 25 50 100 km

biologic Environmental Survey

BHP Ministers North Project
Level 2 Vertebrate Fauna Survey
Fig. 1.1: Regional location and IBRA sub-region

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 02/08/2017

2 Environment

2.1 Climate

The Study Area is located within the Hamersley sub-region of the Pilbara bioregion (following Thackway and Cresswell 1995) (Figure 1.1). The region features a semi-desert to tropical climate, with rainfall occurring sporadically within either summer or winter, but mostly during the former season. Summer rainfall is a result of either tropical storms in the north or tropical cyclones that impact upon the coast and move inland. The winter rainfall is generally lighter and is the result of cold fronts moving north easterly across the state (Leighton 2004). The average annual rainfall ranges from about 200 to 350 mm, but there are significant fluctuations between years (Department of Water 2012) with up to 1200 mm falling in some locations in some years (McKenzie *et al.* 2009).

The climate of the region is semi-arid, hot and mostly dry, with an average annual rainfall of 317.8 mm at Newman Airport (BoM 2017). Most rainfall generally occurs in the summer wet season from December to June with occasional major rainfall events from tropical cyclones. Temperatures vary significantly throughout the year with average maximum summer temperatures reaching 35°C to 40°C and winter temperatures generally fluctuating between 22°C and 30°C.

Long-term climatic data is not available for Ministers North; however, the BoM weather station at Newman Airport (Station 007176, located 90 km south west of the Study Area) and Marillana (Station 5009, located 33 km north east of the Study Area) can be used as reference points for climatic observations in the Study Area. The average monthly temperatures at Newman from 2016 are plotted against the longer-term averages in Figure 2.1 below.

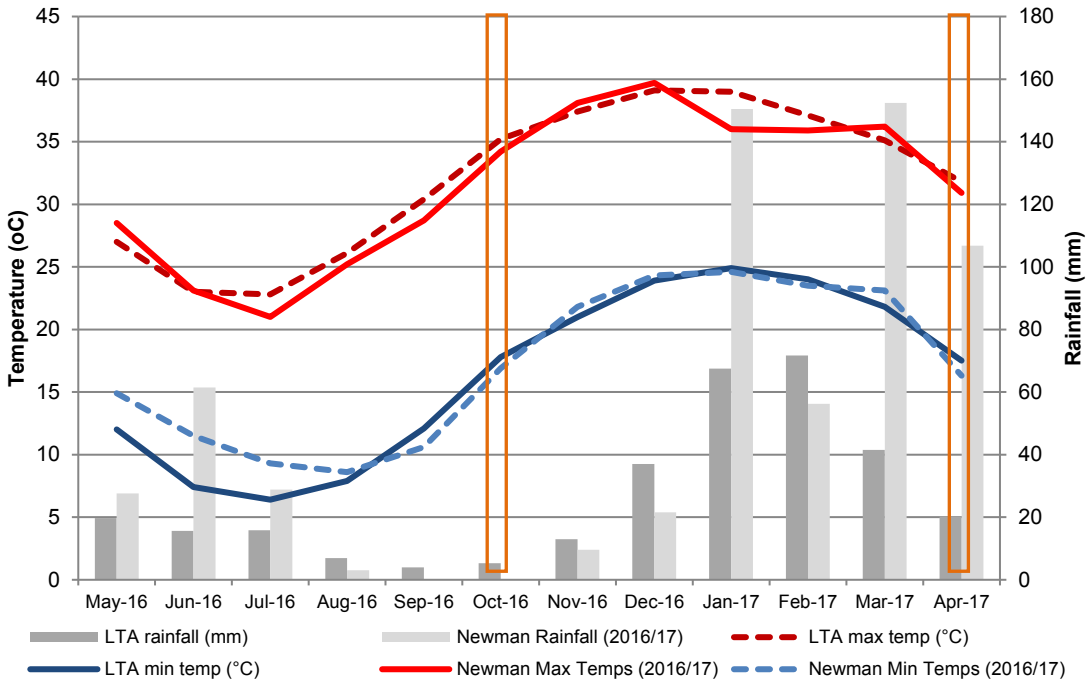


Figure 2.1: Climate data for Newman airport (BoM 2017), comparing long-term average (LTA) monthly rainfall (mm) and temperatures (°C) with conditions observed during the surveys (timing indicated by orange box).

2.1.1 Conditions during the surveys

The weather conditions during the first season dry survey (15 – 26 October 2016) were typical of that time of year, averaging around the long-term average for October of 35.2°C (BoM 2017). Figure 2.1 shows that there was no rainfall recorded in the month before or during the time of the first season survey. However, heavy rainfall in the summer months falling between the two surveys was well above the average for Newman with 152.4 mm of rain falling during March 2017, compared to the long-term average of 41.5 mm. Rainfall for April 2017 (106.8 mm) was also well above the long-term average of 20.2 mm. These months of heavy rainfall caused some access issues around the Study Area during the second season survey (3 – 13 April 2017). Maximum daily temperatures were as expected for the time of year during the second season survey, averaging 32.4°C.

2.2 Physical environment

The Study Area falls within the Hamersley sub-region, which forms the southern section of the Pilbara Craton (Kendrick 2001) (Figure 1.1) within the Pilbara biogeographic region as defined by the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Cresswell 1995). This sub-region is characterised by mountainous areas of Proterozoic sedimentary ranges (ironstone ranges) and plateaux dissected by gullies and gorges.

The Study Area is dominated by a plateau in the south west section, and a large, continuous river gorge in the south-east section of the Study Area, while the remaining Study Area is primarily low hill terrain dissected by minor drainage lines, gullies and gorges (Figure 2.2).

The vegetation of the sub-region is dominated by *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils on the ranges, and swathes of Mulga woodland over bunch

grasses on fine-textured soils (Kendrick 2001). Also within the Pilbara bioregion, the IBRA identifies River Red Gum (*Eucalyptus camaldulensis*) woodlands fringing drainage lines (Thackway and Cresswell 1995) and Mulga (formerly *Acacia aneura*) groves within the alluvial valley floors.

2.3 Vegetation

Beard (1980) broadly (1:1,000,000) mapped the major structural vegetation types of Western Australia. The Study Area is situated in the Hamersley Plateau in the Eremaean Botanical Province of Western Australia as per Beard (1975) who broadly mapped the area as ranges and valley plains. The most common vegetation associations within the Study Area were *Eucalyptus leucophloia* (Snappy Gum) and *Triodia wiseana* (hard Spinifex) tree steppe occurring on hills, and tall woodlands of *Eucalyptus camaldulensis* (River Red Gum), *Eucalyptus victrix* (Coolibah) and *Acacia aneura* (Mulga) along drainage lines and in groves within the valley floors (Beard 1980).

710000 711000 712000 713000 714000 715000 716000 717000 718000 719000 720000 721000 722000 723000

7478000 7477000 7476000 7475000 7474000 7473000 7472000 7471000

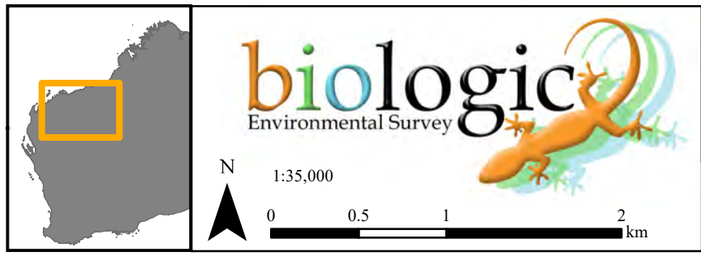
Yandicoogina Creek

Legend

- Study Area
- Pilbara Rail
- Pilbara Water Courses

Elevation (mAHD)

540.0 - 550.0 | 550.1 - 570.0 | 570.1 - 590.0 | 590.1 - 610.0 | 610.1 - 630.0 | 630.1 - 650.0 | 650.1 - 670.0 | 670.1 - 690.0 | 690.1 - 710.0 | 710.1 - 730.0 | 730.1 - 750.0 | 750.1 - 770.0 | 770.1 - 790.0 | 790.1 - 810.0 | 810.1 - 830.0 | 830.1 - 850.0 | 850.1 - 870.0 | 870.1 - 890.0 | 890.1 - 910.0 | 910.1 - 930.0



BHP Ministers North Project
Level 2 Vertebrate Fauna Survey

Fig. 2.2: Topography and drainage

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 12/10/2017

3 Methods

3.1 Compliance

The literature and database review, and field survey of the Study Area were carried out in a manner consistent with the Western Australian Environmental Protection Authority (EPA), Department of Biodiversity, Conservation and Attractions (DBCA), Department of the Environment (DoE), and BHP Iron Ore guidelines for the environmental surveying and reporting of fauna. A full list of guidance documents considered in the preparation of the survey approach can be found in Appendix A.

3.2 Database Review

Three online databases were searched to obtain information on species recorded or likely to occur in the local area surrounding the Study Area. These databases comprise of the DBCA NatureMap database, Atlas of Living Australia database, and the DoE Protected Matters Database (Table 3.1). All online databases were searched in 2017 using either a 20 km or 10 km radial search parameter from a co-ordinate in the middle of the Study Area (22° 49' 41" S, 119° 06' 26" E) depending on the database search limitations.

Table 3.1: Databases used for the review

Provider	Database	Date accessed	Data type
Department of Biodiversity, Conservation and Attractions (DBCA)	NatureMap	21 March 2017	All survey records uploaded to the DBCA fauna databases, including records from the Pilbara Biological Survey (McKenzie *et al.* 2009).
Atlas of Living Australia (ALA)	Atlas of Living Australia (ALA)	21 March 2017	All survey records uploaded in a 10 km radius from the Study Area centre point
Department of Environment (DoE)	Protected Matters Database Search Tool	21 March 2017	Likely occurrence of “matters of national environmental significance” based on regional habitat and bioclimatic modelling

3.3 Literature Review

A review of relevant publicly available literature and survey reports held by BHP Iron Ore within 10 km of the Study Area was undertaken in March 2017. The reports reviewed are listed below in Table 3.2, and details regarding survey effort and significant results are shown in Appendix B. Three previous surveys, Biologic (2010), ENV Australia (2009), and Ecologia Environment (2006), overlap the current Study Area.

Table 3.2 Reports used for the literature review

Survey Title	Reference	Survey Type
Mining Area C Desktop Review of Baseline Information on vertebrate Fauna	Biologic (2014)	Desktop Review
Area C West Vertebrate Fauna Survey	Biologic (2013)	Two Phase Level 2
Area C West to Yandi Level 2 Vertebrate Fauna Survey	Biota Environmental Sciences (2013)	Level 2
Area C and Surrounds Vertebrate Fauna Survey	Biologic (2011a)	Two Phase Level 2
Yandi Vertebrate Fauna Review	Biologic (2011b)	Desktop Review
Area C to Yandi Fauna Survey	Biologic (2010)	Level 1
Yandicoogina Junction and Oxbow Fauna Survey	Biota Environmental Sciences (2010)	Single Phase Level 2
Munjina and Ministers North (Yandi Hub) Fauna Assessment	ENV Australia (2009)	Single Phase Level 2
Marillana Creek (Yandi) Iron Ore Mine Modification Level 2 Survey	Ecologia Environment (2008)	Two Phase Level 2
Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial Vertebrate Fauna Assessment	Outback Ecology (2008)	Single Phase Level 2
Area C Southern Flank Deposit Fauna Assessment	ENV Australia (2008)	Level 1
Survey for Conservation Significant Bats between Kurrajura siding and the Yandi Wye	Specialised Zoological (2008a)	Targeted bat survey
Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment	Specialized Zoological (2008b)	Targeted bat survey
Area C R Deposit Fauna Assessment	ENV Australia (2007)	Single Phase Level 2
Ministers North Biological Survey	Ecologia Environment (2006)	Level 2
Mining Area C Expansion Deposit E Bat Assessment	Ecologia Environment (2005)	Targeted bat survey
Area C: Deposits D, E and F Biological Survey	Ecologia Environment (2004)	Single Phase Level 2
Marillana Creek Western Access Corridor Biological Assessment	Halpern Glick Maunsell (1999)	Level 1
Mining Area C Biological Survey	Ecologia Environment (1998)	Single Phase Level 2

3.3 Data Analysis

The computation of sample-based rarefaction curves from sampling programmes, together with non-parametric estimators of species richness species was undertaken to estimate the adequacy of the sampling.

Accumulation curves were generated using abundance data for non-volant vertebrate fauna based on the trapping programme, and for birds based on the bird survey data. These analyses do not include opportunistic records of species. Species accumulation curves were generated using EstimateS® version 9.1.0 (Colwell 2013). The analyses used the default settings in EstimateS with the following exceptions:

- Accumulation curves were smoothed using 5,000 repetitions; and
- Upper abundance limit for rare taxa set to two (2), so as to more reliably treat 'rare' taxa within the data set.

Species richness estimates were developed using four widely-used species richness estimators (ACE, Chao 1, Bootstrap, and Michaelis-Menten), and this was then used to assess what proportion of the predicted total number of species was detected during the survey.

The resulting S(est) lines represent smoothed curves of the actual numbers of species observed in the samples. EstimateS was also used to extrapolate the expected numbers for a doubling of the sampling effort, and to compute various non-parametric estimators of species richness.

3.4 Field Survey

A two season Level 2 field survey was undertaken by Biologic personnel from 15 – 26 October 2016, and 3 – 13 April 2017. The purpose of the survey was to verify the data collated during the literature and database reviews, map and describe the fauna habitats present within the Study Area, and undertake targeted surveys for fauna of conservation significance.

3.4.1 Survey team

The vertebrate fauna sampling for this survey was conducted under a DBCA Regulation 17 "Licence to Take Fauna for Scientific Purposes" (SF010000881) issued to M. O'Connell.

The assessment was undertaken by senior and principal zoologists with extensive experience with fauna in the Pilbara region. The following personnel were involved in the field component of the project:

- Mr Morgan O'Connell (Principal Zoologist) – Season 1;
- Mr Thomas Rasmussen (Senior Zoologist) – Season 1;
- Mr Brad Maryan (Senior Zoologist) – Season 1 and 2; and
- Mr Pat Cullen (Senior Zoologist) – Season 2.

3.4.2 Targeted transects

The majority of the Study Area was accessible for targeted transects, and during the course of the dry season survey eight (8) transects were conducted in habitats most likely to support conservation significant fauna (Figure 3.1 'Targeted Transects'). During the targeted transects the team recorded all vertebrate fauna species encountered, either from primary (*i.e.* direct observation of species) or secondary (*e.g.* burrows, scratching's, diggings and scats) evidence.

3.4.3 Night work

Handheld spotlighting, head torching and road spotting were undertaken to document nocturnal species in the Study Area. Three (3) nights spotting transects were undertaken throughout the Study Area. During the nocturnal transects the team recorded all vertebrate fauna species encountered, either from primary (*i.e.* direct observation of species) or secondary (*e.g.* burrows, scratching's, diggings and scats) evidence.

3.4.4 Targeted trapping

A total of seven (7) trapping sites were established in the first season dry survey, with sites covering various fauna habitats present within the Study Area (Major Drainage Line, Minor Drainage Line, Gorge/Gully and Hillcrest/slope) (Figure 3.1; Appendix C). Due to access issues to Sites 1, 2 and 7 from heavy rainfall during the second season wet survey, three new trapping sites were established in similar habitat types (bringing the total number of sites to 10). A total of seven (7) sites were carried out for each survey season (Appendix C). A team of two (2) zoologists checked the traps daily, within three hours of sunrise. Each trapping site consisted of the following:

- Pit and funnel traps – 10 pit traps were installed at each trapping site, comprising five (5) alternating 20 L buckets and five (5) PVC pipes (dimensions of 50 cm deep and 16 cm wide). A 5 x 0.3 m aluminium fence bisected the pipe / bucket and two "snake" funnel traps were placed at either end (totalling 20 funnel traps at each site). Trap sites were placed along a single transect, approximately 20 m apart. Traps were placed in locations deemed most likely to catch fauna (*i.e.* areas with dense ground cover, litter, rocks etc.). Traps were opened for seven (7) nights. Styrofoam trays were placed within all pits to provide refuge from heat, cold and rain to any captured fauna.
- Elliott traps – 20 medium (Type B) Elliott style box traps were placed at each site. Traps were located along two parallel transects 5 m apart, with each trap placed in niches likely to be attractive to small non-volant mammals and reptiles (*i.e.* areas of cover and shade). Traps were baited with "universal bait" (a mixture of oats, peanut butter and sardines), and open for a period of seven (7) nights.
- Cage Traps – Two (2) cage traps were located at each site, placed at the ends of the trap lines. Cages were baited with chicken and/or universal bait, and opened for seven (7) nights.

3.4.5 Bat surveys

Overnight recordings of bat echolocation calls were made with SM2BAT+ (Wildlife Acoustics 2010) sound recorders at 28 locations in prospective bat foraging grounds such as Gorge/Gully and Major Drainage Lines (Figure 3.2 'SM2BAT+' sites; Appendix C). Recordings were carried out for one (1), two (2) or three (3) nights at each site (Appendix C). The jumper and audio settings used for the SM2BAT+ followed the manufacturer's recommendations contained in the

user manual (Wildlife Acoustics 2010). Selectable filters and triggers were also set using the manufacturer's recommendations.

Bat calls were analysed by Mr Bob Bullen of Bat Call WA, a recognised expert in the field.

3.4.6 Motion sensitive cameras

Motion sensitive video cameras were used to survey for larger mammals, including introduced predators. Cameras were deployed at 26 locations considered prospective for detecting conservation significant fauna, including Major Drainage Line and Gorge/Gully habitats (Figure 3.1 'Camera' sites; Appendix C), and were left in situ between the two field surveys. The resulting footage was analysed visually by Biologic personnel.

3.4.7 Foraging surveys and incidental records

Active searching for herpetofauna was undertaken at opportunistic sites within each habitat type. Opportunistic sites were selected with the following aims:

- Habitats that contain substrates not suitable for pit-trap establishment;
- Microhabitats that would contain species not recorded in the traps or by the nocturnal surveys (determined from analysis of survey data and knowledge of species' ecology);
- Areas considered to support a high species diversity of herpetofauna (*e.g.* spinifex grasslands, areas of exfoliating rock or leaf litter accumulation); and
- Habitats likely to contain species of conservation significance.

At all times while surveying, all records pertaining to species not previously recorded during the survey, rare or conservation significant fauna or other fauna of interest were documented. These records included records of secondary evidence as well as incidental sightings of live animals.

3.4.8 Habitat assessment

Habitat assessments were conducted at every trapping site/ motion camera/ bat recorder nocturnal transect, and targeted search site location, as well as at standalone habitat assessment location. A total of 73 habitat assessment were undertaken across the Study Area; 50 in the dry season and 23 in the wet season survey (Figure 3.1 'Habitat Assessment' sites; Appendix C). For simplicity, only habitat assessments undertaken at locations that do not correspond with a trapping site, bat recorder, or camera sites are shown on Figure 3.1. Habitats in the Study Area were assessed using methodology and terminology adapted from the Australian Soil and Land Survey Field Handbook (CSIRO 2009) and modified to suit the survey requirements according to BHP Iron Ore guidelines. The characteristics recorded during the habitat assessments were:

- site information, photo and location;
- landform: slope, relative inclination of slope, morphological type and landform type;
- vegetation: leaf litter %, twig litter %, wood litter, dead stags and hollow bearing trees, broad floristic formation, vegetation structure (tall, mid and low), and dominant species;

- land surface: micro relief, sheet erosion, rill erosion, gully erosion, gully depth, abundance and size of coarse fragments, rock outcropping, water bodies, comments on nests, burrows, roosts and diggings;
- soil: texture, colour;
- substrate: bare ground, rock size, rock type, rock outcropping; and
- disturbance: time since last fire, evidence of weeds, grazing, or human disturbances.

Fauna habitats were also assessed for the likelihood that they may support conservation significant fauna. All major fauna habitats present within the Study Area were scored for significance (High, Medium or Low) according to the criteria shown below in Table 3.3.

Table 3.3 Fauna habitat significance assessment criteria

Score	**Possible criteria** (score results from any possible criterion being met)
High	Fauna listed on the Environment Protection and Biodiversity Conservation (EPBC) Act has been recorded within the habitat.
	Habitat is known to be suitable core habitat for EPBC listed species, and there are records of the species within 50 km. If survey work in the vicinity of the Study Area has been limited, then the species will be considered likely to be present, using a precautionary approach.
	Habitat is uncommon (regionally) and considered critical for DBCA listed Priority fauna. For example, if the habitat for a Priority species is limited in the region and the extent within the Study Area forms a large proportion of the known habitat, it would be scored 'high'.
	Habitat that only occurs in small, isolated geographic areas.
Medium	Habitat is known to supports DBCA listed Priority fauna that do not occur in any of the other habitat types.
	Habitat that supports *EPBC Act* listed Migratory fauna. Habitat may be used by *EPBC Act* listed fauna but it is not their core habitat *(i.e.* may be used periodically/ seasonally or for dispersal).
	Habitat supports a particularly diverse and uncommon faunal assemblage. Habitat that occurs throughout region, and does not occur in small or isolated areas, is excluded.
Low	Habitat is widespread, common, and does not solely support any significant fauna.

711000 712000 713000 714000 715000 716000 717000 718000 719000 720000 721000 722000

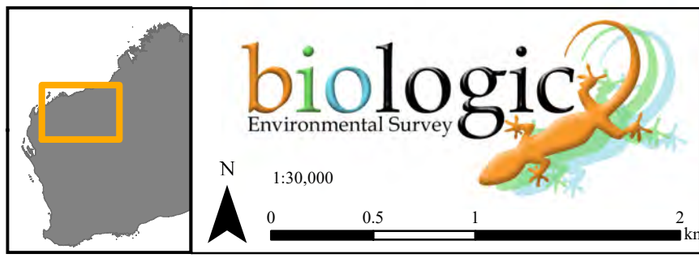
7477000 7476000 7475000 7474000 7473000 7472000 7471000

Legend

Study Area
Pilbara Rail

Sampling Method

Trapping Site
Bat Detector
Motion Camera
Habitat Assessment
Targeted Transects



biologic Environmental Survey

BHP Ministers North Project
Level 2 Vertebrate Fauna Survey

Fig. 3.1: Sampling effort and transects

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 01/09/2017

3.4.9 Potential limitations and constraints

EPA Technical Guidance (EPA 2016a) outlines several potential limitations to fauna surveys. These aspects are assessed and discussed in Table 3.4 below.

Table 3.4: Survey limitations and constraints

Potential limitation or constraint	Applicability to this survey
Experience of personnel.	The field personnel involved in the survey were all suitably qualified and collectively had over 45 years of fauna survey experience in the Pilbara.
Scope (faunal groups sampled and whether any constraints affect this)	The scope was a two season Level 2 survey and was conducted within that framework. Nocturnal work was undertaken to detect nocturnally active species.
Proportion of fauna identified	All observed fauna were identified at the point of observation. All recorded bat calls were identified; however due to identical characteristics in the calls of some bat species within a genus, it was not possible to differentiate all species using calls. Nevertheless, all conservation significant species of bats are able to be identified to species level.
Sources of information (recent or historic) and availability of contextual information	Three previous surveys have been conducted within or overlapping the Study Area, and were available as a source of information. A large amount of survey work has been undertaken in the local area and the surrounding region, and the majority of these previous survey results (particularly those undertaken for BHP Iron Ore) were available for review. DBCA has also undertaken the Pilbara Biological Survey, which provided information on regional distribution of selected species. These reports were available at the time of reporting.
Proportion of the task achieved	A two season Level 2 survey of the Study Area was completed to scope, and related to the results of surveys in the broader area.
Disturbances (e.g. fire or flood).	Heavy rainfall during March 2017 delayed the second season survey and caused access restrictions to three (3) of the trapping sites, resulting in three (3) new trapping sites being established. A fire which had recently burnt through the Study Area also reduced the area suitable for site placement, although this is unlikely to have altered the results of the surveys substantially.
Intensity of survey.	A two season Level 2 survey was identified by BHP Iron Ore as the requirement for this survey.
Completeness of survey.	The survey was adequately completed to meet the requirements of a two season Level 2 survey.
Resources (*e.g.* degree of expertise available).	All resources required to complete the survey were available.
Remoteness or access issues.	The Study Area was accessible either by vehicle or on foot. However, site placement was restricted in some cases due to the presence of heritage sites.

3.5 Taxonomy and nomenclature

The latest checklist of mammal, reptile and amphibian names published by the Western Australian Museum (WAM) (WAM 2016) was used as a guide to the current taxonomy and nomenclature of these groups. This list is updated annually using the most recent taxonomic literature and conservation statuses from the DBCA. For birds, the current checklist of Australian birds maintained by Birds Australia (based on Christidis and Boles 2008) was used in conjunction with the WAM species list (WAM 2016).

3.6 Assessment of species conservation significance

Within Western Australia, all native fauna is protected under the *Wildlife Conservation Act 1950* (*WC Act*) and any action that has the potential to impact on native fauna needs to be approved by relevant State and/ or Federal departments as dictated by the Western Australian *Environmental Protection Act 1986* and the Federal *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*).

Current listings for conservation significant fauna were checked against the latest (January 2017) Western Australian Government Gazette (State of Western Australia 20157) and the *EPBC Act* list of threatened species (available online at http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl).

Some species of fauna that are determined to be at risk of extinction or decline are afforded extra protection under these Acts. For the purposes of this report, these species are called conservation significant species. A summary of applicable legislation and status codes is provided in Table 3.5. Additional information on conservation status codes is provided in Appendix D.

A number of migratory bird species are prioritised for conservation under the *EPBC Act* or international agreements. In addition, the IUCN compiles a 'Red List' upon which species at risk of extinction are listed. The *EPBC Act* also identifies Threatened Ecological Communities (TECs), ecological communities at risk of extinction.

For some species, there is insufficient information to determine their conservation status. These species are generally considered by the EPA/ DBCA as 'conservation significant' for all development related approvals and are listed on a 'Priority List', which is regularly reviewed and maintained by DBCA. DBCA also identifies TECs, which are naturally occurring biological assemblages found to fit into one of four categories (Table 3.5). Possible TECs that do not meet these survey criteria are added to DBCA's 'Priority Ecological Communities' (PECs) lists under Priorities 1, 2 or 3.

Table 3.5: Conservation significance assessment guidelines

Agreement, Act or List	Status Codes
INTERNATIONAL	
The IUCN *Red List* lists species at risk under nine categories (listed under 'Status Codes').	• IUCN Extinct • IUCN Extinct in the Wild • IUCN Critically Endangered • IUCN Endangered • IUCN Vulnerable • IUCN Near Threatened • IUCN Least Concern • IUCN Data Deficient • IUCN Not Evaluated

Agreement, Act or List	Status Codes
Migratory taxa listed under the following international conventions are generally listed as Migratory under the federal *Environment Protection and Biodiversity Conservation Act 1999* (see below): • Japan-Australia Migratory Bird Agreement (JAMBA); • China-Australia Migratory Bird Agreement (CAMBA); • Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).	Generally listed as Migratory under the *EPBC Act*
FEDERAL	
Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act*) DoE lists threatened fauna, which are determined by the Threatened Species Scientific Committee (TSSC) according to criteria set out in the Act. The Act lists fauna that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes').	• Extinct (EX) • Extinct in the Wild (EW) • Critically Endangered (CE) • Endangered (EN) • Vulnerable (VU) • Conservation Dependent (CD) • Migratory (MG) • Marine (MA)
Threatened Ecological Communities (TECs) are those that are at risk of extinction.	• Critically Endangered • Endangered • Vulnerable
STATE	
Wildlife Conservation Act 1950 (*WC Act*) At a state level, native fauna are protected under the *WC Act*. Species in need of conservation are given a ranking ranging from Schedule 1 to 7.	• Schedule 1 (S1) • Schedule 2 (S2) • Schedule 3 (S3) • Schedule 4 (S4) • Schedule 5 (S5) • Schedule 6 (S6) • Schedule 7 (S7)
DBCA Priority list (DBCA) DBCA produces a list of Priority species and ecological communities (*e.g.* PECs or TECs that have not been assigned statutory protection under the *WC Act*). This system gives a ranking from Priority 1 to Priority 4.	• Priority 1 (P1) • Priority 2 (P2) • Priority 3 (P3) • Priority 4 (P4)

4 Results

4.1 Fauna recorded within the Study Area

A total of 116 vertebrate fauna species, comprising 17 mammal species, 54 bird species, 43 reptile species, and two (2) amphibian species were recorded from the Study Area during the survey (Table 4.1, Appendix E). These totals are higher than that of the other surveys conducted within the Study Area (i.e. Biologic 2010 and Ecologia Environment 2006), although both these surveys were Level 1, therefore no trapping was undertaken the species recorded is expected to be less. The exception was ENV Australia (2009) which recorded slightly more species and this is likely due to the larger survey area sampled.

Table 4.1 (and Appendix E) show that the total species richness for all surveys within a 10 km radius and from database searches within a 20 km radius of the Study Area currently stands at 319 species, comprising of 47 species of mammals, 151 species of birds, 114 species of reptiles, and seven (7) amphibian species.

Table 4.1: Summary of fauna species recorded within the local area of the Study Area

Source	Mammals (native)	Mammals (introduced)	Birds	Reptiles	Amphibians	Total species
Current Survey	**15**	**2**	**54**	**45**	**3**	**119**
Mining Area C Desktop Review of Baseline Information on Vertebrate Fauna (Biologic 2014)	N/A	N/A	N/A	N/A	N/A	N/A
Area C West Vertebrate Fauna Survey (Biologic 2013)	26	5	100	79	3	213
Area C West to Yandi Level 2 Vertebrate Fauna Survey (Biota Environmental Sciences 2013)	24	4	84	57	3	172
Area C and Surrounds Vertebrate Fauna Survey (Biologic 2011a)	22	4	76	60	4	166
Yandi Vertebrate Fauna Review (Biologic 2011b)	N/A	N/A	N/A	N/A	N/A	N/A
Area C to Yandi Fauna Survey (Biologic 2010)	13	3	47	10	1	74
Yandicoogina Junction and Oxbow Fauna Survey (Biota Environmental Sciences 2010)	10	2	46	14	0	72
Munjina and Ministers North (Yandi Hub) Fauna Assessment (ENV Australia 2009)	16	6	66	45	1	134
Marillana Creek (Yandi) Iron Ore Mine Modification Level 2 Survey (Ecologia Environment 2008)	16	3	60	37	3	119

Source	Mammals (native)	Mammals (introduced)	Birds	Reptiles	Amphibians	Total species
Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Terrestrial Vertebrate Fauna Assessment (Outback Ecology 2008)	8	3	61	26	2	100
Area C Southern Flank Deposit Fauna Assessment (ENV Australia 2008)	13	4	56	23	4	100
Survey for Conservation Significant Bats between Kurrajura siding and the Yandi Wye (Specialised Zoological 2008a)	8	0	0	0	0	8
Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment (Specialized Zoological 2008b)	6	0	0	0	0	6
Area C R Deposit Fauna Assessment (ENV Australia 2007)	14	0	68	25	1	108
Ministers North Biological Survey (Ecologia Environment 2006)	10	0	42	18	1	71
Mining Area C Expansion Deposit E Bat Assessment (Ecologia Environment 2005)	2	0	0	0	0	2
Area C: Deposits D, E and F Biological Survey (Ecologia Environment 2004)	15	2	55	32	0	104
Marillana Creek Western Access Corridor Biological Assessment (Halpern Glick Maunsell 1999)	5	0	42	1	1	49
Mining Area C Biological Survey (Ecologia Environment 1998)	17	3	80	44	2	146
DBCA NatureMap	28	5	127	108	5	273
DoE Protected Matters	4	8	14	0	0	26
Total species recorded	**38**	**9**	**151**	**114**	**7**	**319**
Conservation Significant species	**7**	**0**	**23**	**3**	**0**	**33**

Note: Table includes all surveys within a 10 km radius and database searches within a 20 km radius.

The following conservation significant species were reported in database searches, but were omitted from further consideration herein, due to the following reasons:

- Greater Bilby, *Macrotis lagotis* (*EPBC Act* Vulnerable, IUCN Vulnerable, *WC Act* Schedule 3,) – This species is more common in the northern Pilbara, but has not been recorded in the south-eastern Pilbara despite high survey effort over many years. The nearest populations of Greater Bilby have been recorded from areas north of the Fortescue Marsh, more than 100 km north of the Study Area, and owing to the scarcity of potentially suitable habitats i.e. spinifex sandplains with deep sand, it is considered highly unlikely to occur within the Study Area;

- Night Parrot, *Pezoporus occidentalis* (*EPBC Act* Endangered, *WC Act* Schedule 1, IUCN Endangered) – The Night Parrot is one of Australia's rarest birds, with very few confirmed sightings in recent years. Night Parrots may reportedly occur in spinifex grasslands in stony or sandy areas on floodplains or near creeks, shrubby samphire and chenopod vegetation on claypans or at the edges of salt lakes, and in dense, low vegetation around watercourses (Higgins 1999). Despite the potential occurrence of some of these habitat features, the Night Parrot is considered highly unlikely to occur within the Study Area; and
- Southern Great Petrel, *Macronectes giganteus* (*EPBC* Endangered, *WC Act* Schedule 5) – Due to the marine nature of the species, the distance inland of the Study Area from the coast, and the complete lack of records in the general area, it is considered highly unlikely to occur within the Study Area.

4.2 Data Analysis

An estimate of species richness in an area, in terms of the numbers of species the area contains, is one objective of faunal surveys. In particular it is desirable to have an indication of the adequacy of the sampling programme. Although results from any sampling programme are inevitably an underestimation of the actual species richness, there are a range of statistical sampling models that account for under sampling bias by adjusting or controlling for differences in the numbers of individuals and the number of samples collected, as well as models that use abundance or incidence distributions to estimate the numbers of undetected species (Gotelli and Colwell 2011).

Table 4.2 Mean estimates of total species richness for the trapping and bird survey programmes (excluding opportunistic sites and non-repeated methods such as night spotting)

Richness estimators	Total species estimate		
	Trapping programme for mammals	Trapping programme for reptiles	Bird Surveys
Observed	**7**	**59**	**52**
Extrapolation to double survey effort	7.82	77.25	63.4
ACE	10	99.13	66.18
Chao 1	8.9	84.97	59.67
Bootstrap	8	72.4	61.16
Michaelis-Menten (1 run)	10.56	103.73	78.24

4.2.1 Mammal (non-volant) trapping data

From the current survey, 18 records were used in the analysis, with a total observed catch of seven small mammal species. Results of the analyses are shown in Figures 4.1 – 4.3 below. S(est) is the observed total species number, while the ACE, Chao 1, and Bootstrap means all correct for unrecorded species. MM is the mean from fitting the Michaelis-Menten equation. Figure 4.3 below indicates that the trapping survey recorded between 66 – 87% of the species present in the Study Area.

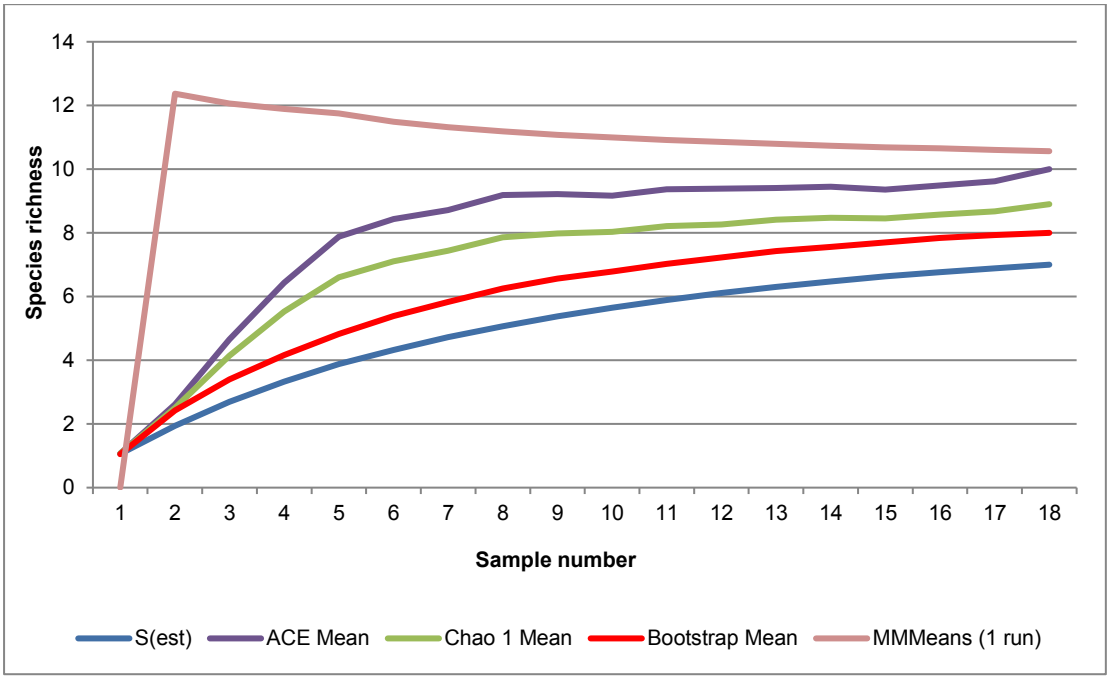


Figure 4.1 Accumulation curves computed for the 18 mammal trap samples

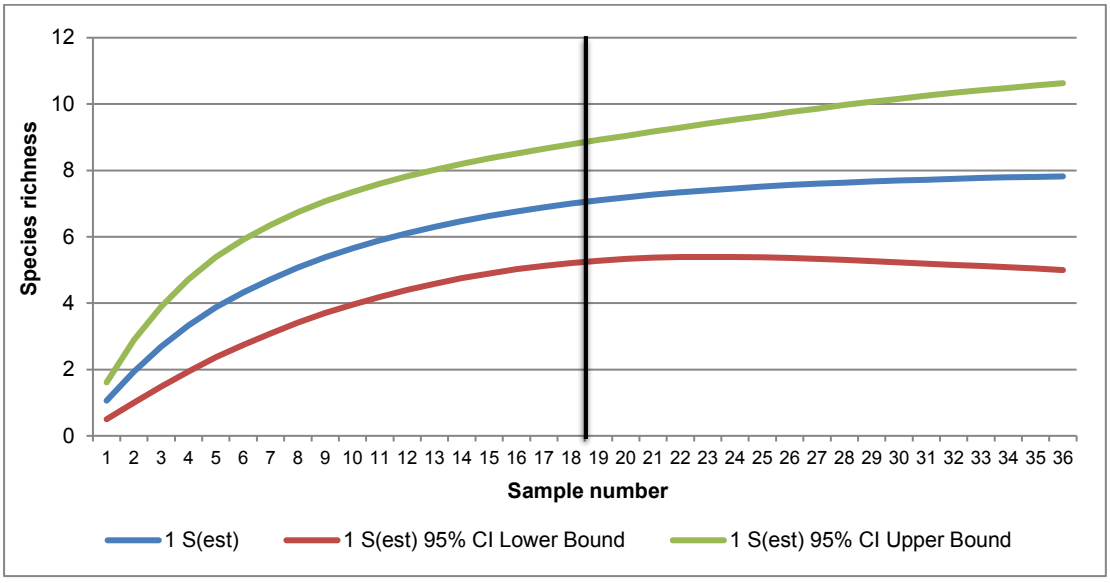


Figure 4.2 Extrapolation of S (est) and 95% confidence boundaries to 36 mammal trapping samples. The black line is the number of actual samples from the current survey.

An extrapolation of the data to 36 samples (doubling the sample effort) estimates that only one additional species would be captured. Other indicators range from an additional 2 - 4 species (Table 4.2). This indicates that the trapping programme is estimated to have recorded at least 66% of the species. The use of the Michaelis-Menten function as a stopping point, indicates 87.5% of species were recorded. It is important also to note that the species richness calculated here is for the trappable species at the ten trapping sites from the survey, and the total number of trappable species within the Study Area will be greater than this.

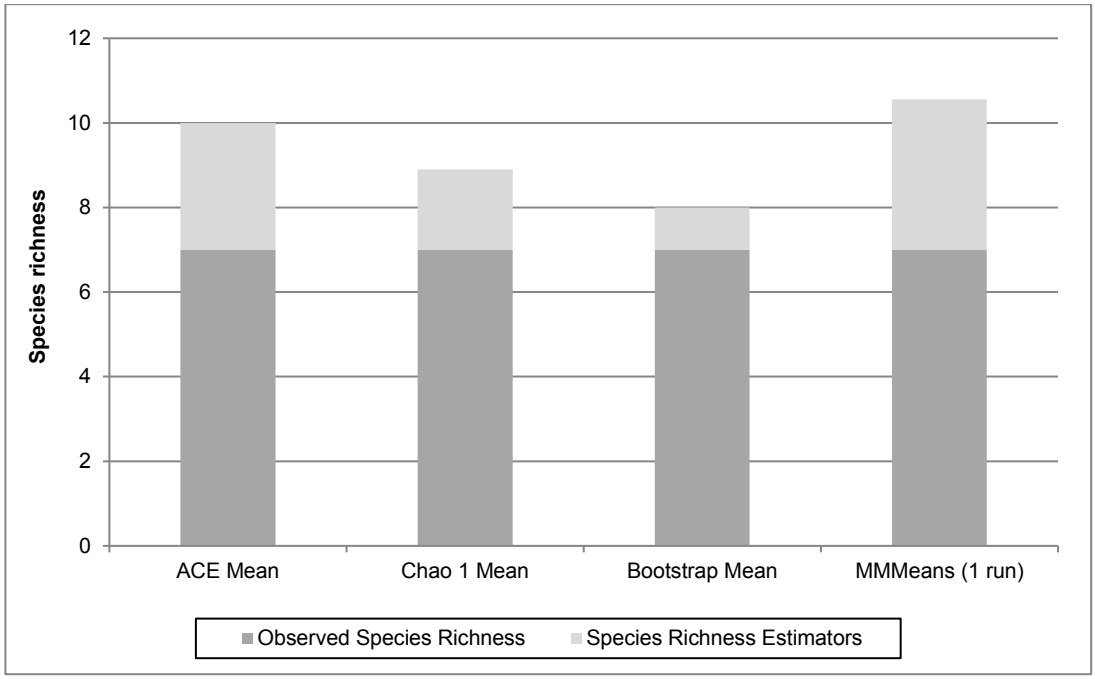


Figure 4.3 Observed mammal species richness, relative to predicted species richness, across multiple species richness estimators.

4.2.2 Reptile survey data

Sixty-nine (69) samples were used in the analysis, with a total observed catch of 59 small reptile species. Results of the analyses are shown in Figures 4.4 – 4.6 below. As before, S(est) is the observed total species number, while ACE, Chao 1, and Bootstrap means all correct for unrecorded species. MM is the mean from fitting the Michaelis-Menten equation. Curves indicate that the trapping survey recorded between 57 – 82% of the species.

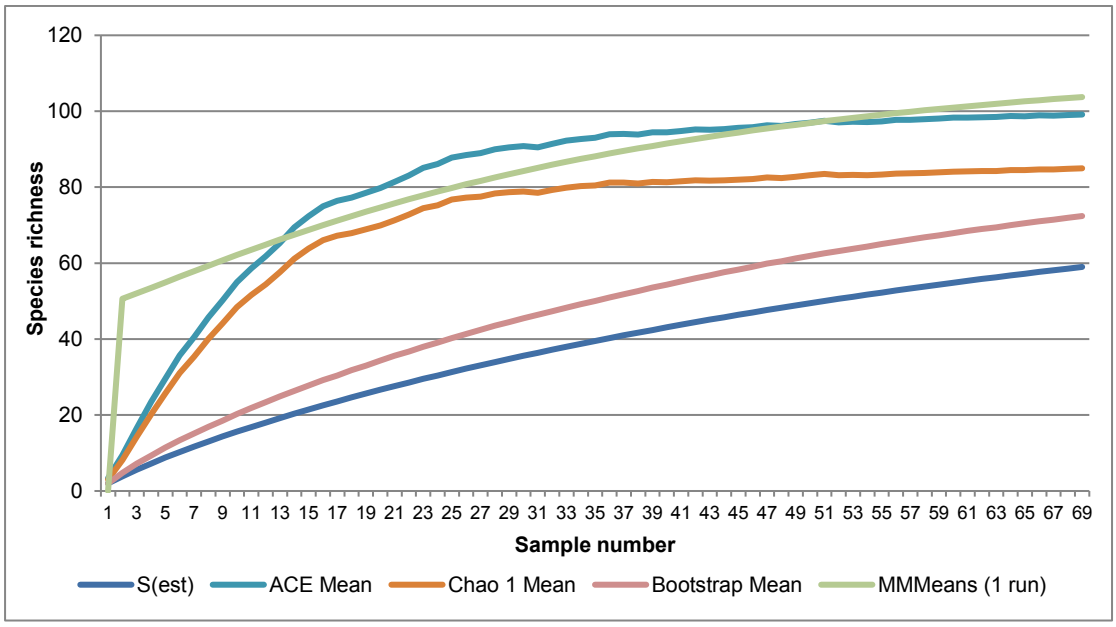


Figure 4.4 Species accumulation curve for the 69 reptile samples

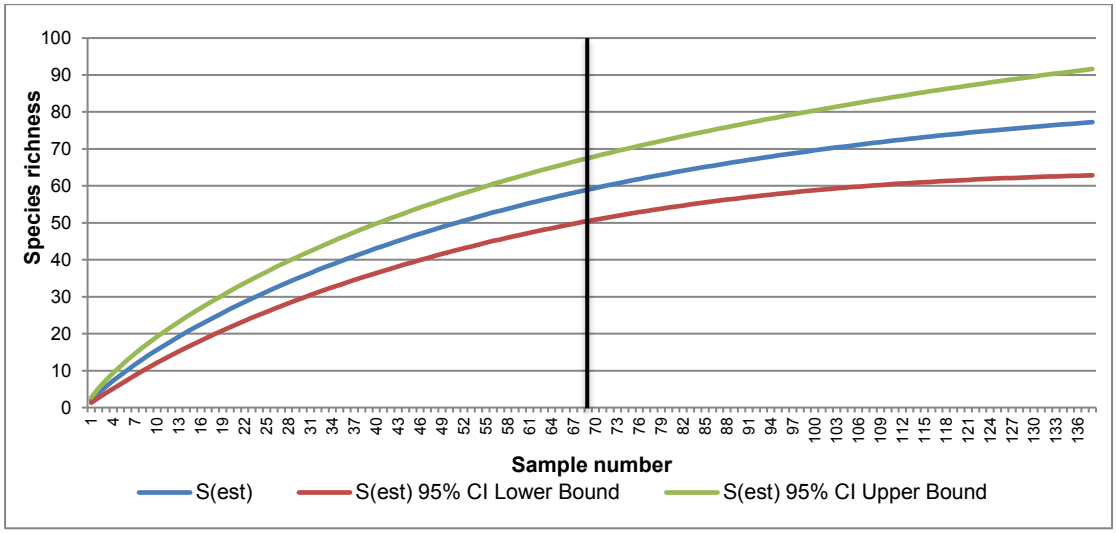


Figure 4.5 Extrapolation of S(est) and 95% confidence boundaries to 138 trapping reptile samples. The black line is the number of actual samples from the current survey.

An extrapolation of the data to 138 samples (doubling the sample effort) estimates that an additional 18 species would be captured (Figure 4.5). The other calculated indicators range from an additional 13 - 45 species (Table 4.2). This indicates that the trapping programme is estimated to have recorded at least 57%. The use of the Michaelis-Menten function as a stopping point indicates 81.5% of species were recorded. These figures suggest that an additional trapping season could significantly increase the number of reptiles captured. It is important also to note that the species richness calculated here is for the trappable species at the ten trapping sites from the survey, and the total number of trappable species within the Study Area will be greater than this. Opportunistic records and night transects resulted in the recording of an additional three species.

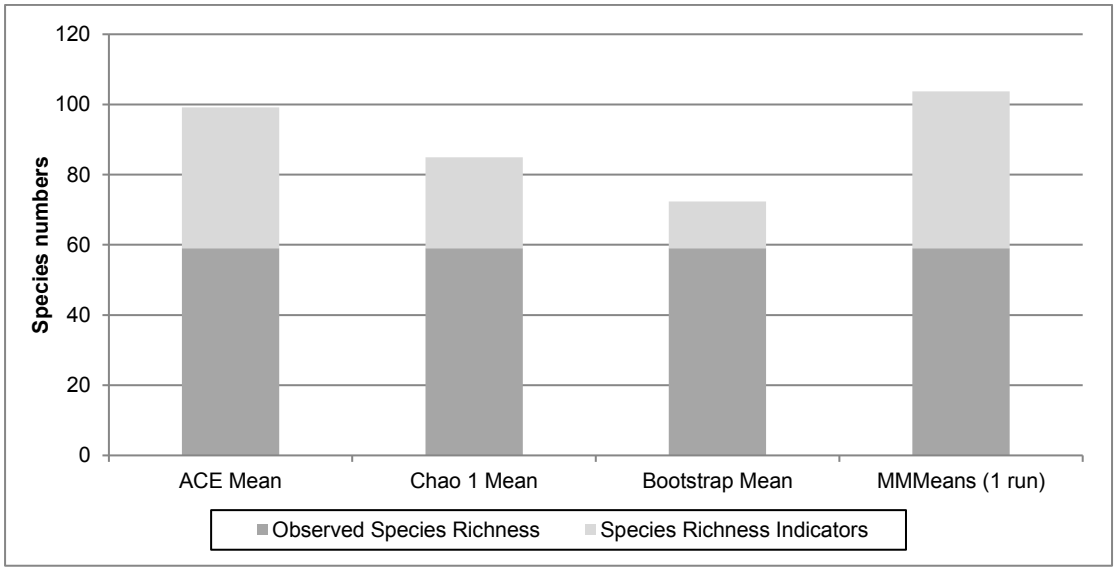


Figure 4.6 Observed reptile species richness, relative to predicted species richness, across multiple species richness estimators.

4.2.3 Bird survey data

Thirty-seven (37) samples were used in the analysis, each being a 20 minute bird census, with a total of 52 species being recorded. Results of the analyses are shown in Figures 4.7 - 4.9 below. An extrapolation of the data to 74 samples (doubling the sample effort) estimates that an additional 12 species would be recorded (Figure 4.8). The other calculated indicators range from an additional 8 - 27 species (Table 4.2). This indicates that the survey programme is estimated to have recorded at least 66% of the species, and potentially up to 87% (Figure 4.9). The use of the Michaelis-Menten function as a stopping point indicates 87.14% of species were recorded.

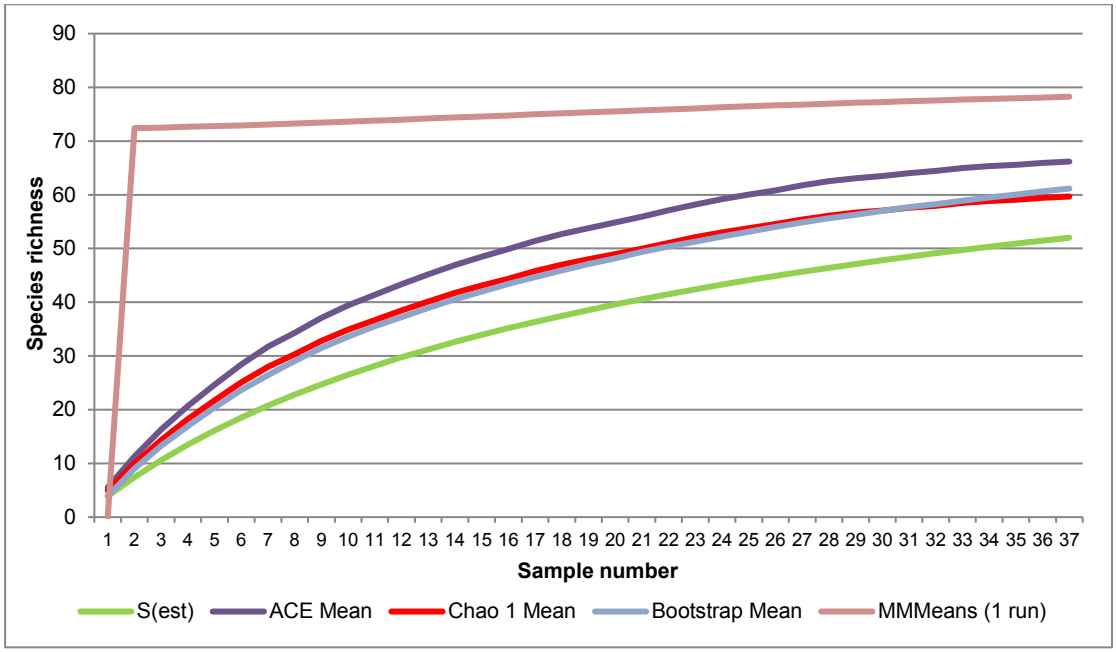


Figure 4.7 Species accumulation curves for the 37 bird samples

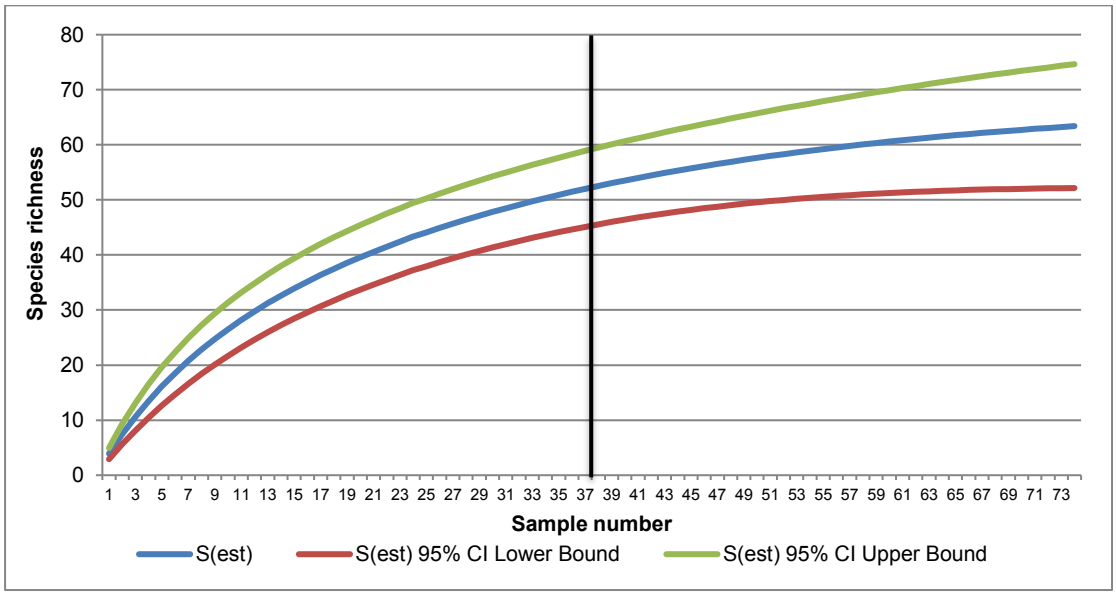


Figure 4.8 Extrapolation of S(est) and 95% confidence boundaries to 138 bird samples. The black line is the number of actual samples from the current survey.

It is important to note that the species richness calculated is for the bird species recorded at the ten survey sites, and hence the total number of species within the Study Area will be greater than this. Opportunistic bird sightings resulted in an additional three bird species being recorded.

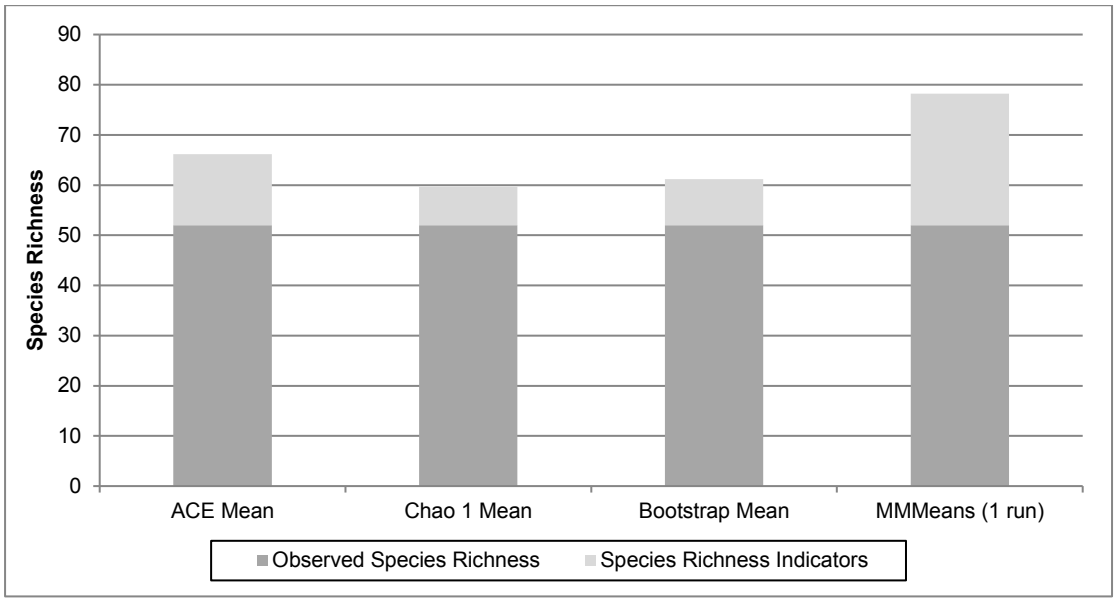


Figure 4.9 Observed bird species richness, relative to predicted species richness, across multiple species richness estimators.

Overall, analyses of trapping and bird survey data show that the survey recorded a majority of vertebrate fauna species present at the time of surveying.

4.3 Conservation significant fauna recorded within the Study Area

The overall number of conservation significant species recorded identified from the database and literature review stands at 25 species, comprising seven (7) species of mammals, 16 species of birds, and two (2) species of reptiles, in addition to one locally significant species (Table 4.1).

Two (2) conservation significant species have been recorded from within the Study Area (Table 4.2 and Figure 4.10), they are:

- Rainbow Bee Eater, *Merops ornatus* (*EPBC Act* Migratory, *WC Act* Schedule 5) – recorded from two sites during the current survey. This species was also recorded adjacent to the Study Area by Biologic (2010), and from many of the fauna surveys conducted in the vicinity of the Study Area; and
- Western Pebble-mound Mouse, *Pseudomys chapmani* (DBCA Priority 4) – recorded from four trapping sites and two opportunistic sites during the current survey. This species has also been recorded from within the Study Area during the Ecologia Environment (2006), ENV Australia (2009), and Biologic (2010) surveys; and from most of the surveys conducted in the vicinity of the Study Area.

One species considered locally significant, the Chocolate Wattled Bat (*Chalinolobus morio*) was recorded during the current survey. This species was recorded from two locations within the Study Area (Figure 4.10).

Table 4.3 Locations of conservation significant fauna recorded during the current survey

Species	Status	Site	Latitude	Longitude	Notes
Rainbow Bee-Eater	*WC Act* S5	MN-04	-22.8317	119.1338	Three individuals (alive)
		MN-04	-22.8317	119.1338	One individual (alive)
		MN-04	-22.8317	119.1338	Three individuals (alive)
		MN-06	-22.8328	119.1275	One individual (alive)
		MN-10	-22.8277	119.1252	One individual (alive)
		MN-04	-22.8317	119.1338	Nest and individual
Western Pebble-mound Mouse	DBCA Priority 4	MN-06	-22.8327	119.1274	Mound (active)
		Opportunistic	-22.8316	119.1346	Mound (active)
		Opportunistic	-22.8277	119.1253	Mound (active)
		MN-01	-22.8048	119.0742	Individual (alive)
		MN-01	-22.8048	119.0742	Individual (alive)
		MN-07	-22.8252	119.1001	Individual (alive)
Chocolate Wattled Bat	Locally significant	MN-BAT04	-22.8143	119.1165	One call, consistent with foraging
		MN-BAT13	-22.8249	119.1325	Two calls, consistent with foraging
		MN-BAT13	-22.8249	119.1325	One call, consistent with foraging

Further details regarding these species are presented below.

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater (*EPBC Act* Migratory, *WC Act* Schedule 5) has broad habitat requirements and lives almost anywhere suitable for hawking insects. Despite being listed as migratory under *EPBC Act* and *WC Act*, the demographics of the species are complex in Western Australia, including populations of resident birds, breeding visitors, post-nuptial nomads, passage migrants and winter visitors (Johnstone & Storr 1998).

This species was recorded from the current survey during targeted bird surveys in both seasons, although records were more common from the second season wet survey. This may be due to the species migration north to the Pilbara from its southern summer locations. It was most commonly recorded at Site 4, in Major Drainage Line habitat (Figure 4.10, Table 4.2). A nest was also recorded at Site 4 (Plate 4.1), where a motion camera was set up to record any activity in and around the nest, although it is abundant and versatile in its selection of nest sites. Potential foraging and nesting habitat for this species exists in Major and Minor Drainage Line habitats.

Bee-eaters were also recorded adjacent to the Study Area during the Biologic (2010) Area C to Yandi survey (Figure 4.10). The Rainbow Bee-eater is common in the immediate vicinity, recorded in eight other surveys within 10 km of the Study Area (Table 4.3).

Plate 4.1 Rainbow Bee Eater nest (Site 4) and motion camera setup

Western Pebble-mound Mouse (*Pseudomys chapmani)*

The Western Pebble-mound Mouse is currently listed as Priority 4 by the DBCA. This species has experienced a significant decline in their range through the Gascoyne and Murchison, and is now considered endemic to the Pilbara (Van Dyck and Strahan 2008). This species almost exclusively occurs on the gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (Van Dyck and Strahan 2008).

Active mounds constructed by colonies of these mice were recorded in both seasons of the current survey from Site 6 and two opportunistic records, covering Hillcrest/slopes. One and two individuals were also captured in pitfall traps at sites 7 (Hillcrest/slope) and 1 (Minor Drainage Line), respectively. (Figure 4.10, Table 4.2). The number of records from the surveys suggests that the species is a common resident in suitable habitat within the Study Area.

In addition, the species has been recorded from within the Study Area from the three previous surveys that overlap the Study Area; Biologic (2010), ENV Australia (2009) and Ecologia

Environment (2006) (Figure 4.10, Table 4.3). The majority of other surveys conducted within 10 km of the Study Area also recorded the Western Pebble-mound Mouse (Table 4.3).

Chocolate Wattled Bat (*Chalinolobus morio*)

The Chocolate Wattled Bat occurs in the southern part of Western Australia but has a restricted distribution (Churchill 2008). Weeli Wolli Spring and Marillana Creek represent the only two locations in the Pilbara where this species has been recorded and are the most northern localities for this species (van Leeuwen 2009). Given its geographic separation from the main population in Western Australia, the Pilbara population may be genetically distinct. Therefore, although not formally listed as a conservation significant species, it is considered locally significant.

One call of the Chocolate Wattled Bat was recorded from two sites within the Study Area: one recorded near Site MN-03 on 19 October 2016 in Gorge/Gully habitat, and one recorded over two nights (22 and 23 October 2016) in Major Drainage Line habitat (Figure 4.10, Table 4.2). The small number of calls recorded is consistent with foraging individuals. Chocolate Wattled Bats have also been previously recorded by Biota Environmental Science (2013) along Marillana Creek, but this is the first record for the Study Area.

4.4 Introduced species

Of note is the high number of feral cats (*Felis catus*) recorded on five separate motion cameras throughout the Study Area, in particular the presence of juvenile cats (Plate 4.2). This species is a major threat to native species within the Pilbara, of particular note due to the presence of conservation significant species within the Study Area.

Plate 4.2 Example of a juvenile feral cat recorded on motion camera in the Study Area

Table 4.4: Summary of conservation significant fauna recorded in or adjacent to the Study Area, and those that may potentially occur based on database searches

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area														Current Survey
Species	Common Name	EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ecologia (2006)	ENV (2009)	Biologic (2010)	Ecologia (1998a)	HGM (1999)	Ecologia (2004b)	Ecologia (2005a)	ENV 2007)	Ecologia (2008)	Outback Ecology (2008)	ENV (2008b)	SZ (2008a)	Specialised Zoological (2008b)	Biota (2010)	Biologic (2011)	Biota (2013)	Biologic (2013c)	
MAMMALS																										
Dasyurus hallucatus	Northern Quoll	EN	S1		EN		•	•																	•	
Macrotis lagotis	Bilby, Dalgyte	VU	S1		VU			•																		
Macroderma gigas	Ghost Bat	VU	S3		VU		•	•			•												•		•	
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1					•								•								•		
Chalinolobus morio	Chocolate Wattled Bat					LOCAL	•																	•		•
Leggadina lakedownensis	Short-tailed Mouse			P4																					•	
Pseudomys chapmani	Western Pebble-mound Mouse			P4			•		•	•	•	•	•	•		•	•	•				•	•	•	•	•
BIRDS																										
Macronectes giganteus	Southern Great Petrel	EN	S5				•																			
Apus pacificus	Fork-tailed Swift	MG	S5				•	•										•					•			
Ardea ibis	Cattle Egret	MG	S5					•																		
Ardea modesta	Eastern Great Egret	MG	S5					•																		
Pandion cristatus	Eastern Osprey	MG	S5																							
Falco hypoleucos	Grey Falcon		S3																							
Falco peregrinus	Peregrine Falcon		S7									•											•	•	•	
Charadrius veredus	Oriental Plover	MG	S5				•																			
Calidris ferruginea	Curlew Sandpiper	CR	S3					•																		
Tringa glareola	Wood Sandpiper	MG	S5																						•	
Rostratula australis	Australian Painted Snipe	EN	EN					•																		

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area														Current Survey
Species	Common Name	EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ecologia (2006)	ENV (2009)	Biologic (2010)	Ecologia (1998a)	HGM (1999)	Ecologia (2004b)	Ecologia (2005a)	ENV 2007)	Ecologia (2008)	Outback Ecology (2008)	ENV (2008b)	SZ (2008a)	Specialised Zoological (2008b)	Biota (2010)	Biologic (2011)	Biota (2013)	Biologic (2013c)	
Pezoporus occidentalis	Night Parrot	CR	S1		CE			•																	
Merops ornatus	Rainbow Bee-eater	MG	S5				•	•	•	•	•	•	•			•	•	•	•			•	•	•	•	•
Hirundo rustica	Barn Swallow	MG	S5					•																		
Motacilla cinerea	Grey Wagtail	MG	S5																							
Motacilla flava	Yellow Wagtail	MG	S5																							
REPTILES																										
Anilios ganei			P1				•									•							•			
Liasis olivaceus barroni	Pilbara Olive Python	VU	VU				•	•					•					•							•	

708000 709000 710000 711000 712000 713000 714000 715000 716000 717000 718000 719000 720000 721000 722000 723000

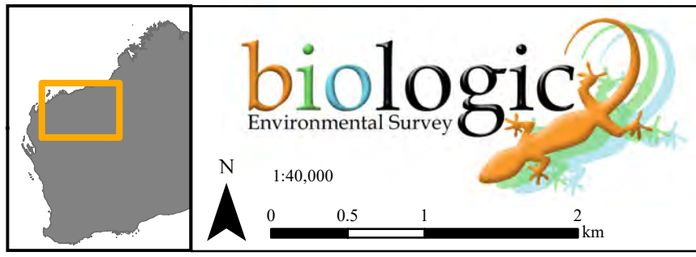
7477000 7476000 7475000 7474000 7473000 7472000 7471000 7470000 7469000

Legend

- Study Area
- Pilbara Rail

Conservation Significant Species, survey

- Chocolate Wattled Bat, Current survey
- Ghost Bat, Biologic (2010)
- Rainbow Bee Eater, Current survey
- Rainbow Bee Eater (nest), Current survey
- Rainbow Bee Eater, Biologic (2010)
- Western Pebble Mound Mouse, Current survey
- Western Pebble Mound Mouse, Biologic (2010)
- Western Pebble Mound Mouse, ENV (2009)
- Western Pebble Mound Mouse, Ecologia (2006)



biologic Environmental Survey

BHP Ministers North Project
Level 2 Vertebrate Fauna Survey

Fig. 4.10: Records of conservation significant fauna

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 12/10/2017

4.5 Fauna habitats occurring within the Study Area

Following extensive habitat assessments and review of previous surveys, four (4) fauna habitat types were identified throughout the Study Area, as follows:

- Gorge/Gully
- Hillcrests/slopes
- Major Drainage Line
- Minor Drainage Line

A fifth 'habitat type' has also been mapped and described (Disturbed); however, these areas do not provided habitat suitable for vertebrate fauna.

Descriptions of the distinguishing characteristics and the occurrence inside and outside of the Study Area for each of these habitat types are presented in Table 4.4 and the data from on-site habitat assessments are presented in Appendix F. Figure 4.11 shows the extent of fauna habitats and features throughout the Study Area.

Significant fauna habitat occurring within the Study Area includes two recently recorded caves (MN01 and MnA), classified as possible Ghost Bat night roosts (Figure 4.11). A rock pool has also been previously recorded within Minor Drainage Line habitat (Figure 4.11); however, it is unlikely to provide a permanent water source. Details of these habitat features are provided in Appendix G.

Table 4.5: Fauna habitat descriptions

Habitat	Distinguishing habitat characteristics	Occurrence of the habitat within the Study Area	Extent of the habitat outside Study Area	Photo
Gorge/ Gully	Gorges and gullies are rugged, steep-sided valleys incised into the surrounding landscape. Gorges tend to be deeply incised, with vertical cliff faces, while gullies are more open (but not as open as Drainage Area or Valleys). Caves and rock pools are most often encountered in this habitat type. Vegetation can be dense and complex in areas of soil deposition or sparse and simple where erosion has occurred.	Run along Major and Minor Drainage Lines throughout the entire Study Area. Uncommon in the north-east sections where plains dominate.	These are common habitats associated with the ranges. However, because this habitat type is narrow and linear, they only represent a small proportion of the total land area.	
Hillcrests/ slopes	These fauna habitats tend to be more open and structurally simple than other fauna habitats, and are dominated by varying species of spinifex. Common features of these habitats are rocky substrates, often with exposed bedrock, and skeletal red soils. This habitat is usually dominated by *Eucalyptus* woodlands, *Acacia* and *Grevillea* scrublands and *Triodia* low hummock grasslands.	Covers extensive parts of the Study Area along the southern and western areas	A very common habitat feature in the region, occurring wherever there are ridges and low rises.	
Major Drainage Line	Major Drainage Lines comprise mature River Red Gums/ Coolabahs over dry river pools. Open, sandy or gravelly riverbeds characterise this habitat type. In non-grazed areas, the vegetation adjacent to the main channel or channels is denser, taller and more diverse than adjacent terrain.	The Major Drainage Line within the Study Area runs north-east from the south to the north-eastern corner of the Study Area	Common habitat throughout the Pilbara, and are generally associated with all major rivers in the Pilbara, such as the Fortescue, De Grey, Yule and Turner rivers. However, because they tend to be relatively narrow, linear features, they only represent a small proportion of the total land area.	

Habitat	Distinguishing habitat characteristics	Occurrence of the habitat within the Study Area	Extent of the habitat outside Study Area	Photo
Minor Drainage Line	Characterised by low and sparse vegetation compared to Major Drainage Lines. Consisted of *Acacia* low woodland sometimes with scattered *Eucalyptus xerothermica* and *Corymbia hamersleyana*. The understorey generally lack density and often consists solely of sparse tussock grassland, often of **Cenchrus ciliaris* where it has been introduced. The substrate can be sandy in places but generally consists of a loam gravel or stone.	Minor Drainage Lines run throughout the Study Area, particularly through the central section.	A common habitat in the Hamersley Range and adjacent to the Study Area.	
Disturbed	This habitat zone comprises major road and rail tracks, and cleared areas alongside these, which are not suitable for vertebrate fauna.	A major road and rail track dissects the Study Area. There were no other large cleared areas in the Study Area at the time of survey, although some small rehabilitated areas were observed in the vicinity of the rail track.	This habitat type commonly occurs in active mining tenements, however proportionally it does not cover large areas of the landscape.	N/A

711000 712000 713000 714000 715000 716000 717000 718000 719000 720000 721000 722000

7477000 7476000 7475000 7474000 7473000 7472000 7471000

MNA

MN01

Rock pool

Legend

- Pilbara Rail
- Study Area

Fauna habitat

- Gorge / Gully
- Major Drainage Line
- Minor Drainage Line
- Hillcrests / slopes
- Disturbed

Habitat features

- Cave
- Waterhole

biologic Environmental Survey

N

1:30,000

0 0.5 1 2 km

BHP Ministers North Project
Level 2 Vertebrate Fauna Survey

Fig. 4.11: Vertebrate fauna habitats of the Study Area

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 12/10/2017

4.5.1 Habitats for conservation significant fauna

Each of the four (4) major fauna habitats identified in Table 4.4 was given a significance score of High, Medium or Low based on the likelihood of supporting conservation significant fauna, as outlined in Table 4.5. Within the Study Area, Gorge/Gully and Major Drainage Lines habitats were given High significance scores because they were most likely to support conservation significant species. None of the habitats present are restricted to the Study Area. Refer Figure 4.11 for the extent of each habitat within the Study Area.

Table 4.6: Conservation significance scores of fauna habitats present

Fauna habitat	Score	Rationale
Gorge/Gully	High	Gorge habitats within the Study Area represent potential habitat for numerous species listed under the *EPBC Act* and *WC Act*, such as Pilbara Olive Pythons. This habitat also contains caves and overhangs some of which may provide roosting opportunities for the conservation significant bat species, such as the Ghost Bat and may provide a nocturnal refuge for the Pilbara Leaf-nosed Bats.
Major Drainage Line	High	Rainbow Bee-eaters were recorded from Major Drainage Line habitat during the current survey. This habitat provides suitable nesting habitat for this migratory species. Major Drainage Line provides potential habitat for migratory water birds at any persistent pools following rainfall. Provides potential breeding and foraging habitat for Peregrine Falcon. Provides potential foraging habitat for Ghost Bats and Pilbara Leaf-nosed Bats. Provides habitat and dispersal opportunities for the Pilbara Flat-headed Blind Snake.
Hillcrests/ slopes	Medium	Hillcrest/slope habitat supports local populations of the Western Pebble-mound Mouse. The species is largely restricted to this habitat type.
Minor Drainage Line	Low	This habitat is utilised by several species listed under the DBCA Priority List but does not support a significant population of these species and these species are not restricted to this habitat type.

4.6 Conservation significant fauna with potential to occur in the Study Area

Based on databases searched, previous reports and the types of habitats present within the Study Area, an additional seven (7) conservation significant fauna species are considered to have some potential to occur within the Study Area. This includes two (2) species of mammals, three (3) species of birds, and two (2) species of reptile. Table 5.1 and Appendix E show the known records of these species in the vicinity of the Study Area, and details regarding their conservation status and potential habitats are discussed further below. Within each subsection, species are ordered in relative terms of the likelihood of occurrence within the Study Area.

4.6.1 Mammals with potential to occur

Ghost Bat (*Macroderma gigas*)

In the Pilbara region, the Ghost Bat (IUCN Vulnerable, EPBC Act Vulnerable, *WC Act* Schedule 3) roosts in deep, complex caves beneath bluffs or hills composed of Marra Mamba or Brockman Iron Formation, granite rock piles and abandoned mine shafts (Armstrong & Anstee 2000). Ghost Bats in the Northern Territory have been recorded foraging on average

within 2 km of their day roost each night (Tidemann *et al.* 1985), although this range may be larger in the semi-arid Pilbara region.

The SM2BAT+ recorders used during the survey did not record any Ghost Bat calls, however the Ghost Bat has been previously recorded ~2 km south of the Study Area through observation, scat records and ANABAT recordings (Biologic, 2010). One Ghost Bat roost was recorded adjacent to the Study Area during the Biologic (2010) survey (Figure 4.10). There is a recently recorded cave within the Study Area boundary ("MN01" Figure 4.11), classified as a possible Night Roost, however the ceiling may be too low for regular Ghost Bat use. The Major Drainage Line or Gorge/Gully habitats within the Study Area may possibly be used for hunting by this species considering the close proximity of records.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia)*

The Pilbara Leaf-nosed Bat is classified as Vulnerable under the *EPBC Act* and Schedule 1 under the *WC Act*. The few known roosts of this species are concentrated in five disused mines in the eastern Pilbara, and one gorge system in Barlee Range Nature Reserve (DEWHA 2010a), which are thought to contain most of the region's population. The Pilbara Leaf-nosed Bat has a very limited ability to conserve heat and water and requires very hot (28–32ºC) and humid (96–100%) roost sites in caves and/or abandoned mines (Armstrong 2001). Such caves are relatively uncommon in the Pilbara (Armstrong and Anstee 2000; Armstrong 2001; Armstrong 2006), which limits the availability of diurnal roosts for this species.

Based on previous work on the Area C to Yandi Pipeline (Biologic 2010), Biologic was aware of a cave occurring in Gorge habitat adjacent to a *Melaleuca* woodland with permanent water. It was noted as potential Pilbara Leaf-nosed Bat habitat, however the SM2BAT+ recorders did not record any Pilbara Leaf-nosed Bat calls during either season of the current survey. The species have been previously recorded within 10 km of the Study Area by ENV Australia (2007) and Biota Environmental Sciences (2013). Pilbara Leaf-nosed Bats may utilise a foraging range that extends over the Study Area, however the likelihood of recording this species within the Study Area is not considered high.

4.6.2 Birds with potential to occur

Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is listed under the *WC Act* as "other specially protected fauna" (Schedule 7) and is considered rare over much of its range, including the Pilbara (Johnstone and Storr 1998). In arid areas, it is most often encountered along cliffs above rivers, ranges and wooded watercourses where it hunts birds (Johnstone and Storr 1998). It typically nests on rocky ledges occurring on tall, vertical cliff faces and occasionally within tall trees occurring along Major Drainage Lines (Olsen & Olsen 1989).

The Peregrine Falcon has not been recorded within the Study Area, although it has been sighted in previous surveys within 10 km of the Study Area (Ecologia Environmental 1998; Biologic 2011a; Biologic 2013). Given the widespread nature of this species and its generalist foraging habitat requirements, it may possibly occur within the Study Area. The steep cliff faces

occurring within the Gorge/ Gully habitats may also provide potential breeding habitat for Peregrine Falcon.

Fork-tailed Swift (*Apus pacificus*)

The Fork-tailed Swift (*EPBC Act* Migratory, *WC Act* Schedule 5) is a migratory species that breeds in north-east and east Asia, wintering in Australia and southern New Guinea (Johnstone & Storr 1998). The species is known to be entirely aerial within the Pilbara region and does not utilise the terrestrial surface. It would be reasonably likely to occur in the skies above the Study Area and the wider local area occasionally, possibly being attracted to thunderstorms and cyclonic systems (Johnstone & Storr 1998). Flocks of various sizes have been recorded in the wider local area from previous surveys (Outback Ecology 2008; Biologic 2011a), indicating that the species is likely to be present over the Study Area sporadically as a visitor.

Barn Swallow (*Hirundo rustica*)

The Barn Swallow (*EPBC Act* Migratory, *WC Act* Schedule 5) is a widespread species which includes a number of populations that are migratory over long distances. It builds cup nests in shallow caves and overhangs, and also makes use of human structures (Cornell 2009). The Barn Swallow was listed in the DoE database search as potentially occurring in the vicinity of the Study Area. Given the widespread nature of this species and its generalist habitat requirements, it is reasonably likely to occur within the Study Area occasionally and throughout the wider region; however, it has not been recorded by any surveys conducted in the vicinity of the Study Area.

4.6.3 Reptiles with potential to occur

Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python is listed as Vulnerable under the *EPBC Act* and Schedule 3 under the *WC Act*. This species is primarily nocturnal and tends to shelter in small caves or under vegetation during the day, although it is occasionally active after sunrise, particularly in the warmer summer months (DSEWPaC 2011a). In the winter months, adult pythons can sometimes be found basking in the morning sun (Pearson, 2001 in DSEWPaC 2011a). The breeding season of the Pilbara Olive Python extends from June to August, when males will travel up three kilometres in search of a mate (DSEWPaC 2011a).

The Pilbara Olive Python is known from a number of sites throughout the Pilbara and is associated with drainage systems, including areas with localised drainage and semi-permanent watercourses (DSEWPaC 2011a). In the Hamersley region, the Pilbara Olive Python is most often encountered in the vicinity of permanent waterholes in rocky ranges or among riverine vegetation (Pearson 1993; DSEWPaC 2011a). Pilbara Olive Pythons have been recorded within 10 km of the Study Area, by Halpern Glick Maunsell (1999), Outback Ecology (2008) and Biologic (2013). This most recent record by Biologic (2013) was in Major Drainage Line habitat in Area C West. Based on the presence of rocky Gorge/Gully and Major Drainage Line habitat within the Study Area, Pilbara Olive Pythons have the potential to occur, particularly due to the presence of foraging habitat at the recorded rock pool.

Pilbara Flat-headed Blind Snake (*Anilios ganei*)

The Pilbara Flat-headed Blind Snake (DBCA Priority 1) is endemic to the Pilbara region. Given its cryptic fossorial habit, this species is rarely encountered during surveys. Little is known of the species' ecology but like most other blind snakes, it is insectivorous, feeding on termites and their eggs, and larvae and pupae of ants (Wilson & Swan 2010). This species is known to be associated with moist soils and leaf litter within gorges and gullies (Wilson & Swan 2010), and potentially within a wide range of other stony habitats.

This species has been recorded within Mining Area C (ENV Australia 2007) in an open drainage line and later at a very rocky slope below the vertical wall of a gully and in a Mulga woodland habitat. During the Biologic (2011a) survey it was recorded at two locations, a very rocky slope below the vertical wall of a gully and also in Mulga woodland habitat, showing that the species is not necessarily restricted to gorges and gully systems. Based on the known habitat characteristics and distribution, the Pilbara Flat-headed Blind Snake has the potential to occur within any of the habitats throughout the Study Area.

5 Key Findings

The current survey recorded 116 vertebrate fauna species from the Study Area, comprising 17 mammal species, 54 bird species, 43 reptile species, and two (2) amphibian species. Based upon previous survey records, fauna databases, and current knowledge of species distributions and habitat preferences, approximately 319 fauna species are thought to potentially occur in the local area surrounding the Study Area (within approximately 10 km).

Of these, 25 species are regarded as conservation significant (*i.e.* species listed under relevant federal and state legislation, by IUCN, or by DBCA, or regarded as locally significant). Two (2) conservation significant species and one locally significant species have been recorded within the Study Area, and an additional seven (7) conservation significant species would be expected to occur. The remaining species are considered to have a low potential of occurring.

The conservation significant species recorded within the Study Area are:

- Rainbow Bee-eater, *Merops ornatus* (*EPBC Act* Migratory, *WC Act* Schedule 5) – recorded from two sites during the current survey in suitable breeding habitat in the banks in Major Drainage Line habitat. A nest was found at one of these sites. Suitable foraging habitat exists throughout the Study Area; and
- Western Pebble-mound Mouse, *Pseudomys chapmani* (DBCA Priority 4) – recorded from four trapping sites and two opportunistic sites within the Study Area in Hillcrest/slope habitat.

The current survey also recorded one locally significant species, the Chocolate Wattled Bat (*Chalinolobus morio*). This species was recorded from two sites within the Study Area within Gorge/Gully and Major Drainage Line habitats.

An additional seven (7) species of conservation significant fauna are considered to potentially occur within the Study Area, based on previous survey records, fauna databases and habitats present, comprising:

- Ghost Bat, *Macroderma gigas* (*EPBC Act* Vulnerable, IUCN Vulnerable, *WC Act* Schedule 3) – recorded adjacent to the Study Area during a previous survey (Biologic 2010) and suitable foraging habitat is present in the Study Area;
- Pilbara Leaf-nosed Bat, *Rhinonicteris aurantia,* (*EPBC Act* Vulnerable, *WC Act* Schedule 3) – may possibly utilise a foraging range that extends over the Study Area;
- Barn Swallow, *Hirundo rustica* (*EPBC Act* Migratory, *WC Act* Schedule 5) – considered likely to occur occasionally, based on generalist habitat requirements;
- Peregrine Falcon, *Falco peregrinus* (*WC Act* Schedule 7) – may possibly occur occasionally, based on generalist feeding habitat requirements and the presence of potential breeding habitat along cliff faces in the Study Area;
- Fork-tailed Swift, *Apus pacificus* (*EPBC Act* Migratory, *WC Act* Schedule 5) – considered likely to occur occasionally in the skies above the Study Area;

- Pilbara Olive Python (*EPBC Act* Vulnerable, *WC Act* Schedule 3) – likely to occur in Gorge/Gully and Major Drainage Line habitats based on habitat requirements and local area records; and
- Pilbara Flat-headed Blind Snake, *Anilios ganei* (DBCA Priority 1) – may possibly occur occasionally in any of the habitats throughout the Study Area.

Based on the habitat assessments conducted, the Study Area was classified into four (4) broad habitat types occurring within three major landform categories, with an additional unit mapped for 'Disturbed' areas. These habitats extend throughout the Study Area and the immediate surrounding area beyond the Study Area boundaries. Of the habitats recorded, the following were found to be most suitable for potential conservation significant species:

- Major Drainage Lines – Confirmed occurrence of Rainbow Bee-eater and the Chocolate Wattled Bat. Provides potential foraging habitat for Ghost Bats. Also considered potential habitat for Peregrine Falcon. Provides likely habitat and dispersal opportunities for the Pilbara Flat-headed Blind Snake;
- Gorge/Gully – Confirmed occurrence of Chocolate Wattled Bat. Provides potential roosting and foraging habitat for Ghost Bats and Pilbara Leaf-nosed Bats. Also provides potential habitat for Pilbara Olive Python and the Pilbara Flat-headed Blind Snake.
- Hillcrest/slope – Confirmed occurrence of Western Pebble-mound Mouse. This species is mainly restricted to this core habitat type. Also provide potential habitat for the Pilbara Flat-headed Blind Snake.

6 References

Atlas of Living Australia (ALA) (2017). http://www.ala.org.au/. Accessed March 2017.

Armstrong, K., & Anstee, S. (2000). The ghost bat in the Pilbara: 100 years on. Australian Mammalogy, 22(2), 93-101. doi: http://dx.doi.org/10.1071/AM00093

Armstrong, K. (2001). The roost habitat and distribution of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia. *Wildlife Research*, **28**: 95–104.

Armstrong, K. (2006). Phylogeographic structure in *Rhinonicteris aurantia* (Chiroptera: Hipposideridae): implications for conservation. *Acta Chiropterologica*, **8**: 63–81.

Beard, J. S. (1980). A new phytogeographic map of Western Australia. Western Australian Herbarium Research Notes, 3, 45.

BHP Billiton Iron Ore (BHPBIO) (2010a) Terrestrial Fauna Habitat Assessment Proforma (FRM-IEN-EMS-003) (BHPBIO 2010a). Perth, WA.

BHP Billiton Iron Ore (BHPBIO) (2010b) Western Australia Projects Biological Survey Data Templates (FRM-IEN-EMS-002) Perth, WA.

BHP Billiton Iron Ore (BHPBIO) (2014) Biodiversity Survey Spatial Data and Digital Photography Requirements (SPR-IEN-EMS-015) v5.0. Perth, WA.

BHP Billiton Iron Ore (BHPBIO) (2016) Guidance for Vertebrate Fauna Surveys in the Pilbara (SPR-IEN-EMS-012) v3.0. Perth, WA.

Biologic Environmental Survey (2010). Area C to Yandi Fauna Survey. Unpublished report for BHP Billiton Pty Ltd.

Biologic Environmental Survey (2011a). Area C and Surrounds Fauna Survey. Unpublished report for BHP Billiton Pty Ltd.

Biologic Environmental Survey (2011a). Yandi Vertebrate Fauna Review. Unpublished report for BHP Billiton Pty Ltd.

Biologic Environmental Survey (2013). Mining Area C – Desktop Review of Baseline Information on Vertebrate Fauna. Unpublished report for BHP Billiton Pty Ltd.

Biologic Environmental Survey (2014). Mining Area C Vertebrate Fauna Desktop Review. Unpublished report for BHP Billiton Pty Ltd.

Biota (2010). Yandicoogina Junction South West and Oxbow Fauna Survey. Unpublished report for Rio Tinto Iron Ore.

Biota (2013). Area C West to Yandi Level 2 Vertebrate Fauna Survey. Unpublished report for BHP Billiton Pty Ltd.

Bureau of Meteorology. (2017). Data Services, from http://www.bom.gov.au/climate/data-services/

Christidis, L., & Boles, W. (2008). Systematics and Taxonomy of Australian Birds. Collingwood, Australia: CSIRO.

Churchill, S.K. (2008). *Australian Bats*. 2nd Edition. Allen and Unwin, Crows Nest, NSW.

Commonwealth Scientific and Industrial Research Organisation. (CSIRO) (2009). Australian Soil and Land Survey Field Handbook, 3rd Edition. Collingwood, Australia: CSIRO Publishing.

Cornell Lab of Ornithology, Cornell University (2009). All About Birds. Available from: http://www.allaboutbirds.org/guide/barn_swallow/lifehistory.

Department of Environment and Energy (2017). Protected Matters Search Tool. Available from: http://www.environment.gov.au/epbc/protected-matters-search-tool. Accessed March 2017

Department of Environment, Water, Heritage and the Arts. (DEWHA) (2010a). Survey Guidelines for Australia's Threatened Mammals. Canberra, ACT.

Department of Environment, Water, Heritage and the Arts. (DEWHA) (2010b). Survey Guidelines for Australia's Threatened Birds. Canberra, ACT.

Department of Environment, Water, Heritage and the Arts. (DEWHA) (2010c). Survey Guidelines for Australia's Threatened Frogs. Canberra, ACT.

Department of Environment, Water, Heritage and the Arts. (DEWHA) (2010d). Survey Guidelines for Australia's Threatened Reptiles. Canberra, ACT.

Department of Environment, Water, Heritage and the Arts. (DEWHA) (2010e). Survey Guidelines for Australia's Threatened Bats.

Department of Parks and Wildlife (2017). *NatureMap: Mapping Western Australia's Biodiversity*. Database: http://naturemap.dec.wa.gov.au/default.aspx. Date accessed March 2017.

Department of Water. (2012). Pilbara Retrieved 25 September 2012, 2012, from http://www.water.wa.gov.au/Understanding+water/Priority+water/Pilbara/default.aspx

Ecologia Environmental Consultants (1998) Mining Area C Biological Survey. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (2004) Area C: Deposits D, E and F Biological Survey. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (2005). Mining Area C Expansion Deposit E Bat Assessment. Unpublished report for BHP Billiton Pty Ltd.

Ecologia Environmental Consultants (2006) Ministers North Biological Survey. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (2009). Marillana Iron Ore Project Vertebrate Fauna Assessment. Brockman Resources Limited.

ENV Australia (2007) Area C R-deposit Fauna Assessment. Unpublished report for BHP Billiton Iron Ore.

ENV Australia (2008). Area C Southern Flank Deposit Fauna Assessment. Unpublished report for BHP Billiton Pty Ltd.

ENV (2009). Munjina And Ministers North (Yandi Hub) Fauna Assessment. Unpublished report for BHP Billiton Pty Ltd.

Environmental Protection Authority (EPA) (2002) Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection. Perth, WA.

Environmental Protection Authority (EPA) (2004) Guidance for the Assessment of Environmental Factors (in accordance with the *Environmental Protection Act 1986*). Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. No. 56. Perth, WA.

Environmental Protection Authority and Department of Environment and Conservation (EPA & DBCA) (2010) Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (Eds B.M. Hyder, J. Dell and M.A Cowan). Perth, Western Australia

Higgins, P.J., ed. (1999). Handbook of Australian, New Zealand and Antarctic Birds Volume 4: Parrots to Dollarbird. Melbourne: Oxford University Press.

Halpern Glick Maunsell (HGM) (1999). Marillana Creek Western Access Corridor – Biological Assessment. Unpublished report for BHP Billiton Iron Ore

IUCN (2012). IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.

Johnstone, R., & Storr, G. M. (1998). Handbook of Western Australian Birds Volume 1 - Non-passerines (Emu to Dollarbird). Perth, Australia: Western Australian Museum.

Kendrick, P. (2001) Pilbara 3 (PIL3 – Hamersley subregion). In: May, J. and McKenzie, N (Eds.) A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management, Perth.

Leighton, K. A. (2004). Climate An inventory and condition survey of the Pilbara region, Western Australia. technical Bulletin 92. (pp. 19-38). Perth, Australia: Department of Agriculture.

McKenzie, N. L., van Leeuwen, S., & Pinder, A. M. (2009). Introduction to the Pilbara Biodiversity Survey, 2002-2007 A Biodiversity Survey of the Pilbara region of Western Australia, 2002-2007. Records of the Western Australian Museum Supplement 78 (pp. 3-89). Perth: Western Australian Museum.

Olsen, P. D., & Olsen, J. (1989). Breeding of the peregrine falcon *Falco peregrinus*. III. Weather, nest quality and breeding success. Emu, 89(1), 6-14.

Outback Ecology Services (2008). Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

Pearson, D. (1993). Distribution, status and conservation of pythons in Western Australia. In D. Lunney & D. Ayers (Eds.), Herpetology in Australia: a diverse discipline. Sydney: Royal Zoological Society of New South Wales.

Specialised Zoological (2008a). Survey for conservation significant bats between Kurrajura siding and the Yandi Wye. Unpublished report for BHP Billiton Iron Ore Pty Ltd

Specialised Zoological (2008b). Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment. Unpublished report for BHP Billiton Iron Ore Pty Ltd and Resource Strategies.

State of Western Australia (2015) Western Australian Government Gazette. No. 166 Tuesday, 3 November 2015, Perth Western Australia.

Thackway, R., & Creswell, I. D. (1995). An interim biogeographic regionalisation for Australia: a framework for establishing the national system of reserves. Version 4.0. Canberra: Australian Nature Conservancy Agency.

Tidemann, C., Priddel, D., Nelson, J., & Pettigrew, J. (1985). Foraging Behaviour of the Australian Ghost Bat, *Macroderma gigas* (Microchiroptera: Megadermatidae). Australian Journal of Zoology, 33(5), 705-713. doi: http://dx.doi.org/10.1071/ZO9850705

Van Dyck, S., & Strahan, R. (Eds.). (2008). Mammals of Australia 3rd Edition. Sydney: Australian Museum.

Western Australian Museum. (WAM) (2016). Checklist of the terrestrial vertebrate fauna of Western Australia, April 2015, Accessed March 2017. Available online from http://museum.wa.gov.au/research/departments/terrestrial-zoology/checklist-terrestrial-vertebrate-fauna-western-australia

Wilson, S., & Swan, G. (2010). A complete Guide to Reptiles of Australia. Sydney, Australia: New Holland Publishers.

7 Appendices

Appendix A: Guidance documents considered during the survey

Author	Year	Guidance document
EPA	2002	Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002)
EPA	2016	Technical Guidance Terrestrial Fauna Surveys (previously Guidance Statement No. 56, 2004) (EPA 2016a)
EPA	2016	Technical Guidance Sampling Methods for Terrestrial Vertebrate Fauna (previously Technical Guide for Environmental Impact Assessment, 2010) (EPA 2016b)
DoE	2010	Survey Guidelines for Australia's Threatened Mammals (DEWHA 2010a)
DoE	2010	Survey Guidelines for Australia's Threatened Birds (DEWHA 2010b)
DoE	2010	Survey Guidelines for Australia's Threatened Frogs (DEWHA 2010c)
DoE	2010	Survey Guidelines for Australia's Threatened Reptiles (DEWHA 2010d)
DoE	2010	Survey Guidelines for Australia's Threatened Bats (DEWHA 2010e)
BHP Iron Ore	2010	Western Australia Projects Biological Survey Data Templates (FRM-IEN-EMS-002) (BHPBIO 2010b)
BHP Iron Ore	2014	Biological Survey Spatial Data and Digital Photography Requirements (SPR-IEN-EMS-015) (BHPBIO 2014)
BHP Iron Ore	2016	Guidance for Vertebrate Fauna Surveys in the Pilbara (SPR-IEN-EMS-012) (BHPBIO 2016)

Appendix B: Survey effort and details of reports reviewed (excluding desktop reviews)

Survey	Ministers North Biological Survey	Munjina and Ministers North (Yandi Hub) Fauna Assessment	Area C to Yandi Fauna Survey	Mining Area C Biological Survey	Marillana Creek Western Access Corridor – Biological Assessment	Area C: Deposits D, E and F Biological Survey	Mining Area C Expansion Deposit E Bat Assessment	Area C R Deposit Fauna Assessment	Marillana Creek (Yandi) Iron Ore Mine Modification Level 2 Survey	Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: T Terrestrial Vertebrate Fauna Assessment	Area C Southern Flank Deposit Fauna Assessment	Survey for Conservation Significant Bats between Kurrajura siding and the Yandi Wye	Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment	Yandicoogina Junction and Oxbow Fauna Survey	Area C and Surrounds Fauna Study	Area C West to Yandi Level 2 Vertebrate Fauna Survey	Area C West (Biologic 2013c)
Consultant	Ecologia Environment	ENV Australia	Biologic	Ecologia Environment	Halpern Glick Maunsell	Ecologia Environment	Ecologia Environment	ENV Australia	Ecologia Environment	Outback Ecology	ENV Australia	Specialised Zoological	Specialised Zoological	Biota Environmental Sciences	Biologic	Biota Environmental Sciences	Biologic
Year	2006	2009	2010	1998	1999	2004	2005	2007	2008	2008	2008	2008a	2008b	2010	2011a	2013	2013b
Type	Level 1	Single Phase Level 2	Level 1	Single Phase Level 2	Level 1	Single Phase Level 2	Targeted Survey	Single Phase Level 2	Single Phase Level 2	Single Phase Level 2	Level 1	Targeted Bat Survey	Targeted Bat Survey	Single Phase Level 2	Two Phase Level 2	Level 2	Level 2
Duration	10-14 May 2006	21 Nov-2 Dec 2007	13-20 Sept 2010	14-30 Apr 1998	23-30 Apr 1999	28 May-7 Jun 2004	6-8 Sep 2005	22-27 Nov 2006	25 Apr-7 May 2008; 30 Aug-10 Sep 2008	17-31 Mar 2008	30 Jan-6 Feb 2008	2-8 Oct 2008	17-24 April 2008	5-12 July 2008	5-18 Oct 2009; 20 Mar-1 May 2010	25 May-2 June 2011; 7-15 Sept 2011; 5-8 Feb 2012	18 April – 1 May; 12-25 September; 3-14 October 2011
No. of trapping sites	0	5	0	11	0	6	0	4 full sites, 2 Elliott only sites.	6	4 full sites, 1 Funnel / Elliott only site	0	0	0	11	12 Sites. 5 run both Phases, 3 run first Phase only, 5 run second Phase only	23	27
Trapping site configuration	N/A	Ten units of: fence, 1 bucket, two pot traps, 2 funnel traps. 1 Elliott and cage per line	N/A	CALM Pilbara grid	N/A	Linear transect or Grid. Varied, inconsistent.	N/A	2 pot traps, 2 funnels, 10 Elliott, 5 Cages	5 pipe/buckets, 20 Elliott, 20 Funnell, 2 Cage	Linear transect or Grid. Varied, inconsistent.	N/A	N/A	N/A	Six grids of 10 pit-traps, 3 funnel trap sites of 20 traps/site, and two lines of Elliotts	Linear transect. 5 Bucket, 5 PVC, 20 Funnel, 20 Elliott, 2 Cage	16 sites of ten pit traps, 5 sites of Elliott, 2 sites of funnel traps	Linear transect. 5 Bucket, 5 PVC, 20 Funnel, 20 Elliott, 2 Cage
Nights trapped	N/A	8	N/A	Average of 5.9, range from 5 to 7	N/A	7	N/A	3 (3 sites), 4 (1 site)	6	Average of 5.6, range 4-7	N/A	N/A	N/A	6	6	8	7
Cage nights	N/A	310	N/A	0	N/A	0	N/A	100	240	48	N/A	N/A	N/A	0	216	0	350
Elliott nights	N/A	310	N/A	1180	N/A	840	N/A	185	2400	590	N/A	N/A	N/A	310	2160	1595	7,000
Funnel nights	N/A	620	N/A	0	N/A	336	N/A	280	2400	149	N/A	N/A	N/A	360	2160	600	7,000
Bucket nights	N/A	310	N/A	265	N/A	210	N/A	0	600	85.5	N/A	N/A	N/A	360	540	1240	1,750
PVC Pipe nights	N/A	0	N/A	265	N/A	210	N/A	0	600	85.5	N/A	N/A	N/A	0	540	1240	1,750
Pot nights [1]	N/A	620	N/A	0	N/A	0	N/A	280	0	0	N/A	N/A	N/A	0	0	0	0
Total Trap nights	N/A	2170	N/A	1710	N/A	1596	N/A	845	6240	958	N/A	N/A	N/A	1030	5616	4675	17,850

Survey	Ministers North Biological Survey	Munjina and Ministers North (Yandi Hub) Fauna Assessment	Area C to Yandi Fauna Survey	Mining Area C Biological Survey	Marillana Creek Western Access Corridor – Biological Assessment	Area C: Deposits D, E and F Biological Survey	Mining Area C Expansion Deposit E Bat Assessment	Area C R Deposit Fauna Assessment	Marillana Creek (Yandi) Iron Ore Mine Modification Level 2 Survey	Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: T Terrestrial Vertebrate Fauna Assessment	Area C Southern Flank Deposit Fauna Assessment	Survey for Conservation Significant Bats between Kurrajura siding and the Yandi Wye	Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment	Yandicoogina Junction and Oxbow Fauna Survey	Area C and Surrounds Fauna Study	Area C West to Yandi Level 2 Vertebrate Fauna Survey	Area C West (Biologic 2013c)
Diurnal search (hrs)	17.16	14.75	36	62.5	Not stated	39.3	Not stated (searched 10 gullies and gorges)	23	5040	5	33	Not stated	Not stated	Not stated	51.2	51	70.13
Nocturnal search (hrs)	2	13.5	N/A	10	Not stated	20	0	Not stated	1690	5	27.25	N/A	0	N/A	48	9.75	~8
Bird surveys (hrs)	16.6	30	4.33	44	Not stated	35	N/A	18.5	3515	22	19	N/A	N/A	10.16	35.3	44.5	70.13
Bird survey method	40 min census at 23 sites	0.5-3 hrs/ location	20 min set time	1 hr set-time period survey, 2 x AM, 1 x mid-day, 1 x PM	Not stated	20 min set time	N/A	Opportunistic	29 censuses	30 or 60 min set time.	Opportunistic	N/A	N/A	19 censuses of 30-40 mins	20 min set time	30-40 min censuses	20 min set time
Bat recording (nights)	4	10	5	0	Not stated	3	2	4	2795	0	6	19	4	11	23	31	Not stated
Bat recording (hrs)	Not stated	52	Not stated	0	Not stated	3	5	5.3	46.5	0	N/A	57	Unknown	N/A	>180	Not stated	Not stated
Bat survey method	ANABAT II	ANABAT II	ANABATTM	Mist nets	Not stated	ANABAT	ANABAT II, cave searches	ANABAT	ANABAT II	Conducted by Specialized Zoological	ANABATTM	Daytime examination, passive and active audio monitoring	ANABATTM SD-1, gully searches, Harp trap, cave entrance examination using video or barrier	One site of harp trapping, two sites of ANABAT recording	ANABAT II and ANABATTM SD-1, gully searches	Harp Traps and ANABAT SD1/ SM2 Recorder	Song Meter 2 Recordings
Limitations	Conditions may have reduced fauna activity levels	Recently burnt Study Area	Heavy rain during one day of surveying, but it did not affect access or survey efforts	No cage traps used. Pre-ANABAT TM and pre-funnel trap use. Single Phase only. Sites 6 and 11 Elliott traps only.	Not stated	The cool winter weather is likely to have reduced the number of reptile species recorded.	Bat survey only	Fire on 24th November. Sites 1, 3, 4 and 6 affected. Pot traps instead of bucket or pipe. Pot traps not used at Sites 1 and 10. Site 6 consisted of Elliotts around a pebble mound. Very limited trapping. Casual bird observations		South-west of survey area was burnt. Trap line configuration and layout varied considerably between sites. Trap line number of nights varied across sites. Bird survey periods varied in length.	Non-systematic bird surveys. No trapping undertaken (Level 1).		Bat survey only	Recently burnt study area.	Bird surveys inconsistent between sites.		

Survey	Ministers North Biological Survey	Munjina and Ministers North (Yandi Hub) Fauna Assessment	Area C to Yandi Fauna Survey	Mining Area C Biological Survey	Marillana Creek Western Access Corridor – Biological Assessment	Area C: Deposits D, E and F Biological Survey	Mining Area C Expansion Deposit E Bat Assessment	Area C R Deposit Fauna Assessment	Marillana Creek (Yandi) Iron Ore Mine Modification Level 2 Survey	Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: T Terrestrial Vertebrate Fauna Assessment	Area C Southern Flank Deposit Fauna Assessment	Survey for Conservation Significant Bats between Kurrajura siding and the Yandi Wye	Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits: Bat Survey and Assessment	Yandicoogina Junction and Oxbow Fauna Survey	Area C and Surrounds Fauna Study	Area C West to Yandi Level 2 Vertebrate Fauna Survey	Area C West (Biologic 2013c)
Notes										Pit traps are not discriminated so a ratio of 50:50 is assumed. Bat survey conducted by Specialized Zoological (separate report)	Report incorrectly states that Fox was recorded in ENV (2007) R Deposit survey				Hair trap sites and camera traps were used. Extensive searches of gully systems and gorges for caves suitable for Ghost Bat and Pilbara Leaf-nosed Bat.		

Appendix C: Locations of SM2BAT+ recorders, motion cameras, habitat assessments and trap sites

Site ID	Start Date	End Date	Trap Nights	Easting	Northing
MN01	16/10/2016	23/10/2016	7	-22.80483	119.07430
MN02	16/10/2016	23/10/2016	7	-22.81643	119.08241
MN03	18/10/2016	25/10/2016	14	-22.81507	119.11617
MN04	18/10/2016	25/10/2016	14	-22.83171	119.13379
MN05	17/10/2016	24/10/2016	14	-22.83077	119.13989
MN06	19/10/2016	26/10/2016	14	-22.83277	119.12748
MN07	19/10/2016	26/10/2016	7	-22.82528	119.10012
MN08	06/04/2017	12/04/2017	6	-22.83313	119.10992
MN09	06/04/2017	12/04/2017	6	-22.83483	119.11007
MN10	06/04/2017	12/04/2017	6	-22.82772	119.12524
MN-BAT01	21/10/2016	23/10/2016	2	-22.80418	119.07329
MN-BAT02	19/10/2016	21/10/2016	2	-22.82558	119.10122
MN-BAT03	25/10/2016	26/10/2016	1	-22.83865	119.13252
MN-BAT04	18/10/2016	20/10/2016	2	-22.81435	119.11646
MN-BAT05	23/10/2016	25/10/2016	2	-22.84818	119.11096
MN-BAT06	20/10/2016	22/10/2016	2	-22.83197	119.11117
MN-BAT07	25/10/2016	26/10/2016	1	-22.84096	119.10191
MN-BAT08	24/10/2016	25/10/2016	1	-22.84009	119.13967
MN-BAT09	25/10/2016	26/10/2016	1	-22.83711	119.14493
MN-BAT10	20/10/2016	22/10/2016	2	-22.84245	119.12364
MN-BAT11	18/10/2016	20/10/2016	2	-22.83182	119.13931
MN-BAT13	22/10/2016	24/10/2016	2	-22.82486	119.13248
MN-BAT14	23/10/2016	25/10/2016	2	-22.81522	119.08228
MN-BAT15	07/04/2017	09/04/2017	2	-22.84472	119.12056
MN-BAT16	07/04/2017	09/04/2017	2	-22.84250	119.12376
MN-BAT17	07/04/2017	10/04/2017	3	-22.81588	119.11623
MN-BAT18	09/04/2017	10/04/2017	1	-22.81628	119.12331
MN-BAT19	09/04/2017	10/04/2017	1	-22.81663	119.12632
MN-BAT20	07/04/2017	10/04/2017	3	-22.81687	119.11592
MN-BAT21	10/04/2017	11/04/2017	1	-22.84857	119.11118
MN-BAT22	10/04/2017	11/04/2017	1	-22.83518	119.10788
MN-BAT23	10/04/2017	11/04/2017	1	-22.83719	119.10414
MN-BAT24	11/04/2017	12/04/2017	1	-22.82942	119.11380
MN-BAT25	11/04/2017	12/04/2017	1	-22.82843	119.12528
MN-BAT26	11/04/2017	12/04/2017	1	-22.83485	119.11397
MN-BAT27	12/04/2017	13/04/2017	1	-22.82704	119.14239
MN-BAT28	12/04/2017	13/04/2017	1	-22.83549	119.11994
MN-BAT29	12/04/2017	13/04/2017	1	-22.82768	119.14564
MN-CAM01	22/10/2016	23/10/2016	1	-22.83238	119.13501
MN-CAM02	22/10/2016	23/10/2016	1	-22.83220	119.13505
MN-CAM03	20/10/2016	04/04/2017	166	-22.82902	119.14251
MN-CAM04	21/10/2016	04/04/2017	165	-22.81751	119.07232
MN-CAM05	21/10/2016	04/04/2017	165	-22.82083	119.07059

Site ID	Start Date	End Date	Trap Nights	Easting	Northing
MN-CAM06	21/10/2016	04/04/2017	165	-22.82448	119.06869
MN-CAM07	21/10/2016	04/04/2017	165	-22.82725	119.09315
MN-CAM08	21/10/2016	04/04/2017	165	-22.82762	119.09388
MN-CAM09	23/10/2016	04/04/2017	163	-22.81508	119.08170
MN-CAM10	23/10/2016	04/04/2017	163	-22.81589	119.08135
MN-CAM11	23/10/2016	04/04/2017	163	-22.81742	119.08108
MN-CAM12	23/10/2016	04/04/2017	163	-22.82956	119.09826
MN-CAM13	23/10/2016	04/04/2017	163	-22.83042	119.10138
MN-CAM14	20/10/2016	04/04/2017	166	-22.82744	119.14520
MN-CAM15	23/10/2016	04/04/2017	163	-22.84070	119.10258
MN-CAM16	23/10/2016	04/04/2017	163	-22.84100	119.10167
MN-CAM17	25/10/2016	04/04/2017	161	-22.84818	119.11115
MN-CAM18	26/10/2016	04/04/2017	160	-22.83707	119.14484
MN-CAM19	26/10/2016	04/04/2017	160	-22.83699	119.14479
MN-CAM20	20/10/2016	04/04/2017	166	-22.82790	119.14719
MN-CAM21	20/10/2016	04/04/2017	166	-22.82644	119.15103
MN-CAM22	20/10/2016	04/04/2017	166	-22.82838	119.14976
MN-CAM23	20/10/2016	04/04/2017	166	-22.82951	119.14855
MN-CAM24	20/10/2016	04/04/2017	166	-22.82990	119.14248
MN-CAM25	20/10/2016	04/04/2017	166	-22.83152	119.13983
MN-CAM26	21/10/2016	04/04/2017	165	-22.81541	119.07335
MN-HAB01	21/10/2016	21/10/2016	-	-22.83241	119.12669
MN-HAB02	23/10/2016	23/10/2016	-	-22.81529	119.08230
MN-HAB03	23/10/2016	23/10/2016	-	-22.82838	119.09822
MN-HAB04	24/10/2016	24/10/2016	-	-22.84590	119.12948
MN-HAB05	11/04/2017	11/04/2017	-	-22.83718	119.11088
MN-HAB06	11/04/2017	11/04/2017	-	-22.81782	119.13969
MN-Nightspot 1	13/04/2017	13/04/2017	-	-22.84845	119.11681
MN-Nightspot 2	13/04/2017	13/04/2017	-	-22.83957	119.13158
MN-Nightspot 3	13/04/2017	13/04/2017	-	-22.82627	119.14269

Appendix D: Conservation status codes

International Union for Conservation of Nature

Category	Definition
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CE)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Environment Protection and Biodiversity Conservation Act 1999

Category	Definition
Extinct (EX)	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (EW)	Taxa known to survive only in captivity.
Critically Endangered (CE)	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 high risk of extinction in the wild in the medium-term future.
Migratory (MG)	Consists of species listed under the following International Conventions: Japan-Australia Migratory Bird Agreement (JAMBA) China-Australia Migratory Bird Agreement (CAMBA) Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention)

Wildlife Conservation Act 1950

Category	Definition
Schedule 1 (S1)	Critically Endangered
Schedule 2 (S2)	Endangered
Schedule 3 (S3)	Vulnerable
Schedule 4 (S4)	Presumed Extinct
Schedule 5 (S5)	Migratory
Schedule 6 (S6)	Conservation Dependent
Schedule 7 (S7)	Other Specially Protected Fauna

Department of Environment and Conservation

Category	Definition
Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4 (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

Appendix E: All fauna recorded from databases and surveys.

Note: Grey font indicates species locally extinct or highly unlikely to occur.

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
MAMMALS																									
TACHYGLOSSIDAE																									
Tachyglossus aculeatus	Echidna											•										•		•	
DASYURIDAE																									
Dasykaluta rosamondae	Little Red Kaluta						•			•		•		•		•	•	•	•				•	•	•
Dasyurus hallucatus	Northern Quoll	EN	S1		EN		•	•																	•
Ningaui ridei																									•
Ningaui timealeyi	Pilbara Ningaui						•			•		•	•	•			•	•				•	•	•	•
Planigale ingrami	Long-tailed Planigale						•			•														•	•
Planigale sp. 1	Undescribed Pilbara planigale											•		•		•	•		•				•		•
Pseudantechinus woolleyae	Woolley's Pseudantechinus						•				•												•		•
Sminthopsis macroura	Stripe-faced Dunnart						•					•		•			•		•				•	•	
Sminthopsis ooldea	Ooldea Dunnart						•					•													
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart						•												•						
THYLACOMYIDAE																									
Macrotis lagotis	Bilby, Dalgyte	VU	S1		VU			•																	
MACROPODIDAE																									
Osphranter robustus erubescens	Euro, Biggada						•		•	•	•	•	•	•		•	•	•	•				•	•	•
Osphranter rufus	Red Kangaroo, Marlu						•			•								•	•						•
Petrogale rothschildi	Rothschild's Rock-wallaby						•		•		•	•						•	•				•	•	•
MEGADERMATIDAE																									
Macroderma gigas	Ghost Bat	VU	S3		VU		•	•			•												•		•
HIPPOSIDERIDAE																									
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1					•								•								•	
EMBALLONURIDAE																									
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat						•		•	•	•			•			•				•	•	•	•	•	•
Taphozous georgianus	Common Sheathtail-bat						•		•	•	•			•	•	•	?		•		•	•	•	•	•	•
Taphozous hilli	Hill's Sheathtail-bat						•					•					?		•				•	•		
MOLOSSIDAE																									
Chaerophon jobensis	Northern Freetail-bat						•		•	•	•		•			•	•		•				•	•	•	•
Ozimops lumsdenae	Beccari's Freetail-bat								•	•				•		•	•		•		•		•	•	•	•

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Mormopterus loriae	Little Northern Freetail-bat						•																		
Mormopterus planiceps	Southern Freetail-bat											•													
Tadarida australis	White-striped Freetail-bat										•		•	•			•					•		•	•	
VESPERTILIONIDAE																										
Chalinolobus gouldii	Gould's Wattled Bat						•		•	•	•	•	•	•		•	•		•		•	•	•	•	•	•
Chalinolobus morio	Chocolate Wattled Bat					LOCAL	•																	•		•
Nyctophilus daedalus	North-western Long-eared Bat						•		•															•		
Nyctophilus geoffroyi	Lesser Long-eared Bat						•		•	•	•					•			•				•	•	•	•
Scotorepens greyii	Little Broad-nosed Bat						•		•	•	•	•		•		•	•		•		•	•	•	•	•	•
Vespadelus finlaysoni	Finlayson's Cave Bat						•		•	•	•	•		•	•	•			•		•	•	•	•	•	•
MURIDAE																										
Leggadina lakedownensis	Short-tailed Mouse			P4																					•	
**Mus musculus*	House Mouse						•	•		•			•				•		•				•		•	•
Notomys alexis	Spinifex Hopping-mouse																									
Pseudomys chapmani	Western Pebble-mound Mouse			P4			•		•	•	•	•	•	•		•	•	•				•	•	•	•	•
Pseudomys desertor	Desert Mouse						•									•	•		•				•		•	•
Pseudomys hermannsburgensis	Sandy Inland Mouse						•			•		•	•	•			•	•	•			•	•	•	•	•
Zyzomys argurus	Common Rock-rat						•			•		•		•		•	•	•	•			•	•	•	•	
BOVIDAE																										
**Bos taurus*	European Cattle						•			•	•	•	•					•				•	•	•	•	
CANIDAE																										
**Canis lupus dingo*	Dingo						•			•		•	•	•				•	•				•		•	
**Canis lupus*	Dog							•									•							•		
**Vulpes vulpes*	Red Fox							•		•																
CAMELIDAE																										
**Camelus dromedarius*	Dromedary, Camel						•	•		•														•		
EQUIDAE																										
**Equus asinus*	Donkey							•			•												•			
**Equus caballus*	Horse							•																	•	•
FELIDAE																										
**Felis catus*	Cat						•	•		•	•	•		•			•	•								•	•
LEPORIDAE																										
**Oryctolagus cuniculus*	Rabbit							•																		

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
BIRDS																									
CASUARIIDAE																									
Dromaius novaehollandiae	Emu						•			•		•	•						•					•	•	
PHASIANIDAE																									
Coturnix pectoralis	Stubble Quail																	•				•			
Coturnix ypsilophora	Brown Quail						•			•									•						•	•
ANATIDAE																									
Chenonetta jubata	Australian Wood Duck																								•	
Anas gracilis	Grey Teal												•									•			•	
Anas superciliosa	Pacific Black Duck						•				•		•											•	•	
Dendrocygna eytoni	Plumed Whistling-duck																								•	
PELECANIDAE																									
Pelecanus conspicillatus	Australian Pelican						•																	•		
PROCELLARIIDAE																									
Macronectes giganteus	Southern Great Petrel	EN	S5				•																			
RALLIDAE																									
Gallirallus philippensis	Buff-banded Rail																									
Porzana tabuensis	Spotless Crake						•																			
COLUMBIDAE																									
Geophaps plumifera ferruginea	Spinifex Pigeon						•		•	•	•	•		•		•	•	•	•			•	•	•	•	•
Geopelia cuneata	Diamond Dove						•		•	•		•		•		•	•	•	•			•	•	•	•	•
Geopelia striata placida	Peaceful Dove						•			•	•	•				•	•					•	•			•
Ocyphaps lophotes	Crested Pigeon						•		•	•	•	•		•		•	•	•	•			•	•	•	•	•
Phaps chalcoptera	Common Bronzewing						•		•	•	•	•				•	•	•	•				•	•	•	•
PODARGIDAE																									
Podargus strigoides	Tawny Frogmouth								•		•	•	•	•		•							•	•	•	
EUROSTOPODIDAE																									
Eurostopodus argus	Spotted Nightjar						•		•	•		•	•	•		•		•	•				•	•	•	•
AEGOTHELIDAE																									
Aegotheles cristatus	Australian Owlet-nightjar						•		•	•		•		•		•		•	•				•	•	•	•
APODIDAE																									
Apus pacificus	Fork-tailed Swift	MG	S5				•	•										•					•			
ANHINGIDAE																									

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Anhinga novaehollandiae	Australasian Darter																							•	•	
PHALACROCORACIDAE																										
Phalacrocorax melanoleucos	Little Pied Cormorant												•									•				
Phalacrocorax sulcirostris	Little Black Cormorant																									
Phalacrocorax varius	Pied Cormorant						•																	•		
ARDEIDAE																										
Ardea ibis	Cattle Egret	MG	S5					•																		
Ardea modesta	Eastern Great Egret	MG	S5					•																		
Ardea pacifica	White-necked Heron						•				•		•													
Egretta novaehollandiae	White-faced Heron						•					•	•				•							•		
Nycticorax caledonicus	Nankeen Night-Heron																							•		
THRESKIORNITHIDAE																										
Threskiornis spinicollis	Straw-necked Ibis						•																			
ACCIPITRIDAE																										
Aquila audax	Wedge-tailed Eagle						•			•		•		•		•	•		•				•	•	•	
Accipiter cirrocephalus	Collared Sparrowhawk									•	•	•	•										•		•	
Accipiter fasciatus	Brown Goshawk						•					•	•				•		•				•	•	•	•
Circus assimilis	Spotted Harrier						•			•		•	•			•							•	•	•	•
Elanus caeruleus axillaris	Black-shouldered Kite						•			•						•	•									
Haliastur sphenurus	Whistling Kite						•			•	•	•				•	•	•	•			•	•	•	•	•
Hamirostra isura	Square-tailed Kite						•																			
Milvus migrans	Black Kite						•			•							•	•						•		•
Hamirostra melanosternon	Black-breasted Buzzard						•			•							•						•		•	
Hieraaetus morphnoides	Little Eagle												•			•		•				•	•		•	•
Pandion cristatus	Eastern Osprey	MG	S5																							
FALCONIDAE																										
Falco berigora	Brown Falcon						•		•	•	•	•	•	•		•	•	•	•				•	•	•	•
Falco cenchroides	Nankeen Kestrel						•			•		•		•		•	•		•			•	•	•	•	•
Falco hypoleucos	Grey Falcon		S3																							
Falco longipennis	Australian Hobby						•			•		•	•				•						•	•	•	
Falco peregrinus	Peregrine Falcon		S7									•											•	•	•	
OTIDIDAE																										
Ardeotis australis	Australian Bustard						•			•	•	•	•				•	•					•	•	•	•

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
BURHINIDAE																									
Burhinus grallarius	Bush Stone-curlew																		•						•	
RECURVIROSTRIDAE																										
Himantopus himantopus	Black-winged Stilt															•									•	
CHARADRIIDAE																										
Charadrius veredus	Oriental Plover	MG	S5				•																			
Erythrogonys cinctus	Red-kneed Dotterel						•																			
Elseyornis melanops	Black-fronted Dotterel						•					•	•				•								•	•
SCOLOPACIDAE																										
Calidris ferruginea	Curlew Sandpiper	CR	S3					•																		
Tringa glareola	Wood Sandpiper	MG	S5																						•	
Tringa nebularia	Common Greenshank						•																		•	
ROSTRATULIDAE																										
Rostratula australis	Australian Painted Snipe	EN	EN					•																		
TURNICIDAE																										
Turnix velox	Little Button-quail						•			•		•	•	•		•	•	•	•				•	•	•	•
CACATUIDAE																										
Cacatua roseicapilla	Galah						•			•		•	•	•		•	•	•	•				•	•	•	•
Cacatua sanguinea	Little Corella						•			•		•	•			•	•		•			•		•	•	
Nymphicus hollandicus	Cockatiel						•			•			•				•		•				•	•	•	
PSITTACIDAE																										
Platycercus zonarius zonarius	Australian Ringneck						•		•	•	•	•		•		•	•	•	•			•	•	•	•	•
Platycercus varius	Mulga Parrot						•									•		•	•							
Melopsittacus undulatus	Budgerigar						•		•	•		•	•	•		•	•	•	•				•	•		•
Neopsephotus bourkii	Bourke's Parrot									•		•						•	•						•	
Neophema elegans	Elegant Parrot																								•	
Pezoporus occidentalis	Night Parrot	CR	S1		CE			•																		
CUCULIDAE																										
Centropus phasianinus	Pheasant Coucal																					•				
Chalcites basalis	Horsfield's Bronze-Cuckoo						•		•			•	•	•			•	•				•	•	•	•	
Chalcites osculans	Black-eared Cuckoo											•														
Cacomantis pallidus	Pallid Cuckoo						•		•			•	•	•		•		•					•		•	
STRIGIDAE																										

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Ninox connivens	Barking Owl						•																•		
Ninox boobook	Southern Boobook									•		•	•	•		•			•				•	•	•	•
TYTONIDAE																										
Tyto alba	Barn Owl						•			•																
Tyto javanica	Eastern Barn Owl													•									•			
HALCYONIDAE																										
Dacelo leachii leachii	Blue-winged Kookaburra						•				•		•				•	•				•	•	•	•	•
Todiramphus pyrrhopygius	Red-backed Kingfisher						•				•		•	•		•	•	•	•			•	•	•	•	•
Todiramphus sanctus	Sacred Kingfisher						•			•			•				•							•	•	•
MEROPIDAE																										
Merops ornatus	Rainbow Bee-eater	MG	S5				•	•	•	•	•	•	•			•	•	•	•			•	•	•	•	•
CLIMACTERIDAE																										
Climacteris melanura	Black-tailed Treecreeper											•	•													
PTILINORHYNCHIDAE																										
Ptilonorhynchus maculatus guttatus	Western Bowerbird						•		•	•		•	•	•		•	•	•	•				•	•	•	•
MALURIDAE																										
Amytornis striatus whitei	Striated Grasswren						•		•		•	•	•	•			•	•	•				•		•	
Malurus lamberti assimilis	Variegated Fairy-wren						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Malurus leucopterus leuconotus	White-winged Fairy-wren						•		•		•	•	•	•		•	•	•	•				•	•	•	•
Malurus splendens	Splendid Fairy-wren																		•						•	
Stipiturus ruficeps	Rufous-crowned Emu-wren						•				•	•		•					•				•		•	
ACANTHIZIDAE																										
Pyrrholaemus brunneus	Redthroat						•												•							
Smicrornis brevirostris	Weebill						•		•	•	•	•		•		•	•	•	•			•	•	•	•	•
Gerygone fusca	Western Gerygone						•			•	•	•		•				•	•			•	•	•	•	
Acanthiza apicalis	Inland Thornbill						•					•		•				•	•				•	•	•	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill						•					•							•						•	
Acanthiza robustirostris	Slaty-backed Thornbill											•		•					•						•	
Acanthiza uropygialis	Chestnut-rumped Thornbill						•			•		•							•						•	
PARDALOTIDAE																										
Pardalotus rubricatus	Red-browed Pardalote						•		•		•	•	•			•	•	•	•			•	•	•	•	•
Pardalotus striatus murchisoni	Striated Pardalote						•		•		•	•	•	•		•		•	•			•	•	•	•	•
MELIPHAGIDAE																										

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	Current Survey
Acanthagenys rufogularis	Spiny-cheeked Honeyeater						•		•	•		•		•		•	•	•	•			•	•	•	•	
Certhionyx variegatus	Pied Honeyeater												•			•									•	
Lacustroica whitei	Grey Honeyeater						•											•					•			
Ptilotula keartlandi	Grey-headed Honeyeater						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Ptilotula plumula	Grey-fronted Honeyeater																								•	•
Ptilotula penicillata	White-plumed Honeyeater									•	•	•	•				•	•	•			•	•	•	•	•
Gavicalis virescens	Singing Honeyeater						•			•	•	•	•	•		•	•	•	•			•	•	•	•	•
Lichmera indistincta	Brown Honeyeater						•		•	•		•	•	•		•	•	•				•	•	•		
Melithreptus gularis	Black-chinned Honeyeater						•			•	•	•		•		•			•				•	•	•	
Purnella albifrons	White-fronted Honeyeater						•																•			
Sugomel niger	Black Honeyeater								•				•											•	•	
Manorina flavigula	Yellow-throated Miner						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Epthianura tricolor	Crimson Chat						•		•				•			•			•				•	•	•	
POMATOSTOMIDAE																										
Pomatostomus superciliosus	White-browed Babbler						•			•		•							•						•	
Pomatostomus temporalis rubeculus	Grey-crowned Babbler						•		•	•	•	•	•	•			•	•	•			•	•	•	•	•
CINCLOSOMATIDAE																										
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush																									
Psophodes occidentalis	Chiming Wedgebill																								•	
NEOSITTIDAE																										
Daphoenositta chrysoptera	Varied Sittella											•				•			•							
CAMPEPHAGIDAE																										
Coracina maxima	Ground Cuckoo-shrike						•					•				•			•				•	•	•	•
Coracina novaehollandiae subpallida	Black-faced Cuckoo-shrike						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Lalage tricolor	White-winged Triller						•		•	•		•	•	•		•	•	•	•				•	•	•	
PACHYCEPHALIDAE																										
Pachycephala rufiventris rufiventris	Rufous Whistler						•			•	•	•	•	•		•	•	•	•			•	•	•	•	•
Colluricincla harmonica rufiventris	Grey Shrike-thrush						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Oreoica gutturalis	Crested Bellbird						•		•	•		•	•	•		•	•	•	•			•	•	•	•	
ARTAMIDAE																										
Artamus cinereus	Black-faced Woodswallow						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Artamus cyanopterus	Dusky Woodswallow																									•
Artamus minor	Little Woodswallow						•		•	•	•	•		•		•		•	•			•	•	•	•	•

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Artamus personatus	Masked Woodswallow						•		•			•				•						•		•	•	
Cracticus nigrogularis	Pied Butcherbird						•		•	•	•	•	•	•		•	•	•	•				•	•	•	•
Cracticus tibicen	Australian Magpie						•			•	•	•	•	•		•	•	•	•				•	•	•	•
Cracticus torquatus	Grey Butcherbird						•			•		•		•		•		•	•				•		•	•
HIRUNDINIDAE																										
Hirundo rustica	Barn Swallow	MG	S5					•																		
RHIPIDURIDAE																										
Rhipidura albiscapa	Grey Fantail						•			•	•	•		•		•			•				•	•	•	
Rhipidura leucophrys leucophrys	Willie Wagtail						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
MOTACILLIDAE																										
Motacilla cinerea	Grey Wagtail	MG	S5																							
Motacilla flava	Yellow Wagtail	MG	S5																							
CORVIDAE																										
Corvus bennetti	Little Crow						•					•					•		•							
Corvus coronoides	Australian Raven						•																			
Corvus orru	Torresian Crow						•		•	•	•		•	•		•	•	•	•				•	•	•	
Corvus orru cecilae	Western Crow						•																			•
MONARCHIDAE																										
Grallina cyanoleuca	Magpie-lark						•			•	•	•	•	•		•	•	•	•			•	•	•	•	•
PETROICIDAE																										
Petroica goodenovii	Red-capped Robin						•					•				•	•		•					•	•	
Melanodryas cucullata	Hooded Robin						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
ALAUDIDAE																										
Mirafra javanica	Horsfield's Bushlark						•																	•	•	
ACROCEPHALIDAE																										
Acrocephalus australis	Australian Reed-Warbler						•																	•		
MEGALURIDAE																										
Cincloramphus cruralis	Brown Songlark									•			•											•	•	
Cincloramphus mathewsi	Rufous Songlark									•		•	•			•		•				•	•	•	•	
Eremiornis carteri	Spinifexbird						•		•	•	•	•	•	•		•	•	•					•	•	•	•
Megalurus gramineus	Little Grassbird										•															
HIRUNDINIDAE																										
Cheramoeca leucosterna	White-backed Swallow																									

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Hirundo neoxena	Welcome Swallow															•									
Petrochelidon ariel	Fairy Martin									•			•			•		•						•	•	
Petrochelidon nigricans	Tree Martin						•				•	•	•			•	•						•		•	•	
NECTARINIIDAE																										
Dicaeum hirundinaceum	Mistletoebird						•		•	•		•		•		•			•				•		•	
ESTRILDIDAE																										
Emblema pictum	Painted Finch						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Neochmia ruficauda	Star Finch						•				•			•								•				
Taeniopygia guttata castanotis	Zebra Finch						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
MOTACILLIDAE																										
Anthus novaeseelandiae	Richard's Pipit						•						•			•		•	•				•	•		
REPTILES																										
CHELUIDAE																										
Chelodina steindachneri	Flat-shelled Turtle																								•	
AGAMIDAE																										
Amphibolurus longirostris							•			•	•	•	•	•			•	•				•	•	•	•	•
Caimanops amphiboluroides												•												•	•	
Ctenophorus caudicinctus caudicinctus	Ring-tailed Dragon						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	•
Ctenophorus isolepis	Crested Dragon						•			•		•	•	•			•		•			•	•	•	•	
Ctenophorus nuchalis	Central Netted Dragon						•																			
Ctenophorus reticulatus	Western Netted Dragon						•																		•	
Diporiphora valens										•				•										•	•	
Diporiphora winneckei	Canegrass Dragon									•																
Pogona minor							•					•		•					•				•	•	•	
Tympanocryptis cephalus	Pebble Dragon																								•	
DIPLODACTYLIDAE																										
Crenadactylus ocellatus horni	Clawless Gecko						•		•	•															•	•
Diplodactylus conspicillatus	Fat-tailed Gecko						•			•							•									
Diplodactylus pulcher							•																		•	
Diplodactylus savagei	Yellow-spotted Pilbara Gecko						•					•						•	•				•	•	•	•
Lucasium stenodactylum	Pale-snouted Ground Gecko						•			•				•								•	•	•	•	
Lucasium wombeyi							•			•		•				•			•				•	•	•	
Oedura fimbria																										•

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Oedura marmorata	Marbled Velvet Gecko						•		•	•	•	•		•		•	•	•				•	•	•	•	
Rhynchoedura ornata	Beaked Gecko						•			•			•				•	•					•	•	•	•
Strophurus ciliaris																										
Strophurus elderi							•			•							•						•		•	
Strophurus jeanae							•																		•	
Strophurus stenodactylum																	•									
Strophurus strophurus																										
Strophurus wellingtonae							•			•						•			•				•		•	•
CARPHODACTYLIDAE																										
Nephrurus wheeleri	Banded Knob-tailed Gecko						•																•	•	•	
Underwoodisaurus seorsus	Pilbara Barking Gecko																						•		•	
GEKKONIDAE																										
Gehyra montium																										•
Gehyra pilbara							•			•		•											•	•		
Gehyra punctata	Spotted Rock Dtella						•		•	•		•	•	•		•	•		•				•	•	•	•
Gehyra purpurascens							•																		•	
Gehyra variegata	Tree Dtella						•		•	•		•	•	•		•	•						•	•	•	•
Heteronotia binoei	Bynoe's Gecko						•			•		•	•	•		•	•	•	•				•	•	•	•
Heteronotia spelea	Desert Cave Gecko						•			•				•		•			•				•	•	•	•
PYGOPODIDAE																										
Delma butleri	Unbanded Delma									•		•													•	
Delma elegans	Pilbara Delma						•																•			
Delma haroldi							•			•				•												
Delma nasuta							•							•								•	•	•	•	
Delma pax							•		•			•		•			•	•	•			•	•	•	•	•
Delma tincta							•					•						•					•	•	•	
Lialis burtonis	Burton's legless lizard						•		•	•			•			•	•		•				•	•	•	•
Pygopus nigriceps	Hooded Scaly foot						•			•																
SCINCIDAE																										
Carlia munda							•			•	•	•	•	•		•	•	•	•			•	•	•	•	•
Carlia triacantha	Desert Rainbow Skink						•																•	•		
Cryptoblepharus buchananii							•																		•	
Cryptoblepharus plagiocephalus	Fence or Wall Skink						•			•																•

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Cryptoblepharus ustulatus							•				•												•	•	•	•
Cryptoblepharus sp.									•			•		•		•		•	•						•	
Ctenotus ariadnae																										
Ctenotus duricola							•					•	•	•			•						•	•	•	•
Ctenotus grandis							•																			
Ctenotus hanloni							•					•					•					•				
Ctenotus helenae							•			•				•		•	•						•	•	•	
Ctenotus inornatus																										•
Ctenotus leonhardii												•					•								•	
Ctenotus pantherinus ocellifer	Leopard Ctenotus						•			•		•	•	•		•	•	•	•			•	•	•	•	•
Ctenotus piankai												•														
Ctenotus rubicundus							•		•			•		•			•		•			•	•	•	•	•
Ctenotus rutilans	Pilbara Rusty Ctenotus						•			•		•												•		
Ctenotus saxatilis	Rock Ctenotus						•		•	•	•	•		•		•	•	•	•				•	•	•	•
Ctenotus schomburgkii	Barred Wedge-tailed Ctenotus						•					•		•					•					•	•	
Ctenotus serventyi							•						•										•		•	
Ctenotus uber																									•	
Cyclodomorphus branchialis	Gunther's Skink																									
Cyclodomorphus melanops	Slender Blue-tongue						•			•		•	•			•	•	•	•			•	•	•	•	
Egernia cygnitos	Pygmy Spiny-tailed Skink (western)						•																		•	
Egernia depressa	Pygmy Spiny-tailed Skink						•					•		•										•	•	
Egernia formosa	Crevice Skink						•				•	•				•		•						•	•	•
Egernia pilbarensis	Pilbara Skink								•																	
Eremiascincus fasciolatus	Narrow-banded Sand Swimmer						•					•						•						•	•	
Eremiascincus isolepis																										•
Eremiascincus pallidus	Western Narrow-banded Skink																									•
Eremiascincus richardsonii	Broad-banded Sand Swimmer									•														•		
Lerista bipes							•																			
Lerista labialis							•																			
Lerista muelleri							•		•	•		•							•				•	•	•	•
Lerista neander							•					•				•										
Lerista timida																										
Lerista zietzi							•		•			•	•	•									•	•	•	•

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Menetia greyii	Dwarf Skink						•			•		•		•					•				•	•	•	
Menetia surda							•																		•	
Morethia ruficauda exquisita	Fire-tailed Skink						•		•	•		•		•			•	•	•				•	•	•	•
Notoscincus ornatus																										
Proablepharus reginae							•																		•	
Tiliqua multifasciata	Central Blue-tongue						•			•		•				•	•		•				•	•	•	
VARANIDAE																										
Varanus acanthurus	Spiny-tailed Monitor						•			•		•	•	•			•	•	•				•	•	•	•
Varanus brevicauda	Short-tailed Pygmy Monitor						•											•						•	•	
Varanus bushi	Pilbara Mulga Monitor						•					•		•		•			•				•		•	
Varanus caudolineatus	Stripe-tailed Monitor																		•						•	
Varanus eremius	Desert Pygmy Monitor						•																			
Varanus giganteus	Perentie						•		•		•	•					•	•	•				•		•	•
Varanus gilleni	Pygmy Mulga Monitor									•			•													
Varanus gouldii	Bungarra or Sand Monitor						•																	•	•	
Varanus hamersleyensis	Southern Pilbara Rock Goanna						•																			
Varanus panoptes	Yellow-spotted Monitor						•		•	•		•	•	•			•						•	•	•	•
Varanus pilbarensis	Pilbara Rock Monitor						•		•	•	•	•						•					•		•	•
Varanus tristis tristis	Racehorse Monitor						•							•			•	•	•				•	•	•	•
TYPHLOPIDAE																										
Anilios ammodytes										•								•					•	•		•
Anilios ganei			P1				•									•							•			
Anilios grypus										•													•	•	•	
Anilios hamatus																	•						•			
BOIDAE																										
Antaresia perthensis	Pygmy Python						•					•				•	•						•	•	•	•
Antaresia stimsoni	Stimson's Python						•				•						•		•					•	•	•
Aspidites melanocephalus	Black-headed Python						•					•												•	•	
Liasis olivaceus barroni	Pilbara Olive Python	VU	VU				•	•						•				•							•	
ELAPIDAE																										
Acanthophis wellsi	Pilbara Death Adder						•			•				•		•	•								•	
Brachyurophis approximans							•			•													•		•	•
Demansia psammophis cupreiceps	Yellow-faced Whipsnake						•							•		•	•		•				•	•	•	•

Species		Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey
		EPBC	WCA	DBCA	IUCN	OTHER	Nature Map	Protected Matters	Ministers North (Ecologia 2006)	Munjina and Ministers North (ENV, 2009)	Area C to Yandi (Biologic, 2010)	Mining Area C (Ecologia 1998a)	Marillana Creek Biological Assessment (HGM, 1999)	Area C: Deposits D, E, F (Ecologia 2004b)	Mining Area C Bat Survey (Ecologia 2005a)	Area C R Deposit (ENV 2007)	Marillana Creek Level 2 survey (Ecologia, 2008)	Area C (Outback Ecology 2008)	Area C West (ENV 2008b)	Kurrajura siding and Yandi Wye Bat Survey (SZ, 2008a)	Area C Bat Survey (Specialised Zoological 2008b)	Yandicoogina Junction and Oxbow (Biota, 2010)	Area C and Surrounds (Biologic 2011)	Area C West to Yandi (Biota, 2013)	Area C West (Biologic 2013c)	
Demansia rufescens	Rufous Whipsnake						•						•	•				•	•				•	•	•	•
Furina ornata	Moon Snake						•									•	•	•	•				•	•	•	•
Parasuta monachus	Inland Hooded Snake						•										•						•		•	
Pseudechis australis	Mulga Snake						•		•	•			•			•	•							•	•	•
Pseudonaja mengdeni	Western Brown Snake																	•						•	•	•
Pseudonaja modesta	Ringed Brown Snake						•			•													•	•	•	
Pseudonaja nuchalis	Gwardar						•										•									•
Suta fasciata	Rosen's Snake						•			•		•											•		•	
Suta punctata	Spotted Snake						•																			
Vermicella snelli																										
AMPHIBIANS																										
HYLIDAE																										
Cyclorana maini	Main's Frog						•				•	•					•	•	•				•		•	
Cyclorana platycephala	Water-Holding Frog																									
Litoria rubella	Desert Tree Frog						•		•	•		•				•	•	•					•		•	•
MYOBATRACHIDAE																										
Pseudophryne douglasi	Douglas' Toadlet						•																•			
Uperoleia russelli	Russell's Toadlet						•										•						•			
Uperoleia saxatilis	Pilbara Toadlet						•																			•
LIMNODYNASTIDAE																										
Neobatrachus sutor	Shoemaker Frog																								•	

Appendix F: On site habitat assessments

Site ID	Latitude	Longitude	Date	Season	Habitat Type	Landform	Aspect	Slope	Soil Type; Soil Outcrop	Outcropping	Rock Size; Veg Litter; Soil Availability	Hollow count	Fire history	Disturbances
MN01	-22.80483	119.07429	16/10/2016	1	Minor Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Silty Loam; Limited Outcropping	Limited	Pebbles (5-10cm); Few Small Patches; Scarce	0	Old (6+yr)	Mining Exploration
MN02	-22.81644	119.08241	16/10/2016	1	Hillcrest/ Hillslope	Hillslope	Flat	Flat	Silty Loam; Moderate Outcropping	Moderate	Pebbles (5-10cm); Scarce; Few Small Patches	0	Old (6+yr)	None Discernible
MN03	-22.81507	119.11617	18/10/2016	1	Gorge/ Gully	Medium Drainage Line	Flat	Flat	Sandy Clay Loam; Limited Outcropping	Limited	Boulders (>61cm); Few Small Patches; Many Large Patches	3	Recent (0-2yr)	Mining Exploration
MN04	-22.83171	119.13379	18/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Sandy Loam; Negligible	Negligible	Small Rocks (11-20cm); Scarce; Many Small Patches	2	Recent (0-2yr)	Cattle Grazing
MN05	-22.83077	119.13989	17/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Silty Loam; Minor Outcropping	Minor	Boulders (>61cm); Few Large Patches; Scarce	20	Recent (0-2yr)	Cattle Grazing
MN06	-22.83277	119.12748	19/10/2016	1	Hillcrest/ Hillslope	Hillslope	Flat	Flat	Clayey Sand; Negligible	Negligible	Pebbles (5-10cm); Few Small Patches; Few Large Patches	0	Old (6+yr)	Mining Exploration
MN07	-22.82529	119.10012	19/10/2016	1	Minor Drainage Line	Major Drainage Line	Flat	Flat	Silty Loam; Negligible	Negligible	Pebbles (5-10cm); Many Small Patches; Scarce	0	Old (6+yr)	Cattle Grazing
MN08	-22.83313	119.10992	6/04/2017	2	Minor Drainage Line	Gully	North	Moderate	Clayey Sand; Limited Outcropping	Limited	Boulders (>61cm); Few Small Patches; Few Large Patches	5	Old (6+yr)	Mining Exploration
MN09	-22.83483	119.11006	6/04/2017	2	Hillcrest/ Hillslope	Hillslope	Flat	Flat	Clayey Sand; Limited Outcropping	Limited	Pebbles (5-10cm); Few Small Patches; Few Large Patches	0	Old (6+yr)	Mining Exploration
MN10	-22.82772	119.12524	6/04/2017	2	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	Flat	Flat	Clayey Sand; Negligible	Negligible	Pebbles (5-10cm); Scarce; Few Large Patches	0	Old (6+yr)	Mining Exploration
MN-BAT01	-22.80418	119.07329	21/10/2016	1	Minor Drainage Line	Drainage Area/ Floodplain	Flat	Flat	Silty Loam; Limited Outcropping	Limited	Pebbles (5-10cm); Few Small Patches; Scarce	0	Old (6+yr)	Mining Exploration
MN-BAT02	-22.82559	119.10121	19/10/2016	1	Minor Drainage Line	Major Drainage Line	Flat	Flat	Silty Loam; Negligible	Negligible	Pebbles (5-10cm); Many Small Patches; Scarce	0	Old (6+yr)	Cattle Grazing
MN-BAT03	-22.83865	119.13252	25/10/2016	1	Gorge/ Gully	Cliff	West	Cliff	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Large Patches	0	Recent (0-2yr)	None Discernible
MN-BAT04	-22.81435	119.11646	18/10/2016	1	Gorge/ Gully	Medium Drainage Line	Flat	Flat	Sandy Clay Loam; Limited Outcropping	Limited	Boulders (>61cm); Few Small Patches; Many Large Patches	3	Recent (0-2yr)	Mining Exploration
MN-BAT05	-22.84819	119.11095	23/10/2016	1	Gorge/ Gully	Medium Drainage Line	Flat	Flat	Sandy Loam; Limited Outcropping	Limited	Boulders (>61cm); Many Small Patches; Few Large Patches	5	Old (6+yr)	Road/ Access Track
MN-BAT06	-22.83198	119.11117	20/10/2016	1	Gorge/ Gully	Gully	West	Steep	Silty Loam; Extensive Outcropping	Extensive	Pebbles (5-10cm); Few Small Patches; Few Small Patches	0	Old (6+yr)	Mining Exploration
MN-BAT07	-22.84096	119.10191	25/10/2016	1	Gorge/ Gully	Gully	North/ West	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Many Small Patches	1	Recent (0-2yr)	None Discernible
MN-BAT08	-22.8401	119.13966	24/10/2016	1	Gorge/ Gully	Medium Drainage Line	Flat	Flat	Silty Loam; Limited Outcropping	Limited	Boulders (>61cm); Scarce; Many Small Patches	0	Recent (0-2yr)	None Discernible
MN-BAT09	-22.83711	119.14492	25/10/2016	1	Gorge/ Gully	Gully	West	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Small Patches	0	Old (6+yr)	None Discernible
MN-BAT10	-22.84246	119.12363	20/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Small Patches	0	Recent (0-2yr)	Road/ Access Track
MN-BAT11	-22.83183	119.13931	18/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Silty Loam; Minor Outcropping	Minor	Boulders (>61cm); Few Large Patches; Scarce	20	Recent (0-2yr)	Cattle Grazing
MN-BAT13	-22.82487	119.13248	22/10/2016	1	Gorge/ Gully	Gully	East	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); None Discernible; Many Small Patches	0	Recent (0-2yr)	Road/ Access Track
MN-BAT14	-22.81523	119.08227	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Large Patches	0	Old (6+yr)	None Discernible
MN-BAT15	-22.84473	119.12055	7/04/2017	2	Gorge/ Gully	Cliff	North	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Many Small Patches; Many Small Patches	0	Moderate (3-5yr)	Road/ Access Track
MN-BAT16	-22.8425	119.12375	7/04/2017	2	Gorge/ Gully	Cliff	North	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Small Patches	0	Recent (0-2yr)	Road/ Access Track
MN-BAT17	-22.81589	119.11623	7/04/2017	2	Gorge/ Gully	Cliff	West	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Many Small Patches	0	Recent (0-2yr)	Mining Exploration
MN-BAT18	-22.81628	119.1233	9/04/2017	2	Gorge/ Gully	Gully	North/ West	Steep	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	0	Recent (0-2yr)	Mining Exploration
MN-BAT19	-22.81664	119.12632	9/04/2017	2	Minor Drainage Line	Minor Drainage Line	Flat	Flat	Clayey Sand; Limited Outcropping	Limited	Large Rocks (21-60cm); Few Small Patches; Many Small Patches	0	Recent (0-2yr)	Mining Exploration
MN-BAT20	-22.81688	119.11592	7/04/2017	2	Gorge/ Gully	Breakaway	West	Moderate	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Scarce	0	Recent (0-2yr)	Mining Exploration
MN-BAT21	-22.84857	119.11118	10/04/2017	2	Gorge/ Gully	Gorge	West	Cliff	Sandy Clay Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Many Large Patches; Many Large Patches	5	Old (6+yr)	Road/ Access Track
MN-BAT22	-22.83519	119.10788	10/04/2017	2	Gorge/ Gully	Gully	South	Steep	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Many Small Patches; Few Small Patches	0	Old (6+yr)	Mining Exploration
MN-BAT23	-22.8372	119.10413	10/04/2017	2	Gorge/ Gully	Cliff	South/ West	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Scarce	0	Recent (0-2yr)	Mining Exploration
MN-BAT24	-22.82943	119.1138	11/04/2017	2	Gorge/ Gully	Gully	West	Steep	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Scarce	0	Recent (0-2yr)	Mining Exploration
MN-BAT25	-22.82844	119.12528	11/04/2017	2	Gorge/ Gully	Gorge	West	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Many Small Patches; Scarce	2	Old (6+yr)	Mining Exploration
MN-BAT26	-22.83485	119.11397	11/04/2017	2	Gorge/ Gully	Gully	West	Steep	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	0	Recent (0-2yr)	Mining Exploration
MN-BAT27	-22.82704	119.14238	12/04/2017	2	Gorge/ Gully	Cliff	South/ East	Cliff	Loamy Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	2	Recent (0-2yr)	Mining Exploration

Site ID	Latitude	Longitude	Date	Season	Habitat Type	Landform	Aspect	Slope	Soil Type; Soil Outcrop	Outcropping	Rock Size; Veg Litter; Soil Availability	Hollow count	Fire history	Disturbances
MN-BAT28	-22.8355	119.11993	12/04/2017	2	Gorge/ Gully	Gully	East	Steep	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	0	Recent (0-2yr)	Mining Exploration
MN-BAT29	-22.82769	119.14564	12/04/2017	2	Gorge/ Gully	Gorge	South/ East	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	2	Recent (0-2yr)	Mining Exploration
MN-CAM01	-22.83239	119.13501	22/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Sandy Loam; Negligible	Negligible	Small Rocks (11-20cm); Scarce; Many Small Patches	2	Recent (0-2yr)	Cattle Grazing
MN-CAM02	-22.8322	119.13505	22/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Sandy Loam; Negligible	Negligible	Small Rocks (11-20cm); Scarce; Many Small Patches	2	Recent (0-2yr)	Cattle Grazing
MN-CAM03	-22.82902	119.14251	20/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Silty Loam; Minor Outcropping	Minor	Boulders (>61cm); Few Large Patches; Scarce	20	Recent (0-2yr)	Cattle Grazing
MN-CAM04	-22.81751	119.07231	21/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); None Discernible; Few Small Patches	0	Old (6+yr)	None Discernible
MN-CAM05	-22.82083	119.07058	21/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); None Discernible; Few Small Patches	0	Old (6+yr)	None Discernible
MN-CAM06	-22.82448	119.06869	21/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); None Discernible; Few Small Patches	0	Old (6+yr)	None Discernible
MN-CAM07	-22.82726	119.09314	21/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Small Patches	0	Old (6+yr)	None Discernible
MN-CAM08	-22.82762	119.09387	21/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Small Patches	0	Old (6+yr)	None Discernible
MN-CAM09	-22.81509	119.0817	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Large Patches	0	Old (6+yr)	None Discernible
MN-CAM10	-22.8159	119.08135	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Large Patches	0	Old (6+yr)	None Discernible
MN-CAM11	-22.81743	119.08107	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Large Patches	0	Old (6+yr)	None Discernible
MN-CAM12	-22.82956	119.09825	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Small Patches	0	Old (6+yr)	None Discernible
MN-CAM13	-22.83043	119.10137	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Large Patches	0	Old (6+yr)	None Discernible
MN-CAM14	-22.82745	119.14519	20/10/2016	1	Gorge/ Gully	Gorge	South/ East	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	2	Recent (0-2yr)	Mining Exploration
MN-CAM15	-22.8407	119.10257	23/10/2016	1	Gorge/ Gully	Gully	North/ West	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Many Small Patches	1	Recent (0-2yr)	None Discernible
MN-CAM16	-22.841	119.10166	23/10/2016	1	Gorge/ Gully	Gully	North/ West	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Many Small Patches	1	Recent (0-2yr)	None Discernible
MN-CAM17	-22.84818	119.11114	25/10/2016	1	Gorge/ Gully	Medium Drainage Line	Flat	Flat	Sandy Loam; Limited Outcropping	Limited	Boulders (>61cm); Many Small Patches; Few Large Patches	5	Old (6+yr)	Road/ Access Track
MN-CAM18	-22.83707	119.14483	26/10/2016	1	Gorge/ Gully	Gully	West	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Small Patches	0	Old (6+yr)	None Discernible
MN-CAM19	-22.837	119.14478	26/10/2016	1	Gorge/ Gully	Gully	West	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Small Patches	0	Old (6+yr)	None Discernible
MN-CAM20	-22.82791	119.14718	20/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Silty Loam; Minor Outcropping	Minor	Boulders (>61cm); Few Large Patches; Scarce	20	Recent (0-2yr)	Cattle Grazing
MN-CAM21	-22.82644	119.15103	20/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Heavy Clay; Minor Outcropping	Minor	Boulders (>61cm); Few Small Patches; Few Large Patches	0	Recent (0-2yr)	Cattle Grazing
MN-CAM22	-22.82839	119.14975	20/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Heavy Clay; Minor Outcropping	Minor	Boulders (>61cm); Few Small Patches; Few Large Patches	0	Recent (0-2yr)	Cattle Grazing
MN-CAM23	-22.82952	119.14854	20/10/2016	1	Gorge/ Gully	Gorge	North	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	2	Recent (0-2yr)	Mining Exploration
MN-CAM24	-22.8299	119.14247	20/10/2016	1	Gorge/ Gully	Gorge	North/ West	Cliff	Clayey Sand; Extensive Outcropping	Extensive	Boulders (>61cm); Few Small Patches; Few Small Patches	2	Recent (0-2yr)	Mining Exploration
MN-CAM25	-22.83153	119.13983	20/10/2016	1	Major Drainage Line	Major Drainage Line	Flat	Flat	Silty Loam; Minor Outcropping	Minor	Boulders (>61cm); Few Large Patches; Scarce	20	Recent (0-2yr)	Cattle Grazing
MN-CAM26	-22.81541	119.07334	21/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); None Discernible; Few Small Patches	0	Old (6+yr)	None Discernible
MN-HAB01	-22.83241	119.12669	21/10/2016	1	Hillcrest/ Hillslope	Hillslope	Flat	Flat	Silty Loam; Moderate Outcropping	Moderate	Pebbles (5-10cm); Scarce; Many Small Patches	0	Old (6+yr)	Mining Exploration
MN-HAB02	-22.8153	119.08229	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Small Patches	0	Old (6+yr)	None Discernible
MN-HAB03	-22.82839	119.09821	23/10/2016	1	Gorge/ Gully	Gully	North	Steep	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Few Small Patches	0	Old (6+yr)	None Discernible
MN-HAB04	-22.8459	119.12947	24/10/2016	1	Gorge/ Gully	Major Drainage Line	Flat	Flat	Silty Loam; Limited Outcropping	Limited	Boulders (>61cm); Many Small Patches; Few Small Patches	5	Old (6+yr)	None Discernible
MN-HAB05	-22.83719	119.11087	11/04/2017	2	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	Flat	Flat	Clayey Sand; Negligible	Negligible	Pebbles (5-10cm); Few Small Patches; Few Small Patches	0	Old(6+yr)	Road/ Access Track
MN-HAB06	-22.81782	119.13968	11/04/2017	2	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	Flat	Flat	Loamy Sand; Negligible	Negligible	Gravel (1-4cm); Few Small Patches; Few Large Patches	0	Old (6+yr)	Road/ Access Track
MN-HAB07	-22.84845	119.11681	13/04/2017	2	Gorge/ Gully	Gorge	North	Cliff	Sandy Clay Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Many Large Patches; Many Large Patches	5	Old (6+ yr.)	Road/ Access Track
MN-HAB08	-22.83958	119.13157	13/04/2017	2	Gorge/ Gully	Cliff	West	Cliff	Silty Loam; Extensive Outcropping	Extensive	Boulders (>61cm); Scarce; Many Large Patches	0	Recent (0-2yr)	None Discernible
MN-HAB09	-22.82627	119.14269	13/04/2017	2	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	Flat	Flat	Clayey Sand; Negligible	Negligible	Pebbles (5-10cm); Scarce; Few Large Patches	0	Old (6+yr)	Mining Exploration

Appendix G: Cave and Waterhole data

	Location	Width	Length	Depth	Position	Habitat	Floor slope	Aspect	Exposure	Entrance type	Entrance Shape	# Chambers	Chamber height	Comments	Photo
MnA	-22.8145, 119.1164	1.5	35	2	Lower Slope		Incline	East	Sheltered	Cavity, Cavern	Round/ Oval			No scats. Excellent cave, very hot and humid in top end chamber. Seemed on par in suitability with maternity roosts in other areas.	
MN01	-22.8309, 119.1465	4	2	40	Upper Slope	None	Flat	West	Semi Exposed	Cavern, Cavity	Round/ Oval	3	1.3	No scats. Ceiling may be too low for Ghost bats	
Rock Pool	-22.8371, 119.1449	7	8	0.6										No aquatic vegetation present. Not a permanent water source	

[Page left blank intentionally]

biologic

Area C to Yandi Fauna Survey

BHP Billiton Iron Ore Pty Ltd

August 2011

DOCUMENT STATUS				
Revision No.	Author	Review / Approved for Issue	Approved for Issue to	
			Name	Date
1	Morgan O'Connell	Stewart Ford / Morgan O'Connell	Jamie Gleeson	10/01/10
2	Morgan O'Connell	Morgan O'Connell	Jamie Gleeson	06/06/11
3	Jessica Oates	Morgan O'Connell	Jamie Gleeson	16/08/11

TABLE OF CONTENTS

Appendices

Figures

Tables

EXECUTIVE SUMMARY

Biologic was commissioned by BHP Billiton Iron Ore Pty Ltd to undertake a fauna study for an area between Area C and Marillana Creek (Yandi Mine), herein known as the Study Area. Numerous previous surveys have taken place within and near to the Study Area. These previous surveys are assessed in the report. The four objectives of the study were to:

1) Undertake a comprehensive review of previous fauna surveys within and surrounding the Study Area;
2) Describe and map fauna habitat within the Study Area;
3) Assess the likelihood of habitat within the Study Area to support conservation significant species; and
4) Provide a list of all fauna species observed including conservation significant species.

Database searches and the literature review revealed that seven mammal, 12 bird and two reptile species may occur in the Study Area that are listed under one or more of the following Acts or conservation lists:

- Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act);
- Western Australia (WA) *Wildlife Conservation Act, 1950* (WC Act);
- WA Department of Environment and Conservation (DEC) Priority list; and/or
- The International Union for Conservation of Nature Red List.

An assessment of the habitats in the Study Area revealed that 14 of these species have a medium to high likelihood of occurrence. This includes five significant species recorded during the survey:

- Ghost Bat (*Macroderma gigas*), DEC Priority 4;
- Star Finch (*Neochmia ruficauda subclarescens*), DEC Priority 4;
- Australian Bustard (*Ardeotis australis*), DEC Priority 4;
- Western Pebble-mound Mouse (*Pseudomys chapmani*), DEC Priority 4; and
- Rainbow Bee-eater (*Merops ornatus*), EPBC Act Listed Migratory.

The data collected from the Habitat Assessment showed that five major habitat types are present within the Study Area, these are:

- Gorge;
- Major Drainage Line;
- Valley (within both Ironstone and Basalt geology);
- Minor Drainage Line; and
- Hilltop and Slopes.

The Gorge, Major Drainage Line and Valley were deemed habitats of high significance. This is due to the high likelihood of these habitats supporting species listed under the EPBC Act or WC Act. Other habitat features of significance include three caves recorded during targeted species transects. Caves ACY 1, ACY 2 and ACY 3 were deemed suitable as a Ghost Bat (*Macroderma gigas*) roost. Cave ACY 2 occurs on the eastern edge of the Study Area within a gorge containing pools and a low *Melaleuca* forest. This cave was deemed possibly suitable as a Pilbara Leaf-nosed Bat roost, although two nights of ANABAT^{TM} recording within Gorge habitat did not detect this species.

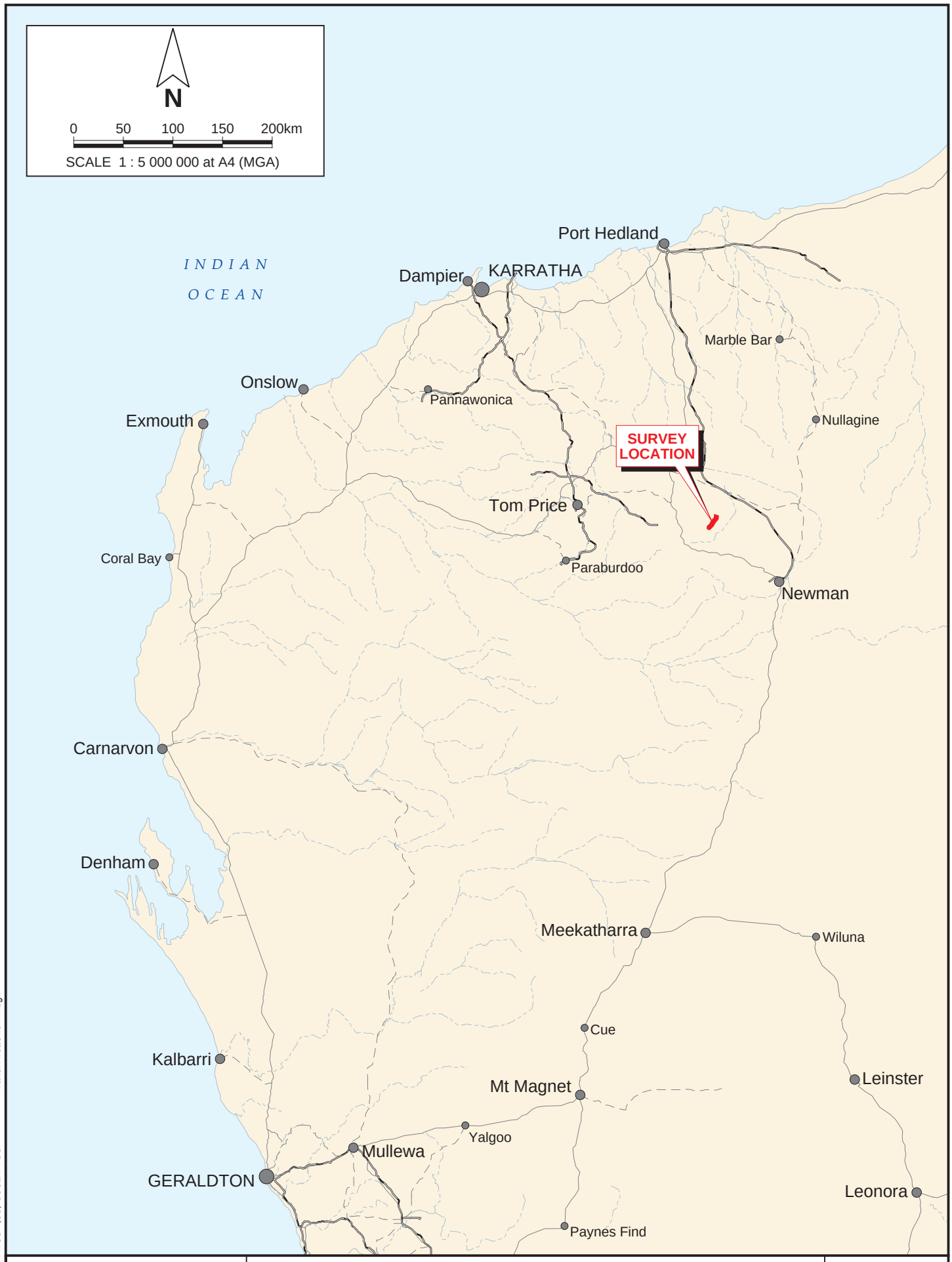
1 INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) currently undertakes mining operations at Mining Area C and at nearby Yandi Mine. Both mines are approximately 80 kilometres (km) north-west of Newman, Western Australia (WA).

Biologic was commissioned by BHP Billiton Iron Ore to undertake a fauna survey for an area between Area C and Marillana Creek (Yandi Mine), herein known as the Study Area (see Figure 1.1). Numerous previous surveys have taken place within and near to the Study Area. These previous surveys are summarised in Section 3.2.

The four objectives of the study were to:

1) Undertake a comprehensive review of previous fauna surveys within and surrounding the Study Area;
2) Describe and map fauna habitat within the Study Area;
3) Assess the likelihood of habitat within the Study Area to support conservation significant species; and
4) Provide a list of all fauna species observed, including conservation significant species.



biologic

BHP Billiton Iron Ore
AREA C TO YANDI
FAUNA SURVEY

REGIONAL LOCATION

Figure 1.1

Drawn: M. O'Connell | Date: 15 Nov 2010 | Job: --

PINPOINT CARTOGRAPHICS (08) 9562 7136 Yandi-AreaC-f01-1.dgn

2 ENVIRONMENT

2.1 Biogeography

Broadly, the Study Area falls within the Pilbara biogeographical region as defined by the Interim Biogeographic Regionalisation of Australia (Thackway and Cresswell, 1995). The Pilbara is subdivided into four subregions, and the Study Area lies in the Hamersley subregion (PIL-3), which forms the southern section of the Pilbara Craton (Kendrick, 2001). This subregion is characterised by mountainous areas of Proterozoic sedimentary ranges and plateaux, dissected by gorges. The vegetation of the subregion is dominated by *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils on the ranges, and swathes of Mulga woodland over bunch grasses on fine-textured soils (Kendrick, 2001).

2.2 Climate

The Pilbara region has a semi-desert to tropical climate with highly variable, mostly summer rainfall. The average rainfall over the broader Pilbara area ranges from approximately 200 to 350 millimetres (mm), although rainfall may vary widely from year to year (Australian Natural Resource Atlas, 2008).

The Pilbara climate is heavily influenced by tropical cyclones that develop over the Indian Ocean in the north of Australia. These sometimes cross the north-west coastline, bringing heavy rainfall to inland regions of the Pilbara. Average maximum summer temperatures are typically in the range of 35 to 40 degrees Celsius (°C) and winter maximum temperatures are generally between 22°C and 30°C (Bureau of Meteorology, 2010).

2.3 Existing Land Use

Pastoralism and mining are the major industries of the Pilbara region. The Study Area lies between two active mines on an active pastoral station.

2.4 Geology and Soils

The area is underlain by bedrock of Archaean and Proterozoic age belonging to the Hamersley Basin, consisting mainly of Banded Iron Formation (BIF), chert and shale (Thorne and Tyler, 1997). The Study Area passes through mostly Weeli Wolli Formation (BIF, shale, dolerite sills) and Brockman Iron Formation (BIF, chert, shale). The Marra Mamba and Brockman Iron Formations to the south are currently being mined by BHP Billiton Iron Ore at Area C.

Valleys are occupied by red sandy loams, containing gravel and rock fragments along the flanks of the higher ground. On the higher ground soils are generally thin to absent.

2.5 Hydrology

The average annual rainfall for the nearest Commonwealth Bureau of Meteorology (BoM) recording station, Newman Airport, is 324 mm (BoM, 2010). The rain falls mainly as tropical summer storms, therefore monthly and annual totals vary widely. Watercourses flow only after heavy or prolonged rainfall, as short-duration floods with rapid peaks and slightly less rapid decline. Water may pond along major watercourses and persist as pools for several weeks.

3 METHODOLOGY

3.1 Compliance

The fauna survey was carried out in a manner compliant with WA Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of fauna in WA:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA, 2002); and
- *Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. No. 56.* (EPA, 2004).

Survey guidelines released by the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA[1]) (2010a, 2010b and 2010c) were also considered in this survey report.

3.2 Available Information

A review of all reports containing information on the vertebrate fauna of the Study Area and relevant reports from the surrounding region was conducted. In addition, a number of fauna databases were searched. The databases searched, and the details of the search parameters used are presented below in Table 3.1.

Table 3.1: Databases used for the review

Provider	Database	Parameters
DEWHA (2010d)	Protected Matters Database Search Tool. Accessed November 2010.	Circle of radius 40 km centred on the point 119°07'44"E, 22°49'51"S. Plus 40 km buffer.
WA Department of Environment and Conservation (DEC) (2010a)	NatureMap. Accessed September 2010. This database includes Birds Australia – Birdata and DEC Threatened Fauna Database.	Circle of radius 40 km centred on the point 119°00'25"E, 22°57'15"S.

Data collected as part of the Pilbara Biological Survey undertaken by DEC and bird data associated with the Birds Australia atlas were available through the DEC NatureMap database (DEC, 2010a).

A number of biological surveys have been conducted in the Study Area and the surrounding region. A summary of the reports reviewed is shown in Table 3.2.

[1] Currently the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC, 2011).

Table 3.2: Reports used for the review – all surveys within 20km of Study Area.

Survey Title	Consultant	Year the Survey was Conducted	Survey Type
Mining Area C Biological Survey	Ecologia (1998a)	1997	Single phase Level 2
Weeli Wolli Creek Biological Assessment Survey	Ecologia (1998b)	1994 and 1995	Two phase Level 2
Packsaddle Range Biological Survey	Ecologia (2004a)	2004	Level 1
Area C: Deposits D, E and F Biological Survey	Ecologia (2004b)	2004	Single phase Level 2
Ministers North Biological Survey	Ecologia (2006)	2006	Level 1
Area C R Deposit Fauna Assessment	ENV (2007)	2006	Single phase Level 2
Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits	Outback Ecology Services (2008)	2008	Single phase Level 2
Area C South Flank Deposit Fauna Assessment	ENV (2008a)	2008	Level 1
Area C West Fauna Assessment	ENV (2008b)	2007	Single phase Level 2
Area A and Additional Areas Level 2 Terrestrial Fauna Survey	Ecologia (2008)	2008	Two phase Level 2
Jinayri Vertebrate Fauna Assessment	ENV (2008c)	2008	Single phase Level 2
Newman to Yandi Powerline	ENV (2010)	2010	Level 1
Area C and Surrounds Fauna Study	Biologic (*in prep* a)	2009 and 2010	Two phase Level 2
Southern Flank Fauna Study	Biologic (*in prep* b)	2010	Two phase Level 2

3.3 Taxonomy and Nomenclature

The latest checklists of WA mammals, reptiles and amphibians were used as a guide to describe the current taxonomy and nomenclature of these groups (Western Australian Museum, 2009). For birds, the current checklist of Australian birds, maintained by Birds Australia, was used. The bird list is based on the most recent review of the systematics and taxonomy of Australian birds by Christidis and Boles (2008).

3.4 Climatic Conditions

Climatic conditions near the Study Area are monitored at Area C by Compliance Monitoring, which maintains a weather station there. From the 13th to 20th of September conditions were cool and wet. The maximum temperature recorded for this period was 23.8°C and the minimum temperature recorded was 9.4°C. Rain fell early on during the survey with a total of 14.2 mm for the survey period.

According to the weather station at Newman Aero (Station 007176, located 75 km to the south-west) the last significant rains (over 60 mm) were recorded in November 2009 and April 2010 (BoM, 2010).

3.5 Field Assessment

This section describes the survey methods used by Biologic to investigate the vertebrate fauna of the Study Area.

3.5.1 Survey Team

The project was undertaken by:

Mr Morgan O'Connell Project Manager/Senior Ecologist

Mr Jeff Turpin Principal Zoologist

Biologic wishes to acknowledge the assistance of Mr Bob Bullen of Bat Call WA, who analysed ANABAT™ recordings.

3.5.2 Opportunistic Survey Sites

Surveys conducted by hand in a given habitat are termed opportunistic survey sites. The main aim of these surveys is to sample the herpetofaunal assemblage at a locality. The experienced herpetologists of the fauna team were able to target these species by investigating the microhabitats utilised by each species. Opportunistic surveys were conducted in all fauna habitats. Locations are shown in Figure 3.1 and Appendix A.

Thirty-six hours of opportunistic surveying was undertaken at 13 locations. This does not include time taken to undertake targeted surveys for conservation significant species (Section 3.5.7) and habitat assessments (Section 3.8).

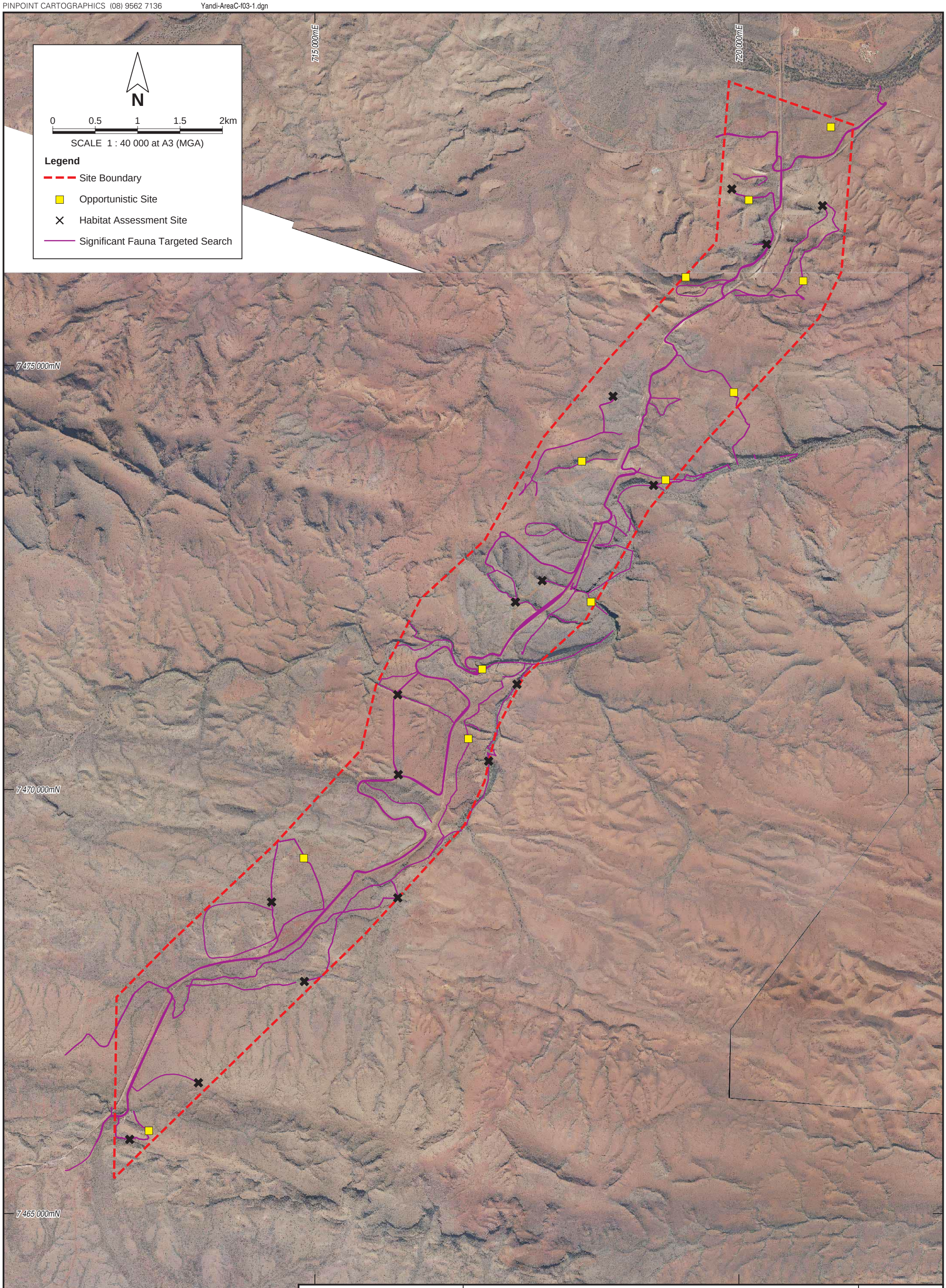
3.5.3 Bird Surveys

At each of the opportunistic survey sites, bird surveys were undertaken. Species presence and abundance were recorded within a 2 hectare (ha) area of uniform habitat. Surveys were preferably undertaken prior to 10:00 am, before increasing temperatures resulted in reduced activity.

3.5.4 General Bat Surveys

Bat echolocation calls were recorded using an ANABAT™ receiver coupled to a minidisc recorder or ZCAIM unit. The recordings aimed to document all bats present and were conducted at locations deemed more likely to be attractive to bats, such as points adjacent to large caves or near water.

Overnight bat recordings using ANABAT™ systems were performed at five locations during the survey. ANABAT survey locations were selected according to habitat favoured by the conservation significant Ghost Bat and Pilbara Leaf-nosed Bat as outlined in the Survey Guidelines for Australia's Threatened Bats (DEWHA, 2010c).



biologic

BHP Billiton Iron Ore
AREA C TO YANDI
FAUNA SURVEY

FAUNA SURVEY SITE LOCATIONS AND SIGNIFICANT FAUNA TRANSECTS

Figure 3.1

Drawn: M. O'Connell | Date: 15 Nov 2010 | Job: --

3.5.5 Motion Sensitive Cameras

Motion sensitive cameras were used to survey for animals that are hard to detect and larger mammals, such as rock wallabies, possums, birds and introduced predators. Cameras were set up at five different locations during the survey and were generally operated for three nights.

3.5.6 Incidental Records

At all times while surveying, opportunistic sightings of species, particularly species not previously recorded during the survey, rare or conservation significant fauna or other fauna of interest were documented. These records included tracks, scats and any other traces of fauna, as well as incidental sightings of live animals.

3.5.7 Targeted Surveys for Conservation Significant Fauna

Targeted searches for conservation significant fauna were undertaken during the field survey in addition to transects and opportunistic searches conducted in other suitable habitat. Transects of most major and minor gully systems in the Study Area were conducted for potential Ghost Bat (*Macroderma gigas*) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) caves, as well as suitable locations for the Pilbara Olive Python (*Liasis olivaceus barroni*), Northern Quoll (*Dasyurus hallucatus*) and Peregrine Falcon (*Falco peregrinus*). Searches aimed to locate secondary evidence of the species presence. This included searching for scats (Ghost Bat, Northern Quoll, Pilbara Olive Python), tracks (Northern Quoll), burrows or shelters (Western Pebble-mouse, Ghost Bat, Orange Leaf-nosed Bat) and sloughs (Pilbara Olive Python).

3.6 Potential Limitations and Constraints

EPA Guidance Statement No. 56 (EPA, 2004) outlines several potential limitations to fauna surveys. These potential survey limitations and constraints are presented and discussed in Table 3.3.

Table 3.3: Survey limitations and constraints

Potential limitation or constraint	Applicability to this survey
Experience of personnel.	The field personnel involved in the survey each had six or more years of fauna survey experience.
Scope (what faunal groups were sampled and whether any constraints affect this).	Scope was a Level 1 survey and within that framework was completed. Prevailing cool conditions may have reduced detection rates. Nocturnal work did not occur; this reduced the ability for opportunistic detection of nocturnally active animals.
Proportion of fauna identified.	All fauna were identified at the point of capture or observation.
Sources of information (recent or historic) and availability of contextual information.	A number of surveys have been undertaken in the Study Area and the surrounding region. The DEC has also completed the Pilbara Biological Survey which provided information on regional distribution of selected species. These reports were

Potential limitation or constraint	Applicability to this survey
	available at the time of writing.
Proportion of the task achieved.	A Level 1 survey of the Study Area was completed, and related to the results of surveys in the broader area.
Disturbances (e.g. fire or flood).	Heavy rain fell for one day during the survey. This did not affect access or the ability for the zoologists to assess habitat or detect species.
Intensity of survey.	The intensity of survey work meets the requirements of a Level 1 survey.
Completeness of survey.	The Level 1 survey is complete.
Resources (e.g. degree of expertise available).	All resources required to complete the survey were available.
Remoteness or access issues.	None. More remote areas of the Study Area were accessed on foot.

3.7 Assessment of Significance

The significance of fauna is classified on an International, Commonwealth, and State level on the basis of various Acts and Agreements. Species listed under such instruments are classified as 'conservation significant fauna'. Table 3.4 outlines the Acts and conservation codes applicable to the area, and explanations of the status codes are given in Appendix B.

Fauna not listed under legislation but considered to be of conservation concern by the DEC are listed as Priority Species. Additionally, fauna that do not meet the criteria for classification as conservation significant may be listed as of 'local significance' if they meet certain criteria, as outlined in Table 3.4.

Table 3.4: Acts and levels of significance

Level	Act	Status Codes
Conservation significance		
International	***International Union for Conservation of Nature (IUCN)*** The IUCN Red List is a comprehensive inventory of the global conservation status of plant and animal species. Animals listed as 'Least Concern' are not considered conservation significant.	Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Near Threatened Data Deficient
International	***Commonwealth Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act)*** Species listed under the following Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention)	Migratory

Level	Act	Status Codes
Federal	***EPBC Act*** DEWHA lists threatened fauna, which are determined by the Threatened Species Scientific Committee according to criteria set out in the EPBC Act. The EPBC Act lists fauna that are considered to be of conservation significance under one of six categories.	Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Conservation Dependent
State	***WA Wildlife Conservation Act, 1950 (WC Act)*** At a state level, native fauna species are protected under the WC Act. Specially protected fauna are specified in the *Wildlife Conservation* (*Specially Protected Fauna*) *Notice 2010*.	Schedule 1 Schedule 2 Schedule 3 Schedule 4
State	**DEC Priority list** The DEC produces a list of Priority species and ecological communities that have not been assigned statutory protection under the WC Act. This system gives a ranking from Priority 1 to Priority 5.	Priority 1 Priority 2 Priority 3 Priority 4 Priority 5
Local significance		
Local	**Locally significant fauna** Species may be significant for a range of reasons other than those protected by international agreement or treaty, specially protected or priority fauna. Significant fauna may include short-range endemic species, species that have declining populations or declining distributions, species at the extremes of their range, or isolated outlying populations, or species which may be undescribed.	N/A

3.8 Habitat Assessment

Habitats in the Study Area were assessed using methodology and terminology adapted from the *Australian Soil and Land Survey Field Handbook* (Commonwealth Scientific and Industrial Research Organisation, 2009) and modified to suit the survey requirements. The characteristics recorded during the habitat assessments were:

- site information, photo and location;
- landform: slope, relative inclination of slope, morphological type and landform type;
- vegetation: disturbance, condition, leaf litter percentage, twig litter percentage, wood litter, dead stags and hollow bearing trees per 2,500 square metre (m^2), broad floristic formation, tree structure (tall, mid and low), shrub structure (tall, mid and low), grass structure (tall, mid and low), dominant trees, shrubs, grasses and herbs;

- land surface: microrelief, sheet erosion, rill erosion, gully erosion, gully depth, abundance and size of coarse fragments, rock outcropping and waterbodies;
- soil: texture, colour, water status and strength; and,
- substrate: substrate form, rock type, comments on geology.

Fauna habitats were also assessed for the likelihood that they may support conservation significant fauna. All major fauna habitats present within the Study Area were sampled and scored (High, Medium or Low) according to the criteria shown in Table 3.5. Conservation significant habitats are discussed in Section 5.

Table 3.5: Fauna habitat significance assessment criteria

Score	Criteria
High	1) Habitat supports EPBC or WC Act listed threatened fauna, OR 2) Habitat for EPBC or WC Act species is present in the Study Area, and there are records of that species within 50 km of the Study Area. If limited surveys have been undertaken in the vicinity of the Study Area then a precautionary approach will be used and the species will be considered likely to be present, OR 3) Uncommon habitat is critical habitat for a population of DEC listed Priority fauna. For example, if habitat is limited in the region and the habitat in the Study Area forms a significant portion of the known habitat for a Priority species, it would be scored as High significance.
Medium	1) Habitat supports DEC listed Priority fauna that are largely restricted to that habitat type within the Study Area, OR 2) Habitat supports EPBC Act listed Migratory fauna, OR 3) Habitat supports a particularly diverse and uncommon faunal assemblage. Habitat that occurs throughout region, and does not occur in small or isolated areas, is excluded.
Low	Habitat is widespread, common, and does not solely support any conservation significant fauna.

4 RESULTS

4.1 Desktop Review

Analysis of the databases and reports outlined in Section 3.2 showed that a total of 294 vertebrate fauna taxa have the potential to occur within the Study Area. The greatest potential diversity is in the birds (139 species), followed by reptiles (101 species), mammals (48 species, including nine introduced species) and amphibians (six species).

Within these groups, seven mammal, 12 bird and two reptile species are conservation significant. Six of the 12 bird species are listed as Migratory under the EPBC Act which are not listed under any other legislative or priority codes: Eastern Osprey (*Pandion cristatus*), Fork-tailed Swift (*Apus pacificus*), Eastern Great Egret (*Ardea modesta*), Cattle Egret (*Ardea ibis*), Oriental Plover (*Charadrius veredus*) and Rainbow Bee-eater (*Merops ornatus*).

Conservation significant mammals that could potentially occur are:

- Northern Quoll (*Dasyurus hallucatus*);
- Long-tailed Dunnart (*Sminthopsis longicaudata*);
- Bilby (*Macrotis lagotis*);
- Ghost Bat (*Macroderma gigas*);
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*);
- Short-tailed Mouse (*Leggadina lakedownensis*); and
- Western Pebble-mound Mouse (*Pseudomys chapmani*).

Conservation significant birds that could potentially occur are:

- Grey Falcon (*Falco hypoleucos*);
- Peregrine Falcon (*Falco peregrinus*);
- Australian Bustard (*Ardeotis australis*);
- Bush Stone-Curlew (*Burhinus grallarius*);
- Night Parrot (*Pezoporus occidentalis*); and
- Star Finch (western subspecies: *Neochmia ruficauda subclarescens*).

Conservation significant reptiles that could potentially occur are Pilbara Olive Python (*Liasis olivaceus barroni*) and the blind snake *Ramphotyphlops ganei*.

Some of these species have not been recorded during previous surveys undertaken in the Study Area or surrounding region.

Detailed lists of the fauna recorded previously in the Study Area and the surrounding region, based on the reports in Table 3.2, are presented in Appendix C. The results of this survey are included for comparison.

4.2 Fauna Recorded

This survey recorded 13 native and three introduced mammals (Table 4.1), 47 birds, 10 reptiles and one amphibian, totalling 74 species. Native fauna recorded are discussed in the following sections and introduced fauna are discussed in Section 4.2.5. Species records are provided in Appendix C.

4.2.1 Mammals

Sixteen mammal species from nine families were recorded during the survey (Table 4.1). Mammal species of significance recorded were the Western Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4), of which several active or recently active mounds were found, and Ghost Bat (*Macroderma gigas*) (Priority 4), the scats of which were found in cave ACY 1. These species are discussed in further detail in Section 5. Numerous species of bat were recorded using ANABAT^{TM} detectors

Table 4.1: Mammal species recorded during the survey.

Family	Scientific Name	Common Name
DASYURIDAE	*Pseudantechinus woolleyae*	Woolley's Pseudantechinus
EMBALLONURIDAE	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat
EMBALLONURIDAE	*Taphozous georgianus*	Common Sheath-tailed Bat
MACROPODIDAE	*Macropus robustus erubescens*	Euro
MACROPODIDAE	*Petrogale rothschildi*	Rothschild's Rock Wallaby
MEGADERMATIDAE	*Macroderma gigas*	Ghost Bat
MOLOSSIDAE	*Chaerephon jobensis*	Northern Freetail-bat
MOLOSSIDAE	*Tadarida australis*	White-striped Freetail-bat
MURIDAE	*Pseudomys chapmani*	Western Pebble-mound Mouse
VESPERTILIONIDAE	*Chalinolobus gouldii*	Gould's Wattled Bat
VESPERTILIONIDAE	*Nyctophilus geoffroyi*	Lesser Long-eared Bat
VESPERTILIONIDAE	*Scotorepens greyii*	Little Broad-nosed Bat
VESPERTILIONIDAE	*Vespadelus finlaysoni*	Finlayson's Cave Bat
BOVIDAE	**Bos taurus*	European Cattle
EQUIDAE	**Equus asinus*	Donkey
FELIDAE	**Felis catus*	Feral Cat

* Introduced species.

4.2.2 Birds

Forty seven bird species from 26 families were recorded during the survey (Table 4.2). Significant bird species recorded were the Star Finch (Priority 4), Australian Bustard (Priority 4) and Rainbow Bee-eater (Migratory). The Star Finch has only been recorded in the vicinity of Area C twice before. Little Grassbird (*Megalurus timoriensis*) was recorded in Gorge habitat and represents the first record in the vicinity of Area C. Little Grassbird is described by Storr (1963) as a vagrant or rare non-breeding visitor to the Pilbara.

Table 4.2: Bird species recorded during the survey.

Family	Scientific Name	Common Name
ACANTHIZIDAE	*Gerygone fusca*	Western Gerygone
ACANTHIZIDAE	*Smicrornis brevirostris*	Weebill
ACCIPITRIDAE	*Accipiter cirrocephalus*	Collared Sparrowhawk
ACCIPITRIDAE	*Haliastur sphenurus*	Whistling Kite
ANATIDAE	*Anas superciliosa*	Pacific Black Duck
ARDEIDAE	*Ardea pacifica*	White-necked Heron
ARTAMIDAE	*Artamus cinereus*	Black-faced Woodswallow
ARTAMIDAE	*Artamus minor*	Little Woodswallow
ARTAMIDAE	*Cracticus nigrogularis*	Pied Butcherbird
ARTAMIDAE	*Cracticus tibicen*	Australian Magpie
CAMPEPHAGIDAE	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike
COLUMBIDAE	*Geopelia striata*	Peaceful Dove
COLUMBIDAE	*Geophaps plumifera*	Spinifex Pigeon
COLUMBIDAE	*Ocyphaps lophotes*	Crested Pigeon
COLUMBIDAE	*Phaps chalcoptera*	Common Bronzewing
CORVIDAE	*Corvus orru*	Torresian Crow
DICRURIDAE	*Grallina cyanoleuca*	Magpie-lark
DICRURIDAE	*Rhipidura leucophrys*	Willie Wagtail
ESTRILDIDAE	*Emblema pictum*	Painted Finch
ESTRILDIDAE	*Neochmia ruficauda subclarescens*	Star Finch
ESTRILDIDAE	*Taeniopygia guttata*	Zebra Finch
FALCONIDAE	*Falco berigora*	Brown Falcon
HALCYONIDAE	*Dacelo leachii*	Blue-winged Kookaburra
HALCYONIDAE	*Todiramphus pyrrhopygius*	Red-backed Kingfisher
HIRUNDINIDAE	*Petrochelidon nigricans*	Tree Martin
MALURIDAE	*Amytornis striatus whitei*	Striated Grasswren
MALURIDAE	*Malurus lamberti*	Variegated Fairy-wren
MALURIDAE	*Malurus leucopterus*	White-winged Fairy-wren
MALURIDAE	*Stipiturus ruficeps*	Rufous-crowned Emu-wren
MEGALURIDAE	*Megalurus timoriensis*	Little Grassbird
MELIPHAGIDAE	*Lichenostomus keartlandi*	Grey-headed Honeyeater

Family	Scientific Name	Common Name
MELIPHAGIDAE	*Lichenostomus penicillatus*	White-plumed Honeyeater
MELIPHAGIDAE	*Lichenostomus virescens*	Singing Honeyeater
MELIPHAGIDAE	*Manorina flavigula*	Yellow-throated Miner
MELIPHAGIDAE	*Melithreptus gularis*	Black-chinned Honeyeater
MEROPIDAE	*Merops ornatus*	Rainbow Bee-eater
OTIDIDAE	*Ardeotis australis*	Australian Bustard
PACHYCEPHALIDAE	*Colluricincla harmonica*	Grey Shrike-thrush
PACHYCEPHALIDAE	*Pachycephala rufiventris*	Rufous Whistler
PARDALOTIDAE	*Pardalotus rubricatus*	Red-browed Pardalote
PARDALOTIDAE	*Pardalotus striatus*	Striated Pardalote
PETROICIDAE	*Melanodryas cucullata*	Hooded Robin
PODARGIDAE	*Podargus strigoides*	Tawny Frogmouth
POMATOSTOMIDAE	*Pomatostomus temporalis*	Grey-crowned Babbler
PSITTACIDAE	*Barnardius zonarius*	Australian Ringneck
RHIPIDURIDAE	*Rhipidura albiscapa*	Grey Fantail
SYLVIIDAE	*Eremiornis carteri*	Spinifexbird

4.2.3 Reptiles

Ten reptile species from five families were recorded during the survey (Table 4.3). No reptile species of significance were recorded.

Table 4.3: Reptile species recorded during the survey.

Family	Scientific Name	Common Name
AGAMIDAE	*Amphibolurus longirostris*	Long-nosed Dragon
AGAMIDAE	*Ctenophorus caudicinctus*	Ring-tailed Rock Dragon
BOIDAE	*Antaresia stimsoni*	Stimson's Python
GEKKONIDAE	*Oedura marmorata*	Marbled Velvet Gecko
SCINICIDAE	*Carlia munda*	Rainbow Skink
SCINICIDAE	*Cryptoblepharus ustulatus*	Skink
SCINICIDAE	*Ctenotus saxatilis*	Rock Ctenotus
SCINICIDAE	*Egernia formosa*	Skink
VARANIDAE	*Varanus giganteus*	Perentie
VARANIDAE	*Varanus pilbarensis*	Pilbara Rock Monitor

4.2.4 Amphibians

Main's Frog (*Cyclorana maini*) (Family Hylidae) was the only frog recorded during the survey (Appendix C).

4.2.5 Introduced Fauna

Three introduced mammals were recorded during the survey. Evidence of cattle (**Bos taurus*) was widespread in lower lying areas, particularly gorges and valleys. Donkey (**Equus asinus*) and Feral Cat (**Felis catus*) scats were recorded in single locations.

4.3 Fauna Habitats

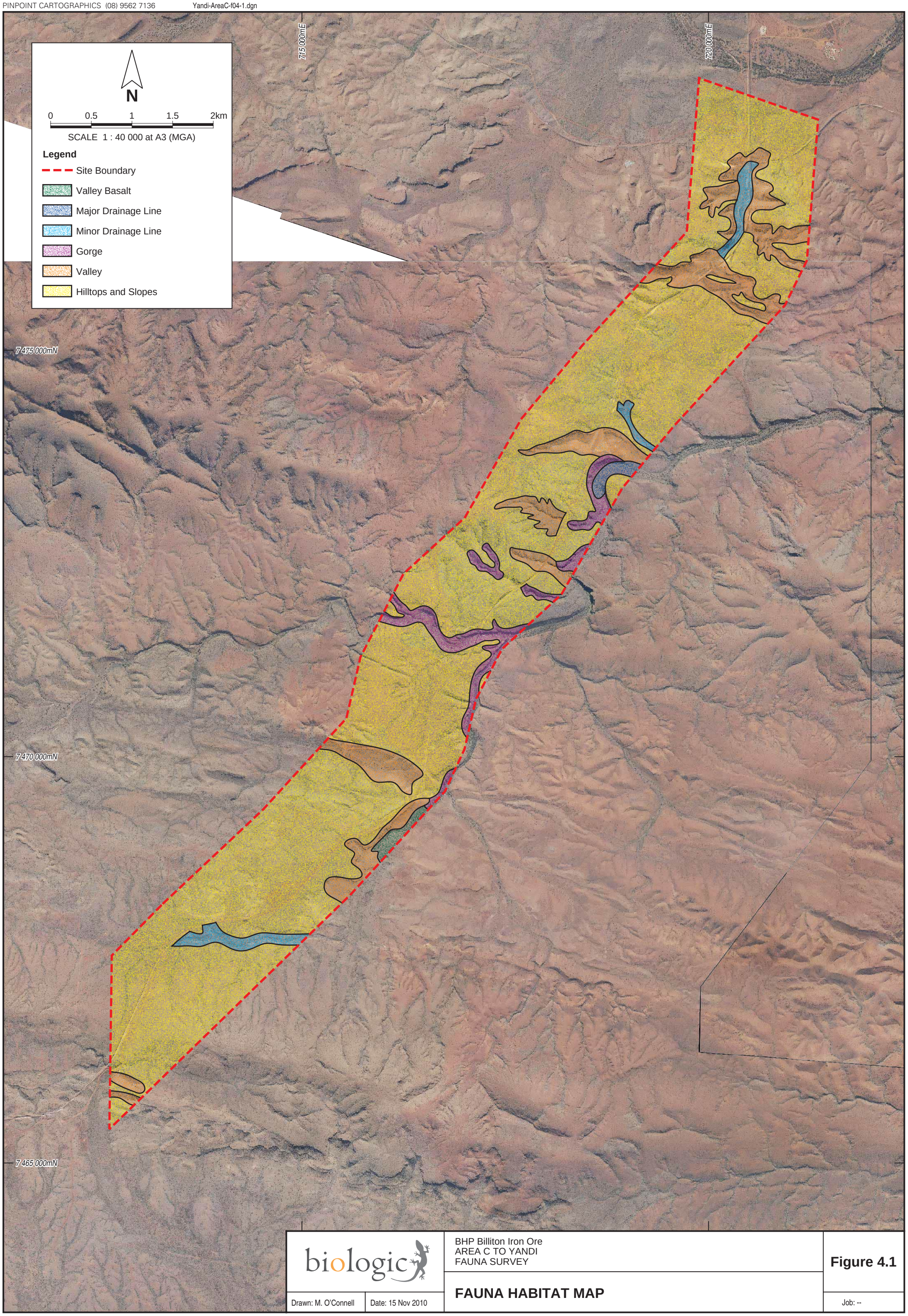
Fauna habitat assessments were undertaken with the aim of recording a minimum of three assessments per habitat type.

Five major fauna habitats were identified within the Study Area: Valley (including subtype Valley-Basalt), Hilltops and Slopes, Major Drainage Line, Minor Drainage Line and Gorge. Habitat descriptions are presented in Table 4.4 and a summary of the details recorded during the habitat assessments is given in Appendix D. The habitat assessments were analysed to determine the key characteristics that differentiated each habitat from the others (Table 4.4). The extent of each fauna habitat outside of the Study Area is also given in Table 4.4.

Table 4.4: Fauna habitat descriptions

Habitat type	Total Hectares	Description	Distinguishing habitat characteristics	Extent outside Study Area	Significant Species Associated with Habitat	Photo
Hilltops and Slopes	1766	This habitat occurs on hills and ridges and is characterised by rocky outcrops and gravelly substrate where *Eucalyptus leucophloia* low trees and hummock forming grasses dominate. The majority of the Study Area is this habitat type.	This habitat is dominated by *Triodia* hummock grassland. On average, when compared to the other habitat types, this habitat has the lowest leaf litter (<1%), twig litter (<1%), wood litter (<1/2500m^2), dead stags (<1/2500m^2) and hollow bearing trees (<1/2500m^2).	This habitat is common throughout the Pilbara and is recorded in most biological surveys (e.g. Biologic, *in prep* a; Biologic, *in prep* b).	Western Pebble-mound Mouse (*Pseudomys chapmani*) and Long-tailed Dunnart (*Sminthopsis longicaudata*).	
Major Drainage Line	11	This habitat occurs in a small area on the eastern edge of the Study Area. The drainage line is heavily scoured and bare in places due to large amounts of flow during heavy rainfall.	High leaf, twig, and wood litter on the banks of the major drainage line. Most hollow bearing trees and hollows are of a large size. Further characterised by tall *Eucalyptus* trees.	This habitat is common, but restricted in area, throughout the Pilbara and is recorded in most biological surveys (Biologic, *in prep* a; Biologic, *in prep* b).	*Ramphotyphlops ganei,* Pilbara Olive Python *(Liasis olivaceus barroni),* Star Finch (western subspecies) *(Neochmia ruficauda subclarescens)*, Rainbow Bee-eater *(Merops ornatus),* Peregrine Falcon *(Falco peregrinus),* Grey Falcon *(Falco hypoleucos),* Bush Stone-curlew *(Burhinus grallarius),* Australian Bustard *(Ardeotis australis),* Pilbara Leaf-nosed Bat *(Rhinonicteris aurantia),* Northern Quoll *(Dasyurus hallucatus)* and Northern Brushtail Possum *(Trichosurus vulpecula arnhemensis).*	
Minor Drainage Line	48	Occurs in three locations in the Study Area. Forms where runoff from nearby hills erodes a drainage line and creates moist clay loam banks, suitable for Acacias to form dense scrub.	Habitat is dominated by *Acacia* scrub. Leaf litter (10%), twig litter (7.5%), wood litter (2/2500m^2), dead stags (2/2500m^2), and hollow (small hollows) bearing trees (5/2500m^2).	This habitat is common, but restricted in area, throughout the Pilbara and is recorded in most biological surveys (Biologic, *in prep* a; Biologic, *in prep* b).	*Ramphotyphlops ganei*, Rainbow Bee-eater (*Merops ornatus*), Bush Stone-curlew (*Burhinus grallarius*) and Australian Bustard (*Ardeotis australis*).	
Gorge	86	Gorges in the Study Area comprise heavily dissected valleys with sheer cliff walls and a rocky base that has the ability to hold water for longer periods than the surrounding area. A major Gorge occurs along a tributary to Marrilana Creek and includes Yandicoogina gorge, which is crossed by the present rail. Minor gorges occur elsewhere.	Dry, narrow sections of the gorges support *Corymbia ferriticola* and *Eucalpytus leucophloia*. Where the gorges contain pools of water the vegetation changes to *Melaleuca glomerata* low forest over *Cyperus* sp. (50K 717133, 7470780). Further down the same gorge a patch of *Melalueca argentea* tall forest over *Typha* sp occurs.(50K 716818, 7469778, eastern edge of the study area). Highest Leaf litter (11%), twig litter (9%) and wood litter (19/2500m^2). High hollow bearing trees.	Dry gorges containing *Corymbia ferriticola* are a common feature in the Pilbara and recorded in many consultant reports (Biologic, *in prep* b). Wet gorges containing tall *Melaleuca argentea* forest are an uncommon habitat in the Pilbara. Habitat similar to the *Melaleuca argentea* forest in the Study Area occurs at Weeli Wolli Springs and Marillana creek (immediately north of the Study Area).	*Ramphotyphlops ganei*, Pilbara Olive Python (*Liasis olivaceus barroni*), Star Finch (western subspecies) (*Neochmia ruficauda subclarescens*), Rainbow Bee-eater (*Merops ornatus*), Peregrine Falcon (*Falco peregrinus*), Grey Falcon (*Falco hypoleucos*), Eastern Osprey (*Pandion cristatus*), Eastern Great Egret (*Ardea modesta*), Cattle Egret (*Ardea ibis*), Australian Bustard (*Ardeotis australis*), Northern Quoll (*Dasyurus hallucatus*), Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*), Long-tailed Dunnart (*Sminthopsis longicaudata*), Ghost Bat (*Macroderma gigas*), Bush Stone-curlew (*Burhinus grallarius*) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*).	

Habitat type	Total Hectares	Description	Distinguishing habitat characteristics	Extent outside Study Area	Significant Species Associated with Habitat	Photo
Valley and Valley (basalt)	270	Characterised by sloping sides vegetated with hummock forming grasses and valley bases sometimes dominated by thick *Acacia* spp. Rocky outcropping is common throughout these valleys and crumbling breakaways form boulder piles in some locations. In one location (see Figure 4.1) basalt replaces the ironstone.	*Eucalyptus leucophloia*, *Acacia* spp. and *Triodia* and *Themeda* spp. grasses variously dominant. Coarse fragments are common to abundant and vary in size. Very rocky. Waterbody presence varies from none to small seasonal waterbodies. Low in most recorded categories.	The ironstone valley is common throughout the Pilbara and is recorded in most biological surveys (Biologic, *in prep* a; Biologic, *in prep* b). Basalt valleys are less common in the vicinity of the Study Area although they become more common in the north.	*Ramphotyphlops ganei*, Bush Stone-curlew (*Burhinus grallarius*), Australian Bustard (*Ardeotis australis*), Northern Quoll (*Dasyurus hallucatus*), Northern Brushtail Possum (*Trichosurus vulpecula arnhemensis*) and Ghost Bat (*Macroderma gigas*).	 



biologic

BHP Billiton Iron Ore
AREA C TO YANDI
FAUNA SURVEY

FAUNA HABITAT MAP

Figure 4.1

Drawn: M. O'Connell | Date: 15 Nov 2010 | Job: --

5 SIGNIFICANT FAUNA

Species are defined as 'conservation significant' if they are listed under international, federal and state legislation or listed as a Priority by the DEC.

Species not formally listed, that are undescribed or are significantly important within the Study Area are considered 'locally significant' and are also included.

5.1 Conservation Significant Fauna with the Potential to Occur in the Study Area

Based on the results of previous surveys and database searches as outlined in Section 3.2, it was determined that 21 species (seven native mammals, 12 birds and two reptiles) of conservation significance have the potential to occur in the Study Area. Table 5.1 details these species including their conservation status, preferred habitat, extent of their habitat in the Study Area, previous records and likelihood of occurrence taking into account habitats present in the Study Area. Five of the 21 species identified during the database and literature searches were recorded during the survey. These species are identified in Table 5.1 and further discussed in Section 5.2.

Table 5.1: Conservation significant fauna potentially occurring within the Study Area

Name	Conservation Status	Preferred Habitat	Extent of habitat in Study Area	Previous records	Expected likelihood of occurrence
Mammals					
Bilby *Macrotis lagotis*	EPBC Act: Vulnerable WC Act: Schedule 1	Variable. Sandy areas with acacia shrublands and spinifex grassland.	No suitable habitat in the Study Area	Nearest record is approximately 70km north of the Study Area, but the bulk of records come from the Abydos plain area, approximately 140 km north of the Study Area (DEC, 2010a). No records of Bilby in the Study Area or the Hamersley Range exist.	**Low** Species not expected to occur.
Ghost Bat *Macroderma gigas*	IUCN: Vulnerable DEC Priority List: Priority 4	Valleys and gorges containing deep complex caves.	Three suitable caves recorded during the targeted transect searches (see Figure 5.1). Foraging habitat is extensive in the Study Area.	Numerous caves with evidence of Ghost Bats have been recorded at Area C (Biologic, *in prep* a) and nearby Southern Flank (Biologic, *in prep* b).	**Recorded** See Figure 5.1 for locations.
Long-tailed Dunnart *Sminthopsis longicaudata*	DEC Priority List: Priority 4	Rugged, rocky areas and screes, often with sparse vegetation. Species is noted as being difficult to trap by Gibson and McKenzie (2009), although Elliott traps were not used in their study.	Suitable habitat in the Study Area is widespread and includes rocky areas of Hilltop and Slopes, Valley and Gorge habitats (see Figure 4.1). These habitats are characteristic of the Hamersley range.	There are few records in the Pilbara and they occur at widely scattered localities, however the Study Area is located in a broad rocky region between widely separated records at Newman (80 km south-east) and near Tom Price (110 km west).	**Low** Suitable habitat exists; however this species has not been recorded despite numerous surveys nearby. If present, is likely to only occur in very low numbers.
Northern Brushtail Possum *Trichosurus vulpecula arnhemensis*	Locally significant The Brushtail Possum has significantly declined in the arid zone with few recent records across the Pilbara (DEC, 2010b).	The few recent records come from gorges and major drainage lines with eucalypt woodland (DEC, 2010b).	Gorge, Valley and Major Drainage Line habitat occurs in the Study Area (see Figure 4.1).	Scats attributable to the Northern Brushtail Possum were recorded from the mouth of a large cave in the west Packsaddle Range west of the Study Area (J. Turpin, pers. comm.). This is the first record of the species in the area despite numerous surveys including in other areas of suitable habitat such as Weeli Wolli Creek.	**Medium** Expected to occur as an uncommon breeding resident.

Name	Conservation Status	Preferred Habitat	Extent of habitat in Study Area	Previous records	Expected likelihood of occurrence
Northern Quoll *Dasyurus hallucatus*	EPBC Act: Endangered WC Act: Schedule 1	Rocky areas, caves, outcrops, gorges, rock crevices, major drainage lines.	Suitable habitat in the Study Area includes Valley, Gorge and Major Drainage Line habitat associated with ranges (see Figure 4.1). The habitats outside of the Study Area are very similar and include extensions of the rocky range/valley complex present in the Study Area.	A single scat has been recorded at South Flank, approximately 20 km to the south west of the Study Area (Biologic, *in prep* b). A dead individual was recorded at Yandi, approximately 5 km to the north of the Study Area.	**Medium** Gorge habitat is ideal for this species, especially the patches of *Melaleuca* forest with permanent water. Numerous previous surveys have taken place in the vicinity of the Study Area and only one record has been made.
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*	EPBC Act: Vulnerable WC Act: Schedule 1	Gorge habitat with permanent water. Roost caves must be hot and humid.	Suitable Gorge habitat exists (see Figure 4.1). One cave (Cave ACY 2) was recorded as possibly suitable for roosting (50K 717012, 7470467; see Figure 5.1).	Single calls of itinerant individuals have been recorded approximately 12 km to the south and 25 km to the south west (Biologic, *in prep* b)	**Medium** Suitable habitat exists; however three nights of ANABAT^{TM} recordings were conducted in Gorge habitat (two in *Melaleuca* forest with permanent water) with no records made. One potential roost cave (Cave ACY 2) was recorded during the survey.
Short-tailed Mouse *Leggadina lakedownensis*	DEC Priority List: Priority 4	Generally restricted to cracking clays in the region (Gibson and McKenzie, 2009).	No areas of cracking clay are present in the Study Area. Cracking clay is not a dominant feature in the local landscape. It is more common towards the northern Pilbara coast. An uncommon habitat locally.	A DEC (2010a) record for this species occurs at West Packsaddle (Biologic, *in prep* a).	**Low** No suitable habitat for the species.
Western Pebble-mound Mouse *Pseudomys chapmani*	DEC Priority List: Priority 4	Hill tops and slopes where pebbles are present.	Suitable hilltops and slopes are extensive in the Study Area (see Figure 4.1).	Numerous records throughout the area (see Biologic, *in prep* a).	**Recorded** See Figure 5.1 for locations.

Name	Conservation Status	Preferred Habitat	Extent of habitat in Study Area	Previous records	Expected likelihood of occurrence
Birds					
Australian Bustard *Ardeotis australis*	DEC Priority List: Priority 4	A nomadic species occurring in open or lightly wooded grasslands (including *Triodia* sp. sandplains).	Gorge, Valley, Minor and Major Drainage Line (see Figure 4.1) may be utilised by this species.	Recorded in most surveys in the area (see Biologic, *in prep* a).	**Recorded** See Figure 5.1 for location.
Bush Stone-curlew *Burhinus grallarius*	DEC Priority List: Priority 4	Lightly wooded country (including *Acacia* woodlands) near daytime shelter, e.g. thickets or long grass (Johnstone and Storr, 1998) and often with fallen timber (Marchant and Higgins, 1993). In inland Australia, generally around ranges, lakes and watercourses with permanent water. Around day shelters there is generally greater fallen debris, more bare ground and less grass and disturbance.	Areas of potential habitat exist in the Study Area in Gorges, Valley and Major Drainage Line.	The species is shy and extremely wary (Marchant and Higgins, 1993), and is therefore very easily overlooked. Nearest records are from Dale's Gorge, Karijini National Park (Birds Australia, 2010) and the Fortescue Marsh, (DEC, 2010a).	**High** Species is expected to occur in the Study Area as an uncommon breeding resident.
Cattle Egret *Ardea ibis*	EPBC Act: Migratory Irregular visitor, mainly in Autumn.	Short grass, especially damp pastures, and wetlands (Johnstone and Storr, 1998).	Within the Study Area, there is very little suitable habitat. Permanent water occurs in some gorges but vegetation is likely to be too thick and closed to be utilised by this species. Open short grasslands and damp pastures are not well represented in the region. Seasonal inundation may create temporary potential habitat.	The Cattle Egret is an irregular visitor, mainly in Autumn, and is not regular in the Pilbara (Marchant and Higgins, 1990). Closest record from Ophthalmia Dam area approximately 80 km south-east of Study Area (Birds Australia, 2010).	**Low** Species not expected to occur.

Name	Conservation Status	Preferred Habitat	Extent of habitat in Study Area	Previous records	Expected likelihood of occurrence
Eastern Great Egret *Ardea modesta*	EPBC Act: Migratory	Favoured breeding habitat includes wooded swamps and river pools with Eucalyptus camaldulensis and paperbarks (Johnstone and Storr, 1998).	Pools of water exist in small patches within Gorge habitat.	Recorded at Weeli Wolli (Outback Ecology Services, 2010)	**Low** Pools are too small to support this species.
Eastern Osprey *Pandion cristatus*	EPBC Act: Migratory	Typically a coastal species. Johnstone and Storr (1998) note that the species may be uncommon to common on larger rivers north of the Tropic of Capricorn.	No rivers with large bodies of permanent water occur in the Study Area	Recorded at Weeli Wolli Springs (Outback Ecology Services, 2008).	**Low** Species not expected to occur.
Fork-tailed Swift *Apus pacificus*	EPBC Act: Migratory	Aerial species.	Can occur over all habitat types.	Recorded approximately 6 km to the south of the Study Area (Biologic, *in prep* a).	**High** Expected to occur occasionally above the Study Area, but as it is an aerial species it would not use any of the habitats present.
Grey Falcon *Falco hypoleucos*	DEC Priority List: Priority 4	Inhabits more open areas, such as lightly wooded riverine plains (Johnstone and Storr, 1998). It utilises corvid nest platforms to breed, including those built in *Eucalyptus camaldulensis* or *E. victrix* (Johnstone and Storr, 1998).	Study Area would provide hunting habitat and possibly breeding habitat in the Gorge and Major Drainage Line. Especially where large *Eucalyptus camaldulensis* and *E. victrix* are available.	Recorded at Area C and Southern Flank (Biologic, *in prep* a, b).	**Medium** Species is highly likely to be recorded flying over the area. Species may breed in the area at some point in the future as habitat exists in the Study Area.

Name	Conservation Status	Preferred Habitat	Extent of habitat in Study Area	Previous records	Expected likelihood of occurrence
Night Parrot *Pezoporus occidentalis*	EPBC Act: Endangered, Migratory WC Act: Schedule 1	Treeless or sparsely wooded spinifex near water (Johnstone and Storr, 1998). Spinifex grasslands in stony or sandy areas, with large, dense clumps with much bare ground between them, or shrubby samphire and chenopod associations on floodplains (Higgins, 1999).	Although ostensibly suitable habitat exists in the form of spinifex grasslands, large clumps are generally absent and habitats are generally woodland.	Sparse records throughout the arid zone. Nearest record in the Pilbara from near the Fortescue Marsh at Minga well, 55 km north west of the Study Area (Davis and Metcalf, 2008).	**Low** Species not expected to occur.
Oriental Plover *Charadrius veredus*	EPBC Act: Migratory Overwinters in Australia late August to April from northern hemisphere breeding grounds	Sparsely vegetated plains, including samphire and short-grass flats.	No suitable habitat in the Study Area. Small, localised patches of open, sparse vegetation are not extensive enough.	Very few records in the Pilbara are from the Abydos plains, >200 km north of the Study Area (Birds Australia, 2010)	**Low** Species not expected to occur.
Peregrine Falcon *Falco peregrinus*	WC Act: Schedule 4	Inland, this species is most often encountered along cliffs above rivers, ranges and wooded watercourses and lakes, where it seeks out its main prey: aerial birds (Johnstone and Storr, 1998).	Gorges and Major Drainage Line habitat (see Figure 4.1) may be utilised by this species for breeding or hunting.	Numerous sightings of individuals have been recorded at Area C and nearby Southern Flank (Biologic, *in prep* b).	**Medium** Species is highly likely to utilise the area for hunting and may breed along the cliff walls in Gorge habitat or tall trees in the Major Drainage Line habitat.
Rainbow Bee-eater *Merops ornatus*	EPBC Act: Migratory	Any habitats with water nearby.	Gorge, Major Drainage Line, Minor Drainage Line and Valley may be utilised by this species.	Recorded in most surveys in the area (Biologic, *in prep* a).	**Recorded** See Figure 5.1 for location.
Star Finch (western subspecies) *Neochmia ruficauda subclarescens*	DEC Priority List: Priority 4	Occurs in grasslands near water (Simpson and Day, 2004).	Gorge habitat and Major Drainage Line (see Figure 4.1) is utilised by this species.	Recorded in two previous surveys at Area C (Biologic, *in prep* a).	**Recorded** See Figure 5.1 for location.

Name	Conservation Status	Preferred Habitat	Extent of habitat in Study Area	Previous records	Expected likelihood of occurrence
Reptiles					
Pilbara Olive Python *Liasis olivaceus barroni*	EPBC Act: Vulnerable WC Act: Schedule 1	Locations with deep horizontal spaces and caves near dry or near-dry pools could provide habitat.	Gorge, Major Drainage Line and Valley habitats may be utilised by this species.	Recorded at Area C (Outback Ecology Services, 2008).	**High** Gorge habitat in the Study Area is ideal.
Ramphotyphlops ganei	DEC Priority List: Priority 1	Possibly associated with moist gorges and gullies (Wilson and Swan, 2008) although recent surveys have recorded this species in Mulga and Valley habitat (Biologic, *in prep* a).	Gorge, Major Drainage Line, Minor Drainage Line and Valley may be utilised by this species (see Figure 4.1).	Numerous records exist at Area C and Southern Flank (Biologic, *in prep* a, b).	**High** Good quality habitat exists in the Study Area.

5.2 Conservation Significant Fauna Recorded During the Survey

Five species, consisting of two native mammals and three birds were recorded during the 2010 survey. Information on each of these species is provided below. Conservation codes are explained in Appendix B, while locations of conservation significant fauna from the Study Area are presented in Appendix E.

5.2.1 Ghost Bat (*Macroderma gigas*)

The Ghost Bat is listed as Priority 4 on the DEC Priority list. They formerly occurred over a wide area of central, northern and southern Australia but have declined significantly in the southern parts of their range in the last 200 years (van Dyck and Strahan, 2008). In Western Australia, Ghost Bats are now confined to the Kimberley and Pilbara regions.

The distribution of Ghost Bats is influenced by the availability of suitable caves and mines for roost sites. The preferred roosting habitats of Ghost Bats in the Pilbara are deep, complex caves beneath bluffs of low rounded hills composed of Marra Mamba geology, Brockman Iron Formations, granite rock piles and abandoned mines (Armstrong and Anstee, 2000). Armstrong and Anstee (2000) note that most caves used by Ghost Bats in bluff caves have narrow entrances (less than 0.5 m^2) that opened into larger chambers. Ghost Bats move between a number of caves seasonally, or as dictated by weather changes, and roost either individually or in colonies of up to 1500 (Churchill, 2008). During breeding, female Ghost Bats congregate into maternity roosts, generally selecting very warm caves during pregnancy and lactation (Hutson *et al.*, 2001).

The Ghost Bat has been previously recorded in the local area by observation, scat records and using the ANABAT detector (Biologic records). One Ghost Bat roost was recorded during the survey. Scats were recorded at cave ACY 1 (see Appendix E). See Figure 5.1 for location.

5.2.2 Western Pebble-mound Mouse (*Pseudomys chapmani*)

The Western Pebble-mound Mouse is listed as Priority 4 by the DEC, due to a significant decline in their range from the Gascoyne and Murchison (van Dyck and Strahan, 2008). Preferred habitat includes the gentler slopes of rocky ranges where the ground is covered with a stony mantle and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs (van Dyck and Strahan, 2008).

The characteristic mounds constructed by colonies of these mice were commonly recorded within the Study Area on the crests and lower slopes of ironstone ridges and low rocky hills. A large number of mounds were recorded within the study area (see Figure 5.1 and Appendix E) suggesting that the species is a common resident in suitable habitat within the Study Area.

5.2.3 Australian Bustard (*Ardeotis australis*)

The Australian Bustard is classified as Priority 4 by the DEC. This species occurs in a variety of grassland, grassy woodland and shrubland habitats. It is nomadic and may range over very large areas. The Australian Bustard has declined from its range further to the south, with the main threats to its survival being a combination of habitat loss/degradation and predation by feral cats and foxes. This species was recorded within the Study Area with a single individual observed.

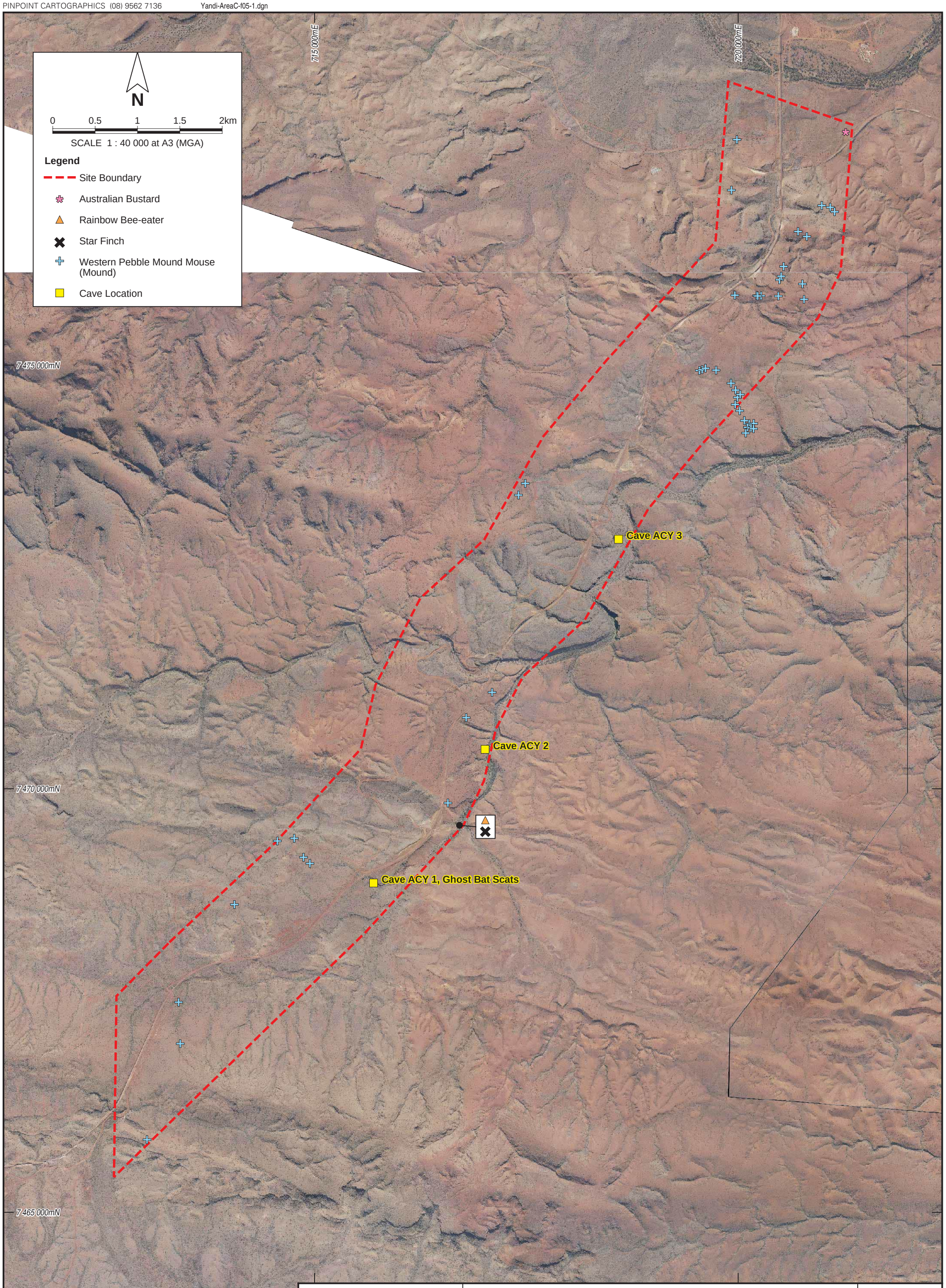
5.2.4 Star Finch (*Neochmia ruficauda subclarescens*)

The 'western' population of Star Finch is considered by DEC to represent a separate subspecies (*N. r. subclarescens*) distinct from Kimberley and Northern Territory birds (*N. r. clarescens*), although this is not recognised by the WAM (Johnstone and Storr, 2008). These birds are generally uncommon and patchily distributed in the Pilbara and are listed as Priority 4 by the DEC. Within the Pilbara, Star Finches are predominantly associated with sedgelands adjacent to permanent water (Biologic records). This species has been recorded in the Newman area and was recorded during the current survey. A flock of five individuals was recorded from sedgeland along a major drainage line within the study area (see Appendix E)

5.2.5 Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is listed as Migratory under the EPBC Act and under Schedule 3 of the *WC Act*. The Rainbow Bee-eater occurs year-around in the tropics of northern Australia, with a southward migration, to both south-eastern and south-western Australia, in early spring. Southern birds return north in autumn (Johnstone and Storr 1998). It has a wide range and occurs in the better watered parts of Western Australia, between the Kimberley and south-west of WA, preferring lightly wooded, preferably sandy country near water (Johnstone and Storr, 1998). It nests in burrows dug usually at a slight angle in flat ground, gently elevated slopes, sandy banks or cuttings, and often at the margins of roads or tracks.

When present, the Rainbow Bee-eater is common and prominent in both natural and altered environments. Although a species of conservation significance, it is abundant and versatile in its selection of nest sites. This species was recorded at two locations within the Study Area (Figure 5.1).



biologic

BHP Billiton Iron Ore
AREA C TO YANDI
FAUNA SURVEY

SIGNIFICANT FAUNA LOCATIONS

Figure 5.1

Drawn: M. O'Connell | Date: 16 Nov 2010 | Job: --

5.3 Important Fauna Habitats

Each of the fauna habitats identified in Section 4 was given a significance score of High, Medium or Low based on criteria outlined in Table 3.5. Details of the assessment are provided in Table 5.2 below. Gorge, Valley and Major Drainage Line habitats were considered to be of High significance because they support or provide habitat for a number of conservation significant species. Fauna habitats within the Study Area are shown on Figure 4.1.

Table 5.2: Fauna habitat significance scores

Fauna habitat	Score	Rationale
Major Drainage Line	High	Supports Migratory bird species such as the Rainbow Bee-eater, as well as a locally high diversity of bird species. Provides potential breeding and/or foraging sites for the Grey Falcon (listed as a Priority 4 species by the DEC) and Peregrine Falcon (listed under Schedule 4 of the WC Act). Provides habitat and dispersal opportunities for the Pilbara Olive Python (listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act). May provide habitat and dispersal opportunities for Northern Quoll. Drainage lines are important habitats for *Ramphotyphlops ganei* , listed as a Priority 1 species by the DEC.
Gorge	High	Gorge habitats within the Study Area represents habitat for numerous species listed under the EPBC Act and WC Act). See Tables 4.4 and 5.1 for list of species that may occur in this habitat. This habitat also contains several caves some of which may provide roosting opportunities for conservation significant bat species (see Appendix E).
Valley	High	This habitat is utilised by several species listed under the DEC Priority List (see Tables 4.4 and 5.1 for list of species that may occur in this habitat) but does not support a significant population of these species and these species are not restricted to this habitat type. This habitat may be utilised by the Northern Quoll which is listed under the EPBC Act and WC Act but is unlikely to represent core habitat as more suitable habitat is available in the Study Area.
Crest/Slope	Medium	Crest/Slope habitat supports local populations of the Western Pebble-mound Mouse, listed as a Priority 4 species by the DEC. The species is largely restricted to this habitat type.
Minor Drainage Line	Low	This habitat is utilised by several species listed under the DEC Priority List (see Tables 4.4 and 5.1 for list of species that may occur in this habitat) but does not support a significant population of these species and these species are not restricted to this habitat type.

6 REFERENCES

Australian Natural Resource Atlas (2008). *Biodiversity Assessment – Pilbara*. Australian Website: http://www.anra.gov.au. Accessed: June 2010.

Biologic (in prep a) *Area C and Surrounds Fauna Study*. In prep, unpublished report for BHP Billiton Iron Ore.

Biologic (in prep b) *Southern Flank Fauna Study*. In prep, unpublished report for BHP Billiton Iron Ore.

Birds Australia (2010) *Birdata*. Website: http://www.birdata.com.au/homecontent.do. Accessed: July 2010, circle of radius 40 km centred on the point 119°00'25"E, 22°57'15"S conducted.

Bureau of Meterology (2010) *Webpage*. Website: www.bom.gov.au. Accessed: November 2010.

Christidis, L. and Boles, W. (2008) *Systematics and Taxonomy of Australian Birds*. CSIRO Publishing, Collingwood.

(CSIRO) Commonwealth Scientific and Research Organisation (2009) *Australian Soil and Land Survey Field Handbook*. 3rd Edition. CSIRO Publishing, Collingwood.

Davis, R. and Metcalf, B. (2008) The Nigh Parrot (*Pezoporus occidentalis*) in northern Western Australia: a recent sighting from the Pilbara region. *Emu*, 108: 233-236.

(DEC) Department of Environment and Conservation (2010a) *NatureMap Mapping Western Australia's Biodiversity*. Website: http://naturemap.dec.wa.gov.au/default.aspx. Accessed: July 2010, circle of radius 40 km centred on the point 119°00'25"E, 22°57'15"S conducted.

(DEC) Department of Environment and Conservation (2010b) *Threatened and Priority Fauna Database*. Accessed October 2010.

(DEWHA) Department of the Environment, Water, Heritage and the Arts (2010a) *Survey Guidelines for Australia's Threatened Frogs*. Website: http://www.environment.gov.au/epbc /publications/pubs/survey-guidelines-frogs.pdf Accessed August 2010.

(DEWHA) Department of the Environment, Water, Heritage and the Arts (2010b) *Survey Guidelines for Australia's Threatened Birds*. Website: http://www.environment.gov.au/epbc /publications/pubs/survey-guidelines-birds.pdf Accessed August 2010.

(DEWHA) Department of the Environment, Water, Heritage and the Arts (2010c) *Survey Guidelines for Australia's Threatened Bats*. Website: http://www.environment.gov.au/epbc /publications/pubs/survey-guidelines-bats.pdf Accessed August 2010.

(DEWHA) Department of the Environment, Water, Heritage and the Arts (2010d) *Protected Matters Database Search Tool*. Website: http://www.environment.gov.au/epbc/pmst/index.html Accessed October 2010, circle of radius 40 km centred on the point 119°07'44"E, 22°49'51"S plus 40 km buffer conducted.

Ecologia Environmental Consultants (1998a) *Mining Area C Biological Survey*. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (1998b) *Weeli Wolli Creek Biological Assessment Survey*. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (2004a) *Packsaddle Range Biological Survey*. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (2004b) *Area C: Deposits D, E and F Biological Survey*. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (2006) *Ministers North Biological Survey*. Unpublished report for BHP Billiton Iron Ore.

Ecologia Environmental Consultants (2008) *Area A and Additional Areas Level 2 Terrestrial Fauna survey*. Unpublished report for United Minerals Corporation Pty Ltd.

ENV Australia (2007) *Area C R-deposit Fauna Assessment*. Unpublished report for BHP Billiton Iron Ore.

ENV Australia (2008a) *Area C South Flank Deposit Fauna Assessment.* Unpublished report for BHP Billiton Iron Ore.

ENV Australia (2008b) *Area C West Fauna Assessment*. Unpublished report for BHP Billiton Iron Ore.

ENV Australia (2008c) *Jinayri Vertebrate Fauna Assessment*. Unpublished report for BHP Billiton Iron Ore.

Environmental Protection Authority (2002) *Terrestrial Biological Surveys as an Element of Biodiversity Protection Position Statement No. 3.* Perth.

Environmental Protection Authority (2004) *Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia No. 56.* Perth.

Gibson, L.A. and McKenzie, N.L. (2009) *Environmental associations of small ground-dwelling mammals in the Pilbara region, Western Australia*. Records of the Western Australian Museum, Supplement 78: 91-122.

Higgins, P. (Ed.) (1999) *Handbook of Australian*, *New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird*. Oxford University Press, Melbourne.

International Union for Conservation of Nature (2010) *IUCN Red List of Threatened Species. Version 2010.3*. Website: http://www.iucnredlist.org/. Accessed: 13 October 2010.

Johnstone, R. and Storr, G. (1998) *Handbook of Western Australian Birds. Volume I – Non-passerines* (*Emu to Dollarbird*). Western Australian Museum, Perth

Kendrick, P. (2001) *Pilbara 3 (PIL3 – Hamersley subregion)*. In: May, J. and McKenzie, N (Eds.) *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*. Department of Conservation and Land Management, Perth.

Marchant, S. and Higgins, P. (1990) *Handbook of Australian*, *New Zealand and Antarctic Birds. Volume 1: Ratites to Ducks.* Oxford University Press, Melbourne.

Marchant and Higgins (1993) *Handbook of Australian*, *New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings*. Oxford University Press, Melbourne.

(OES) Outback Ecology Services (2008) *Area C Mining Operation Environmental Management Plan (Revision 4) A, D, P1 and P3 Deposits*. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

(OES) Outback Ecology Services (2010) *Area C to Jinayri to Mount Newman Railway Terrestrial Vertebrate Fauna Survey*. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

Simpson, K. & Day, N. (1999) *Field Guide to the Birds of Australia*. Penguin, Australia.

Storr, G. M. (1963) *West Australian Naturalist*. 8:188.

Thackway, R. and Cresswell, I.D. (1995) *An Interim Biogeographic Regionalisation for Australia: A framework for establishing the national system of reserves*, *Version 4.0.* Australian Nature Conservation Agency, Canberra.

Thorne, A.M. and Tyler, I.M. (1997) *Roy Hill, 1:250 000 Geological Map and Explanatory Notes*.

Western Australian Museum (2009) *Checklists of the Fauna of Western Australia.* Unpublished checklist. Last updated 6 October 2009.

Wilson, S. and Swan, G. (2008) *A Complete Guide to Reptiles of Australia*. 2nd Edition. New Holland Publishers (Australia), Sydney.

Appendix A: Survey site locations

Survey Type	Zone	Easting	Northing
Habitat Assessments			
Habitat01	50K	712816	7465875
Habitat02	50K	714490	7468674
Habitat03	50K	713627	7466543
Habitat04	50K	714876	7467737
Habitat05	50K	715978	7468723
Habitat06	50K	717383	7471241
Habitat07	50K	717049	7470335
Habitat08	50K	719917	7477080
Habitat09	50K	720327	7476429
Habitat10	50K	718994	7473587
Habitat11	50K	720987	7476884
Habitat12	50K	718516	7474637
Habitat13	50K	717681	7472463
Habitat14	50K	715984	7470176
Habitat15	50K	715977	7471118
Habitat16	50K	717365	7472210
Opportunistic Survey Sites			
Opportunistic Site 1	50K	713042	7465977
Opportunistic Site 2	50K	714869	7469191
Opportunistic Site 4	50K	716973.6	7471419
Opportunistic Site 5	50K	718256	7472211
Opportunistic Site 6	50K	716810	7470599
Opportunistic Site 7	50K	721085	7477811
Opportunistic Site 8	50K	720116.9	7476951
Opportunistic Site 9	50K	719373	7476041
Opportunistic Site 10	50K	719940	7474682
Opportunistic Site 11	50K	719136	7473651
Opportunistic Site 12	50K	720758.2	7475998
Opportunistic Site 13	50K	718148.5	7473871
Bat Recorder Locations			
Anabat™ 1	50K	712788	7466193
Anabat™ 2	50K	716895	7471358
Anabat™ 3	50K	719630	7473720
Anabat™ 4	50K	721646	7478386
Anabat™ 5	50K	719579	7473699
Camera Trap Locations			
Camera 1	50K	712788	7466193
Camera 2	50K	716841	7471569
Camera 3	50K	716895	7471358
Camera 4	50K	719630	7473720
Camera 5	50K	721646	7478386

Appendix B: Conservation status codes

International Union for Conservation of Nature

Category	Definition
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CE)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future
Data Deficient	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Environment Protection and Biodiversity Conservation Act, 1999

Category	Definition
Extinct (EX)	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (EW)	Taxa known to survive only in captivity.
Critically Endangered (CE)	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 high risk of extinction in the wild in the medium-term future.
Migratory (MG)	Consists of species listed under the following International Conventions: • Japan-Australia Migratory Bird Agreement (JAMBA); • China-Australia Migratory Bird Agreement (CAMBA); and • Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention).

Wildlife Conservation Act, 1950

Category	Definition
Schedule 1 (S1)	Rare and Likely to become Extinct.
Schedule 2 (S2)	Extinct.
Schedule 3 (S3)	Migratory species listed under international treaties.
Schedule 4 (S4)	Other Specially Protected Fauna.

Department of Environment and Conservation Priority codes

Category	Definition
Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4 (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix C: Fauna recorded in the Study Area and region

Mammals

Family and Species	Common name	Conservation Status				Database			Reports relevant to the Study Area													
		EPBC	WCA	DEC	Other	I	II	III	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
TACHYGLOSSIDAE																						
Tachyglossus aculeatus	Echidna								x							x					x	
DASYURIDAE																						
Dasykaluta rosamondae	Little Red Kaluta						x		x	x		x	x	x		x		x	x	x	x	
Dasyurus hallucatus	Northern Quoll	EN	S1			x															x	
Ningaui timealeyi	Pilbara Ningaui						x		x	x		x		x		x			x	x	x	
Planigale sp. 1	Undescribed Pilbara planigale								x	x		x	x			x		x	x		x	
Pseudantechinus roryi	Rory's Pseudantechinus						x															
Pseudantechinus woolleyae	Woolley's Pseudantechinus						x									x					x	x
Sminthopsis longicaudata	Long-tailed Dunnart			P4				x														
Sminthopsis macroura	Stripe-faced Dunnart						x		x			x				x			x		x	
Sminthopsis ooldea	Ooldea Dunnart						x		x													
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart						x													x		
THYLACOMYIDAE																						
Macrotis lagotis	Bilby, Dalgyte	VU	S1			x																
MACROPODIDAE																						
Macropus robustus erubescens	Euro, Biggada						x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Macropus rufus	Red Kangaroo, Marlu						x							x	x			x	x	x	x	
Petrogale rothschildi	Rothschild's Rock-wallaby						x		x	x				x	x	x	S	x			x	x
PHALANGERIDAE																						
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum				Local			x														
PTEROPODIDAE																						
Pteropus alecto	Black Flying-fox									x												
MEGADERMATIDAE																						
Macroderma gigas	Ghost Bat			P4			x									x				x	x	S
HIPPOSIDERIDAE																						
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1			x	x						x							x	x	
EMBALLONURIDAE																						
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat						x				A	A			x	x	A		A	x	x	x
Taphozous georgianus	Common Sheathtail-bat						x				A	A	x		x	x	A	x	A	x	x	x
Taphozous hilli	Hill's Sheathtail-bat						x		A							x		x		x	x	
MOLOSSIDAE																						
Chaerephon jobensis	Northern Freetail-bat						x			x			x		x	x	A	x	A	x	x	x
Mormopterus beccarii	Beccari's Freetail-bat						x				A	A	x		x	x	A	x	A	x	x	
Mormopterus planiceps	Southern Freetail-bat								A	x												
Tadarida australis	White-striped Freetail-bat						x					A			x				A	x	x	x
VESPERTILIONIDAE																						
Chalinolobus gouldii	Gould's Wattled Bat						x		A	x	A	A	x		x	x	A	x	A	x	x	x
Chalinolobus morio	Chocolate Wattled Bat						x															

Family and Species	Common name	Conservation Status				Database			Reports relevant to the Study Area													
		EPBC	WCA	DEC	Other	I	II	III	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
Nyctophilus bifax daedalus	Northwestern Long-eared Bat						x										A		A			
Nyctophilus geoffroyi	Lesser Long-eared Bat						x			x	A		x			x	A	x		x	x	x
Scotorepens balstoni	Inland Broad-nosed Bat								A													
Scotorepens greyii	Little Broad-nosed Bat						x		A		A	A	x		x	x	A	x	A	x	x	x
Vespadelus finlaysoni	Finlayson's Cave Bat						x		A	x	A	A	x		x	x	A	x	A	x		x
MURIDAE																						
Notomys alexis	Spinifex Hopping-mouse						x													x		
Leggadina lakedownensis	Short-tailed Mouse			P4			x															
Pseudomys chapmani	Western Pebble-mound Mouse			P4			x		x	M	x	x	x	M	M	M	x		x	M	x	M
Pseudomys desertor	Desert Mouse						x						x			x		x	x		x	
Pseudomys hermannsburgensis	Sandy Inland Mouse						x		x	x		x		x		x		x	x	x	x	
Zyzomys argurus	Common Rock-rat						x		x	x		x	x	x	x	x		x	x	x	x	
INTRODUCED MAMMALS																						
Bos taurus	European Cattle						x		x	x				x	x	x			x	x	x	x
Canis lupus dingo	Dingo								x		x	x		x	x	x		x		x	x	
Camelus dromedarius	Dromedary, Camel															T				x	x	
Equus caballus	Horse																		x			
Felis catus	Cat								x			x		x	x					x	x	S
Mus musculus	House Mouse						x			x						x		x		x	x	
Oryctolagus cuniculus	Rabbit									x											x	
Vulpes vulpes	Red Fox														x						x	
Equus asinus	Donkey																					x

Database search codes: I) EPBC Protected Matters Search Tool; II) DEC NatureMap; III) Biologic & Other Data.

Other symbols used: M) pebble mound; A) ANABAT™ record; S) scats; T) tracks; x) individual or record type not specified. Conservation status codes as per Appendix B.

Birds

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
CASUARIIDAE																				
Dromaius novaehollandiae	Emu					x	x	x								x	x			
PHASIANIDAE																				
Coturnix pectoralis	Stubble Quail											x								
Coturnix ypsilophora	Brown Quail												x			x				
ANATIDAE																				
Dendrocygna eytoni	Plumed Whistling-duck					x														
Tadorna tadornoides	Australian Shelduck					x														
Chenonetta jubata	Australian Wood Duck					x														
Anas gracilis	Grey Teal					x		x												
Anas superciliosa	Pacific Black Duck					x														x
Aythya australis	Hardhead					x														
PODICIPEDIDAE																				
Tachybaptus novaehollandiae	Australasian Grebe					x														
COLUMBIDAE																				
Phaps chalcoptera	Common Bronzewing					x	x	x	x		x	x	x	x	x	x	x	x	x	x
Ocyphaps lophotes	Crested Pigeon					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Geophaps plumifera	Spinifex Pigeon					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Geopelia cuneata	Diamond Dove					x	x	x	x	x	x	x	x	x	x	x	x	x		
Geopelia striata	Peaceful Dove					x	x	x			x			x			x			x
PODARGIDAE																				
Podargus strigoides	Tawny Frogmouth					x	x		x	x	x		x	x	x			x	x	x
EUROSTOPODIDAE																				
Eurostopodus argus	Spotted Nightjar					x	x	x	x	x	x	x		x	x	x	x	x	x	
AEGOTHELIDAE																				
Aegotheles cristatus	Australian Owlet-nightjar					x	x	x	x	x	x	x	x	x	x	x			x	
APODIDAE																				
Apus pacificus	Fork-tailed Swift	MG			x							x		x						
ANHINGIDAE																				
Anhinga novaehollandiae	Australasian Darter					x														
PHALACROCORACIDAE																				
Microcarbo melanoleucos	Little Pied Cormorant					x														
Phalacrocorax sulcirostris	Little Black Cormorant					x		x												
CICONIIDAE																				
Ephippiorhynchus asiaticus	Black-necked Stork					x														
ARDEIDAE																				
Ardea pacifica	White-necked Heron					x		x												x
Ardea modesta	Eastern Great Egret	MG			x	x														
Egretta novaehollandiae	White-faced Heron					x	x	x												
Ardea ibis	Cattle Egret	MG			x	x														
Egretta garzetta	Little Egret					x														

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
THRESKIORNITHIDAE																				
Threskiornis spinicollis	Straw-necked Ibis					x		x									x			
Platalea regia	Royal Spoonbill					x														
Platalea flavipes	Yellow-billed Spoonbill					x														
ACCIPITRIDAE																				
Pandion cristatus	Eastern Osprey	MG																		
Elanus axillaris	Black-shouldered Kite										x							x		
Lophoictinia isura	Square-tailed Kite					x														
Hamirostra melanosternon	Black-breasted Buzzard													x				x		
Haliastur sphenurus	Whistling Kite					x	x		x		x	x	x	x		x	x		x	x
Milvus migrans	Black Kite					x						x								
Accipiter fasciatus	Brown Goshawk					x	x	x						x		x	x	x	x	
Accipiter cirrocephalus	Collared Sparrowhawk					x	x	x						x				x	x	x
Circus assimilis	Spotted Harrier					x	x	x			x			x						
Aquila audax	Wedge-tailed Eagle					x	x	x	x	x	x		x	x		x	x		x	
Hieraaetus morphnoides	Little Eagle					x		x			x	x	x	x				x		
FALCONIDAE																				
Falco cenchroides	Nankeen Kestrel					x	x	x		x	x		x	x		x	x			
Falco berigora	Brown Falcon					x	x	x	x	x	x	x	x	x	x	x	x	x		x
Falco longipennis	Australian Hobby					x	x	x					x	x						
Falco hypoleucos	Grey Falcon			P4		x			x				x							
Falco peregrinus	Peregrine Falcon		S4			x	x	x						x						
RALLIDAE																				
Gallirallus philippensis	Buff-banded Rail					x														
OTIDIDAE																				
Ardeotis australis	Australian Bustard			P4		x	x	x				x	x	x			x	x	x	x
BURHINIDAE																				
Burhinus grallarius	Bush Stone-curlew			P4												x				
RECURVIROSTRIDAE																				
Himantopus himantopus	Black-winged Stilt										x									
CHARADRIIDAE																				
Charadrius veredus	Oriental Plover	MG			x															
Elseyornis melanops	Black-fronted Dotterel					x	x	x												
TURNICIDAE																				
Turnix velox	Little Button-quail					x	x	x	x	x	x	x	x	x		x		x		
CACATUIDAE																				
Eolophus roseicapillus	Galah					x	x	x	x	x	x	x	x	x		x	x	x	x	
Cacatua sanguinea	Little Corella					x	x	x			x					x				
Nymphicus hollandicus	Cockatiel					x		x						x		x		x	x	
PSITTACIDAE																				
Barnardius zonarius	Australian Ringneck					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Psephotus varius	Mulga Parrot										x	x				x				
Melopsittacus undulatus	Budgerigar					x	x	x	x	x	x	x		x	x	x	x	x		

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
Neopsephotus bourkii	Bourke's Parrot						x		x			x				x	x		x	
Pezoporus occidentalis	Night Parrot	EN, MG	S1		x															
CUCULIDAE																				
Chalcites basalis	Horsfield's Bronze-Cuckoo					x	x	x	x	x		x	x	x	x			x	x	
Chalcites osculans	Black-eared Cuckoo						x													
Cacomantis pallidus	Pallid Cuckoo					x	x	x	x	x	x	x	x	x	x		x	x		
STRIGIDAE																				
Ninox connivens	Barking Owl							x												
Ninox novaeseelandiae	Southern Boobook					x	x	x		x	x			x		x			x	
TYTONIDAE																				
Tyto javanica	Eastern Barn Owl					x			x	x				x						
HALCYONIDAE																				
Dacelo leachii	Blue-winged Kookaburra					x		x				x		x				x		x
Todiramphus pyrrhopygius	Red-backed Kingfisher					x		x	x	x	x	x	x	x		x	x		x	x
Todiramphus sanctus	Sacred Kingfisher					x		x					x					x		
MEROPIDAE																				
Merops ornatus	Rainbow Bee-eater	MG			x	x	x	x			x	x	x	x	x	x	x	x	x	x
CLIMACTERIDAE																				
Climacteris melanura	Black-tailed Treecreeper						x	x	x											
PTILINORHYNCHIDAE																				
Ptilonorhynchus guttatus	Western Bowerbird					x	x	x	x	x	x	x	x	x	x	x		x	x	
MALURIDAE																				
Malurus splendens	Splendid Fairy-wren												x			x	x			
Malurus leucopterus	White-winged Fairy-wren					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Malurus lamberti	Variegated Fairy-wren					x	x	x	x	x	x	x		x	x	x	x	x	x	X
Stipiturus ruficeps	Rufous-crowned Emu-wren						x		x	x				x		x	x	x	x	X
Amytornis striatus whitei	Striated Grasswren					x	x		x	x		x		x	x	x	x	x	x	X
ACANTHIZIDAE																				
Pyrrholaemus brunneus	Redthroat					x										x				
Smicrornis brevirostris	Weebill					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Gerygone fusca	Western Gerygone					x	x	x		x		x	x	x		x	x	x	x	X
Acanthiza robustirostris	Slaty-backed Thornbill						x			x			x			x	x		x	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill						x									x	x		x	
Acanthiza uropygialis	Chestnut-rumped Thornbill					x	x									x	x	x	x	
Acanthiza apicalis	Inland Thornbill					x	x	x		x		x		x		x	x	x	x	
PARDALOTIDAE																				
Pardalotus rubricatus	Red-browed Pardalote					x	x	x			x	x		x	x	x		x	x	X
Pardalotus striatus	Striated Pardalote					x	x	x	x	x	x	x		x	x	x		x	x	X
MELIPHAGIDAE																				
Certhionyx variegatus	Pied Honeyeater										x									
Lichenostomus virescens	Singing Honeyeater					x	x	x	x	x	x	x	x	x		x	x	x	x	X
Lichenostomus keartlandi	Grey-headed Honeyeater					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
Lichenostomus penicillatus	White-plumed Honeyeater					x	x	x				x		x		x	x	x	x	X
Purnella albifrons	White-fronted Honeyeater													x						
Manorina flavigula	Yellow-throated Miner					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Conopophila whitei	Grey Honeyeater											x		x			x		x	
Epthianura tricolor	Crimson Chat					x		x			x		x	x	x	x				
Sugomel niger	Black Honeyeater							x							x		x			
Lichmera indistincta	Brown Honeyeater					x	x	x	x	x	x	x	x	x	x		x	x	x	
Melithreptus gularis	Black-chinned Honeyeater						x	x	x	x	x			x		x		x	x	x
POMATOSTOMIDAE																				
Pomatostomus temporalis	Grey-crowned Babbler					x	x	x		x		x	x	x	x	x	x	x	x	x
Pomatostomus superciliosus	White-browed Babbler					x	x									x	x	x	x	
PSOPHODIDAE																				
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush																x		x	
Psophodes occidentalis	Chiming Wedgebill					x														
NEOSITTIDAE																				
Daphoenositta chrysoptera	Varied Sittella						x	x			x					x	x			
CAMPEPHAGIDAE																				
Coracina maxima	Ground Cuckoo-shrike						x				x			x		x		x	x	
Coracina novaehollandiae	Black-faced Cuckoo-shrike					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lalage sueurii	White-winged Triller					x	x	x	x	x	x	x	x	x	x	x	x	x	x	
PACHYCEPHALIDAE																				
Pachycephala rufiventris	Rufous Whistler					x	x	x	x	x	x	x	x	x		x	x	x	x	X
Colluricincla harmonica	Grey Shrike-thrush					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Oreoica gutturalis	Crested Bellbird					x	x	x	x	x	x	x	x	x	x	x	x	x	x	
ARTAMIDAE																				
Artamus personatus	Masked Woodswallow					x	x	x			x				x					
Artamus cinereus	Black-faced Woodswallow					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Artamus minor	Little Woodswallow					x	x	x	x	x	x	x		x	x	x		x	x	X
Cracticus torquatus	Grey Butcherbird					x	x	x	x	x	x	x	x	x		x	x	x	x	
Cracticus nigrogularis	Pied Butcherbird					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cracticus tibicen	Australian Magpie					x	x	x	x	x	x	x	x	x		x	x	x	x	X
RHIPIDURIDAE																				
Rhipidura albiscapa	Grey Fantail						x	x		x	x		x	x		x	x	x	x	X
Rhipidura leucophrys	Willie Wagtail					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
CORVIDAE																				
Corvus bennetti	Little Crow					x	x	x								x				
Corvus orru	Torresian Crow					x		x	x	x	x	x	x	x	x	x	x	x	x	x
MONARCHIDAE																				
Grallina cyanoleuca	Magpie-lark					x	x	x	x	x	x	x	x	x		x	x	x	x	x
PETROICIDAE																				
Petroica goodenovii	Red-capped Robin					x	x	x			x					x	x		x	

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
Melanodryas cucullata	Hooded Robin					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ALAUDIDAE																				
Mirafra javanica	Horsfield's Bushlark					x			x				x							
ACROCEPHALIDAE																				
Acrocephalus australis	Australian Reed-Warbler					x														
MEGALURIDAE																				
Cincloramphus mathewsi	Rufous Songlark					x	x	x	x		x	x	x	x				x		
Cincloramphus cruralis	Brown Songlark					x														
Eremiornis carteri	Spinifexbird						x	x	x	x	x	x	x	x	x		x	x	x	x
Megalurus timoriensis	Little Grassbird																			x
HIRUNDINIDAE																				
Cheramoeca leucosterna	White-backed Swallow							x												
Hirundo neoxena	Welcome Swallow					x					x		x							
Petrochelidon ariel	Fairy Martin					x					x	x								
Petrochelidon nigricans	Tree Martin					x	x	x			x						x	x		x
NECTARINIIDAE																				
Dicaeum hirundinaceum	Mistletoebird					x	x	x	x	x	x			x	x	x	x	x	x	
ESTRILDIDAE																				
Taeniopygia guttata	Zebra Finch					x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Neochmia ruficauda subclarescens	Star Finch (western subspecies)			P4					x	x										X
Emblema pictum	Painted Finch					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MOTACILLIDAE																				
Anthus novaeseelandiae	Australasian Pipit					x		x			x	x		x		x	x		x	

Database search codes: I) EPBC Protected Matters Search Tool; II) DEC NatureMap; Conservation status codes as per Appendix B.

Reptiles

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
CHELUIDAE																				
Chelodina steindachneri	Flat-shelled Turtle					x														
AGAMIDAE																				
Amphibolurus longirostris	Long-nosed Dragon					x	x	x	x	x		x	x	x			x	x	x	x
Caimanops amphiboluroides						x	x										x		x	
Ctenophorus caudicinctus	Ring-tailed Dragon					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ctenophorus isolepis	Crested Dragon					x	x			x			x	x		x	x		x	
Ctenophorus nuchalis	Central Netted Dragon					x														
Ctenophorus reticulatus	Western Netted Dragon					x													x	
Diporiphora valens						x				x							x		x	
Pogona minor						x	x		x	x				x		x	x	x	x	
Tympanocryptis cephalus	Pebble Dragon					x														
DIPLODACTYLIDAE																				
Crenadactylus ocellatus	Clawless Gecko					x		x							x			x		
Diplodactylus conspicillatus	Fat-tailed Gecko					x												x		
Diplodactylus granariensis						x														
Diplodactylus pulcher						x													x	
Diplodactylus savagei						x	x					x	x	x		x		x		
Lucasium stenodactylum						x		x		x				x				x	x	
Lucasium wombeyi						x	x				x			x		x	x	x	x	
Oedura marmorata	Marbled Velvet Gecko					x	x	x	x	x	x	x	x	x	x			x	x	x
Rhynchoedura ornata	Beaked Gecko					x						x		x					x	
Strophurus ciliaris																		x		
Strophurus elderi						x								x				x		
Strophurus jeanae						x														
Strophurus strophurus																	x			
Strophurus wellingtonae						x			x		x		x	x		x	x	x	x	
CARPHODACTYLIDAE																				
Nephrurus milii	Barking Gecko					x			x					x					x	
Nephrurus wheeleri						x		x						x				x	x	
GEKKONIDAE																				
Gehyra pilbara						x	x							x				x		
Gehyra punctata						x	x		x	x	x		x	x	x	x	x	x	x	
Gehyra purpurascens						x												x		
Gehyra variegata						x	x	x		x	x		x	x	x		x		x	
Heteronotia binoei	Bynoe's Gecko					x	x	x		x	x	x		x		x	x	x	x	
Heteronotia spelea	Desert Cave Gecko					x		x		x	x		x	x		x	x	x	x	
PYGOPODIDAE																				
Delma butleri							x										x	x		
Delma elegans						x								x				x		
Delma haroldi						x				x										
Delma nasuta						x				x				x			x		x	
Delma pax						x	x			x		x		x	x	x		x		
Delma tincta						x	x	x				x		x			x	x	x	
Lialis burtonis						x					x			x	x	x	x		x	
Pygopus nigriceps						x							x				x	x		

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
SCINCIDAE																				
Carlia munda	Rainbow Skink					x	x	x	x	x	x	x		x		x	x	x	x	x
Carlia triacantha						x								x					x	
Cryptoblepharus buchananii						x													x	
Cryptoblepharus ustulatus						x								x					x	x
Cryptoblepharus sp.							x	x		x	x	x			x	x		x		
Ctenotus duricola						x	x		x	x				x						
Ctenotus hanloni							x											x		
Ctenotus helenae						x				x	x		x	x			x	x	x	
Ctenotus leonhardii							x	x									x			
Ctenotus pantherinus	Leopard Ctenotus					x	x	x	x	x	x	x		x		x	x	x	x	
Ctenotus piankai							x											x		
Ctenotus rubicundus						x	x		x	x				x	x	x		x		
Ctenotus rutilans						x	x						x					x	x	
Ctenotus saxatilis	Rock Ctenotus					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ctenotus schomburgkii						x	x			x						x	x		x	
Ctenotus serventyi						x		x						x				x		
Ctenotus uber						x											x			
Cyclodomorphus melanops	Slender Blue-tongue					x	x	x			x	x		x		x	x	x	x	
Egernia depressa	Pygmy Spiny-tailed Skink					x	x		x	x				x				x	x	
Egernia formosa						x	x	x			x	x	x	x				x	x	x
Egernia pilbarensis	Pilbara Skink														x					
Eremiascincus fasciolatus	Narrow-banded Sand Swimmer					x	x					x	x	x						
Eremiascincus richardsonii	Broad-banded Sand Swimmer					x		x						x						
Lerista amicorum						x														
Lerista labialis						x														
Lerista muelleri						x	x	x					x	x	x	x	x	x	x	
Lerista neander						x	x	x			x							x		
Lerista zietzi						x	x	x	x	x				x	x			x	x	
Menetia greyii						x	x	x		x			x	x		x	x	x	x	
Menetia surda						x														
Morethia ruficauda						x	x	x	x	x		x		x	x	x		x	x	
Proablepharus reginae						x														
Tiliqua multifasciata	Central Blue-tongue					x	x		x		x		x	x		x	x	x	x	
VARANIDAE																				
Varanus acanthurus	Spiny-tailed Monitor					x	x		x	x		x		x		x	x	x	x	
Varanus brevicauda	Short-tailed Pygmy Monitor					x		x				x						x		
Varanus bushi	Pilbara Mulga Monitor					x	x			x	x			x		x		x	x	
Varanus caudolineatus						x										x	x	x		
Varanus giganteus	Perentie						x					x	x	x	x	x		x	x	x
Varanus gouldii	Bungarra or Sand Monitor					x							x				x	x		
Varanus panoptes	Yellow-spotted Monitor					x	x	x	x	x			x	x	x			x	x	
Varanus pilbarensis	Pilbara Rock Monitor					x	x					x		x	x				x	x
Varanus tristis tristis	Racehorse Monitor					x		x		x		x	x	x		x	x		x	
TYPHLOPIDAE																				
Ramphotyphlops ammodytes						x						x		x				x		
Ramphotyphlops ganei				P1		x					x			x				x	x	
Ramphotyphlops grypus						x								x				x	x	

Family and Species	Common name	Conservation Status			Database		Reports relevant to the Study Area													
		EPBC	WCA	DEC	I	II	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
Ramphotyphlops hamatus						x								x				x		
BOIDAE																				
Antaresia perthensis	Pygmy Python					x	x				x			x					x	
Antaresia stimsoni	Stimson's Python					x			x							x	x			x
Aspidites melanocephalus	Black-headed Python						x											x		
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1		x	x						x								
ELAPIDAE																				
Acanthophis wellsi	Pilbara Death Adder					x				x	x							x	x	
Brachyurophis approximans						x								x				x	x	
Demansia psammophis	Yellow-faced Whipsnake					x		x			x			x		x	x	x	x	
Demansia rufescens	Rufous Whipsnake					x			x	x		x		x		x		x	x	
Furina ornata	Moon Snake										x	x		x		x		x	x	
Parasuta monachus						x		x						x					x	
Pseudechis australis	Mulga Snake					x					x				x			x		
Pseudonaja modesta	Ringed Brown Snake					x								x			x		x	
Pseudonaja mengdeni	Western Brown Snake											x	x				x			
Suta fasciata	Rosen's Snake					x	x												x	
Vernicella snelli	Bandy Bandy													x					x	

Database search codes: I) EPBC Protected Matters Search Tool; II) DEC NatureMap. Conservation status codes as per Appendix B.

Amphibians

Family and Species	Common name	Database	Reports relevant to the Study Area													
		DEC NatureMap	Ecologia 1998a	Ecologia 1998b	Ecologia 2004a	Ecologia 2004b	ENV 2007	OES 2008	ENV 2008a	Biologic *in prep* a	Ecologia 2006	ENV 2008b	Ecologia 2008	ENV 2008c	Biologic *in prep* b	Current Survey
HYLIDAE																
Cyclorana maini	Main's Frog	x	x	x				x	x	x		x			x	x
Cyclorana platycephala	Water-Holding Frog								x							
Litoria rubella	Desert Tree Frog	x	x	x			x	x	x	x	x			x	x	
MYOBATRACHIDAE																
Neobatrachus sutor	Shoemaker Frog								x							
Pseudophryne douglasi	Douglas' Toadlet	x								x						
Uperoleia russelli	Russell's Toadlet	x		x						x						

Appendix D: Habitat assessments

		Minor Drainage Line	Gorge	Gorge	Gorge	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Major Drainage Line	Valley	Valley with basalt
	Date	9/14/2010	9/15/2010	9/18/2010	9/15/2010	9/14/2010	9/14/2010	9/16/2010	9/17/2010	9/17/2010	9/18/2010	9/18/2010	9/18/2010	9/16/2010	9/16/2010	9/14/2010
	Site name	hab4	hab7	hab 16	hab6	hab1	hab2	hab8	hab11	hab12	hab 15	hab14	hab 17	hab10	hab9	hab5
	Describing persons	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell	M. O'Connell
	Site position	50K 0714876 7467737	50K 0717042 7470105	50K 0717365 7472210	50K 0717383 7471241	50K 0712816 7465875	50K 0714490 746867	50K 0719917 7477080	50K 0720987 7476884	50K 0718516 7474637	50K 0715977 7471118	50K 0715984 7470176	50K 0713627 7466543	50K 0718994 7473587	50K 0720327 7476429	50K 0715978 7468723
	Altitude	636.2	597.8	622.3	586.2	685.7	685.7	594.2	626.6	611.3	651.6	653.3	720.1	563.2	552.1	650.8
Landform	**Slope**	Level	Level	Gently inclined	Level	Steep	Level	Gently inclined	Very steep	Gently inclined	Gently inclined	Level	Moderately inclined	Level	Gently inclined	Level
	Relative inclination of slope	Not required for flats	Not required for flats	Not required for flats	Not required for flats	Waning	Not required for flats	Waning	Maximal	Maximal	Maximal	Not required for flats	Maximal	Not required for flats	Waxing	Not required for flats
	Morphological type	Open depression	Open depression	Closed depression	Open depression	Upper slope	Hillock	Crest	Ridge	Upper slope in minor drainage line	Open depression	Ridge	Mid-slope	Open depression	Open depression	Open depression
	Landform type	Channel	Channel	Gully	Channel	Breakaway	Hillcrest	Hillcrest	Hillslope	Gully	Gully	Hillcrest	Hillslope	Stream channel	valley	Gully
Vegetation	**Disturbance**	Light grazing by hoofed mammals; Fire damage (5-10 years ago);	No disturbance;	Light grazing by hoofed mammals;	Light grazing by hoofed mammals;	Light grazing by hoofed mammals;	No disturbance;	Fire damage (1-5 years ago);	No disturbance;	No disturbance;	Light grazing by hoofed mammals;	No disturbance;	No disturbance;	Heavy grazing by hoofed mammals;	Light grazing by hoofed mammals; Fire damage (more than 10 years ago);	Light grazing by hoofed mammals;
	Vegetation Condition Growth Stage	Mature phase	Mature phase	Mature phase	Mature phase	Mature phase	Mature phase	Early regeneration	Advanced regeneration	Mature phase	Mature phase	Uneven age	Mature phase	Mature phase	Mature phase	Mature phase
	Leaf litter	10	10	4	20	0.5	0.1	0.1	0.5	3	1	1	0.5	8	1	1
	Twig litter	7.5	10	2	15	0.5	0.1	0.1	0.5	2	0.5	1	0.5	5	1	1
	Wood litter	2	4	2	52	1	0.1	0	0.5	1	1	1	0.2	3	2	3
	Dead stags	2	2	1	2	0.5	0	0	1	1	0.5	0.5	1	2	2	0
	Hollow-bearing trees	5	4	2	5	1	0.1	1	1	1	1	0.5	1	4	1	2
	Broad floristic formation	*Corymbia* low open woodland	*Eucalyptus* woodland	*Triodia* hummock grassland	*Melaleuca* sp. Low woodland	*Triodia* open hummock grassland	*Triodia* open hummock grassland	*Triodia* open hummock grassland	*Triodia* hummock grassland	*Triodia* open hummock grassland	*Eucalyptus leucophloia* open woodland	*Triodia* very open hummock grassland	*Triodia* hummock grassland	*Eucalyptus* tall open woodland	*Triodia* hummock grassland	*Eucalyptus* scattered woodland
	Tree structure - Tall		Open woodland											Open woodland		
	Tree structure - Mid															Isolated trees
	Tree structure - Low	Open woodland	Isolated clumps of trees	Open woodland	Woodland	Isolated trees	Isolated trees	Isolated trees	Open woodland	Open woodland	Open woodland	Isolated trees	Isolated trees		Open woodland	Isolated clumps of trees
	Shrub structure - Tall		Open shrubland		Open shrubland								Isolated shrubs			
	Shrub structure - Mid	Shrubland		Sparse shrubland		Sparse shrubland			Isolated shrubs	Sparse shrubland				Open shrubland	Sparse shrubland	Sparse shrubland
	Shrub structure - Low						Sparse shrubland	Isolated shrubs	Isolated shrubs		Isolated shrubs	Isolated shrubs				
	Grass structure - Tall		Grassland													
	Grass structure - Mid	Open grassland	Open grassland	Grassland	Open grassland			Open grassland	Grassland	Open grassland	Sparse grassland	Isolated grasses		Grassland	Grassland	
	Grass structure - Low					Open grassland	Open grassland						Grassland			Sparse grassland
	Dominant tree spp	*Corymbia hamersleyana*	*Euclayptus victrix*, *Melaleuca* sp	*Eucalyptus leucophloia, Corymbia hamersleyana*	*Eucalyptus camaldulensis, E. victrix, Melaleuca* sp.	*Eucalyptus leucophloia*	*Eucalyptus leucophloia*	*Eucalyptus leucophloia*	*Eucalyptus leucophloia*	*Corymbia hamersleyana*	*Eucalyptus leucophloia*	*Eucalyptus leucophloia*	*Eucalyptus leucophloia, E. gammophylla, Corymbia hamersleyana*	*Eucalyptus victrix, E. camaldulensis*	*Corymbia hamersleyana , Eucalyptus leucophloia*	*Eucalyptus victrix, E. leucophloia*
	Dominant shrub spp	*Acacia tumida*	*Melaleuca* sp.	*Grevillea wickhami*	*Melaleuca* sp.	*Acacia* sp.	*Acacia hilliana, Gompholobium karijini*	*Goodenia stobbsiana*	*Acacia inaequilatera*	*Grevillea wickhamii*	*Acacia* sp.	*Acacia* sp.		*Acacia tumida*	*Acacia bivenosa*	*Acacia aneura*
	Dominant	*Themeda* sp.	*Typha* sp.,	*Triodia* sp.	*Cyperus* sp.	*Triodia*	*Triodia* sp.	*Triodia*	*Triodia*	*Triodia*	*Triodia*	*Triodia*	*Triodia*	*Themeda* sp.	*Triodia*	*Themeda* sp.,

		Minor Drainage Line	Gorge	Gorge	Gorge	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Hilltop slopes	Major Drainage Line	Valley	Valley with basalt
	grass spp		*Cyperus* sp.			*wiseana*	Shovelana Hill	*wiseana*	*wiseana*	*wiseana*	*wiseana*	*wiseana*	*wiseana*		*wiseana*	*Triodia pungens*
Land Surface	**Microrelief**	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief
	Sheet erosion	No sheet erosion	No sheet erosion	Minor sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion	No sheet erosion
	Rill erosion	No rill erosion	No rill erosion	Minor rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion	No rill erosion
	Gully erosion	Severe gully erosion	Severe gully erosion	Moderate gully erosion	Severe gully erosion	Moderate gully erosion	No gully erosion	Severe gully erosion nearby	No gully erosion	Minor gully erosion	Moderate gully erosion	No gully erosion	No gully erosion	Moderate gully erosion	Severe gully erosion	Severe gully erosion
	Gully depth	3 m +	3 m +	3 m +	3 m +	1.5 m -	N/A No gullies	3 m +	N/A No gullies	1.5-3.0 m	3 m +	N/A No gullies	N/A No gullies	1.5-3.0 m	3 m +	3 m +
	Abundance of coarse fragments	Moderate or many	Moderate or many	Moderate or many	Moderate or many	Common	Common	Very or abundant	Common	Moderate or many	Moderate or many	Common	Very or abundant	Very or abundant	Very or abundant	Very or abundant
	Size of course fragments	Fine gravelly or small pebbles to rocks	Bouldery or boulders to gravel	Cobbly or cobbles with large stones	to boulders	Medium gravelly or large pebbles	Fine gravelly or small pebbles	Fine gravelly or small pebbles	Coarse gravelly or large pebbles	Medium gravelly or large pebbles	Coarse gravelly or large pebbles	Medium gravelly or large pebbles	Coarse gravelly or large pebbles	Coarse gravelly or large pebbles to large pebbles	Medium gravelly or large pebbles to rocks	Fine gravelly or small pebbles to boulders
	Abundance of rock outcrop	Slightly rocky	Very rocky	Very rocky	Very rocky	Rocky	Very slightly rocky	Very rocky	Rocky	Slightly rocky	Rocky	Rocky	Slightly rocky	Very rocky	Rocky	Very rocky
	Waterbodies	seasonal	large running pools 50-100 m pools	seasonal	permanent water in creek down middle of gorge, currently flowing	nil	nil	nil	nil	nil	nil	nil	nil	seasonal	nil	seasonal, one semi permanent
Soil	**Soil texture**	Clayey sand	Loamy sand	Clay loam	Course Sand with clay loam	Clay loam	Clay loam	Clay loam	Clay loam	Clay loam	Clayey sand	Clay loam	Clay loam	Clay loam	Clay loam	Clay loam
	Soil colour	Brown	Red	Red	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red
	Soil water status	Dry	Moist	Dry	Wet	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	Soil strength	Weak	Firm	Weak	Weak	Weak	Very weak	Very weak	Very weak	Weak	Very weak	Very weak	Weak	Weak	Weak	Very weak
Substrate (Geology)	**Existence of substrate form**	Vertical exposure (Outcropping);	Vertical exposure (Outcropping); Course fragments(Boulder, etc)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping); Course fragments (Boulders, etc);	Vertical exposure (Outcropping)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping) ;Course fragments(Boulder, etc)	Vertical exposure (Outcropping)	Vertical exposure (Outcropping) ;Course fragments(Boulder, etc);
	Rock type	Ironstone	Ironstone and basalt	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Ironstone	Basalt

Appendix E: Conservation significant fauna recorded during the survey

Species	Significance	Zone	East	North	Comments
Australian Bustard	DEC Priority 4	50K	721270	7477748	1 individual
Western Pebble-mound Mouse	DEC Priority 4	50K	714561	7469383	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	714760	7469415	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	714869	7469191	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	714945	7469118	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	716574	7469832	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719920	7477065	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719543	7474936	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719990	7474620	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719965	7474535	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720018	7474461	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720073	7474345	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720131	7474307	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720110	7474266	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720110	7474266	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719961	7475825	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720270	7475818	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720537	7476164	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720810	7476517	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720987	7476884	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	721087	7476863	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	721138	7476810	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720758	7475958	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720777	7475776	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720474	7475815	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	717487	7473604	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	717407	7473466	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	713022	7465858	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	714054	7468633	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	716789	7470839	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	717095	7471138	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719985	7477661	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719575	7474946	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719614	7474963	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719739	7474940	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719915	7474786	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	719970	7474705	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720024	7474653	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720183	7474311	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720151	7474260	Active mound

Species	Significance	Zone	East	North	Comments
Western Pebble-mound Mouse	DEC Priority 4	50K	720182	7474249	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720089	7474198	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720218	7475821	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720231	7475816	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720488	7476007	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720507	7476049	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	720707	7476576	Active mound
Western Pebble-mound Mouse	DEC Priority 4	50K	713396	7467481	Inactive mound
Western Pebble-mound Mouse	DEC Priority 4	50K	713414	7466991	Active mound
Rainbow Bee-eater	EPBC Act Migratory	50K	716709	7469568	1 individual
Rainbow Bee-eater	EPBC Act Migratory		720979	7476724	1 individual
Star Finch	DEC Priority 4	50K	716709	7469568	5 individuals
Ghost Bat (scats)	DEC Priority 4	50K	715696	7468887	Scats

Locations of caves (with notes)

Name	Coordinates			Notes
Cave ACY 1	50K	715696	7468887	Large pile of fresh Ghost Bat Scats. Cave contained large tunnel in roof.
Cave ACY 2	50K	717012	7470465	No Ghost Bat scats. Possible Pilbara-nosed Bat roost.
Cave ACY 3	50K	718587	7472944	No Ghost Bat scats.

MUNJINA AND MINISTERS NORTH (YANDI HUB)

FAUNA ASSESSMENT

Prepared for

BHP BILLITON IRON ORE PTY LTD

Diplodactylus stenodactylus

Job No: 07.403

Report No: RP002

Australia

MUNJINA AND MINISTERS NORTH (YANDI HUB)

FAUNA ASSESSMENT

Prepared for

BHP BILLITON IRON ORE PTY LTD

Prepared by

ENV.Australia Pty Ltd
Level 7, 182 St Georges Terrace
PERTH WA 6000
Phone: (08) 9289 8360
Fax: (08) 9322 4251
Email: env@env.net.au

Prepared by:	*Mr Matthew Love*
Status:	*Final*
QA Review:	*Dr Michael Brewis*
Technical Review:	*Mr Michael Welsh*
Content Review:	*Mr Michael Welsh*
Date:	*3 November 2009*

TABLE OF CONTENTS

FIGURES

TABLES (INCLUDED IN TEXT)

APPENDICES

STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ('the report') has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ('scope of services'). In some circumstances the scope of services may have been limited by factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, ENV has relied on data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ('the data'). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ('conclusions') are based in whole or in part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, unavailable, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied on the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, express or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and for no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including, without limitation, matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying on the matters dealt with or conclusions expressed in the report). Other parties should not rely on the report or the accuracy or completeness of any conclusions, and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

ENV will not be liable to update or revise the report to take into account any events or circumstances occurring or facts becoming apparent after the date of the report.

EXECUTIVE SUMMARY

ENV.Australia Pty Ltd was commissioned in August 2007 by BHP Billiton Iron Ore's Resource Evaluation Group to undertake a biological assessment survey of the Munjina and Ministers North Exploration leases ('project area') as part of the broader project area termed Yandi Hub. The proposed impacts to the project area are confined to drill pads targeted for exploratory drilling. The survey consisted of a Level Two fauna survey conducted from 21 November - 2 December 2007.

Seven major landform units/habitat types were selected as being representative of the project area, and as being habitats likely to be used as foraging grounds by species of conservation importance. These habitat types were: gorge/gully, minor drainage line, riverine, breakaway, alluvial plain, scree slope and hill crest. Trapping grids comprising Elliott traps, cage traps, funnel traps, pot traps and bucket traps were established, and the remainder of the project area was searched using opportunistic fauna-collecting techniques. Bat recordings, using AnaBat II recording units, were also undertaken in areas where bat species were likely to be found.

From the results of a desktop survey of relevant records, 50 species of mammals, 115 species of reptiles, nine species of amphibians and 138 species of birds were assessed as potentially occurring in the project area. The current Level Two survey recorded 134 species of vertebrates in the project area, comprising 22 mammal, 45 reptile, one amphibian and 66 bird species.

The survey recorded eight mammal species, 24 reptile species, and 16 bird species not recorded in previous surveys carried out at Yandi.

Ninety-one fauna species of conservation significance were recorded during the survey, of which 68 were of the Conservation Importance 5 category and ten of the Conservation Importance 4 category.

No Conservation Importance 1 species were recorded during the survey.

Two Conservation Importance 2 species, the Western Pebble-mound Mouse (*Pseudomys chapmani*), and the Australian Bustard (*Ardeotis australis*), were recorded in the project area. No individuals of the Western Pebble-mound Mouse were captured, but active pebble mounds were recorded in the project area. As the proposed developments will not impact on active pebble mounds, there will be no adverse effects on this species. The Australian Bustard inhabits open woodlands with substantial groundcover, and, since its habitat is well represented in the Pilbara, no significant impact is anticipated on this species.

Eleven species classified as Conservation Importance 3 were recorded during the survey, The habitats of these fauna are well represented elsewhere in the Pilbara. Therefore these species are not solely dependent on habitats in the project area, and are unlikely to be significantly affected by the proposed development. However, because of the restricted

distribution of these species, they may suffer some impact from the associated habitat destruction.

The habitats present in the project area have been well surveyed, and are generally well represented in the Pilbara. None of the habitats appear to be important in supporting fauna of conservation significance; they are also represented outside the project area. The proposed disturbance is therefore unlikely significantly to impact fauna in the project area.

1 INTRODUCTION

1.1 THE PROJECT

1.1.1 Objectives

ENV.Australia Pty Ltd (ENV) was commissioned in August 2007 by BHP Billiton Iron Ore's Resource Evaluation Group to undertake a biological assessment survey of the Munjina and Ministers North Exploration leases ('project area') as part of the broader project area termed Yandi Hub. The proposed disturbances to the project area are confined to exploratory drilling access tracks and drill pad areas. The proposed impact area is less than 5% of the total lease area. This fauna assessment comprises the findings of a Level Two fauna survey (reported here).

The objectives of the fauna component of the biological assessment were to:

- document the general habitat types of the project area as they relate to faunal assemblages;
- compile a list (based on database searches) of terrestrial vertebrate fauna likely to occur in the project area;
- identify (based on database searches) terrestrial vertebrate fauna of conservation significance that may occur in the project area;
- report on the likely occurrence of terrestrial vertebrate fauna, including that of conservation significance, being found in the project area, based on habitats present and their condition; and
- document any opportunistic records of fauna observed whilst onsite.

1.1.2 Location

Munjina and Ministers North mining tenements are part of the Yandi Hub.

The Munjina project area is approximately 25km north-east of the Yandi mine site. Yandi mine site is approximately 96 km north-west of Newman in the Pilbara region of Western Australia (Figure 1).

The Munjina project area consists of a drainage line and associated floodplains and gently rising undulating plains. The total survey area covers approximately 28km^2.

The Ministers North project area is 120km north-west of the Newman townsite, in the Pilbara region of Western Australia (Figure 1). Ministers North is

approximately 12km south-west of Yandicoogina mine site, and eight kilometres south of the Yandi mine site.

The Ministers North project area consists of one main ridge which extends east to west, with colluvial spurs or toes extending north off the ridge into a central drainage system.

1.1.3 Previous Biological Studies

Historically, the flora and fauna of the Pilbara has not generally been recorded systematically, with significant exceptions being flora studies by Burbidge (1959) and Beard (1975). More recently, the Department of Agriculture (van Vreeswyk *et al.* 2004) conducted an inventory and condition survey of the Pilbara. This report provides a regional inventory of flora species and a description of land resources. A comprehensive and systematic field review of Pilbara regional fauna is in preparation by the Department of Environment and Conservation ('DEC') (DEC Pilbara Biological Survey 2002-2007).

In recent decades, a boom in large-scale regional resource development projects in Western Australia has resulted in a significant amount of site-specific biological survey work being carried out in the region, most of which is undertaken for formal environmental approvals. Those most relevant to the current survey are:

- West Angelas (*ecologia* Environment 1998a);
- Marillana/Marillana Creek (Halpern Glick Maunsell 1999, *ecologia* Environment 2007);
- Packsaddle Range (*ecologia* Environment 2004b);
- Ministers North (*ecologia* Environment 2006);
- Yandi (Maunsell 2003);
- Upper Marillana Exploration Lease (*ecologia* Environment 2005, ENV 2007b); and
- Mining Area C (*ecologia* Environment 1998b, ENV 2006a, ENV 2007c).
- Weeli Wolli (*ecologia* Environment 1998c; *ecologia* Environment 2004a)

A comprehensive bibliography of biological survey work undertaken in the Pilbara is available at *http://science.calm.wa.gov.au/projects/pilbaradb/*.

1.2 PHYSICAL ENVIRONMENT

1.2.1 Climate

The project area is in the Pilbara region of Western Australia. The nearest accessible climate data to the project area is available from the Newman Bureau of Meteorology weather station.

The eastern Pilbara has an arid-tropical climate with two distinct seasons, a hot summer from October to April and a mild winter from May to September. The area experiences a wide range of temperatures, with an average temperature of 31.4°C (1965-1998). In summer, maximum temperatures may reach 46.0°C, whilst in winter, minimum temperatures may reach -2.0°C (Bureau of Meteorology 2007).

Rainfall in the Pilbara is often sporadic, and can occur in summer and winter. The Newman area has average annual rainfall of 310.2mm (1965-2003) (Figure 2). Summer rainfall is typically associated with tropical storms in the north, or tropical cyclones that cross the coast and move inland. Winter rainfall is generally less significant, and is commonly the result of cold fronts moving north-easterly across the State.

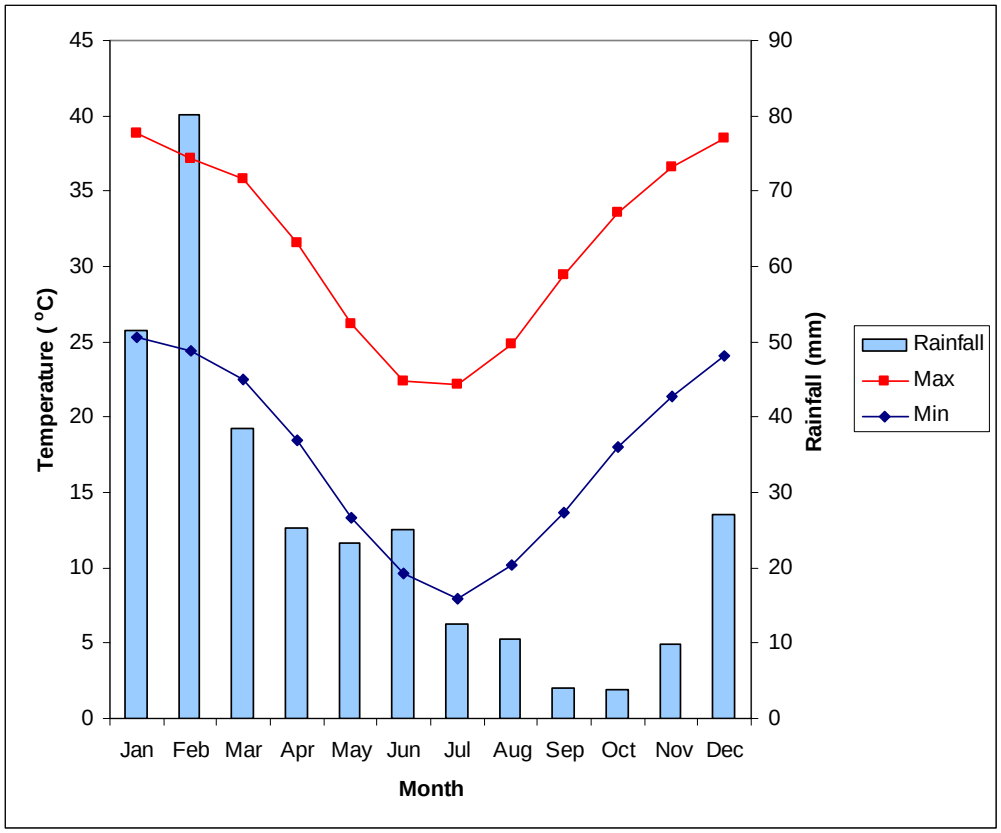


Figure 2: Average monthly rainfall and maximum and minimum temperatures at Newman from 1965-2003 (Bureau of Meteorology 2007)

1.2.2 Geology and Soils

The Munjina project area comprises landforms including ridges, breakaways and plains. Thorne and Tyler (1997) mapped the geology of the area as consisting of seven units:

Czk: Calcrete: sheet carbonate; found along major drainage lines. This unit forms the drainage lines and floodplains in the project area.

Qw: Alluvium and colluvium: Red-brown sandy and clayey soil. This unit forms the undulating plains and floodplains in the project area.

Qc: Colluvium: unconsolidated quartz and rock fragments in soil, locally derived soil and scree and talus deposits. This unit occurs in only one isolated patch at the boundary of the project area.

Qa: Alluvium: Clay, silt, sand, gravel; in drainage channels and adjacent flood plains. This unit forms the undulating plains and floodplains in the project area.

Phj: Weeli Wolli formation: banded iron-formation (commonly jaspilitic), pelite and numerous metadolerite sills. This unit forms the low hills in the project area.

Ql: Alluvium: unconsolidated silt, sand and gravel in drainage channels and on adjacent floodplains. This unit forms parts of the drainage system in the project area.

Czc: Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix, old valley-fill deposits. This unit forms the undulating hills in the eastern section of the project area.

The Ministers North project area comprises a number of different landforms, including rocky hills and slopes, low colluvium hills, plains and flood plains. Thorne and Tyler (1997) mapped the geology of the area as consisting of three units, these being:

Czr: Hematite-goethite deposits on banded iron-formation and adjacent scree deposits. This unit is the most dominant unit in the project area, and occurs across the central and northern extents of the tenement.

Czp: Robe Pisolite: pisolitic limonite deposits developed along river channels. This unit forms only a small part of the project area, and occurs in the north of the tenement.

PHb: Brookman Iron Formation: banded iron-formation, chert, and pelite. This unit is the thickest and most economically important iron formation unit in the Hamersley Group.

1.2.3 Biogeography

Pilbara Biographic Regionalisation for Australia

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 85 bioregions based on major biological and geographical/geological attributes (Thackway and Cresswell 1995). These bioregions are subdivided into 404 subregions (Department of Environment and Water Resources 2007c).

The project area is in the Pilbara bioregion and Hamersley subregion. Kendrick (2001) describes the Hamersley subregion as Mulga low woodland over bunched grasses on fine textured soils in valley floors, and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils on the ranges.

Munjina

Beard Vegetation Mapping

Beard (1975) described the project area as falling in the Hamersley Plateau, which forms part of the Fortescue Botanical District in the Eremaean Botanical Province of Western Australia. Beard mapped the project area as tree steppe on ranges with *Eucalyptus leucophloia* subsp*. leucophloia* and Spinifex, shrub steppe on sandplains, and low woodland with Mulga trees in groves and patches.

Land Systems

Land system mapping is based on regional patterns in topography, soils and vegetation. The most recent land system mapping of the Pilbara bioregion was completed by van Vreeswyk *et al.* (2004). The mapping divides the Pilbara into 102 land systems. The project area consists of six main land systems:

Bgd: Boolgeeda: stony lower slopes and plains located in the region at the base of the hill systems; forms 4.3% of the Pilbara bioregion.

Cal: Calcrete: Low calcrete platforms and plains supporting shrubby hard Spinifex grassland; forms 0.8% of the Pilbara bioregion.

Mck: McKay: Hills, ridges, plateaux remnants and breakaways of metasedimentary and sedimentary rocks supporting hard Spinifex grasslands; forms 2.3% of the Pilbara bioregion.

New: Newman: rugged jaspilite plateaux, ridges and mountains supporting hard Spinifex grasslands; forms 8% of the Pilbara bioregion.

Pdg: Pindering: Gravelly hardpan plains supporting groved Mulga shrublands with hard and soft Spinifex; forms 0.2% of the Pilbara bioregion.

Wnm: Wannamunna: Hardpan plains and internal drainage tracts supporting Mulga and occasional eucalypt shrublands and woodlands; forms 0.3% of the Pilbara bioregion.

Ministers North

Beard Vegetation Mapping

Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Beard (1975). The Ministers North project area is in the Hamersley Plateau, which forms part of the Fortescue Botanical District in the Eremaean Botanical Province of Western Australia, as per Beard (1975). Beard (1975) mapped the project area as Mulga (*Acacia aneura*) trees in valleys, and tree steppe on ranges with *Eucalyptus leucophloia* subsp*. leucophloia* and spinifex.

Land Systems

Land system mapping is based on regional patterns in topography, soils and vegetation. The most recent land system mapping of the Pilbara bioregion, where the current project area falls, was completed by van Vreeswyk *et al.* (2004). The mapping divides the Pilbara region into 102 land systems. The Ministers North project area includes two main land systems:

New: Newman: Rugged jaspilite plateaux, ridges and mountains; supporting hard Spinifex grasslands; forms 8.0% of the Pilbara bioregion.

Pla: Platform: Dissected slopes and raised plains; supporting hard Spinifex grasslands; forms 0.9% of the Pilbara bioregion.

2 METHODOLOGY

2.1 BACKGROUND TO SURVEY METHODOLOGY

2.1.1 State and Federal Legislation

All fauna surveys undertaken by ENV are designed to be compliant with the Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of fauna surveys in Western Australia, as set out in the following documents:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3 (EPA 2002); and*
- *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56* (EPA 2004).

ENV then assesses and reports the results of its surveys with particular regard to the provisions of the following State and Federal legislation:

- the Environment Protection and Biodiversity Conservation Act 1999 (Cth) ('EPBC Act');
- the Wildlife Conservation Act 1950 (WA) ('WC Act'); and
- the Environmental Protection Act 1986 (WA).

2.1.2 EPA Guidance Statement No. 56

A baseline field fauna survey for an Environmental Impact Assessment (EIA) should provide a comprehensive list of species in a given area. There are two formal levels of fauna survey, as delineated by the EPA:

- ***Level One:*** a 'desktop' study to collate historical knowledge, conducted in conjunction with a reconnaissance survey (site inspection); and
- ***Level Two:*** a trapping and opportunistic field survey to characterise the fauna present, combined with a Level One survey.

Where the scale and nature of the proposed impact is moderate to high, a Level Two survey will be required in most areas of the State, and is typically required for resource development projects. The expectations of the EPA are set out in *Guidance Statement No. 56* (EPA 2004). Specifically, it details the extent, design and intensity of field surveys for environmental assessments in Western Australia.

The methodology of the current survey, a Level Two survey, has been developed in accordance with the requirements of EPA *Guidance Statement No. 56.* This level of survey work was conducted to cover the broader survey area, making provisions for future impacts and disturbances to the project area likely to be associated with more intensive drilling or operations in future.

2.1.3 Fauna of Conservation Significance

Fauna species can be classified as of conservation significance on an international, Commonwealth, State or local level. Under each level, the conservation status of fauna is determined by various Acts and Agreements. A short description of these Acts and Agreements is provided below, with definitions of the conservation codes detailed in Appendix A.

International Level

- IUCN: The World Conservation Union publishes an international listing of species of conservation importance, known as the IUCN Red List (IUCN 2006). This list identifies those species most in need of conservation attention.

- JAMBA: Australia has an agreement with the Government of Japan relating to the conservation and protection of migratory birds. This agreement is known as the Japan-Australia Migratory Bird Agreement (JAMBA) and lists terrestrial, water and shorebird species which migrate between Australia and Japan.

- CAMBA: Australia has an agreement with the Government of the People's Republic of China, relating to the conservation and protection of migratory birds. This agreement is known as the China-Australia Migratory Bird Agreement (CAMBA) and lists terrestrial, water and shorebird species which migrate between Australia and China.

- ROKAMBA: Australia has an agreement with the Government of the Republic of Korea, relating to the conservation and protection of migratory birds. This agreement is known as the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) and lists terrestrial, water and shorebird species which migrate between Australia and Korea.

- Bonn Convention: The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) aims to improve the status of all threatened migratory species through national action and international Agreements. The convention lists migratory species that would benefit from conservation measures undertaken by the countries that are party to the Convention.

Commonwealth Level

- EPBC Act: The Department of Environment, Water, Heritage and the Arts (formerly the Department of Environment and Water Resources) (DEWR) lists threatened species determined by criteria set out in the EBPC Act (DEWR 2007b).

State Level

- WC Act: The Minister for the Environment produces notices listing fauna taxa as protected and classified as Schedule 1 to Schedule 4, according to their need for protection.

- DEC Priority species: The DEC produces a list of Priority species that have not been assigned statutory protection under the WC Act. Priority Fauna are under consideration as 'Scheduled' fauna, but are in urgent need of further survey or require regular monitoring, and although not currently threatened, may become so.

Local Level

- Species may be considered of local conservation significance because of their patterns of distribution and abundance. Although not formally recognised under legislation, many species are in decline as a result of threatening processes such as the loss and/or restriction of breeding grounds, foraging areas or resident habitat.

2.1.4 Assignment of Fauna Conservation Codes

Levels of conservation importance have been assigned to the fauna in this report based on the background information detailed in Section 2.1.3. These levels are outlined below:

- ***Conservation Importance 1 (CI 1):*** Species listed as Declared Threatened Fauna as per international publications, Commonwealth Acts and State Acts. These species are those with a rating of Vulnerable, Endangered or Critically Endangered under the IUCN Red List (international level) or under the EPBC Act (Commonwealth Level), or those with a Schedule rating under the WC Act (State Level).

- ***Conservation Importance 2 (CI 2):*** Species listed as Priority Fauna by the WA branch of the DEC, and species listed in peer-reviewed publications on threatened fauna. These species are not protected by legislation, but are considered as being of conservation importance on a State level.

- ***Conservation Importance 3 (CI 3):*** Species not formally identified (CI 1, CI 2 or CI 4), but considered of conservation importance on a local level because

of their patterns of distribution and abundance. This status includes regionally endemic species and species with habitats that are in decline.

- ***Conservation Importance 4 (CI 4):*** Species that are recognised on an International Level under treaties such as CAMBA, JAMBA and ROKAMBA, the Bonn Convention, and also on a State level under the EPBC Act list of marine species. Because of the high mobility of many of these species, impacts on them are generally less direct or severe, therefore generally requiring a lower status of conservation importance.

- ***Conservation Importance 5 (CI 5):*** Species identified by the IUCN as Near Threatened, Least Concern or Data Deficient. Although these species are recognised on an international level, they are considered to be of lower conservation importance as they may be widespread and abundant, and are not exclusively dependent on habitats in the project area.

2.2 SURVEY METHODOLOGY

2.2.1 Desktop Survey

The purpose of a desktop survey is to gather background information on the project area and the fauna it may support. This involves a search of literature, data, aerial photographs and maps for information relating to habitats likely to be found in the project area.

A search of the Western Australian Museum's (WAM) FaunaBase (WAM 2003) was undertaken to generate a list of fauna species previously recorded in the area. In addition, a review of literature was conducted, together with a review of historical and current records of fauna species for the project area. These sources were used to compile a list of species that may occur in the project area. Habitat knowledge gained from the above initial research, and that gained during the field habitat assessment, was used to refine this list of species to those likely to occur in the project area.

2.2.2 Field Survey

The purpose of the field survey was to verify the accuracy of the desktop survey and further to delineate and characterise the fauna and faunal assemblages present in the project area. The field survey was conducted at Yandi Hub from 21 November-2 December 2007. The field survey consisted of:

- a fauna habitat assessment;

- a trapping program;

- opportunistic searches;

- an ornithological census; and
- bat recordings.

Habitat Assessment

During the field survey, the vegetation communities and landforms in the project area were used to identify broad fauna habitats. These fauna habitats were assessed for specific habitat components, such as significant trees with hollows, loose bark, fallen hollow logs or leaf litter, to determine the potential of these habitats to support threatened species.

In addition to assessing these habitats for the likely occurrence of threatened fauna species, the habitat types were assessed for their complexity and the presence of microhabitats. From these attributes, the fauna habitats were then ranked according to the quality they provide for a wider suite of fauna species.

Trapping Program

A trapping site was established in the Munjina exploration lease in each fauna habitat type identified by the habitat assessment. Five sites were set up in the habitat types: plain, riverine, minor drainage line, scree slope and riverine. The location and habitat details of each site are detailed in Appendices B1 and B2, and are illustrated in Figure 3, with site photographs presented in Appendix C.

Each trapping site contained ten trapping units. Each unit consisted of seven-metre fences with one bucket trap at the centre of the fence, two pot traps halfway between the bucket trap and the end of the fence, and a funnel trap at each end. The trap units were approximately 30 m apart, with one Elliott trap and one cage trap at each trapping line. Details of the trap units erected at each site are presented in Appendix B3.

The trapping program was conducted from 21-29 November 2007, with traps being open for an average of six nights. Each trapping site was subjected to an average of 60 trap-nights for cage, Elliott and bucket traps, and 120 trap-nights for funnel and pot traps. Details of trap effort are presented in Appendix B4.

Opportunistic Searches

Opportunistic diurnal and nocturnal searches of major habitats across the entire project area were undertaken to search for the presence and signs of fauna species. Searches included:

incidental observations of active or roosting birds;

investigating burrows;

- investigating rock crevices;
- investigating scats, tracks and other traces;
- splitting exfoliated rock;
- turning rocks and fallen timber;
- opening standing timber crevices;
- raking leaf litter, and;
- searches (using binoculars) for rock-wallabies in and around breakaways.

Ornithological Census

Ornithological surveys were undertaken throughout the entire project area. Census locations were not specifically limited to site locations, but rather all habitats were surveyed across the entire site. The ornithologist targeted habitats likely to support threatened species and unique or poorly-represented habitat in an effort to record species not recorded in earlier surveys. Details of the ornithological census are presented in Appendices D1 and D2, and in Figure 4.

Pebble-mound Mouse Search

During flora surveys conducted by ENV from 13-20 September 2007, searches were made for mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*), in 50m x 50m quadrats. The presence or absence of mounds was recorded, and it was noted whether mounds appeared active (active mounds are indicated by the presence of obscurely positioned rocks at the entrance of the hole at the top of the mound). Ninety-four sites were searched at Munjina, including the proposed drill-sites. Sixty-five sites were searched at Minister's North, the locations being chosen at random.

Nocturnal Spotlighting Surveys

Nocturnal spotlighting surveys were conducted by traversing the site on foot or in a vehicle, with the aid of 50 W spotlights.

Where rocky habitat was encountered during foot-based spotlighting, rocks were lifted and cracks inspected with the aid of hand-held torches. Details of the fauna detected during nocturnal spotlighting surveys are presented in Appendices E5 and E6.

Bat Recordings

Echolocation bat recordings were undertaken at dusk and early evening, using AnaBat II recording units to document the presence of bat species in the area.

The detectors convert ultrasonic echolocation signals produced by bats into audible electronic signals, which are analysed to determine the presence of species-specific calls. Caves identified as potential roosting or maternal nesting sites were subjected to AnaBat II recordings. In addition, AnaBat II units were set in areas likely to be utilised by bats for foraging (e.g. gullies and drainage lines). AnaBat units were left overnight where possible, and were set to record all night. AnaBat II recording locations and details are presented in Appendices E1-E4, and in Figure 5.

2.2.3 Taxonomic Identification

Where field identification of the species was not possible, specimens were systematically collected for later identification by expert taxonomists from the Western Australian Museum Collections and Research Facility.

3 FAUNA

3.1 FAUNA SURVEY CONSTRAINTS

It is important to note the constraints imposed on individual surveys. Constraints are often difficult to predict, as is the extent to which they influence survey outcomes. Survey constraints of the Yandi Hub fauna survey are detailed in Table 1.

Table 1: Constraints associated with the Yandi Hub Fauna Assessment

Variable	Impact on Survey Outcomes
Experience levels/ Resources	The biologists who executed these surveys were practitioners suitably qualified in their respective fields: • Mr Michael Welsh - Senior Zoologist/Ornithologist • Mr Sean Doody - Zoologist • Mr Michael Brown - Zoologist • Mr Matthew Love - Zoologist • Mr Shane McAdam - Zoologist • Mr Brad Maryan - Taxonomist
Scope: sampling methods/Intensity	The survey carried out was a Level Two survey, comprising a desktop survey and a site visit that included a habitat assessment, trapping program, and opportunistic observations. As part of the Yandi Hub fauna assessment, a trapping program was set up at Munjina, and opportunistic observations were made at Munjina and at Ministers North.
Proportion of fauna recorded/ Completeness	The field survey recorded 134 taxa, which is 43% of the expected fauna for the project area.
Sources of Information	At the bioregion level, the Pilbara has been the subject of many targeted biological surveys, primarily for the resources sector. For example, *ecologia* Environment has conducted surveys at Upper Marillana 2005 and Ministers North 2006, and ENV has undertaken surveys at Area C 2006, 2007.
Proportion of task completed	The field survey was completed adequately, with the trapping program and opportunistic searches carried out to a sufficient level. Six nights were invested in trapping and in opportunistic searches conducted from 21-29 November 2007.
Timing, weather, season.	The survey was undertaken in November 2007. The area received 2.8 mm of rain in the three months preceding the survey (Bureau of Meteorology 2007). The day temperatures were in the low 40s, with night temperatures

Variable	Impact on Survey Outcomes
	in the high 20s (Bureau of Meteorology 2007). These weather conditions are likely to limit the activity of certain fauna groups, in particular those such as frogs that are less active in hot, dry conditions.
Disturbances	The Minister's North site had been recently burned, with only a small proportion of the site left unburned. The fauna survey was focused, where possible, on the unburned areas, and in particular the galleys and a few unburned scree slopes.
Access problems	All areas were accessible and adequately surveyed during the survey.

3.2 HABITAT ASSESSMENT

Part of the Yandi Hub project area consists of two exploration leases: Munjina and Ministers North.

The Ministers North exploration lease is in the south-east of the project area, and is dominated by a main range extending east to west. This main range consists of scree slopes, gorges and gullies, hill crests and breakaways. The Munjina project area consists of a drainage line and associated floodplains, and gently rising undulating plains.

There are seven habitat types in the Yandi Hub project area (Table 2).

Table 2: Major Habitat Types for the Yandi Hub Project Area

Habitat	Vegetation Description
Gorge / Gullies	*Acacia* aff. *aneura* (narrow, fine-veined; site 1259) / *Calitris glaucophylla* forest over low *Ficus brachypoda*, *Corymbia ferriticola* subsp. *ferriticola* / *Eucalyptus leucophloia* subsp. *leucophloia* woodland over open *Eremophila latrobei* subsp. *glabra* / *Gossypium robinsonii* shrubland over low open *Ptilotus obovatus* and *Solanum* sp. (1) (MET 378) *Clerodendrum floribundum* var. *angustifolium* shrubland over *Triodia pungens* open hummock grassland over *Cymbopogon ambiguus* / *Digitaria brownii* / *Eriachne mucronata* (typical form) / *Themeda triandra* very open tussock grassland
Minor Drainage	*Corymbia hamersleyana* scattered to sparse medium to tall woodland, over *Acacia tumida* var. *pilbarensis* / *Petalostylis labicheoides* / *Gossypium robinsonii* open medium shrubs, over sparse grasses.

Habitat	Vegetation Description
Riverine	*Eucalyptus* low open woodland over *Acacia* shrubland over *Triodia* hummock grassland. Wide stony creek bed in centre with vegetation on borders.
Breakaway	Low open *Eucalyptus leucophloia* subsp. *leucophloia* woodland over open *Acacia bivenosa* shrubland over low open *Ptilotus rotundifolius* and *Solanum sturtianum* shrubland over open *Triodia pungens* hummock grassland.
Alluvial Plain	*Acacia aneura* var. *intermedia* open to moderately dense medium woodland, over *Acacia pruinocarpa* scattered medium shrubs, over *Codonocarpus cotinifolius* / *Acacia bivenosa* open medium shrubs over moderately dense mixed small shrubs, over mixed herbs and grasses.
Scree Slope	*Eucalyptus leucophloia* subsp. *leucophloia* scattered medium trees, over *Corymbia deserticola* subsp. *deserticola* / *Eucalyptus gamophylla* / *Hakea chordophylla* open medium shrubs, and mallee, over mixed low shrubs, such as *Dampiera candicans* and *Gompholobium karijini*, over open *Triodia basedowii* and other grasses.
Hill Crest	Low open *Eucalyptus leucophloia* subsp. *leucophloia* woodland over *Petalostylis labicheoides* / *Acacia hamersleyensis* shrubland over a low *Acacia arida* / *Goodenia stobbsiana* / *Indigofera monophylla* (brown calyx form) shrubland over very open *Triodia wiseana* hummock grassland

The gorge/gully habitat is moderately represented in the project area. This habitat is considered of high conservation value, as numerous microhabitats exist for fauna to exploit, namely, caves, rock crevices, leaf litter and logs. Furthermore, this habitat is suitable habitat for fauna of high conservation significance, such as the Pilbara Olive Python (*Liasis olivaceus barroni*) and the Orange Leaf-nosed Bat (*Rhinonicteris aurantius*). Species of lower conservation significance likely to be found in the gorge/gully habitat include the Desert Cave Gecko *(Heteronotia spelea*), the gecko *Gehyra punctata* and the Pygmy Spiny-tailed Skink (*Egernia depressa*).

The minor drainage lines of the project area are of high conservation importance to vertebrates because of the microhabitats present and the moderate representation of this habitat. Such drainage lines provide hollow branches, vegetation buildup from past floods, and soft soils suitable for burrowing reptiles of various sizes, such as the Yellow-Spotted monitor (*Varanus panoptes*) and the small skink (*Lerista flammicaudia*), as well as arboreal lizards such as the Tree

Dtella (*Gehyra variegata*). Mammals such as the Red Kangaroo (*Macropus rufus*) and the Sandy Inland Mouse (*Pseudomys hermannsburgensis*), and birds such as the seasonally-nesting Rainbow Bee-eater (*Merops ornatus*), are likely to shelter in such drainage lines. Furthermore, well-vegetated drainage lines can serve as important corridors for fauna movement by connecting fragmented landscapes.

The riverine habitat, with its accompanying thick vegetation dominated by eucalypt species, is also considered to be of high habitat value, as it provides an abundance of microhabitats such as trees, leaf litter, and soils suitable for burrowing. Tree hollows and fallen logs are excellent microhabitats which fauna can readily exploit. Bats such as the Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*) and Hill's Sheathtail-bat (*Taphozous hilli*) often use such hollows as roosting spots. Arboreal lizards such as the Tree Dtella (*Gehyra variegata*) and the Spiny-tailed gecko (*Strophurus wellingtonae*), and bird species such as the Nankeen Night Heron (*Nycticorax caledonicus*) will also be found in this habitat type. Furthermore, riverine habitats are under-represented landforms in the Pilbara. This habitat is also considered to be of value as drainage lines can serve as important fauna movement corridors.

The breakaway habitat is considered to be of medium habitat value. Despite providing fewer microhabitats for fauna to exploit compared to the gorge/gully habitat, they may support fauna of conservation significance, namely the Northern Quoll (*Dasyurus hallucatus)*. This species is listed as Endangered under the EPBC Act. Breakaways in the project area are characterised by large rocky outcrops with little vegetation, and are generally unsuitable for burrowing fauna. The vegetation and leaf litter in these habitats is not dense, and thus the number of bird species and arboreal lizards in these habitats is likely to be restricted, as is (to a lesser extent) the number of ground-dwelling reptiles and mammals. Ground-dwelling reptiles that may be present include the Spiny-tailed Monitor (*Varanus acanthurus*) and the Pygmy Spiny-tailed Skink (*Egernia depressa*).

The plain habitat of the project area is characterised by patchy and sparse stands of Mulga (*Acacia aneura*) over open *Triodia* hummock grassland. This habitat is considered to be of lower conservation significance because of the lack of vegetation structure and its limited microhabitat complexity. These plains form a homogeneous habitat, with few refuge sites for birds, reptiles or mammals. Furthermore, the plain habitat is well-represented in the Pilbara region. Reptiles found in this habitat type include the Western Military dragon (*Ctenophorus isolepis*) and the Central-netted dragon (*Ctenophorus reticulatus*). Mammals include the Spinifex Hopping mouse (*Notomys alexis*) and the Red Kangaroo (*Macropus rufus*).

Despite offering low microhabitat complexity, the scree slope habitat is of medium habitat value, as secondary evidence was found of the Western Pebble-mound

Mouse, *Pseudomys chapmani* (Priority 4, DEC). The rock crevices and *Triodia* hummocks present in this habitat provide microhabitats to a number of ground-dwelling reptiles, such as the Ring-tailed dragon (*Ctenophorus caudicinctus*) and ground-dwelling mammals such as the Common Rock-rat (*Zyzomys argurus*). However, the rocky substrate and lack of tall shrubs in these areas limits fauna diversity, as the former is unsuitable for burrowing species of mammals and the latter is unsuitable for arboreal fauna.

The hill crests are considered to be of low habitat value, as they provide limited microhabitats for fauna to exploit and are well-represented in the project area. These habitats are characterised by large open rocky areas with open grasslands, predominantly *Triodia* hummock grasslands. The vegetation in these habitats is not dense, nor is the cover of leaf litter. Thus, the number of bird species and arboreal lizards in these habitats is likely to be restricted, as is (to a lesser extent) the number of ground-dwelling reptiles and mammals. Ground-dwelling reptiles that were present include the Perentie Monitor (*Varanus giganteus*) and the gecko *Gehyra punctata*. The lack of ground cover and the compact nature of the substratum would limit the number of ground-dwelling reptiles and mammals, and the number of burrowing species likely to be found in this habitat.

3.3 RECORDED FAUNA

The field survey was conducted from 21 November - 2 December 2007, with five sites established in the major fauna habitat types in the project area. Each trapping site was subjected to an average of 60 trap-nights for bucket, cage and Elliott traps and 120 trap-nights for funnel traps and pot traps. The fauna species recorded (Appendix F) during the survey are discussed in the following sections. Detailed information on each of the recorded species, classified as CI 1 to CI 3, is presented in Appendix G.

3.3.1 Mammals

Fifty species of mammal potentially occur in the project area (Appendix H1), 22 of which were recorded (Appendix I). Twenty-two species of mammal were recorded at Munjina (Appendix J1) and 12 species of mammal were recorded at Ministers North (Appendix J2). Of the recorded 22 species, six are introduced, the House Mouse (**Mus musculus*), the Dingo (**Canis lupus* subsp*. dingo*), the European Fox (**Vulpes vulpes*), the Feral Cat (**Felis catus*), the Camel (**Camelus dromedarius*), and European Cattle (**Bos taurus*).

Nineteen species were recorded by previous surveys conducted in the Yandi Hub project area (*ecologia* Environment 2005, 2006 and Maunsell 2003). This survey recorded eight species not recorded in these past surveys, including the Little Red Kaluta (*Dasykaluta rosamondae*), the Pilbara Ningaui (*Ningaui timealeyi*),

the Long-tailed Planigale (*Planigale ingrami*) and the Sandy Inland Mouse (*Pseudomys hermannsburgensis*).

Conservation Importance

The survey recorded 16 native mammal species. Of these, one species, the Western Pebble Mound Mouse (*Pseudomys chapmani*), is classified as CI 2, and three species, the Little Red Kaluta (*Dasykaluta rosamondae*), the Pilbara Ningaui (*Ningaui timealeyi*) and the Common Rock-rat (*Zyzomys argurus*) (Appendix H1) are classified as CI 3.

The Western Pebble-mound Mouse (*Pseudomys chapmani*) is listed as Priority 4 (DEC). This species is recognised as a Pilbara endemic. Although no individuals were recorded from the project area, active pebble mounds were observed (Appendix N) (Figure 6). As the preferred habitat of this species, scree slopes, are well-represented outside the project area, and as active pebble mounds were not located in the proposed drill sites, the planned development is unlikely to have any significant effect on this species.

The Little Red Kaluta and the Pilbara Ningaui are endemic to the Pilbara. The Little Red Kaluta inhabits areas of dense Spinifex hummocks (Strahan 1995), whilst the Pilbara Ningaui inhabits hummock vegetated cliffs, rockpiles and scree slopes (Strahan 1995). The Common Rock-rat, although found in other regions of Western Australia such as the Kimberley, has a disjunct population in the Pilbara. Common Rock-rats inhabit rocky outcrops, breakaways and scree slopes. The Common Rock-rat is one of the most commonly-recorded species in the Pilbara, with individuals recorded in numerous surveys in the area surrounding Newman. Because of the high number of records for these three species, and the fact that their preferred habitats are well-represented outside the project area, impacts on these species are expected to be minimal.

The remaining 12 native mammal species are classified under the conservation importance status CI 5 (Appendix H). These species have an IUCN rating of Near Threatened, Least Concern or Data Deficient, and do not qualify for the rating of Vulnerable. Therefore these species will not be discussed further, as many of the taxa are considered widespread and abundant and not exclusively dependent on the project area at the local level.

3.3.2 Reptiles

One hundred and fifteen species of reptile potentially occur in the region of the project area (Appendix H2), 45 of which were recorded in the project area during the survey (Appendix I). Thirty-nine species of reptile were recorded at Munjina (Appendix K1) and 11 species of reptile were recorded at Ministers North (Appendix K2).

Thirty-two species have been previously recorded in the Yandi Hub project area (*ecologia* Environment 2005, 2006 and Maunsell 2003) (Appendix H2). This survey recorded 24 species not recorded in these past surveys. These include the Canegrass Dragon (*Diporiphora winneckei*, the gecko (*Diplodactylus wombeyi*), the Desert Cave Gecko (*Heteronotia spelea*), Burton's Snake-lizard (*Lialis burtonis*), Spinifex-slender Blue Tongue (*Cyclodomorphus melanops melanops*), Blind Snake (*Ramphotyphlops ammodytes*) and Pilbara Death Adder (*Acanthophis wellsi*).

Conservation Importance

Of the 45 species of reptiles recorded in the project area, eight are classified as CI 3: *Diplodactylus wombeyi, Heteronotia spelea, Carlia munda, Lerista muelleri, Morethia ruficauda exquisita, Varanus pilbarensis, Ramphotyphlops ammodytes*, and *Acanthophis wellsi*. These species are not listed under State or Federal legislation, but are known to have specific habitat requirements, are currently under taxonomic review, or have disjunct populations in the Pilbara. All of these species are endemic to the Pilbara region. In addition, species such as the Pilbara Cave Gecko (*Heteronotia spelea*), and the Pilbara Rock Monitor (*Varanus pilbarensis*) are restricted to gorges and breakaways.

3.3.3 Amphibians

Nine species of amphibians potentially occur in the region of the project area (Appendix H3), one of which, the Inland Tree Frog (*Litoria rubella)* was recorded in the Munjina exploration lease (Appendix L1).

Conservation Importance

The only amphibian recorded during the survey, the Inland Tree Frog (*Litoria rubella*, is classified as CI 5. This species was recorded from the Munjina exploration lease. The Inland Tree Frog is usually found calling from trees and vegetation beside watercourses and temporary or permanent swamps (Cogger 2000). This species has been recorded during surveys at Yandi, and at numerous other survey locations in the Pilbara region and around Newman (Appendix H3). The preferred habitat of this species is well-represented outside the tenement, and therefore potential impacts upon this species are expected to be minimal.

3.3.4 Birds

One hundred and thirty-eight species of bird potentially occur in the region of the project area (Appendix H4), 66 species of which were recorded in the project area (Appendix I). Sixty-three species of birds were recorded at Munjina (Appendix M1) and 45 species of birds were recorded at Ministers North (Appendix M2).

Seventy-nine species have been previously recorded in the Yandi Hub project area (*ecologia* Environment 2005, 2006 and Maunsell 2003) (Appendix H4). This survey recorded sixteen species not previously recorded for the area (Appendix H4).

Conservation Importance

Of the 66 bird species observed, one, the Australian Bustard (*Ardeotis australis*) is classified as CI 2. Ten species are classified as CI 4 and the remaining 55 species as CI 5 (Appendix H4).

The Australian Bustard is listed as a Priority 4 species by the DEC. This species is typically widespread but is locally scarce. Two sightings were made at Munjina, one near a water source and another in a spinifex plain. The Australian Bustard inhabits woodlands and grasslands, moving widely over large areas (Johnstone and Storr 1998). The habitat of the Australian Bustard is well-represented in the Pilbara, and, given its mobility, the impacts associated with the proposed disturbances are not likely to significantly affect this species.

Ten bird species classified as CI 4 were observed during the survey (Appendix H4). These are those species recognised under international treaties such as CAMBA, JAMBA and ROKAMBA, as well as the Bonn Convention for migratory species and the EPBC Act list of marine species. Many of these are largely aerial species and have an extensive home range, and therefore impacts upon these species are expected to be negligible.

The remaining species, CI 5 species, have an IUCN rating of Near Threatened, Least Concern or Data Deficient, and do not qualify for the rating of Vulnerable. These species are considered to be widespread and abundant, and not exclusively dependent on the project area. Potential impacts associated with the project are unlikely to significantly affect these species.

3.4 POTENTIALLY OCCURRING FAUNA

Fauna species of conservation importance that potentially occur in the Yandi Hub project area are discussed in the following sections. This list of species (Appendix H) has been refined through the assessment of the habitat in the project area. Detailed information on each of the potentially occurring species, classified as CI 1 to CI 2, is presented in Appendix G.

3.4.1 Mammals

Conservation Importance 1

Five mammal species classified as CI 1 potentially occur in the project area (Appendix H1).

The Mulgara (*Dasycercus cristicauda*) is listed as Schedule 1 (WC Act) and Vulnerable (EPBC Act and IUCN Red List 1996). This species is found in Central Australia in sandy regions living in burrows. The Mulgara has not been recorded in any of the surveys previously conducted for BHPIO in the Newman area (Appendix H1), but has been recorded from the Goldsworthy area (*ecologia* Environment 2005c). Several populations have been monitored over long periods in the northern Goldfields, and show fluctuating but persistent populations (pers. comm. M. Ladyman, ENV.Australia). The Mulgara is unlikely to be found in the project area and is therefore unlikely to be impacted by the proposed development.

The Northern Quoll (*Dasyurus hallucatus*) is listed as Schedule 1 (WC Act) and Endangered under the EPBC Act. It has been recorded in a range of vegetation types, but it favours rocky areas and is known to den in rock crevices. There has been a recent sighting of this species at Redmont Camp (ENV.Australia 2007d). However, no sightings have been made near the Munjina and Ministers North tenements. It is therefore unlikely that the Northern Quoll will be impacted by the development.

The Black-footed Rock-wallaby (*Petrogale lateralis*) is listed as Schedule 1 (WC Act) and Vulnerable (EPBC Act). This species utilises rock outcrops and breakaways for shelter. It has a scattered distribution throughout its range (DEC 2007a). There have been numerous unconfirmed sightings of the Black-footed Rock-wallaby: the difficulty of confirming the sightings arises because of its similarity to the common Rothschild's Rock-wallaby. An extensive search was carried out in the project area, and in particular at Ministers North, where this species' preferred habitat exists, but no sightings were made. It is therefore unlikely there will be any adverse impacts on this species.

The Ghost Bat (*Macroderma gigas*) is listed as Vulnerable (IUCN Red List) and as Priority 4 (DEC). The Orange Leafnosed-bat (*Rhinonicteris aurantius*) is listed as Vulnerable (DEC and EPBC Act) and Schedule 1 (WC Act). Both species require an undisturbed cave, deep fissure, or disused mine shaft for roosting (Strahan 1995). Potential roosting locations (large caves) are present in the Coondiner and Mindy East tenements. Although these species were not recorded during the survey, they may utilise the project area for roosting and for foraging. As the proposed drill pads do not cover habitats in which these species may roost, and suitable foraging grounds are well-represented outside the project area, the proposed development is unlikely to affect the Ghost Bat or the Orange Leafnosed-bat.

Conservation Importance 2

Four mammal species classified as CI 2 potentially occur in the project area (Appendix H1).

The Western Pebble-mound Mouse was recorded during the survey, and has been discussed in Section 3.3.1.

The Long-tailed Dunnart (*Sminthopsis longicaudata*) is listed as Priority 4 (DEC). It is known to occur in Spinifex grasslands in association with low open Mulga woodlands (Strahan 1995). Although suitable habitat is present in the project area, it is also well-represented elsewhere in the Pilbara. This, coupled with the historically low capture rates of this species in the Pilbara, suggests that impacts on this species are likely to be minimal.

The Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) is listed as Priority 3 (DEC). There have no records within the last 50 years of this species by WAM (WAM 2003) or by other environmental studies of the region. However, there are anecdotal historical records around Shay Gap (pers. comm. M. Ladyman, ENV.Australia).

The Lakeland Downs Mouse (*Leggadina lakedownensis*) is listed as Priority 4 (DEC). The Lakeland Downs Mouse and the Spectacled Hare-wallaby are known to prefer sand plains and clay pans (DEC 2007b) with a good cover of Spinifex and shrubs. Such habitats are not the primary focus of impact, and therefore these two taxa are not likely to be influenced.

Conservation Importance 3

Five mammal species classified as CI 3 potentially occur in the project area (Appendix H1): the Little Red Kaluta (*Dasykaluta rosamondae*), Pilbara Ningaui (*Ningaui timealeyi*), Rothschild's Rock-wallaby (*Petrogale rothschildi*), Pallid Long-eared Bat (*Nyctophilus bifax daedalus*) and the Common Rock-rat (*Zyzomys argurus*). The Little Red Kaluta, Pilbara Ningaui, and Common Rock-rat were recorded during the survey, and have been discussed previously in Section 3.3.1.

The Rothschild's Rock-wallaby is endemic to the Pilbara. It inhabits hummock vegetated cliffs, rockpiles and scree slopes. Although suitable habitat was located at the Ministers North tenement, there were no recordings of this species. The project is unlikely to have an effect on this species.

The Pallid Long-eared Bat (*Nyctophilus bifax daedalus*) is the western subspecies of *Nyctophilus bifax.* The Pallid Long-eared Bat is endemic to the Pilbara, and studies suggest it could be a distinct species (Strahan 1995). ENV's records show this species has been recorded twice in the Pilbara, at Ministers North and at West Angelas (Appendix H1). The Pallid Long-eared Bat prefers large riverine habitats, and roosts in hollow trees. The proposed exploration drilling will not impact on this species, as the drilling program does not cover this habitat type: however, any future clearing of this habitat will impact on this species.

Conservation Importance 5

Fifteen mammal species (additional to those recorded) classified as CI 5 potentially occur in the project area (Appendix H1). As stated previously, these species have an IUCN rating of Near Threatened, Least Concern, or Data Deficient, and do not qualify for the rating of Vulnerable. These species will not be discussed further, as many of them are considered widespread and abundant, and not exclusively dependent on the project area at the local level.

3.4.2 Reptiles

Conservation Importance 1

One reptile species classified as CI 1 potentially occurs in the project area (Appendix H2). The Pilbara Olive Python (*Liasis olivaceus barroni*) is listed as Vulnerable (EPBC Act) and Schedule 1 (WC Act). This regional sub-species is geographically distinct to the Kimberley sub-species. It inhabits rocky gorges and gullies, usually near watercourses, but may also be recorded in other habitats, including drier areas of woodlands (Wilson and Swan 2003). Potential habitat for this species is present in the Ministers North tenement, in particular along Yandicoogina Creek at the southern edge of the tenement: however, there were no records of the Pilbara Olive Python during the survey. Little potential habitat for the Pilbara Olive Python appears to occur on most of the two sites, and the habitat likely to be used by the species (deeper gorges) is unlikely to be disturbed by the proposed drilling activity.

Conservation Importance 2

Two reptile species classified as CI 2 potentially occur in the project area (Appendix H2). *Lerista macropisthopus remota* is listed as Priority 2 (DEC), and the blind snake, *Ramphotyphlops ganei*, is listed as Priority 1 (DEC). There are few previous records of these species, and little is known of their habitat requirements. The *Lerista macropisthopus remota* is thought to shelter in loose soil under leaf litter at shrub bases, whilst it appears the blind snake prefers rocky or stony soils. With such habitat requirements, both species should occur broadly across the region, and therefore any localised disturbance is unlikely to severely impact these species.

Conservation Importance 3

Eighteen reptile species (additional to those recorded) classified as CI 3 potentially occur in the project area (Appendix H2). These are species of local conservation importance not listed under State or Federal Acts. Such species have restricted distribution or specific habitat requirements, and may suffer some impact from further habitat destruction.

3.4.3 Amphibians

Conservation Importance 5

Nine amphibian species classified as CI 5 potentially occur in the project area, one of which was recorded during the survey (Appendix H3). CI 5 species have an IUCN rating of Near Threatened, Least Concern, or Data Deficient, and do not qualify for the rating of Vulnerable. These species are considered widespread and abundant, and not exclusively dependent on the project area at a local level. Potential impacts associated with the project are unlikely to affect these species.

3.4.4 Birds

Conservation Importance 1

Two bird species classified as CI 1 potentially occur in the project area (Appendix H4).

The Peregrine Falcon (*Falco peregrinus*) is listed as Schedule 4 (DEC). This species is considered widespread throughout Australia, but uncommon. The Peregrine Falcon utilises the ledges, cliff faces and large hollows/broken spouts of trees for nesting. It also occasionally uses the abandoned nests of other birds of prey (Johnstone and Storr 1998). Potential nesting sites occur in the Ministers North tenement: however, no evidence of Peregrine Falcon nests was observed. The Peregrine Falcon may utilise the project area as part of its larger foraging territory. Because of the high mobility of this species and the lack of evidence it is present in the project area, it is unlikely to be adversely affected by any proposed developments.

The Night Parrot (*Pezoporus occidentalis*) is listed as Critically Endangered (WC Act) and Endangered (EPBC Act). It is known to inhabit inland plains and Spinifex breakaways (Simpson and Day 2004). There are few previous records of the Night Parrot. No evidence of this species was found during the survey, although potential habitat for it is present near the Munjina and Ministers North tenements. It is highly unlikely this species is present in the project area.

Conservation Importance 2

Five bird species classified as CI 2 potentially occur in the project area (Appendix H4). This includes the Australian Bustard, which was recorded during the project, and which has been discussed in Section 3.3.4.

The Grey Falcon (*Falco hypoleucos*) is listed as Priority 4 (DEC) and Near Threatened (IUCN Red List). There has been a recent sighting of this species near the Roy Hill tenements (ENV.Australia 2007d). Grey Falcons inhabit woodland areas in arid zones (Simpson and Day 2004), and may forage in the project area. However, given the large home range and mobility of this species,

impacts associated with the Yandi Hub project area are likely not to have an effect on this species.

The Bush Stone-curlew (*Burhinus grallarius*) is listed as Priority 4 (DEC) and as Near Threatened (IUCN Red List). It is known to inhabit open woodlands with groundcover of small sparse shrubs, grass or litter consisting of twigs. It tends to avoid dense forest closed-canopy habitats (Morcombe 2004). This species would not exclusively depend on habitats in the project area, and therefore is unlikely to be affected by the proposed impacts.

The Star Finch (*Neochmia ruficauda clarescens*) is listed as Priority 4 (DEC) and as Near Threatened (IUCN Red List). This species occurs in sparsely-vegetated grasslands near water. This species would not exclusively depend on habitats in the Yandi Hub project area, and therefore is unlikely to be affected by the proposed disturbance.

Conservation Importance 4

Thirteen bird species (additional to those recorded) classified as CI 4 potentially occur in the project area (Appendix H4). As stated previously, many of these species are largely aerial species and have an extensive home range. Impacts upon these species are expected to be negligible.

Conservation Importance 5

Fifty-three bird species (additional to those recorded in the project area and its vicinity) classified as CI 5 potentially occur in the project area (Appendix H4). As discussed previously, these species are considered widespread and abundant, and not exclusively dependent on the project area. Potential impacts associated with the project are therefore unlikely to affect these species.

4 DISCUSSION

A fauna assessment was carried out at Yandi, and in particular at Munjina and Ministers North exploration leases. Within these leases seven habitat types exist:

- alluvial plain
- riverine
- breakaways;
- scree slopes;
- gorge/gullies;
- hill crests; and
- minor drainage lines.

The value of habitat types to fauna varies. High- to medium-value habitats are those displaying vegetation structure and habitat complexity, providing elements important to a variety of fauna (e.g. gorge/gully), or those providing elements specific to fauna of conservation significance (e.g. scree slope). The lack of vegetation structure and ground cover in the hill crest habitat leads to it being classed as of lower value, as it lacks an array of microhabitats for fauna to exploit.

Three hundred and twelve fauna species potentially occur in the area. One hundred and thirty-four fauna species were recorded in the project area during the survey, consisting of 22 mammal species, 45 reptile species, one amphibian species and 66 bird species.

Eight mammal, 24 reptile, one amphibian and 16 bird species recorded during the survey have not previously been recorded in the area (Appendix H). The recording of 49 additional species demonstrates the benefit of multiple surveys in the same or adjacent areas when attempting to inventory vertebrate fauna for environmental impact assessment.

Table 3: Comparisons of Potentially Occurring and Recorded Species

	Mammals	Reptiles	Amphibians	Birds
Potentially Occurring Species	50	115	9	138
Yandi (Maunsell 2003)	4	8	0	67

	Mammals	Reptiles	Amphibians	Birds
Upper Marillana (*ecologia* Environment 2005)	11	15	0	36
Ministers North (*ecologia* Environment 2006)	10	18	1	42
Current survey (ENV 2007)	22	45	1	66
New Species Recorded	**8**	**24**	**0**	**16**

There are few previous records of the following mammal, reptile and bird species recorded in this survey:

- Long-tailed Planigale (*Planigale ingrami*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Fat-tailed Gecko (*Diplodactylus conspicillatus*);
- *Diplodactylus wombeyi*;
- Beaked Gecko (*Rhynchoedura ornata*);
- Jewelled Gecko (*Strophurus elderi*);
- *Delma butleri*;
- Hooded Scalyfoot (*Pygopus nigriceps*);
- Brown Quail (*Coturnix ypsilophora*);
- Black-breasted Buzzard (*Hamirostra melanosternon*);
- Australian Bustard (*Ardeotis australis*);
- Barn Owl (*Tyto alba*); and
- Brown Songlark (*Cincloramphus cruralis*).

The records of these species made in this survey may be a function of greater survey effort, improved survey methodology and/or more suitable timing. More specifically, there are no previous records of the Long-tailed Planigale in surveys carried out for BHPBIO (Appendix H1), with only one record for the Pilbara on the WAM database (WAM 2003). The scarcity of records of this species could be attributable to its similarity to the Common Planigale. The Pilbara Planigale species are under taxonomic review, and the distribution of the species is yet to be clarified (WAM 2003).

The Yellow-bellied Sheathtail-bat has been recorded in only four surveys conducted for BHPBIO (Appendix H1). This species usually roosts singly or in groups of up to six, typically in tree hollows (Strahan 1995). The recording of this species can be attributed to the use of AnaBat II recording units.

The extensive reptile capture from this survey suggests that previous studies may have not conducted full reptile surveys, or did not set pitfall traps for sufficiently long periods.

The high number of bird records may be a reflection of the increases in survey effort and in time spent traversing the project area, with ornithologists having greater flexibility of movement and not being confined to searching specific sites. The increase in bird diversity, when compared to other surveys in the region, is likely the result of the presence of permanent water (the Munjina Bore) to the south-east of the Munjina lease.

Ninety-one fauna species of conservation significance were recorded during the survey, none of which were CI 1 species.

Two CI 2 species, the Western Pebble-mound Mouse (*Pseudomys chapmani*) and the Australian Bustard (*Ardeotis australis*), were recorded in the project area. Secondary evidence only of the Western Pebble-mound Mouse was recorded (Appendix N) (Figure 6) in the project area. As the preferred habitat of this species, scree slopes, are well-represented outside the project area, and as active pebble mounds were not located in the proposed drill sites, the planned development will not have an effect on this species. The habitat of the Australian Bustard is well-represented in the Pilbara, and thus no significant impact is expected on this species.

Eleven species recorded during the survey are classified as CI 3 (Appendix H). The habitats of all these species are well-represented elsewhere in the Pilbara. As these species do not exclusively depend on habitats in the project area, the potential impacts on these species from the proposed developments are assessed as low.

Ten species are migratory birds, and are listed as CI 4. These CI 4 species are largely aerial species, and are not likely to be exclusively dependent on the proposed impact areas.

Sixty-eight species are of the CI 5 category, and are considered widespread and abundant, and not exclusively dependent on the project area at the local level.

Potentially occurring fauna of conservation significance in the project area includes:

- Mulgara (*Dasyurus cristicauda*)

- Northern Quoll (*Dasyurus hallucatus*);
- A skink (*Lerista macropisthopsus remota*);
- A blind snake (*Ramphotyphlops ganei*);
- Peregrine Falcon (*Falco peregrinus*); and
- Grey Falcon (*Falco hypoleucos*).

These species occupy habitats that are broadly located across the Pilbara, and they are unlikely to rely exclusively on those in the project area.

In conclusion, the habitats in the project area have been well surveyed, and are generally well represented in the Pilbara region. None of the habitats appear to be important in supporting fauna of conservation significance. The proposed disturbance is unlikely to affect significantly the representation of the habitats in the project area, and therefore the fauna they support.

5 REFERENCES

Beard, J.S. (1975) *Vegetation Survey of Western Australia: Sheet 5 Pilbara,* University of Western Australia Press, Perth, Western Australia.

Burbidge, N.T. (1959) *Notes on Plants and Plant Habitats Observed in the Abydos-Woodstock Area, Pilbara District, Western Australia,* CSIRO Div. Plant Ind. Tech. Paper 12.

Bureau of Meteorology (2007) *Daily Weather Observations,* Commonwealth of Australia. Online: http://www.bom.gov.au/climate.

Cogger, H. G. (2000) *The Reptiles of Australia*, Reed New Holland Publishers, Sydney.

Department of Environment and Conservation (2007a) *Black-footed Rock Wallaby*, Online: www.naturebase.net.

Department of Environment and Water Resources (2007a) *Interim Biogeographic Regionalisation for Australia, Version 6.1*. Online: www.environment.gov.au.

Department of Environment and Water Resources (2007b) *EPBC Act List of Threatened Fauna,* Online: www.environment.gov.au.

ecologia Environment (1995a) *Yandi Stage II Iron Ore Biological Assessment Survey,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1995b) *Orebody 25 Biological Assessment Survey,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1995c) *East Angelas Biological Assessment Survey,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1995d) *Orebody 18 Biological Assessment Survey,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1997) *Hope Downs Biological Assessment Survey*, Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1998a) *Yandi Vegetation and Soil Survey,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1998b) *Mount Whaleback Fauna Monitoring Programme: Baseline Sampling 1997-1998,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1998c) *Orebody 23 Extension: Biological Assessment Survey,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1998d) *Mining Area C Biological Survey,* Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1998e) *Weeli Wolli Biological Survey*, Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (1998f) *West Angeles Biological Assessment Survey,* Unpublished report for Robe River Mining Ltd.

ecologia Environment (2004a) *Area C: Deposits D, E and F Biological Survey*, Unpublished report for MPDJV.

ecologia Environment (2004b) *Packsaddle Range Biological Survey*, Unpublished report for BHP Iron Ore Pty Ltd.

ecologia Environment (2004c) *Orebody 24 Expansion Biological Survey,* Unpublished report for MPD JV.

ecologia Environment (2004d) *East Ophthalmia Range Expansion Biological Survey,* Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2005a) *Orebody 25 Biological Review and Environmental Impact Assessment,* Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2005b) *Upper Marillana Biological Survey*, Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2005c) 'Goldsworthy Extension Biological Assessment Survey', in *Goldsworthy Extension Project Environmental Protection Statement*, BHP Billiton Iron Ore, Western Australia.

ecologia Environment (2006) *Marillana Biological Survey*, Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2007) *Marillana ML70/270 SA Sec 2 Flora and Vegetation assessments,* Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ENV.Australia (2006a) *Mount Whaleback Flora and Fauna Assessment Phase III*, Unpublished report for BHP Iron Ore Pty Ltd.

ENV.Australia (2006b) *Orebody 24 Flora and Fauna Assessment Phase II,* Unpublished report for MPD JV.

ENV.Australia (2006c) *Orebody 18 Flora and Vegetation Assessment Phase II,* Unpublished report for BHP Iron Ore Pty Ltd.

ENV.Australia (2007a) *Coondiner and Mindy East Exploration Leases Flora and Vegetation Assessment*, in preparation.

ENV.Australia (2007b) *Upper Marillana Exploration Lease Fauna Assessment,* in preparation.

ENV.Australia (2007c) *Prairie Downs Exploration Lease Biological Assessment,* Unpublished report for BHPBIO.

ENV.Australia (2007d) *Roy Hill Exploration Lease Fauna Assessment,* Unpublished report for BHPBIO.

Environmental Protection Authority (2002) *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3,* EPA, Perth, Western Australia.

Environmental Protection Authority (2004) *Terrestrial Fauna Surveys for* Environmental *Impact Assessment in Western Australia, No. 56,* EPA, Perth, Western Australia.

Halpern Glick Maunsell (1999) *Marillana Creek Western Access Corridor – Biological Assessment,* Unpublished report for BHP Iron Ore Pty Ltd.

IUCN (2006) *2006 IUCN Red List of Threatened Species,* Online: www.iucnredlist.org.

Johnstone, R.E. and Storr, G.M. (1998) *Handbook of Western Australian Birds: Volume 1 – Non-passerines (Emu to Dollarbird),* Western Australian Museum, Perth Western Australia.

Kendrick (2001) *Pilbara 2* in A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. Department of Conservation and Land Management, Western Australia.

Maunsell Australia Pty Ltd (2003) *Yandi Life of Mine Flora and Fauna,* Unpublished report for BHP Billiton Irone Ore.

Morcombe, M. (2004) *Field Guide to Australian Birds*. Steve Parish Publishing, Archerfield, Queensland.

Simpson, K. and Day, N. (2004) *A Field Guide to the Birds of Australia*, Penguin Books Australia Ltd, Melbourne.

Strahan, R. (1995) *The Mammals of Australia,* Reed New Holland Publishers, Sydney.

Thackway, R. and Cresswell, I.D. (1995) *An Interim Biogeographic Regionalisation for Australia: A framework for setting priorities in the National Reserves System Cooperative Program, Version 4.0.* Australian Nature Conservation Agency, Canberra.

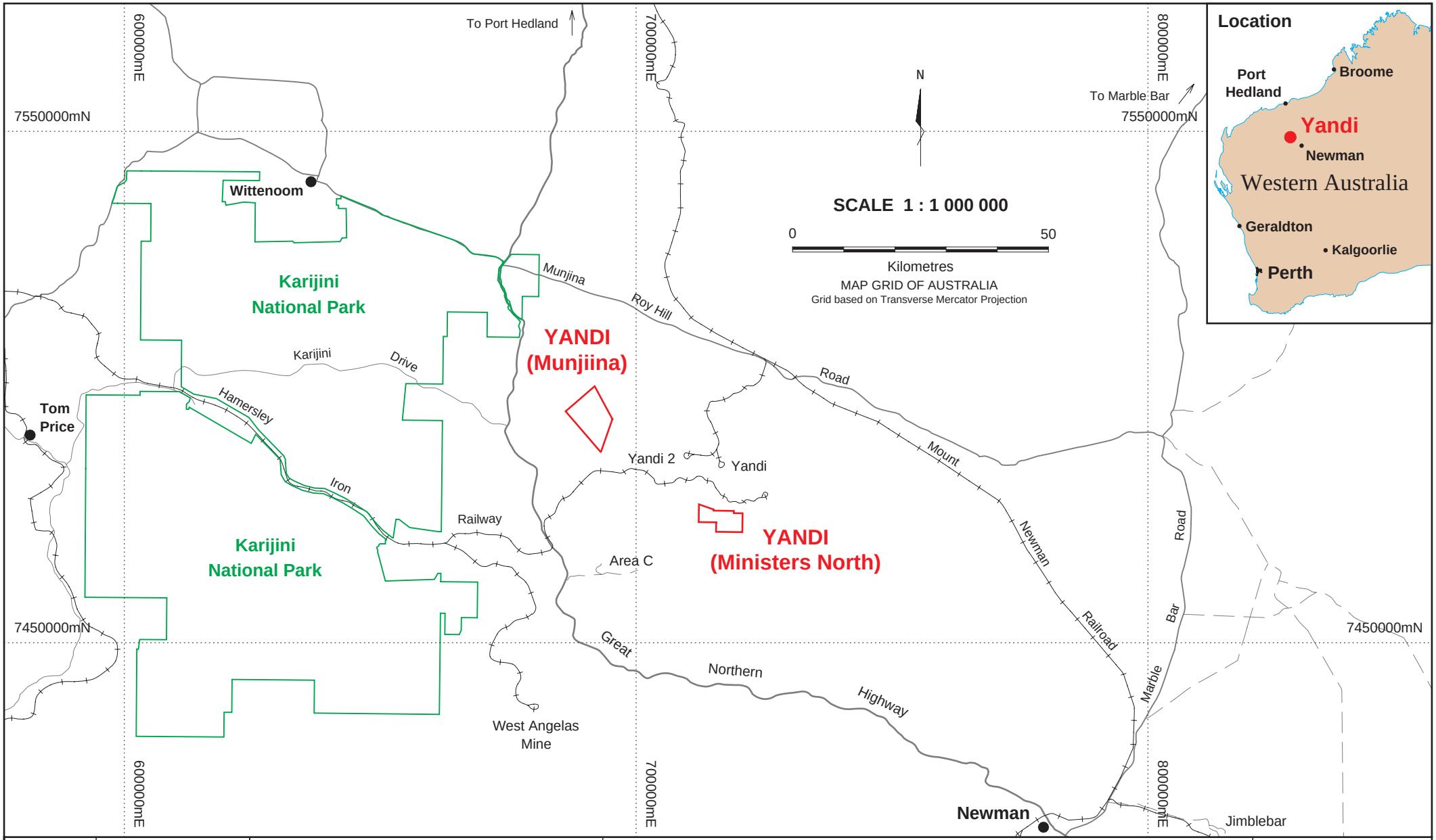
Thorne, A.M. and Tyler, I.M. (1997) *Roy Hill, Western Australia. 1:250 000 Geological Series - Explanatory Notes,* Geological Survey of Western Australia, Perth, Western Australia.

van Vreeswyk, A.M.E., Payne, A.L., Leighton, K.A., and Hennig, P. (2004) *An Inventory and Condition Survey of the Pilbara Region of Western Australia: Technical Bulletin # 92.* Department of Agriculture. Government of Western Australia.

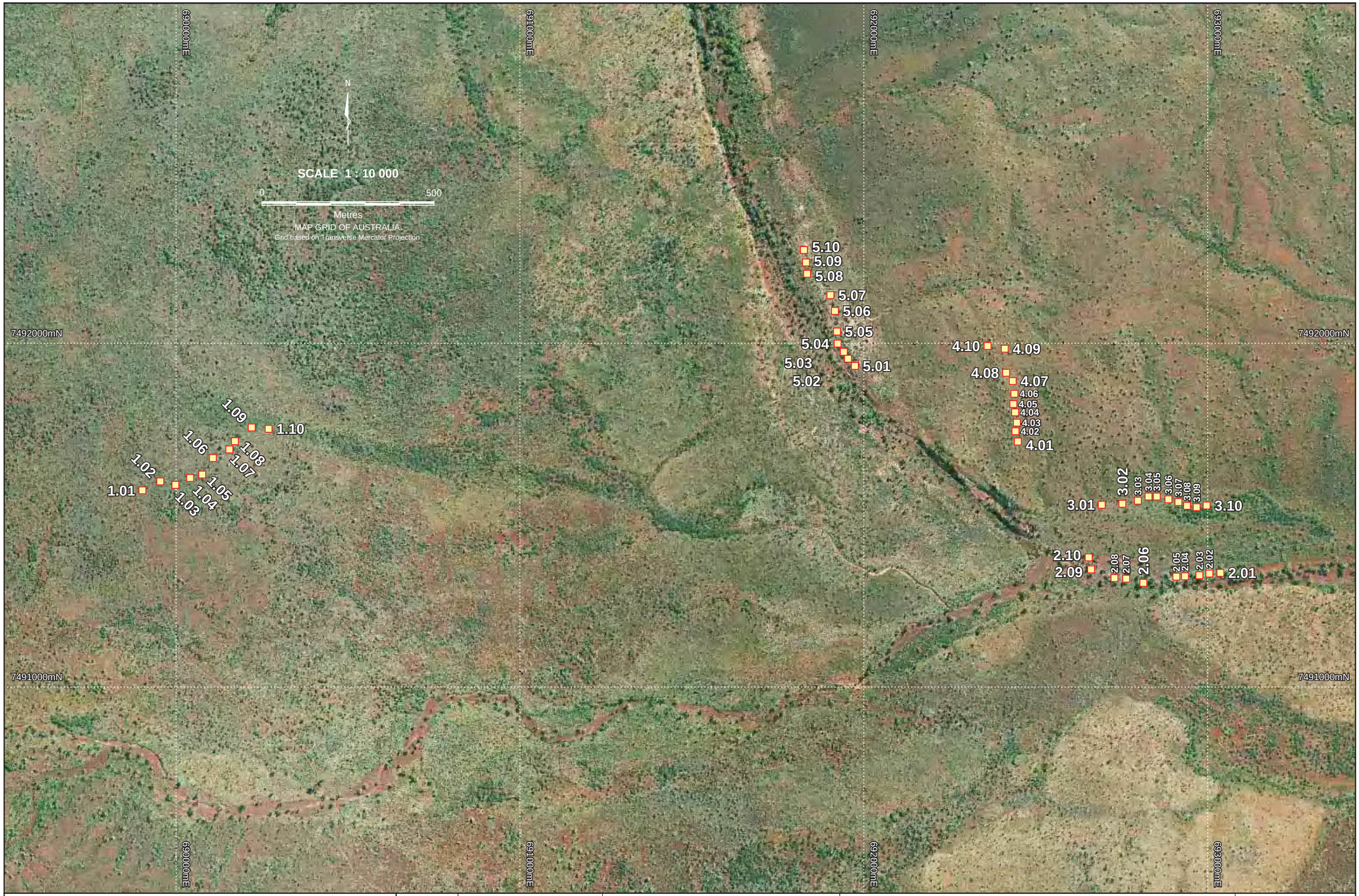
Western Australian Museum (2003) *Faunabase – Collections Database,* Online: www.museum.wa.gov.au/faunabase

Wilson, S. & Swan, G. (2003) *Reptiles of Australia,* New Holland Publishers, Australia.

FIGURES



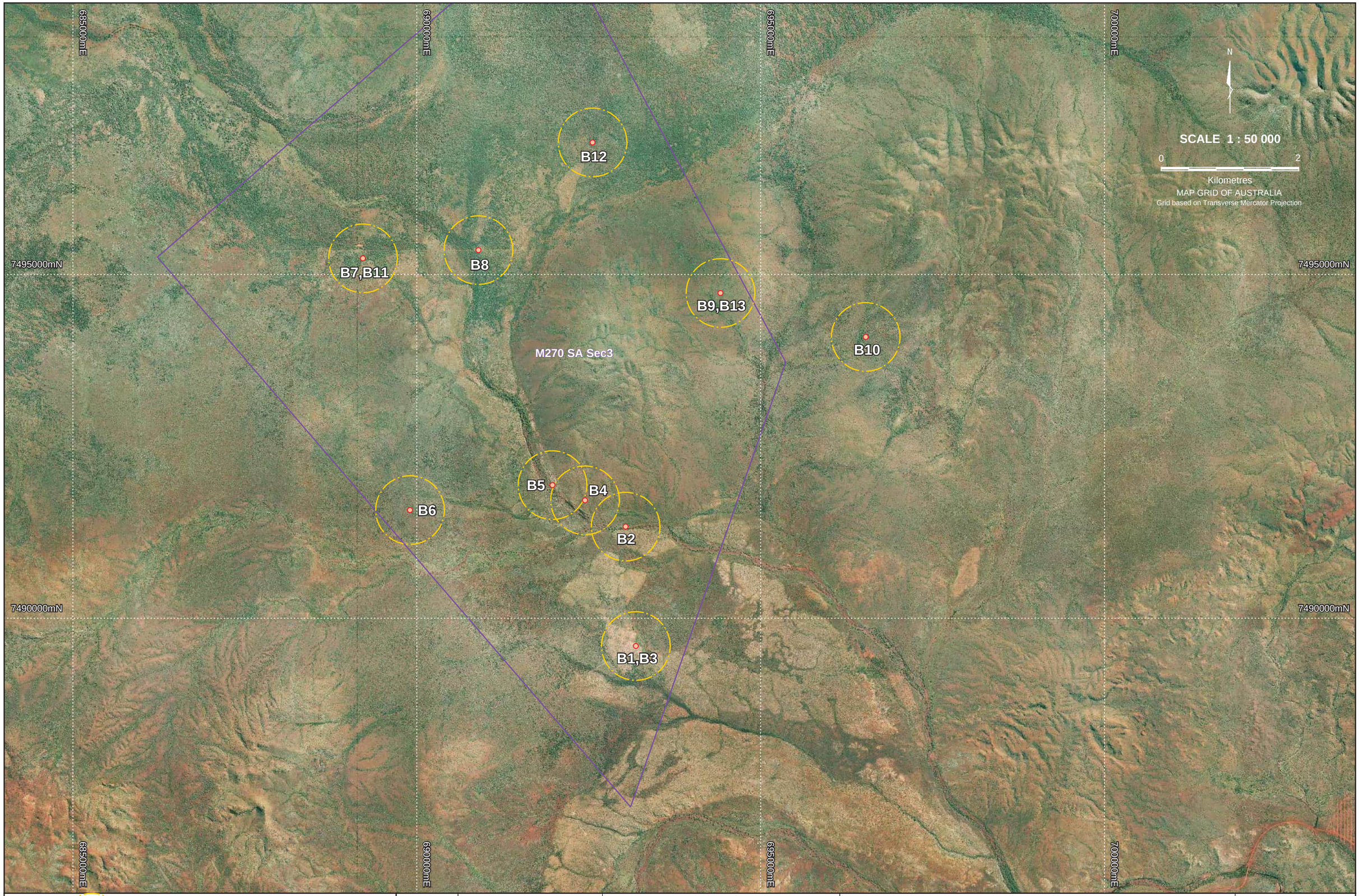
env Australia	Author: M.Love	Client: **BHP BILLITON IRON ORE PTY LTD**	Date: 29 February 2008
	Drawn: S.Coleman	Project: **YANDI HUB FAUNA ASSESSMENT**	Scale: 1: 1 Million
	Status:		Figure No. **1**
	Job Number: 07.403	**REGIONAL LOCATION**	A4 Plan No. **YND-001**



Legend

1.10 Trap Site

Author: M.Love	Client: **BHP BILLITON IRON ORE PTY LTD**	**TRAP LOCATIONS FOR THE YANDI HUB PROJECT AREA**	Date: 29 February 2008
Drawn: S.Coleman	Project: **YANDI HUB FAUNA ASSESSMENT**		Scale: 1:10 000
Status:		A3	Figure No. **3a**
Job Number: 07.403			Plan No. **YND-002**



Legend

B10 — Ornithological Survey (500m radius buffer)

env Australia

Author: M.Love	Client: **BHP BILLITON IRON ORE PTY LTD**
Drawn: S.Coleman	Project: **YANDI HUB FAUNA ASSESSMENT**
Status:	
Job Number: 07.403	

OPPORTUNISTIC ORNITHOLOGICAL SURVEY AREAS FOR THE YANDI HUB PROJECT AREA

A3

Date: 29 February 2008
Scale: 1:50 000
Figure No. **4a**
Plan No. **YND-003**

Legend

△ **29 November 2007** Bat Recording Location

Author: M.Love	Client: **BHP BILLITON IRON ORE PTY LTD**	**BAT RECORDING LOCATIONS FOR THE YANDI HUB PROJECT AREA**	Date: 29 February 2008
Drawn: S.Coleman	Project: **YANDI HUB FAUNA ASSESSMENT**		Scale: 1:50 000
Status:			Figure No. **5a**
Job Number: 07.403		A3	Plan No. **YND-004**

712500mE
715000mE
717500mE
720000mE
7475000mN
7472500mN

E 47/628

▲26 November 2007

▲27 November 2007

▲1 December 2007

▲30 November 2007

▲27 November 2007

E 47/628

N

SCALE 1 : 25 000

0 1

Kilometres

MAP GRID OF AUSTRALIA

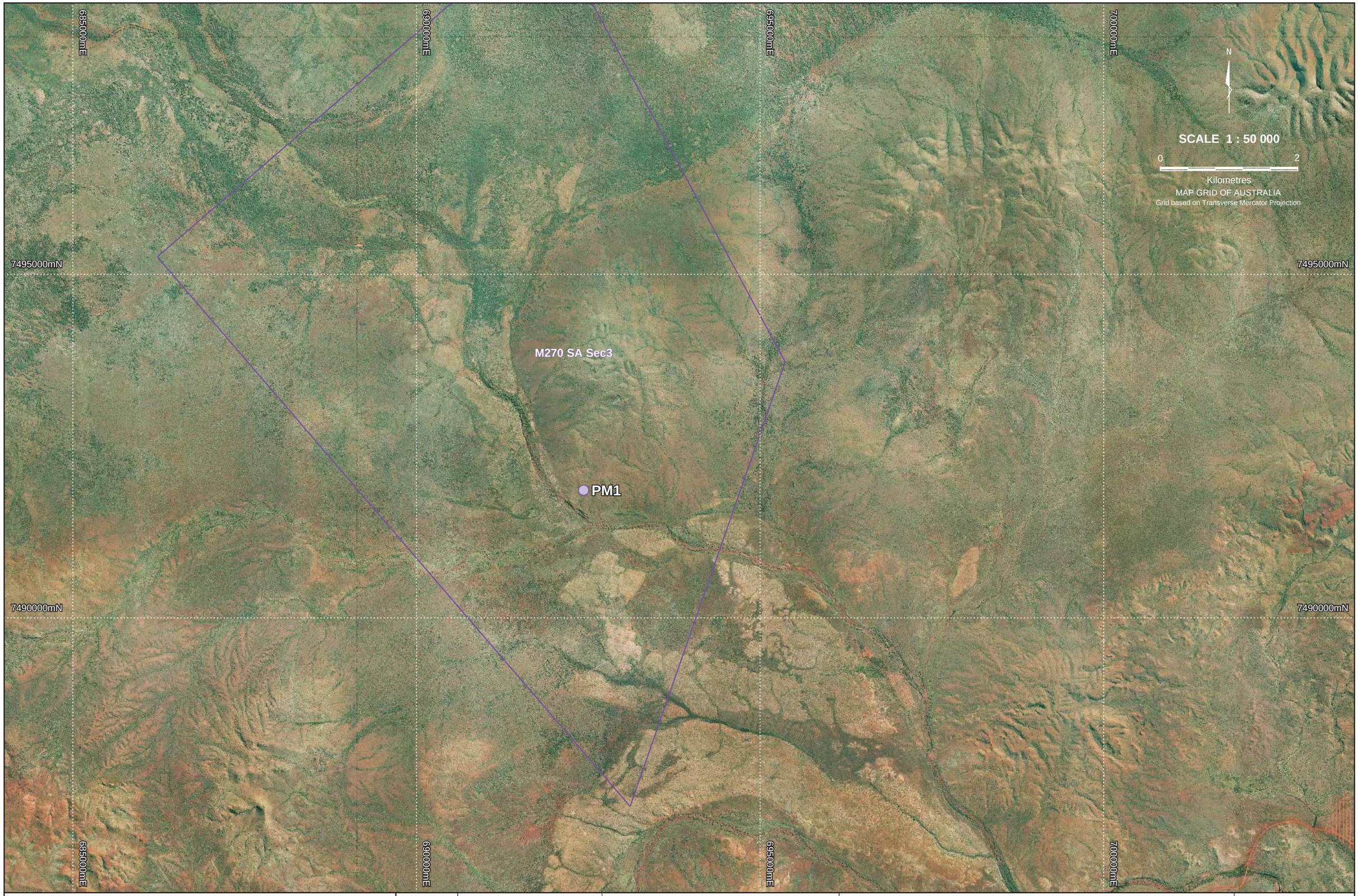
Grid based on Transverse Mercator Projection

Legend

△**29 November 2007** Bat Recording Location

env Australia

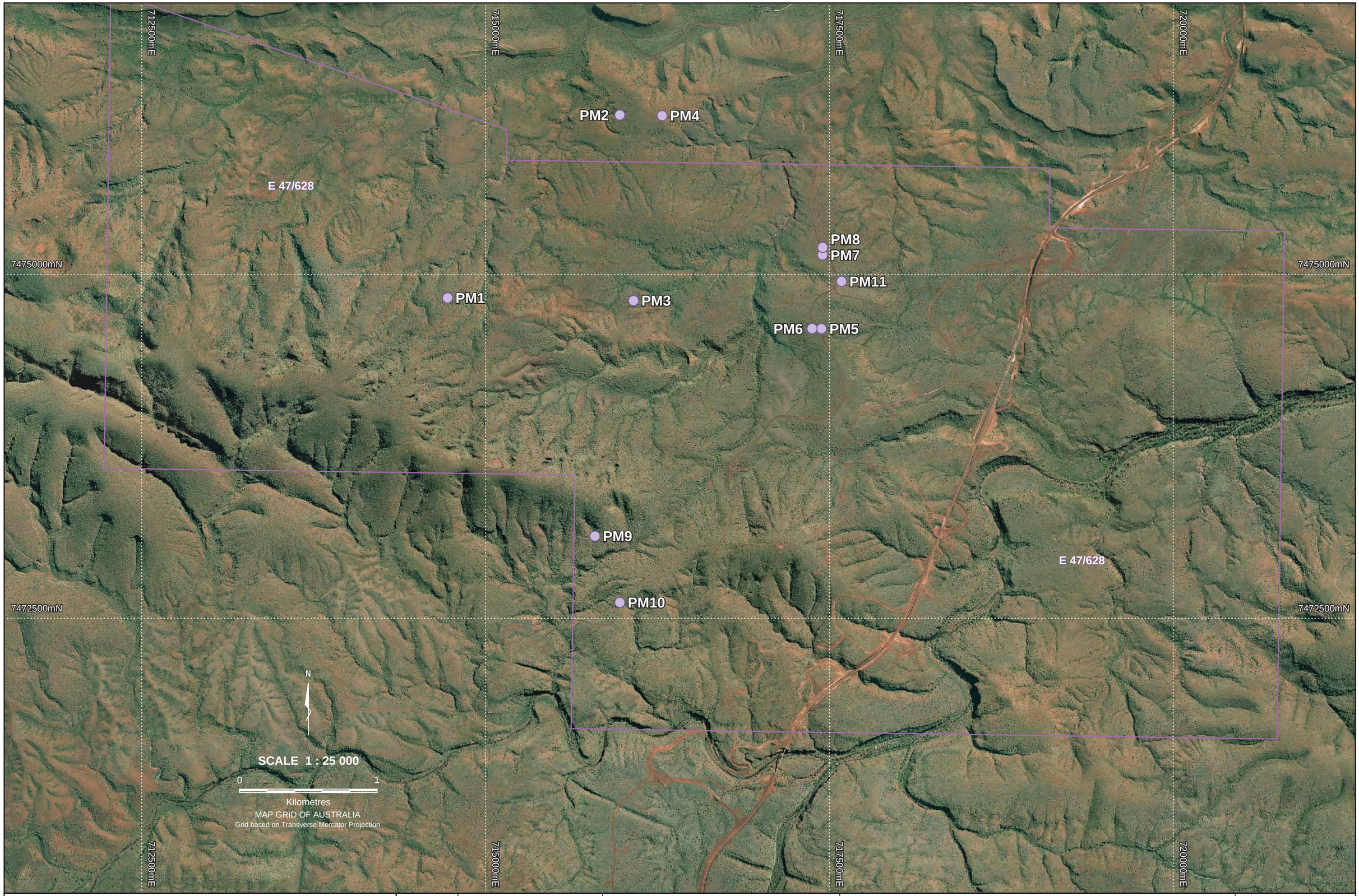
Author: M.Love	Client: **BHP BILLITON IRON ORE PTY LTD**	**BAT RECORDING LOCATIONS FOR THE YANDI HUB PROJECT AREA**	Date: 29 February 2008
Drawn: S.Coleman	Project: **YANDI HUB FAUNA ASSESSMENT**		Scale: 1:50 000
Status:			Figure No. **5b**
Job Number: 07.403		A3	Plan No. **YND-007**



Legend

PM1 Active Pebble Mound Location

Author: M.Love	Client: **BHP BILLITON IRON ORE PTY LTD**	**LOCATIONS OF ACTIVE PEBBLE MOUNDS FOR THE YANDI HUB PROJECT AREA**	Date: 29 February 2008
Drawn: S.Coleman	Project: **YANDI HUB FAUNA ASSESSMENT**		Scale: 1:50 000
Status:			Figure No. **6a**
Job Number: 07.403		A3	Plan No. **YND-005**



Legend

PM1 Active Pebble Mound Location

env Australia

Author: M.Love	Client: **BHP BILLITON IRON ORE PTY LTD**
Drawn: S.Coleman	Project: **YANDI HUB FAUNA ASSESSMENT**
Status:	
Job Number: 07.403	

LOCATIONS OF ACTIVE PEBBLE MOUNDS FOR THE YANDI HUB PROJECT AREA

A3

Date:	29 February 2008
Scale:	1:50 000
Figure No.	**6b**
Plan No.	**YND-008**

APPENDIX A

DEFINITION OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX A

Definition of Conservation Codes for Fauna of Conservation Significance

Western Australian Threatened Fauna Categories

Category	Code	Description
Schedule 1	S1	Fauna which is rare or likely to become extinct.
Schedule 2	S2	Fauna which is presumed extinct.
Schedule 3	S3	Birds which are subject to an agreement between the governments of Australia and Japan (JAMBA) relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Fauna that is otherwise in need of special protection.

Department of Environment and Conservation (DEC) Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring which are considered not currently threatened or in need of special protection, but could be if present circumstances change. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)
Threatened Species Codes

Category	Code	Description
Extinct	EX	Taxa for which there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	EW	Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range and it has not been recorded in known or expected habitat despite exhaustive survey over a time frame appropriate to its life cycle and form.
Critically endangered	CR	Taxa which is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	EN	Taxa which is not critically endangered but is facing a high risk of extinction in the wild in the near future.
Vulnerable	VU	Taxa which is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term future.
Conservation dependent	CO	Taxa which are the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

IUCN Red List of Threatened Species Codes

Category	Code	Description
Extinct	EX	Taxa for which there is no reasonable doubt that the last individual has died.
Extinct in the Wild	EW	Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range and it has not been recorded in known or expected habitat despite exhaustive survey over a time frame appropriate to its life cycle and form.
Critically endangered	CR	Taxa facing an extremely high risk of extinction in the wild.
Endangered	EN	Taxa facing a very high risk of extinction in the wild.
Vulnerable	VU	Taxa facing high risk of extinction in the wild
Near threatened	NT	Taxa which has been evaluated but does not qualify for CR, EN, or VU now but is close to qualifying or likely to qualify in the near future.
Least Concern	LC	Taxa which has been evaluated but does not qualify for CR, EN, VU, or NT but is likely to qualify for NT in the near future.
Data deficient	DD	Taxa for which there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

International conventions and agreements

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

This is an intergovernmental treaty under the United Nations Environmental Program which lists migratory species that would significantly benefit from international cooperation on their conservation and management.

Japan-Australia Migratory Bird Agreement (JAMBA)

This is an agreement between the Government of Australia and the Government of Japan for the protection of migratory, threatened and birds in danger of extinction. It requires both parties to conserve and protect the birds and their habitats as well as exchange information and build a cooperative relationship.

China-Australia Migratory Bird Agreement (CAMBA)

This is an agreement between the Government of Australia and the Government of the People's Republic of China for the protection of migratory birds and their environment. It requires both parties to conserve and protect the birds and their habitats as well as exchange information and build a cooperative relationship.

APPENDIX B
TRAPPING PROGRAM

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX B

TRAPPING PROGRAM

Appendix B1 - Trap Site Locations

Trap Number	#GPS Coordinates	
	Easting	Northing
1.01	689902	7491572
1.02	689954	7491598
1.03	689998	7491588
1.04	690041	7491608
1.05	690076	7491618
1.06	690107	7491666
1.07	690155	7491691
1.08	690171	7491715
1.09	690220	7491755
1.10	690269	7491751
2.01	693037	7491332
2.02	693005	7491330
2.03	692976	7491325
2.04	692934	7491322
2.05	692909	7491321
2.06	692813	7491303
2.07	692763	7491315
2.08	692729	7491317
2.09	692661	7491342
2.10	692654	7491377
3.01	692692	7491530
3.02	692752	7491533
3.03	692797	7491542
3.04	692828	7491554
3.05	692852	7491554
3.06	692886	7491546
3.07	692915	7491538
3.08	692940	7491527
3.09	692968	7491523
3.10	692997	7491528
4.01	692448	7491714
4.02	692441	7491744
4.03	692445	7491769
4.04	692440	7491799
4.05	692435	7491823
4.06	692438	7491853

Trap Number	#GPS Coordinates	
	Easting	Northing
4.07	692433	7491890
4.08	692414	7491914
4.09	692410	7491984
4.10	692360	7491992
5.01	691974	7491934
5.02	691954	7491955
5.03	691942	7491975
5.04	691924	7491999
5.05	691922	7492034
5.06	691916	7492094
5.07	691903	7492140
5.08	691835	7492202
5.09	691832	7492235
5.10	691826	7492271

Australian Geocentric 1994 (GDA94) Zone 50K

Appendix B2 - Major Habitat Types and Vegetation Descriptions of Traps Sites

Site Number	Habitat Type	Vegetation Description
1	Alluvial Plain	*Acacia aneura* var. *intermedia* open to moderately dense medium woodland, over *Acacia pruinocarpa* scattered medium shrubs, over *Codonocarpus cotinifolius* / *Acacia bivenosa* open medium shrubs over moderately dense mixed small shrubs, over mixed herbs and grasses.
2	Riverine	*Eucalyptus* low open woodland over *Acacia* shrubland over *Triodia* hummock grassland. Wide stony creek bed in centre with vegetation on borders.
3	Minor Drainage	*Corymbia hamersleyana* scattered to sparse medium to tall woodland, over *Acacia tumida* var. *pilbarensis* / *Petalostylis labicheoides* / *Gossypium robinsonii* open medium shrubs, over sparse grasses.
4	Scree Slope	*Eucalyptus leucophloia* subsp. *leucophloia* scattered medium trees, over *Corymbia deserticola* subsp. *deserticola* / *Eucalyptus gamophylla* / *Hakea chordophylla* open medium shrubs, and mallee, over mixed low shrubs, such as *Dampiera candicans* and *Gompholobium karijini*, over open *Triodia basedowii* and other grasses.
5	Riverine	*Eucalyptus* low open woodland over *Acacia* shrubland over *Triodia* hummock grassland. Wide stony creek bed in centre with vegetation on borders.

Appendix B3 - Traps and Number of Replicates Used at Each Site

Site Number	# Cage Traps	# Elliott Traps	# Funnel Traps	# Bucket Traps	# Pot Traps	Total
1	10	10	20	10	20	**70**
2	10	10	20	10	20	**70**
3	10	10	20	10	20	**70**
4	10	10	20	10	20	**70**
5	10	10	20	10	20	**70**
TOTAL	**50**	**50**	**100**	**50**	**100**	**350**

Appendix B4 - Systematic Trapping Program

Site Number	# trap nights for Cage Traps	# trap nights for Elliott Traps	# trap nights for Funnel Traps	# trap nights for Bucket Traps	# trap nights for Pot Traps	Total # nights
1	80	80	160	80	160	560
2	70	70	140	70	140	490
3	60	60	120	60	120	420
4	50	50	100	50	100	350
5	50	50	100	50	100	350
TOTAL	310	310	620	310	620	2170

APPENDIX C
SITE PHOTOGRAPHS

YANDI HUB FAUNA ASSESSMENT

APPENDIX C

SITE PHOTOGRAPHS

Site 1

Site 2

Site 3

Site 4

Site 5

APPENDIX D
ORNITHOLOGICAL CENSUS

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX D

DIURNAL SURVEYS

Appendix D1 - Munjina ornithological sensus program

Location	Survey #	Description	Date	Duration (hours)
Section 3	B1	Well (Alluvial Plain)	23 November 2007	0.5
Section 3	B2	Riverine	23 November 2007	1
Section 3	B3	Well (Alluvial Plain)	24 November 2007	1.0
Section 3	B4	Scree Top	25 November 2007	0.75
Section 3	B5	Riverine	25 November 2007	1.0
Section 3	B6	Spinifex Plain/ Alluvial Plain	25 November 2007	1.0
Section 3	B7	Well (Alluvial Plain)	27 November 2007	1.25
Section 3	B8	Alluvial Plain	27 November 2007	1.25
Section 3	B9	Alluvial Plain and Spinifex Plain	27 November 2007	1.0
East of Section 3	B10	Alluvial Plain	29 November 2007	0.75
Section 3	B11	Well (Alluvial Plain)	30 November 2007	0.5
Section 3	B12	Well (Alluvial Plain)	30 November 2007	0.5
TOTAL				**10.5 hours**

Appendix D2 - Ministers North ornithological sensus program

Location	Survey #	Description	Date	Duration (hours)
Section A	B13	Gorge	26 November 2007	0.5
Section B	B14	Gorge	27 November 2007	0.5
Section B	B15	Unburnt Scree Slope	28 November 2007	1.0
Section B	B16	Gorge	28 November 2007	0.5
Section B, C *	B17	Scree Slopes	28 November 2007	2.0
Section A	B18	Gorge	28 November 2007	1.0
Section A	B19	Gorges Cliffs and Scree Slopes	30 November 2007	1.5
Section A	B20	Gorges Cliffs and Slopes	1 December 2007	2.25
Section A, B, C *	B21	Scree Slopes	1 December 2007	3.0
Section B, C, D *	B22	Scree Slopes	1 December 2007	1.75
Section A	B23	Scree Hilltop	1 December 2007	0.45
Section B, C, D *	B24	Scree Slopes	2 December 2007	3.0
Section D	B25	Major Gorge	2 December 2007	1.75
TOTAL				**19.5 hours**

* indicates wide-roaming car-based survey

Appendix D3 – Munjina herpetological survey program

Date	Duration (person hours)	Description
22 November	3.0	Spinifex Plain
23 November	1.5	Alluvial Plain
25 November	1.0	Breakaway, Gorges
29 November	0.75	Alluvial Plain
30 Novembers	1.0	Spinifex Plain

Appendix D4 - Ministers North herpetological survey program

Date	Duration (person hours)	Description
30 November	1.5	Gorges
1 December	2.5	Breakaways, Gorges
1 December	1.75	Gorges
2 December	1.75	Gorges

APPENDIX E
BAT RECORDINGS

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX E

NOCTURNAL SURVEYS

Appendix E1 - AnaBat II Acoustic Bat Recording locations at Munjina

Date	GPS Coordinates	
	#Easting	#Northing
25 November 2007	700297	7489927
28 November 2007	693207	7489589
	693037	7491332
29 November 2007	689226	7495305
	696566	7494114

Australian Geocentric 1994 (GDA94) Zone 50K

Appendix E2 - AnaBat II Acoustic Bat Recording Details at Munjina

Date	No. of AnaBat II	Duration	Habitat
25 November 2007	1	125 minutes	Escarpment
28 November 2007	2	60 minutes	Permanent well
		300 minutes	River bed
29 November 2007	2	575 minutes	Large well
		2 minutes	Acacia scrub

Appendix E3 - AnaBat II Acoustic Bat Recording locations at Minsters North

Date	GPS Coordinates	
	#Easting	#Northing
26 November	717086	7475891
27 November	717238	7475451
	717952	7473791
30 November	714727	7473825
1 December	714862	7474359

Australian Geocentric 1994 (GDA94) Zone 50K

Appendix E4 - AnaBat II Acoustic Bat Recording Details at Minsters North

Date	No. of AnaBat II	Duration	Habitat
26 November	1	40 minutes	Gorge
27 November	2	610 minutes	Cave in gorge
		200 minutes	Cave in gorge
30 November	1	610 minutes	Cliff face
1 December	1	610 minutes	Drainage line

Appendix E5 – Nocturnal Spotlighting Surveys at Munjina

Date	Survey Type	Person Hours	Habitat
25 November	Foot	4.0	Breakaways
25 November	Car	0.5	Spinifex Plain
28 November	Car	0.75	Several Habitat Types
29 November	Foot	0.5	Alluvial Plain
29 November	Foot	0.5	Alluvial Plain
29 November	Foot	0.75	Alluvial Plain
29 November	Car	2.0	Alluvial Plain, Spinifex Plain

Appendix E6 – Nocturnal Spotlighting Surveys at Minsters North

Date	Survey Type	Person Hours	Habitat
30 November	Car	1.5	Breakaways, Hillcrests
30 November	Foot	2.5	Gorges/ Gullies
1 December	Car	0.5	Breakaways, Hillcrests

APPENDIX F
SITE-SPECIFIC CAPTURES

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX F

SITE SPECIFIC DATA

Yandi Fauna **Site** 1

Described by MB **Date** 27/11/2007 **Type:** F
Season: **Uniformity** Munjina
Location Munjina Long Term Fauna Trapping Site #1
MGA Zone 50 689903 **mE** 7491573 **mN**
Habitat Spinifex Plain
Soil Red brown loam
Rock Type Ironstone, Quartz
Vegetation
Veg Condition Very Good
Fire Age Moderate
Notes
Habitat type: PLA **Logs:** 1 **Leaves:** 2 **Twigs:** 2 **Rocks:** 1 **Rock Litter:** **Bare:** 0

Effort:

Species List: Number of individuals by Obs

Name	Pit	Pot	Ca	Ell	Fu	Ne	No	Opp
Mammals								
Ningaui timealeyi	1							
Zyzomys argurus				1				
Reptiles								
Brachyurophis approximans					1			
Carlia munda	4	2			4			
Ctenotus pantherinus subsp. ocellifer	1	3			10			
Ctenotus saxatilis	4				22			
Cyclodomorphus melanops subsp. melanops	1							
Delma haroldi					1			
Diplodactylus conspicillatus		1						
Diporiphora valens	3							
Diporiphora winneckei	1							
Gehyra variegata	1	1			1			
Heteronotia binoei		3			3			
Lialis burtonis					1			
Menetia greyii		3						
Ramphotyphlops grypus	2	1						
Strophurus wellingtonae	1							
Tiliqua multifasciata			1	1				
Varanus gilleni					1			

Yandi Fauna Site 2

Described by MB **Date** 27/11/2007 **Type:** F
Season: **Uniformity** Munjina
Location Munjina Long Term Fauna Trapping Site #2
MGA Zone 50 693038 **mE** 7491332 **mN**
Habitat Riverine
Soil Alluvial gravely sand
Rock Type Quartz, Ironstone, Chert, Banded Ironstone, Marramamba
Vegetation
Veg Condition Good - Very Good
Fire Age Old
Notes
Habitat type: **Logs:** 2 **Leaves:** 3 **Twigs:** 3 **Rocks:** 1 **Rock** **Litter:** **Bare:**

Effort:

Species List: Number of individuals by Obs

Name	Pit	Pot	Ca	Ell	Fu	Ne	No	Opp
Mammals								
Mus musculus				1				
Reptiles								
Brachyurophis approximans					1			
Carlia amax					1			
Carlia munda	5	6			6			
Delma butleri	1							
Gehyra variegata	2				9			
Heteronotia binoei	1				4			
Lerista muelleri	5	11						
Lialis burtonis	1							
Menetia greyii		3						
Ramphotyphlops ammodytes	2							
Varanus gilleni				1				

Yandi Fauna Site 3

Described by ML **Date** 27/11/2007 **Type:** F
Season: **Uniformity** Munjina
Location Munjina Long Term Fauna Trapping Site #3
MGA Zone 50 692693 **mE** 7491531 **mN**
Habitat Minor Drainage
Soil Red brown loam
Rock Type Quartz, Ironstone
Vegetation
Veg Condition Very Good - Excellent
Fire Age Old
Notes
Habitat type: **Logs:** 1 **Leaves:** 2 **Twigs:** 2 **Rocks:** 1 **Rock** **Litter:** **Bare:**

Effort:

Species List: Number of individuals by Obs

Name	Pit	Pot	Ca	Ell	Fu	Ne	No	Opp
Mammals								
Dasykaluta rosamondae					1			
Ningaui timealeyi	1							
Reptiles								
Carlia munda	1	1			2			
Ctenophorus isolepis subsp. isolepis					1			
Ctenotus pantherinus subsp. ocellifer					1			
Ctenotus saxatilis				1	2			
Cyclodomorphus melanops subsp. melanops		1						
Diplodactylus stenodactylus	1							
Diplodactylus wombeyi	1							
Gehyra variegata	1	1			4			
Lerista muelleri	1				1			
Amphibolurus longirostris					1			
Menetia greyii		4						
Pygopus nigriceps					1			
Rhynchoedura ornata	1							

Yandi Fauna Site 4

Described by MB **Date** 27/11/2007 **Type:** F
Season: **Uniformity** Munjina
Location Munjina Long Term Fauna Trapping Site #4
MGA Zone 50 692448 **mE** 7491715 **mN**
Habitat Ridge top
Soil Red brown loam
Rock Type Scree ironstone
Vegetation
Veg Condition Excellent
Fire Age Old
Notes Slate cracking chert / ironstone
Habitat type: **Logs:** 0 **Leaves:** 1 **Twigs:** 1 **Rocks:** 4 **Rock** **Litter:** **Bare:**

Effort:

Species List: Number of individuals by Obs

Name	Pit	Pot	Ca	Ell	Fu	Ne	No	Opp
Mammals								
Ningaui timealeyi				1	1			
Pseudomys hermannsburgensis	1							
Reptiles								
Ctenophorus caudicinctus					2			
Ctenophorus isolepis subsp. isolepis					1			
Ctenotus pantherinus subsp. ocellifer					4			
Ctenotus rutilans	1	1						
Ctenotus saxatilis	2	1			1			
Gehyra variegata		1						
Heteronotia binoei					1			
Lerista muelleri	1							
Varanus acanthurus					3			

Yandi Fauna Site 5

Described by MB **Date** 27/11/2007 **Type:** F
Season: **Uniformity** Munjina
Location Munjina Long Term Fauna Trapping Site #5
MGA Zone 50 691975 **mE** 7491935 **mN**
Habitat Riverine
Soil Alluvial river deposits
Rock Type Quartz, ironstone, chert
Vegetation
Veg Condition Very Good
Fire Age Old
Notes
Habitat type: **Logs:** 2 **Leaves:** 2 **Twigs:** 2 **Rocks:** 1 **Rock** **Litter:** **Bare:**

Effort:

Species List: Number of individuals by Obs

Name	Pit	Pot	Ca	Ell	Fu	Ne	No	Opp
Mammals								
Planigale ingrami		1						
Zyzomys argurus				1				
Reptiles								
Carlia munda								
Crenadactylus ocellatus subsp. ocellatus	1							
Ctenotus helenae	1				2			
Ctenotus saxatilis					4			
Cyclodomorphus melanops subsp. melanops					1			
Diplodactylus stenodactylus								
Diplodactylus wombeyi	1							
Eremiascincus richardsonii								
Gehyra variegata					2			
Heteronotia binoei		1			2			
Lerista muelleri								
Amphibolurus longirostris								
Menetia greyii								
Morethia ruficauda subsp. exquisita								
Strophurus elderi					1			
Suta fasciata					1			
Varanus acanthurus								

Yandi Fauna **Site** Min opp

Described by **Date** **Type:** O

Season: **Uniformity** Ministers North

Location

MGA Zone **mE** **mN**

Habitat

Soil

Rock Type

Vegetation

Veg Condition

Fire Age

Notes

Habitat type: **Logs:** **Leaves:** **Twigs:** **Rocks:** **Rock** **Litter:** **Bare:**

Effort:

Species List: Number of individuals by Obs

Name	Pit	Pot	Ca	Ell	Fu	Ne	No	Opp
Birds								
Acanthiza uropygialis								1
Aquila audax								1
Artamus cinereus								1
Artamus minor								1
Barnardius zonarius subsp. zonarius								1
Cacatua roseicapilla								1
Cacatua sanguinea								1
Chlamydera guttata								1
Circus assimilis								1
Colluricincla harmonica								1
Coracina maxima								1
Coracina novaehollandiae								1
Corvus orru								1
Cracticus tibicen								1
Dicaeum hirundinaceum								1
Elanus caeruleus								1
Emblema pictum								1
Eurostopodus argus								1
Falco berigora								1
Falco cenchroides								1
Falco longipennis								1
Geopelia cuneata								1
Geopelia striata								1
Geophaps plumifera								1
Grallina cyanoleuca								1
Haliastur sphenurus								1
Lalage tricolor								1
Lichenostomus keartlandi								1
Lichmera indistincta								1
Malurus lamberti								1
Manorina flavigula								1
Melithreptus gularis								1
Merops ornatus								1
Milvus migrans								1
Ninox novaeseelandiae								1
Ocyphaps lophotes								1
Pachycephala rufiventris								1
Petroica cucullata								1
Phaps chalcoptera								1
Rhipidura fuliginosa								1
Rhipidura leucophrys								1
Smicrornis brevirostris								1
Taeniopygia guttata								1
Todiramphus sanctus								1
Turnix velox								1
Mammals								

Bos taurus	1
Canis lupus subsp. dingo	1
Chalinolobus gouldii	2
Felis catus	1
Macropus robustus subsp. erubescens	1
Mormopterus beccarii	1
Pseudomys chapmani	1
Scotorepens greyii	3
Taphozous georgianus	1
Vespadelus finlaysoni	5
Vulpes vulpes	1
Zyzomys argurus	1
Reptiles	
Cryptoblepharus plagiocephalus	1
Ctenophorus caudicinctus	1
Ctenophorus isolepis subsp. isolepis	1
Ctenotus saxatilis	2
Eremiascincus fasciolatus	1
Gehyra punctata	1
Gehyra variegata	1
Heteronotia spelea	1
Amphibolurus longirostris	1
Oedura marmorata	5
Pseudechis australis	1
Varanus pilbarensis	1

Yandi Fauna **Site** Mun opp

Described by **Date** **Type:** O

Season: **Uniformity** Munjina

Location

MGA Zone **mE** **mN**

Habitat

Soil

Rock Type

Vegetation

Veg Condition

Fire Age

Notes

Habitat type: **Logs:** **Leaves:** **Twigs:** **Rocks:** **Rock** **Litter:** **Bare:**

Effort:

Species List: Number of individuals by Obs

Name	Pit	Pot	Ca	Ell	Fu	Ne	No	Opp
Amphibia								
Litoria rubella								1
Birds								
Acanthagenys rufogularis								1
Accipiter cirrocephalus								2
Aegotheles cristatus								1
Aquila audax								2
Ardeotis australis								3
Artamus cinereus								4
Artamus minor								1
Barnardius zonarius subsp. zonarius								2
Cacatua roseicapilla								1
Cacatua sanguinea								2
Cincloramphus cruralis								1
Cincloramphus mathewsi								1
Circus assimilis								1
Colluricincla harmonica								1
Coracina novaehollandiae								2
Corvus orru								1
Coturnix ypsilophora								1
Cracticus nigrogularis								2
Cracticus tibicen								1
Cracticus torquatus								2
Dicaeum hirundinaceum								1
Dromaius novaehollandiae								2
Elanus caeruleus								2
Emblema pictum								1
Eremiornis carteri								1
Eurostopodus argus								1
Falco berigora								1
Falco cenchroides								2
Geopelia cuneata								1
Geopelia striata								1
Geophaps plumifera								2
Gerygone fusca								1
Grallina cyanoleuca								3
Haliastur sphenurus								2
Hamirostra melanosternon								1
Hirundo ariel								1
Lalage tricolor								1
Lichenostomus keartlandi								1
Lichenostomus penicillatus								1
Lichenostomus virescens								1
Lichmera indistincta								1
Malurus lamberti								1
Manorina flavigula								1
Melopsittacus undulatus								1

Merops ornatus	1
Milvus migrans	1
Neophema bourkii	2
Ninox novaeseelandiae	1
Nymphicus hollandicus	1
Ocyphaps lophotes	2
Oreoica gutturalis	2
Pachycephala rufiventris	1
Petroica cucullata	2
Phaps chalcoptera	2
Pomatostomus superciliosus	2
Pomatostomus temporalis	1
Rhipidura fuliginosa	1
Rhipidura leucophrys	1
Smicrornis brevirostris	1
Taeniopygia guttata	1
Todiramphus sanctus	1
Turnix velox	1
Mammals	
Bos taurus	1
Camelus dromedarius	1
Canis lupus subsp. dingo	1
Chaerephon jobensis	3
Chalinolobus gouldii	4
Felis catus	1
Macropus robustus subsp. erubescens	1
Macropus rufus	1
Mormopterus beccarii	1
Nyctophilus geoffroyi	1
Pseudomys chapmani	1
Saccolaimus flaviventris	4
Scotorepens greyii	3
Taphozous georgianus	3
Vespadelus finlaysoni	4
Vulpes vulpes	1
Reptiles	
Acanthophis wellsi	1
Carlia munda	1
Ctenophorus caudicinctus	4
Ctenophorus isolepis subsp. isolepis	1
Diporiphora valens	1
Diporiphora winneckei	1
Eremiascincus richardsonii	1
Heteronotia binoei	1
Lerista muelleri	1
Amphibolurus longirostris	2
Menetia greyii	1
Pogona minor subsp. minor	1
Pseudonaja modesta	1
Rhynchoedura ornata	1
Tyto alba	1
Varanus panoptes subsp. panoptes	1

APPENDIX G

INFORMATION ON FAUNA SPECIES OF CONSERVATION IMPORTANCE

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX G

Information on Fauna Species of Conservation Importance

CI 1: Northern Quoll, *Dasyurus hallucatus*
Conservation Status: Endangered (EPBC Act 1999), Near Threatened (IUCN Red List 2006).
Description: The size of a large rat or kitten, the Northern Quoll is the smallest of the quolls having a head and body length of between 125mm and 310mm, with a tail length of between 180mm and 340mm long tail. It weighs between 300g and 1000g, with males larger than females. The Northern Quoll has grey-brown to brown fur, with white spots covering its back, but not its tail. The tail has little fur, and the quoll has cream, white, or grey fur on its underside. The head is long and pointed, with large eyes and ears. The Northern Quoll has five toes on its hindfeet, with furrowed pads, the first toe lacking a claw. Active mostly at night, Northern Quolls are carnivorous and can be quite aggressive. They are known as good climbers, although they spend most of their time on the ground.
Preferred Habitat: Originally the Northern Quoll could be found across the northern part of Australia, however, its current range is far smaller. It is known to exist in the Hamersley Range and the north Kimberley, the north and western Northern Territory, northern Cape York, the Atherton-Cairns area and the Carnarvon Range-Bowen area. This species is more commonly found in rocky Eucalypt woodland, but is known to inhabit broken or rocky areas in open forests, savanna and woodlands, usually within 150-200km of the coast. The Northern Quoll is often attracted to areas inhabited by humans, with one recently being identified at the Redmont Line Camp and Mount Whaleback minesite. This species dens in hollow trees (particularly Eucalypts), hollow logs, crevices, and holes in termite mounds, with more successful breeding populations occurring near creek lines.
Threatening Processes: Locally common, but absent from its former range. Areas where Cane toads occur have seen a rapid decline in Northern Quoll populations. In addition, the introduction of cats and foxes has attributed to the decline of this species.
Previous Records: • Western Australian Museum Records
References and Further Reading: • Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales. • Department of the Environment and Water Resources (2007) *Northern Quoll Dasyurus hallucatus* in Species Profile and Threats Database, Department of the Environment and Water Resources, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tsd05northern-quoll.html#download Accessed 5th June 2007. • Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne. • Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney. • Western Australian Museum. (2003) *Dasyurus hallucatus,* Western Australian Museum.

Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 1: Mulgara, *Dasycercus cristicauda*
Conservation Status: Vulnerable (EPBC Act 1999), Vulnerable (IUCN Red List 2006), Schedule 1 (WC Act 1950).
Description: The Mulgara is light sandy brown in colour with a lighter greyish white underneath. It has reddish hair on the base of its tail which tapers to long black hairs on the distal two-thirds. This species is consisted to be stocky with small limbs. It has a broad head with a pointed muzzle and short rounded ears.
Preferred Habitat: The Mulgara inhabits arid sandy areas within hummock grasslands, or Mulga shrublands on loamy sand. This species lives in burrows dug on the flats between low sand dunes.
Threatening Processes: The introduction of cats and foxes has contributed to the decline of this species. Where fox and cat controls have been put into place, there is evidence that the numbers of Mulgara's have increased.
Previous Records: • Western Australian Museum Records • Cattle Gorge Biological Survey (*ecologia* Environment 2005)
References and Further Reading: • Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales. • Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne. • Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.

CI 1: Black-footed Rocky-wallaby, *Petrogale lateralis lateralis*

Conservation Status: Vulnerable (EPBC Act 1999), Vulnerable (IUCN Red List 2006).

Description: The Black-footed Rock-wallaby is very similar in appearance to the Rothschild's Rock-wallaby. The Black-footed species consists of six genetically distinct forms. *Petrogale lateralis lateralis* is the Western Australian form and has a head and body length of 450-530mm with a tail measuring between 410mm and 605mm. Individuals weigh between 3.1kg and 5kg, with the males being larger than females.

This species is characterised by dark grey-brown colour with a paler chest, becoming dark brown on the stomach. The Black-footed Rock-wallaby's face is dark with white or sandy coloured markings on the cheeks and light brown patches near the ears. This wallaby feature a dark brown or black dorsal stripe that extends from between the ears to beyond the shoulders. They have a white side stripe, followed by a wider dark brown stripe. As the name suggests, the tips of the Black-footed Rock-wallaby's feet are black, while the rest of the foot is a sandy colour, similar to the arms and paws which are sandy, becoming darker brown or black towards the paw. They have a brown-grey coloured tail, becoming black.

The Black-footed Rock-wallaby is predominantly nocturnal and considered shy; it rarely goes far from shelter.

Preferred Habitat: The Black-footed Rock-wallaby can be found in crevices and caves, sunning themselves when it is cool and sheltering from the heat during summer.

Individuals inhabit granite outcrops, in particular those with mallee scrub, but also occupy other scrub and tussock grassland.

Threatening Processes: The Black-footed Rock-wallaby's decline in Western Australia is said to have been drastic. This is thought to be largely a result of predation by Foxes, however, where foxes have been controlled, Black-footed Rock-wallaby populations are thriving.

Previous Records:

- Western Australian Museum Records

References and Further Reading:

- Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales.
- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.
- Western Australian Museum. (2003) *Petrogale lateralis lateralis,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [5 June 2007].

CI 1: Ghost Bat, *Macroderma gigas*

Conservation Status: Vulnerable (IUCN Red List 2006), Priority 4 (DEC).

Description: The Ghost Bat has a wingspan of 500mm and is Australia's only carnivorous bat. It has a head and body measurement of between 98mm and 130mm and weighs between 74g and 165g.

The dorsal part of the body is a mid to pale grey in colour, with a lighter grey to white ventral side and head. The Ghost Bat's muzzle and ears are a pale brown.

The Ghost Bat has no tail, but retains a full tail membrane between its legs and features large ears which are joined above the head.

Preferred Habitat: Active mainly at night, Ghost Bats roost in caves, rock fissures and mines with multiple openings during the day, hanging 2m above the ground, 25cm apart from one another. Usually their foraging grounds are within 2km of their roost sites, namely in rainforests, wet and dry sclerophyll forests and arid woodlands. They can be found in the northern part of Australia, namely the Pilbara and Kimberley, the northern part of the Northern Territory and north-east Queensland.

Threatening Processes: The Ghost Bat's distribution is such that its decline is open to some speculation. It is sensitive to disturbance and the few large colonies that do exist need to be managed carefully.

Predominantly, this species is at risk from the loss of suitable roosting sites due to mining.

Previous Records:

- Western Australian Museum Records
- Orebody 24 Biological Survey (ENV 2006)
- West Angelas Rail Corridor Survey (*ecologia* Environment 1998)

References and Further Reading:

- Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales.
- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.
- Western Australian Museum. (2003) *Macroderma gigas,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 1: Orange Leafnosed-bat, *Rhinonicteris aurantius*
Conservation Status: Vulnerable (DEC), Vulnerable (EPBC Act 1999), Schedule 1 (WC Act 1950).
Description: The fur of the Orange Leafnosed-bat is uniformly orange in colour, occasionally can appear darkened by brown-tipped hairs, with darker fur around the eyes. Its noseleaf is broad at the lower section with the central gap at the front and the upper section scalloped. The ears of this species are short and acutely pointed.
Preferred Habitat: They prefer warm humid caves, although some have been found in hollow tree trunks and roost together in colonies that can be as small as 20 or as large as a few thousand bats.
Threatening Processes: Vulnerable to disturbance from human visitors to roost caves, destruction of caves by mining, and loss of feeding habitat by clearing and land degradation from agriculture.
Previous Records: • Western Australian Museum Records • Nimingarra Project Biological Survey (*ecologia* Environment 2005) • Cattle Gorge Biological Survey (*ecologia* Environment 2005) • Area C R-Deposit Biological Survey (ENV 2006)
References and Further Reading: • Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales. • Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne. • Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney. • Australian Museum (1999) *Bats in Australia – The Orange Leafed-nosed Bat*, Available from: http://www.austmus.gov.au/bats/records/bat22.htm [18 June 2007].

CI 1: Pilbara Olive Python, *Liasis olivaceus barroni*

Conservation Status: Vulnerable (EPBC Act 1999), Schedule 1 (WC Act 1950).

Description: The Pilbara Olive Python grows up to 6.5m long, has no pattern, and is a dull olive-grey colour with cream or white ventral surfaces. The Pilbara subspecies is distinguished by having 58-63 midbody scale rows as opposed to 61-72 midbody scale of the *Liasis olivaceus olivaceus,* which is found in the Kimberley. The Pilbara Olive Python can be further distinguished from the more common subspecies by the number of ventral scales. *Liasis olivaceus olivaceus* has 321-377, whereas the *Liasis olivaceus barroni* has 374-411.

Preferred Habitat: The Pilbara Olive Python inhabits deep gorges, rocky outcrops and water holes within the Pilbara region. It has been located on the Burrup Peninsula, the Ord Ranges and Meentheena, Nanutarra and Newman and another population is located on Mount Augustus in the Gascoyne.

Threatening Processes: Due to its specific habitat requirements, the Pilbara Olive Python is threatened by the destruction of habitat from mining activities within the Pilbara.

Previous Records:

- Western Australian Museum Records
- Marillana Creek Biological Survey (*ecologia* Environment 1999)
- Orebody 24 Biological Survey (ENV 2006)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Department of the Environment and Water Resources (2007) *Liasis olivaceus barroni* in Species Profile and Threats Database, Department of the Environment and Water Resources, Canberra. Available from: http://www.environment.gov.au/sprat. [5 May 2007].
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) Snakes *of Western Australia: Skinks*. Western Australian Museum, Perth.
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.
- Western Australian Museum. (2003) *Macroderma gigas,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 1: Peregrine Falcon, *Falco peregrinus*

Conservation Status: Schedule 4 (WC Act 1950).

Description: Head and cheeks dark in colour giving the bird a hooded appearance. The underparts are creamy in colour with the dorsal surface being a blue-grey colour. In flight the Peregrine Falcon soars with wings rigidly outstretched. When hunting, the falcon will soar to great heights and dive steeply at speed into either wing of its prey. They are able to reach speeds of up to 200mph while diving and are considered the fastest animal on the planet. It is due to this hunting dive the Peregrine Falcon has been a favourite with falconers for centuries (Australian Museum 2003).

Preferred Habitat: Peregrine Falcons can be found in most land types, preferring cliffs for nesting, however, trees and tree hollows are also suitable nesting sites. While no reliable published reports have indicated that Australian Falcon's build their own nest, it is believed that disused stick nests of other species are used.

Threatening Processes: The use of DDT in the 1960s and 1970s has had the greatest influence on the decline of the Peregrine Falcon throughout Australia. The biomagnification of DDT within the environment resulted in top order predators, like the Peregrine Falcon, having the greatest quantity of the toxin in their body tissues. The DDT resulted in the thinning of the falcon's egg shells, resulting in fewer young. Like most birds of prey, the Peregrine Falcon has a long life span and low reproductive rates, which helped mask the problem caused by DDT. Since the use of DDT is now restricted, the major threat that the falcon faces is the destruction of habitat, particularly in areas where there are no cliff faces and nesting occurs in trees. Accidental poisoning through baiting for dingos is also a threat to this falcon.

Previous Records:

- Orebody 25 Biological Survey (*ecologia* Environment 1995)
- Mount Whaleback Biological Survey (*ecologia* Environment 1997/1998)
- Weeli Wolli Biological Survey (*ecologia* Environment 1998)
- Area C Biological Survey (*ecologia* Environment 1998)

References and Further Reading:

- Australian Museum (2003) *Wild Kids – Birds: Peregrine Falcon.* Available from http://www.amonline.net.au/wild_kids/birds/perigrine_falcon.htm [7 June 2007].
- Department of the Environment and Water Resources (2007) *The Peregrine Falcon* (*Falco peregrinus*) *in Species Profile and Threats Database*, Department of the Environment and Water Resources, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/peregrine-fact.html [5 June 2007].
- Simpson, K. & Day, N. (2004) *Birds of Australia*. Penguin Group, Victoria.
- Storr, G. M. & Johnstone, R. E. (2004) *A Field Guide to the Birds of Western Australia*. Western Australian Museum, Perth.
- Western Australian Museum. (2003) *Macroderma gigas,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 1: Night Parrot, *Pezoporus occidentalis*

Conservation Status: Schedule 1 (WC Act 1950), Critically Endangered (IUCN Red List 2006), Endangered (EPBC Act 1999).

Description: The Night Parrot has a body length of between 220mm to 260mm and is more rotund than the Ground Parrot (*Pezoporus wallicus*), to which it is quite similar in appearance. The dorsal surface is a dull yellow-green colour, mottled with black or dark brown. The ventral surface is a yellow colour and it features a markedly shorter tail than the Ground Parrot. Juvenile Night Parrots have a more brown coloration, particularly on the head and neck regions.

Preferred Habitat: The Night Parrot has been recorded so sporadically and infrequently that there is some conjecture as to its preferred habitat. The majority of recordings come from areas with *Triodia* hummock grasslands or chenopod shrublands, however, more recent recordings have been made in *Astrebla* grasslands with scattered chenopods. This species is also thought to inhabit inland plains, breakaways and samphire flats.

Threatening Processes: Key threatening processes as defined by the EPBC Act 1999 for this species include predation by feral cats and the European Red Fox, as well as a beak and feather disease that affects endangered *Psittacine* species.

It is also thought that feral cats, a change in fire regimes, increased competition for food, degradation of potential habitat by stock and rabbits and a reduction in available water sources are to blame for the Night Parrot's decline.

Previous Records:

- Western Australian Museum Records

References and Further Reading:

- Garnett, S. T. & Crowley, G. M. (2000) *The Action Plan for Australian Birds 2000,* Environment Australia.
- Olsen, P., Silcocks, A. & Weston, M. (2006) *The State of Australia's Birds 2006: Invasive Species*. Available from: http://www.birdsaustralia.com.au/soab/SOAB2006.pdf [3 June 2007].
- Simpson, K. & Day, N. (2004) *Birds of Australia*. Penguin Group, Victoria.
- Storr, G. M. & Johnstone, R. E. (2004) *A Field Guide to the Birds of Western Australia*. Western Australian Museum, Perth.
- Western Australian Museum. (2003) *Pezoporus occidentalis,* Western Australian Museum. Available from:http://www.museum.wa.gov.au/faunabase/ [7 June 2007].

CI 2: Long-tailed Dunnart, *Sminthopis longicaudata*

Conservation Status: Priority 4 (DEC).

Description: The Long-tailed Dunnart is the only dunnart which has a tail at least twice the length of the head and body combined. The combined head and body length is between 66mm and 70mm and the tail length is between 180mm and 210mm. An adult weighs between 15g and 20g and has a grey dorsal surface with a cream or white ventral surface. The legs and feet are also white and the feet have striated pads. The tail is covered with short hairs and terminates with a tuft of long hairs.

Preferred Habitat: The Long-tailed Dunnart is restricted to rugged rocky areas with hummock grasses and shrubs.

Threatening Processes: Due to limited information regarding the biology of the Long-tailed Dunnart and its distribution, it is hard to accurately identify specific threatening processes. Potential threats include destruction of habitat by fire and the grazing animals. The introduction of buffel grass and predators like the fox and cat also pose a threat.

Previous Records:

- Western Australian Museum Database
- Mount Whaleback Biological Survey (*ecologia* Environment 1997/1998)

References and Further Reading:

- Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales.
- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.
- Western Australian Museum. (2003) *Sminthopis longicaudata,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 2: Spectacled Hare-wallaby, *Lagorchestes conspicillatus leichardti*

Conservation Status: Priority 3 (DEC).

Description: The Spectacled Hare-wallaby has a head and body length of between 400mm and 470mm, and weighs between 1.5kg and 4.5kg. The back is brown with white tipped hair and the belly is white. Its fur is shaggy giving the wallaby a grizzled look. The ears are pointed with silvery edges and orange patches at the base. Orange patches around the eyes, extending back towards the base of the ears, are present. There is a distinctive white colouration under the nose.

Preferred Habitat: The Spectacled Hare-wallaby requires tropical tussock or hummock grasslands with mid-dense tree and shrub cover. The Spectacled Hare-wallaby tunnels into large Spinifex hummocks to escape the heat of the day.

Threatening Processes: Destruction of habitat and the introduction of feral cats are the greatest threat to the Spectacled Hare-wallaby. The burning of hummock grassland by station owners has prevented large spinifex hummocks from developing. These hummocks are used by this Hare-wallaby to keep cool during the day.

Previous Records:

- Western Australian Museum Records

References and Further Reading:

- Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales.
- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.
- Western Australian Museum. (2003) *Lagorchestes conspicillatus leichardti,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 2: Lakeland Downs Mouse, *Leggadina lakedownensis*

Conservation Status: Priority 4 (DEC), Low Risk/Near Threatened (IUCN Red List 2006).

Description: The Lakeland Downs Mouse is a secretive mouse found in the Pilbara, Kimberley and Cape York Peninsula. It has a head and body length between 600mm and 750mm, with a tail length between 400mm and 450mm. Similar to *Leggadina forresti*, this species is grey-brown on the dorsal surface and white on the ventral surface, with small ears. The features of this species which distinguish this species from *Leggadina forresti* are, wider incisive foramina posteriorly and upper incisors which point forward.

Preferred Habitat: The Lakeland Downs Mouse is found mostly in damp grasslands or tropical savannah. However, in the Pilbara it is likely to be found within hummock grassland.

Threatening Processes: Due to its rarity, not enough is known about the biology of Lakeland Downs Mouse.

Previous Records:

- Western Australian Museum Records

References and Further Reading:

- Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales.
- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.
- Western Australian Museum. (2003) *Leggadina lakedownensis,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 2: Western Pebble-mound Mouse, *Pseudomys chapmani*

Conservation Status: Priority 4 (DEC).

Description: The Western Pebble-mound Mouse has a head and body length between 52mm and 67mm with a tail length of about 75mm. The head, back and sides are a buff brown, with a white belly and a white throat and mouth. The head is long and flat with small eyes, short ears and a narrow muzzle. The tail is clearly longer than the total head and body length.

Preferred Habitat: The Western Pebble-mound Mouse is endemic to the Pilbara region of Western Australia. The pebble-mounds it builds can usually be found on stony hillsides with hummock grassland, often on the lower slopes of rocky hills and on spurs.

Threatening Processes: Limited information on the Western Pebble-mound Mouse lead to it being classed as endangered. It has since been removed from the endangered list, but due to little being known about the mouse and its biology it is still listed as a Priority species by the DEC.

Previous Records:

- Western Australian Museum Records
- Orebody 25 Biological Survey (*ecologia* Environment 1995)
- Orebody 18 Biological Survey (*ecologia* Environment 1995)
- Jimblebar Biological Survey (*ecologia* Environment 1995)
- East Angelas Biological Survey (*ecologia* Environment 1995)
- Mount Whaleback Biological Survey (*ecologia* Environment 1997/1998)
- Weeli Wolli Biological Survey (*ecologia* Environment 1998)
- West Angelas Biological Survey (*ecologia* Environment 1998)
- Mining Area C Biological Survey (*ecologia* Environment 1998)
- Marillana Creek Biological Survey (HGM 1999)
- Packsaddle Range Biological Survey (*ecologia* Environment 2004)
- Area C - Deposits D, E, and F Biological Survey (*ecologia* Environment 2004)
- Wheelarra Hill Biological Survey (*ecologia* Environment 2004)
- Orebody 24 Biological Survey (ENV 2006)
- Area C R-Deposit Biological Survey (Phase II) (ENV 2006)
- Marillana Creek Biological Survey (*ecologia* Environment 2006)

References and Further Reading:

- Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales.
- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.
- Western Australian Museum. (2003) *Pseudomys chapmani,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [5 June 2007].

Cl 2: Unpatterned Robust Lerista, *Lerista macropisthopus remota*
Conservation Status: Priority 2 (DEC).
Description: A large *Lerista* with a snout-vent length of between 37mm and 96mm and total length up to 190mm. This species usually has two (occasionally one) digits on the forelimbs and three (occasionally two) digits on hindlimbs with dark stippling on the head and rows of brown spots on the back. An identifying feature of this *Lerista* is its lower eyelid which is moveable.
Preferred Habitat: *Lerista macropisthopus remota* is found within the leaf litter of Acacia shrublands and woodlands in semi-arid to arid regions of Western Australia. Usually, it is located in the loose soil found at the base of shrubs in a wide variety of soils.
Threatening Processes: unknown.
Previous Records: • Western Australian Museum Database • Mount Whaleback Biological Survey (*ecologia* Environment 1997/1998)
References and Further Reading: • Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney. • Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) *Lizards of Western Australia: Skinks*. Western Australian Museum, Perth. • Western Australian Museum. (2003) *Lerista macropisthopus remota,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [5 June 2007]. • Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.

CI 2: Blind Snake, *Ramphotyphlops ganei*

Conservation Status: Priority 1 (DEC).

Description: A robust blind snake with a total length of up to 335mm. It has a blunt foreshortened head and rounded snout, both in profile and from above. The nasal cleft extends to make contact with the labial scale on top of the head. Its colouration is grey-brown on the dorsal side and a cream colour on the ventral side. The eyes are moderately large and widely spaced on upper surface of the head.

Preferred Habitat: The blind snake, *Ramphotyphlops ganei,* is likely to be found within gorges and gullies.

Threatening Processes: Very few collections have been made of this species and little is known about its biology.

Previous Records:

- Western Australian Museum Database
- Orebody 24 Biological Survey (ENV 2006)
- Orebody 18 Biological Survey (ENV 2006)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) Snakes *of Western Australia: Skinks*. Western Australian Museum, Perth.
- Western Australian Museum. (2003) *Ramphotyphlops ganei,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [5 June 2007].
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.

CI 2: Grey Falcon, *Falco hypoleucos*

Conservation Status: Priority 4 (DEC).

Description: This species is grey dorsally with black wing tips and black streaks under eyes. On the ventral side it is white in colouration with fine dark streaks and the underwings barred. The cere, feet and eye-ring are yellow. It is similar to the Peregrine Falcon in flight, with stiffly outstretched wings, although, the Grey Falcon has a greater wingspan. Body length is between 300mm and 450mm with a wing span between 850mm and 950mm.

Preferred Habitat: They Grey Falcon is endemic to Australia and can be found within arid zones of Australia. Typically, it occurs in areas with woodland and scrub vegetation types. They are also known to occur in areas with wetlands where surface water attracts prey like pigeons and parrots. Grey Falcons, like other Australian Falcons, make use of the old nests of other birds of prey and ravens. Grey Falcon nests are usually located in Eucalyptus trees located along watercourses.

Threatening Processes: Grazing and clearing of arid and semi-arid regions have been recognised as a threat to Grey Falcons, together with secondary poisoning through baiting programs used to control dingoes, mice and locusts. The taking of eggs for falconry collection also poses a threat.

Previous Records:

- Western Australian Museum Database
- Packsaddle Range Biological Survey (*ecologia* Environment 2004)
- Roy Hill Biological Survey (ENV 2007)

References and Further Reading:

- Department of Environment and Climate Change NSW (2005) *Grey Falcon – profile*. Available from: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10330 [5 June 2007].
- Simpson, K. & Day, N. (2004) *Birds of Australia*. Penguin Group, Victoria.
- Storr, G. M. & Johnstone, R. E. (2004) *A Field Guide to the Birds of Western Australia*. Western Australian Museum, Perth.

CI 2: Australian Bustard, *Ardeotis australis*

Conservation Status: Priority 4 (DEC), Near Threatened (IUCN Red List 2006).

Description: The male Bustard stands at 100cm high, while the female stands at 70cm, with body lengths of between 105cm and 120cm, and 75cm and 90cm, respectively. The male Australian Bustard features a black crown with white eyebrows and neck with faint grey markings. The back, wings and tail are brown in colour with fine buff marks, whilst the underwing coverts are black and white. A black band is featured on the breast, with the bird's underparts being grey. The female is similar in colour, although it has a narrow, brown crown and a less visible neck band. The female also has an off-white to grey coloured neck and breast and is less black and white on the wing.

A ground dwelling bird, the Australian Bustard is often seen standing motionless with its neck outstretched, pointing upwards.

Preferred Habitat: The Australian Bustard can be found throughout most of the northern half of Australia and Southern New Guinea, namely, in open or lightly wooded areas, such as tropical open grasslands, grassy woodlands, pastoral land and crops. It prefers making its home in the understorey, so clearing land for pastoral applications is particularly detrimental to this species.

Threatening Processes: Between 1977 and 1981, the first national atlas of Australian birds was compiled, with a more recent edition consisting of survey work conducted between 1998 and 2002. In the 20 years between volumes there was been a decrease of up to 49% in the number of Australian Bustard's that were reported (Olsen, 2004)

Principally, it is thought that predation by foxes and loss or degradation of habitat is to blame for the Australian Bustard's decline, however, unmonitored illegal hunting is also likely to be a contributing factor. The species is now considered extinct in south eastern Australia.

Previous Records:

- Western Australian Museum Records
- Orebody 18 Biological Survey (*ecologia* Environment 1995)
- Mount Whaleback Biological Survey (Phases I and II) (*ecologia* Environment 1997/1998)
- West Angelas Rail Corridor Survey (*ecologia* Environment 1998)
- Mining Area C Biological Survey (*ecologia* Environment 1998)
- East Jimblebar Biological Survey (*ecologia* Environment 2005)
- Area C R-Deposit Biological Survey (Phase II) (ENV 2006)

References and Further Reading:

- Department of Environment and Climate Change NSW. (2005) *Australian Bustard – profile*. Available from: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile [30 May 2007].
- Barrett, G., Silcocks, A., Barry, S., Cunningham, R. & Poulter, R. (2003) *The New Atlas of Australian Birds*. Royal Australasian Ornithologists Union, Victoria.
- Olsen, P. & Weston, M. (2004) *The State of Australia's Birds 2004: Water, Wetlands, and Birds.* Available from: http://www.environment.gov.au/biodiversity/publications/birds-04/pubs/birds-04.pdf [30 May 2007].
- Olsen, P., Weston, M., Tzaros, C. & Silcocks, A. (2005) *The State of Australia's Birds 2005: Woodlands and Birds*. Available from:

http://www.birdsaustralia.com.au/soab/SOAB2005.pdf [30 May 2007].

- Simpson, K. & Day, N. (2004) *Birds of Australia*. Penguin Group, Victoria.
- Storr, G. M. & Johnstone, R. E. (2004) *A Field Guide to the Birds of Western Australia*. Western Australian Museum, Perth.
- Western Australian Museum. (2003) *Ardeotis australis,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [30 May 2007].

CI 2: Bush Stone-curlew, *Burhinus grallarius*

Conservation Status: Priority 4 (DEC), Near Threatened (IUCN Red List 2006).

Description: The Bush Stone-curlew is a nocturnal bird that stands at between 500mm and 600mm in height. The upper parts of the body are grey-brown in colour with tan-white underparts. This species has a black eye-stripe through to the neck and a medium black bill. They have lanky legs and move rigidly. To avoid detection from predators the Bush-stone Curlew crouches down and freezes in position.

Preferred Habitat: Generally, the Bush Stone-curlew is found in grassy woodlands and likes habitat with sparse grassy understorey. Leaf litter and branches on the ground are essential for the birds camouflage and are associated with nesting areas. Nests are usually located next to fallen logs, which help hide the bird form possible predators.

Threatening Processes: The introduction of the European Fox and the presence of cats has facilitated the decline of the Bush Stone-curlew. Since this bird builds its nests on the ground it is vulnerable to attack. The presence of predators also make nesting less successful. In the south of Australia the decline of this bird can be attributed to the introduction of predators, as well as the clearing and fragmentation of suitable habitat. Their reliance on fallen logs and timber for nesting makes them particularly sensitive to the effects of clearing.

Previous Records:

- Western Australian Museum Database
- Wheelarra Hill Biological Survey (*ecologia* Environment 2004)
- Orebody 18 Biological Survey (ENV 2006)
- Roy Hill Biological Survey (ENV 2007)

References and Further Reading:

- Department of Government and Water Resources (2007) Bush stone-curlew *Burhinus grallarius*, Department of Government and Water Resources. Available from http://www.environment.gov.au/biodiversity/threatened/publications/tsd05bush-stone-curlew.html [5 June 2007].
- Simpson, K. & Day, N. (2004) *Birds of Australia*. Penguin Group, Victoria.
- Storr, G. M. & Johnstone, R. E. (2004) *A Field Guide to the Birds of Western Australia*. Western Australian Museum, Perth.
- Western Australian Museum. (2003) *Burhinus grallarius,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 2: Flock Bronzewing, *Phaps histrionica*

Conservation Status: Priority 4 (DEC).

Description: The Flock Bronzewing is a medium-sized plump pigeon which has long pointed wings and a short rounded tail. Adult males have a sandy brown back, blue grey belly and a distinctive black and white head and neck. Adult females are duller and generally have the same patterning. The species is usually silent, however a soft *cooo* can be heard in flocks on the ground while a *wok* sound is produced by adult males during mating displays. The Flock Bronzewing is highly nomadic. The pigeon has a body length of between 280mm and 310mm, wing length between 200mm and 208mm, tail length between 79mm and 87mm, bill length of between 17mm and 18mm and a weight of approximately 300g.

Preferred Habitat: Arid zone grasslands, open woodland and plains, occasionally extending into other surrounding areas. As this species needs to drink daily, it is often found near water bodies.

Threatening Processes: Grazing by livestock and rabbits causes habitat degradation for it removes grass coverage that provides habitat and shelter for the Flock Bronzewing. In addition, trampling of nests by livestock when this species is nesting within grasses. Predation by cats and foxes is also a threat to this species, particularly when nesting.

Previous Records:

- Western Australian Fauna Base

References and Further Reading:

- Barrett, G., Silcocks, A., Barry, S., Cunningham, R. & Poulter, R. (2003) *The New Atlas of Australian Birds*. Royal Australasian Ornithologists Union, Victoria.
- NSW National Parks and Wildlife Service. (1999) *Flock Bronzewing*, NSW National Parks and Wildlife Service: NSW. Available from: http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_flock_bronzewing.pdf

CI 2: Star Finch, *Neochmia ruficauda subclarescens*

Conservation Status: Priority 4 (DEC).

Description: The Star Finch stands at between 100mm to 120mm. Adults have a red face with dark olive colouration above and yellow-olive colouration below. The females head is a paler red in comparison to the males and restricted to the forehead, lores and eye rings. The upper tail coverts are a dull red colour. The chest, flanks, rump and tail are all roughly spotted white, giving the appearance of stars after which the bird is named.

Preferred Habitat: The Star Finch inhabits long grasses, sedges and rushes near water bodies.

Threatening Processes: The introduction of cattle and sheep into areas that are populated by Star Finches has resulted in the destruction of their habitat. Star Finches rely on grasses and rushes often located around water bodies. Introduced grazing animals tend to trample and destroy this habitat when moving to water bodies to drink.

Previous Records:

- Western Australian Museum Database
- Weeli Wolli Biological Survey (*ecologia* Environment 1998)
- Marillana Creek Biological Survey (HGM 1999)
- Packsaddle Range Biological Survey (*ecologia* Environment 2004)
- Area C Biological Survey (*ecologia* Environment 2004)
- Orebody 24 Biological Survey (ENV 2006)
- Mindy North Biological Survey (ENV 2007)
- Mindy East/Coondiner Biological Survey (ENV 2007)
- Roy Hill Biological Survey (ENV 2007)

References and Further Reading:

- Department of Environment and Climate Change NSW. (2005) *National recovery plan for the white-bellied subspecies of the crimson finch Neochmia phaeton evangelinae and the northernsubspecies of the star finch Neochmia ruficauda clarescens.* Available from: http://www.environment.gov.au/biodiversity/threatened/publications/pubs/crimson-star-finch.pdf [6 June 2007].
- Simpson, K. & Day, N. (2004) *Birds of Australia*. Penguin Group, Victoria.
- Storr, G. M. & Johnstone, R. E. (2004) *A Field Guide to the Birds of Western Australia*. Western Australian Museum, Perth.
- Western Australian Museum. (2003) *Ardeotis australis,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

CI 3: Pilbara Ningaui, *Ningaui timealeyi*

Conservation Status: Endemic to the Pilbara region of Western Australia, with limited number of recordings (WAM 2003).

Description: The species has a head body length of between 45mm to 58mm, tail length between 60mm to 76mm and a weight of between 0.5g and 9.4g. Narrow muzzle with small, close-set eyes, ears barely protrude above fur of the crown and a tail which is greater than the head-body length. Fur gingery-brown to greyish-brown on the upper body with distinct protruding black guard hairs. Whitish underparts with a rufous wash across the face, ears and flanks.

Preferred Habitat: Inhabits dense to mid-dense hummock grassland, usually along drainage lines or runoff areas, with an upper-storey of open mallee or acacia scrub.

Threatening Processes: Altered fire regimes, grazing by introduced herbivores, introduced predators and weed invasion.

Previous Records:

- Western Australian Museum Database
- Orebody 18 (ecologia Environment 1995)
- Mining Area C (ecologia Environment 1998)
- Mount Whaleback Phase II (ecologia Environment 1998)
- West Angelas (ecologia Environment 1998)
- Jimblebar Wheelarra Hill (ecologia Environment 2004)
- Area C deposits D, E, and F(ecologia Environment 2004)
- Marillana (ecologia Environment 2006)
- R-Deposit Phase II (ENV 2006)

References and Further Reading:

- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Outback Ecology. (2006) *Spinifex Ridge Molybdenum Project: Terrestrial Vertebrate Fauna Baseline Surveys*. Outback Ecology: Australia.

CI 3: Common Rock-rat, *Zyzomys argurus*

Conservation Status: Endemic to the Pilbara region of Western Australia.

Description: The Common Rock-rat will usually be clay brown to brown on the dorsal side with white below. This species is distinguished from other *Zyzomys* due to their smaller slender body size and lightly haired tail.

Preferred Habitat: The Common Rock-rat is usually associated with rocky outcrops such as gorges, gullies and breakaways. The rocks provide the cover required for nesting and protection as they are not known for burrowing in hard soils. The vegetation can vary from riverine species to spinifex covering scree slopes.

Threatening Processes: As this species is endemic to the Pilbara region, it will be impacted to some degree by future habitat destruction. Such as vegetation clearing, fire.

Previous Records:

- Western Australian Museum Records
- Mons Cupri Copper Mine Biological Survey *(ecologia* Environment 1991)
- East Angelas Biological Survey (*ecologia* Environment 1995)
- Orebody 18 Biological Survey (*ecologia* Environment 1995)
- Mount Whaleback Biological Survey (*ecologia* Environment 1997/1998)
- West Angelas Biological Survey (*ecologia* Environment 1998)
- Mining Area C Biological Survey (*ecologia* Environment 1998)
- Area C - Deposits D, E, and F Biological Survey (*ecologia* Environment 2004)
- Wheelarra Hill Biological Survey (*ecologia* Environment 2004)
- Sunrise Hill Biological Survey (*ecologia* Environment 2005)
- Nimingarra Project Biological Survey (*ecologia* Environment 2005)
- Yarrie Biological Survey (*ecologia* Environment 2005)
- Cattle Gorge Biological Survey (*ecologia* Environment 2005)
- Whim Creek Copper Project Biological Survey (Phase II) (ENV 2006)
- Orebody 24 Biological Survey (ENV 2006)
- Orebody 18 phase II Biological Survey (ENV 2006)
- Area C R-Deposit Biological Survey (ENV 2006)
- Ophthalmia Biological Survey Biological Survey (ENV 2007)
- Roy Hill Biological Survey Biological Survey (ENV 2007)
- Ord Ridley Biological Survey (ENV 2007)

References and Further Reading:

- Cronin, L. (2000) *Key Guide to Australian Mammals*. Envirobook, New South Wales.
- Menkhorst, P. & Knight, F. (2004) *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Strahan, R. (2004) *The Mammals of Australia*. Reed New Holland, Sydney.

Cl 3: Gecko, *Diplodactylus wombeyi*

Conservation Status: Endemic to the Pilbara region of Western Australia, with limited number of recordings (WAM 2003).

Description: A slender long tailed Gecko species that is usually pale (almost translucent) to dark reddish brown above, with a series of darker reddish-brown markings tending to form a series of broken cross-bands or reticulations. The reddish brown flanks and limbs are often finely spotted with a series of prominent pale white dots.

Preferred Habitat: *Diplodactylus wombeyi* is usually a rock dwelling species that is often found on spinifex covered stony hills, scree slopes and small breakaways.

Threatening Processes: Given the restricted distribution of *Diplodactylus wombeyi* in the Pilbara, future habitat destruction may have some impact upon this species.

Previous Records:

- Western Australian Museum Database
- Mount Whaleback Biological Survey (*ecologia* Environment 1997/1998)
- Mining Area C Biological Survey (*ecologia* Environment 1998)
- Jimblebar - Wheelarra Hill Biological Survey (*ecologia* Environment 2004)
- Orebody 24 Biological Survey (Phase I) (*ecologia* Environment 2004)
- Mining Area C – R Deposit Biological Survey phase II (ENV 2006)
- Marillana Biological Survey (*ecologia* Environment 2006)
- Orebody 18 phase II Biological Survey (ENV 2006)
- Upper Marillana Fauna Assessment (ENV 2007)
- Mindy North Biological Survey (ENV 2007)
- Mindy East/Coondiner Biological Survey (ENV 2007)
- Roy Hill Biological Survey (ENV 2007)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) *Lizards of Western Australia: Skinks*. Western Australian Museum, Perth.
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.
- Western Australian Museum (2003) *Diplodactylus wombeyi,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [30 June 2007].

CI 3: Desert Cave Gecko, *Heteronotia spelea*

Conservation Status: Endemic to the Pilbara region of Western Australia, with limited number of recordings (WAM 2003).

Description: Individuals are slender and long-tailed, with tubercles in regular longitudinale rows on the dorsal surface. Yellow brown to reddish brown in colour with three prominent sharp-edged dark brown bands along the body.

Preferred Habitat: This species can be found in rocky areas; sheltering in crevices, caves or beneath rocks in ranges and outcrops within the Pilbara region.

Threatening Processes: As this species is endemic to the Pilbara region, it will be impacted to some degree by future habitat destruction.

Previous Records:

- Western Australian Museum Database
- Mount Whaleback Phase II (*ecologia* Environment 1998)
- West Angelas, (*ecologia* Environment 1998)
- Weeli Wolli (*ecologia* Environment 1998)
- Jimblebar Wheelarra Hill (*ecologia* Environment 2004)
- Area C deposits D, E, and F(*ecologia* Environment 2004)
- Orebody 18 Phase II (ENV 2006)
- Marillana (*ecologia* Environment 2006)
- R-Deposit Phase II (ENV 2006)
- Orebody 24 phase II (ENV 2006)
- Mindy North Biological Survey (ENV 2007)
- Mindy East/Coondiner Biological Survey (ENV 2007)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) *Lizards of Western Australia: Skinks*. Western Australian Museum, Perth.
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.
- Western Australian Museum (2003) *Heteronotia spelea,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [3 July 2007].

CI 3: Skink, *Lerista muelleri*

Conservation Status: Species currently under taxonomic review.

Description: *Lerista muelleri* is a small skink with a snout-vent length of 50mm. It has well developed limbs with 3 digits on the forelimbs and 3 digits on the hindlimbs. Colour and pattern can vary, although it is usually grey to brown on top with a dark upper lateral stripe. There is often a yellow-red colouring of the tail, predominantly on juveniles.

Preferred Habitat: *Lerista muelleri* is found within all mainland states within arid regions. It is found within leaf litter, under rocks, and under logs in sandy soils. This species will inhabit a variety of arid forests, woodland and shrubland vegetation types.

Threatening Processes: *Lerista muelleri* is currently under taxonomic review as it is believed that many undescribed species are included under this name (Wilson & Swan 2003).

Previous Records:

- Western Australian Museum Database
- MindyNorth/Mindy East/Coondiner (ENV 2007)
- Roy Hill Biological Survey (ENV 2007)
- Orebody 18 Biological Survey (ENV 2006)
- Weeli Wolli Biological Survey (*ecologia* Environment 1998)
- West Angelas Biological Survey (*ecologia* Environment 1998)
- Mining Area C Biological Survey (*ecologia* Environment 1998)
- Orebody 18 Biological Survey (*ecologia* Environment 1995)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) *Lizards of Western Australia: Skinks*. Western Australian Museum, Perth.
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia
- Western Australian Museum (2003) *Lerista muelleri,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [5 June 2007].

CI 3: Fire-tailed Skink, *Morethia ruficauda* subsp. *exquisita*
Conservation Status: Endemic to the Pilbara region of Western Australia, with limited number of recordings (WAM 2003).
Description: Glossy black with white dorsolateral stripes converging on the snout with a prominent white vertebral stripe. The species has a red flush on its hind-limbs, a fiery red tail and has a snout-vent length of approximately 46mm.
Preferred Habitat: Inhabits dry to arid rocky areas.
Threatening Processes: Human disturbance.
Previous Records: • Area C West (ENV 2007)
References and Further Reading: • Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.

CI 3: Pilbara Rock Monitor, *Varanus pilbarensis*

Conservation Status: Endemic to the Pilbara region of Western Australia, with limited number of recordings (WAM 2003).

Description: The species is slender with a long neck and tail. The distal half of the tail is cream with prominent, narrow, dark brown rings. The body of the monitor is pale to bright reddish brown and has transverse rows of pale greyish brown spots. The sides of the head and neck are marked by dark reddish brown mesh-like reticulations which extend onto the throat. The monitor grows to approximately 47cm long.

Preferred Habitat: Inhabits rocks, shelters in narrow crevices and patrols along exposed cliff faces, gorges and rocky hills.

Threatening Processes: Altered fire regimes, introduced predators, such as feral foxes and cats, and habitat loss.

Previous Records:

- Western Australian Museum Database
- Weeli Wolli (*ecologia* Environment 1998);
- Marillana Creek (HGM 1999);
- Orebody 24 Phase I (*ecologia* Environment 2004);
- Jimblebar Wheelarra Hill (*ecologia* Environment 2004);
- East Jimblebar (*ecologia* Environment 2005);
- Mount Whaleback Phase III (ENV 2006);
- Orebody 24 phase II (ENV 2006);
- Ministers North (ecologia Environment 2006);

References and Further Reading:

- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.
- Bamford Consulting Ecologists. (2007) Fauna Assessment of the Pardoo Direct Shipping Ore Project, Atlas Iron Limited. Bamford Consulting Ecologists, Australia.

CI 3: Blind Snake, *Ramphotyphlops ammodytes*

Conservation Status: Endemic to the Pilbara region of Western Australia, with limited number of recordings (WAM 2003).

Description: This species slender snake with highly polished, close-fitting scales of uniform size around the body. It has a rounded snout from both above and in profile. Pink to pinkish purple, merging with a pale ventral surface.

Preferred Habitat: Typically in sandy soils in arid Pilbara regions.

Threatening Processes: As this species is endemic to the Pilbara region, it will be impacted to some degree by future habitat destruction.

Previous Records:

- Western Australian Museum Database
- Roy Hill (ENV 2007)
- Mindy North Biological Survey (ENV 2007)
- Mindy East/Coondiner Biological Survey (ENV 2007)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) *Lizards of Western Australia: Skinks*. Western Australian Museum, Perth.
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.
- Western Australian Museum (2003) *Ramphotyphlops ammodytes* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [3 July 2007].

CI 3: Skink, *Carlia munda*

Conservation Status: Endemic to the Pilbara region of Western Australia, with limited number of recordings (WAM 2003).

Description: This species is a small skink, greyish brown to brown in colour with darks spots and pale flecks. It has a white midlateral stripe from the upper lip to the top of ear opening and continues back from the bottom of ear-opening towards the forelimb. The ear-openings are horizontally elongated with a few small lobules on the upper edge.

Preferred Habitat: This skink usually inhabits woodlands, shrublands or spinifex with heavy to stony soils.

Threatening Processes: As this species has a disjunct population to the Pilbara region, it may be impacted to some degree by future habitat destruction.

Previous Records:

- Western Australian Museum Database
- East Angelas (*ecologia* Environment 1995)
- Mining Area C (*ecologia* Environment 1998)
- Mount Whaleback Phase II (*ecologia* Environment 1998)
- West Angelas, (*ecologia* Environment 1998)
- Weeli Wolli (*ecologia* Environment 1998)
- Marillana Creek (HGM 1999)
- Orebody 24 Phase I (*ecologia* Environment 2004)
- Area C deposits D, E, and F(*ecologia* Environment 2004)
- Packsaddle Range, (*ecologia* Environment 2004)
- Upper Marillana (*ecologia* Environment 2005)
- Mount Whaleback Phase III (ENV 2006)
- R-Deposit Phase II (ENV 2006)
- Orebody 24 phase II (ENV 2006)
- Ophthalmia (ENV 2007)
- Roy Hill (ENV 2007)
- Mindy North Biological Survey (ENV 2007)
- Mindy East/Coondiner Biological Survey (ENV 2007)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) *Lizards of Western Australia: Skinks*. Western Australian Museum, Perth.
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.
- Western Australian Museum (2003) *Carlia munda,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [3 July 2007].

Cl 3: Pilbara Death Adder, *Acanthophis wellsi*

Conservation Status: Widespread throughout the Pilbara, however, not believed to occur elsewhere in Australia.

Description: The Pilbara Death Adder is relatively slender with weakly rugose head shields, usually undivided prefrontal scales, and body scale moderately keeled dorsally and smooth laterally in 19 midbody rows (Wilson and Swan 2003). Reddish brown and banded, either with pale bands or with black bands and head.

Preferred Habitat: Inhabits stony soil areas with Spinifex.

Threatening Processes: As this species is endemic to the Pilbara region, it will be impacted to some degree by future habitat destruction.

Previous Records:

- Western Australian Museum Database
- Ord Ridley Biological Survey (ENV 2007)

References and Further Reading:

- Cogger, H. G. (2000) *Reptiles and Amphibians of Australia.* 6th ed. Reed New Holland Publishers, Sydney.
- Storr, G. M., Smith, L. A. & Johnstone, R. E. (2002) *Lizards of Western Australia: Skinks*. Western Australian Museum, Perth.
- Wilson, S. & Swan, G. (2003) *Reptiles of Australia.* New Holland Publishers, Australia.
- Western Australian Museum (2003) *Acanthophis wellsi ,* Western Australian Museum. Available from: http://www.museum.wa.gov.au/faunabase/ [6 June 2007].

APPENDIX H

FAUNA SPECIES EXPECTED AND OBSERVED WITHIN 50 KM OF THE PROJECT AREA

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX H

FAUNA EXPECTED AND OBSERVED WITHIN 50KM OF THE YANDI HUB PROJECT AREA

Appendix H1 - Mammal species expected and observed within 50km of the Yandi Hub project area

Key: A= Western Australian Museum Records; B= East Angelas (*ecologia* Environment 1995); C= Mining Area C (*ecologia* Environment 1998); D= West Angelas (*ecologia* Environment 1998); E= Weeli Wolli (*ecologia* Environment 1998); F= Marillana Creek (HGM 1999); G= Yandi LOM (Maunsell 2003); H= Area C Deposits D, E, and F(*ecologia* Environment 2004); I= Packsaddle Range (*ecologia* Environment 2004); J= Upper Marillana (*ecologia* Environment 2005); K= Marillana (*ecologia* Environment 2006); L= R-Deposit Phase II (ENV 2006); M= Ministers North (*ecologia* Environment 2006); N= Area C West (ENV2007); O= Yandi Hub (ENV 2007).

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Tachyglossidae (Echidnas)																	
Echidna	*Tachyglossus aculeatus*	CI 5	x		x	x											
Dasyuridae (Carnivorous Marsupials)																	
Mulgara	*Dasycercus cristicauda*	CI 1	x														
Little Red Kaluta	*Dasykaluta rosamondae*	CI 5	x	x	x	x	x			x			x	x		x	x
Northern Quoll	*Dasyurus hallucatus*	CI 1	x														
Pilbara Ningaui	*Ningaui timealeyi*	CI 3	x		x	x				x			x	x			x
Wongai Ningaui	*Ningaui ridei*	CI 5					x	x									
Planigale	*Planigale* sp.	-	x	x						x			x				
Long-tailed Planigale	*Planigale ingrami*	CI 5														x	x
Common Planigale	*Planigale maculata*	CI 5		x	x		x									x	
Woolley's Pseudantechinus	*Pseudantechinus woolleyae*	CI 5	x														
Rory's Pseudantechinus	*Pseudantechinus roryi*	CI 5															
Long-tailed Dunnart	*Sminthopsis longicaudata*	CI 2	x														
Stripe-faced Dunnart	*Sminthopsis macroura*	CI 5	x	x	x	x				x							
Ooldea Dunnart	*Sminthopsis ooldea*	CI 5	x		x	x											
Lesser Hairy-footed Dunnart	*Sminthopsis youngsoni*	CI 5	x														

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Macropodidae (Kangaroos)																	
Spectacled Hare-wallaby	*Lagorchestes conspicillatus*	CI 2	x														
Euro	*Macropus robustus*	CI 5	x	x	x	x	x	x		x	x		x	x		x	
Euro	*Macropus robustus* subsp. *erubescens*	CI 5							x							x	x
Red Kangaroo	*Macropus rufus*	CI 5	x			x						x	x		x	x	x
Black-footed Rock-wallaby	*Petrogale lateralis*	CI 1	x														
Rothschilds Rock-wallaby	*Petrogale rothschildi*	CI 3	x		x		x						x		x	x	
Rock-wallaby	*Petrogale* sp.	-	x								x						
Emballonuridae (Sheathtail-bats)																	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	CI 5	x			x				x	x	x					x
Common Sheathtail-bat	*Taphozous georgianus*	CI 5	x			x				x	x	x	x	x	x	x	x
Hill's Sheathtail-bat	*Taphozous hilli*	CI 5	x		x	x										x	
Megadermatidae (Ghost bat)																	
Ghost Bat	*Macroderma gigas*	CI 1	x			x						x					
Hipposideridae (Leafnosed-bats)																	
Orange Leaf-nosed Bat	*Rhinonicteris aurantius*	CI 1	x											x			
Vespertilionidae (Ordinary Bats)																	
Gould's Wattled Bat	*Chalinolobus gouldii*	CI 5	x		x	x	x	x		x	x	x	x	x	x	x	x
Little Broad-nosed Bat	*Scotorepens greyii*	CI 5	x		x	x				x	x	x	x	x	x	x	x
Chocolate Wattled Bat	*Chalinolobus morio*	CI 5	x														
Finlayson's Cave Bat	*Vespadelus finlaysoni*	CI 5	x	x	x	x	x			x	x		x	x	x	x	x
Inland Broad-nosed Bat	*Scotorepens balstoni*	CI 5			x					x	x						
Pallid Long-eared Bat	*Nyctophilus bifax daedalus*	CI 3	x			x									x		
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	CI 5	x			x	x				x	x		x	x		x

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Molossidae (Freetail-bats)																	
Northern Freetail-bat	*Chaerephon jobensis*	CI 5	x			x	x	x				x	x	x	x	x	x
Beccaris Freetailed bat	*Mormopterus beccarii*	CI 5	x			x					x	x	x	x		x	x
Little Mastiff-bat	*Mormopterus planiceps*	CI 5	x		x		x										
White-striped Freetailed Bat	*Tadarida australia*	CI 5	x			x	x	x									
Muridae (Rodents)																	
Lakeland Downs Mouse	*Leggadina lakedownensis*	CI 2	x														
House Mouse	**Mus musculus*	-	x	x		x	x	x									x
Spinifex Hopping-mouse	*Notomys alexis*	CI 5	x										x			x	
Western Pebble-mound Mouse	*Pseudomys chapmani*	CI 2	x	x	x	x	x	x	x	x	x		x	x	x		x
Desert Mouse	*Pseudomys desertor*	CI 5	x			x								x		x	
Sandy Inland Mouse	*Pseudomys hermannsburgensis*	CI 5	x	x	x	x	x	x		x			x			x	x
Common Rock Rat	*Zyzomys argurus*	CI 3	x	x	x	x	x			x			x	x		x	x
Leporidae (Rabbits)																	
Rabbit	**Oryctolagus cuniculus*	-	x				x										
Canidae (Dingo)																	
Dingo	**Canis lupus dingo*	-	x		x			x		x	x	x				x	x
Fox	**Vulpes vulpes*	-	x														x
Felidae (Cats)																	
Feral Cat	**Felis catus*	-	x	x	x				x	x			x				x
Equidae (Horse)																	
Donkey	**Equus asinus*	-	x														
Horse	**Equus caballus*	-										x					
Camelidae (Camels)																	
Camel	**Camelus dromedarius*	-	x														x

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Bovidae (Cow)																	
European Cattle	**Bos taurus*	-	x				x	x	x				x				x

[X] fauna species recorded from within the project area. [O] fauna species recorded outside of the project area.
The conservation importance of species is noted as a CI status.
[*] denotes introduced species.

Appendix H2 - Reptile species expected and observed within 50km of the Yandi Hub project area

Key: A= Western Australian Museum Records; B= East Angelas (*ecologia* Environment 1995); C= Mining Area C (*ecologia* Environment 1998); D= West Angelas (*ecologia* Environment 1998); E= Weeli Wolli (*ecologia* Environment 1998); F= Marillana Creek (HGM 1999); G= Yandi LOM (Maunsell 2003); H= Area C Deposits D, E, and F(*ecologia* Environment 2004); I= Packsaddle Range (*ecologia* Environment 2004); J= Upper Marillana (*ecologia* Environment 2005); K= Marillana (*ecologia* Environment 2006); L= R-Deposit Phase II (ENV 2006); M= Ministers North (*ecologia* Environment 2006); N= Area C West (ENV2007); O= Yandi Hub (ENV 2007).

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Cheluidae																	
Flat-shelled Turtle	*Chelodina steindachneri*	-	x														
Agamidae (Dragons)																	
	Caimanops amphiboluroides	-	x	x	x												
Ring-tailed Dragon	*Ctenophorus caudicinctus*	-	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Military Dragon	*Ctenophorus isolepis*	-	x		x	x		x		x			x			x	
	Ctenophorus isolepis isolepis																x
Central Netted Dragon	*Ctenophorus nuchalis*	-	x			x											
Western Netted Dragon	*Ctenophorus reticulatus*	-	x			x											
Canegrass Dragon	*Diporiphora winneckei*	-	x														x
	Diporiphora valens	-	x							x							x
Long-nosed Dragon	*Amphibolurus longirostris*	-	x		x		x	x		x	x	x	x				x
Bearded Dragon	*Pogona minor*	-	x	x	x	x				x	x		x			x	
Bearded Dragon	*Pogona minor minor*	-	x													x	x
Bearded Dragon	*Pogona minor mitchelli*	-	x													x	
Pebble Dragon	*Tympanocryptis cephalus*	-	x														
Gekkonidae (Geckoes)																	
Clawless Gecko	*Crenadactylus ocellatus horni*	-	x				x										x
	Crenadactylus ocellatus		x												x		
Northern Spiny-tailed gecko	*Diplodactylus ciliaris*	-				x											
Fat-tailed Diplodatcylus	*Diplodactylus conspicillatus*	-	x		x								x				x
	Diplodactylus pulcher	-	x			x											
	Diplodactylus mitchelli	CI 3	x														

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Diplodactylus savagei	CI 3	x		x								x			x	
Sand-plain Gecko	*Diplodactylus stenodactylus*	-	x			x	x		x	x		x	x				x
	Diplodactylus wombeyi	CI 3	x		x								x	x		x	x
Pilbara Dtella	*Gehyra pilbara*	-	x		x												x
Spotted Dtella	*Gehyra punctata*	-	x	x	x	x		x		x	x		x	x	x	x	x
	Gehyra purpurascens	-	x														
Tree Dtella	*Gehyra variegata*	-	x	x	x		x	x	x	x		x	x	x	x		x
Bynoes Gecko	*Heteronotia binoei*	-	x	x	x	x	x	x	x	x			x	x		x	x
Desert Cave Gecko	*Heteronotia spelea*	CI 3	x			x	x			x			x	x		x	x
Smooth Knob-tailed Gecko	*Nephrurus levis pilbarensis*	CI 3	x														
Banded Knob-tailed Gecko	*Nephrurus wheeleri cinctus*	-	x			x	x								x		
Marbled Velvet Gecko	*Oedura marmorata*	-	x				x		x				x	x			x
Beaked Gecko	*Rhynchoedura ornata*	-	x					x				x	x				x
Jewelled Gecko	*Strophurus elderi*	-	x										x				x
	Strophurus jeanae	-	x										x				
Spiny-tailed gecko	*Strophurus wellingtonae*	-	x	x		x					x	x	x	x		x	x
Barking Gecko	*Underwoodisaurus milii*	-									x						
Pygopodidae (Legless Lizards)																	
	Delma borea	CI 3															
	Delma butleri	-			x												x
	Delma elegans	CI 3	x			x											
	Delma haroldi	-	x	x						x							x
	Delma nasuta	-	x	x		x				x			x				
	Delma pax	CI 3	x		x					x			x		x	x	
	Delma tincta	-	x		x	x	x						x				
Burtons Snake-lizard	*Lialis burtonis*	-	x	x		x		x				x	x	x	x	x	x
Hooded Scalyfoot	*Pygopus nigriceps*	-	x			x											x
Scincidae (Skinks)																	
	Carlia munda	CI 3	x	x	x	x	x	x		x	x	x		x		x	x

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Desert Rainbow Skink	*Carlia triacantha*	-	x			x											
Spiny-palmed Shinning Skink	*Cryptoblepharus carnabyi*	-	x	x						x					x		
Fence Skink	*Cryptoblepharus plagiocephalus*	-	x	x	x		x						x			x	x
	Cryptoblepharus sp.	CI 3												x			
	Ctenotus ariadnae	-	x										x				
	Ctenotus duricola	CI 3	x		x	x				x	x		x				
	Ctenotus grandis titan	CI 3	x			x							x				
	Ctenotus hanloni	-	x		x												
	Ctenotus helenae	-	x	x		x				x		x	x	x			x
	Ctenotus leonhardii	-	x		x		x										
Leopard Ctenotus	*Ctenotus pantherinus ocellifer*	-	x	x	x	x	x	x		x	x		x	x		x	x
	Ctenotus piankai	-	x		x	x											
	Ctenotus rubicundus	CI 3	x		x	x				x	x				x	x	
	Ctenotus rutilans	-	x	x	x	x											x
Rock Ctenotus	*Ctenotus saxatilis*	-	x	x	x	x	x			x	x	x	x	x	x	x	x
	Ctenotus schomburgkii	-	x		x	x				x						x	
	Ctenotus serventyi	-	x				x	x									
	Ctenotus uber uber	-	x			x											
Spinifex-slender Blue Tounge	*Cyclodomorphus melanops melanops*	-	x	x	x	x		x						x		x	x
Pygmy Spiny-tailed Skink	*Egernia depressa*	-	x	x	x	x				x	x						
	Egernia formosa	-	x		x		x							x			
	Egernia pilbarensis	CI 3	x												x		
Broard-banded Sand-swimmer	*Eremiascincus richardsonii*	-	x				x										x
Narrow-banded Sand-swimmer	*Eremiascincus fasciolatus*	-	x		x												x
	Lerista bipes	-	x														
	Lerista flammicauda	CI 3	x														
	Lerista labialis	-	x														
	Lerista macropisthopus remota	CI 2															
	Lerista muelleri	CI 3	x		x	x	x								x	x	x
	Lerista neander	CI 3	x	x	x	x	x							x			

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Lerista zietzi	CI 3	x	x	x	x	x	x		x	x	x			x		
Common Dwarf Skink	*Menetia greyii*	-	x	x	x	x	x			x			x			x	x
	Menetia surda	-	x	x		x											
Fire-tailed Skink	*Morethia ruficauda*	-	x	x	x	x	x			x	x		x		x		
	Morethia ruficauda subsp. exquisita	CI 3														x	x
	Proablepharus reginae	-	x														
Desert Bluetongue	*Tiliqua multifasciata*	-	x		x	x					x	x	x	x		x	x
Western Bluetongue	*Tiliqua occipitalis*	-															
Varanidae (Monitors)																	
Ridge-tailed Monitor	*Varanus acanthurus*	-	x	x	x	x		x		x	x		x			x	x
Short-tailed Pygmy Monitor	*Varanus brevicauda*	-	x			x	x										
	Varanus bushi	CI 3														x	
Striped-tailed Monitor	*Varanus caudolineatus*	-	x			x										x	
Striped-tailed Monitor	*Varanus* aff. *caundolineatus*	CI 3												x			
Pygmy Desert Monitor	*Varanus eremius*	-	x										x				
Pygmy Mulga Monitor	*Varanus gilleni*	-		x	x			x		x							x
	Varanus aff. gilleni											x					
Perentie	*Varanus giganteus*	-	x		x	x									x	x	
Sand Monitor	*Varanus gouldii*	-	x														
Yellow-spotted Monitor	*Varanus panoptes rubidus*	-	x		x		x	x		x	x						x
	Varanus panoptes panoptes														x		
Pilbara Rock Monitor	*Varanus pilbarensis*	CI 3	x		x				x						x		x
Black-headed Monitor	*Varanus tristis tristis*	-	x	x	x	x	x			x						x	
Typhlopidae (Blind Snakes)																	
Pilbara Blind Snake	*Ramphotyphlops pilbarensis*	CI 3	x														
	Ramphotyphlops ganei	CI 2	x											x			
Beaked Blind Snake	*Ramphotyphlops grypus*	-	x	x								x	x				x
	Ramphotyphlops hamatus	-	x			x											

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Ramphotyphlops ammodytes	CI 3	x														x
	Ramphotyphlops waitii	-	x														
	Ramphotyphlops sp.						x						x				
Boidae (Pythons)																	
Black-headed Python	*Aspidites melanocephalus*	-	x		x	x											
Pygmy Python	*Antaresia perthensis*	-			x	x								x			
Stimsons Python	*Antaresia stimsoni stimsoni*	-	x													x	
Pilbara Olive Python	*Liasis olivaceus barroni*	CI 1	x					x	x								
Elapidae (Front-fanged Snakes)																	
Pilbara Death Adder	*Acanthophis wellsi*	CI 3	x			x				x				x			x
Shovel-nosed Snake	*Brachyurophis approximans*	-	x			x				x			x				x
Yellow-faced Whip-Snake	*Demansia psammophis cupreiceps*	-	x			x	x	x						x		x	
Rufous Whip-Snake	*Demansia rufescens*	CI 3	x					x		x	x		x			x	
Moon Snake	*Furina ornata*	-	x						x					x		x	
Monk Snake	*Parasuta monachus*	-	x			x	x					x					
Ringed Snake	*Pseudonaja modesta*	-	x														x
Mulga Snake	*Pseudechis australis*	-	x					x	x					x	x		x
Gwarder	*Pseudonaja nuchalis*	-	x	x		x											
Rosen's Snake	*Suta fasciata*	-	x		x												x
Spotted Snake	*Suta punctata*	CI 3	x														
Pilbara Bandy Bandy	*Vermicella snelli*	CI 3	x														

[X] fauna species recorded from within the project area. [O] fauna species recorded outside of the project area.
The conservation importance of species is noted as a CI status.
[*] denotes introduced species.

Appendix H3 - Amphibian species expected and observed within 50km of the Yandi Hub project area

Key: A= Western Australian Museum Records; B= East Angelas (*ecologia* Environment 1995); C= Mining Area C (*ecologia* Environment 1998); D= West Angelas (*ecologia* Environment 1998); E= Weeli Wolli (*ecologia* Environment 1998); F= Marillana Creek (HGM 1999); G= Yandi LOM (Maunsell 2003); H= Area C Deposits D, E, and F(*ecologia* Environment 2004); I= Packsaddle Range (*ecologia* Environment 2004); J= Upper Marillana (*ecologia* Environment 2005); K= Marillana (*ecologia* Environment 2006); L= R-Deposit Phase II (ENV 2006); M= Ministers North (*ecologia* Environment 2006); N= Area C West (ENV2007); O= Yandi Hub (ENV 2007).

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Hylidae (Tree Frogs)																	
Mains Frog	*Cyclorana maini*	CI 5	x	x	x	x	x						x			x	
Water Holding Frog	*Cyclorana platycephala*	CI 5	x														
Inland Tree Frog	*Litoria rubella*	CI 5	x		x	x	x						x	x	x		x
Myobatrachidae (Ground Frogs)																	
Spencers Frog	*Limnodynastes spenceri*	CI 5	x			x	x										
Kunapalari Frog	*Neobatrachus kunapalari*	CI 5	x														
Shoemaker Frog	*Neobatrachus sutor*	CI 5	x														
Desert Spadefoot	*Notaden nichollsi*	CI 5	x			x											
Russells Toadlet	*Uperoleia russelli*	CI 5	x			x	x										
Desert Trilling Frog	*Neobatrachus centralis*	CI 5															

[X] fauna species recorded from within the project area. [O] fauna species recorded outside of the project area.
The conservation importance of species is noted as a CI status.
[*] denotes introduced species.

Appendix H4 - Bird species expected and observed within 50km of the Yandi Hub project area

Key: A= Western Australian Museum Records; B= East Angelas (*ecologia* Environment 1995); C= Mining Area C (*ecologia* Environment 1998); D= West Angelas (*ecologia* Environment 1998); E= Weeli Wolli (*ecologia* Environment 1998); F= Marillana Creek (HGM 1999); G= Yandi LOM (Maunsell 2003); H= Area C Deposits D, E, and F(*ecologia* Environment 2004); I= Packsaddle Range (*ecologia* Environment 2004); J= Upper Marillana (*ecologia* Environment 2005); K= Marillana (*ecologia* Environment 2006); L= R-Deposit Phase II (ENV 2006); M= Ministers North (*ecologia* Environment 2006); N= Area C West (ENV2007); O= Yandi Hub (ENV 2007).

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Dromaiidae (Emus)																	
Emu	*Dromaius novaehollandiae*	CI 5			x		x	x	x							x	x
Phasianidae (Pheasants and Quails)																	
Brown Quail	*Coturnix ypsilophora*	CI 5														x	x
Stubble Quail	*Coturnix pectoralis*	CI 5															
Anatidae (Ducks and ducklike water fowl)																	
Australian Wood Duck	*Chenonetta jubata*	CI 4															
Pacific Black Duck	*Anas superciliosa*	CI 4						x	x			x					
Grey Teal	*Anas gracilis*	CI 4					x	x									
Phalacrocoracidae (Cormorants)																	
Little Pied Cormorant	*Phalacrocorax melanoleucos*	CI 5						x	x			x					
Little Black Cormorant	*Phalacrocorax sulcirostris*	CI 4					x		x								
Ardeidae (Herons, Egrets and Bitterns)																	
White-faced Heron	*Egretta novaehollandiae*	CI 4					x	x									
White-necked Heron	*Ardea pacifica*	CI 5					x	x									
Great Egret	*Ardea alba*	CI 5							x								
Nankeen Night Heron	*Nycticorax caledonicus*	CI 5							x								
Threskiornithidae																	
Straw-necked Ibis	*Threskiornis spinicollis*	CI 5					x										

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Accipitridae (Kites, Hawks and Eagles)																	
Black-shouldered Kite	*Elanus caeruleus*	Cl 4							x					x			x
Square-tailed Kite	*Lophoictinia isura*	Cl 4															
Black-breasted Buzzard	*Hamirostra melanosternon*	Cl 4		x													x
Black Kite	*Milvus migrans*	Cl 4					x		x								x
Whistling Kite	*Haliastur sphenurus*	Cl 4		x	x				x		x	x		x		x	x
Spotted Harrier	*Circus assimilis*	Cl 4	x		x	x	x	x					x	x			x
Brown Goshawk	*Accipiter fasciatus*	Cl 4		x	x		x	x				x				x	
Collared Sparrowhawk	*Accipiter cirrhocephalus*	Cl 4		x	x		x	x	x								x
Wedge-tailed Eagle	*Aquila audax*	Cl 4	x		x	x	x			x	x		x	x		x	x
Little Eagle	*Hieraaetus morphnoides*	Cl 4		x				x	x					x			
Falconidae (Falcons)																	
Brown Falcon	*Falco berigora*	Cl 4		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Australian Hobby	*Falco longipennis*	Cl 4	x				x	x	x				x				x
Grey Falcon	*Falco hypoleucos*	Cl 2									x						
Black Falcon	*Falco subniger*	Cl 4			x	x											
Peregrine Falcon	*Falco peregrinus*	Cl 1			x		x										
Nankeen Kestrel	*Falco cenchroides*	Cl 4		x	x	x	x		x	x			x	x		x	x
Rallidae (Rails)																	
Buff-banded Rail	*Gallirallus philippensis*	Cl 5															
Spotless Crake	*Porzana tabuensis*	Cl 5															
Otidae (Bustards)																	
Australian Bustard	*Ardeotis australis*	Cl 2	x		x	x	x	x						x			x
Turnicidae (Button-quails)																	
Little Button-quail	*Turnix velox*	Cl 5			x	x	x	x		x	x		x	x		x	x

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Scolopacidae (Sandpipers and Snipes)																	
Common Sandpiper	*Actitis hypoleucos*	CI 4							x								
Burhinidae (Stone-curlews)																	
Bush Stone-curlew	*Burhinus grallarius*	CI 2														x	
Recurvirostridae																	
Black-winged Stilt	*Himantopus himantopus*	CI 5												x			
Charadriidae (Plovers, Dotterels and Lapwings)																	
Black-fronted Dotterel	*Charadrius melanops*	CI 4					x	x									
Columbidae (Pigeons and Doves)																	
Common Bronzewing	*Phaps chalcoptera*	CI 5	x	x	x	x	x		x			x	x	x	x	x	x
Crested Pigeon	*Ocyphaps lophotes*	CI 5		x	x		x		x	x	x	x	x	x	x	x	x
Spinifex Pigeon	*Geophaps plumifera*	CI 5		x	x		x		x		x		x	x	x	x	x
Diamond Dove	*Geopelia cuneata*	CI 5		x	x		x		x				x	x	x	x	x
Peaceful Dove	*Geopelia striata*	CI 5	x		x	x	x		x			x		x	x		x
Flock Bronzewing	*Phaps histrionica*	CI 2															
Cacatuidae (Cockatoos)																	
Galah	*Cacatua roseicapilla*	CI 5	x		x	x	x	x	x	x	x	x	x	x		x	x
Little Corella	*Cacatua sanguinea*	CI 5			x		x	x	x				x	x		x	x
Inland Red-tailed Black Cockatoo	*Calyptorhynchus banksii*	CI 5															
Cockatiel	*Nymphicus hollandicus*	CI 5					x	x					x			x	x
Psittacidae (Lorikeets and Parrots)																	
Australian Ringneck	*Barnardius zonarius zonarius*	CI 5	x	x	x		x		x	x	x	x	x	x	x	x	x
Mulga Parrot	*Psephotus varius*	CI 5	x	x		x								x		x	
Budgerigar	*Melopsittacus undulatus*	CI 5			x	x	x	x		x	x		x	x	x	x	

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Bourke's Parrot	*Neophema bourkii*	CI 5	x		x						x					x	x
Night Parrot	*Pezoporus occidentalis*	CI 1	x														
Cuculidae (Cuckoos)																	
Pallid Cuckoo	*Cuculus pallidus*	CI 5			x		x	x		x	x		x	x	x		
Black-eared Cuckoo	*Chrysococcyx osculans*	CI 5			x												
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	CI 5			x	x	x	x	x	x	x	x	x		x		
Centropidae (Coucals)																	
Pheasant Coucal	*Centropus phasianus*	CI 5															
Strigidae (Hawk-owls)																	
Barking Owl	*Ninox connivens*	CI 5	x				x		x								
Southern Boobook Owl	*Ninox novaeseelandiae*	CI 5	x	x	x	x	x	x		x				x		x	x
Tytonidae (Barn owls)																	
Barn Owl	*Tyto alba*	CI 5								x	x						x
Podargidae (Frogmouths)																	
Tawny Frogmouth	*Podargus strigoides*	CI 5		x	x			x		x	x		x	x	x		
Caprimulgidae (Nightjars)																	
Spotted Nightjar	*Eurostopodus argus*	CI 5	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Aegothelidae (Owlet-nightjars)																	
Australian Owlet-nightjar	*Aegotheles cristatus*	CI 5		x	x		x		x	x	x		x	x	x	x	x
Apodidae (Swifts)																	
Fork-tailed Swift	*Apus pacificus*	CI 4															

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Halcyonidae (Kingfishers)																	
Blue-winged Kookaburra	*Dacelo leachii*	CI 5					x	x	x				x				
Red-backed Kingfisher	*Todiramphus pyrrhopygia*	CI 5					x	x	x	x	x			x		x	
Sacred Kingfisher	*Todiramphus sanctus*	CI 5					x	x									x
Meropidae (Bee-eaters)																	
Rainbow Bee-eater	*Merops ornatus*	CI 4		x	x		x	x	x			x	x	x	x	x	x
Climacteridae (Treecreepers)																	
Black-tailed Treecreeper	*Climacteris melanura*	CI 5	x		x	x	x	x			x						
Maluridae (Fairy-wrens)																	
Splendid Fairy-wren	*Malurus splendens*	CI 5		x												x	
Variegated Fairy-wren	*Malurus lamberti*	CI 5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
White-winged Fairy-wren	*Malurus leucopterus*	CI 5		x	x	x	x	x	x	x	x			x	x	x	
Rufous-crowned Emu-wren	*Stipiturus ruficeps*	CI 5			x				x	x	x		x			x	
Striated Grasswren	*Amytornis striatus*	CI 5	x		x	x		x	x	x	x		x		x	x	
Pardalotidae (Pardalotes and Thornbills)																	
Red-browed Pardalote	*Pardalotus rubricatus*	CI 5			x	x	x	x	x				x	x	x	x	
Striated Pardalote	*Pardalotus striatus*	CI 5	x	x	x	x	x	x	x	x	x		x	x	x	x	
Redthroat	*Pyrrholaemus brunneus*	CI 5		x												x	
Weebill	*Smicrornis brevirostris*	CI 5		x	x		x		x	x	x	x	x	x	x	x	x
Western Gerygone	*Gerygone fusca mungi*	CI 5			x	x	x		x	x		x				x	x
Inland Thornbill	*Acanthiza apicalis*	CI 5		x	x		x			x		x				x	
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	CI 5		x	x	x						x				x	x
Slaty-backed Thornbill	*Acanthiza robustirostris*	CI 5	x	x	x					x						x	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	CI 5	x		x	x										x	
Southern Whiteface	*Aphelocephala leucopsis*	CI 5															

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Meliphagidae (Honeyeaters)																	
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	CI 5		x	x		x		x	x	x		x	x	x	x	x
Yellow-throated Miner	*Manorina flavigula*	CI 5		x	x		x	x	x	x	x	x	x	x	x	x	x
Singing Honeyeater	*Lichenostomus virescens*	CI 5	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Grey-headed Honeyeater	*Lichenostomus keartlandi*	CI 5		x	x	x	x	x	x	x	x		x	x	x	x	x
White-plumed Honeyeater	*Lichenostomus penicillatus*	CI 5		x	x	x	x	x	x			x				x	x
Black-chinned Honeyeater	*Melithreptus gularis*	CI 5	x	x	x		x		x	x	x		x	x		x	x
Brown Honeyeater	*Lichmera indistincta*	CI 5		x	x		x	x	x	x	x	x	x	x	x		x
White-fronted Honeyeater	*Phylidonyris albifrons*	CI 5	x	x		x											
Grey Honeyeater	*Conopophila whitei*	CI 5	x			x											
Black Honeyeater	*Certhionyx niger*	CI 5					x	x							x		
Pied Honeyeater	*Certhionyx variegatus*	CI 5		x				x				x		x			
Crimson Chat	*Epthianura tricolor*	CI 5	x			x	x	x	x				x	x	x	x	
White-fronted Chat	*Epthianura albifrons*	CI 5	x														
Orange Chat	*Epthianura aurifrons*	CI 5	x														
Petroicidae (Australian Robins)																	
Red-capped Robin	*Petroica goodenovii*	CI 5		x	x	x	x			x	x			x		x	
Hooded Robin	*Petroica cucullata*	CI 5	x		x		x	x	x				x	x	x	x	x
Pomatostomidae (Australian Babblers)																	
Grey-crowned Babbler	*Pomatostomus temporalis*	CI 5	x		x	x	x	x	x	x		x			x	x	x
White-browed Babbler	*Pomatostomus superciliosus*	CI 5		x	x											x	x
Cinclosomatidae (Quail-thrushes and Allies)																	
Chiming Wedgebill	*Psophodes occidentalis*	CI 5															
Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*	CI 5	x			x											
Neosittidae (Sittellas)																	
Varied Sittella	*Daphoenositta chrysoptera*	CI 5			x	x	x							x		x	

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Pachycephalidae (Whistlers)																	
Crested Bellbird	*Oreoica gutturalis*	CI 5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rufous Whistler	*Pachycephala rufiventris*	CI 5	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Grey Shrike-thrush	*Colluricincla harmonica*	CI 5		x	x		x	x	x	x	x	x	x	x		x	x
Dicruridae (Flycatchers)																	
Magpie-Lark	*Grallina cyanoleuca*	CI 5		x	x		x	x	x	x	x	x		x		x	x
Grey Fantail	*Rhipidura fuliginosa*	CI 5	x	x	x		x			x		x		x		x	x
Willie Wagtail	*Rhipidura leucophrys*	CI 5		x	x		x	x	x	x	x	x	x	x	x	x	x
Campephagidae (Cuckoo-shrikes)																	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	CI 5		x	x	x	x	x	x	x	x		x	x	x	x	x
Ground Cuckoo-shrike	*Coracina maxima*	CI 5		x	x									x		x	x
White-winged Triller	*Lalage tricolor*	CI 5			x		x	x	x	x	x		x	x	x	x	x
Artamidae (Woodswallows)																	
Masked Woodswallow	*Artamus personatus*	CI 5	x		x		x							x	x		
Black-faced Woodswallow	*Artamus cinereus*	CI 5	x	x	x		x	x	x	x	x	x	x	x	x	x	x
Little Woodswallow	*Artamus minor*	CI 5			x		x		x	x	x		x	x	x	x	x
Grey Butcherbird	*Cracticus torquatus*	CI 5		x	x		x			x	x	x		x		x	x
Pied Butcherbird	*Cracticus nigrogularis*	CI 5		x	x		x	x	x	x	x	x	x	x	x	x	x
Australian Magpie	*Cracticus tibicen*	CI 5		x	x		x	x	x	x	x	x		x		x	x
Corvidae (Ravens and Crows)																	
Little Crow	*Corvus bennetti*	CI 5	x				x					x	x			x	
Torresian Crow	*Corvus orru*	CI 5	x	x	x		x	x	x	x	x		x	x	x	x	x
Ptilonorhynchidae (Bowerbirds)																	
Western Bowerbird	*Chlamydera guttata*	CI 5		x	x		x	x	x	x	x		x	x	x	x	x

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Hirundinidae (Swallows)																	
White-backed Swallow	*Cheramoeca leucosternus*	CI 5					x										
Tree Martin	*Hirundo nigricans nigricans*	CI 5			x		x	x						x			
Fairy Martin	*Hirundo ariel*	CI 5						x					x	x			x
Welcome Swallow	*Hirundo neoxena*	CI 5												x			
Sylviidae (Old World Warblers)																	
Spinifex Bird	*Eremiornis carteri*	CI 5			x	x	x	x	x	x	x			x	x		x
Little Grassbird	*Megalurus gramineus*	CI 5															
Clamorous Reed Warbler	*Acrocephalus australis*	CI 5							x								
Brown Songlark	*Cincloramphus cruralis*	CI 5						x									x
Rufous Songlark	*Cincloramphus mathewsi*	CI 5			x		x	x	x		x		x	x			x
Alauidae (Song Larks)																	
Singing Bushlark	*Mirafra javanica*	CI 5									x		x				
Dicaeidae (Flower-peckers)																	
Mistletoebird	*Dicaeum hirundinaceum*	CI 5		x	x		x		x	x	x			x	x	x	x
Passeridae (Finches and Allies)																	
Zebra Finch	*Taeniopygia guttata*	CI 5		x	x				x	x	x	x	x	x	x	x	x
Star Finch	*Neochmia ruficauda clarescens*	CI 2					x	x		x	x						
Painted Finch	*Emblema pictum*	CI 5			x		x	x	x	x	x		x	x	x	x	x
Motacillidae (Pipits and True Wagtails)																	
Richard's Pipit	*Anthus novaeseelandiae*	CI 5						x					x	x		x	

[X] fauna species recorded from within the project area. [O] fauna species recorded outside of the project area.
The conservation importance of species is noted as a CI status.
[*] denotes introduced species.

APPENDIX I

FAUNA SPECIES EXPECTED AND OBSERVED IN THE PROJECT AREA AND IN ITS VICINITY

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAUNA EXPECTED AND OBSERVED WITHIN THE PROJECT AREA AND ITS VICINITY

MAMMALS

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Tachyglossidae (Echidnas)																																			
Echidna	*Tachyglossus aculeatus*	CI 5	x		x			x	x	x														x				x							
Dasyuridae (Carnivorous Marsupials)																																			
Mulgara	*Dasycercus cristicauda*	CI 1	x																																
Little Red Kaluta	*Dasykaluta rosamondae*	CI 5	x	x			x	x	x	x	x			x	x	x										x	x			x				x	x
Northern Quoll	*Dasyurus hallucatus*	CI 1	x																																
Pilbara Ningaui	*Ningaui timealeyi*	CI 3	x		x			x	x	x					x	x		x								x	x								x
Wongai Ningaui	*Ningaui ridei*	CI 5									x	x																							
Planigale	*Planigale* sp.	CI 5	x		x		x							x		x				x						x						x			
Long-tailed Planigale	*Planigale ingrami*	CI 5																																x	x
Common Planigale	*Planigale maculata*	CI 5					x	x	x		x							x														x		x	
Woolley's Pseudantechinus	*Pseudantechinus woolleyae*	CI 5	x					x																											
Rory's Pseudantechinus	*Pseudantechinus roryi*	CI 5																																	
Long-tailed Dunnart	*Sminthopsis longicaudata*	CI 2	x					x																											
Stripe-faced Dunnart	*Sminthopsis macroura*	CI 5	x				x	x	x	x						x								x											
Ooldea Dunnart	*Sminthopsis ooldea*	CI 5	x					x	x	x																									
Lesser Hairy-footed Dunnart	*Sminthopsis youngsoni*	CI 5	x															x																	
Macropodidae (Kangaroos)																																			
Spectacled Hare-wallaby	*Lagorchestes conspicillatus*	CI 2	x																																
Euro	*Macropus robustus*	CI 5	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x			x		x	x	x	x	x		x		x	x	x	
Euro	*Macropus robustus* subsp. *erubescens*	CI 5											x																						x	x
Red Kangaroo	*Macropus rufus*	CI 5	x					x	x										x	x	x			x		x			x	x	x	x	x	x	x
Black-footed Rock-wallaby	*Petrogale lateralis*	CI 1	x																																
Rothschilds Rock-wallaby	*Petrogale rothschildi*	CI 3	x		x			x	x		x											x			x	x		x	x	x				x	
Rock-wallaby	*Petrogale* sp.	CI 5	x											x	x		x	x						x				x							
Emballonuridae (Sheathtail-bats)																																			
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	CI 5	x						x				x		x	x		x		x				x				x		x	x	x			x
Common Sheathtail-bat	*Taphozous georgianus*	CI 5	x						x				x		x	x	x			x				x	x	x	x	x	x	x	x	x		x	x
Hill's Sheathtail-bat	*Taphozous hilli*	CI 5	x			x		x	x	x																									x	
Megadermatidae (Ghost bat)																																			
Ghost Bat	*Macroderma gigas*	CI 1	x						x												x							x							
Hipposideridae (Leafnosed-bats)																																			
Orange Leaf-nosed Bat	*Rhinonicteris aurantius*	CI 1	x																								x								

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Vespertilionidae (Ordinary Bats)																																			
Gould's Wattled Bat	*Chalinolobus gouldii*	CI 5	x					x		x	x	x		x		x	x		x	x	x			x	x	x	x	x	x		x	x		x	x
Little Broad-nosed Bat	*Scotorepens greyii*	CI 5	x					x	x	x				x		x	x		x	x	x			x	x	x	x	x	x	x	x	x		x	x
Chocolate Wattled Bat	*Chalinolobus morio*	CI 5	x																																
Finlayson's Cave Bat	*Vespadelus finlaysoni*	CI 5	x				x	x	x	x	x					x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x
Inland Broad-nosed Bat	*Scotorepens balstoni*	CI 5						x	x					x		x	x																		
Pallid Long-eared Bat	*Nyctophilus bifax daedalus*	CI 3	x							x																		x			x				
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	CI 5	x							x	x						x		x	x	x			x	x		x	x	x		x				x
Molossidae (Freetail-bats)																																			
Northern Freetail-bat	*Chaerephon jobensis*	CI 5	x							x	x	x							x	x	x					x	x		x	x	x	x		x	x
Beccaris Freetailed bat	*Mormopterus beccarii*	CI 5	x							x							x				x			x	x	x	x	x		x	x	x		x	x
Little Mastiff-bat	*Mormopterus planiceps*	CI 5	x					x	x		x																								
White-striped Freetailed Bat	*Tadarida australia*	CI 5	x							x	x	x		x																					
Muridae (Rodents)																																			
Lakeland Downs Mouse	*Leggadina lakedownensis*	CI 2	x																																
House Mouse	**Mus musculus*	-	x	x	x		x		x	x	x	x		x	x			x						x	x			x		x	x	x	x		x
Spinifex Hopping-mouse	*Notomys alexis*	CI 5	x						x					x									x		x	x						x		x	
Western Pebble-mound Mouse	*Pseudomys chapmani*	CI 2	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x					x			x	x	x	x							x
Desert Mouse	*Pseudomys desertor*	CI 5	x						x	x				x	x			x						x	x		x				x			x	
Sandy Inland Mouse	*Pseudomys hermannsburgensis*	CI 5	x	x	x		x	x	x	x	x	x		x	x	x		x						x	x	x					x			x	x
Common Rock Rat	*Zyzomys argurus*	CI 3	x	x	x		x	x	x	x	x				x	x		x						x	x	x	x	x		x	x	x	x	x	x
Leporidae (Rabbits)																																			
Rabbit	**Oryctolagus cuniculus*	-	x	x	x				x		x											x		x						x					
Canidae (Dingo)																																			
Dingo	**Canis lupus dingo*	-	x	x		x		x	x			x		x		x	x	x	x	x	x		x					x			x	x	x	x	x
Fox	**Vulpes vulpes*	-	x	x																				x	x										x
Felidae (Cats)																																			
Feral Cat	**Felis catus*	-	x	x			x	x					x			x		x	x			x		x	x	x									x
Equidae (Horse)																																			
Donkey	**Equus asinus*	-	x																												x				
Horse	**Equus caballus*	-																			x												x		
Camelidae (Camels)																																			
Camel	**Camelus dromedarius*	-	x															x					x										x		x
Bovidae (Cow)																																			
European Cattle	**Bos taurus*	-	x								x	x	x									x	x			x				x	x	x	x		x

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

REPTILES

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Cheluidae																																			
Flat-shelled Turtle	*Chelodina steindachneri*	-	x						x						x			x																	
Agamidae (Dragons)																																			
	Caimanops amphiboluroides	-	x				x	x																											
Ring-tailed Dragon	*Ctenophorus caudicinctus*	-	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Military Dragon	*Ctenophorus isolepis*	-	x		x			x	x	x		x				x		x	x				x	x		x						x		x	
	Ctenophorus isolepis isolepis																																			x
Central Netted Dragon	*Ctenophorus nuchalis*	-	x		x					x								x															x	x	
Western Netted Dragon	*Ctenophorus reticulatus*	-	x						x	x															x										
Canegrass Dragon	*Diporiphora winneckei*	-	x																																x
	Diporiphora valens	-	x													x									x										x
Long-nosed Dragon	*Amphibolurus longirostris*	-	x					x	x		x	x			x	x	x	x	x	x	x		x	x		x		x		x	x	x	x		x
Bearded Dragon	*Pogona minor*	-	x		x	x	x	x	x	x						x	x	x		x		x	x	x	x	x					x			x	
Bearded Dragon	*Pogona minor minor*	-	x																																x	x
Bearded Dragon	*Pogona minor mitchelli*	-	x																															x	x	
Pebble Dragon	*Tympanocryptis cephalus*	-	x															x														x				
Gekkonidae (Geckoes)																																			
Clawless Gecko	*Crenadactylus ocellatus horni*	-	x								x																								
	Crenadactylus ocellatus ocellatus																												x						x
Northern Spiny-tailed gecko	*Diplodactylus ciliaris*	-								x					x				x																
Fat-tailed Diplodatcylus	*Diplodactylus conspicillatus*	-	x					x	x									x						x		x						x			x
	Diplodactylus pulcher	-	x							x																										
	Diplodactylus mitchelli	CI 3	x																																
	Diplodactylus savagei	CI 3	x					x	x					x										x	x	x						x		x	
Sand-plain Gecko	*Diplodactylus stenodactylus*	-	x						x	x	x		x	x	x	x		x	x	x	x			x	x	x		x		x			x	x	x
	Diplodactylus wombeyi	CI 3	x					x	x					x	x			x							x	x	x					x	x	x	x	x
Pilbara Dtella	*Gehyra pilbara*	-	x					x										x																x		x
Spotted Dtella	*Gehyra punctata*	-	x	x	x	x	x	x	x	x		x				x	x	x		x		x		x	x	x	x	x	x	x	x	x	x	x	x
	Gehyra purpurascens	-	x																																	
Tree Dtella	*Gehyra variegata*	-	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	x				x	x	x		x	x	x	x	x		x
Bynoes Gecko	*Heteronotia binoei*	-	x		x	x	x	x	x	x	x	x	x		x	x		x	x	x				x	x	x	x	x		x	x	x	x	x	x
Desert Cave Gecko	*Heteronotia spelea*	CI 3	x						x	x	x				x	x		x				x			x	x	x	x				x		x	x
Smooth Knob-tailed Gecko	*Nephrurus levis pilbarensis*	CI 3	x																																	
Banded Knob-tailed Gecko	*Nephrurus wheeleri cinctus*	-	x						x	x	x			x						x		x						x	x	x	x	x			

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Marbled Velvet Gecko	*Oedura marmorata*	-	x						x		x		x					x						x		x	x	x				x	x		x
Beaked Gecko	*Rhynchoedura ornata*	-	x		x				x			x		x				x	x		x				x	x						x			x
Jewelled Gecko	*Strophurus elderi*	-	x															x							x	x									x
	Strophurus jeanae	-	x																x							x									
Spiny-tailed gecko	*Strophurus wellingtonae*	-	x				x		x	x							x		x	x	x			x	x	x	x	x		x		x	x	x	x
Barking Gecko	*Underwoodisaurus milii*	-															x																		
Pygopodidae (Legless Lizards)																																			
	Delma borea	CI 3																																	
	Delma butleri	-						x																x	x							x			x
	Delma elegans	CI 3	x							x																									
	Delma haroldi	-	x				x		x							x		x																	x
	Delma nasuta	-	x		x		x		x	x				x	x	x		x						x	x	x									
	Delma pax	CI 3	x		x			x						x	x	x		x						x	x	x			x			x	x	x	
	Delma tincta	-	x					x		x	x															x									
Burtons Snake-lizard	*Lialis burtonis*	-	x			x	x			x		x			x			x		x	x	x		x		x	x	x	x	x		x	x	x	x
Hooded Scalyfoot	*Pygopus nigriceps*	-	x						x	x										x							x					x			x
Scincidae (Skinks)																																			
	Carlia munda	CI 3	x				x	x	x	x	x	x		x		x	x				x			x			x	x		x	x	x		x	x
Desert Rainbow Skink	*Carlia triacantha*	-	x						x	x					x			x							x										
Spiny-palmed Shinning Skink	*Cryptoblepharus carnabyi*	-	x				x		x							x		x						x	x			x	x			x			
Fence Skink	*Cryptoblepharus plagiocephalus*	-	x		x		x	x			x											x			x	x								x	x
	Cryptoblepharus sp.	CI 3																									x								
	Ctenotus ariadnae	-	x															x							x	x									
	Ctenotus duricola	CI 3	x					x		x				x	x	x	x	x							x	x									
	Ctenotus grandis titan	CI 3	x							x				x				x							x	x									
	Ctenotus hanloni	-	x					x																											
	Ctenotus helenae	-	x		x		x		x	x				x	x	x		x		x	x			x	x	x	x	x		x	x	x	x		x
	Ctenotus leonhardii	-	x	x	x	x		x			x				x			x	x					x	x					x					
Leopard Ctenotus	*Ctenotus pantherinus ocellifer*	-	x		x	x	x	x	x	x	x	x		x	x	x	x	x				x		x	x	x	x			x	x			x	x
	Ctenotus piankai	-	x					x		x																									
	Ctenotus rubicundus	CI 3	x					x	x	x				x		x	x												x					x	
	Ctenotus rutilans	-	x				x	x		x								x																	x
Rock Ctenotus	*Ctenotus saxatilis*	-	x		x		x	x	x	x	x			x	x	x	x	x		x	x			x	x	x	x	x	x	x	x	x	x	x
	Ctenotus schomburgkii	-	x					x		x						x																			x
	Ctenotus serventyi	-	x								x	x																					x	x		
	Ctenotus uber uber	-	x							x																		x							
Spinifex-slender Blue Tounge	*Cyclodomorphus melanops melanops*	-	x		x	x	x	x	x	x		x						x		x							x				x			x	x
Pygmy Spiny-tailed Skink	*Egernia depressa*	-	x				x	x		x				x		x	x	x		x													x			
	Egernia formosa	-	x					x			x			x													x	x		x					
	Egernia pilbarensis	CI 3	x																										x						
Broard-banded Sand-swimmer	*Eremiascincus richardsonii*	-	x						x		x				x			x	x											x					x

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Narrow-banded Sand-swimmer	*Eremiascincus fasciolatus*	-	x					x																								x			x
	Lerista bipes	-	x																													x	x		
	Lerista flammicauda	CI 3	x																													x			
	Lerista labialis	-	x																																
Unpatterned Robust Lerista	*Lerista macropisthopus remota*	CI 2							x																										
	Lerista muelleri	CI 3	x		x			x		x	x							x							x				x	x	x	x	x	x	x
	Lerista neander	CI 3	x		x		x	x	x	x	x				x			x							x		x								
	Lerista zietzi	CI 3	x		x		x	x	x	x	x	x			x	x	x	x			x				x			x	x			x			
Common Dwarf Skink	*Menetia greyii*	-	x		x		x	x		x	x					x		x		x		x			x	x								x	x
	Menetia surda	-	x				x			x																									
Fire-tailed Skink	*Morethia ruficauda*	-	x	x	x		x	x	x	x	x				x	x	x	x				x		x	x	x		x	x		x	x	x		
	Morethia ruficauda subsp. exquisita	CI 3																																x	x
	Proablepharus reginae	-	x																												x				
Desert Bluetongue	*Tiliqua multifasciata*	-	x					x		x					x		x	x	x		x			x	x	x	x			x		x		x	x
Western Bluetongue	*Tiliqua occipitalis*	-																										x							
Varanidae (Monitors)																																			
Ridge-tailed Monitor	*Varanus acanthurus*	-	x		x	x	x	x	x	x		x		x	x	x	x	x		x				x	x	x		x		x	x	x	x	x	x
Short-tailed Pygmy Monitor	*Varanus brevicauda*	-	x							x	x																			x					
	Varanus bushi	CI 3																						x										x	
Striped-tailed Monitor	*Varanus caudolineatus*	-	x						x	x																					x	x	x	x	
Striped-tailed Monitor	*Varanus* aff. *caundolineatus*	CI 3																									x								
Pygmy Desert Monitor	*Varanus eremius*	-	x																						x	x							x		
Pygmy Mulga Monitor	*Varanus gilleni*	-					x	x				x				x																			x
	Varanus aff. gilleni																				x														
Perentie	*Varanus giganteus*	-	x		x	x		x	x	x								x					x	x				x	x			x		x	
Sand Monitor	*Varanus gouldii*	-	x	x																					x								x		
Yellow-spotted Monitor	*Varanus panoptes rubidus*	-	x					x	x		x	x			x	x	x	x	x											x		x	o		x
	Varanus panoptes panoptes																												x						
Pilbara Rock Monitor	*Varanus pilbarensis*	CI 3	x		x	x		x	x				x					x										x	x						x
Black-headed Monitor	*Varanus tristis tristis*	-	x	x	x		x	x	x	x	x				x	x		x							x			x			x	x		x	
Typhlopidae (Blind Snakes)																																			
Pilbara Blind Snake	*Ramphotyphlops pilbarensis*	CI 3	x																	x															
	Ramphotyphlops ganei	CI 2	x																	x					x		x								
Beaked Blind Snake	*Ramphotyphlops grypus*	-	x		x		x		x						x			x			x			x	x	x					x			x
	Ramphotyphlops hamatus	-	x							x																				x					
	Ramphotyphlops ammodytes	CI 3	x																												x	x	x		x
	Ramphotyphlops waitii	-	x																																
	Ramphotyphlops sp.										x															x									
Boidae (Pythons)																																			
Black-headed Python	*Aspidites melanocephalus*	-	x					x		x																					o				

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Pygmy Python	*Antaresia perthensis*	-			x	x		x	x	x				x	x			x		x							x	x			x				
Stimsons Python	*Antaresia stimsoni stimsoni*	-	x															x										x			x	x		x	
Pilbara Olive Python	*Liasis olivaceus barroni*	CI 1	x									x	x															x							
Elapidae (Front-fanged Snakes)																																			
Pilbara Death Adder	*Acanthophis wellsi*	CI 3	x						x	x						x				x							x	x							x
Shovel-nosed Snake	*Brachyurophis approximans*	-	x						x	x						x		x		x					x	x		x		x	x	x			x
Yellow-faced Whip-Snake	*Demansia psammophis cupreiceps*	-	x							x	x	x							x					x	x		x				x	x	x	x	
Rufous Whip-Snake	*Demansia rufescens*	CI 3	x						x			x				x	x								x	x								x	
Moon Snake	*Furina ornata*	-	x										x							x							x	x				x	x	x	
Monk Snake	*Parasuta monachus*	-	x						x	x	x									x	x										x				
Ringed Snake	*Pseudonaja modesta*	-	x																									x			x				x
Mulga Snake	*Pseudechis australis*	-	x			x			x			x	x		x			x		x				x			x	x	x						x
Gwarder	*Pseudonaja nuchalis*	-	x				x			x				x						x								x			o				
Rosen's Snake	*Suta fasciata*	-	x					x	x											x															x
Spotted Snake	*Suta punctata*	CI 3	x																																
Pilbara Bandy Bandy	*Vermicella snelli*	CI 3	x																	x															

AMPHIBIANS

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Hylidae (Tree Frogs)																																			
Mains Frog	*Cyclorana maini*	CI 5	x				x	x	x	x	x							x		x						x		x		x	x			x	
Water Holding Frog	*Cyclorana platycephala*	CI 5	x																									x							
Inland Tree Frog	*Litoria rubella*	CI 5	x					x	x	x	x				x			x	x							x	x	x	x	x	x	x			x
Myobatrachidae (Ground Frogs)																																			
Spencers Frog	*Limnodynastes spenceri*	CI 5	x						x	x	x				x			x																	
Kunapalari Frog	*Neobatrachus kunapalari*	CI 5	x																																
Shoemaker Frog	*Neobatrachus sutor*	CI 5	x																												x				
Desert Spadefoot	*Notaden nichollsi*	CI 5	x							x					x			x																	
Russells Toadlet	*Uperoleia russelli*	CI 5	x							x	x				x			x																	
Desert Trilling Frog	*Neobatrachus centralis*	CI 5													x			x																	

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
BIRDS																																			
FAMILY GROUPS	**SCIENTIFIC NAME**	**Status**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**AA**	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**
Dromaiidae (Emus)																																			
Emu	*Dromaius novaehollandiae*	CI 5		x	x			x			x	x	x					x					x		x						o	x	x	x
Phasianidae (Pheasants and Quails)																																			
Brown Quail	*Coturnix ypsilophora*	CI 5																x									x		x	x	x		x	x
Stubble Quail	*Coturnix pectoralis*	CI 5																	x																
Anatidae (Ducks and ducklike water fowl)																																			
Australian Wood Duck	*Chenonetta jubata*	CI 4																												x					
Pacific Black Duck	*Anas superciliosa*	CI 4										x	x								x									o				
Grey Teal	*Anas gracilis*	CI 4									x	x																		o				
Phalacrocoracidae (Cormorants)																																			
Little Pied Cormorant	*Phalacrocorax melanoleucos*	CI 5										x	x								x										x			
Little Black Cormorant	*Phalacrocorax sulcirostris*	CI 4									x		x																		o				
Ardeidae (Herons, Egrets and Bitterns)																																			
White-faced Heron	*Egretta novaehollandiae*	CI 4									x	x						x		x											o				
White-necked Heron	*Ardea pacifica*	CI 5									x	x																							
Great Egret	*Ardea alba*	CI 5											x																						
Nankeen Night Heron	*Nycticorax caledonicus*	CI 5											x																						
Threskiornithidae																																			
Straw-necked Ibis	*Threskiornis spinicollis*	CI 5									x																								
Accipitridae (Kites, Hawks and Eagles)																																			
Black-shouldered Kite	*Elanus caeruleus*	CI 4			x				x				x	x				x						x	x		x				o	x	o		x
Square-tailed Kite	*Lophoictinia isura*	CI 4												x				x																	
Black-breasted Buzzard	*Hamirostra melanosternon*	CI 4					x											x	x					x	x			x				x			x
Black Kite	*Milvus migrans*	CI 4									x		x	x				x	x					x	x			x				x			x
Whistling Kite	*Haliastur sphenurus*	CI 4			x	x	x	x	x				x	x			x	x			x		x	x	x		x	x		x	x	x	x	x	x
Spotted Harrier	*Circus assimilis*	CI 4	x		x			x	x	x	x	x		x				x								x	x				x	x			x
Brown Goshawk	*Accipiter fasciatus*	CI 4					x	x	x		x	x			x			x			x	x		x						x	x	x	x	x	
Collared Sparrowhawk	*Accipiter cirrhocephalus*	CI 4				x	x	x	x		x	x	x	x																x	x	x	x		x
Wedge-tailed Eagle	*Aquila audax*	CI 4	x					x	x	x	x			x	x	x	x	x	x			x		x	x	x	x	x		x	x	x	x	x	x
Little Eagle	*Hieraaetus morphnoides*	CI 4				x	x					x	x						x								x	x		x	x		x		
Falconidae (Falcons)																																			
Brown Falcon	*Falco berigora*	CI 4			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Australian Hobby	*Falco longipennis*	CI 4	x						x		x	x	x					x								x		x		x	x	x			x
Grey Falcon	*Falco hypoleucos*	CI 2															x														o				
Black Falcon	*Falco subniger*	CI 4						x		x				x	x				x																
Peregrine Falcon	*Falco peregrinus*	CI 1				x		x	x		x																						o		
Nankeen Kestrel	*Falco cenchroides*	CI 4		x	x	x	x	x	x	x	x		x	x	x	x		x	x	x				x	x	x	x	x		x	x	x	x	x	x
Rallidae (Rails)																																			
Buff-banded Rail	*Gallirallus philippensis*	CI 5																														x			
Spotless Crake	*Porzana tabuensis*	CI 5																														x			
Otidae (Bustards)																																			
Australian Bustard	*Ardeotis australis*	CI 2	x		x			x	x	x	x	x						x	x	x						x			x	x	x	o		x
Turnicidae (Button-quails)																																			
Little Button-quail	*Turnix velox*	CI 5			x	x		x	x	x	x	x		x		x	x	x						x	x	x	x	x		x	x	x	x	x	x
Scolopacidae (Sandpipers and Snipes)																																			
Common Sandpiper	*Actitis hypoleucos*	CI 4											x												x										
Burhinidae (Stone-curlews)																																			
Bush Stone-curlew	*Burhinus grallarius*	CI 2													x			x							x						x			x	
Recurvirostridae																																			
Black-winged Stilt	*Himantopus himantopus*	CI 5																									x				x				
Charadriidae (Plovers, Dotterels and Lapwings)																																			
Black-fronted Dotterel	*Charadrius melanops*	CI 4									x	x																			o				
Columbidae (Pigeons and Doves)																																			
Common Bronzewing	*Phaps chalcoptera*	CI 5	x	x		x	x	x	x	x	x		x		x			x	x	x	x	x		x	x	x	x		x	x	x	x	x	x
Crested Pigeon	*Ocyphaps lophotes*	CI 5					x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Spinifex Pigeon	*Geophaps plumifera*	CI 5		x	x	x	x	x	x		x		x	x	x		x	x						x	x	x	x	x	x	x	x	o	x	x
Diamond Dove	*Geopelia cuneata*	CI 5		x	x	x	x	x	x		x		x	x	x			x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Peaceful Dove	*Geopelia placida*	CI 5	x				x		x	x		x						x			x		x				x		x	x	x	x		
	Geopelia striata																																		x
Flock Bronzewing	*Phaps histrionica*	CI 2																																	
Cacatuidae (Cockatoos)																																			
Galah	*Cacatua roseicapilla*	CI 5	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x
Little Corella	*Cacatua sanguinea*	CI 5			x			x	x		x	x	x		x			x						x		x	x	x		x	x	x	o	x	x
Inland Red-tailed Black Cockatoo	*Calyptorhynchus banksii*	CI 5																																	
Psittacidae (Lorikeets and Parrots)																																			

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Cockatiel	*Nymphicus hollandicus*	CI 5							x		x	x		x				x							x	x		x		x	x	x	x	x
Australian Ringneck	*Barnardius zonarius*	CI 5	x		x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	
	Barnardius zonarius zonarius	CI 5																																	x
Mulga Parrot	*Psephotus varius*	CI 5	x				x		x	x																	x			x			x	x	
Budgerigar	*Melopsittacus undulatus*	CI 5		x	x	x		x		x	x	x		x		x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	
Bourke's Parrot	*Neophema bourkii*	CI 5	x					x									x											x		x	x		x	x	x
Night Parrot	*Pezoporus occidentalis*	CI 1	x																																
Cuculidae (Cuckoos)																																			
Pallid Cuckoo	*Cuculus pallidus*	CI 5			x	x		x	x		x	x		x		x	x	x							x	x	x	x	x	x	x		x		
Black-eared Cuckoo	*Chrysococcyx osculans*	CI 5						x	x																					x	x				
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	CI 5			x			x	x	x	x	x	x	x	x	x	x	x		x	x					x		x	x		x	x	x		
Centropidae (Coucals)																																			
Pheasant Coucal	*Centropus phasianus*	CI 5																									x			x	x				
Strigidae (Hawk-owls)																																			
Barking Owl	*Ninox connivens*	CI 5	x								x		x																						
Southern Boobook Owl	*Ninox novaeseelandiae*	CI 5	x	x		x	x	x	x	x	x	x		x		x		x				x					x	x		x	x	x	x	x	x
Tytonidae (Barn owls)																																			
Barn Owl	*Tyto alba*	CI 5							x					x	x	x	x	x						x							x				x
Podargidae (Frogmouths)																																			
Tawny Frogmouth	*Podargus strigoides*	CI 5					x	x				x			x	x	x	x	x						x	x	x	x	x	x	x	x			
Caprimulgidae (Nightjars)																																			
Spotted Nightjar	*Eurostopodus argus*	CI 5	x		x			x	x	x	x	x	x	x		x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x
Aegothelidae (Owlet-nightjars)																																			
Australian Owlet-nightjar	*Aegotheles cristatus*	CI 5		x	x		x	x	x		x		x	x		x	x	x	x	x		x			x	x	x		x	x	x	x		x	x
Apodidae (Swifts)																																			
Fork-tailed Swift	*Apus pacificus*	CI 4																x																	
Halcyonidae (Kingfishers)																																			
Blue-winged Kookaburra	*Dacelo leachii*	CI 5							x		x	x	x	x										x		x		x		x	x	x			
Red-backed Kingfisher	*Todiramphus pyrrhopygia*	CI 5			x	x			x		x	x	x	x	x	x	x	x						x	x		x	x		x	x	x	x	x	
Sacred Kingfisher	*Todiramphus sanctus*	CI 5							x		x	x						x	x									x		x	x	x			x
Meropidae (Bee-eaters)																																			
Rainbow Bee-eater	*Merops ornatus*	CI 4					x	x			x	x	x	x	x			x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Climacteridae (Treecreepers)																																			
Black-tailed Treecreeper	*Climacteris melanura*	CI 5	x					x		x	x	x					x																		
Maluridae (Fairy-wrens)																																			
Splendid Fairy-wren	*Malurus splendens*	CI 5					x																							x			x	x	
Variegated Fairy-wren	*Malurus lamberti*	CI 5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
White-winged Fairy-wren	*Malurus leucopterus*	CI 5				x	x	x	x	x	x	x	x	x	x	x	x	x	x					x			x	x	x	x	x	x	x	x	
Rufous-crowned Emu-wren	*Stipiturus ruficeps*	CI 5						x	x				x			x	x									x								x	
Striated Grasswren	*Amytornis striatus*	CI 5	x	x	x	x		x	x	x		x	x	x	x	x	x	x					x		x	x	x		x	x	x	x			x	
Pardalotidae (Pardalotes and Thornbills)																																			
Red-browed Pardalote	*Pardalotus rubricatus*	CI 5						x	x	x	x	x	x	x	x			x		x			x		x	x	x	x	x	x	x	x		x	
Striated Pardalote	*Pardalotus striatus*	CI 5	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x								x	x	x	x	x	x	x		x	
Redthroat	*Pyrrholaemus brunneus*	CI 5					x																										x	x	
Weebill	*Smicrornis brevirostris*	CI 5		x		x	x	x	x		x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Western Gerygone	*Gerygone fusca mungi*	CI 5						x		x	x		x	x		x				x	x		x		x			x		x		x	x	x	x
Inland Thornbill	*Acanthiza apicalis*	CI 5					x	x	x		x			x		x			x		x	x								x			x	x	
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	CI 5		x		x	x	x	x	x					x			x		x	x						x		x	x	x	x	x	x
Slaty-backed Thornbill	*Acanthiza robustirostris*	CI 5	x				x	x	x							x															x		x	x	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	CI 5	x					x	x	x																				x			x	x	
Southern Whiteface	*Aphelocephala leucopsis*	CI 5																															x		
Meliphagidae (Honeyeaters)																																			
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	CI 5		x			x	x	x		x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Yellow-throated Miner	*Manorina flavigula*	CI 5		x			x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Singing Honeyeater	*Lichenostomus virescens*	CI 5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
Grey-headed Honeyeater	*Lichenostomus keartlandi*	CI 5		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x	x
White-plumed Honeyeater	*Lichenostomus penicillatus*	CI 5		x			x	x	x	x	x	x	x	x	x			x	x		x		x	x	x			x		x	x	x	x	x	x
Black-chinned Honeyeater	*Melithreptus gularis*	CI 5	x				x	x			x		x	x	x	x	x	x								x	x	x		x	x	x		x	x
Brown Honeyeater	*Lichmera indistincta*	CI 5		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x		x		x	x	x	x	x	x	x	x			x
White-fronted Honeyeater	*Phylidonyris albifrons*	CI 5	x	x	x	x	x		x	x				x				x												x	x	x	x		
Grey Honeyeater	*Conopophila whitei*	CI 5	x							x																							x		
Black Honeyeater	*Certhionyx niger*	CI 5			x	x					x	x						x											x	x	x	x	x		
Pied Honeyeater	*Certhionyx variegatus*	CI 5			x		x					x						x		x	x						x			x	x	x	x		
Crimson Chat	*Epthianura tricolor*	CI 5	x		x	x			x	x	x	x	x					x		x			x		x	x	x		x	x	x	x	x	x	
White-fronted Chat	*Epthianura albifrons*	CI 5	x																																
Orange Chat	*Epthianura aurifrons*	CI 5	x																																
Petroicidae (Australian Robins)																																			
Red-capped Robin	*Petroica goodenovii*	CI 5		x	x	x	x	x	x	x	x			x	x	x	x	x		x				x			x			x	x	x	x	x	
Hooded Robin	*Petroica cucullata*	CI 5	x	x				x	x		x	x	x					x	x	x		x			x	x	x	x	x	x	x	x	x	x	x
Pomatostomidae (Australian Babblers)																																			

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Grey-crowned Babbler	*Pomatostomus temporalis*	CI 5	x					x	x	x	x	x	x	x	x	x		x			x		x	x	x			x	x	x	x	x	x	x	x
White-browed Babbler	*Pomatostomus superciliosus*	CI 5					x	x	x											x										x	x		x	x	x
Cinclosomatidae (Quail-thrushes and Allies)																																			
Chiming Wedgebill	*Psophodes occidentalis*	CI 5																	x	x															
Chestnut-breasted Quail-thrush	*Cinclosoma castaneothorax*	CI 5	x							x																									
Neosittidae (Sittellas)																																			
Varied Sittella	*Daphoenositta chrysoptera*	CI 5						x		x	x							x									x				x			x	
Pachycephalidae (Whistlers)																																			
Crested Bellbird	*Oreoica gutturalis*	CI 5	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x			x	x	x	x	x	x	x		x	x	x
Rufous Whistler	*Pachycephala rufiventris*	CI 5	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x
Grey Shrike-thrush	*Colluricincla harmonica*	CI 5		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	x	x	x	x	x
Dicruridae (Flycatchers)																																			
Magpie-Lark	*Grallina cyanoleuca*	CI 5					x	x	x		x	x	x	x	x	x	x	x	x	x	x			x	x		x	x		x	x	x	x	x	x
Grey Fantail	*Rhipidura fuliginosa*	CI 5	x				x	x			x					x					x						x			x			x	x	x
Willie Wagtail	*Rhipidura leucophrys*	CI 5		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Campephagidae (Cuckoo-shrikes)																																			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	CI 5		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
Ground Cuckoo-shrike	*Coracina maxima*	CI 5					x	x						x	x			x									x			x	x	x		x	x
White-winged Triller	*Lalage tricolor*	CI 5			x	x		x	x		x	x	x	x	x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x	x
Artamidae (Woodswallows)																																			
Masked Woodswallow	*Artamus personatus*	CI 5	x					x	x		x																x		x	x					
Black-faced Woodswallow	*Artamus cinereus*	CI 5	x	x		x	x	x	x		x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x
Little Woodswallow	*Artamus minor*	CI 5		x	x	x		x	x		x		x	x	x	x	x	x						x	x	x	x	x	x	x	x	x	x	x	x
Grey Butcherbird	*Cracticus torquatus*	CI 5		x			x	x	x		x				x	x	x	x	x	x	x	x		x			x	x		x	x	x	x	x	x
Pied Butcherbird	*Cracticus nigrogularis*	CI 5		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x		x		x	x	x	x	x	x	x	x	x	x	x
Australian Magpie	*Cracticus tibicen*	CI 5		x		x	x	x	x		x	x	x	x	x	x	x	x			x	x		x	x		x	x		x	x	x	x	x	x
Corvidae (Ravens and Crows)																																			
Little Crow	*Corvus bennetti*	CI 5	x								x										x	x				x								x	
Torresian Crow	*Corvus orru*	CI 5	x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x
Ptilonorhynchidae (Bowerbirds)																																			
Western Bowerbird	*Chlamydera guttata*	CI 5				x	x	x			x	x	x	x	x	x	x	x						x		x	x	x	x	x	x	x	x	x	x
Hirundinidae (Swallows)																																			
White-backed Swallow	*Cheramoeca leucosternus*	CI 5		x		x					x			x	x			x																	
Tree Martin	*Hirundo nigricans nigricans*	CI 5				x		x			x	x						x				x					x			x	o	x			

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Fairy Martin	*Hirundo ariel*	CI 5				x			x			x												x	x	x	x	x			o	x			x
Welcome Swallow	*Hirundo neoxena*	CI 5																									x								
Sylviidae (Old World Warblers)																																			
Spinifex Bird	*Eremiornis carteri*	CI 5		x	x	x		x	x	x	x	x	x	x	x	x	x	x						x	x		x	x	x	x	x	x	x		x
Little Grassbird	*Megalurus gramineus*	CI 5																																	
Clamorous Reed Warbler	*Acrocephalus australis*	CI 5											x																			x			
Alauidae (Song Larks)																																			
Rufous Songlark	*Cincloramphus mathewsi*	CI 5						x	x		x	x	x		x		x	x						x	x	x	x	x		x	x		x		x
Brown Songlark	*Cincloramphus cruralis*	CI 5										x			x			x													o		x		x
Singing Bushlark	*Mirafra javanica*	CI 5															x									x		x		x	x	x	x		
Dicaeidae (Flower-peckers)																																			
Mistletoebird	*Dicaeum hirundinaceum*	CI 5			x		x	x	x		x		x	x	x	x	x	x						x			x	x	x		x	x		x	x
Passeridae (Finches and Allies)																																			
Zebra Finch	*Taeniopygia guttata*	CI 5		x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Star Finch	*Neochmia ruficauda clarescens*	CI 2								x	x					x	x											x			o	x			
Painted Finch	*Emblema pictum*	CI 5			x	x		x			x	x	x	x	x	x	x	x		x				x	x	x	x	x	x	x	x	x	x	x	x
Motacillidae (Pipits and True Wagtails)																																			
Richard's Pipit	*Anthus novaeseelandiae*	CI 5		x	x	x			x			x		x	x			x	x	x			x	x	x	x	x			x	x	o	x	x	

FISH

FAMILY GROUPS	SCIENTIFIC NAME	Status	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Plotosidae (Eeltail Catfish)																																			
	Neosilurus hyrtlii	-	x																																
Pseudomugilidae																																			
	Melanotaenia australis	-	x																																
Terapontidae (Grunters)																																			
	Amniataba percoides	-	x																																
Spangled perch	*Leiopotherapon unicolor*	-	x																													x			

Key

A	Western Australian Museum Records
B	Jimblebar (Endersby 1994)
C	Orebody 18 (*ecologia* Environment 1995);

MUNJINA AND MINISTERS NORTH (YANDI HUB)
FAUNA ASSESSMENT

APPENDIX I

FAMILY GROUPS	SCIENTIFIC NAME	Status A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
D	Orebody 25 (ecologia Environment 1995);																																	
E	East Angelas (ecologia Environment 1995);																																	
F	Mining Area C (ecologia Environment 1998);																																	
G	Mount Whaleback Phase II (*ecologia* Environment 1998);																																	
H	West Angelas, (*ecologia* Environment 1998);																																	
I	Weeli Wolli (*ecologia* Environment 1998);																																	
J	Marillana Creek (HGM 1999);																																	
K	Yandi LOM (Maunsell 2003)																																	
L	Orebody 24 Phase I (*ecologia* Environment 2004);																																	
M	Jimblebar Wheelarra Hill (*ecologia* Environment 2004);																																	
N	Area C deposits D, E, and F(*ecologia* Environment 2004);																																	
O	Packsaddle Range, (*ecologia* Environment 2004);																																	
P	East Ophthalmia Range (*ecologia* Environment 2004);																																	
Q	East Jimblebar (*ecologia* Environment 2005);																																	
R	Roy Hill (ecologia Environment 2005);																																	
S	Upper Marillana (ecologia Environment 2005);																																	
T	Western Ridge (ecologia Environment 2005);																																	
U	Mindy East / Coondiner (ecologia Environment 2005);																																	
V	Mount Whaleback Phase III (ENV 2006);																																	
W	Orebody 18 Phase II (ENV 2006);																																	
X	Marillana (*ecologia* Environment 2006);																																	
Y	R-Deposit Phase II (ENV 2006);																																	
Z	Orebody 24 phase II (ENV 2006);																																	
AA	Ministers North (ecologia Environment 2006);																																	
AB	Ophthalmia (ENV 2007);																																	
AC	Roy Hill (ENV 2007);																																	
AD	Mindy North/Mindy East/Coondiner (ENV 2007);																																	
AE	West Jimblebar (ENV 2007);																																	
AF	Area C West (ENV 2007);																																	
AG	Yandi Fauna (ENV 2007);																																	
AH																																		
AI																																		

APPENDIX J
MAMMAL INVENTORY

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX J

Appendix J1 - Munjina Mammal Species Inventory

Family	Scientific Name	Common Name	Status
DASYURIDAE	*Dasykaluta rosamondae*	Little Red Kaluta	CI 5
	Ningaui timealeyi	Pilbara Ningaui	CI 3
	Planigale ingrami	Long-tailed Planigale	CI 5
MACROPODIDAE	*Macropus robustus* subsp. *erubescens*	Euro	CI 5
	Macropus rufus	Red kangaroo	CI 5
EMBALLONURIDAE	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	CI 5
	Taphozous georgianus	Common Sheathtail Bat	CI 5
VESPERTILIONIDAE	*Chalinolobus gouldii*	Gould's Wattled Bat	CI 5
	Nyctophilus geoffroyi	Lesser Long-eared Bat	CI 5
	Scotorepens greyii	Little Broad-nosed Bat	CI 5
	Vespadelus finlaysoni	Finlayson’s Cave Bat	CI 5
MOLOSSIDAE	*Chaerephon jobensis*	Northern Freetail Bat	CI 5
	Mormopterus beccarii	Beccari’s Freetail Bat	CI 5
MURIDAE	**Mus musculus*	House Mouse	-
	Pseudomys chapmani	Western Pebble-mound Mouse	CI 2
	Pseudomys hermannsburgensis	Sandy Inland Mouse	CI 5
	Zyzomys argurus	Common Rock Rat	CI 3
CANIDAE	**Canis lupus* subsp. *dingo*	Dingo	-
	**Vulpes vulpes*	Red Fox	-

Family	Scientific Name	Common Name	Status
FELIDAE	**Felis catus*	House Cat	-
CAMELIDAE	**Camelus dromedarius*	One-humped Camel	-
BOVIDAE	**Bos taurus*	Cow	-

* Introduced Species

Appendix J2 - Ministers North Mammal Species Inventory

Family	Scientific Name	Common Name	Status
MACROPODIDAE	*Macropus robustus* subsp. *erubescens*	Euro	CI 5
EMBALLONURIDAE	*Taphozous georgianus*	Common Sheathtail Bat	CI 5
VESPERTILIONIDAE	*Chalinolobus gouldii*	Gould's Wattled Bat	CI 5
	Scotorepens greyii	Little Broad-nosed Bat	CI 5
	Vespadelus finlaysoni	Finlayson's Cave Bat	CI 5
MOLOSSIDAE	*Mormopterus beccarii*	Beccari's Freetail Bat	CI 5
MURIDAE	*Pseudomys chapmani*	Western Pebble-mound Mouse	CI 2
	Zyzomys argurus	Common Rock Rat	CI 3
CANIDAE	**Canis lupus* subsp. *dingo*	Dingo	-
	**Vulpes vulpes*	Red Fox	-
FELIDAE	*Felis catus	House Cat	-
BOVIDAE	*Bos taurus	Cow	-

* Introduced Species

APPENDIX K
REPTILE INVENTORY

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX K

Appendix K1 - Munjina Reptile Species Inventory

Family	Scientific Name	Common Name	Status
AGAMIDAE	*Amphibolurus longirostris*	Long-nosed Dragon	-
	Ctenophorus caudicinctus	Ring-tailed Dragon	-
	Ctenophorus isolepis subsp. *isolepis*	Central Military Dragon	-
	Diporiphora valens	-	-
	Diporiphora winneckei	Canegrass Dragon	-
	Pogona minor subsp. *minor*	Bearded Dragon	-
GEKKONIDAE	*Crenadactylus ocellatus* subsp. *horni*	Clawless Gecko	-
	Diplodactylus conspicillatus	Fat-tailed Gecko	-
	Diplodactylus stenodactylus	Sand-plain Gecko	-
	Diplodactylus wombeyi	-	CI 3
	Gehyra variegata	Tree Dtella	-
	Gehyra pilbara	Pilbara Dtella	-
	Gehyra punctata	Spotted Dtella	-
	Heteronotia binoei	Bynoe's Gecko	-
	Oedura marmorata	Marbled Velvet Gecko	-
	Rhynchoedura ornata	Beaked Gecko	-
	Strophurus elderi	Jewelled Gecko	-
	Strophurus wellingtonae	Spiny-tailed Gecko	-
PYGOPODIDAE	*Delma butleri*	-	-

Family	Scientific Name	Common Name	Status
	Delma haroldi	-	-
	Lialis burtonis	Burton's Legless Lizard	-
	Pygopus nigriceps	Western Hooded Scaly-foot	-
SCINCIDAE	*Carlia munda*	-	CI 3
	Ctenotus helenae	-	-
	Ctenotus pantherinus subsp. *ocellifer*	Leopard Skink	-
	Ctenotus rutilans	-	-
	Ctenotus saxatilis	Rock Ctenotus	-
	Cyclodomorphus melanops subsp. *melanops*	Northern Slender Blue-tongue	-
	Eremiascincus richardsonii	Broad-banded Sand-swimmer	-
	Lerista muelleri	Dwarf Three-toed Slider	CI 3
	Menetia greyii	Common Dwarf Skink	-
	Morethia ruficauda subsp. *exquisita*	Fire-tailed Skink	CI 3
	Tiliqua multifasciata	Central Blue-tongue	-
VARANIDAE	*Varanus acanthurus*	Ridge-tailed Monitor	-
	Varanus gilleni	Pygmy Mulga Monitor	-
	Varanus panoptes subsp. *rubidus*	Yellow-spotted Monitor	-
TYPHLOPIDAE	*Ramphotyphlops ammodytes*	-	CI 3
	Ramphotyphlops grypus	Beaked Blind Snake	-
ELAPIDAE	*Acanthophis wellsi*	Pilbara Death Adder	CI 3
	Brachyurophis approximans	Shovel-nosed Snake	-
	Pseudonaja modesta	Ringed Brown Snake	-
	Suta fasciata	Rosen's Snake	-

Appendix K2 – Ministers North Reptile Species Inventory

Family	Scientific Name	Common Name	Status
AGAMIDAE	*Amphibolurus longirostris*	Long-nosed Dragon	-
	Ctenophorus caudicinctus	Ring-tailed Dragon	-
	Ctenophorus isolepis subsp. *isolepis*	Military Dragon	-
GEKKONIDAE	*Gehyra punctata*	Spotted Dtella	-
	Gehyra variegata	Tree Dtella	-
	Heteronotia spelea	Desert Cave Gecko	CI 3
	Oedura marmorata	Marbled Velvet Gecko	-
SCINCIDAE	*Cryptoblepharus plagiocephalus*	Fence or Wall Skink	-
	Ctenotus saxatilis	Rock Ctenotus	-
	Eremiascincus fasciolatus	Narrow-banded Sand-swimmer	-
VARANIDAE	*Varanus pilbarensis*	Pilbara Rock Monitor	CI 3
ELAPIDAE	*Pseudechis australis*	Mulga Snake	-

APPENDIX L
AMPHIBIAN INVENTORY

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX L

Appendix L1 - Munjina Amphibian Species Inventory

Family	Scientific Name	Common Name	Status
HYLIDAE	*Litoria rubella*	Inland Tree Frog	CI 5

APPENDIX M
BIRD INVENTORY

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX M

Appendix M1 - Munjina Bird Species Inventory

Family	Scientific Name	Common Name	Status
CASUARIIDAE	*Dromaius novaehollandiae*	Emu	CI 5
PHASIANIDAE	*Coturnix ypsilophora*	Brown Quail	CI 5
ACCIPITRIDAE	*Accipiter cirrocephalus*	Collared Sparrowhawk	CI4
	Aquila audax	Wedge-tailed Eagle	CI 4
	Circus assimilis	Spotted Harrier	CI 4
	Elanus caeruleus	Black-shouldered Kite	CI 4
	Haliastur sphenurus	Whistling Kite	CI 4
	Hamirostra melanosternon	Black-breasted Buzzard	CI 4
	Milvus migrans	Black Kite	CI 4
FALCONIDAE	*Falco berigora*	Brown Falcon	CI 4
	Falco cenchroides	Nankeen Kestrel	CI 4
OTIDIDAE	*Ardeotis australis*	Australian Bustard	CI 2
TURNICIDAE	*Turnix velox*	Little Button-quail	CI 5
CACATUIDAE	*Cacatua roseicapilla*	Galah	CI 5
	Cacatua sanguinea	Little Corella	CI 5
	Nymphicus hollandicus	Cockatiel	CI 5
COLUMBIDAE	*Geopelia cuneata*	Diamond Dove	CI 5

Family	Scientific Name	Common Name	Status
	Geopelia striata	Peaceful Dove	CI 5
	Geophaps plumifera	Spinifex Pigeon	CI 5
	Ocyphaps lophotes	Crested Pigeon	CI 5
	Phaps chalcoptera	Common Bronzewing	CI 5
CACATUIDAE	*Cacatua roseicapilla*	Galah	CI 5
	Cacatua sanguinea	Little Corella	CI 5
PSITTACIDAE	*Barnardius zonarius* subsp. *zonarius*	Australian Ringneck	CI 5
	Melopsittacus undulatus	Budgerigar	CI 5
	Neophema bourkii	Bourke's Parrot	CI 5
	Nymphicus hollandicus	Cockatiel	CI 5
STRIGIDAE	*Ninox novaeseelandiae*	Southern Bookook Owl	CI 5
TYTONIDAE	*Tyto alba*	Barn Owl	CI 5
CAPRIMULGIDAE	*Eurostopodus argus*	Spotted Nightjar	CI 5
AEGOTHELIDAE	*Aegotheles cristatus*	Australian Owlet-nightjar	CI 5
HALCYONIDAE	*Todiramphus sanctus*	Sacred Kingfisher	CI 5
MEROPIDAE	*Merops ornatus*	Rainbow Bee-eater	CI 4
MALURIDAE	*Malurus lamberti*	Variegated Fairy-wren	CI 5
PARDALOTIDAE	*Gerygone fusca*	Western Gerygone	CI 5
	Smicrornis brevirostris	Weebill	CI 5
MELIPHAGIDAE	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	CI 5

Family	Scientific Name	Common Name	Status
	Lichenostomus keartlandi	Grey-headed Honeyeater	CI 5
	Lichenostomus penicillatus	White-plumed Honeyeater	CI 5
	Lichenostomus virescens	Singing Honeyeater	CI 5
	Lichmera indistincta	Brown Honeyeater	CI 5
	Manorina flavigula	Yellow-throated Miner	CI 5
PETROICIDAE	*Petroica cucullata*	Hooded Robin	CI 5
POMATOSTOMIDAE	*Pomatostomus superciliosus*	White-browed Babbler	CI 5
	Pomatostomus temporalis	Grey-crowned Babbler	CI 5
PACHYCEPHALIDAE	*Colluricincla harmonica*	Grey Shrike-thrush	CI 5
	Oreoica gutturalis	Crested Bellbird	CI 5
	Pachycephala rufiventris	Rufous Whistler	CI 5
DICRURIDAE	*Grallina cyanoleuca*	Magpie-lark	CI 5
	Rhipidura fuliginosa	Grey Fantail	CI 5
	Rhipidura leucophrys	Willie Wagtail	CI 5
CAMPEPHAGIDAE	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	CI 5
	Lalage tricolor	White-winged Triller	CI 5
ARTAMIDAE	*Artamus cinereus*	Black-faced Woodswallow	CI 5
	Artamus minor	Little Woodswallow	CI 5
	Cracticus nigrogularis	Pied Butcherbird	CI 5
	Cracticus tibicen	Australian Magpie	CI 5

Family	Scientific Name	Common Name	Status
	Cracticus torquatus	Grey Butcherbird	CI 5
CORVIDAE	*Corvus orru*	Torresian Crow	CI 5
HIRUNDINIDAE	*Hirundo ariel*	Fairy Martin	CI 5
SYLVIIDAE	*Cincloramphus cruralis*	Brown Songlark	CI 5
	Cincloramphus mathewsi	Rufous Songlark	CI 5
	Eremiornis carteri	Spinifexbird	CI 5
DICAEIDAE	*Dicaeum hirundinaceum*	Mistletoebird	CI 5
PASSERIDAE	*Emblema pictum*	Painted Finch	CI 5
	Taeniopygia guttata	Zebra Finch	CI 5

Appendix M2 - Ministers North Bird Species Inventory

Family	Scientific Name	Common Name	Status
ACCIPITRIDAE	*Aquila audax*	Wedge-tailed Eagle	CI 4
	Circus assimilis	Spotted Harrier	CI 4
	Elanus caeruleus	Black-shouldered Kite	CI 4
	Haliastur sphenurus	Whistling Kite	CI 4
	Milvus migrans	Black Kite	CI 4
FALCONIDAE	*Falco berigora*	Brown Falcon	CI 4
	Falco cenchroides	Australian Kestrel	CI 4
	Falco longipennis	Australian Hobby	CI 4
TURNICIDAE	*Turnix velox*	Little Button-quail	CI 5

Family	Scientific Name	Common Name	Status
CACATUIDAE	*Cacatua roseicapilla*	Galah	CI 5
	Cacatua sanguinea	Little Corella	CI 5
COLUMBIDAE	*Geopelia cuneata*	Diamond Dove	CI 5
	Geopelia striata	Peaceful Dove	CI 5
	Geophaps plumifera	Spinifex Pigeon	CI 5
	Phaps chalcoptera	Common Bronzewing	CI 5
	Ocyphaps lophotes	Crested Pigeon	CI 5
CACATUIDAE	*Cacatua roseicapilla*	Galah	CI 5
	Cacatua sanguinea	Little Corella	CI 5
PSITTACIDAE	*Barnardius zonarius* subsp. *zonarius*	Australian Ringneck	CI 5
STRIGIDAE	*Ninox novaeseelandiae*	Southern Bookook Owl	CI 5
CAPRIMULGIDAE	*Eurostopodus arsgus*	Spotted Nightjar	CI 5
HALCYONIDAE	*Todiramphus sanctus*	Sacred Kingfisher	CI 5
MEROPIDAE	*Merops ornatus*	Rainbow Bee-eater	CI 4
MALURIDAE	*Malurus lamberti*	Variegated Fairy-wren	CI 5
PARDALOTIDAE	*Acanthiza uropygialis*	Chestnut-rumped Thornbill	CI 5
	Smicrornis brevirostris	Weebill	CI 5
MELIPHAGIDAE	*Lichenostomus keartlandi*	Grey-headed Honeyeater	CI 5
	Lichmera indistincta	Brown Honeyeater	CI 5
	Manorina flavigula	Yellow-throated Miner	CI 5

Family	Scientific Name	Common Name	Status
	Melithreptus gularis	Black-chinned Honeyeater	CI 5
PETROICIDAE	*Petroica cucullata*	Hooded Robin	CI 5
PACHYCEPHALIDAE	*Colluricincla harmonica*	Grey Shrike-thrush	CI 5
	Pachycephala rufiventris	Rufous Whistler	CI 5
DICRURIDAE	*Grallina cyanoleuca*	Magpie-lark	CI 5
	Rhipidura fuliginosa	Grey Fantail	CI 5
	Rhipidura leucophrys	Willie Wagtail	CI 5
CAMPEPHAGIDAE	*Coracina maxima*	Ground Cuckoo-shrike	CI 5
	Coracina novaehollandiae	Black-faced Cuckoo-shrike	CI 5
	Lalage tricolor	White-winged Triller	CI 5
ARTAMIDAE	*Artamus cinereus*	Black-faced Woodswallow	CI 5
	Artamus minor	Little Woodswallow	CI 5
	Cracticus tibicen	Australian Magpie	CI 5
CORVIDAE	*Corvus orru*	Torresian Crow	CI 5
PTILONORHYNCHIDAE	*Chlamydera guttata*	Western Bowerbird	CI 5
DICAEIDAE	*Dicaeum hirundinaceum*	Mistletoebird	CI 5
PASSERIDAE	*Emblema pictum*	Painted Finch	CI 5
	Taeniopygia guttata	Zebra Finch	CI 5

APPENDIX N

LOCATIONS OF ACTIVE PEBBLE MOUNDS

MUNJINA AND MINISTERS NORTH (YANDI HUB) FAUNA ASSESSMENT

APPENDIX N

Appendix N1 - Locations of Active Pebble Mounds at Munjina

Active Pebble Mound	#GPS Coordinates	
	Easting	Northing
PM1	692432	7491858

Australian Geocentric 1994 (GDA94) Zone 50K

Appendix N2 - Locations of Active Pebble Mounds at Minsters North

Active Pebble Mound	#GPS Coordinates	
	Easting	Northing
PM1	714724	7474830
PM2	715976	7476160
PM3	716076	7474810
PM4	716284	7476155
PM5	717442	7474606
PM6	717374	7474607
PM7	717450	7475142
PM8	717451	7475197
PM9	715795	7473097
PM10	715976	7472615
PM11	717588	7474950

Australian Geocentric 1994 (GDA94) Zone 50K

July 2006



BHP Billiton Iron Ore

MINISTERS NORTH BIOLOGICAL SURVEY

Providing sustainable environmental strategies, management and monitoring solutions to industry and government.

ecologia
ENVIRONMENT

1025 Wellington Street WEST PERTH WA 6005 phone: 9322 1944 fax: 9322 1599 ACN 088 821 425 ABN 63 088 821 425

www.ecologia.com.au

Document Status					
Rev No.	**Author**	**Reviewer**	**Approved for Issue**		
			Name	**Distributed to**	**Date**
1	S Perks J Turpin M O'Connell A Capobianco	M. C. Cox	J. Turpin	S. Harrison S. Cancio-Newton P. Lilley	06/07/06
2	J Turpin	M. C. Cox	J. Turpin	S. Harrison S. Cancio-Newton P. Lilley	13/07/06

Restrictions on Use

This report has been prepared specifically for BHP Billiton Iron Ore. Neither the report nor its contents may be referred to or quoted in any statement, study, report, application, prospectus, loan, or other agreement document, without the express approval of *ecologia* Environment and/or BHP Billiton Iron Ore.

ecologia Environment
1025 Wellington Street
West Perth WA 6005
Ph: 08 9322 1944
Fax: 08 9322 1599
Email: ecologia@ecologia.com.au

Table of Contents

TABLES

FIGURES

PLATES

EXECUTIVE SUMMARY

BHPBIO has access to a number of leases in the East Pilbara that are being actively explored for iron ore as part of potential future expansion of existing mining operations. BHPBIO holds exploration licences for Ministers North, which is located approximately 85 km north-west of Newman. Although exact disturbance areas have yet to be finalised, BHPBIO contracted *ecologia* Environment to conduct a biological survey of these areas in preparation for exploratory drilling. The objectives of the survey were to:

- Survey the flora and vegetation of the proposed drill pad areas to determine whether any species or ecological communities of conservation significance occurred, and if present, indicate management options to prevent or minimise the impacts due to disturbance.

- Survey the terrestrial vertebrate fauna in the habitat types of each proposed drill pad area and determine the likely impacts of clearing disturbance and possible management requirements.

A baseline survey of the vascular flora of the Ministers North exploration area was undertaken between 10th May 2006 and 14th May 2006.

One hundred and twenty five flora taxa were recorded at Ministers North including subspecies, varieties, forms and affinities. The taxa comprised 37 families, 72 genera and 125 species. The most species rich plant families were Poaceae (20 taxa) and Malvaceae (10 taxa), while the most species rich genera were *Acacia* (12 taxa) and *Eriachne* (6 taxa): 17 families and 51 genera were represented by a single taxon.

A population of a Priority 3 taxon, *Triumfetta leptacantha,* was recorded at drill location PMNO1, which consisted of at least 15 plants.

A vertebrate fauna survey of the Ministers North project area was undertaken between 10th May 2006 and 14th May 2006. The exploration area encompasses three fauna habitats; gorges/deep gullies, minor drainage lines and shallow hills. Prior to the current survey, a list was prepared of 358 fauna taxa that had been recorded previously in the surrounding area. The list included 57 mammals, 164 birds, 129 reptiles and eight frog species (Appendix D).

The current Ministers North survey recorded 71 species, including 18 reptiles, 42 birds, 10 mammals and one frog (Appendix D). Due to temporal and spatial variations in fauna population numbers and the limitations of a non-systematic sampling methodology, it is unlikely that all vertebrate fauna species with potential to occur would be detected in the project area during the course of a single fauna survey.

One fauna species of conservation significance was recorded at Ministers North; evidence of the Western Pebble-mound Mouse (*Pseudomys chapmani*) (priority 4) was found in the form of potentially active burrows at numerous locations (PMN 4, 8, 10, 11, 15, 17, 18, 19, 21).

RECOMMENDATIONS

Design Level

RECOMMENDATION 1
Limit vegetation clearing to within the areas surveyed by *ecologia*. This will ensure that any significant species occurring outside the study area will not be impacted.

RECOMMENDATION 2
Minimise clearing to that which is absolutely necessary. Drill pads should be no larger than 30 x 20 m and existing access tracks should be used where possible. Additional tracks to access drill lines should not be made. Where it is necessary to create a track to access a drill line (sites PMN04, PMN05), disturbance should be restricted to the designated route which has been searched for flora of conservation significance.

RECOMMENDATION 3
Construct access tracks only in the areas surveyed by *ecologia*. The routes for access tracks to sites PMN04 and 05 were flagged and surveyed (to a maximum width of 10 m) by *ecologia*. Tracks should be constructed only along the routes surveyed, to prevent disturbance to areas not checked for flora of significance.

RECOMMENDATION 4
Remove the minimum amount of topsoil as possible. Minimal topsoil disturbance will encourage natural regeneration due to retention of the seed store and micobiological activity, which is largely confined to the topsoil. Achieving minimum disturbance will also discourage weeds and other species which proliferate following disturbance.

RECOMMENDATION 5
Minimise the height of stockpiles of soil and cleared vegetation. Multiple smaller stockpiles, dispersed at regular intervals along the length of the edges of cleared areas, are preferable to a single stockpile. Lower stockpiles allow greater retention of biological activity within the soil (bacteria, fungi and lichen), which improves seed germination rates once the soil is respread.

RECOMMENDATION 6
Avoid impacting Western Pebble-mound Mouse burrow systems. This includes 'inactive' mounds which may be re-colonised. Drilling and track placement should be excluded within a 20 m radius of Western Pebble-mound Mouse mounds and areas containing mounds should be clearly marked. Western Pebble-mound Mouse mounds were located at sites PMN 4, 8, 10, 11, 15, 17, 18, 19, and 21.

RECOMMENDATION 7
Avoid the clearance of any priority flora. Approximately 15 individuals of *Triumfetta leptacantha* (Priority 3) were recorded at site PMN01 at location 50K, 714217E, 7474561N (AGD84); this area should not be cleared.

RECOMMENDATION 8
Avoid disturbance to caves and gorges (significant habitat for species of conservation concern). Caves may provide permanent or temporary roosts for Ghost Bats and Orange Leaf-nosed Bats, and gorges may provide habitat for Olive Pythons, Peregrine Falcons and short-range endemic fauna. Such habitat is found at PMN01, 02, 05, 09, 12 and 13. Drilling should be avoided at sites PMN01 and PMN13 where numerous caves and gorges occur.

RECOMMENDATION 9
Avoid drilling near caves. Caves may provide habitat for species of conservation significance, including temporary roosts for many bat species. It is recommended that drilling be avoided at PMN01 and 02.

Management Level

RECOMMENDATION 10
BHPBIO should continue to implement existing environmental procedures for staff and contractors. These include managing the risk of fire, the spread of weeds (particularly Buffel grass, Ruby dock and Bipinnate beggartick) and encouraging general environmental impact awareness.

RECOMMENDATION 11
BHPBIO should develop and implement policies which specifically address the reduction of impacts to the Western Pebble-mound Mouse.

1.0 INTRODUCTION

1.1 Project Background

Ministers North is a proposed mining operation located approximately 85 km north-west of Newman and is covered by Exploration Licences E47/628 (**Error! Reference source not found.**).

The Newman area currently supports high levels of mining activity and BHP Billiton Iron Ore (BHPBIO) manages a number of operations in the area including Yandi, Mining Area C, Mt Whaleback and Jimblebar. BHPBIO is proposing to carry out track clearance and exploration drilling operations at the proposed Ministers North project area.

1.2 Objectives

BHPBIO commissioned *ecologia* Environment (*ecologia*) to undertake a baseline biological investigation of the flora and fauna of the Ministers North exploration area. The investigation includes flora and fauna surveys of a single drill pattern. This report also comprises a review of the previous surveys undertaken within 100 km of the exploration area.

The study was conducted to assist with the assessment of the potential impacts of exploration activity on flora and fauna. This report provides:

(a) An inventory of:

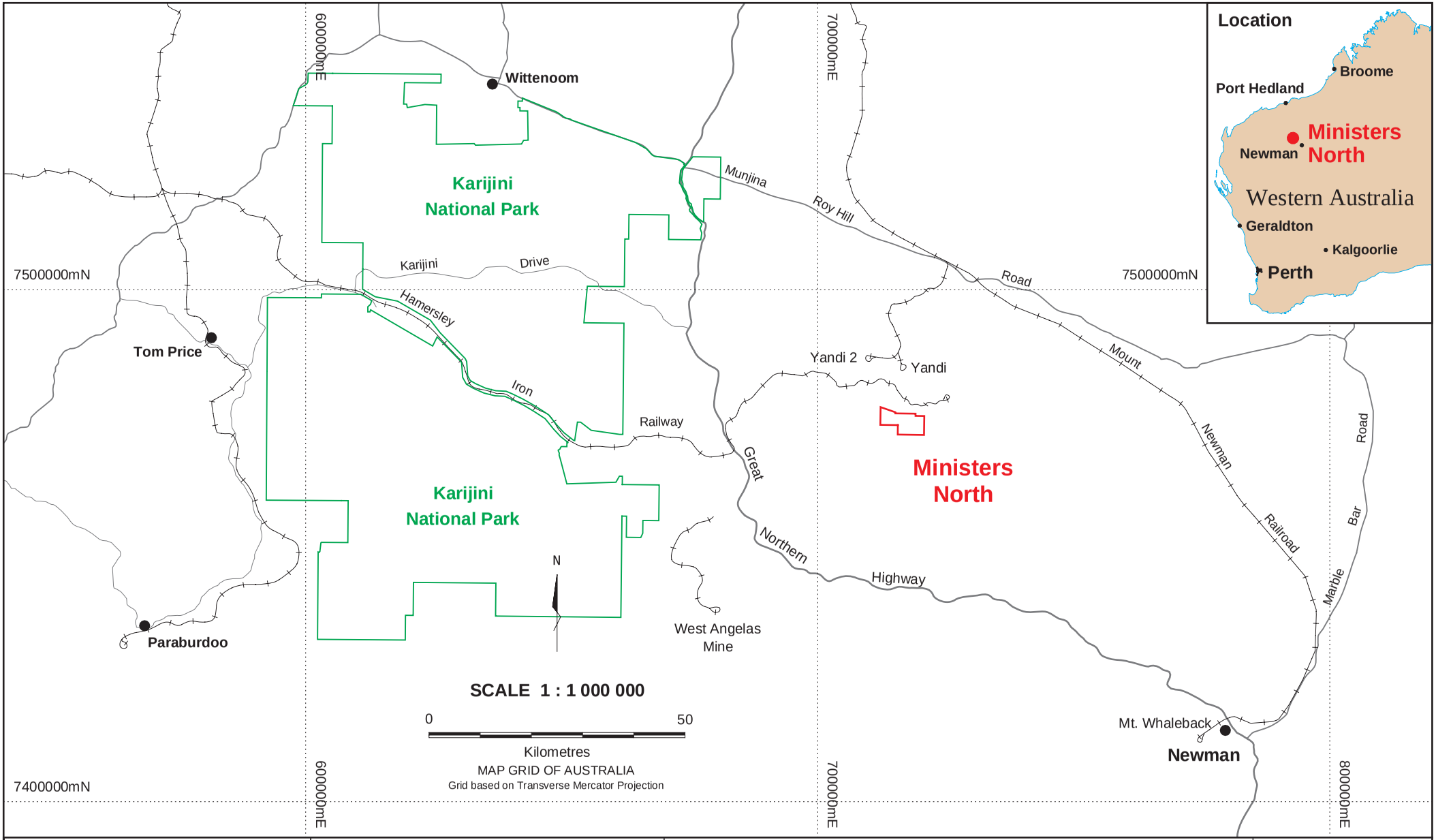
- Vascular flora and vertebrate fauna species occurring in the study area, incorporating recent published and unpublished records;
- Biologically significant species, including rare flora and fauna in the study area;
- Vegetation associations and fauna communities occurring in the study area; and
- Habitats and vegetation associations in the study area that are poorly represented, or that are essential to the survival of rare flora or fauna.

(b) A review of:

- Fauna populations and habitats in the broader study area;
- Regional and local conservation value of flora and fauna present, or likely to be present, in the study area;
- Flora and fauna species of particular conservation value, such as Scheduled or Priority species, likely to occur in the study area;
- Current impact of the land-use on fauna habitats and vegetation associations; and
- Other potential impacts on the existing environment.

(c) Recommendations for:

- Fauna and fauna habitat management and the management of under-represented vegetation associations that will accommodate future land use practices;
- Priority Flora and weed management; and
- Management of current and future potential impacts on the existing environment.



ecologia ENVIRONMENT	Client: BHP BILLITON	REGIONAL LOCATION	Date: 13 July 2006
			Scale: 1: 1 Million
	Project: MINISTERS NORTH		Figure No. 1.1
Author: J.Turpin / Drawn: S.Coleman		A4	Plan No. MN-002

2.0 EXISTING ENVIRONMENT

2.1 Climate

The Ministers North exploration area is situated in the Pilbara region of Western Australia and experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September. Annual evaporation exceeds rainfall by as much as 500 mm per year. Seasonally low but unreliable rainfall, together with high temperatures and high diurnal temperature variations, are also characteristic climatic features of the region. In the past this region has received no rainfall during any month of the year, which is typical of a desert climate (Beard, 1975). Within the Pilbara, the temperature range is large and maxima are high. Summer temperatures may reach as high as 49°C, with a mean maximum of 30°C, and winter temperatures have a mean maximum of 23°C (ranging from 14–35°C). Light frosts occasionally occur during July and August. The climate experienced throughout the year is usually very dry, as both high temperatures and humidities seldom occur simultaneously.

Rainfall in the Pilbara is highly unpredictable and recordings are highest at stations around the Hamersley Ranges, which lie at altitudes of up to 900 m (Beard, 1975). The majority of the Pilbara has a 'bimodal' rainfall distribution, resulting in two rainfall maxima per year. From January to March rain results from moist tropical storms penetrating from the north, producing sporadic and drenching thunderstorms. Tropical cyclones moving south from northern Australian waters also bring sporadic heavy rains. From May to June extensive cold fronts move easterly across the state and occasionally reach the Pilbara. These fronts produce only light winter rains that are ineffective for plant growth other than herbs and grasses. Larger perennial species require the intense and prolonged storms of summer. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses only flow briefly due to the short wet season.

Within the study region, meteorological data has been recorded at the Bureau of Meteorology (BOM) weather station at Newman. This BOM weather station is located approximately 85 km south-east of the Ministers North exploration site, providing an indication of climatic conditions experienced within the project area (**Error! Reference source not found.**).

Table 2.1 Summary of climatatic data from Newman

NEWMAN	Elevation: 554 m; Location: 23°22'S 119°44'E											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
TEMPERATURE (°C)												
Daily max. (mean)	38.7	37.1	35.9	31.7	26.0	22.4	22.1	24.7	29.2	33.5	36.4	38.3
Daily min. (mean)	25.1	24.3	22.3	18.3	13.0	9.3	7.8	10.1	13.6	17.8	21.2	23.9
RAINFALL (mm)												
Mean	55	72	40	23	24	20	12	10	5	4	11	27
Mean # raindays	7	7	5	3	4	4	2	2	1	1	3	5

The calculated average annual rainfall is 303 mm, occurring over 44 rain days (**Error! Reference source not found.**). It loosely follows the typical Pilbara bimodal distribution pattern, with a peak between December and March and a smaller peak in May and June. Most of the rainfall occurs in the summer period, with over 55% of total annual precipitation occurring between December and March.

Mean annual maximum and minimum temperatures for Newman are 31.3°C and 17.2°C respectively. Mean monthly maxima range from 38.7°C during January to 22.1°C in July, while mean monthly minima range from 25.1°C in January to 7.8°C in July.

2.2 Landforms

Ministers North exploration area is situated on the Hamersley Plateau, which is marked on the western, eastern and northern boundaries by an abrupt escarpment, while the southern edge of the outcrop near the project area is blurred due to the past trend of strong folding of rock. The Hamersley Plateau is comprised mainly of the Hamersley and Ophthalmia Ranges, which are characterised by long strike ridges rising 300 m or more above the valley floors. Flats of Cainozoic sediments may be found on the valley floors, which were deposited on the less resistant units of the lower Hamersley Group (Tyler *et al*., 1991). The entire region is one of rounded ranges and hills, and does not exhibit the 'mesa-form' hills seen in the country to the north-east.

In their biological survey of the Hamersley Range National Park (Karijini National Park), Dawe and Dunlop (1983) developed a landform-vegetation classification system of nine main landforms for the region, which were further categorised into many sub-units. The Ministers North exploration area covers four of these main landforms (see Table 2.2 below):

Table 2.2 Landforms occurring within the Minister North Exploration Project Area (after Dawe and Dunlop, 1983)

Landform	Soil Type	Vegetation Unit
Low ridges, or hills	Skeletal, shallow	i. *Eucalyptus leucophloia* open low woodland over mid-dense *Triodia wiseana* or *T. basedowii* hummock grass. ii. *Acacia maitlandii* or *A. acradenia* low scrub A over mid-dense hummock grass. iii. Mid-dense *Triodia basedowii* hummock grassland.
Scree Slopes	Gibber with pockets of skeletal neutral soil	i. *Acacia bivenosa*, *A. dictyophleba*, *A. rhodophloia*, *A. kempeana* or *A. pyrifolia* scrub over mid-dense *Triodia basedowii* hummock grass. ii. Senna spp. Low scrub B over *Triodia* spp. Mid-dense hummock grass. iii. *Eucalyptus gamophylla* open shrub mallee over *Triodia basedowii* mid-dense hummock grass. iv. *Acacia hilliana* and *A. adoxa* dwarf scrub over *Triodia basedowii* mid-dense hummock grass.
Minor Drainage i. Channels	Shallow sandy soils.	i. Very open fringing woodland of *Corymbia hamersleyana*, *E. leucophloia* or *E. coolabah* over mixed scrub including *Grevillea wickhamii*, *Acacia maitlandii*, *A. tumida*, *A. dictyophleba*, *A. bivenosa* etc. over *Triodia pungens* hummock grass.

ii. Minor outwashes	Sandy loams of varying pH.	ii. Open to very open Acacia scrub *A. tenuissima*, *A. ancistrocarpa*, *A. tumida*, *A. dictyophleba*, *A. inaequilatera* over dense *Triodia pungens* hummock grass.
Gorges	Exposed rock, gravel and sand.	i. Sparse to open *Corymbia hamersleyana*, or *Eucalyptus leucophloia* over open *Acacia tumida* over open *Triodia basedowii* or *Triodia wiseana* on steeper slopes.

2.3 Soils

Ministers North lies within a large region of soils that have been classified by Bettenay *et al*. (1967) as 'loamy soils with weak pedologic development' (Um 5). At higher resolution, the area lies upon a region of 'shallow, coherent and porous loamy soils' with shallow profiles (Fa 13). This soil type is associated with the Hamersley and Ophthalmia Ranges. The soils are mainly stony, shallow loams, but there are wide areas with no or limited soil cover.

As a consequence of the sparse vegetation cover and the erosive force of heavy summer cyclonic rains, much of the soil on the hill-slopes tends to be transported down to the valleys and plains. Thus, species and associations of vegetation on the hills and slopes tend to be correlated to geology rather than soil type (Beard, 1975). Along drainage lines, superficial deposits influence the distribution of vegetation. However, the presence of surface and groundwater is also a major determining factor.

2.4 Land Systems Classification

An inventory of the land systems occurring in the Pilbara was completed by Van Vreeswyk *et al.* (2004). The survey aimed to provide a comprehensive description and mapping of the biophysical resources of the region, together with an evaluation of the condition of soils and vegetation throughout. The Ministers North exploration area lies in a region described by Van Vreeswyk *et al.* (2004) as hills and ranges with Spinifex grasslands (Land Type 1).

At a finer scale, the area is classified within the Newman system, described as rugged jaspilite plateaux, ridges and mountains supporting hard Spinifex grasslands. The Newman system is generally poorly accessible for pastoral practises and as a result 91% of the vegetation is deemed to be in very good condition. Spinifex is the dominant vegetation and the system is burnt fairly regularly. The Newman System contains iron ore deposits which are currently being mined and deposits which are likely to be mined in the future (Van Vreeswyk *et al.,* 2004).

2.5 Pilbara Biogeographic Region

Several zoogeographic regions are recognised in continental Australia. In Western Australia, regions can be most broadly defined as the mesic Bassian region of the south-west, the Torresian region of subtropical northern Western Australia, and the arid Eyrean region. The Ministers North exploration area is located with the Eyrean region.

On a finer scale, the Interim Biogeographic Regionalisation for Australia (IBRA) sees the continent divided into 85 biogeographic regions based on characteristics of climate, fauna, vegetation, landforms and geology (IBRA Version 5.1). In Western Australia, there are 26 Bioregions, and the project area falls within Pilbara region (Thackway and Cresswell, 1995; Figure 2.1).

The Pilbara biogeographic region is similar to that commonly recognised as the Pilbara region, and includes four major components; Hamersley (PL 3), Fortescue Plains (PL 2), Chichester (PL 1) and Roebourne (PL 4, see figure 2.1). Hamersley, the component relevant to this biological assessment, is summarised by Thackway and Cresswell (1995: 69) as follows:

"Mountainous areas of Proterozoic sedimentary ranges and plateaus with Mulga low woodland over bunch grasses on fine textured soils, and Snappy Gum over *Triodia* on skeletal sandy soils of the ranges".

With an area of 179,287 km^2, the Pilbara bioregion is within the largest area class. Other bioregions vary from 2,372 to 423,751 km^2 (Thackway and Cresswell, 1995), most being between 14,000 and 200,000 km^2 in size. However, the size of the Pilbara bioregion is fairly typical of bioregions situated in remote arid and semi-arid areas.

Dominant limiting factors and constraints for the Pilbara bioregion listed by Thackway and Cresswell (1995) include extinction of critical weight-range (CWR) mammals, wildfire, feral animals (in particular the cat and fox), weeds, and grazing or pastoral activities. The reservation status of the bioregion is 1-5%, which is relatively low (some bioregions have a greater than 10% reservation status).

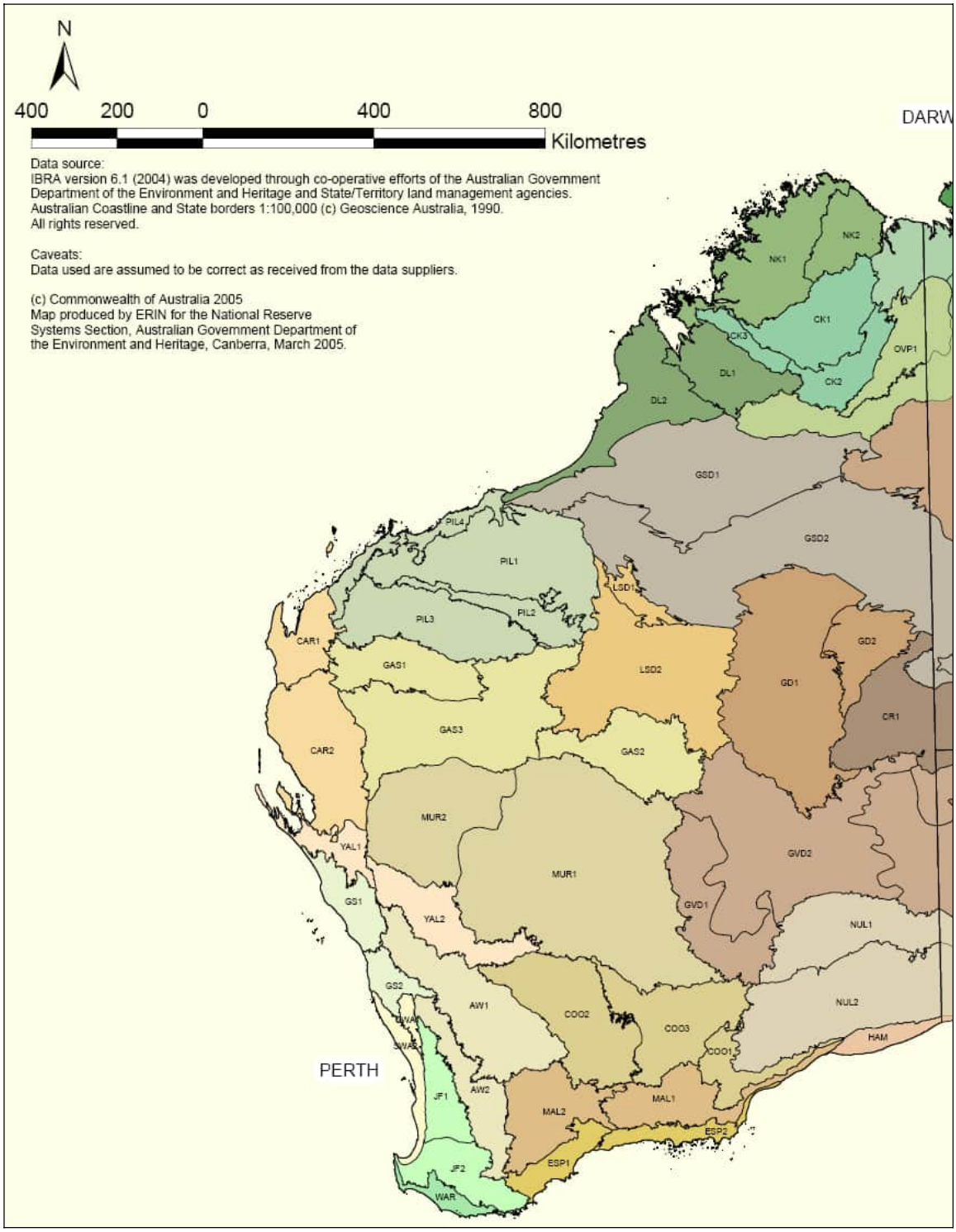


Figure 2.1 A Map of Western Australia showing the the IBRA bioregions (Environment Australia 2000) and the IBRA subregions (McKenzie *et al.* 2000), source: EPA Guidance Statement 56. Note the Pilbara bioregion is the combination of the four subregions (PL1 – PL4). The Hamersley Subregion is defined by PL3.

2.6 Previous Biological Surveys

The Pilbara is a region of considerable environmental significance, lying on the southern limits of the Northern Botanical Province (Burbidge, 1959; Beard, 1975). The region includes species from both the north-west, a region of high species endemism, and the arid interior, as well as numerous species that are either endemic to the Pilbara or have restricted geographic distributions (Beard, 1975). Beard (1975) provides a detailed account of previous exploration in the area.

Early flora survey work was carried out by Royce (1948) and Burbidge (1959), while broad scale vegetation mapping was first carried out by Burbidge (1945) and later refined by Beard (1975). However, site-specific detailed flora and fauna surveys have only been conducted in the Pilbara region during the last 20 years, prompted by the increased development of mineral resources in the region (Muir, 1983).

Work on the vertebrate fauna of the Pilbara region has largely been confined to site-specific surveys, including work at Millstream (Burbidge, 1971), Marandoo (Texasgulf Australia Ltd, 1979), Harding River (Dames and Moore, 1982) and the Deepdale area (Natural Systems Research, 1979).

Recently, more extensive biological surveys have been undertaken, and include the Karijini National Park (Muir, 1983), Burrup Peninsula (Butler, 1983; Tingay and Tingay, 1983), Pilbara wetlands (Masini, 1988; Masini and Walker, 1989) and Millstream (Dames and Moore, 1984). Several recent reports describing the vertebrate fauna of localised sites in the Pilbara have resulted from proposed or current mining activities and transport corridors, including BHP-Utah Minerals International (1987), Biota (2004), How *et al*. (1991) and Ninox Wildlife Consulting (1985, 1986, 1991).

Research projects conducted by the Department of Conservation and Land Management (CALM) and opportunistic collecting by amateur naturalists have further supplemented this information. CALM, in association with the Western Australian Museum (WAM) are currently undertaking a five year regional biological survey of the Pilbara to provide comprehensive, long-term baseline data for future management.

A small number of species-specific studies have examined aspects of the ecology of some endemic Pilbara fauna, such as the Pilbara Ningaui (*Ningaui timealeyi*) (Dunlop and Sawle, 1982) and the Western Pebble-mound Mouse (*Pseudomys chapmani*) (Dunlop and Pound, 1981).

ecologia Environment has conducted a number of biological surveys in areas adjacent to Ministers North. These include Yandi to the north (*ecologia*, 1995c, 1998f, 2002, 2003, 2004d, 2006b) and to the south at Mining Area C (*ecologia*, 1998a, 2004a) and Packsaddle Range (*ecologia*, 2004b). In addition, surveys have been conducted at West Angelas (*ecologia*, 1998d, e, 1999a, b, 2000a, b, 2001b) and south-east of Mining Area C at Orebodies 18, 23, 24 and 25 (*ecologia*, 1995a, b, 1998b, c, 2004c).

2.7 Land Use History

Mineral exploration in the Pilbara began in 1888 when gold was found in the Pilbara Creek, and although this did not prove productive, more consistent deposits were subsequently discovered at Marble Bar. Tin was discovered in 1899 and manganese and asbestos have also since been mined in the Pilbara. Massive iron-ore deposits were discovered, with exploitation expanding immensely in the 1960s when the Commonwealth embargo on exporting iron-ore was relaxed (Beard, 1975). Subsequently, the construction of several mining towns, including Newman, was undertaken. Newman was developed in the early 1970s to provide accommodation for workers at the Mt. Whaleback iron-ore mine. Ports, such as Port Hedland and Dampier, and standard gauge railways from Mt. Tom Price and Paraburdoo to Dampier, Pannawonica to Cape Lambert, and Mt. Goldsworthy and Mt. Newman to Port Hedland, also were constructed. The development of the iron ore industry has resulted in activity within the Pilbara increasing from cattle and sheep stations and small coastal ports to a large mining economic base with a commensurate increase in population.

Tourism is a smaller but rapidly developing industry within the region. The nearest conservation reserve to Ministers North is Karijini National Park, which is located approximately 50 km to the west.

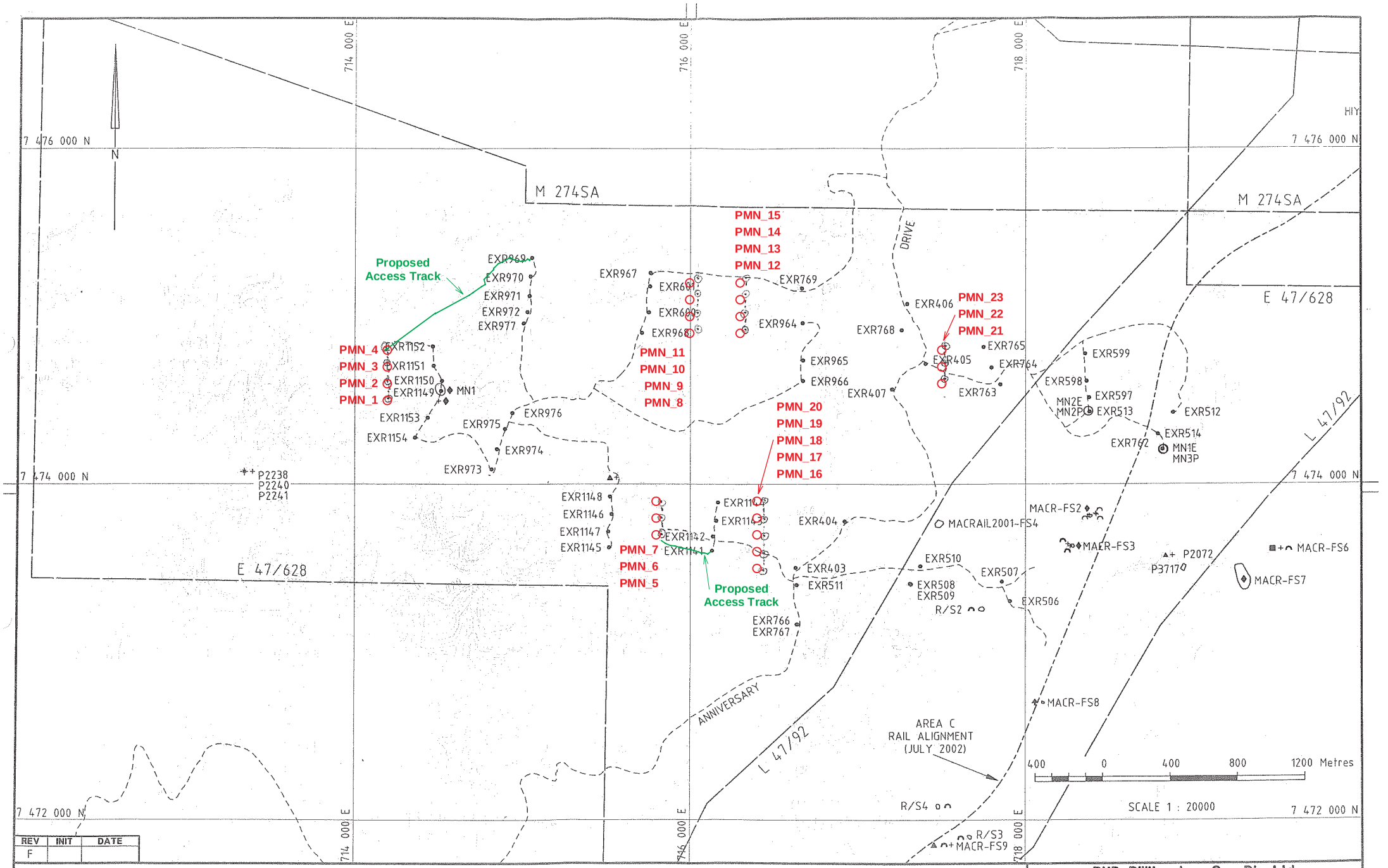
The area currently supports high levels of mining activity in close proximity to the Ministers North exploration area. The nearest active mines are at Yandi, Area C and Hope Downs.

3.0 VEGETATION AND FLORA

3.1 Methods

3.1.1 Floristic Survey Sites

A survey of the vascular flora of the Minister's North exploration drill sites was undertaken between 10th May 2006 and 14th May 2006. Sampling sites were exact drill pad locations (Figure 3.1, Table 4.1). The sampling sites were approximately 50 m by 50 m, or an area of 2,500 m^2 in sites that were less than 50 m wide. The position of each site was established with a GPS using the UTM coordinates in the AGD84/AMG84 datum. Additionally, proposed access tracks for two drill locations (PMN 04 and PMN 05) were surveyed, as vegetation disturbance will be required to access these areas (see Appendix A) . The proposed access tracks were flagged by BHPBIO and connect the drill points PMN 04 and PMN 05 with existing tracks. Plant species either were identified in the field or were collected for later identification and verification. Vegetation type, life-form strata, percentage cover, and disturbance details were recorded for all flora taxa at all survey sites, based upon Muir's (1977) classification system. Nomenclature and taxonomy follow Hnatiuk (1990) and CALM FloraBase (http://florabase.calm.wa.gov.au/).



REV	INIT	DATE
F		

LEGEND:

- MYTHOLOGICAL APPROXIMATE
- OTHER
- STONE ARRANGEMENT
- ARTEFACT SCATTER
- ENGRAVING
- SCARRED TREE
- ROCKSHELTER
- ABORIGINAL SITE LOCATION POINT
- ABORIGINAL SITE LOCATION AREA
- EXR0767 DRILL HOLE
- MN2E / MN2P EXPLORATION WATER BORE / PRODUCTION BORE

NOTES:

1. HORIZONTAL DATUM: AMG84 (ZONE 50)
   VERTICAL DATUM: AHD
2. TOPOGRAPHY : AUSLIG 1:50000 (CONTOUR INTERVAL 10M)
3. EXISTING MINING TENEMENT BOUNDARIES OBTAINED FROM DEPARTMENT OF MINERAL & PETROLEUM RESOURCES

BHP Billiton Iron Ore Pty Ltd

Figure 3.1
Fauna and Flora Sites/ Proposed Drill Sites, Ministers North

SCALE 1:20000	DATE 12.1.1999	A3	DRG. NO. 810 – G –1290/F

FILE p:\common\civil\geomag\mac_nth\dgn\810g1290.dgn
DATE 20-Nov-02 08:09

3.1.2 Survey Limitations and Constraints

According to the EPA Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a), flora and vegetation surveys may be limited by the following:

- Scope (i.e. the influence in terms of reference, such as what life forms etc. were sampled);
- Proportion of flora collected and identified (based on sampling, timing and intensity);
- Sources of information (i.e. pre-existing background versus new material);
- The proportion of the task achieved and further work which might be needed;
- Timing/weather/season/cycle;
- Disturbances (e.g. fire, flood, accidental human intervention etc.);
- Intensity (in retrospect, was the intensity adequate?);
- Completeness (e.g. was the relevant area fully surveyed?);
- Resources (e.g. degree of expertise available in plant identification to taxon level);
- Access problems;
- Availability of contextual information; and
- Experience levels.

These potential constraints and their relevance to this biological survey are presented in Table 3.1.

Table 3.1 Flora survey constraints and their relevance to the survey.

Aspect	Constraint (yes/no); Significant, moderate or negligible	Comment
Scope	No	The scope was diverse, including recording of all flora taxa, description of vegetation, and an emphasis on searching for Declared Rare Flora (DRF) and Priority Flora.
Proportion of flora identified, recorded and/or collected	No	The current survey recorded all of the flora taxa within the proposed drill sites. A total of 125 flora taxa were recorded in this survey.
Sources of information e.g. previously available information (whether historic or recent) vs new data	No	Many surveys have been conducted by *ecologia* or others in the vicinity of Ministers North Exploration Lease. See Section 2.6.
The proportion of the task achieved and further work which might be needed	No	Task was completed with surveys conducted at each drill line.
Timing/weather/season/cycle	No	Rainfall has been high in the previous 4 months. As a consequence, most annuals and semi-perennials that may occur in the area were present.
Disturbances which affected results of survey	No	Disturbance in the general area was present and mostly due to grazing pressure from cattle, which has resulted in some degradation of vegetation and encouragement of weeds.
Intensity (in retrospect, was the intensity adequate?)	No	The intensity of the survey was appropriate with adequate survey effort applied to survey the proposed drill pad areas and drill lines.
Completeness	No	The completeness of the survey was adequate, with all drill pads or drill lines surveyed. All distinct habitats associated with drill pads or drill lines within the project area were investigated.
Resources	No	Resources were adequate for the survey with ten person days invested in botanical survey work.
Remoteness and/or access problems	No	Due to the previous exploration work and the nature of the land area as cattle station grazing country, accessibility via tracks was not a restriction.
Availability of contextual (e.g. biogeographic) information on the region	No	This is a commonly explored region botanically, and a significant amount of literature is available on the botany of the area.
Competency/experience of the consultant carrying out the survey	No	Carol MacPherson has many years of field experience. Amy Capobianco is a qualified natural scientist.

3.2 Vegetation Communities

The proposed drill sites are located within vegetation types typical of the region, and thus are well represented both within the immediate vicinity, and throughout the eastern Pilbara.

The vegetation within the area proposed for clearance was classified into three main and two sub types:

1. Steep gullies / gorge: On the steeper faces: Emergent *Eucalyptus leucophloia / Corymbia ferriticola* subsp. *ferriticola,* over unevenly distributed *Eriachne mucronata / Triodia pungens* in skeletal soil. At the base, a sparse to moderately dense tall shrub layer of *Gossypium robinsonii / Grevillea wickhamii / Petalostylis labicheoides,* over sparse *Hibiscus* aff. *goldsworthii / Corchorus lasiocarpus* subsp. *parvus / Sida* sp. Shovelanna Hill (S. van Leeuwen 384), over dense *Triodia pungens / Paspalidium clementii / Porana commixta / Polycarpaea holtzei*, and other soft grasses and herbs. The Priority 3 species, *Triumfetta leptacantha,* occurs as isolated plants within this vegetation type on rocky slopes and at the base, on skeletal soil.

2. Minor drainage lines: Scattered *Eucalyptus leucophloia* over open to moderate density *Acacia hamersleyensis / Grevillea wickhamii / Gossypium robinsonii,* over sparse to open *Trichodesma zeylanicum / Tephrosia rosea*, over open *Cymbopogon ambiguus / Triodia pungens*.

3. Shallow hills.

    a. Crests: Emergent *Corymbia hamersleyana / Eucalyptus leucophloia* / *Acacia pruinocarpa*, and/or *Hakea chordophylla,* over scattered *Acacia hilliana / Gomphrena karijini* and/or *Acacia spondylophylla*, over open to moderate density *Triodia basedowii*.

    b. Slopes: Open *Corymbia hamersleyana / Eucalypus leucophloia,* over open *Petalostylis labicheoides / Acacia monticola / Gomphrena karijini / Acacia hilliana*, over moderate density patches of *Triodia basedowii* and *Triodia pungens* hummock grassland. Some *Triodia wiseana* is present on steeper slopes. *Grevillea wickhamii* may be present on lower slopes.

3.3 Flora

One hundred and twenty five flora taxa were recorded at the Ministers North area including subspecies, varieties, forms and affinities. The taxa comprised 37 families, 72 genera and 125 species. The most species rich plant families were Poaceae (20 taxa) and Malvaceae (10 taxa), while the most species rich genera were *Acacia* (12 taxa) and *Eriachne* (6 taxa): 17 families and 51 genera were represented by a single taxon (Appendix B).

3.3.1 Database Searches

A search of the area was undertaken by CALM on their database that encompassed the Ministers North Exploration Lease area and the surrounding area (see Table 3.2 below).

Table 3.2 Priority species previously recorded in the vicinity of the project area.

Species	Areas Recorded At	Conservation Codes*
Abutilon trudgenii ms	Marillana, Warralong, Woodstock,	3
Eremophila magnifica subsp. *velutina* ms	Hamersley Range, Karratha, Pt	3
Eremophila spongiocarpa ms	Sampson, Newman, Pannawonica	1
Goodenia lyrata	Hamersley Ranges, Newman, Marandoo	1
Goodenia omearana ms	Mt Marsh, Chichester Range, Marillana Station	1
Lepidium catapycnon	Laverton, Newman	R
Olearia fluvialis	Weeli Wolli, Mulga Downs, Nullagine, NW of Newman	2
Tephrosia sp. Cathedral Gorge (FH Mollemans 2420)	Wittenoom Gorge, Hamersley Range, Weeli Wolli, Newman	3

* Conservation codes 1,2,3 denote Priority levels and R signifies a Declared Rare Flora taxa

At present, 90 Priority taxa are known to occur within the Pilbara botanical region. Based on known habitat preferences and currently recorded distributions within 200 km of the project area (Atkins, 2005), it is considered that 56 taxa of Priority flora potentially could occur within the vicinity of the proposed exploration area. This list is provided in Appendix C.

3.3.2 Introduced Flora

Priority weeds that are, or have the potential to become, pests to agriculture can formally be declared under the *Agriculture and Related Resources Protection Act, 1976*. Weeds listed under the Act are listed with a coded definition of the requirements for control. Five Priority groupings are used, and more than one Priority may be placed on a weed species. Seventy-seven priority weeds are listed as occurring in the Eastern Pilbara (Department of Agriculture and Food, 2005).

No Declared Weeds or Environmental Weeds were recorded within the Ministers North project area.

Three environmental weeds have been recorded near Ministers North at the Marillana exploration area (*ecologia* 2006 – in prep). Brief descriptions of these weed species are given below.

Buffel Grass (**Cenchrus ciliaris*) is a tufted, caespitose perennial grass growing to 1 m high with purplish flowers produced for much of the year (Western Australian Herbarium 2006). Native to Africa and India, **C. ciliaris* is widely planted in pastoral regions of Western Australia for cattle fodder. This species has become a widespread weed along roadsides, creeklines, river edges, and occurs in most vegetation types from Shark Bay to the Pilbara (Hussey *et al*. 1997).

Ruby Dock (**Acetosa vesicaria)* is an erect, stout, fleshy, hollow-stemmed annual herb, 0.2–1 m high. Its flowers are red to pink and are produced from July to September. It is found on sandy alluvial soils, or gravelly ironstone soils along roadsides or in disturbed areas (Western Australian Herbarium 2006). The plant is a common and widespread weed of the arid zone and is found in a variety of disturbed situations from the Pilbara to the Nullarbor. It is native to North Africa, the Middle East and India (Hussey *et al*. 1997).

Bipinnate beggartick, **Bidens bipinnata,* is an erect, annual herb growing to 0.9 m high. Its yellow flowers are produced between March and September, followed by production of thin black seeds with two-spiked tips. **B. bipinnata* is found along rivers and creeks, coastal areas and rocky hillsides (Western Australian Herbarium 2006), and occurs at Kalbarri, Newman and in the Kimberley (Hussey *et al*. 1997).

3.3.3 Flora of Conservation Significance

Environment Protection and Biodiversity Conservation Act 1999

Flora species are protected at a National level under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Act contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct or Extinct in the Wild.

No flora taxa listed under the *Environment Protection and Biodiversity Conservation Act 1999* were recorded within the Ministers North disturbance footprint.

Wildlife Conservation Act 1950

Conservation significance is determined under the *Wildlife Conservation Act 1950*; under this Act, flora of conservation significance is protected. Declared Rare Flora (DRF) is also protected under the *Western Australian Wildlife Conservation (Rare Flora) Notice 2005* of the above Act. This notice lists flora taxa that are extant and considered likely to become extinct or rare. They are defined as "taxa which have been adequately searched for and deemed to be either rare, in danger of extinction, or otherwise in need of special protection in the wild". These taxa are legally protected and removal or impact to their surroundings cannot be conducted without ministerial approval obtained specifically on each occasion for each population.

No Declared Rare Flora taxa were recorded at the Ministers North Exploration area.

The Department of Conservation and Land Management (CALM) also maintains a list of Priority Flora taxa, which are considered poorly known, uncommon, or under threat, but for which there is insufficient justification based on known distribution and population sizes for inclusion on the DRF schedule. Priority Flora taxa are assigned to one of four Priority categories (Atkins, 2005).

Priority Flora

One Priority Flora species, *Triumfetta leptacantha* (Priority 3) was recorded within the Ministers North Exploration Lease disturbance footprint, (Plate 3.1, 3.2). This species was recorded at two locations in the PMN01 proposed drill pad (AGD84 50K 714217mE 7474561mN, 50K 714209mE 7474534mN).

Triumfetta leptacantha is a spreading shrub, 0.25–0.6 m high, to 0.7 m wide that produces yellow flowers in May, and spiky fruits that turn brown with maturity. Typically it occurs on stony red loam soils and amongst boulders on stony hillsides. *Triumfetta leptacantha* is endemic to the Pilbara.

This species has been previously recorded by *ecologia* at Mining Area C Deposits D, E, and F (*ecologia*, 2004a), Packsaddle Range (*ecologia,* 2004b) and Marillana Biological Survey (*ecologia*, 2006b). Most of these plants were present at the base of the cliff faces, especially under overhangs or at the mouth of small caves, where little other vegetation is present. Occasionally, individuals were present in rock falls that had not been recolonised by other species.

Plate 3.1 ***Triunfetta leptacantha***

Plate 3.2 Close up of *Triumfetta leptacantha* fruits.

4.0 VERTEBRATE FAUNA

4.1 Methods

4.1.1 Regional Assessment

As is the case for the flora, the fauna data was also be subject to analysis to achieve a regional context of fauna conservation value of the project area. Principally this involved consideration of survey adequacy, survey timing and fauna composition when compared with other adjacent surveys.

The Western Australian Museum Fauna Database (Faunabase) was searched to define a list of vertebrate fauna potentially occurring in the project area, in addition to previous surveys conducted in the area surrounding Ministers North. This search yielded eight amphibians, 129 reptiles, 164 birds and 57 mammals (see Appendix D). Furthermore, the potential for fauna of conservation significance to occur in the project area was assessed by searching The Department of Conservation and Land Management Threatened and Priority Fauna Database and the *Environment Protection and Biodiversity Conservation Act 1999*.

4.1.2 Fauna Sites

A vertebrate fauna survey of the Ministers North project area was undertaken between 10th May 2006 and 14th May 2006. BHPBIO supplied drill pad locations for 23 proposed sites at Ministers North. All sites were surveyed, and each proposed drill pad comprised a

fauna site (Table 4.1). Fauna survey sites were located in the same position as the botanical survey sites, as sA survey of the vascular flora of the Minister's North exploration drill sites was undertaken between 10th May 2006 and 14th May 2006. Sampling sites were exact drill pad locations (Figure 3.1, Table 4.1). The sampling sites were approximately 50 m by 50 m, or an area of 2,500 m2 in sites that were less than 50 m wide. The position of each site was established with a GPS using the UTM coordinates in the AGD84/AMG84 datum. Additionally, proposed access tracks for two drill locations (PMN 04 and PMN 05) were surveyed, as vegetation disturbance will be required to access these areas (see Appendix A) . The proposed access tracks were flagged by BHPBIO and connect the drill points PMN 04 and PMN 05 with existing tracks. Plant species either were identified in the field or were collected for later identification and verification. Vegetation type, life-form strata, percentage cover, and disturbance details were recorded for all flora taxa at all survey sites, based upon Muir's (1977) classification system. Nomenclature and taxonomy follow Hnatiuk (1990) and CALM FloraBase (http://florabase.calm.wa.gov.au/).

.Additionally, proposed access tracks for two drill locations (PMN 04 and PMN 05) were surveyed as vegetation disturbance will be required to access these areas (see Appendix A). The proposed access tracks were flagged by BHPBIO and connect the drill points PMN 04 and PMN 05 with existing tracks.

Table 4.1 Proposed drill pad locations and fauna survey sites (AMG84, Zone 50).

Proposed Drill Hole Number/ Fauna Site	Easting	Northing
PMN_1	714200	7474500
PMN_2	714200	7474600
PMN_3	714200	7474700
PMN_4	714200	7474800
PMN_5	715800	7473700
PMN_6	715800	7473800
PMN_7	715800	7473900
PMN_8	716000	7474900
PMN_9	716000	7475000
PMN_10	716000	7475100
PMN_11	716000	7475200
PMN_12	716300	7474900
PMN_13	716300	7475000
PMN_14	716300	7475100
PMN_15	716300	7475200
PMN_16	716400	7473500
PMN_17	716400	7473600
PMN_18	716400	7473700
PMN_19	716400	7473800
PMN_20	716400	7473900
PMN_21	717500	7474600
PMN_22	717500	7474700
PMN_23	717500	7474800

4.1.3 Sampling Methods

The presence of all vertebrate species was assessed via:

Census for Birds

At all 23 proposed drill pad sites for Ministers North, a 40 minute bird census was taken. The observed numbers of each species of bird were recorded within a 2 ha search centred over each proposed drill point. Each bird census was also restricted to the habitat within which the drill point occurred.

Over one third of the bird surveys were undertaken between the hours of 06:00 and 10:00 AM, during the optimal period of bird activity. However, due to logistical limitations, bird surveys were conducted across the full length of the day, and could not be limited to optimal periods of bird activity. As a result there is some inherent variability in the survey results based upon this temporal disparity.

In total, 1000 minutes of bird surveys were undertaken, including 80 minutes surveying access tracks for two drill locations (PMN 04 and PMN 05). These access tracks connect existing tracks to the drill locations

Hand Foraging for Mammals, Reptiles and Amphibians

At each proposed drill site, and replicating the area surveyed for birds, 40 minutes was spent opportunistically searching for all terrestrial vertebrate fauna. This search was also restricted to the one habitat within which the drill point occurred.

In total, 1030 minutes were spent opportunistically searching in this manner. Time spent searching was equally proportioned between raking litter, breaking into deadfalls and logs, and hand-capturing animals.

Secondary Evidence

Tracks, diggings, scats, burrows and nests were recorded where encountered.

Opportunistic sightings

The presence of species was recorded while searching, and travelling within the project area during the day or night.

Bat Fauna

Bat recording was undertaken at two sites (A1 and A2, see Table 4.2) within the Ministers North tenement, over two consecutive nights. Bat echolocation calls were detected using the Anabat II system (Titley Electronics, Ballina, NSW). The Anabat detector transforms ultrasonic bat echolocation calls for analysis and identification with computer software. Anabat recording was undertaken at two sites deemed likely to record bats within the project area and are described below:

Table 4.2 ANABAT recording locations.

Site	Drill Point	Location (AGD84, Zone50)	Habitat Description
A1	Near PMN12	716964E, 7475749N	Rocky gorge with numerous small overhangs, caves, and a number of small waterholes. Within the same gully system as PMN12.
A2	Near PMN20	716154E, 7473949N	Gorge adjacent to PMN20

Spotlighting

Nocturnal foraging was undertaken at the two sites surveyed for bat species. Additionally, nocturnal fauna was recorded opportunistically while driving through the project area at night. A total of 120 minutes was spent foraging for nocturnal species.

Habitat Assessment

The habitat each proposed drill location occurred in was assessed as to suitability and likelihood of supporting threatened fauna species.

4.1.4 Survey Design and Intensity

In accordance with the EPA Guidance Statement 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004), the factors influencing the design and intensity of the Ministers North survey are detailed in **Error! Reference source not found.**.

Table 4.3 Factors influencing the design and intensity of the Ministers North fauna survey.

Factors influencing design	Intensity and design of current survey
Bioregion and level of existing knowledge	The objective was to undertake an opportunistic survey of the proposed drill sites and augment data with that from previous surveys.
Landform characteristics	Sites were chosen based on proposed drill pad locations which encompassed three fauna habitat types.
Lifeforms, life cycles, types of fauna and season	The timing of the survey was autumn; bird activity was high however reptile activity was relatively low.
Number of habitats	Three fauna habitats were described and several sites were established in each habitat.
Climatic constraints	Cool night temperatures reduced the activity of nocturnal species.
Sensitivity of the environment to impact	The proposed project would result in clearing of a small proportion of the habitat occurring in the project area. The Newman Land System dominates the project area and is very well represented within the Pilbara Bioregion outside of the project area, including within Karijini National Park. Consequently, the area to be impacted is of low conservation value.
Size and shape of the impact area	The proposed impact area is comprised of several rows of small 30×20 m drill pads with 4-5 m wide access tracks between each.
Scale and impact	On a local scale, the proposed impact is slight (although precise impact areas and extent is yet to be finalised). When viewed at a regional level the extent of impact is minimal, considering the widespread extent of the vegetation associations and habitat types (as part of the Newman Land System) that would be impacted.

4.1.5 Survey Limitations and Constraints

According to the EPA Guidance Statement for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004a), fauna surveys may be limited by the following:

- Competency/experience of the consultant carrying out the survey;
- Scope (what fauna groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions, *e.g.* pitfall trapping in waterlogged soils);
- Proportion of fauna identified, recorded and/or collected;
- Sources of information *e.g.* previously available information (whether historic or recent) *vs* new data;
- The proportion of the task achieved and further work which might be needed;
- Timing/weather/season/cycle;
- Disturbances (*e.g.* fire, flood, accidental human intervention *etc.*) which affected the results of the survey;
- Intensity (in retrospect, was the intensity adequate?);
- Completeness (*e.g.* was the relevant area fully surveyed?);
- Resources (*e.g.* degree of expertise available in animal identification to taxon level);
- Remoteness and/or access problems; and
- Availability of contextual (*e.g.* biogeographic) information on the region.

An assessment of these aspects is detailed in Table 4.4.

Table 4.4 Fauna survey constraints and their relevance to the survey.

Aspect	Constraint (yes/no); Significant, moderate or negligible	Comment
Competency/experience of the consultant carrying out the survey	No	All members of survey team have had appropriate training, experience and mentoring in fauna identification and fauna assemblage surveys.
Scope	No	The survey effort was sufficient considering the level of disturbance being proposed.
Proportion of potential fauna identified, recorded and/or collected	Yes - moderate	Approximately 17% of the fauna expected in the greater area was observed during the survey, although based on predicted totals, 65% of the bird fauna was recorded. The species richness is comparable to previous surveys in the region of a similar scope.
Sources of information e.g. previously available information (whether historic or recent) *vs* new	No	Several other unpublished reports for the same client produced by ecologia and other organisations. Western Australian Museum voucher records for most species are substantial for the area. CALM and DEH databases record rare fauna within the area. Published reports (e.g. Dawe and Dunlop, 1983) are available for similar land systems within the bioregion.
The proportion of the task achieved and further work which might be needed	No	The biological survey completed is sufficient for the small areas to be cleared for exploration drilling.
Timing/weather/season/cycle	Yes - negligible	Moderate day temperatures and cool night temperatures resulted in a reduced activity level of herpetofauna. However birds were highly active during the survey period.
Disturbances which affected results of survey	No	Habitats surveyed were relatively undisturbed.
Intensity (in retrospect, was the intensity adequate?)	Yes - negligible	Intensity of survey effort was adequate given the small size of the project area, the low impact of the disturbance, and the amount of previous survey work that has been undertaken in adjacent or similar areas.

Aspect	Constraint (yes/no); Significant, moderate or negligible	Comment
Completeness	Yes - moderate	Reptile fauna could have been sampled over a longer duration and (along with mammals and frogs) surveyed using pit-trapping methods. Additional bird censuses could be done to further sample the fauna in the project area. However, such intensive sampling is unwarranted for the minimal disturbance caused by exploration drilling. Habitats adjacent to the drill pads are undisturbed and provide a refuge for displaced fauna.
Resources	No	Resources were adequate.
Remoteness and/or access problems	No	All sites within the project area could be easily accessed.
Availability of contextual (e.g. biogeographic) information on the region	No	Available information includes the WA Museum fauna database, Department of Conservation and Land Management lists, Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Cresswell, 1995) and several unpublished reports undertaken by *ecologia*.

Significant = > 60% of potential fauna not sampled; Moderate = 20-60% of potential fauna not sampled; Negligible = < 20% of potential fauna not sampled

4.1.6 Taxonomy

Field identification of vertebrate species was based on the following field guides:

- Mammals — Menkhorst& Knight (2001)
- Bats — Churchill (1998)
- Birds — Simpson and Day (2004)
- Amphibians — Tyler *et al.* (2000)
- Reptiles — Wilson and Swan (2003)
- Agamids — Storr *et al.* (1983)
- Geckos — Storr *et al.* (1990)
- Pygopods — Storr *et al.* (1990)
- Skinks — Storr *et al.* (1999)
- Varanids — Storr *et al.* (1983)
- Snakes — Storr *et al.* (1986)

For this survey fauna species were identified in the field. In this report, nomenclature is based on the WA Museum FaunaBase (WAM, 2004) and the Western Australian Museum Birds Checklist.

4.1.7 Data Analysis

The number of species present (species richness) is the most simplistic representation of species diversity (Fowler and Cohen, 1990) and is a basic indicator of diversity used for this survey. Due to the small number of fauna observed in association with the disturbance areas, statistical data analysis was by and large not appropriate.

Species accumulation curves were randomised 10^6 times using EstimateS (Version 7.5, Colwell, 2005) software. Fauna data were plotted as Mao Tau (S_{obs}, the number of species observed) against Individuals as the ordinate (Thompson and Withers, 2003). Total species richness was estimated using the Michaelis-Menten function, an asymptotic curve commonly used for such estimates (Colwell and Coddington, 1994).

4.2 Fauna Habitats

The expected fauna diversity of an area is proportional to the landform variation of the area and its floral diversity, since these influence the number of different fauna habitats available. As such, in an area of high landform variation and high vegetation diversity, higher fauna diversity would be expected, while the inverse is also true.

Across the survey sites, four different landforms were encountered. This included Scree slopes, low ridges and hills, gorges and minor drainages. Vegetation associated with these landforms was relatively diverse, with three major vegetation types. Descriptions of the different habitats surveyed are provided in Table 4.5, with photographs of each habitat type presented in Plates 4.1, 4.2 and 4.3.

Table 4.5 Fauna habitat descriptions

Habitat Type	Description
Steep gullies / gorge	Sparse to open *Corymbia hamersleyana* / *Eucalyptus leucophloia* over open *Acacia tumida*, over open *Triodia basedowii* hummock grasses on the steeper slopes at the top of the gorge. Open *Grevillea wickhamii* / *Petalostylis labicheoides* over dense *Cymbopogon ambiguus* / *Triodia wiseana* at the base of the gorge.
Minor drainage line	Scattered *Eucalyptus leucophloia* over open *Acacia tumida / Grevillea wickhamii*, over open low *Acacia spondylophylla*, over open *Cymbopogon ambiguus* / *Triodia pungens*.
Shallow hills	Crests: Sparse to scattered *Corymbia hamersleyana* / *Eucalyptus leucophloia*, over open *Acacia pruinocarpa* / *Eucalyptus gamophylla*, over scattered *Acacia hilliana*, over open to medium density *Triodia basedowii*. Slopes: Sparse to open *Corymbia hamersleyana* / *Eucalyptus leucophloia*, over open *Gomphrena karijini* / *Acacia hilliana*, over medium density patches of *Triodia basedowii* and *Triodia pungens* hummock grassland. Some *Triodia wiseana* is present on steeper slopes.

Plate 4.1 **Steep gullies and gorges**

Plate 4.2 **Minor Drainage Line**

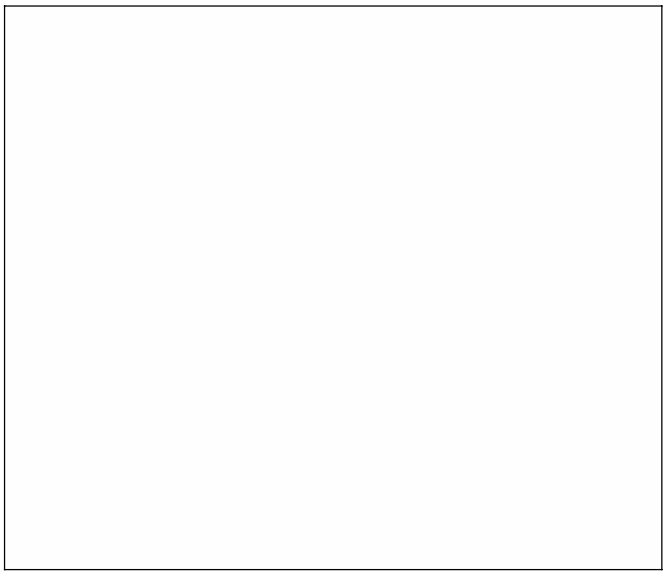


Plate 4.3 **Shallow Hills**

4.3 Vertebrate Fauna Recorded in the Project Area

Prior to the current survey, a list was prepared of 358 fauna taxa that had been previously recorded in the surrounding area. The list included 57 mammals, 164 birds, 129 reptiles and eight frog species (Appendix D). The current Ministers North survey recorded 71 species, including 18 reptiles, 42 birds, ten mammals and one frog (Appendix D). It is unlikely that all potentially occurring vertebrate fauna species would be detected within the project area during the course of a single fauna survey, due to temporal and spatial variations in fauna population numbers and the limitations of a non-systematic sampling methodology. Additionally, the areas surveyed were small, limiting the likelihood of animal observations.

4.3.1 Mammals

Ten species of mammal, representing six families, were recorded in the exploration area during the current survey (Appendix D). Evidence of the Western Pebble-mound Mouse (*Pseudomys chapmanii*) was found in the form of potentially active burrows at numerous locations (PMN 4, 8, 10, 11, 15, 17, 18, 19, 21) within the Ministers North project area.

Euros (*Macropus robustus)* were present at most drill sites, based on numerous scats attributable to the species. Additionally, scats belonging to a Rock Wallaby species (*Petrogale* sp.) were recorded from site PM01, and from a ridge adjacent to site PM05. Previous surveys in the surrounding area have recorded the Rothschild's Rock-wallaby (*Petrogale rothschildi*). It is likely that the scats recorded at PMN01 and near PMN05 belong to this species, which is expected to occur in the area.

Seven bat species were recorded within the project area. These included the Northern Freetail-bat (*Chaerophon jobensis*, site A1), Gould's Wattled Bat (*Chalinolobus gouldii*, sites A1 and A2), the Northern Long-eared Bat (*Nyctophilus bifax*, site A1), the Lesser Long-eared Bat (*Nyctophilus geoffroyi*, site A1), the Little Broad-nosed Bat (*Scotorepens greyii*, site A1), the Inland Cave Bat (*Vespadelus finlaysoni*, site A1) and the Common Sheathtail Bat (*Taphozous georgianus*, site A2). In addition, four individuals of the Common Sheathtail Bat were sighted in a cave near PMN 1.

An old abandoned nest belonging to the Lesser Stick-nest Rat (*Leporillus apicalis*) was recorded in the project area. The nest was observed on under an overhang in a gorge adjacent to PMN12.

Fifty two species of mammal from 16 families have been recorded during previous field surveys in surrounding region (Appendix D). This mammal fauna was comprised of 45 native and seven introduced species.

4.3.2 Avifauna

Forty-two bird species from 23 families were recorded during the current survey (Appendix D). The most speciose family was the Meliphagidae (honeyeaters) with six species. Fourteen families were represented by a single species. Previous surveys around the project area (within 100 km) suggest that 163 species may be observed in proximity to the Ministers North exploration area (Appendix D), although only 127 of these species are expected based upon known habitat preferences. None of the species recorded during the current survey are new for the area.

4.3.3 Herpetofauna

Eighteen reptiles and one amphibian were recorded in the project area during the current survey (Appendix D). Dragons and skinks made up the majority of the reptile observations, with *Ctenophorus caudicinctus*, *Ctenotus saxatilis* and *Morethia ruficauda* being the most abundant reptiles recorded during the survey. Some species rarely encountered on previous surveys were recorded from the Minsters North survey and include *Crenadactylus ocellatus*, *Ctenotus rubicundus*, *Lerista zietzi*, and *Varanus pilbarensis*. One specimen of *Ctenotus saxatilis* was lodged with the Western Australian Museum (R165896).

All of the herpetofauna recorded from the Ministers North area are relatively common and have been recorded on previous surveys. These previous surveys have recorded 130 reptiles and 8 amphibians in the nearby area (Appendix D). The number of species observed from the Ministers North survey is also comparable to surveys of a similar scope within the surrounding area (Figure 4.2).

4.3.4 Feral Fauna

No evidence of feral fauna was observed in the Ministers North exploration area. However seven species previously have been recorded from the surrounding area. These include the Cow (*Bos taurus*), Feral cat (*Felis catus*), House Mouse (*Mus musculus*), Horse (*Equus caballus*), Donkey (*Equus asinus*), Camel (*Camelus dromedarius*) and Rabbit (*Oryctolagus cuniculus*). It is likely that the Feral Cat, Cow and House Mouse occur within the project area.

4.4 Fauna of Conservation Significance

Fauna species that have been formally recognised as rare, threatened with extinction or as having high conservation value are protected by law under Commonwealth and State Legislation. At the National level, fauna are protected under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Within Western Australia, rare fauna are listed under the *Western Australian Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 2005*. Additionally, the Department of Conservation and Land Management (CALM) maintains a Priority Fauna List, last updated in 2005. Appendix E details the definitions of each of the conservation categories.

Searches of EPBC (100 km buffer zone) and CALM (50 km buffer zone) databases yielded several species of significance that may potentially occur in the project area. These are shown in Table 4.6 below.

Table 4.6 Fauna taxa of conservation significance with the potential to occur in the project area.

Scientific Name	Common Name	EPBC	WAWCA 1950	CALM Priority	Likely to occur in project area
Mammals					
Dasycercus cristicauda	Mulgara	Vulnerable	Schedule 1		
Dasyurus hallucatus	Northern Quoll	Endangered			
Leporillus apicalis	Lesser Stick-nest Rat	Extinct			
Macroderma gigas	Ghost Bat			Priority 4	√

Macrotis lagotis	Bilby	Vulnerable	Schedule 1		
Pseudomys chapmani	Western Pebble-mound Mouse			Priority 4	√
Rhinonicteris aurantius	Orange Leaf-nosed Bat	Vulnerable	Schedule 1		√
Birds					
Apus pacificus	Fork-tailed Swift	Marine			√
Ardea alba	Great Egret	Marine			
Ardea ibis	Cattle Egret	Marine			
Ardeotis australis	Australian Bustard			Priority 4	
Charadrius veredus	Oriental Plover	Marine / Migratory			
Falco hypoleucos	Grey Falcon			Priority 4	
Falco peregrinus	Peregrine Falcon		Schedule 4		√
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory / Marine			
Merops ornatus	Rainbow Bee-eater	Marine			√
Pezoporus occidentalis	Night Parrot	Endangered / Migratory	Schedule 1		
Polytelis alexandrae	Princess Parrot	Vulnerable		Priority 4	
Reptiles					
Ctenotus uber johnstonei	A skink			Priority 2	
Liasis olivaceus barroni	Pilbara Olive Python	Vulnerable	Schedule 1		√

4.4.1 Fauna Protected by International Agreements

The List of Migratory Species under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) consists of those species listed under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Convention on the Conservation of Migratory Species of Wild Animals - (Bonn Convention)

Several species listed as Marine or Migratory by the EPBC Act have the potential to occur in the project area (Table 4.6). One of these species, the Rainbow Bee-eater (*Merops ornatus*) was recorded during the current survey. The Rainbow Bee-eater has a very widespread distribution over Australia, wintering in northern Australia and Indonesia, and migrating south during September and October (Johnstone & Storr, 1998).

The Fork-tailed Swift (*Apus pacificus*) is listed under JAMBA and has the potential to occur in the Ministers North exploration area. This species is a relatively common trans-equatorial migrant in October to April throughout mainland Australia (Slater *et al*. 1991). This species was not observed during the current survey and although it has the potential to

be recorded, it is unlikely to utilise any of the habitat proposed to be disturbed as a result of drilling activities.

It is highly unlikely that the remaining migratory and marine species listed in Table 4.6 utilise habitat within the project area.

4.4.2 Commonwealth EPBC Act

Schedule 1 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Extinct, Extinct in the wild and Conservation Dependent (Appendix E).

No species listed under the EPBC Act were recorded within the Ministers North project area.

A number of species listed under the EPBC Act have the potential to occur within the proposed disturbance footprint or the surrounding areas (Table 4.6) and are discussed below.

Extinct

- Lesser Stick-nest Rat (*Leporillus apicalis*)

An old abandoned nest belonging to the Lesser Stick-nest Rat (*Leporillus apicalis*) was recorded in the project area. This species is listed as 'extinct' under the EPBC Act, with the last known specimen collected in 1933 in central Australia (Strahan 1995). The nest was observed on under an overhang in a gorge adjacent to PMN12. An additional nest which may be attributable to this species was observed in a gorge system adjacent to PMN01.

Endangered

- Night Parrot (*Pezoporus occidentalis*)

The Night Parrot inhabits treeless or sparsely wooded spinifex near water (Johnstone and Storr, 2004), and has been recorded on or in stony rises, breakaways, sandy lowlands, chenopods, succulents on flats around salt lakes, flooded claypans, saltbush and bluebush (Pizzey and Knight, 2003). It is rarely seen but recent sightings have been confirmed in the Fortescue Marsh / Chichester Range area in Western Australia, where three individuals were recorded (Bamford Consulting Ecologists, 2005). The large domed spinifex mounds required by this species for shelter are not present in the project area, and neither is the chenopod shrubland in which it was recently observed to the north. The likelihood of the species being in the project area is extremely low.

- Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll is the least well-known of all quolls. It formerly occurred across northern Australia from the Pilbara to south-east Queensland but is now restricted to several highly disjunct areas within its former range. It is arboreal, found in wooded habitats, and is most abundant in rocky and broken country in open Eucalypt forest. They have suffered substantial range reduction following European settlement. Reasons for its population

decline may be predation by introduced animals such as dogs, foxes, cats and cane toads or competition with other predators. Habitat loss may also be a factor, as much of its former range is now used for rangelands agriculture and grazing (Braithwaite and Begg, 1995). Based on the lack of suitable habitat, it is unlikely that the Northern Quoll would be present in the exploration areas.

Vulnerable

- Mulgara (*Dasycercus cristicauda*)

This small, stocky dasyurid is widespread but patchy, preferring sandy regions of arid central Australia and WA, where it inhabits hummock grass plains, sand ridges, and mulga shrubland on loamy sand (Menkhorst and Knight, 2001). Populations fluctuate according to season. The Mulgara eats a wide variety of invertebrates and small vertebrates, particularly large insects, spiders, scorpions and small rodents, and can survive without free water (Menkhorst and Knight, 2001). It is sociable, occupying burrow systems on dune swales or lower slopes. Mulgara occur in the Great Sandy Desert to the east of the Pilbara (Wooley, 2004), although their presence in the Pilbara is not unheard of – four specimens were captured in the decade preceding 1996 (Baker, 1996). There is a lack of suitable habitat (sand plains) for the Mulgara within the Ministers North project area and it is considered highly unlikely to be present.

- Bilby (*Macrotis lagotis*)

This distinctive bandicoot occurs in scattered colonies, inhabiting a range of habitats such as clayey and stony downs soils in Queensland and sands with spinifex and massive red earths with *Acacia* shrubland and hummock grassland, although it is mostly solitary (Menkhorst and Knight, 2001; Johnson, 2004). Its range includes parts of the eastern Pilbara. Home ranges may shift in response to changing availability of food, which includes insects, seeds, bulbs, fruit and fungi (Johnson, 2004). Changes in fire regime, grazing by rabbits and livestock, and predation by foxes and feral cats are thought to be the main factors influencing the Bilby's decline. Ministers North lies outside the recent known range of the Bilby. Additionally, there is a lack of suitable habitat within the project area for this species. The likelihood of occurrence of the Bilby within the project area is considered to be very low.

- Orange Leaf-nosed Bat (*Rhinonicterus aurantius*)

This bat has a predominantly Torresian distribution but isolated populations occur in the Pilbara. It is known to prefer deep, humid caves for roosting although foraging occurs over a wider range of habitats. There are potential roost sites for this species in the exploration area, in caves within some of the more extensive gorge systems. However, the small scale of the proposed disturbance means that this species will not be affected by exploration activity in the project area.

- Princess Parrot (*Polytelis alexandrae*)

This parrot is distributed further east than the Pilbara, although it may at times extend to the western edge of the Great Sandy Desert. It inhabits lightly wooded country, such as groves of desert oak (*Casuarina decaisneana*), open mallee-spinifex, and open marble gum woodland (*Eucalyptus gongylocarpa*) (Johnstone and Storr, 2004). It is highly nomadic and

irregular (Pizzey and Knight, 2003). Based on distribution, habitat preference and general scarcity of occurrence, it is extremely unlikely that Princess Parrot would occur in the project area.

- Pilbara Olive Python (*Morelia olivaceus barroni*)

The Pilbara subspecies of Olive Python is geographically distinct from the Kimberley subspecies (*Morelia olivaceus olivaceus*), and its apparent rarity has caused it to be classified as Vulnerable. A recent study (Pearson, 2003) indicates that (*Morelia olivaceus barroni*) is widespread across the Pilbara and that there are a number of sizeable populations.

This species is usually associated with permanent water, such as riverine woodland areas, and large rock holes in gorges and swamps. Given the number of large gorges in the exploration area, it is likely that the Pilbara Olive Python is present.

4.4.3 WA Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 2005

Classification of rare and endangered fauna under the WA *Wildlife Conservation (Specially Protected Fauna) Notice 2005* recognises four distinct Schedules as described in Appendix E.

No Scheduled species were recorded during the survey. However, several Scheduled species previously have been recorded in or around the project area, as detailed below.

Schedule 1 – Fauna that is rare or likely to become extinct

- Mulgara (*Dasycercus cristicauda*) – discussed in Section 4.4.2
- Bilby (*Macrotis lagotis*) – discussed in Section 4.4.2
- Orange Leaf-nosed Bat (*Rhinonicterus aurantius*) – discussed in Section 4.4.2
- Night Parrot (*Pezoporus occidentalis*) – discussed in Section 4.4.2
- Pilbara Olive Python (*Liasis olivaceus barroni*) – discussed in Section 4.4.2

Schedule 4 – Other specially protected fauna

- Peregrine Falcon (*Falco peregrinus*)

This raptor is widely distributed throughout Australia and is wide-ranging (Pizzey 2003). It is nomadic, inhabiting coastal cliffs or inland cliffs and gorges, timbered watercourses, plains and open woodlands, and is rare or scare in the Pilbara (Johnstone and Storr 1998).

A number of gorges and steep cliffs suitable for the Peregrine Falcon were observed within the project area (for example at sites PMN01, PMN12, and PMN20). Such habitat within the Ministers North area may support this species.

4.4.4 CALM Priority Fauna

Species on the CALM Priority Fauna List (CALM, 2005) include those removed from the Scheduled Fauna list and other species known from only a few populations or in need of monitoring. Five Priority codes are recognised as described in Appendix E.

Six Priority species have previously been recorded within a 100 km radius of the project area, and are detailed below. One Priority Fauna species was recorded during the current survey. Numerous active mounds attributed to the Pilbara Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4) were located within the Ministers North area. These species are discussed below.

Priority 2

- *Ctenotus uber johnstonei*

Ctenotus uber johnstonei is a priority subspecies of the more widespread skink *Ctenotus uber* and potentially occurs in the Ministers North area. The species was recorded to the north of the study area at the Fortescue valley (CALM Threatened Fauna Database). This species of skink is associated with small rock outcrops on open sandy and stony plains. Such habitat is absent from the Ministers North area, and as a result *Ctenotus uber johnstonei* is unlikely to occur in the study area.

Priority 4

- Ghost Bat (*Macroderma gigas*)

Ghost Bats occur in a variety of habitats, from arid spinifex hillsides, to open tall forest and tropical rainforest (Churchill, 1998). Their distribution is determined by the availability of suitable roosting sites. The preferred roosting habitats of Ghost Bats in the Pilbara are caves beneath bluffs of low rounded hills composed of Marra Mamba geology and granite rockpiles. They have also been known to roost in large colonies in sandstone caves, under boulder piles and in abandoned mines (Churchill, 1998). This species has been recorded from areas near Ministers North, at Karijini National Park, West Angelas and at the Jirridi Exploration area (Dunlop & Sawle, 1983; ecologia 1998e; ecologia, 2006a). The Ghost Bat was not recorded during the current survey. However a number of extensive gorge systems and large caves occur in the Ministers North area (for example at sites PMN01, PMN12, and PMN20). It is likely that this species occurs in the area, however due to the small scale of the proposed disturbance this species is unlikely to be impacted.

- Western Pebble-mound Mouse (*Pseudomys chapmani*)

The Western Pebble-mound Mouse inhabits hummock grassland areas of *Triodia*, *Cassia*, *Acacia* and *Ptilotus* on skeletal soils containing an abundance of small (~5 g) pebbles (Start and Kitchener, 1995). These conditions are most common on spurs and the lower slopes of ridges. When first described, it was thought that the range of the Western Pebble-mound

Mouse had decreased substantially due to the occurrence of unused mounds in the Murchison and Gascoyne. This decline was attributed to foxes, cats and cattle. As such, it was classified as 'fauna that is likely to become extinct or is rare' (Start *et al.,* 2000). Since then, it has been found on many sites associated with development projects, particularly iron ore mining in the Pilbara and is possibly the most abundant small mammal in the region. Its status has subsequently been downgraded to Priority 4 by CALM. Pebble-mound Mouse mounds were located during the current survey at sites PMN 4, 8, 10, 11, 15, 17, 18, 19, and 21.

- Australian Bustard (*Ardeotis australis*)

The Australian Bustard (*Ardeotis australis)* is a large ground-dwelling, although not flightless, bird known to occur in open or lightly wooded country. It is nomadic and may range over very large areas, largely dependent on rainfall and hence food availability. At night it roosts in trees, or on the ground in treeless areas. During the day, Australian Bustards fly out onto the plains for food. *Ardeotis australis* has a varied diet, feeding on grasses, seeds, fruit, insects and small vertebrates. The Australian Bustard has been adequately surveyed, and is not considered to be currently threatened, but could be if present circumstances change. Habitat suitable for this species is lacking from the project area and as such the species is unlikely to occur at Ministers North.

- Grey Falcon (*Falco hypoleucos*)

The Grey Falcon is an infrequently observed, uncommon bird of prey, which inhabits Australia's arid zone, preferring lightly wooded coastal and riverine plains (Johnstone and Storr, 2003). They may be sedentary, dispersive or part-migratory (Pizzey, 2003). The exploration area has the potential to support the Grey Falcon, although it was not recorded and because of its rarity is unlikely to occur.

- Princess Parrot (*Polytelis alexandrae*) – discussed in Section 4.4.2

4.5 Sampling Adequacy

Few herpetofauna and mammal records were made and so a species accumulation curve was produced only for birds. The species accumulation curve for birds shows that the number of bird species recorded increases rapidly as individuals accumulate, and then slows (Figure 4.1). This is because the majority of species are relatively common and are recorded early, while other, less common, nomadic and migratory species, or species with large home ranges (*i.e.* raptors), are less frequently observed and may be represented by few if any individuals within the survey area at a given time. The species accumulation curve appears to be approaching the asymptote, suggesting that the species list is a good indication of the species present at the time of sampling. Predictive modelling indicates that the total number of birds at Ministers North during the time of sampling was 47, which would indicate that 89% of the total species present were recorded. The number of bird species recorded at Ministers North is greater than that recorded during other surveys of similar size and scope in the surrounding area (Figure 4.2) but is just 26% of the expected species list (Appendix D), which includes more comprehensive surveys and a wider seasonal range. The expected species list was compiled from a number of surveys over varying seasons and includes a range of habitats, some of which may not occur in the project area.

Relative to the birds, few mammal or reptile species were observed while foraging. Birds are diurnal and generally visible or audible, while reptiles and small mammals tend to be cryptic, sheltering for long periods during the day or abandoning the diurnal habit in favour of nocturnality. Consequently, intensive foraging is required to capture these animals. The best strategy for sampling these groups is to use a systematic trapping grid, which was beyond the scope of this project. Because of the small numbers of mammals observed and reptiles captured, species accumulation curves were not generated for these groups, and it is likely that the species recorded reflect a small fraction of those actually present in each area.

The number of herpetofauna recorded in the current survey is similar to that recorded in other surveys of similar size and scope (Figure 4.2) but only a small percentage of the expected species list (Appendix D). Only 12.5% of amphibians, 15% of reptiles, and 18% of mammals expected were recorded during the Ministers North survey, although in reality the percentage is likely to be higher as not all habitats of previous surveys would be found in the project area.

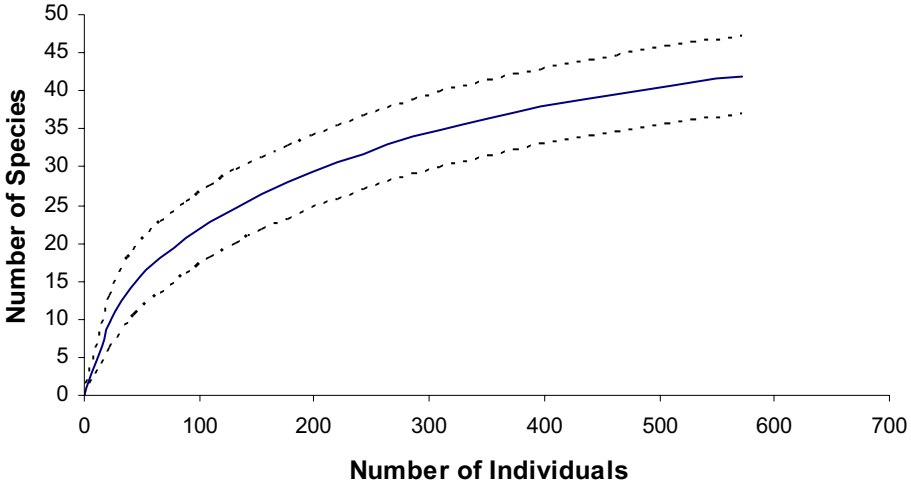


Figure 4.1 Species accumulation for bird species recorded in the Ministers North project area (dashed lines indicate 95% confidence interval).

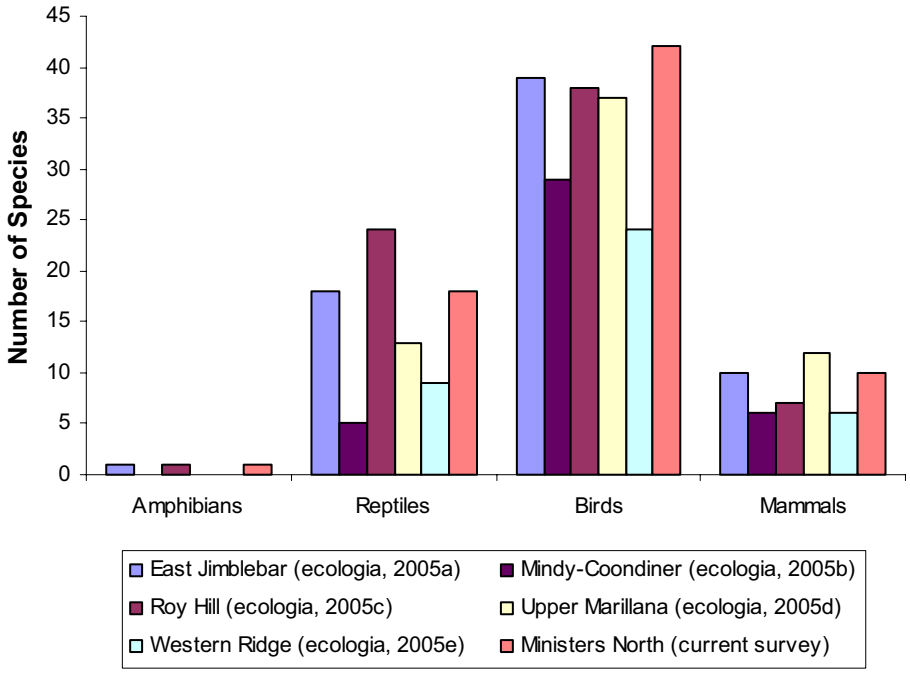


Figure 4.2 Comparison of species richness of each of the fauna groups between exploration surveys of similar scope.

5.0 BIOREGIONAL AND SHORT RANGE ENDEMIC FAUNA

When describing fauna and their conservation value, it is pertinent to note whether species have a widespread distribution or only occupy the biogeographic regions from which they were collected. Endemism refers to the restriction of species to a particular area, whether it is at the continental, national or even local level (Allen *et al*., 2002). Except in cases where cosmopolitan species are in decline (e.g. the Peregrine Falcon, *Falco peregrinus*), species that are endemic to a particular bioregion may be considered of higher conservation value than cosmopolitan species. EPA Guidance Statement 56 (EPA, 2004) describes the high diversity of Australia's biota and recommends that the diversity and endemism of terrestrial fauna be considered when undertaking biological survey work for Environmental Impact Assessment.

Areas which contain a high level of endemism across a broad range of taxa, usually occur when the physical characteristics of the region are unique and impose strong influences or selective pressures on the resident fauna, such that the fauna occurring may be dependant on those characteristics that are not present in other areas. In this instance, loss of habitat can result in a significant loss of fauna diversity in a regional or State context. The decline in biodiversity of terrestrial and aquatic communities has already been observed both nationally and state-wide[1].

With the increase in mining activity, primarily in the Pilbara, it is important to focus on the preservation not only of individual species, but also communities. There is an increasing shift in the creation of conservation strategies from species-based conservation to biodiversity-based conservation (e.g. McKenzie *et al*., 2000; Burbidge *et al*., 2000) and one of the important considerations involved in this is the presence of endemic species.

Historically, impacts on vegetation, fauna and fauna habitats associated with mining in the north-west of Western Australia were very much confined and occurred with relatively low frequency in remote locations where the landscape attributes were consistent over large areas. Moreover, the type of disturbance from mining was not considered to be particularly severe when compared with broad-scale disturbances, such as those created by introduced fauna or agriculture (e.g. extensive grazing, clearing and salinity). Consequently, the overall effect of mining on biodiversity was not considered to be deleterious. In more recent times there has been a significant increase in activity in the resources sector, and the cumulative impact of mining on the terrestrial and aquatic fauna of north-western Australia needs to be considered.

Kendrick (2001) suggests that very little is known concerning short-range and bioregionally endemic invertebrates of the region, and does not discuss the bioregionally endemic vertebrates of the Hamersley subregion at all. In their discussion of the Chichester subregion, Kendrick and McKenzie (2001) identify several vertebrate species endemic to the Pilbara Bioregion. Of these, 21 species have the potential to occur in the Ministers North survey area and are listed in Table 5.1 below:

[1] A discussion paper on the conservation of Western Australia's biodiversity "Towards a Biodiversity Conservation Strategy for Western Australia" is available online at:
http://www.naturebase.net/haveyoursay/pdf_files/biodiversity_draft_lores.pdf

Table 5.1 Bioregionally endemic vertebrate fauna potentially occurring in the Ministers North area.

Scientific Name	Common Name	Recorded on current survey
Ningaui timealeyi	Pilbara Ningaui	
Planigale sp.	an undescribed Planigale	
Dasykaluta rosamondae	Kaluta	
Pseudomys chapmani	Western Pebble-mound Mouse	√
Pseudantechinus roryi	Tan False Antechinus	
Diplodactylus savagei	a gecko	
Diplodactylus wombeyi	a gecko	
Delma elegans	a legless lizard	
Delma pax	a legless lizard	√
Ctenotus rubicundus	a skink	√
Ctenotus affin. robustus	a skink	
Egernia pilbarensis	a skink	√
Lerista zietzi	a skink	√
Lerista flammicauda	a skink	
Lerista neander	a skink	
Two or three undescribed taxa within *Lerista muelleri*	a skink	√
Varanus pilbarensis	Pilbara Rock Monitor	√
Acanthophis wellsi	Pilbara Death Adder	
Demansia rufescens	Rufous Whipsnake	
Ramphotyphlops pilbarensis	Pilbara Blind Snake	
Ramphotyphlops ganei	a blind snake	

5.1 Biogeographical Regionalisation and Endemic Fauna

Nine of the reptiles observed during the survey, the Perentie (*Varanus giganteus*), the Pilbara Rock Monitor (*Varanus pilbarensis*), the Tree Dtella *(Gehyra variegata), Delma pax, Ctenotus saxatilis, Ctenotus rubicundus, Lerista muelleri, Lerista zietzi* and *Egernia pilbarensis* are restricted to the Eyrean region. Six of these*, Varanus pilbarensis, Lerista muelleri* aff., *Delma pax*, *Lerista zietzi, Ctenotus rubicundus* and *Egernia pilbarensis,* are restricted to the Pilbara region (see Table 5.1).

Ministers North lies within the Eyrean zoographic region as discussed in section 2.5. This region encompasses much of arid Western Australia.

Generally, avifauna shows a reduced affinity with any one zoogeographic or biogeographic region. This is primarily due to their mobility. Of the 42 species recorded during the current survey, 62% occur in all three zoogeographic regions. 21.5% of the birds observed share Eyrean and Torresian affinities. Only 7% share Eyrean and Bassean affinities, and just 9.5% of the birds recorded are limited to Eyrean affinities. The species limited to Eyrean affinities are the Spinifex Bird (*Eremiornis carteri*), Western Bowerbird (*Chlamydera guttata*), Grey-headed Honeyeater (*Lichenostomus keartlandii*), and Striated Grasswren (*Amytornis striatus*).

Of the mammmals identified in the project area, the Western Pebble-mound Mouse (*Pseudomys chapmani*) is restricted to the Pilbara, while the Euro, *Macropus robustus,* has Eyrean and Torresian affinities. The Rothschild's Rock Wallaby, *Petrogale rothschildi,* is also likely to occur in the area and is endemic to the Pilbara region.

One Bat species recorded (*Vespadelus finlaysoni*) has an Eyrean affinity. The remaining species are either widespread across northern Australia (*Chaerophon jobensis*, *Nyctophilus bifax* and *Scotorepens greyii*) or widespread across the entire continent (*Chalinolobus gouldii*, *Nyctophilus geoffroyi*).

5.2 Short-Range Endemism

This following section focuses on those species that exhibit tight local range restrictions, known as short-range endemics. It focuses on the causes of short-range endemism, current knowledge of short-range endemism in Australia, with an emphasis on the Pilbara and northern Western Australia, and the conservation implications of such species. It is important to note that the groups discussed are not an exhaustive list of all short-range endemics. The short-range endemics are dominated by invertebrates, a group which is poorly studied and contains a number of undescribed species. It is only relatively recently that extensive, reliable taxonomic evaluation of these species has begun and thus the availability of literature relevant to short-range endemics is scarce.

5.2.1 Processes Promoting Short-Range Endemism

Short-range endemism is influenced by numerous processes generally contributing to the isolation of a fauna species. A number of factors, including the ability and opportunity to disperse, life history, physiology, habitat requirements, habitat availability, biotic and abiotic interactions and historical conditions, will influence not only the distribution of a taxon, but also the tendency for differentiation and speciation (Ponder and Colgan, 2002).

A combination of novel mutation, differing natural selection and genetic drift promote the accumulation of genetic differences between populations. Conversely, the maintenance of genetic similarity is promoted by migration between the populations, repeated mutation and balancing selection (Wright, 1943). The amount of differentiation and speciation between populations will be determined by the relative magnitude of these factors, with the amount of migration generally being the strongest determinant. Migration is hindered by poor dispersal ability of the taxon as well as geographical barriers to dispersal. Thus, those taxa that exhibit short-range endemism are generally characterised by poor dispersal, reliance on habitat types that are discontinuous, low growth rates and low fecundity (Harvey, 2002).

A number of habitats in Australia contain short-range endemics because they are surrounded by geographic barriers. Islands are an example where terrestrial fauna are surrounded by a marine environment which they are unable to cross. Similarly, isolated habitats such as mountains, aquifers, lakes and caves are essentially islands of differing environmental conditions amongst the surrounding landscape. Within the Pilbara and northern Western Australia, caves and other subterranean habitats are examples of areas where short-range endemics are common (Harvey, 2002). These provide a niche for a vast array of both terrestrial and aquatic short-range fauna, many of which are likely awaiting discovery.

Historical connections of habitats are also important in determining species distributions and often explain patterns that are otherwise inexplicable by current conditions. For example, during the Miocene period, the aridification of Australia resulted in the contraction of many areas of suitable habitat and fragmentation of populations (Hill, 1994). Many of the current species that have restricted distributions are a result of these processes.

5.2.2 Current Knowledge of Short-range Endemics in North-western Australia

Generally, the current state of knowledge on short-range species endemism in Australia is poor. The Interim Biogeographic Regionalisation for Australia divides the continent into 85 biogeographic regions based on characteristics of climate, fauna, vegetation, landforms and geology (Environment Australia, 2000). Twenty-six of these regions occur in Western Australia and a number of them contain short-range endemics. However, many taxa that appear to be rare are often poorly documented and could prove to be more widespread than originally thought. Nevertheless, recent taxonomic and survey work has revealed that short-range endemics are more common in Australia than was originally thought, and that some taxonomic groups are made up entirely of these types of species, although this is rare (Harvey, 2002).

Vertebrates

The vertebrate fauna of Australia is generally too mobile to allow the maintenance of genetic variation between population fragments. Thus, among mammals, birds, reptiles and amphibians, short-range endemism is rare, although there are some exceptions among the anurans and squamata (Harvey, 2002).

Freshwater Fish

Freshwater fishes are limited in their dispersal by marine and terrestrial surroundings and radiations of congeneric species have resulted from geographic barriers and geographic isolation within and between drainage systems (Allen *et al*., 2002). In addition to broad scale speciation as a result of continued isolation of drainages, speciation among the freshwater fishes of Australia can occur on finer scales in response to new geological barriers or drying of water bodies isolating local populations (e.g. Phillips, 2004).

North-western Australia encompasses three of the major drainage systems of Australia. The Indian Ocean (Pilbara) division includes intermittent streams and rivers (including the DeGrey, Yule, Fortescue, Ashburton, Gascoyne and Murchison), with occasional permanent pools (Allen *et al*., 2002). These water bodies support just twelve species of freshwater fish, two of which are endemic and listed as Threatened under the Western Australia *Wildlife Conservation Act 1950.*

Within the Western Plateau Drainage Division, surface waters are rare, mostly confined to temporary water bodies after sporadic rainfall, but a few small and widely separated permanent bodies do occur (Allen *et al*., 2002). No fishes have been recorded in this region but it is possible that fish species may occur in some of the isolated water bodies (Allen *et al*., 2002). Thus, the presence of short-range endemic fish species cannot be ruled out.

Invertebrates

Short-range endemics are more common among the invertebrates than the vertebrates. Widespread and uniform short-range endemism is found in both freshwater and terrestrial molluscs, onychophorans, millipedes, some arachnids and some crustaceans. Short-range endemism also occurs in other groups but is not uniform throughout (Harvey, 2002).

Molluscs

Numerous species of freshwater molluscs belonging to many genera have been identified in Australia, with most being short-range endemics. Likewise, the terrestrial molluscan fauna also have highly restricted ranges (Harvey, 2002). Restricted ranges of the terrestrial molluscs of the drier northern and western Australia were noted for a vast number of species (Solem, 1997). Among these were seven endemic species of *Rhagada* from the Dampier Archipelago, five of which were found to occur sympatrically on one of the islands. However, in a genetic study conducted by Johnson *et al.* (2004) on the same species, allozyme analysis revealed little variation between taxa. Such a finding could indicate that there is merely high morphological diversity within one or a few species. On the other hand, it is also possible that there are, in fact, a number of highly endemic species and morphological diversity has taken place rapidly with little genetic change (Johnson *et al*., 2004). Whatever the case, molluscs, especially gastropods, remain one of the most diverse and endemic groups of the north-west Australian fauna.

Worms

Taxonomic status of the earthworm family Megascolecidae in Western Australia was revised by Jamieson (1971). As a result of this study, it was concluded that most of the earthworm genera are made up almost entirely of short-range endemics. This is also the case with the velvet worms (onychophorans). Since a number of taxonomic revisions have been conducted (see references within Harvey, 2002), the number of onychophoran species has increased greatly from six to over 70 species. Moreover, a number of species still remain to be described (Harvey, 2002). Very few of these species exceed ranges of 200 km^2 and some are restricted to single localities and have high genetic differentiation, indicating very little mobility and dependence on their permanently moist habitats (Harvey, 2002).

Arachnids

Although the vast majority of the spider species in Australia are widely distributed, some of the mygalomorph species exhibit short range endemism. Furthermore, some of the mygalomorph genera are completely composed of short-range endemics (Raven, 1982). On the whole, however, short-range endemism in spiders is not on the same scale as other invertebrates. Another member of the arachnid class, the Schizomida, is entirely composed of short-range endemics, with most only recorded from single localities (Harvey, 2002). Forty-six schizomid species have been described in northern Australia, most known to occur in the entrances to and inside caves, and the remainder in nearby habitats (Harvey, 2002). An example of one such species in the Pilbara is the troglobitic species *Draculoides vinei*, which resides in a network of caves in limestone formation on the Cape Range Peninsula. Its range extends to 100 km^2, but allozyme analysis indicates that total speciation may have occurred within this range and a number of species with even narrower ranges exist (Adams and Humphreys, 1993).

Millipedes

Despite the fact that millipedes are highly abundant in soil and leaf litter, and highly diverse at the level of order (Harvey, 2002), they are inadequately studied and relatively little is known of their biogeography. One of the genera that has been studied is *Stygiochiropus* (Humphreys and Shear, 1993; Shear and Humphreys, 1996). This genus consists solely of four species that are found in the caves and subterranean cavities in the Cape Range

Peninsula, three of which are restricted to single caves, *S. isolatus* Humphreys & Shear, *S. sympatricus* Humphreys & Shear and *S. peculiaris* Shear & Humphreys. The fourth species, *S. communis*, occurs throughout the Peninsula, and is sympatric with *S. sympatricus* where the latter occurs.

Crustaceans

Three families of the freshwater isopod (suborder Phreatoicidea) occur in Australia. Most are highly endemic and often allopatric, constrained by their specific habitat requirements of permanent fresh lakes and streams (see references within Harvey, 2002). Their dispersal ability is also thought to be poor as nearly all are restricted to areas that have been above sea level since the middle Cretaceous (Harvey, 2002).

5.2.3 Conservation of Short Range Endemics

Short-range endemics are especially vulnerable to the effects of anthropogenic activity due to their limited dispersal abilities and specific habitat requirements. Therefore, identifying short-range endemics is essential in the conservation of biodiversity, not only because the possibility for there entire range to be destroyed is greater, but also because their limited dispersal capabilities makes them even more vulnerable to the effects of habitat fragmentation and the problems of decreasing population numbers, inbreeding and the loss of fitness that accompany it. Thus, even if loss of habitat only occurs in parts of their range, species extinction may still occur due to their inability to exchange genes between fragments and recolonise those that die out due to stochastic events. In many cases, the activities of man are causing further fragmentation of populations and rates of local extinction will only increase as habitat fragmentation continues. Therefore, it is important to obtain data on the spatial structure of short-range endemics (Clark and Richardson, 2002).

Unfortunately, there is a lack of sampling and taxonomic studies of invertebrate species and many short-range endemics may be unrecognised as a result of insufficient data (Harvey, 2002), placing them at an even greater risk. In order to recognise short-range endemics, investigation of existing taxa, field studies and reliable taxonomic resolution is required (Ponder and Colgan, 2002). Widespread survey work is part of the process but it is not possible to comment on diversity and variation without the use of genetic analysis.

Although morphology can be a useful indicator of genetic similarity (*e.g.* Waters *et al*., 2001), there are many cases in the literature where species have gone unnoticed until the use of molecular techniques due to an apparent uniformity in morphological traits. This has been the case in many freshwater fishes, for example (Phillips, 2004). Taxonomic revisions employing the use of molecular tools, such as those carried out on the onychophorans, could reveal a whole suite of new species. On the other hand, they may also result in the amalgamation of species. In many cases, changes in morphology can occur during development to better suit an organism to its environment. Thus, morphological traits can be a reflection of environment and not genetic make-up (e.g. Kinsey et al., 1994). Although taxonomists generally attempt to use traits that would not be influenced by environment, this is not always the case. The use of molecular markers avoids the confounding effects of environment and they are therefore a useful tool in taxonomy.

5.2.4 Short-Range Endemism at Ministers North

Endemic species are equally important to a specific region, as those species that are more broadly listed as specially protected fauna. Short-range endemics in the Pilbara are most limited to invertebrate groups, and very little is known about them (Kendrick and McKenzie, 2001). Vertebrate short-range endemics of the Pilbara can be fairly accurately assumed to be bioregionally endemic species associated with the Interim Bioregionalisation of Australia (IBRA: Environment Australia, 2000, see section 5.0).

The proposed exploration activities are not likely to heavily impact upon the bioregionally endemic fauna identified during this survey. Clearing of small areas of vegetation and localised disturbances are unlikely to significantly influence habitats that are not well-represented outside the project area. However, disturbances to habitats known to support short-range endemic species, such as caves and gorges, should be avoided.

6.0 CONSERVATION SIGNIFICANCE

The significance of the biota of the project area has been assessed at four spatial scales; International/National, State, regional and local.

6.1 International / National Significance

Fauna species whose conservation is dependent, because of their migration patterns, on the action of other nations as well as Australia's, are of International significance. Such considerations are recognised by State legislation, Federal legislation and also International treaties.

Several species listed as Marine or Migratory by the EPBC Act have the potential to occur in the project area. As discussed previously (see section 4.4.1) these species are unlikely to be impacted by drilling activities.

National significance refers to those features of the environment which are recognised under legislation as being of importance to the Australian community. Species scheduled under the Commonwealth EPBC Act are regarded as nationally significant. No species listed under the EPBC Act were recorded within the Ministers North project area. However a number of species have the potential to occur within the proposed disturbance footprint or the surrounding areas (Table 4.6), and include the Night Parrot (*Pezoporus occidentalis,* Endangered)**,** Northern Quoll (*Dasyurus hallucatus,* Endangered), Mulgara (*Dasycercus cristicauda,* Vulnerable), Bilby (*Macrotis lagotis* Vulnerable), Orange Leaf-nosed Bat (*Rhinonicterus aurantius,* Vulnerable), Princess Parrot (*Polytelis alexandrae,* Vulnerable), Pilbara Olive Python (*Morethia olivaceus barroni,* Vulnerable).

Some of these species are unlikely to occur within the project area due to factors such as distribution, scarcity and habitat requirements. For example the Bilby requires extensive sandplains which are absent from the project area. Nationally significant species that are likely to occur in the Ministers North area include the Orange Leaf-nosed Bat and the Pilbara Olive Python. The small scale of the proposed disturbance means that these species are unlikely to be affected by exploration activity. However, disturbances to habitat suitable for these species (caves and gorges) should be avoided.

6.2 State Significance

State significance refers to those features of the environment that are recognised under State legislation as of importance to the Western Australian community; in particular, species scheduled under the *Wildlife Conservation Act 1950*.

Fauna that are regarded as "rare and/or endangered", or habitats which are site or type specific and possess high ecological value are of State significance. Habitats which exhibit such a level of significance will contain either specific habitat dependent fauna or high biodiversity, and are poorly represented elsewhere. If a species or habitat is poorly represented in conservation reserves its conservation significance is increased.

Of the fauna scheduled under the *Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 2003*, six species potentially occur in the area; the Schedule 1 Mulgara (*Dasycercus cristicauda*), Bilby (*Macrotis lagotis*), Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) Night Parrot (*Pezoporus occidentalis*) and Pilbara Olive Python (*Liasis olivaceus barroni*), and the Schedule 4 Peregrine Falcon (*Falco peregrinus*).

None of these species were recorded during the current survey, and some are unlikely to occur in the area due to such factors as habitat requirements and distribution. However, habitat within the Ministers North (such as caves, gorges and cliffs) area may support the Orange Leaf-nosed Bat, Pilbara Olive Python and the Peregrine Falcon. The small scale of the proposed disturbance means that these species are unlikely to affected by exploration activity. However, disturbances to habitat suitable for these species (caves, gorges and cliffs) should be avoided.

6.3 Regional Significance

Regional significance addresses the representation of species and habitats at a biogeographic regional level. Species or habitat types that are endemic to the Pilbara bioregion or the Ministers North area and whose distributions are limited or unknown are considered regionally significant. Two CALM priority fauna species, one endemic to the Pilbara are likely to occur in the area.

The Western Pebble-mound Mouse (*Pseudomys chapmani)* is endemic to the Pilbara bioregion. Fifteen Pebble-mound mouse mounds attributable to this species were sighted during the current survey, 10 of which were potentially active. This species is apparently widespread throughout the Pilbara and the localised impact of exploratory drilling should not impact this species significantly. However, measures should be taken to prevent directly impacting active or inactive mounds. The locations of the Pebble-mouse mounds are listed in Appendix F.

The Ghost Bat (*Macroderma gigas*) may also occur in the Ministers North area in some of the more extensive cave systems. Impacts to such habitat should be avoided.

One Priority Flora species, *Triumfetta leptacantha* (Priority 3), was recorded in the project area at PMN01. This species is endemic to the Pilbara. Measures should be taken to ensure *Triumfetta leptacantha* is not disturbed.

6.4 Local Significance

Species are of local significance when their presence is confined to a specialised habitat type that is not common within the local area and whose disturbance or removal may lead to local extinction.

None of the species observed at Ministers North were confined to particularly specialised habitats that were not strongly represented outside the project area. Specialised habitat within the project area includes caves and gorges, habitat types known to promote short-range endemism. Disturbance to these habitats is likely to be minimal, due to the small scale of the proposed exploration. However, significant caves and gorges occur at sites PMN01, PMN12 and adjacent to PMN20. Disturbance to these areas should be avoided.

Thus, the Ministers North exploration area is not of particular local significance and proposed clearing of habitat associated with geological exploration drilling operations should not lead to local extinctions of any flora or fauna.

6.5 Biodiversity

Australia has an International obligation to maintain biodiversity. The Commonwealth government has initiated the National Strategy for the Conservation of Biological Diversity, which incorporates elements of the National Strategy for Ecologically Sustainable Development (NSESD). Biological diversity (biodiversity) relates to the richness of the biota at a local, regional, state, National or even global level, and includes all components of the environment, from bacteria to insects, plants, and vertebrate fauna. Biodiversity can be thought of as existing at several levels, including genetic, population and species (or taxon) diversity. This study examines biodiversity at the species and population level, and places it within a local, regional and National context.

One of the major issues from a biodiversity perspective is whether individual species would be restricted to the particular habitat of the project area. The habitats within the project area are well represented within the region. Therefore, loss or modification of habitat within the project area is unlikely to reduce regional biodiversity.

Part of the purpose of the biogeographic regionalisation of Australia (Thackway and Cresswell, 1995) was to examine the representation of ecosystems within conservation reserves at a bioregional level to ensure that the biodiversity of each bioregion was maintained. Within close proximity to the project area, and within the same biotopes occur Karijini National Park (the second largest national park in Western Australia at 627 444 ha) and Chichester Range National Parks. The habitat type present in the project area is well represented in these reserves.

Issues that have been identified as important to conservation planning and management in the future include the extinction of critical weight range mammals, wildfire, grazing and feral animals. All of these issues are considered in the management strategies proposed for the project area.

7.0 ENVIRONMENTAL IMPACTS

The vegetation associations, habitats and landforms found in the project area (and within the proposed disturbance footprint) are not considered to be of regional conservation or ecological significance and are well represented across the Pilbara biogeographic region. This, coupled with the negligible area likely to be cleared (approximately 30 m × 20 m per drill pad), implies that at a regional scale loss of vegetation associations, habitat types and landforms found in the project area will not constitute a significant loss of biodiversity.

Potential impacts on flora and fauna of the Ministers North area include:

- Loss of natural vegetation and fauna through clearing; and
- Indirect loss of fauna and fauna habitat from ongoing practices.

Clearing: Loss of vegetation, flora, fauna and fauna habitat

The most substantial environmental impact arising from the proposed project would be the clearing of native vegetation, the consequent loss of flora and fauna and loss of habitat.

It is expected that the proposed clearing will result in the direct loss of a small number of individual fauna, particularly sedentary fauna species (*i.*e. small mammals, amphibians, reptiles and some birds, such as Fairy-wrens and the Australian Owlet-nightjar) that currently inhabit the proposed disturbance footprint. Fauna species of conservation significance and their associated habitats occurring in the area are unlikely to be impacted. Due to the small size and localised nature of the proposed disturbance, habitat loss for the majority of fauna species will be low. Additionally, some of the more mobile fauna (such as many birds and larger reptiles) will be able to move out of the area prior to the disturbance occurring.

Within the proposed disturbance footprint all flora species are expected to be lost. The areas proposed to be disturbed are generally well represented in the surrounding vegetation. The small areas proposed to be disturbed are likely to be readily capable of rehabilitation, providing that measures are taken to limit the invasion of potential weeds as a result of disturbance.

One priority flora taxa occurs at PMN01. This area does support significant flora and fauna species and as a result vegetation clearance at PMN01 should be avoided.

Significant habitat with the potential to support species of conservation significance occurs within the project area. This habitat includes gorges and caves (for example at sites PMN01 and PMN12). Disturbance to these habitats has the potential to result in the loss of species of conservation significance. Due to the small scale of exploration activities, the likelihood of the loss of significant species is low. However, it is recommended that these habitats remain undisturbed (see section 8).

Indirect loss of flora, fauna and fauna habitat

Flora, fauna and fauna habitats can be impacted by indirect impacts from increased activity in the area such as fire, weeds, feral animals and increased traffic.

No 'declared' weeds listed under the *Agriculture and Related Resources Protection Act,* 1976 have been recorded in the project area. However a number of weeds occur in the region and could be transported into the area unless precautionary measures are taken. Environmental weed species such as Buffel grass (**Cenchrus ciliaris*), Ruby dock (**Acetosa vesicaria*) and Bipinnate beggartick (**Bidens bipinnata*) have been recorded near Ministers North (at Marillana) and their spread should be minimised. Many environmental weeds (including those mentioned above) are highly invasive resulting in the displacement of native vegetation and the loss of habitat for fauna species.

Often, as a consequence of disturbance, pest species may dominate the fauna assemblages. In previous surveys, seven species of introduced mammal have been recorded near Ministers North. The Cow (*Bos Taurus*) has probably not been influenced by activity associated with mining sites. However, the Feral Cat (*Felis catus*), Rabbit (*Oryctolagus cuniculus*) and the House Mouse (*Mus musculus*) can often increase in frequency with an increase in human activity. These species can have a marked impact on local flora and faun through predation (Feral Cat), competition (House Mouse and Rabbit), over grazing and land degradation (Rabbit).

8.0 RECOMMENDATIONS

Detailed recommendations are listed in two categories where appropriate; design level and management level. Recommendations at the design level present strategies which will mitigate impacts to the environment inherent in the design of proposed developments. Management level recommendations aim to reduce the ongoing impacts to the biological environment following construction and to preserve existing conservation values. In order to reduce impacts to flora and fauna from exploration within the Ministers North area, BHPBIO should undertake the following:

RECOMMENDATION 1
Limit vegetation clearing to within the areas surveyed by *ecologia*. This will ensure significant species occurring outside the study area are not impacted

RECOMMENDATION 2
Minimise clearing to that which is absolutely necessary. Drill pads should be no larger than 30 x 20 m and existing access tracks should be used where possible. Additional tracks to access drill lines should not be made. Where it is necessary to create a track to access a drill line (sites PMN04, PMN05), disturbance should be restricted to the designated route which has been searched for flora of conservation significance.

RECOMMENDATION 3
Access tracks to be constructed only in the area surveyed by *ecologia*. The routes for access tracks to sites PMN04 and 05 were flagged and surveyed (to a maximum width of 10 metres) by ecologia. Tracks should only be constructed only along the routes surveyed to prevent disturbance to areas not checked for flora of significance.

RECOMMENDATION 4
Clearing machine operators should remove the minimum amount of topsoil. Minimum topsoil disturbance will encourage natural regeneration due to retention of the seed store and micobiological activity which is largely confined to the topsoil. Achieving minimum disturbance will also discourage weeds and other species which proliferate following disturbance.

RECOMMENDATION 5
The height of stockpiles of soil and cleared vegetation should be minimised. Multiple smaller stockpiles, dispersed at regular intervals along the length of the edges of cleared areas, are preferable to a single stockpile Lower stockpiles allow greater retention of biological activity within the soil (bacteria, fungi and lichen) which improves seed germination rates once the soil is respread.

RECOMMENDATION 6
Avoid impacting Western Pebble-mound Mouse burrow systems. This includes 'inactive' mounds which may be re-colonised. Drilling and track placement should be excluded within a 20 m radius of Western Pebble-mound Mouse mounds and areas containing mounds should be clearly marked. Western Pebble-mound Mouse mounds were located at sites PMN 4, 8, 10, 11, 15, 17, 18, 19, and 21.

RECOMMENDATION 7
The clearance of any priority flora should be avoided. Approximately 15 individuals of *Triumfetta leptacantha* (Priority 3) was recorded at site PMN01 at location 50K, 714217E, 7474561N (AGD84). This area should not be cleared.

RECOMMENDATION 8
Avoid disturbance to caves and gorges (significant habitat for species of conservation concern). Caves may provide permanent or temporary roosts for Ghost Bats and Orange Leaf-nosed Bats and gorges may provide habitat for Olive Pythons, Peregrine Falcons and short-range endemic fauna. Such habitat is found at PMN01, 02, 05, 09, 12 and 13. Drilling should be avoided at sites PMN01 and PMN13 where extensive caves and gorges occur.

RECOMMENDATION 9
Avoid drilling near caves. Caves may provide habitat for species of conservation significance, including temporary roosts for many bat species. It is recommended that drilling be avoided at PMN01 and 02.

Management Level

RECOMMENDATION 10
BHPBIO should continue to implement existing environmental procedures for staff and contractors. These include managing the risk of fire, the spread of weeds (particularly Buffel grass, Ruby dock and Bipinnate beggartick) and general environmental impact awareness.

RECOMMENDATION 11
BHPBIO should develop and implement policies which specifically address the reduction of impacts to Western Pebble-mound Mice.

9.0 STUDY TEAM

The Ministers North Exploration Project Biological Survey described in this document was planned, coordinated and executed by:

ecologia Environment
1025 Wellington Street
WEST PERTH
WA 6005

Project Staff

S. Ford	PhD	Project Manager
C. Macpherson	BSc (Hons)	Principal Botanist
A. Capobianco	BSc (Hons)	Botanist
J. Turpin	BSc.	Senior Zoologist
D. Bradshaw		Zoologist

ecologia wishes to acknowledge the assistance of Bob Bullen for bat call identification and Malcolm Trudgen for plant specimen identification.

PERMITS

The Ministers North Exploration Project Biological Survey was conducted under the authorisation of the following licence issued by Conservation and Land Management to:

S. Ford, *ecologia* Environment
"Licence to take fauna for scientific purposes"
Licence Number SF005226, valid to 28th November, 2006

C. Macpherson, *ecologia* Environment
"Licence to take flora for scientific purposes"
Licence Number: SL007231, valid to 17th August, 2006.

A. Capobianco, *ecologia* Environment
"Licence to take flora for scientific purposes"
Licence Number: SL007507, valid to 2nd March, 2007

10.0 REFERENCES

Adams, M. and Humphreys, W. F. (1993). Patterns of genetic diversity within selected subterranean fauna of the Cape Range peninsula, Western Australia: systematic and biogeographic implications. *Rec. W.A. Mus. Supp*. **45**: 145-164.

Allen, G. R., Midgley, S. H. and Allen, M. (2002). *Field Guide to the Freshwater Fishes of Australia*. CSIRO Publishing, Melbourne.

Atkins, K. J. (2005). Declared Rare and Priority Flora List April 2003, Department of Conservation and Land Management, Perth.

Baker, L. (1996). The Distribution, Habitat Requirements and status of the Mulgara (Dasycercus cristicauda, Krefft). Unpublished thesis, University of New England, Department of Ecosystem Management.

Bamford Consultant Ecologists. (2005). Fauna Survey of Proposed Iron Ore Mine, Cloud Break. Unpublished Report for Fortescue Metals Group.

Beard, J.S. (1975) Pilbara. Explanatory notes to Sheet 4, 1:1,000,000 Series Vegetation Survey of Western Australia. Univ. of W.A.. Press: Nedlands.

Bettany, E., Churchward, H. M. and McArthur, W. M. (1967). Explanatory data sheet 6: Meekatharra – Hamersley Range Area IN Northcote, K.H. (1967) Atlas of Australian Soils, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia.BHP-Utah Minerals International (1987).

Biota Environmental Scientists (2004) Jimblebar-Wheelarra Hill 3 Flora and Fauna Assessment. Unpublished report for BHP BIO.

Braithwaite, R.W. and Begg, R.J. (1995) Northern Quoll Dasyurus hallucatus IN Strahan, R. (1995) The Mammals of Australia Reed Books, Chatswood N.S.W. pp 65 – 66

Burbidge, A. A. (1971). Results of a Biological Survey of the Millstream Area. Report manuscript; Department of Fisheries and Fauna, Western Australia.

Burbidge, A. H., Harvey, M. S. and McKenzie, N. L. (2000). Biodiversity in the southern Carnarvon Basin. *Rec. W.A. Mus. Supp*. **61**: 1-595.

Burbidge, N. T. (1945). The vegetation of the de Grey-Coongan area with special reference to physiography. J. Proc. R. Soc. West. Aust. 29: 151-161.

Burbidge, N. T. (1959). Notes on plants and plant habitats observed in the Abydos-Woodstock area, Pilbara District, Western Australia. C.S.I.R.O. Div. Plant Ind. Tech. Paper 12.

Bureau of Meteorology (2006). Available at www.bom.gov.au.

Butler, W.H. (1983) Burrup Peninsula fauna survey. Woodside Offshore Petroleum Pty. Ltd. (Unpublished report).

Churchill, S. (1998). Australian Bats. Reed New Holland, Sydney.

Clark, S. A. and Richardson, B. J. (2002). Spatial analysis of genetic variation as a rapid assessment tool in the conservation management of narrow-range endemics. *Invert. System.*, **16**: 583-587.

Colwell, R.K. (2005). EstimateS: Statistical estimation of species richness and shared species from samples. Version 7.5. User's Guide and application published at: http://purl.oclc.org/estimates

Colwell, R. K. and Coddington, J. A. (1994). Estimating terrestrial biodiversity through extrapolation. Philosophical Transactions of the Royal Society (B) **345**: 101-118

Dames and Moore (1982). Harding Dam Project Draft Environmental Review & Management Programme. Unpubl. Report to Engineering Division, Public Works Dept. W.A.

Dames and Moore (1984). Millstream Water management Programme. Unpubl. Report to Engineering Division, Public Works Dept.

Dawe, C. and Dunlop, J.N. (1983). Introduction to Hamersley Range National Park. In Muir, B.G. (ed) *A Fauna Survey of the Hamersley Range National Park W.A. Bull No. 1 National Parks Authority WA*.

Dunlop, J. N. and Pound, I. R. (1981). Observations on the Pebble-mound Mouse *Pseudomys chapmani* Kitchener, 1980. *Rec. West. Aust. Mus.* 9 (1): 1-5.

Dunlop, J. N. and Sawle, M. (1982). The habitat and life history of the Pilbara Ningaui *Ningaui timealeyi. Rec. W.A. Mus.* 10: 47-52.

Dunlop, J.N. and Sawle, M. (1983). The small mammals of the eastern Pilbara and the Hamersley Range National Park. In Muir, B.G. (ed) *A Fauna Survey of the Hamersley Range National Park W.A. Bull No. 1 National Parks Authority WA*, pp26-30.

ecologia Environmental Consultants (1995a). Orebody 18 Biological Assessment Survey, November 1995. Unpublished Report for BHP Iron Ore Pty Ltd.

ecologia Environmental Consultants (1995b). Orebody 25 Biological Assessment Survey. Unpublished Report for BHP Iron Ore Pty Ltd.

ecologia Environmental Consultants (1995c) Yandi Stage II Iron Ore Project Biological Assessment Survey. Unpublished Report for BHP Iron Ore Pty Ltd.

ecologia Environmental Consultants (1998a). Mining Area C Biological Survey. Unpublished Report for BHP Iron Ore Pty Ltd

ecologia Environmental Consultants (1998b). Orebody 23 Extension Biological Assessment Survey, January 1998. Unpublished Report for BHP Iron Ore Pty Ltd.

ecologia Environmental Consultants (1998c). Orebody 23 Rare Flora Survey, January 1998. Unpublished Report for BHP Iron Ore Pty Ltd.

ecologia Environmental Consultants (1998d) West Angelas ERMP: Vertebrate Fauna Assessment Survey. Unpublished Report for Robe River Iron Associates.

ecologia Environmental Consultants (1998e). West Angelas Project: Ghost Bat *Macroderma gigas* Assessment Survey. Unpublished Report for Robe River Iron Associates.

ecologia Environmental Consultants (1998f). Yandi Vegetation and Soil Survey. Unpublished Report for BHP Iron Ore Pty Ltd.

ecologia Environmental Consultants (1999a) West Angelas Iron Ore Project Mine Access Road Corridor: Vertebrate Fauna Assessment Survey. Unpublished report for Robe River Mining Co. Pty Ltd.

ecologia Environmental Consultants (1999b) West Angelas Iron Ore Project Turee Creek 'B' Pipeline Corridor: Vertebrate Fauna Assessment. Unpublished report for Robe River Mining Co. Pty Ltd.

ecologia Environmental Consultants (2000a) West Angelas Iron Ore Project 250 KP Quarry: Vertebrate Fauna Assessment Survey. Unpublished report for Robe River Mining Co. Pty Ltd.

ecologia Environmental Consultants (2000b) West Angelas Minesite and Coondewanna West Rail Route: Rare and Priority Flora Survey. Unpublished report for Robe River Mining Co. Pty Ltd.

ecologia Environmental Consultants (2001a) Robe Development Plan West Angelas Rail Line Siding: Rare and Priority Survey. Unpublished report for Robe River Mining Co. Pty Ltd.

ecologia Environmental Consultants (2001b) West Angelas Hill 988 Communication Tower: Rare and Priority Flora Survey. Unpublished report for Robe River Mining Co. Pty Ltd.

ecologia Environment (2002). Yandi Airstrip and Access Road: Rare and Priority Flora Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2003). Newman to Yandi Powerline: Rare & Priority Flora Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2004a) Area C: Deposits D, E and F Biological Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2004b). Packsaddle Range Biological Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environmental Consultants (2004c). Satellite Orebody-OB 24 Biological Assessment. Unpublished Report for MPDJV/BHPBIO.

ecologia Environmental Consultants (2004d). Yandi Stockyard and Overland Conveyor: Fauna and Flora Assessment 2004. Unpublished Report for MPDJV/BHPBIO.

ecologia Environment (2005a) East Jimblebar Exploration Project: Biological Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2005b). Mindy-Coodiner Exploration Project Biological Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2005c) Roy Hill Exploration Project Biological Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2005d) Upper Marillana Exploration Project Biological Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2005e). Western Ridge Exploration Project Biological Survey. Unpublished report for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2006a). Jirridi Terrestrial Vertebrate Fauna Assessment. Report in preparation for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2006b). Marillana Terrestrial Vertebrate Fauna Assessment. Report in preparation for BHP Billiton Iron Ore Pty Ltd.

ecologia Environment (2006b). Marillana Flora and Vegetation Assessment. Report in preparation for BHP Billiton Iron Ore Pty Ltd.

Environment Australia (2000). Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and development of version 5.1 Summary Report

EPA (2004). Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. No. 56. Environmental Protection Authority, Western Australia.

Fowler, J. and Cohen, L. (1990). *Practical Statistics for Field Biology.* John Wiley & Sons, Chichester.

Harvey, M.S. (2002). Short-range endemism among the Australian fauna: some examples form non-marine environments. *Invert. System*., **16**: 555-570.

Hill, R.S. (ed.). (1994). *History of Australian Vegetation: Cretaceous to Recent*. Cambridge University Press, Cambridge.

Hnatiuk, R. J. (1990). Census of Australian Vascular Plants. Australian Flora and Fauna Series Number 11. Bureau of Flora and Fauna, Canberra. Aust. Govt. Publishing Service, Canberra.

How, R.A., J. Dell and N.K. Cooper (1991). Vertebrate Fauna. IN Ecological Survey of Abydos-Woodstock Reserve, Western Australia. Records of the Western Australian Museum Supplement No. 37: 78-126.

Humphreys, W.F. and Shear, W.A. (1993) Troglobitic millipedes (Diplopoda: Paradoxosomatidae) from semi-arid Cape Range, Western Australia: systematics and biology. *Invert. Taxon*., **7**: 173-195.

Hussey, B. M. J., Keirghery, G. J., Cousens, R. D., Dodd, J. and Lloyd, S. G. (1997). Western Weeds. The Plant Protection Society of Western Australia, Victoria Park.

Jamieson, B.G.M. (1971) Earthworms (Megascolecidae: Oligochaeta) from Western Australia and their zoogeography. *J. Zool*., **165**: 471-504.

Johnson, K.A. (1995). Bilby *Macrotis lagotis*. IN Strahan, R. (ed.) (1995). *The Mammals of Australia*. Reed Books, Sydney. pp 590 – 592

Johnson, M. S., Hamilton, Z.R., Murphy, C.E., MacLeay, C.A., Roberts, B. and Kendrick, P.G. (2004) Evolutionary genetics of island and mainland species of *Rhagada* (Gastropoda: Pulmonata) in the Pilbara Region, Western Australia. *Aust. J. Zool*., **52**: 341-355.

Johnstone, R. E. and Storr, G. M. (2004). Handbook of Western Australian Birds; Volume 1 - Non-passerines. Western Australian Museum, Perth.

Kendrick, P. (2001) Pilbara 3 (PIL3 – Hamersley subregion) IN A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. available at http://www.naturebase.net/science/bio_audit/index.html.

Kendrick, P. and McKenzie, N. (2001). Pilbara 1 (PIL1 – Chichester subregion) *IN* A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. available at http://www.naturebase.net/science/bio_audit/index.html

Kinsey, S.T., Orsoy, T., Bert, T.M. and Mahmoudi, B. (1994). Population structure of the Spanish sardine Sardinella aurita: natural morphological variation in genetically homogenous population. *Marine Biology* 118: 309-317.

Masini, R. J. (1988) Inland Waters of the Pilbara, Western Australia, Part 1. Environmental Protection Authority, Perth, Western Australia. Tech. Series No. 10.

Masini, R. J. and Walker, B. A. (1989). Inland waters of the Pilbara, Western Australia, Part 2. Environmental Protection Authority, Perth, Western Australia. Technical Series No. 24.

McKenzie. N.L., Halse, S.A. and Gibson, N. (2000) Some gaps in the reserve system of the southern Carnarvon Basin, Western Australia. *Rec. W.A. Supp*. **61**:547-567.

Menkhorst, P. and Knight, F. (2001). *A Field Guide to the Mammals of Australia.* Oxford University Press, South Melbourne.

Muir, B. G (1977). Biological Survey of the Western Australian Wheatbelt. Pt. 2. Vegetation and habitat of the Bendering Reserve. Rec. West. Aust. Mus. Suppl. 3

Muir, B.G. (ed) (1983) A Fauna Survey of the Hamersley Range National Park W.A. Bull No. 1 National Parks Authority WA.

Natural Systems Research Pty. Ltd. (1979). Vegetation and Fauna Studies for the Environmental Impact Assessment of Deepdale Iron Ore Mine, Western Australia. Unpublished Report commissioned by BHP.

Ninox Wildlife Consulting (1985). A Vertebrate Fauna Survey of the Mount Channar Area near Paraburdoo, Western Australia. Unpublished Report prepared for Hamersley Iron Pty. Ltd.

Ninox Wildlife Consulting (1986). A Second Seasonal Survey of the Channar Area and a Synthesis of all Vertebrate Data. Unpublished Report prepared for Hamersley Iron Pty. Ltd.

Ninox Wildlife Consulting (1991). Vertebrate Fauna assessment of the Proposed Tom Price Tailings Dam Sites. Internal report for Hamersley Iron Pty. Ltd.

O'Brien, J. and Associates Pty. Ltd (1992). Marandoo Iron Ore Mine and Central Pilbara Railway. Environmental Review and Management Program. Report to Hamersley Iron Pty. Ltd.

Pearson, D. (2003). Giant Pythons of the Pilbara. *Landscope.* 19(1): 32-39

Phillips, R.D. (2004) Population structure of the Western Rainbow Fish *Melanotaenia australis* in the east Kimberley. Unpublished Honours Thesis, School of Animal Biology, University of Western Australia.

Pizzey, G. (2003). *A Field Guide to the Birds of Australia.* Vol. 7. Harper-Collins, Sydney.

Pizzey, G. and Knight, F. (2003). The Field Guide to the Birds of Australia. Harper Collins Publishers, Sydney.

Ponder, W. F. and Colgan, D. J. (2002). What makes a narrow-range taxon? Insights from Australian freshwater snails. Invert. System., 16:571-582.

Raven, R.J. (1982) Systematics of the Australian mygalomorph spider genus Ixamatus Simon (Diplurinae: Dipluridae: Chelicerata). *Aust. J. Zool*., **30**: 1035-1067.

Royce, R. D. (1948). Botanical observations along the No. 1 rabbit-proof fence. West. Aust. Nat. 1: 89-95.

Shear, W.A. and Humphreys, W.F. (1996) A new Stygiochiropus from a North West Cape (Western Australia) coastal plain cave (Diplopoda: Polydesmida: Paradoxosomaridae). *Rec. W.A. Mus*., **17**: 447-449.

Simpson, K. and Day, N. (eds) (2004). *Field Guide to the Birds of Australia.* Penguin Books Australia Ltd, Melbourne.

Start, A.N. and Kitchener, D.J. (1995) Western Pebble-mound Mouse *Pseudomys chapmani* IN Strahan, R. (ed.) (1995). The Mammals of Australia. Reed Books, Sydney. pp 590 – 592

Start, A. N. Anstee, S. D. and Endersby, M (2000). A review of the bilogy and conservation status of the ngadji, Pseudomys chapmani Kitchener 1980 (Rodentia: Muridae). CALMScience 3:125-147.

Slater, P., Slater, P. and Slater, R. (1991). *The Slater Field Guide to Australian Birds.* Weldon Publishing, Sydney.

Solem, A. (1997) Camaenid land snails from Western and central Australia (Mollusca: Pulmonata: Camaenidae). *Rec. W.A. Mus. Supp*. **50**: 1461-1909.

Storr, G. M., L. A. Smith and R. E. Johnstone (1983). *Lizards of Western Australia. II. Dragons and Monitors.* Western Australian Museum, Perth.

Storr, G. M., L. A. Smith and R. E. Johnstone (1986). *Snakes of Western Australia.* Western Australian Museum, Perth.

Storr, G. M., L. A. Smith and R. E. Johnstone (1990). *Lizards of Western Australia. III. Geckos and Pygopods.* Western Australian Museum, Perth.

Storr, G. M., L. A. Smith and R. E. Johnstone (1999). *Lizards of Western Australia. I. Skinks. Rev. Ed.* Western Australian Museum, Perth.

Strahan, R. (Ed.) (1995). Mammals of Australia. Reed Books, Australia.

Texasgulf Australia Ltd. (1979). Marandoo Flora and Fauna. Texasgulf Australia Ltd., Perth.

Thackway, R. and Cresswell, I.D. (1995). *An Interim Biogeographic Regionalisation for Australia.* Australian Nature Conservation Agency, Canberra.

Thompson, G.G. and Withers, P.C. (2003) Effect of species richness and relative abundance on the shape of the species accumulation curve. Austral Ecol 28: 355 - 360.

Tingay, A. and S.R. Tingay (1983). Vertebrate fauna study of the Burrup Peninsula. Woodside Offshore Petroleum Pty. Ltd. (Unpubl. report).

Tyler, I.M, Hunter, W.M. and Williams, I.R. (1991). Newman, Western Australia. 1:250 000 Geological Series - Explanatory Notes. Geological Survey of Western Australia

Tyler, M. J., Smith, L. A. and Johnstone, R. E. (2000). *Frogs of Western Australia.* Western Australian Museum, Perth.

Van Vreeswyk, A.M.E.; Payne, A.L.; Leighton, K.A. and Hennig, P. (2004) An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No. 92 Department of Agriculture (Govt. W.A.) South Perth.

WA Museum (2004) FaunaBase. Available at:

http://www.museum.wa.gov.au/faunabase/prod/index.htm

Western Australian Herbarium, CALM. Available at (http://florabase.calm.wa.gov.au/help/copyright). Accessed July 2006.

Waters, J.M., Esa, Y.B. and Wallis, G.P. (2001) Genetic and morphological evidence for reproductive isolation between sympatric populations of Galaxias (Teleostei: Galxiidae) in South Island, New Zealand. *Biol. J. Linn. Soc*., **73**: 287-289.

Wilson, S. and Swan, G. (2003). *A complete guide to reptiles of Australia.* New Holland Publishers, Sydney.

Wooley, P.A. (1995). Mulgara *Dasycercus cristicauda*. IN Strahan, R. (ed.) (1995). The Mammals of Australia. Reed Books, Sydney. pp. 55-56.

Wright, S. (1943) Isolation by distance. *Genetics*, **28**: 114-138.

APPENDIX A: Location of Proposed Access Tracks

Locations of Proposed Access Tracks. Note: Both access tracks for PMN04 and PMN05 were walked and surveyed in their entirety. Waypoints were taken periodically along both tracks and are listed below (AGD84, Zone 50K).

PMN04 Access Track Waypoints	Easting	Northing	PMN05 Access Track Waypoints	Easting	Northing
1	715080.8978	7474519.344	1	716088.2266	7473591.841
2	715050.0764	7475340.73	2	716081.8748	7473593.027
3	715048.1562	7475334.007	3	716066.6458	7473591.527
4	715035.6933	7475342.531	4	716069.3247	7473592.287
5	715020.9555	7475330.875	5	716051.5345	7473599.477
6	715013.2645	7475332.971	6	716006.313	7473611.914
7	715008.3636	7475332.734	7	715944.7139	7473623.786
8	715008.4659	7475332.064	8	715912.5059	7473634.459
9	715002.3433	7475331.259	9	715883.7809	7473636.503
10	714997.016	7475327.668	10	715854.1023	7473649.526
11	714955.6301	7475337.855	11	715831.4222	7473665.68
12	714932.1071	7475350.055			
13	714924.0367	7475347.254			
14	714882.1942	7475323.438			
15	714861.8285	7475314.888			
16	714834.358	7475287.869			
17	714832.6113	7475278.804			
18	714776.1006	7475221.483			
19	714783.255	7475191.253			
20	714760.9858	7475177.743			
21	714710.6933	7475142.506			
22	714689.7481	7475127.659			
23	714485.1606	7475017.461			
24	714485.8961	7475019.558			
25	714199.7543	7474808.555			

APPENDIX B: Flora Species Collected within the Ministers North Exploration Area

Classification and nomenclature according to the Western Australian Herbarium and R.J. Hnatiuk (1990), Census of Australian Vascular Plants. Australian Government Publishing Service.
Key: P3 = Priority Flora

Family	Species
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*
Poaceae	*Aristida holathera* var. *holathera* *Cymbopogon ambiguus* *Cymbopogon obtectus* *Eragrostis cumingii* *Eragrostis pergracilis* *Eriachne aristidea* *Eriachne lanata* *Eriachne mucronata* (arid form) (MET 12 736) *Eriachne mucronata* (typical form) *Eriachne pulchella* *Eriachne pulchella* subsp. *dominii* *Paspalidium clementii* *Perotis rara* *Schizachyrium fragile* *Sporobolus australasicus* *Themeda triandra* *Triodia basedowii* *Triodia pungens* *Triodia wiseana* *Tripogon loliiformis*
Cyperaceae	*Bulbostylis barbata* *Fimbristylis dichotoma*
Moraceae	*Ficus brachypoda*
Proteaceae	*Grevillea wickhamii* subsp. *hispidula* *Hakea chordophylla* *Hakea lorea* ssp. *lorea*
Loranthaceae	*Amyema sanguinea* var. *sanguinea* *Diplatia grandibractea*
Chenopodiaceae	*Dysphania rhadinostachya subsp. rhadinostachya*
Amaranthaceae	*Amaranthus pallidiflorus* *Gomphrena canescens* *Gomphrena cunninghamii* *Ptilotus auriculifolius* *Ptilotus calostachyus* var. *calostachyus* *Ptilotus exaltatus* var. *exaltatus* *Ptilotus fusiformis* var. *fusiformis* *Ptilotus incanus* var. *incanus*
Gyrostemonaceae	*Codonocarpus cotinifolius*
Caryophyllaceae	*Polycarpaea corymbosa* var. *corymbosa*

Family	Species
Caryophyllaceae continued	*Polycarpaea holtzei* *Polycarpaea longiflora*
Lauraceae	*Cassytha capillaris*
Surianaceae	*Stylobasium spathulatum*
Mimosaceae	*Acacia adoxa* var. *adoxa* *Acacia aneura* var. *intermedia* *Acacia coriacea* subsp. *pendens* *Acacia cowaniana* *Acacia hamersleyensis* *Acacia hilliana* *Acacia marramamba* *Acacia monticola* *Acacia pruinocarpa* *Acacia pyrifolia* *Acacia spondylophylla* *Acacia tumida* var. *pilbarensis*
Caesalpiniaceae	*Petalostylis labicheoides* *Senna artemisioides* subsp. *glaucifolia* *Senna artemisioides* subsp. *helmsii* *Senna ferraria* *Senna glutinosa* subsp. *glutinosa* *Senna glutinosa* subsp. *pruinosa* *Senna glutinosa* subsp. *x luerssenii*
Papilionaceae	*Crotalaria medicaginea* *Gompholobium karijini* *Indigofera monophylla* (small leaflet form) *Mirbelia viminalis* *Rhynchosia minima* var. *australis* *Tephrosia spechtii*
Euphorbiaceae	*Euphorbia coghlanii*
Stackhousiaceae	*Stackhousia viminea*
Sapindaceae	*Dodonaea coriacea* *Dodonaea lanceolata* var. *lanceolata*
Tiliaceae	*Corchorus lasiocarpus* subsp. *parvus* *Triumfetta leptacantha*
Malvaceae	*Abutilon dioicum* *Abutilon lepidum* *Gossypium robinsonii* *Hibiscus* aff. *goldsworthii* (site 1260) *Hibiscus haynaldii* *Hibiscus sturtii* var. *campylochlamys*

Family	Species
Malvaceae continued	*Sida excedentifolia* *Sida pilbarensis* (ferrugenous form) R.M. Barker *ms* *Sida pilbarensis* (grey-green form) *Sida sp.* Shovelanna Hill (S. van Leeuwen 3842)
Sterculiaceae	*Rulingia luteiflora*
Violaceae	*Hybanthus aurantiacus*
Myrtaceae	*Calytrix carinata* *Corymbia ferriticola* subsp. *ferriticola* *Corymbia hamersleyana* *Corymbia semiclara* *Eucalyptus gamophylla* *Eucalyptus leucophloia*
Araliaceae	*Astrotricha hamptonii*
Apiaceae	*Trachymene oleracea*
Oleaceae	*Jasminum didymum* subsp. *lineare*
Convolvulaceae	*Evolvulus alsinoides* var. *decumbens* *Porana commixta*
Boraginaceae	*Trichodesma zeylanicum*
Verbenaceae	*Clerodendrum floribundum* var. ?*angustifolium* *Clerodendrum floribundum* var. *angustifolium (juv)*
Solanaceae	*Nicotiana benthamiana* *Solanum cleistogamum* *Solanum gabrielae* *Solanum horridum* *Solanum lasiophyllum* *Solanum phlomoides*
Myoporaceae	*Eremophila jucunda* subsp. *pulcherrima* *Eremophila latrobei* subsp. *glabra*
Rubiaceae	*Oldenlandia crouchiana*
Cucurbitaceae	*Mukia maderaspatana*
Lobeliaceae	*Lobelia heterophylla*
Goodeniaceae	*Dampiera candicans* *Goodenia cusackiana* *Goodenia lamprosperma* *Goodenia stobbsiana* *Goodenia triodiophila* *Scaevola* aff. *browniana*
Asteraceae	*Flaveria australasica* *Pterocaulon sphaeranthoides* *Rhodanthe margarethae* *Streptoglossa decurrens* *Vittadinia arida* *Vittadinia virgata*
Molluginaceae	*Mollugo molluginis*

APPENDIX C: Records of Priority Species within 200 km of the project area

Species	Family	Status	Nearest named locations
Abutilon trudgenii ms.	Malvaceae	3	Marillana, Warralong, Woodstock, Hamersley Range, Newman, Pannawonica
Acacia daweana	Mimosaceae	2	Hamersley Range, Karijini National Park
Acacia effusa	Mimosaceae	2	Mt. Bruce, Hamersley Range, Karijini National Park, Juna Downs
Barbula ehrenbergii	Pottiaceae	1	Dale's Gorge, Hamersley Range
Bulbine pendula	Asphodelaceae	3	Rudall River, Juna Downs, Hamersley Station.
Bulbostylis burbidgeae	Cyperaceae	3	Mount Edgar, Gorge Creek, Woodstock
Calotis squamigera	Asteraceae	1	Wittenoom, Hamersley Range
Cynamchum sp. Hamersley (M Turdgen 2302)	Asclepiadaceae	3	Hamersley Range, Marandoo, West Angelas
Dampiera anonyma ms	Goodeniaceae	3	Mt Bruce, Mt Nameless, Hamersley Range
Dampiera metallorum ms	Goodeniaceae	3	Hamersley Range, Mt Meharry, West Angelas
Diclandanthera glabra	Acanthaceae	2	Wittenoom, Robe River, Hamersley Gorge, Marandoo, Mt. Mossenson
Eragrostis sp. Mt Robinson	Poaceae	1	Hamersley Range
*Eremophila coactam*s	Myoporaceae	1	Mt Vernon, Ashburton Downs
Eremophila magnifica subsp. *magnifica* ms	Myoporaceae	4	Hamersley Range, Tom Price, Marandoo, Wittenoom
Eremophila magnifica subsp. *velutina* ms	Myoporaceae	3	Hamersley Range, Newman, Marandoo
Eremophila pilosa ms	Myoporaceae	1	Roy Hill, Jigalong Community
Eremophila rigens ms	Myoporaceae	1	SE Ashburton Downs
Eremophila sp. Ophthalmia Range (D. Brearley sn 20/3/2004)	Myoporaceae	1	Ophthalmia Range
Eremophila spongiocarpa	Myoporaceae	1	Mt. Marsh, Chichester Range, Marillana Station
Eucalyptus sp. Marandoo	Myrtaceae	1	Marandoo corridor, Mindi Springs
Fimbristylis sieberiana	Cyperaceae	3	Hamersley Range, Millstream, Fitzroy Crossing, Halls Creek
Genus sp. Hamersley Range hilltops (S van Leeuwen 4345)	Asteraceae	1	Hamersley Range
Glycine falcata	Papilionaceae	3	Chichester Range, Hamersley Station, Mulga Downs Station
Goodenia nuda	Goodeniaceae	3	Weeli Wolli, Roy Hill, Mt Stuart
Goodenia omearana ms	Goodeniaceae	1	Weeli Wolli, Mulga Downs, Nullagine
Goodenia pascua	Goodeniaceae	3	Hamersley Station, Sandy Creek
Goodenia stellata	Goodeniaceae	4	Hamersley Range, West Angelas, Yampire Gorge
Helichrysum oligochaetum	Asteraceae	1	Port Walcott, Ashburton Downs
Indigofera gilesii subsp. *gilesii*	Papilionaceae	3	Hamersley Range, Meekatharra, West Angelas
Indigofera ixocarpa ms	Papilionaceae	2	Marandoo, Tom Price, Nullagine
Ischaemum albovillosum	Poaceae	2	Millstream, Mulga Downs Station
Josephinia sp. Marandoo (M Trudgen 1554)	Pedaliaceae	1	Marandoo, West Angelas
Lepidium catapycnon	Brassicaceae	R	Wittenoom Gorge, Hamersley Range, Weeli Wolli, Newman

Species	Family	Status	Nearest named locations
Mimulus clementii	Scrophulariaceae	1	Between Ashburton and DeGrey Rivers
Myriocephalus nudus	Asteraceae	1	Hamersley Range, Juna Downs
Myriocephalus scalpellus	Asteraceae	1	Roy Hill
Olearia fluvialis	Asteraceae	2	Hamersley Range, Karijini Nation Park, West Angelas
Olearia mucronata	Asteraceae	2	Hamersley and Chichester Range area, West Angelas, Paraburdoo
Phyllanthus aridua	Euphorbiaceae	3	Chichester Range, West Angelas, Pardoo
Pilbara trudgenii	Asteraceae	2	Hamersley Range
Plantago sp. Hamersley (M Trudgen 11207)	Plantaginaceae	3	Hamersley Station, Wittenoom
Polymeria sp. Hamersley (M Trudgen 11353)	Convolvulaceae	3	Hamersley Station, Wittenoom, Marandoo, Hamersley Range
Ptilotus mollis	Amaranthaceae	4	Warralong Station, Mt Bruce, Mt Channer
Ptilotus trichocephalus	Amaranthaceae	1	Mt. James Station, Paraburdoo
Rhynchosia bungarensis	Papilionaceae	3	Hamersley Range, Chichester Range, Robe River, Tome Price
Rostellularia adscendens var. *latifolia*	Acanthaceae	3	Hamersley Range
Scaevola sp. Hamersley Range basalts (S. van Leeuwen 3675)	Goodeniaceae	2	Hamersley Range
Sida sp. Barlee Range (S. van Leeuwen 1642)	Malvaceae	2	Barlee Range
Sida sp. Marandoo (M Trudgen 10976)	Malvaceae	3	Marandoo, Mindi Springs
Sida sp. Pilbara (S. van Leeuwen 4377)	Malvaceae	1	Hamersley Range
Spartothamnella puberula	Lamiaceae	2	Mt Bruce, Hamersley Range, West Angelas
Stylidium weeliwolli	Stylidiaceae	2	Weeli Wolli, Barlee Range
Swainsona sp. Millstream (AA Mitchell PRP 798)	Papilionaceae	1	Millstream, Hamersley Station, West Angelas
Tephrosia sp. Cathedral Gorve (FH Mollemans 2420)	Papilionaceae	3	Newman, Hamersley Range, Fortescue Valley
Themeda sp. Hamersley Station (ME Trudgen 11431)	Poaceae	3	Hamersley Station, West Angelas, Millstream
Thryptomene wittweri	Myrtaceae	R	Hamersley Range
Triodia sp. Mt Ella (ME Trudgen 12739)	Poaceae	3	Hamersley Range, Mt Ella
Triumfetta leptacantha	Tiliaceae	3	Hamersley Range, Marandoo

APPENDIX D: Fauna Species Recorded within 100 km of the Ministers North Exploration Area

Key to abbreviations	
A:	Recorded during the Hamersley Range National Park (*National Parks Authority,* 1980)
B:	Recorded during the Survey of Abydos-Woodstock Reserve (WAM, 1991)
C:	Recorded during the West Angeles Rail Corridor Survey (*ecologia,* 1998)
D:	Recorded during the West Angelas Pipeline Corridor Survey (*ecologia,* 1998)
E:	Recorded during the East Jimblebar Exploration Survey (*ecologia,* 2005)
F:	Recorded during the Roy Hill Exploration Survey (*ecologia,* 2005)
G:	Recorded during the Upper Marillana Exploration Survey (*ecologia*, 2005)
H:	Recorded during the Western Ridge Exploration Survey (*ecologia*, 2005)
I:	Recorded during the Mindy-Coondiner Survey (*ecologia*, 2005)

APPENDIX D1: Herpetofauna species previously recorded within 100 km of the Ministers North exploration area, and recorded during the current survey. Species recorded are denoted with *.

FAMILY & species	Common Name	Museum	Previous Surveys	Current survey
AMPHIBIA				
HYLIDAE				
Cyclorana maini	Main's Frog	*	A, B, D, F, K, L, M, P, Q	
Cyclorana platycephala	Water-Holding Frog		A	
Litoria rubella	Desert Tree Frog	*	A, B, C, D, E, K, M, P, Q	*
MYOBATRACHIDAE				
Limnodynastes spenceri	Spencer's Frog		A, B, C, D	
Notaden nichollsi	Desert Spadefoot		D	
Pseudophryne douglasii			A, C	
Uperoleia glandulosa			B	
Uperoleia russelli	Russell's Toadlet	*	A, B, C, D, K, M	
REPTILIA				
AGAMIDAE				
Caimanops amphiboluroides	Mulga Dragon	*	A, C, O, P, Q	
Ctenophorus caudicinctus	Ring-tailed Dragon	*	A, B, C, D, E, F, G, I, K, L, M, N, O, P, Q	*
Ctenophorus isolepis	Military Dragon	*	A, B, C, D, E, I, K, L, P	
Ctenophorus nuchalis	Central Netted Dragon	*	B, D	
Ctenophorus reticulatus	Western Netted Dragon	*	A, C, D	
Diporiphora valens	A Dragon	*	A, C	
Diporiphora winneckei	Common two-lined Dragon		B, C	
Lophognathus longirostris	Long-nosed Water Dragon	*	A, B, C, E, F, G, I, K, L, M, N, P, Q	
Pogona minor	Dwarf Bearded Dragon	*	A, B, C, D, F, H, I, K, L, N, O, P, Q	
Tympanocryptis cephala	Earless Pebble Dragon	*	C	
BOIDAE				
Antaresia perthensis	Pygmy Python	*	A, B, C, D, F, N, P, Q	
Antaresia stimsoni	Stimson's Python	*	A, B, D, E, K	

FAMILY & species	Common Name	Museum	Previous Surveys	Current survey
Aspidites melanocephalus	Black-headed python		A, B, C, D, P, Q	
Liasis olivaceus barroni	Pilbara Olive Python	*	K	
CHELIDAE				
Chelodina steindachneri	Steindachner's or Plate-shelled Turtle	*	A, B	
ELAPIDAE				
Acanthophis pyrrhus	Desert Death-Adder		A, C, B	
Acanthophis wellsi	Death Adder	*	D, F, L, O	
Brachyurophis approximans	NW Shovel-nosed Snake	*	Q	
Demansia psammophis	Yellow-faced Whipsnake	*	A, B, D, F, K, M, Q	
Demansia rufescens	Rufous Whipsnake	*	A, B, D, E, K	
Furina ornata	Moon Snake	*	A, K	
Parasuta monachus	Hooded Snake	*	A, B, F, M	
Pseudechis australis	Mulga Snake	*	A, C, D, F, G, K, N, Q	*
Pseudonaja modesta	Ringed Brown Snake	*	A, B, C, F, N, O	
Pseudonaja nuchalis	Gwardar	*	A, B, C, K, L, O, Q	
Suta fasciata	Rosen's Snake	*	A, B, C, D, F, P	
Suta monachus	Hooded Snake		K, L, O	
Suta punctata	Spotted Snake	*	A, B	
Vermicella snelli	Pilbara Bandy Bandy	*	A, F	
GEKKONIDAE				
Crenadactylus ocellatus	Clawless Gecko	*	M, P	*
Diplodactylus conspicillatus	Fat-tailed Gecko	*	A, E,	
Diplodactylus granariensis	Wheatbelt Stone Gecko	*		
Diplodactylus mitchelli	A Gecko	*		
Diplodactylus pulcher	Beautiful Gecko	*	A, D	
Diplodactylus savagei	A Gecko	*	A, L, O, P, Q	
Diplodactylus squarrosus	A Gecko		A	
Diplodactylus stenodactylus	Pale-snouted Ground Gecko	*	A, B, C, D, E, F, G, K, M	
Diplodactylus wellingtonae	A Gecko		N, O	
Diplodactylus wombeyi	A Gecko	*	A, P, Q	
Gehyra pilbara	Pilbara Dtella	*	A, B, C, P	

FAMILY & species	Common Name	Museum	Previous Surveys	Current survey
Gehyra punctata	Spotted Dtella	*	A, B, C, D, F, H, K, L, N, O, P, Q	*
Gehyra purpurascens	Purple Arid Dtella	*		
Gehyra variegata	Tree Dtella	*	B, C, E, F, G, K, L, M, N, O, P, Q	*
Heteronotia binoei	Bynoe's Gecko	*	A, B, C, D, E, F, K, L, M, N, P, Q	
Heteronotia spelea	Desert Cave Gecko	*	A, D, H, L, M, N, Q	
Nephrurus levis	Common Knob-tailed Gecko		B	
Nephrurus wheeleri	Banded Knob-tailed Gecko	*	A, C, D, F, H, M, Q	
Oedura marmorata	Marbled Velvet Gecko	*	A, B, D, K, L, M, N, P, Q	*
Rhynchoedura ornata	Beaked Gecko	*	A, B, E, G, K	
Strophurus ciliaris	Northern Spiny-tailed Gecko		A, B, E	
Strophurus elderi	Jewelled Gecko	*	A, B, D, E, K, N, Q	
Strophurus jeanae	A Gecko	*	B, E, Q	
Strophurus taeniatus	A Gecko		A	
Strophurus wellingtonae	A Gecko	*	C, D, E, F, G, Q	
Underwoodisaurus milli	Thick-tailed or Barking Gecko	*		
PYGOPODIDAE				
Delma borea	A legless lizard		A, C, N	
Delma butleri	Un-banded Delma		C, P	
Delma elegans	A legless lizard	*	A, D, L, Q	
Delma haroldi	A legless lizard	*		
Delma nasuta	Long-nosed Delma	*	A, B, C, D, K, L, N, O, Q	
Delma pax	A legless lizard	*	A, B, C, K, L, P	*
Delma tincta	A legless lizard	*	A, B, D, L, M, P, Q	
Lialis burtonis	Burton's Snake Lizard	*	A, B, C, D, F, H, K, L, N, O, Q	*
Pygopus nigriceps	Hooded Scaly-foot	*	A, D, F	
SCINCIDAE				
Carlia munda	A skink	*	B, C, D, G, L, M, O, P, Q	
Carlia triacantha	Rainbow Skink		A, D	
Cryptoblepharus carnabyi	A skink	*	A	
Cryptoblepharus plagiocephalus	Fence Skink	*	A, B, C, H, K, L, M, P	
Cryptoblepharus sp. aff. *carnabyi* (Red)[a]	A skink		Q	

FAMILY & species	Common Name	Museum	Previous Surveys	Current survey
Cryptoblepharus sp.	A skink			*
Ctenotus ariadnae	A skink	*		
Ctenotus atlas	A skink		A	
Ctenotus duricola	A skink	*	A, B, C, D, K, L, N, P	
Ctenotus grandis	A skink	*	B, C, D	
Ctenotus hanloni	A skink	*	A, B, C, D, F, G, P, Q	
Ctenotus helenae	A skink	*	K, L, Q	
Ctenotus aff. h*elenae*	A skink		C	
Ctenotus leonhardii	A skink	*	A, C, E, M, P	
Ctenotus nigrilineatus	A skink		B	
Ctenotus pantherinus	Leopard Skink	*	A, C, B, D, H, K, L, M, N, O, P, Q	
Ctenotus piankai	A skink		C, D	
Ctenotus rubicundus	A skink	*	A, C, D, P	*
Ctenotus rutilans	A skink	*	A, D, K, L, O, P, Q	
Ctenotus saxatilis	A skink	*	A, B, C, D, F, G, L, M, N, P, Q	*
Ctenotus serventyi	A skink	*	A, B, K, M	
Ctenotus schomburgkii	A skink	*	A, B, D, L, O, P	
Ctenotus uber	A skink		D	
Cyclodomorphus melanops	Spinifex Slender Blue-tongue	*	A, B, C, D, F, N, O, P, Q	
Cyclodomorphus branchialis	Gilled Slender Blue-tongue		K, L, M	
Egernia depressa	Pygmy Spiny-tailed Skink	*	A, B, C, D, F, L,P, Q	
Egernia formosa	Goldfields Crevice Skink	*	A, B, C, M, P, Q	
Egernia pilbarensis	A skink			*
Egernia striata	Nocturnal Desert Skink		B	
Eremiascincus fasciolatus	Narrow-banded Sand-swimmer		P	
Eremiascincus richardsonii	Banded Skink	*	A, B, C, E, M	
Lerista bipes	A skink	*	B	
Lerista chalybura	A skink		K, L, M, P	
Lerista frosti	A skink		A	
Lerista flammicauda	A skink		C	
Lerista labialis	A skink	*		

FAMILY & species	Common Name	Museum	Previous Surveys	Current survey
Lerista muelleri	A skink	*	A, B, C, D, K, L, M, N, O, P, Q	*
Lerista neander	A skink	*	A, D, L, M, O, P	
Lerista zietzi	A skink	*	D, G, Q	*
Menetia greyii	Common Dwarf Skink	*	A, B, D, F, H, L, M, N, O, P, Q	
Menetia surda	A skink	*	A, C, D, L	
Morethia ruficauda	Three Striped Fire-tail	*	A, B, C, D, H, K, L, M, N, O, P, Q	*
Notoscincus butleri	A skink		C	
Notoscincus ornatus	A skink		B	
Proablepharus reginae	A skink	*	A, B	
Glaphyromorphus (Sphenomorphus) isolepis	A skink		C	
Tiliqua multifasciata	Central Blue-tongue Lizard	*	A, B, C, D, E, G, L, N, P, Q	
TYPHLOPIDAE				
Ramphotyphlops ammodytes	A blind snake	*	A, B	
Ramphotyphlops diversus	A blind snake		L	
Ramphotyphlops ganei	A blind-snake	*	F	
Ramphotyphlops grypus	A blind-snake	*	A, B, C, G, Q	
Ramphotyphlops hamatus	A blind-snake	*	A, B, C, D, Q	
Ramphotyphlops pilbara	A blind-snake		F	
Ramphotyphlops waitii	A blind-snake	*	A	
Ramphotyphlops sp.	A blind snake	*	M	
VARANIDAE				
Varanus acanthurus	Ridge-tailed Monitor	*	A, B, C, D, F, K, L, P, Q	
Varanus brevicauda	Short-tailed Monitor	*	A, B, D, M	
Varanus caudolineatus	Stripe-tailed Monitor	*	A, B, C, D, N	
Varanus eremius	Desert Pygmy Monitor		B, C	
Varanus sp. aff. *gilleni/caudolineatus*	An undescribed goanna		Q	
Varanus giganteus	Perentie	*	A, B, C, D, I , P, Q	*
Varanus gilleni	A goanna		C, K, L, P, Q	
Varanus aff. *gilleni*			G	
Varanus gouldii	Gould's Monitor	*	A, B, Q	
Varanus panoptes	A goanna	*	A, B, C, E , K, L, M, P	*

FAMILY & species	Common Name	Museum	Previous Surveys	Current survey
Varanus pilbarensis	Pilbara Rock Monitor	*	A, B, P	*
Varanus sp. nov. (Pilbara)	A goanna	*	C	
Varanus tristis	Black-headed Monitor	*	A, B, C, D, L, M, N, P, Q	

APPENDIX D2: Bird species previously recorded within 100 km of the Ministers North exploration area, and recorded during the current survey. Species recorded are denoted with *.

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
CASUARIIDAE				
Dromaius novaehollandiae	Emu		A, B, C, I, K, L, M, P	
PELECANIDAE				
Pelecanus conspicillatus	Australian Pelican		A, B, C	
ANHINGIDAE				
Anhinga melanogaster	Darter		A, B	
PHALACROCORACIDAE				
Phalacrocorax sulcirostris	Little Black Cormorant		B, C	
PODICIPEDIDAE				
Poliocephalus poliocephalus	Hoary-headed Grebe		A	
Tachybaptus novaehollandiae	Australasian Grebe		A, B	
ANATIDAE				
Anas gracilis	Grey Teal		A, B, K, M	
Anas superciliosa	Pacific Black Duck		A, B, C, G, K	
Aythya australis	Hardhead		A, G	
Chenonetta jubata	Australian Wood Duck		A, K	
Cygnus atratus	Black Swan		A, C	
Malacorhynchus membranaceus	Pink-eared Duck		A	
PHALACROCORACIDAE				
Phalacrocorax carbo	Great Cormorant		A	
Phalacrocorax melanoleucos	Little Pied Cormorant		A, B, C, G	
Phalacrocorax sulcirostris	Little Black Cormorant		B, C, K, M	
RALLIDAE				
Fulica atra	Eurasian Coot		A, B	
Gallinula ventralis	Black-tailed native hen		A	
Gallirallus philippensis	Buff-banded Rail		A	
Porzana fluminea	Australian Spotted Crake		A	
Porzana tabuensis	Spotless Crake		A	
ARDEIDAE				
Ardea alba	Great Egret		A, B	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
Ardea pacifica	White-necked Heron		A, B, C, K, L, M	
Egretta novaehollandiae	White-faced Heron		A, B, C, F, K, M, P	
Nycticorax caledonicus	Nankeen Night Heron		A, B, C, K	
THRESKIORNITHIDAE				
Threskiornis spinicollis	Straw-necked Ibis		A, B, C, L, M	
SCOLOPACIDAE				
Actitis hypoleucos	Common Sandpiper		A, B	
Tringa glareola	Wood Sandpiper		A, B	
Tringa nebularia	Common Greenshank		B	
GLAREOLIDAE				
Stiltia isabella	Australian Pratincole		B	
CHARADRIIDAE				
Charadrius veredus	Oriental Plover		B	
Elseyornis melanops	Black-fronted Dotterel		A, B, C	
Erythrogonys cinctus	Red-kneed Dotterel		A	
Peltohyas australis	Inland Dotterel	*		
Vanellus tricolour	Banded Lapwing		C	
RECURVIROSTRIDAE				
Himantopus himantopus	Black-winged Stilt		A, B	
LARIDAE				
Chlidonias hybridus	Whiskered Tern		A, B	
PHASIANIDAE				
Coturnix ypsilophora	Brown Quail		B, E	
ACCIPITRIDAE				
Accipiter cirrhocephalus	Collared Sparrowhawk		A, B, C, K, L, M, P	
Accipiter fasciatus	Brown Goshawk		A, B, C, G, H, K, L, M, P, Q	
Aquila audax	Wedge-tailed Eagle	*	A, B, C, D, H, L, M, P, Q	
Circus assimilis	Spotted Harrier		A, B, C, D, K, L, M, P, Q	
Elanus axillaris	Black-shouldered Kite		A, B, C	
Haliastur sphenurus	Whistling Kite		A, C, G, I, L, P	
Hamirostra melanosternon	Black-breasted Buzzard		A, E, L, Q	
Hieraaetus morphnoides	Little Eagle		A, B, C, E, K, M	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
Lophoictinia isura	Square-tailed Kite		Q	
Milvus migrans	Black Kite		A, C	
Pandion haliaetus	Osprey		A	
FALCONIDAE				
Falco berigora	Brown Falcon	*	A, B, C, D, E, F, G, I, K, L, M, N, O, P,	*
Falco cenchroides	Australian Kestrel	*	A, B, C, D, F, K, L, M, N, O, P, Q,	
Falco hypoleucos	Grey Falcon		C	
Falco longipennis	Australian Hobby	*	A, B, D, E, L, M, P, Q,	
Falco peregrinus	Peregrine Falcon		A, B, M, P	
OTIDIDAE				
Ardeotis australis	Australian Bustard	*	A, B, C, D, E, F, K, L, M, O, P, Q,	
TURNICIDAE				
Turnix velox	Little Button-quail	*	A, B, C, D, K, L, M, N, O , P, Q,	
SCOLOPACIDAE				
Actitis (Tringa) hypoleucos	Common Sandpiper	*		
Calidris acuminata	Sharp-tailed Sandpiper	*		
Calidris melanotos	Pectoral Sandpiper	*		
Calidris subminuta	Long-toed Stint	*		
Unidentified Sandpiper			M	
BURHINIDAE				
Burhinus grallarius	Bush Stone-curlew		A, B, C	
CHARADRIIDAE				
Elseyornis melanops	Black-fronted Dotterel/Plover		KMP	
LARIDAE				
Larus novaehollandiae	Silver Gull	*		
COLUMBIDAE				
Geopelia cuneata	Diamond Dove		A, B, C, E, F, H, I, K, L, M, N, O, P, Q	*
Geopelia striata	Peaceful Dove	*	A, B, C, D, G, I, K, M, P	*
Geophaps plumifera	Spinifex Pigeon		A, B, C, K, L, M, N, P, Q	*
Ocyphaps lophotes	Crested Pigeon		A, B, C, E, F, G, H, I, K, L, M, N, O, P, Q	*
Phaps chalcoptera	Common Bronzewing	*	A, B, C, D, E, F, G, H, K, L, M, N, O, P, Q	*
Phaps histrionica	Flock Bronzewing		A	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
CACATUIDAE				
Cacatua roseicapilla	Galah	*	A, B, C, D, E, F, G, I, K, L, M, N, O, P, Q	
Cacatua sanguinea	Little Corella		A, B, C, K, L, M, N, O, P	
Calyptorhynchus banksii	Red-tailed Black Cockatoo		A	
PSITTACIDAE				
Barnardius zonarius	Australian Ringneck	*	A, B, C, E, F, G, H, K, L, M, N, O, P, Q	*
Melopsittacus undulatus	Budgerigar		A, B, C, D, E, F, I, K, L, M, N, O, P, Q	*
Neophema bourkii	Bourke's Parrot	*	A, C, P	
Nymphicus hollandicus	Cockatiel		A, B, C, K, L, M, Q	
Psephotus varius	Mulga Parrot	*	A, D, Q	
CENTROPIDAE				
Centropus phasianus	Pheasant Coucal		C	
CUCULIDAE				
Chalchites (Chrysococcyx) basalis	Horsfield's Bronze Cuckoo		A, C, D, F, G, K, L, M, N, O, P, Q	*
Chalchites (Chrysococcyx) osculans	Black-eared Cuckoo		A, B, N, O, P	
Cuculus pallidus	Pallid Cuckoo		A, B, C, K, L, M, N, O, P, Q	*
STRIGIDAE				
Ninox connivens	Barking Owl	*	A, B, M	
Ninox novaeseelandiae	Southern Boobook	*	A, B, C, D, H, K, L, M ,N, O, P	
TYTONIDAE				
Tyto alba	Barn Owl		A, B, C, Q	
PODARGIDAE				
Podargus strigoides	Tawny Frogmouth		A, B, C, E, K, L, N, P, Q	*
CAPRIMULGIDAE				
Eurostopodus argus	Spotted Nightjar	*	A, B, C, D, E, F, G, L, M, N, O, P, Q	*
AEGOTHELIDAE				
Aegotheles cristatus	Australian Owlet-Nightjar		A, B, C, E, F, H, K, L, M, P, Q	*
APODIDAE				
Apus pacificus	Fork-tailed Swift		A, B, Q	
HALCYONIDAE				
Dacelo leachii	Blue-winged Kookaburra		A, B, C, G, K, M, P	
Todirhamphus pyrrhopygia	Red-backed Kingfisher		A, B, C, K, L, M, O, P, Q	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
Todirhamphus sanctus	Sacred Kingfisher		A, B, C, E, K, M, P	
MEROPIDAE				
Merops ornatus	Rainbow Bee-eater		A, B, C, E, F, G, H, I, K, M, P, Q	*
CLIMACTERIDAE				
Climacteris melanura	Black-tailed Treecreeper		A, C, D, K, L, M, P	
MALURIDAE				
Amytornis striatus	Striated Grasswren	*	A, B, C, D, H, K, L, O, P, Q	*
Malurus lamberti	Variegated Fairy-wren	*	A, B, C, D, E, F, G, H, I, K, L, M, N, O, P, Q	*
Malurus leucopterus	White-winged Fairy-wren		A, B, C, D, E, K, L, M, N, O, P, Q	*
Malurus splendens	Splendid Fairy Wren		C, N, O	
Stipiturus ruficeps	Rufous-crowned Emu-wren		A, B, C, K, L, N, P, Q	
PARDALOTIDAE				
Pardalotus rubricatus	Red-browed Pardalote	*	A, B, C, D, F, I, K, L, M, P, Q	*
Pardalotus striatus	Striated Pardalote	*	A, C, D, K, L, M, N, O, P, Q	*
ACANTHIZIDAE				
Acanthiza apicalis	Inland Thornbill	*	A, C, E, G, H, L, M, N, O, P, Q	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	*	A, D, L, P	
Acanthiza robustirostris	Slaty-backed Thornbill		A, C, N, O, P, Q	
Acanthiza uropygialis	Chestnut-rumped Thornbill	*	A, C, D, F, G, L, N, O, P, Q	
Gerygone fusca	Western Gerygone	*	A, B, C, D, F, G, I, K, L, M, N, O, P, Q	
Pyrrholaemus brunneus	Redthroat		A, C, N, O	
Smicrornis brevirostris	Weebill		A, B, C, F, G, H, I, K, L, M, N, O, P, Q	*
MELIPHAGIDAE				
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		A, B, C, E, F, H, I, L, M, N, O, P, Q	*
Certhionyx niger	Black Honeyeater		A, K, L, M, P	*
Certhionyx variegatus	Pied Honeyeater		A, B, F, G, K, P	
Conopophila whitei	Grey Honeyeater	*	A, D,	
Epthianura aurifrons	Orange Chat	*	A,	
Epthianura tricolor	Crimson Chat	*	A, B, C, D, F, I, K, L, M, N, Q	*
Lichenostomus keartlandi	Grey-headed Honeyeater	*	A, B, C, D, I, K, L, M, N, P, Q	*
Lichenostomus penicillatus	White-plumed Honeyeater		A, B, C, D, E, G, I, K, L, M, P	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
Lichenostomus plumulus	Grey-fronted Honeyeater		P	
Lichenostomus virescens	Singing Honeyeater		A, B, C, D, E, F, G, H, I, K, L, M, N, O, P, Q	
Lichmera indistincta	Brown Honeyeater		A, B, C, E, G, I, K, L, M, N, O, P, Q	*
Manorina flavigula	Yellow-throated Miner		A, B, C, E, G, I, K, L, M, N, O, P, Q	*
Melithreptus gularis laetior	Black-chinned Honeyeater	*	A, C, L, M, P	
Phylidonyris albifrons	White-fronted Honeyeater		A, B, C, D, K, P	
PETROICIDAE				
Melanodryas cucullata	Hooded Robin	*	A, C, D, F, H, K, L, M, N, O, P, Q	*
Petroica goodenovii	Red-capped Robin		A, B, C, E, F, L, M, N, O, P	
POMATOSTOMIDAE				
Pomatostomus superciliosus	White-browed Babbler		C, F, L, N, O, P, Q	
Pomatostomus temporalis	Grey-crowned Babbler		A, C, D, G, I, K, L, M, N, P, Q	*
CINCLOSOMATIDAE				
Cinclosoma castaneothorax	Chestnut-breasted Quail-Thrush		D	
Cinclosoma castanotus	Chestnut Quail-thrush		E	
Psophodes occidentalis	Chiming Wedgebill		C, E, F	
NEOSITTIDAE				
Daphoenositta chrysoptera	Varied Sitella		A, C, D, L, M, O, P	
PACHYCEPHALIDAE				
Colluricincla harmonica	Grey Shrike-thrush		A, B, C, E, F, G, K, L, M, N, O, P, Q	
Oreoica gutturalis	Crested Bellbird	*	A, B, C, D, F, G, H, K, L, M, N, O, P, Q	*
Pachycephala rufiventris	Rufous Whistler	*	A, C, D, E, F, G, I, K, L, M, N, O, P, Q	
DICRURIDAE				
Grallina cyanoleuca	Magpie-lark		A, B, C, E, F, G, K, L, M, P, Q	
Rhipidura albiscapa	Grey Fantail	*	A, C, L, M, N, O, P	
Rhipidura leucophrys	Willie Wagtail		A, B, C, E, F, G, H, I, K, L, M, N, O, P, Q	*
CAMPEPHAGIDAE				
Coracina maxima	Ground Cuckoo-shrike		A, B, C, P, Q	
Coracina novaehollandiae	Black-faced Cuckoo-shrike	*	A, B, C, D, E, F, I, K, L, M, N, O, P, Q	*
Lalage tricolor	White-winged Triller		A, B, C, I, K, L, M, N, O, P, Q	*
ARTAMIDAE				

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
Artamus cinereus	Black-faced Woodswallow	*	A, B, C, E, F, G, H, I, K, L, M, N, O, P, Q	*
Artamus minor	Little Woodswallow		A, B, C, K, L, M, P, Q	*
Artamus personatus	Masked Woodswallow		A, B, L, M, N, P, Q	*
Cracticus nigrogularis	Pied Butcherbird		A, B, C, E, G, I, K, L, M, N, O, P, Q	*
Cracticus torquatus	Grey Butcherbird		A, E, C, F, G, H, K, L, M, N, O, P, Q	
Gymnorhina (Cracticus) tibicen	Australian Magpie		A, B, C, G, H, K, L, M, N, O, P, Q	
CORVIDAE				
Corvus bennetti	Little Crow		A, B, F, G, H, M, Q	
Corvus orru	Torresian Crow		A, B, C, E, F, K, L, M, N, O, P, Q	*
PTILONORHYNCHIDAE				
Chlamydera guttata	Western Bowerbird	*	A, B, C, K, L, M, N, P, Q	*
ALAUDIDAE				
Mirafra javanica	Singing Bushlark	*	Q	
MOTACILLIDAE				
Anthus novaeseelandiae	Australian Pipit		A, B, C, E, F, I, K, L, Q	
ESTRILIDAE				
Emblema pictum	Painted Finch		A, B, C, F, K, L, M, N, P, Q	*
Neochmia ruficauda	Star Finch		A, B, C	
Taeniopygia guttata	Zebra Finch		A, B, C, E, F, G, H I, K, L, M, N, O, P, Q	*
DICAEIDAE				
Dicaeum hirundinaceum	Mistletoebird		A, B, C, K, L, M, N, P	*
HIRUNDINIDAE				
Cheramoeca leucosternum	White-backed Swallow		M	
Hirundo ariel	Fairy Martin		A, B, C, K, L	
Hirundo nigricans	Tree Martin		A, B, C, H, K, L, M, P	
SYLVIIDAE				
Acrocephalus stentoreus	Clamorous Reed Warbler		A, B, C	
Cinclorhamphus cruralis	Brown Songlark		A, B, C, K	
Cinclorhamphus mathewsi	Rufous Songlark		A, C, K, L, M, N, O, P	
Eremiornis carteri	Spinifexbird	*	A, B, C, D, K, L, M, N, O, P, Q	*
Megalurus gramineus	Little Grassbird	*		
Mirafra javanica	Singing Bushlark		A, C	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
ZOSTEROPIDAE				
Zosterops lateralis	Silvereye		C	

APPENDIX D3: Mammal species previously recorded within 100 km of the Ministers North exploration area, and recorded during the current survey. Species recorded are denoted with *.

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
BOVIDAE				
**Bos taurus*	Cow		B, C, H, I, K, M, P, Q	
CAMELIDAE				
**Camelus dromedarius*	Camel		B, I	
CANIDAE				
**Canis lupus*	Dog		I	
Canis lupus dingo	Dingo	*	C, E, F, G, K, L, N, O, P, Q	
DASYURIDAE				
Dasycercus cristicauda	Mulgara		B	
Dasykaluta rosamondae	Kaluta	*	A, B, C, D, K, L, M, N, P	
Dasyurus hallucatus	Northern quoll		B, C	
Ningaui ridei	Wongai Ningaui	*		
Ningaui timealeyi	Pilbara Ningaui	*	A, B, C, D, K, L, M, N, O, P, Q	
Planigale ingrami	Long-tailed Planigale		A, C	
Planigale maculata	Common Planigale		A, B, C, K, L, M, P	
Planigale sp.		*	C, Q	
Pseudantechinus macdonnellensis	Fat-tailed Pseudantechinus		A, B, K, L	
Pseudantechinus roryi	Tan False Antechinus	*		
Pseudantechinus woolleyae	Woolley's Pseudantechinus	*	B	
Sminthopsis longicaudata	Long-tailed Dunnart	*		
Sminthopsis macroura	Stripe-faced Dunnart	*	A, B, C, D, K, L, N, P, Q	
Sminthopsis ooldea	Ooldea Dunnart	*	A, C, D, N, O, P	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart	*	B	
EMBALLONURIDAE				
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat	*	A, D, E, G, K, L, Q	
Taphozous georgianus	Common Sheath-tail Bat	*	A, B, D, G, L, Q	*
Taphozous hilli	Hill's Sheath-tail Bat	*	A, C, D, K, L, P	
EQUIDAE				
**Equus asinus*	Donkey		B	
**Equus caballus*	Horse		C, G	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
FELIDAE				
**Felis catus*	Cat		B, E, H, K, P, Q	
LEPORIDAE				
**Oryctolagus cuniculus*	Rabbit	*	C, H, M	
MACROPODIDAE				
Lagorchestes conspicillatus	Spectacled Hare-wallaby		B	
Macropus robustus	Euro	*	B, C, D, E, H, K, L, M, N, O, P, Q	*
Macropus rufus	Red Kangaroo	*	B, C, D, E, F, G, H, I, K, O, Q	
Petrogale lateralis	Black-footed Rock-wallaby	*		
Petrogale rothschildi	Rothschild's Rock-wallaby	*	B, C, H, M, P	
Petrogale sp.				*
MEGADERMATIDAE				
Macroderma gigas	Ghost Bat	*	A, B, D, G, Q	
MOLOSSIDAE				
Chaerephon jobensis	Northern Mastiff-bat	*	A, D, E, F, G, K, L, M, Q	*
Mormopterus beccarii	Beccari's Freetail-bat	*	A, C, D, G, L, Q	
Mormopterus aff planiceps		*		
Mormopterus planiceps	Little Mastiff-bat		K, M, P	
Tadarida australis	White-striped Mastiff-bat	*	A, D, K, L, M	
MURIDAE				
Leggadina lakedownensis	Lakeland Downs Mouse		C	
**Mus musculus*	House Mouse	*	A, B, C, D, K, L, M, N, O, P, Q	
Notomys alexis	Spinifex Hopping-mouse	*	A, I	
Pseudomys delicatulus	Delicate Mouse		B, C	
Pseudomys chapmani	Western Pebble-mound Mouse	*	A, B, C, D, I, K, L, M, N, O, P, Q	*
Pseudomys desertor	Desert Mouse	*	D, N, O, Q	
Pseudomys hermannsburgensis	Sandy Inland Mouse	*	A, B, C, D, K, L, M, N, O, P, Q	
Pseudomys sp.			Q	
Zyzomys argurus	Common Rock-rat	*	A, B, C, D, K, L, M, N, P	
PTEROPODIDAE				
Pteropus alecto	Black Flying-fox		B	

FAMILY & Species	Common Name	Museum	Previous surveys	Current survey
TACHYGLOSSIDAE				
Tachyglossus aculeatus	Echidna		B, D, L, P	
THYLACOMYIDAE				
Macrotis lagotis	Bilby		B, D	
VESPERTILIONIDAE				
Chalinolobus gouldii	Gould's Wattled Bat	*	A, C, D, E, F, G, K, L, M, N, P, Q	*
Chalinolobus morio	Chocolate Wattle Bat	*		
Nyctophilus bifax daedalus	Northern Long-eared Bat	*	A, D, Q	*
Nyctophilus geoffroyi	Lesser Long-eared Bat	*	A, C, D, E, F, G, K, L, M, Q	*
Scotorepens balstoni	Western Broad-nosed Bat		L	
Scotorepens greyii	Little Broad-nosed Bat	*	A, B, D, E, F, G, P, Q	*
Vespadelus finlaysoni	Finlayson's Cave Bat		B, D, E, F, G, L, M, P, Q	*

APPENDIX E: Explanation of Fauna Conservation Codes

Commonwealth EPBC Act

Schedule 1 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Extinct, Extinct in the wild and Conservation Dependent.

Explanation of Codes for Fauna Under the Commonwealth EPBC Act

Conservation Category	Definition
Critically Endangered	The species is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Extinct	A species is presumed extinct if it has not been located in the last 5 years, or it has not been located in the last 100years despite thorough searching.
Extinct in the wild	The species is only known to survive in cultivation, in captivity or as a naturalised population well outside its past range or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a timeframe appropriate to its life cycle and form.
Conservation Dependent	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

WA Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice

Classification of rare and endangered fauna under the WA *Wildlife Conservation (Specially Protected Fauna) Notice 2003*, recognises four distinct schedules.

Explanation of Codes Under the WA Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 2005

Code	Definition
Schedule 1	"fauna which are Rare or likely to become extinct, are declared to be fauna that is in need of special protection"
Schedule 2	"fauna which are presumed to be extinct, are declared to be fauna that is in need of special protection"
Schedule 3	"birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection"
Schedule 4	"declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned in paragraphs (a), (b) and (c)."

CALM Priority Fauna

Species on the CALM Priority Fauna List (CALM, 2005) include those removed from the Scheduled Fauna List and other species known from only a few populations or in need of monitoring. Five Priority Codes are recognised.

Explanation of CALM Priority Fauna Categories.

Priority Category	Definition
Priority One **Taxa with few, poorly known populations on threatened lands.**	Taxa which are known from few specimens or sight records from one or a few localities, on lands not managed for conservation, *e.g.* agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Two **Taxa with few, poorly known populations on conservation lands.**	Taxa which are known from few specimens or sight records from one or a few localities, on lands not under immediate threat of habitat destruction or degradation, *e.g.* national parks, conservation parks, nature reserves, State forest, vacant crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna
Priority Three **Taxa with several, poorly known populations, some on conservation lands.**	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority Four **Taxa in need of monitoring**	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could if present circumstances change. These taxa are usually represented on conservation lands.
Priority Five **Taxa in need of monitoring**	Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

APPENDIX F: Locations of *Pseudomys chapmani* Mounds Observed During the Minsiters North Survey

Location of *Pseudomys chapmani* Mounds

Locations recorded in AGD84, Zone 50K.

Drill Hole Number	Easting	Northing	Comments
PMN4	714058	7474646	flagged at location, GPS location approximate (within 50m)
PMN8	716000	7474900	GPS location approximate (within 50m)
PMN10	715858	7474946	GPS location approximate (within 50m)
PMN11	715858	7475046	GPS location approximate (within 50m)
PMN15	716300	7475200	flagged at location, GPS location approximate (within 50m)
PMN17	716376	7473624	
PMN18	716369	7473715	
PMN19	716400	7473800	GPS location approximate (within 50m)
PMN21	717493	7474637	
Access to PM04	714488	7475004	