



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

### "IMPORTANT NOTE"

Apart from fair dealing for the purposes of private study, research, criticism, or review as permitted under the Copyright Act, no part of this report, its attachments or appendices may be reproduced by any process without the written consent of Biologic Environmental Survey Pty Ltd ("Biologic"). All enquiries should be directed to Biologic.

We have prepared this report for the sole purposes of BHP ("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 matter of 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.

## Contents

Executive Summary.....	6
1 Introduction.....	8
2 Environment.....	10
2.1 Climate.....	10
2.1.1 Conditions during the surveys.....	11
2.2 Physical environment.....	11
2.3 Vegetation.....	12
3 Methods.....	14
3.1 Compliance.....	14
3.2 Database Review.....	14
3.3 Literature Review.....	14
3.3 Data Analysis.....	15
3.4 Field Survey.....	16
3.4.1 Survey team.....	16
3.4.2 Targeted transects.....	16
3.4.3 Night work.....	17
3.4.4 Targeted trapping.....	17
3.4.5 Bat surveys.....	17
3.4.6 Motion sensitive cameras.....	18
3.4.7 Foraging surveys and incidental records.....	18
3.4.8 Habitat assessment.....	18
3.4.9 Potential limitations and constraints.....	21
3.5 Taxonomy and nomenclature.....	21
3.6 Assessment of species conservation significance.....	22
4 Results.....	24
4.1 Fauna recorded within the Study Area.....	24
4.2 Data Analysis.....	26
4.2.1 Mammal (non-volant) trapping data.....	26
4.2.2 Reptile survey data.....	28
4.3.3 Bird survey data.....	30
4.3 Conservation significant fauna recorded within the Study Area.....	31
4.4 Introduced species.....	34
4.5 Fauna habitats occurring within the Study Area.....	38
4.5.1 Habitats for conservation significant fauna.....	42
4.6 Conservation significant fauna with potential to occur in the Study Area.....	42
4.6.1 Mammals with potential to occur.....	42
4.6.2 Birds with potential to occur.....	43
4.6.3 Reptiles with potential to occur.....	44
5 Key Findings.....	46
6 References.....	48
7 Appendices.....	52

## Appendices

Appendix A: Guidance documents considered during the survey.....	52
Appendix B: Survey effort and details of reports reviewed (excluding desktop reviews).....	53
Appendix C: Locations of SM2BAT+ recorders, motion cameras, habitat assessments and trap sites .....	56
Appendix D: Conservation status codes .....	58
Appendix E: All fauna recorded from databases and surveys. ....	60
Appendix F: On site habitat assessments .....	73
Appendix G: Cave and Waterhole data.....	75

## Tables

Table 3.1: Databases used for the review.....	14
Table 3.2 Reports used for the literature review .....	15
Table 3.3 Fauna habitat significance assessment criteria .....	19
Table 3.4: Survey limitations and constraints.....	21
Table 3.5: Conservation significance assessment guidelines.....	22
Table 4.1: Summary of fauna species recorded within the local area of the Study Area.....	24
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).....	26
Table 4.2 Locations of conservation significant fauna recorded during the current survey ....	32
Table 4.3: Summary of conservation significant fauna recorded in or adjacent to the Study Area, and those that may potentially occur based on database searches .....	35
Table 4.4: Fauna habitat descriptions .....	39
Table 4.5: Conservation significance scores of fauna habitats present.....	42

## Plates

Plate 4.1 Rainbow Bee Eater nest (Site 4) and motion camera setup.....	33
Plate 4.2 Example of a juvenile feral cat recorded on motion camera in the Study Area .....	34

## Figures

Figure 1.1 Regional location and IBRA subregion .....	9
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). ....	11
Figure 2.2 Local topography and drainage.....	13
Figure 3.1 Sampling effort and transects .....	20
Figure 4.1 Accumulation curves computed for the 18 mammal trap samples .....	27
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.....	27
Figure 4.3 Observed mammal species richness, relative to predicted species richness, across multiple species richness estimators.....	28
Figure 4.4 Species accumulation curve for the 69 reptile samples.....	28

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..... 29

Figure 4.6 Observed reptile species richness, relative to predicted species richness, across multiple species richness estimators..... 29

Figure 4.7 Species accumulation curves for the 37 bird samples..... 30

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. .... 30

Figure 4.9 Observed bird species richness, relative to predicted species richness, across multiple species richness estimators..... 31

Figure 4.10: Records of conservation significant fauna ..... 37

Figure 4.11: Vertebrate fauna habitats of the Study Area ..... 41

## 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, *Rhinonictoris 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, *Aniliios 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.

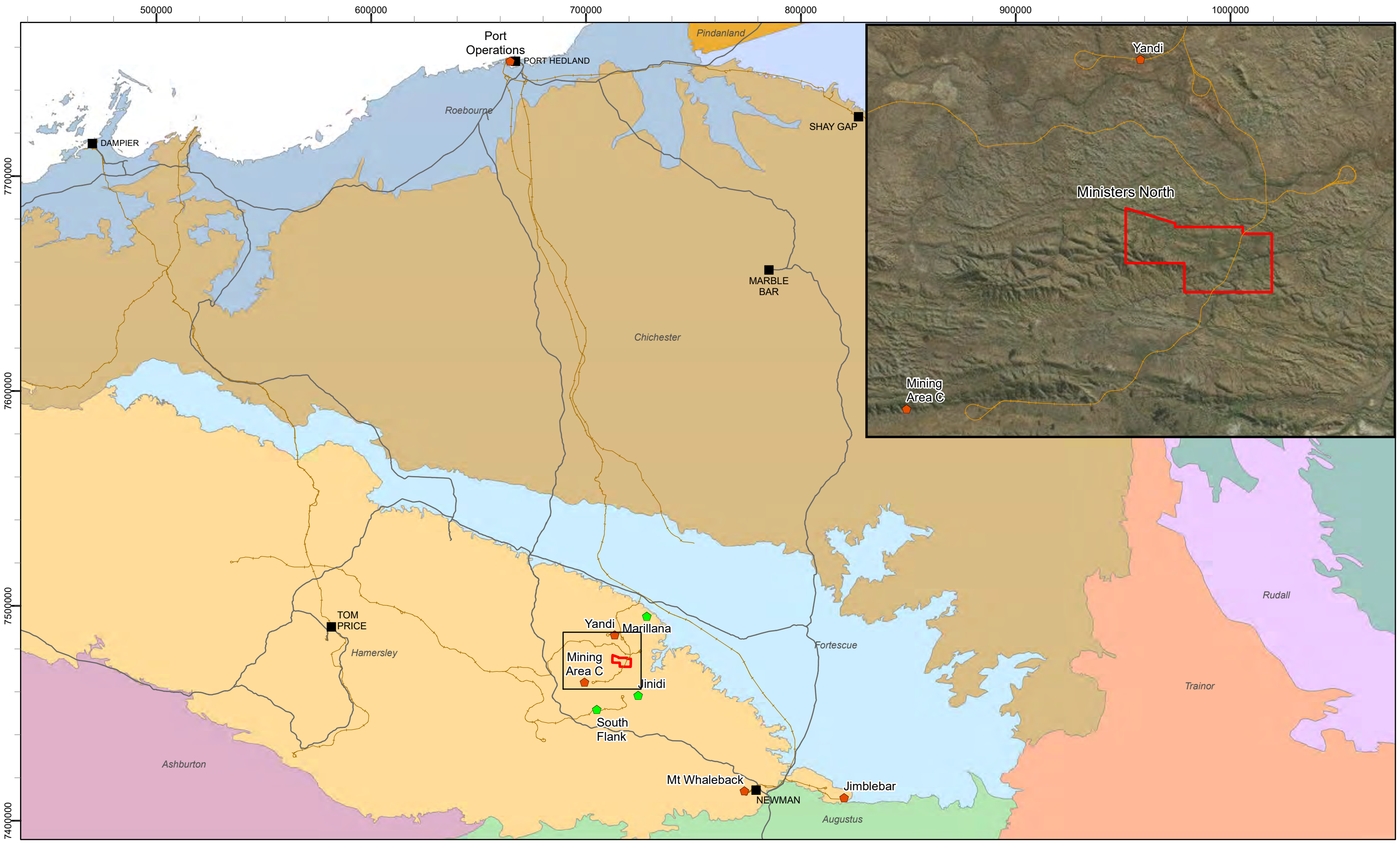
This report provides:

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.



**Legend**

■ Pilbara Towns	IBRA sub-region	Fortescue	Pindanland	Mining locations
— Major Roads	Ashburton	Hamersley	Roebourne	◆ Exploration
— Pilbara Rail	Augustus	Mackay	Rudall	◆ Operations
□ Study Area	Chichester	McLarty	Trainor	

**biologic**  
Environmental Survey

Scale: 1:1,600,000  
0 25 50 100 km

**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

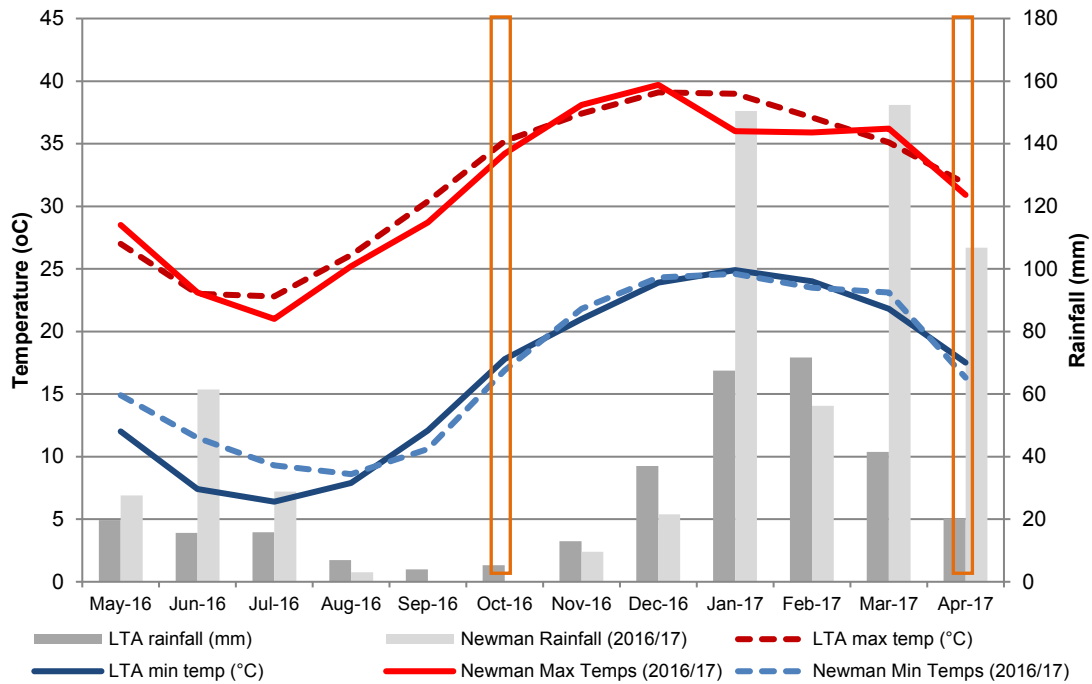
## 2 Environment

### 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.

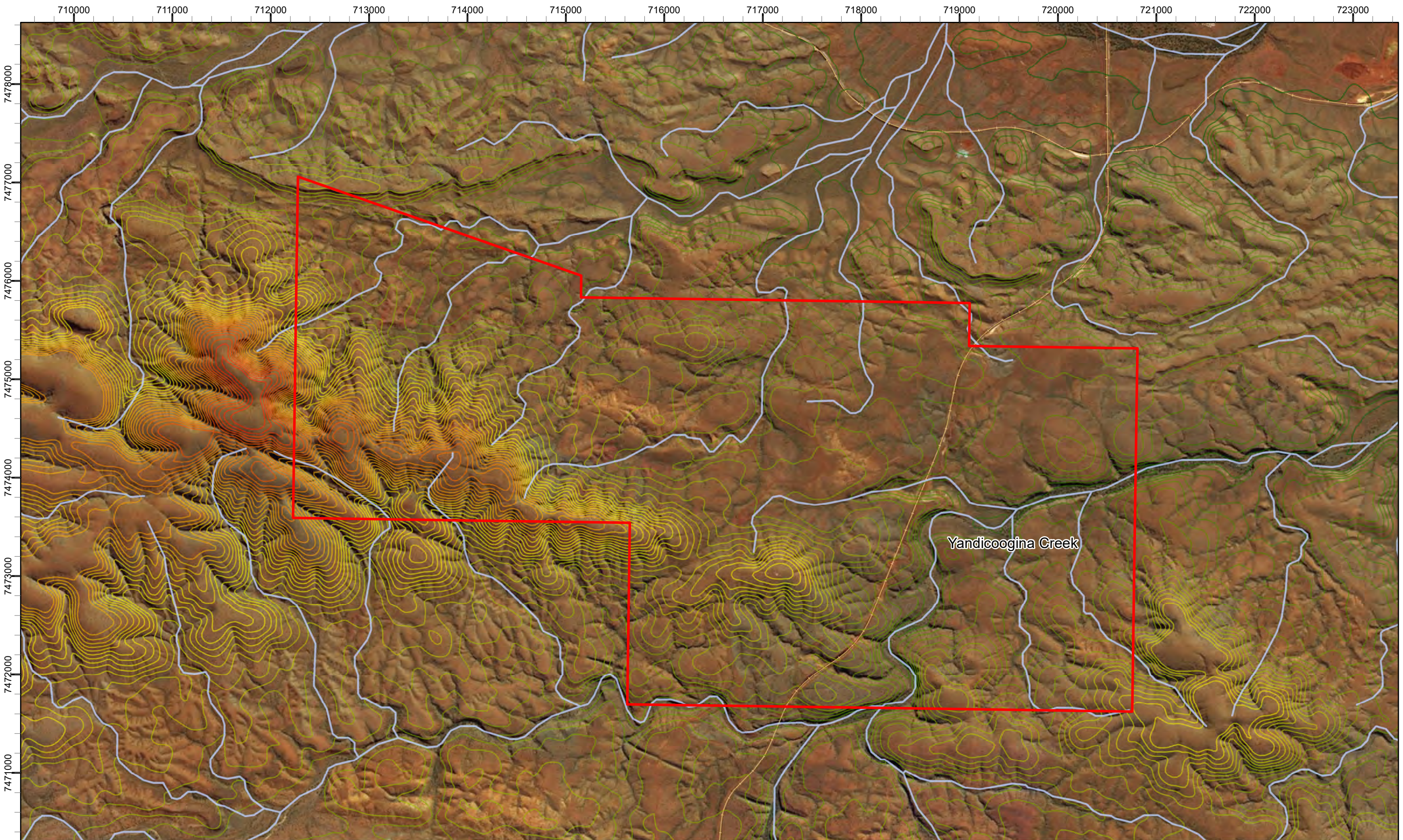
The Study Area is dominated by a plateau in the south west section, and a large, continuous river gorge in the south-east section of the Study Area, while the remaining Study Area is primarily low hill terrain dissected by minor drainage lines, gullies and gorges (Figure 2.2).

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).



**Legend**

Study Area	550.1 - 570.0	650.1 - 670.0	750.1 - 770.0	850.1 - 870.0
Pilbara Rail	570.1 - 590.0	670.1 - 690.0	770.1 - 790.0	870.1 - 890.0
Pilbara Water Courses	590.1 - 610.0	690.1 - 710.0	790.1 - 810.0	890.1 - 910.0
<b>Elevation (mAHD)</b>	610.1 - 630.0	710.1 - 730.0	810.1 - 830.0	910.1 - 930.0
540.0 - 550.0	630.1 - 650.0	730.1 - 750.0	830.1 - 850.0	



**biologic**  
Environmental Survey

N  
1:35,000  
0 0.5 1 2 km

**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 <i>et al.</i> 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:

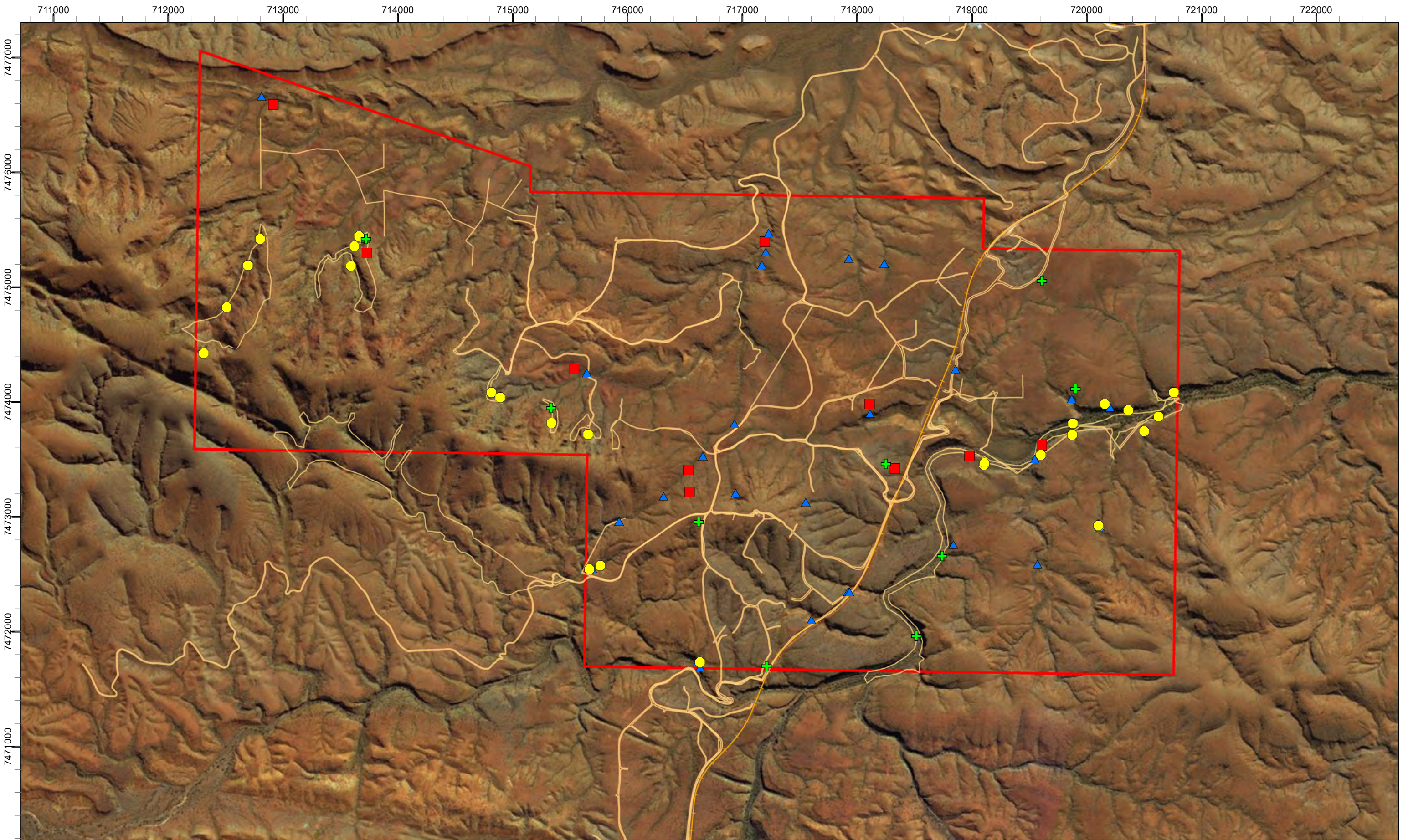
- site information, photo and location;
- landform: slope, relative inclination of slope, morphological type and landform type;
- vegetation: leaf litter %, twig litter %, wood litter, dead stags and hollow bearing trees, broad floristic formation, vegetation structure (tall, mid and low), and dominant 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)
<b>High</b>	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.
<b>Medium</b>	Habitat is known to supports DBCA listed Priority fauna that do not occur in any of the other habitat types.
	Habitat that supports <i>EPBC Act</i> listed Migratory fauna. Habitat may be used by <i>EPBC Act</i> listed fauna but it is not their core habitat ( <i>i.e.</i> 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.
<b>Low</b>	Habitat is widespread, common, and does not solely support any significant fauna.



**Legend**

Study Area	<b>Sampling Method</b>	Motion Camera
Pilbara Rail	Trapping Site	Habitat Assessment
Bat Detector	Targeted Transects	



biologic  
Environmental Survey

N  
1:30,000  
0 0.5 1 2 km

**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
<b>INTERNATIONAL</b>	
<p>The IUCN <i>Red List</i> lists species at risk under nine categories (listed under 'Status Codes').</p>	<ul style="list-style-type: none"> <li>• IUCN Extinct</li> <li>• IUCN Extinct in the Wild</li> <li>• IUCN Critically Endangered</li> <li>• IUCN Endangered</li> <li>• IUCN Vulnerable</li> <li>• IUCN Near Threatened</li> <li>• IUCN Least Concern</li> <li>• IUCN Data Deficient</li> <li>• IUCN Not Evaluated</li> </ul>

Agreement, Act or List	Status Codes
<p>Migratory taxa listed under the following international conventions are generally listed as Migratory under the federal <i>Environment Protection and Biodiversity Conservation Act 1999</i> (see below):</p> <ul style="list-style-type: none"> <li>• Japan-Australia Migratory Bird Agreement (JAMBA);</li> <li>• China-Australia Migratory Bird Agreement (CAMBA);</li> <li>• Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and</li> <li>• Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).</li> </ul>	<p>Generally listed as Migratory under the <i>EPBC Act</i></p>
<b>FEDERAL</b>	
<p><i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i></p> <p>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').</p> <p>Threatened Ecological Communities (TECs) are those that are at risk of extinction.</p>	<ul style="list-style-type: none"> <li>• Extinct (EX)</li> <li>• Extinct in the Wild (EW)</li> <li>• Critically Endangered (CE)</li> <li>• Endangered (EN)</li> <li>• Vulnerable (VU)</li> <li>• Conservation Dependent (CD)</li> <li>• Migratory (MG)</li> <li>• Marine (MA)</li> </ul> <ul style="list-style-type: none"> <li>• Critically Endangered</li> <li>• Endangered</li> <li>• Vulnerable</li> </ul>
<b>STATE</b>	
<p><i>Wildlife Conservation Act 1950 (WC Act)</i></p> <p>At a state level, native fauna are protected under the <i>WC Act</i>. Species in need of conservation are given a ranking ranging from Schedule 1 to 7.</p> <p><b>DBCA Priority list (DBCA)</b></p> <p>DBCA produces a list of Priority species and ecological communities (e.g. PECs or TECs that have not been assigned statutory protection under the <i>WC Act</i>). This system gives a ranking from Priority 1 to Priority 4.</p>	<ul style="list-style-type: none"> <li>• Schedule 1 (S1)</li> <li>• Schedule 2 (S2)</li> <li>• Schedule 3 (S3)</li> <li>• Schedule 4 (S4)</li> <li>• Schedule 5 (S5)</li> <li>• Schedule 6 (S6)</li> <li>• Schedule 7 (S7)</li> </ul> <ul style="list-style-type: none"> <li>• Priority 1 (P1)</li> <li>• Priority 2 (P2)</li> <li>• Priority 3 (P3)</li> <li>• Priority 4 (P4)</li> </ul>

## 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
<b>Current Survey</b>	<b>15</b>	<b>2</b>	<b>54</b>	<b>45</b>	<b>3</b>	<b>119</b>
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
<b>Total species recorded</b>	<b>38</b>	<b>9</b>	<b>151</b>	<b>114</b>	<b>7</b>	<b>319</b>
<b>Conservation Significant species</b>	<b>7</b>	<b>0</b>	<b>23</b>	<b>3</b>	<b>0</b>	<b>33</b>

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.

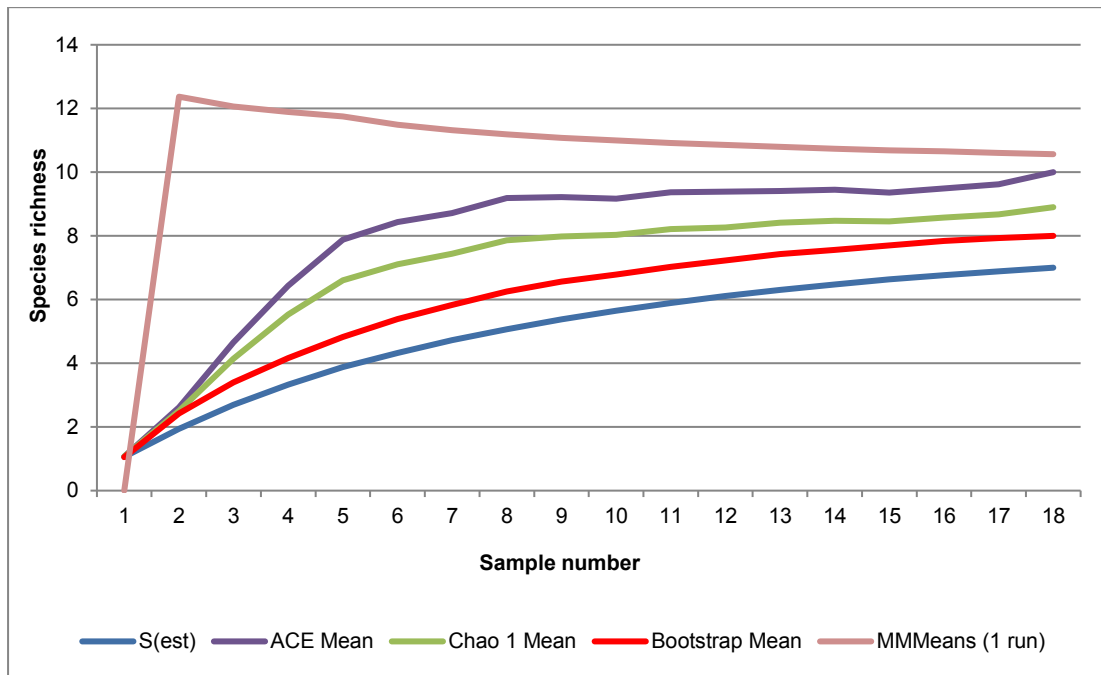


Figure 4.1 Accumulation curves computed for the 18 mammal trap samples

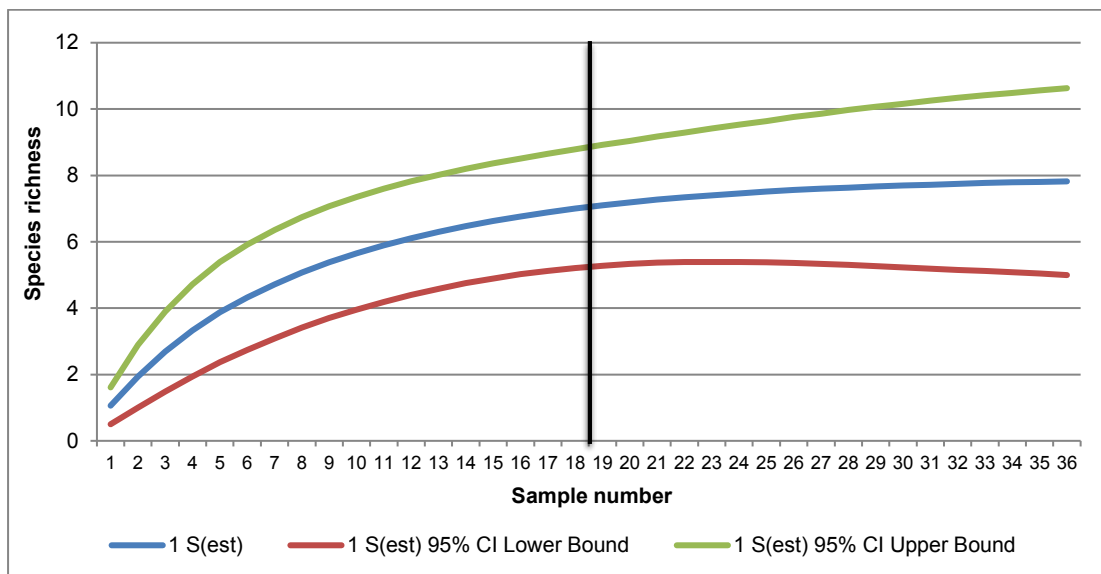
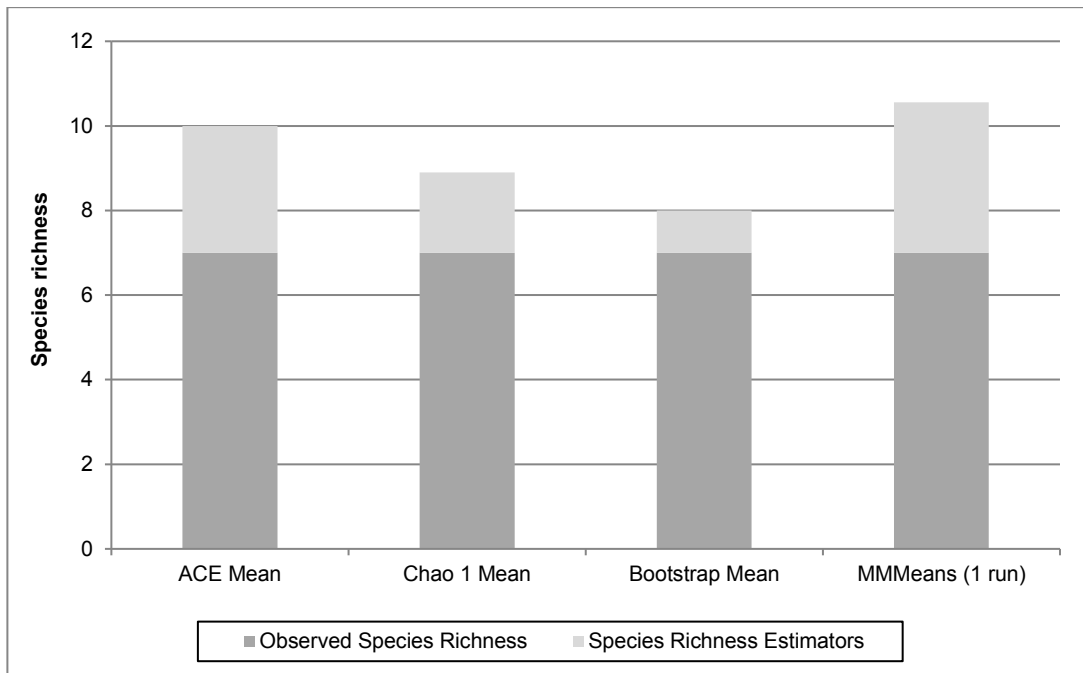


Figure 4.2 Extrapolation of S (est) and 95% confidence boundaries to 36 mammal trapping samples. The black line is the number of actual samples from the current survey.

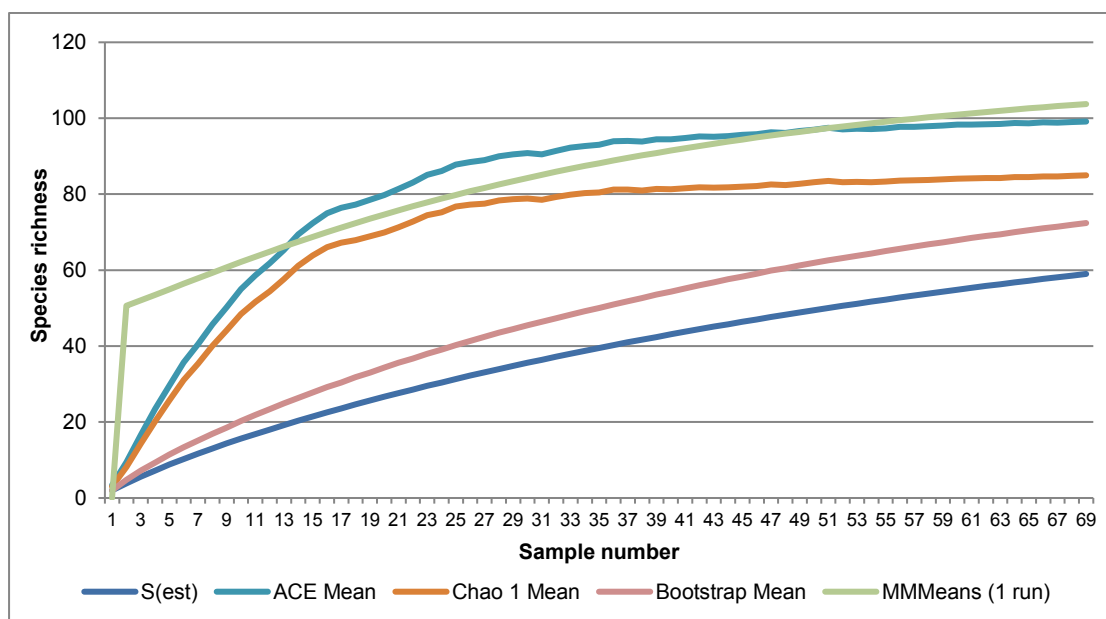
An extrapolation of the data to 36 samples (doubling the sample effort) estimates that only one additional species would be captured. Other indicators range from an additional 2 - 4 species (Table 4.2). This indicates that the trapping programme is estimated to have recorded at least 66% of the species. 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.



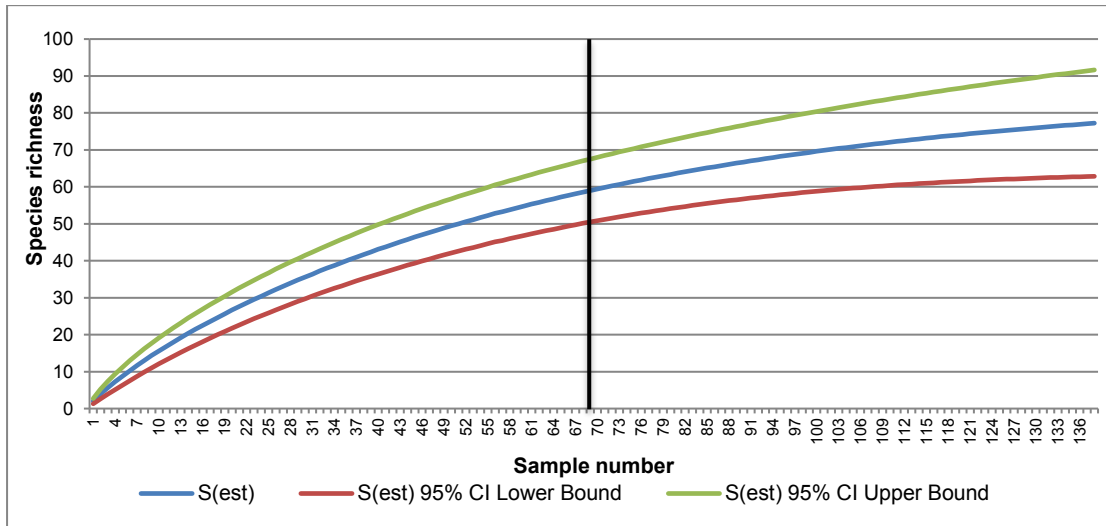
**Figure 4.3 Observed mammal species richness, relative to predicted species richness, across multiple species richness estimators.**

#### 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.

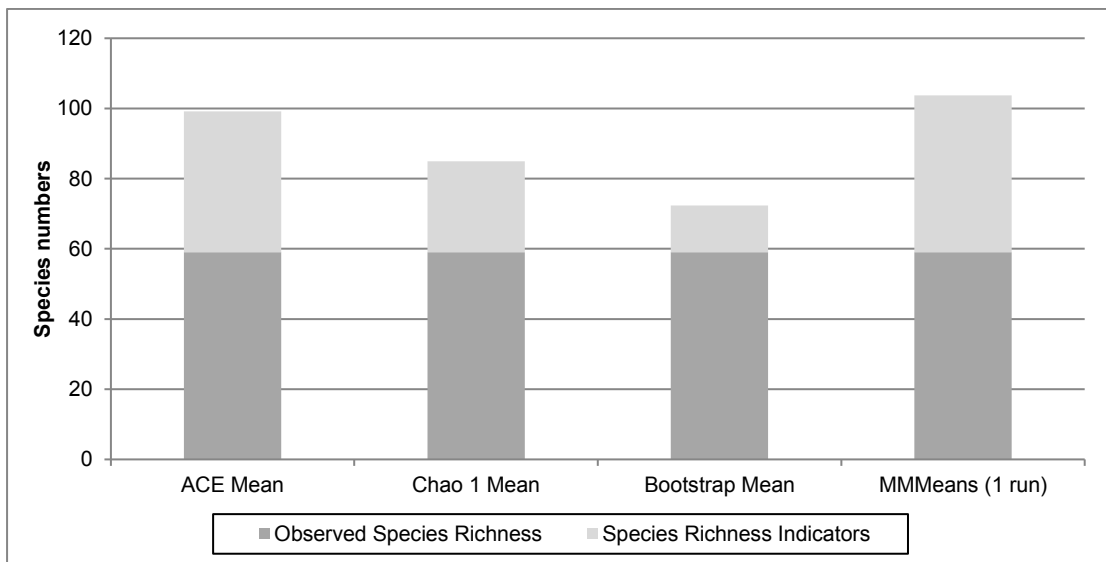


**Figure 4.4 Species accumulation curve for the 69 reptile samples**



**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.

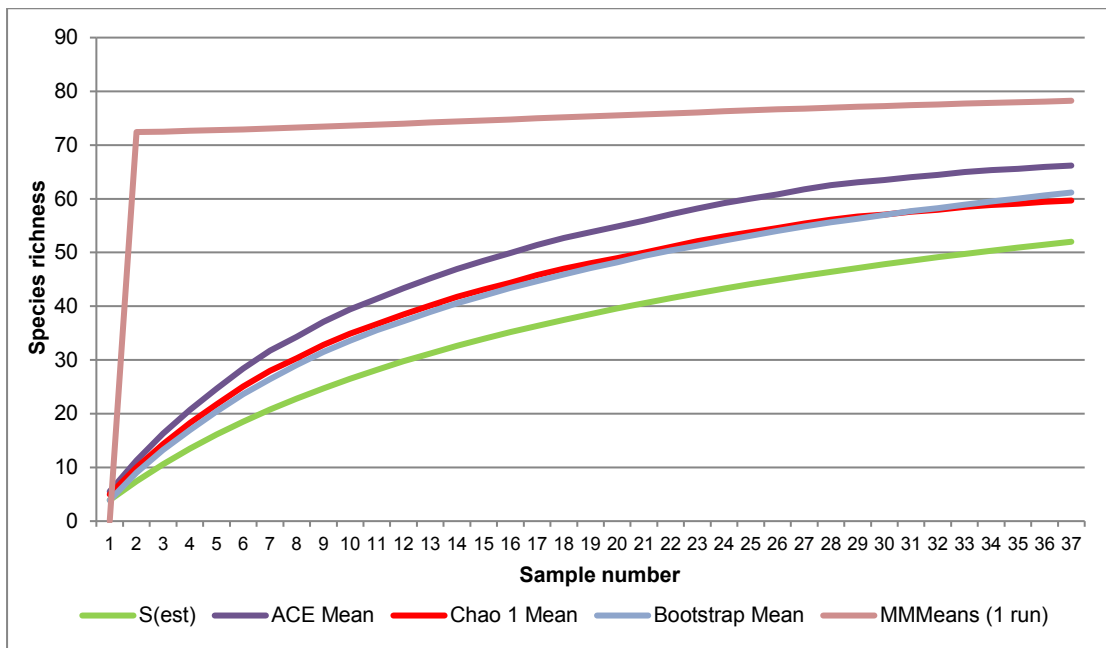


Figure 4.7 Species accumulation curves for the 37 bird samples

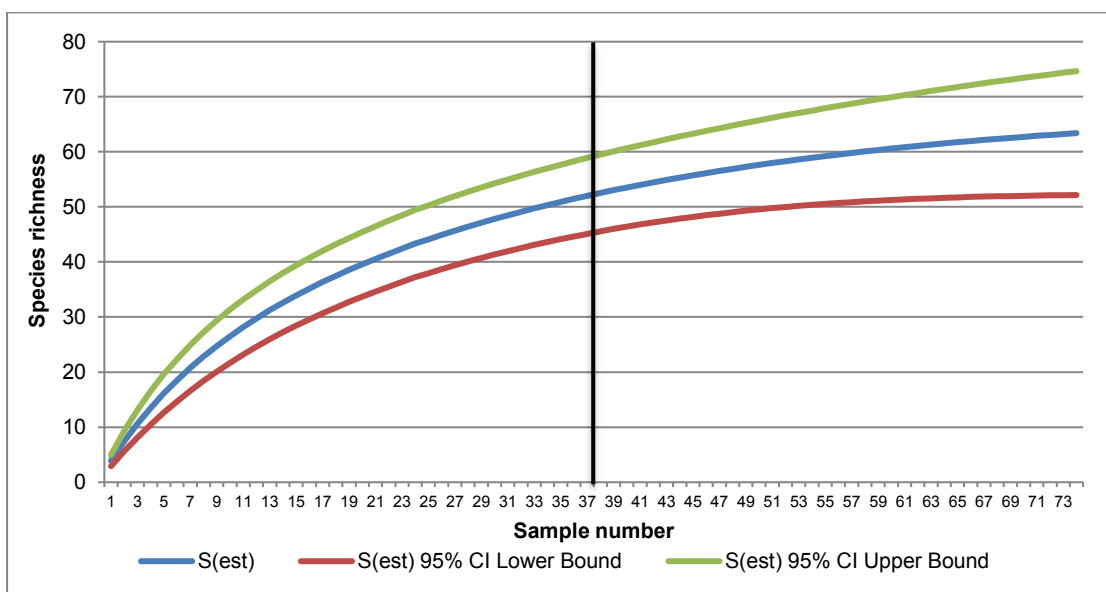
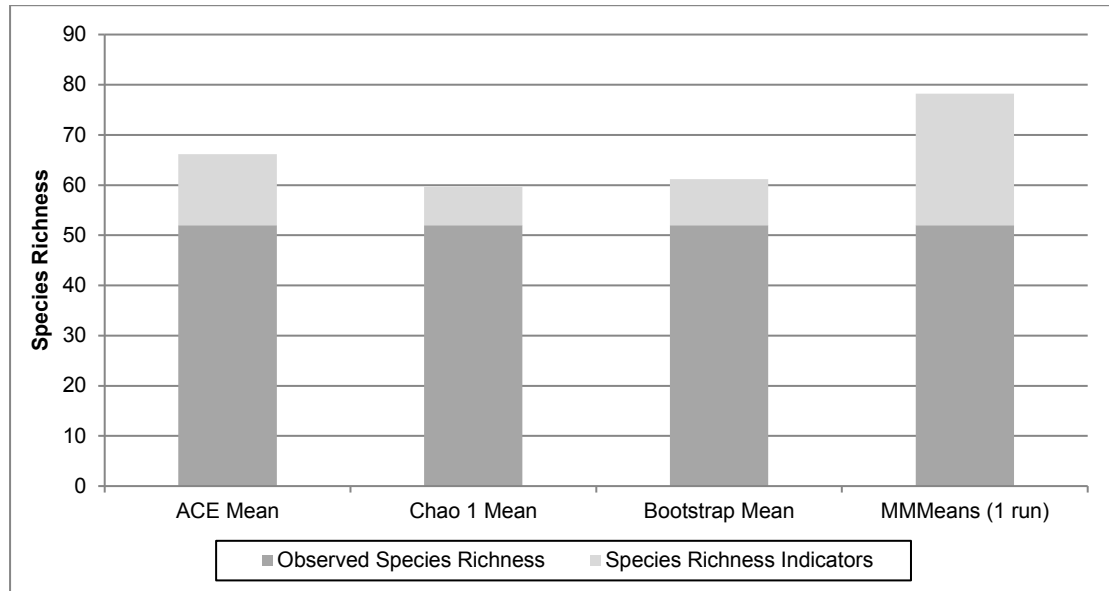


Figure 4.8 Extrapolation of S(est) and 95% confidence boundaries to 138 bird samples. The black line is the number of actual samples from the current survey.

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.

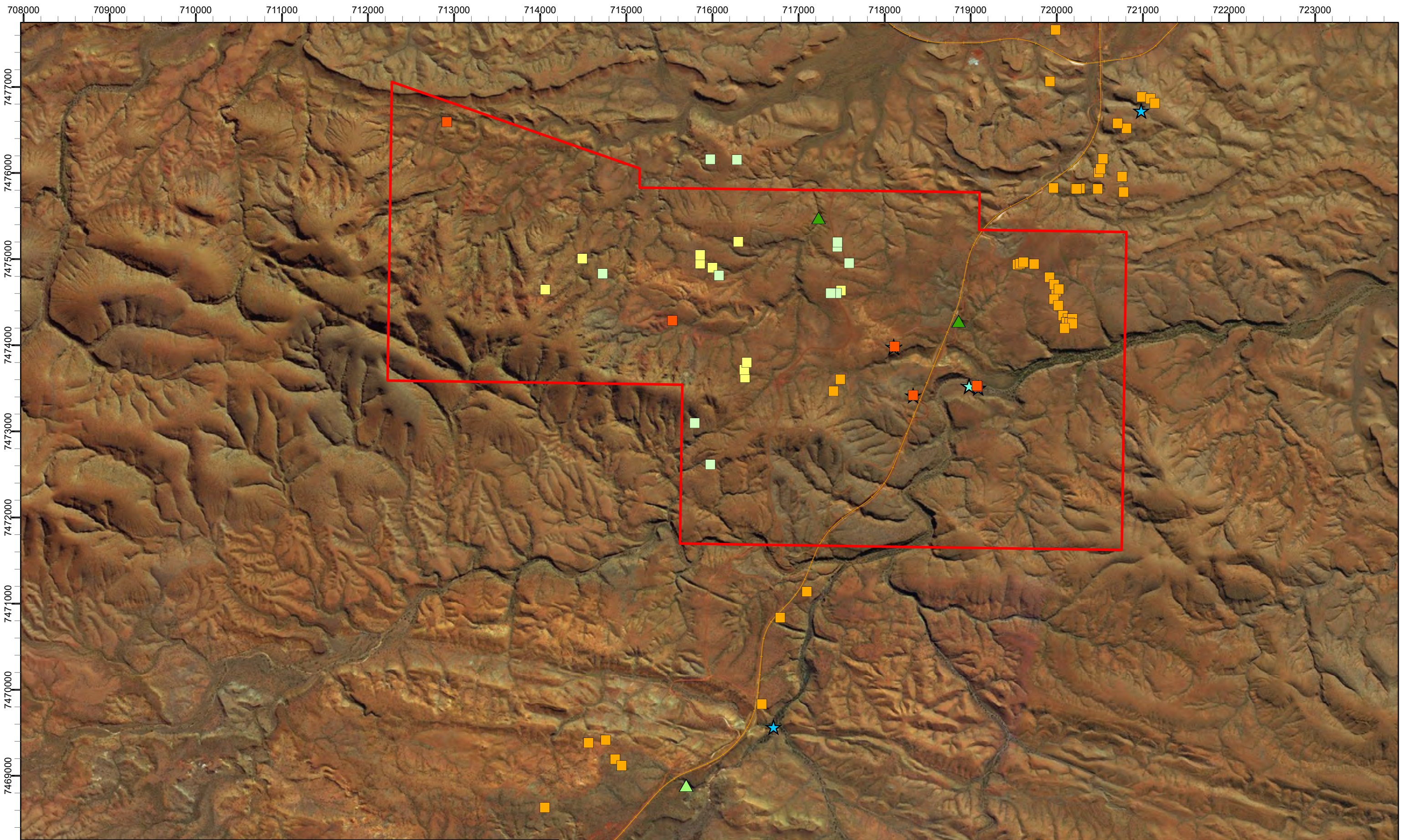


**Plate 4.2 Example of a juvenile feral cat recorded on motion camera in the Study Area**

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			
		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)
<b>MAMMALS</b>																										
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1		EN		•	•																		•
<i>Macrotis lagotis</i>	Bilby, Dalgyte	VU	S1		VU			•																		
<i>Macroderma gigas</i>	Ghost Bat	VU	S3		VU		•	•		•													•		•	
<i>Rhinonicteris aurantia</i>	Pilbara Leaf-nosed Bat	VU	S1					•						•										•		
<i>Chalinolobus morio</i>	Chocolate Wattled Bat				LOCAL		•																	•		•
<i>Leggadina lakedownensis</i>	Short-tailed Mouse			P4																					•	
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4			•		•	•	•	•	•	•	•	•	•	•				•	•	•	•	•
<b>BIRDS</b>																										
<i>Macronectes giganteus</i>	Southern Great Petrel	EN	S5				•																			
<i>Apus pacificus</i>	Fork-tailed Swift	MG	S5				•	•									•						•			
<i>Ardea ibis</i>	Cattle Egret	MG	S5					•																		
<i>Ardea modesta</i>	Eastern Great Egret	MG	S5					•																		
<i>Pandion cristatus</i>	Eastern Osprey	MG	S5																							
<i>Falco hypoleucos</i>	Grey Falcon		S3																							
<i>Falco peregrinus</i>	Peregrine Falcon		S7								•												•	•	•	
<i>Charadrius veredus</i>	Oriental Plover	MG	S5				•																			
<i>Calidris ferruginea</i>	Curlew Sandpiper	CR	S3					•																		
<i>Tringa glareola</i>	Wood Sandpiper	MG	S5																						•	
<i>Rostratula australis</i>	Australian Painted Snipe	EN	EN					•																		

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	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)	
<i>Pezoporus occidentalis</i>	Night Parrot	CR	S1		CE		•																				
<i>Merops ornatus</i>	Rainbow Bee-eater	MG	S5				•	•	•	•	•	•			•	•	•	•				•	•	•	•	•	•
<i>Hirundo rustica</i>	Barn Swallow	MG	S5					•																			
<i>Motacilla cinerea</i>	Grey Wagtail	MG	S5																								
<i>Motacilla flava</i>	Yellow Wagtail	MG	S5																								
<b>REPTILES</b>																											
<i>Anilius ganei</i>			P1				•								•										•		
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	VU				•	•					•				•									•	



**Legend**

- Study Area
- Pilbara Rail
- Conservation Significant Species, survey**
- ▲ Chocolate Wattle 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, Ecologia (2006)
- Western Pebble Mound Mouse, ENV (2009)



**biologic**  
Environmental Survey

N  
1:40,000  
0 0.5 1 2 km

**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 provide 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.

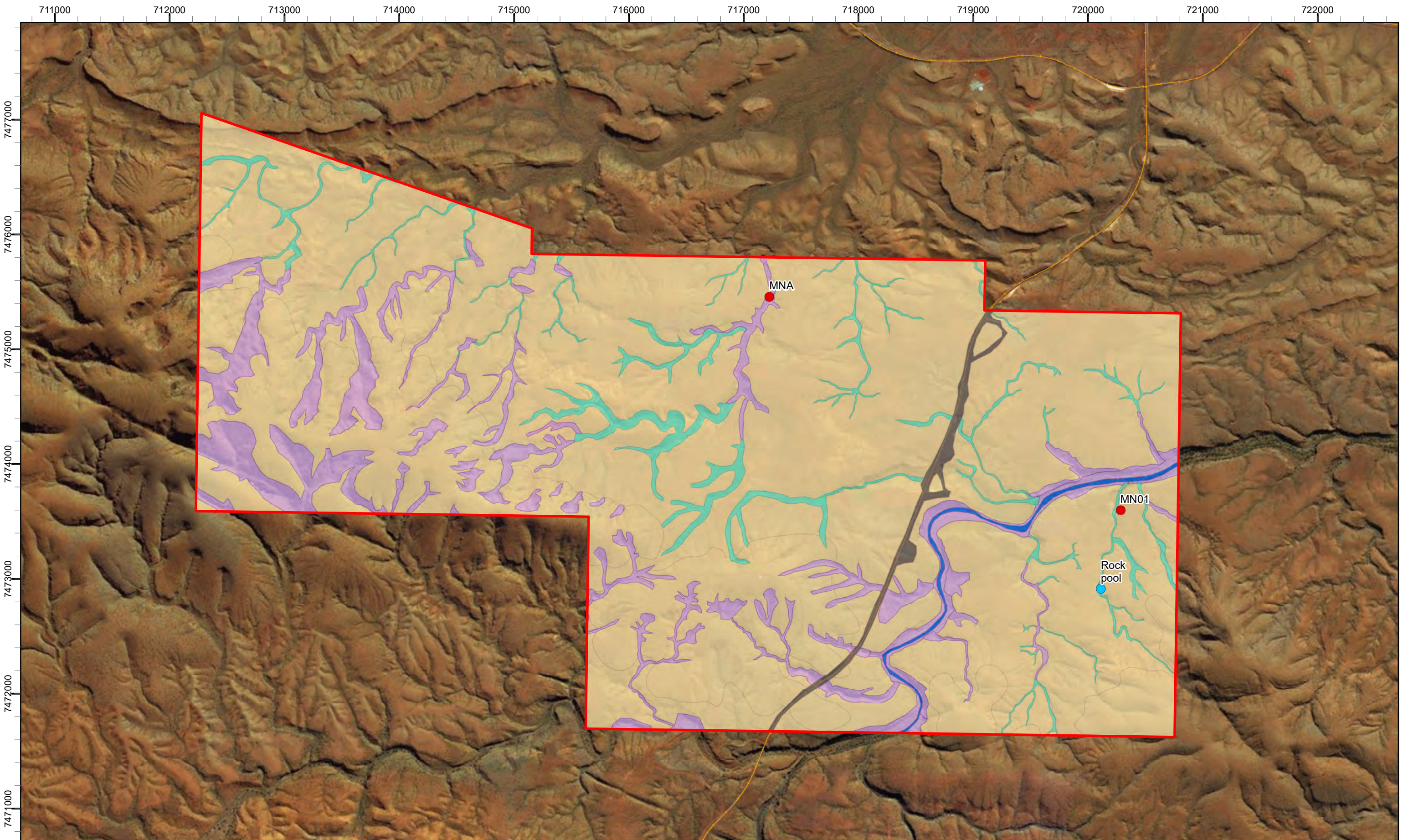


**Table 4.5: Fauna habitat descriptions**

Habitat	Distinguishing habitat characteristics	Occurrence of the habitat within the Study Area	Extent of the habitat outside Study Area	Photo
<p><b>Gorge/ Gully</b></p>	<p>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.</p>	<p>Run along Major and Minor Drainage Lines throughout the entire Study Area. Uncommon in the north-east sections where plains dominate.</p>	<p>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.</p>	
<p><b>Hillcrests/ slopes</b></p>	<p>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 <i>Eucalyptus</i> woodlands, <i>Acacia</i> and <i>Grevillea</i> scrublands and <i>Triodia</i> low hummock grasslands.</p>	<p>Covers extensive parts of the Study Area along the southern and western areas</p>	<p>A very common habitat feature in the region, occurring wherever there are ridges and low rises.</p>	
<p><b>Major Drainage Line</b></p>	<p>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.</p>	<p>The Major Drainage Line within the Study Area runs north-east from the south to the north-eastern corner of the Study Area</p>	<p>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.</p>	



Habitat	Distinguishing habitat characteristics	Occurrence of the habitat within the Study Area	Extent of the habitat outside Study Area	Photo
<p><b>Minor Drainage Line</b></p>	<p>Characterised by low and sparse vegetation compared to Major Drainage Lines. Consisted of <i>Acacia</i> low woodland sometimes with scattered <i>Eucalyptus xerothermica</i> and <i>Corymbia hamersleyana</i>. The understorey generally lack density and often consists solely of sparse tussock grassland, often of <i>Cenchrus ciliaris</i> where it has been introduced. The substrate can be sandy in places but generally consists of a loam gravel or stone.</p>	<p>Minor Drainage Lines run throughout the Study Area, particularly through the central section.</p>	<p>A common habitat in the Hamersley Range and adjacent to the Study Area.</p>	
<p><b>Disturbed</b></p>	<p>This habitat zone comprises major road and rail tracks, and cleared areas alongside these, which are not suitable for vertebrate fauna.</p>	<p>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.</p>	<p>This habitat type commonly occurs in active mining tenements, however proportionally it does not cover large areas of the landscape.</p>	<p>N/A</p>



**Legend**

Pilbara Rail	Major Drainage Line	<b>Habitat features</b>
Study Area	Minor Drainage Line	Cave
<b>Fauna habitat</b>	Hillcrests / slopes	Waterhole
Gorge / Gully	Disturbed	

**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 <i>EPBC Act</i> and <i>WC Act</i> , 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 (*Rhinonictoris 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 (28–32°C) 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 (*Anilius 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, *Rhinonictoris 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, *Aniliios 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, *Rhinonictes aurantius*, in the Pilbara region of Western Australia. *Wildlife Research*, 28: 95–104.
- Armstrong, K. (2006). Phylogeographic structure in *Rhinonictes 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*. 2<sup>nd</sup> 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](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: 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 Funnel, 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: 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	Notes
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: Terrestrial Vertebrate Fauna Assessment	<p>Pit traps are not discriminated so a ratio of 50:50 is assumed. Bat survey conducted by Specialized Zoological (separate report)</p>
Area C Southern Flank Deposit Fauna Assessment	<p>Report incorrectly states that Fox was recorded in ENV (2007) R Deposit survey</p>
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	<p>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.</p>
Area C West to Yandi Level 2 Vertebrate Fauna Survey	
Area C West (Biologic 2013c)	

**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
<b>Extinct (EX)</b>	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.
<b>Extinct in the Wild (EW)</b>	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.
<b>Critically Endangered (CE)</b>	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.
<b>Endangered (EN)</b>	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.
<b>Vulnerable (VU)</b>	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.
<b>Near Threatened (NT)</b>	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
<b>Data Deficient (DD)</b>	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
<b>Extinct (EX)</b>	Taxa not definitely located in the wild during the past 50 years.
<b>Extinct in the Wild (EW)</b>	Taxa known to survive only in captivity.
<b>Critically Endangered (CE)</b>	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
<b>Endangered (EN)</b>	Taxa facing a very high risk of extinction in the wild in the near future.
<b>Vulnerable (VU)</b>	Taxa facing a high risk of extinction in the wild in the medium-term future.
<b>Migratory (MG)</b>	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
<b>Schedule 1 (S1)</b>	Critically Endangered
<b>Schedule 2 (S2)</b>	Endangered
<b>Schedule 3 (S3)</b>	Vulnerable
<b>Schedule 4 (S4)</b>	Presumed Extinct
<b>Schedule 5 (S5)</b>	Migratory
<b>Schedule 6 (S6)</b>	Conservation Dependent
<b>Schedule 7 (S7)</b>	Other Specially Protected Fauna

**Department of Environment and Conservation**

Category	Definition
<b>Priority 1 (P1)</b>	Taxa with few, poorly known populations on threatened lands.
<b>Priority 2 (P2)</b>	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
<b>Priority 3 (P3)</b>	Taxa with several, poorly known populations, some on conservation lands.
<b>Priority 4 (P4)</b>	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)			
<b>MAMMALS</b>																												
<b>TACHYGLOSSIDAE</b>																												
<i>Tachyglossus aculeatus</i>																												
<b>DASYURIDAE</b>																												
<i>Dasykaluta rosamondae</i>						•		•		•		•		•	•	•	•						•		•			
<i>Dasyurus hallucatus</i>		EN	S1		EN	•	•																			•		
<i>Ningauai ridei</i>																											•	
<i>Ningauai timealeyi</i>						•		•		•	•	•			•	•					•		•	•	•	•	•	
<i>Planigale ingrami</i>						•		•																	•	•		
<i>Planigale sp. 1</i>										•		•		•									•		•			
<i>Pseudantechinus woolleyae</i>						•				•													•		•			
<i>Sminthopsis macroura</i>						•				•		•											•		•			
<i>Sminthopsis ooldea</i>						•				•																		
<i>Sminthopsis youngsoni</i>						•																						
<b>THYLACOMYIDAE</b>																												
<i>Macrotis lagotis</i>		VU	S1		VU		•																					
<b>MACROPODIDAE</b>																												
<i>Osphranter robustus erubescens</i>						•		•	•	•	•	•		•	•	•	•						•	•	•	•	•	
<i>Osphranter rufus</i>						•		•																		•		
<i>Petrogale rothschildi</i>						•		•	•	•							•	•						•	•	•		
<b>MEGADERMATIDAE</b>																												
<i>Macroderma gigas</i>		VU	S3		VU	•	•			•													•		•			
<b>HIPPOSIDERIDAE</b>																												
<i>Rhinonictis aurantia</i>		VU	S1				•							•											•			
<b>EMBALLONURIDAE</b>																												
<i>Saccolaimus flaviventris</i>						•		•	•	•		•		•		•					•	•	•	•	•	•	•	
<i>Taphozous georgianus</i>						•		•	•	•		•	•	•	•	?		•			•	•	•	•	•	•	•	
<i>Taphozous hilli</i>						•				•					•								•	•	•			
<b>MOLOSSIDAE</b>																												
<i>Chaerophon jobensis</i>						•		•	•	•		•		•	•								•	•	•	•	•	
<i>Ozimops lumsdenae</i>						•		•	•			•		•	•								•	•	•	•	•	

Species	Conservation status					Online Databases		Studies overlapping Study Area		Studies within 10 km of the Study Area														Current Survey				
	EPBC	WCA	DFBC	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)			
<i>Mormopterus loriae</i>						•																						
<i>Mormopterus planiceps</i>										•																		
<i>Tadarida australis</i>									•	•	•	•	•			•					•			•	•			
<b>VESPERTILIONIDAE</b>																												
<i>Chalinolobus gouldii</i>						•		•	•	•	•	•	•		•	•				•	•	•	•	•	•	•	•	
<i>Chalinolobus morio</i>					LOCAL	•																		•		•		
<i>Nyctophilus daedalus</i>						•		•																•				
<i>Nyctophilus geoffroyi</i>						•		•	•	•				•									•	•	•	•		
<i>Scotorepens greyii</i>						•		•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	
<i>Vespadelus finlaysoni</i>						•		•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	
<b>MURIDAE</b>																												
<i>Leggadina lakedownensis</i>																										•		
* <i>Mus musculus</i>						•	•		•			•				•								•	•	•	•	
<i>Notomys alexis</i>																												
<i>Pseudomys chapmani</i>						•		•	•	•	•	•	•		•	•	•				•	•	•	•	•	•	•	
<i>Pseudomys desertor</i>						•								•	•	•							•	•	•	•	•	
<i>Pseudomys hermannsburgensis</i>						•		•		•	•	•	•			•	•	•			•	•	•	•	•	•	•	
<i>Zyomys argurus</i>						•		•		•			•	•	•	•	•				•	•	•	•	•	•	•	
<b>BOVIDAE</b>																												
* <i>Bos taurus</i>						•		•	•	•	•	•								•	•	•	•	•	•	•	•	
<b>CANIDAE</b>																												
* <i>Canis lupus dingo</i>						•		•		•	•	•					•	•					•		•		•	
* <i>Canis lupus</i>																•								•			•	
* <i>Vulpes vulpes</i>									•																			
<b>CAMELIDAE</b>																												
* <i>Camelus dromedarius</i>						•	•		•																•			
<b>EQUIDAE</b>																												
* <i>Equus asinus</i>										•											•							
* <i>Equus caballus</i>																									•	•		
<b>FELIDAE</b>																												
* <i>Felis catus</i>						•	•	•	•	•		•				•	•								•	•	•	
<b>LEPORIDAE</b>																												
* <i>Oryctolagus cuniculus</i>							•																					

Species	Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area											Current Survey			
	EPBC	WCA	DFBC	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)
<b>BIRDS</b>																									
<b>CASUARIIDAE</b>																									
<i>Dromaius novaehollandiae</i>	Emu					•			•		•								•					•	•
<b>PHASIANIDAE</b>																									
<i>Coturnix pectoralis</i>	Stubble Quail																•				•				
<i>Coturnix ypsilophora</i>	Brown Quail					•			•									•							•
<b>ANATIDAE</b>																									
<i>Chenonetta jubata</i>	Australian Wood Duck																								•
<i>Anas gracilis</i>	Grey Teal											•										•			•
<i>Anas superciliosa</i>	Pacific Black Duck					•				•		•												•	•
<i>Dendrocygna eytoni</i>	Plumed Whistling-duck																								•
<b>PELECANIDAE</b>																									
<i>Pelecanus conspicillatus</i>	Australian Pelican					•																			•
<b>PROCELLARIIDAE</b>																									
<i>Macronectes giganteus</i>	Southern Great Petrel	EN	S5			•																			
<b>RALLIDAE</b>																									
<i>Gallirallus philippensis</i>	Buff-banded Rail																								
<i>Porzana tabuensis</i>	Spotless Crake					•																			
<b>COLUMBIDAE</b>																									
<i>Geophaps plumifera ferruginea</i>	Spinifex Pigeon					•		•	•	•	•		•		•	•	•	•			•	•	•	•	•
<i>Geopelia cuneata</i>	Diamond Dove					•		•	•		•		•		•	•	•	•			•	•	•	•	•
<i>Geopelia striata placida</i>	Peaceful Dove					•			•	•	•				•	•					•	•			•
<i>Ocyphaps lophotes</i>	Crested Pigeon					•		•	•	•	•		•		•	•	•	•			•	•	•	•	•
<i>Phaps chalcoptera</i>	Common Bronzewing					•		•	•	•	•				•	•	•	•				•	•	•	•
<b>PODARGIDAE</b>																									
<i>Podargus strigoides</i>	Tawny Frogmouth							•		•	•	•	•		•								•	•	•
<b>EUROSTOPODIDAE</b>																									
<i>Eurostopodus argus</i>	Spotted Nightjar					•		•	•		•	•	•		•		•	•					•	•	•
<b>AEGOTHELIDAE</b>																									
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar					•		•	•		•		•		•		•	•					•	•	•
<b>APODIDAE</b>																									
<i>Apus pacificus</i>	Fork-tailed Swift	MG	S5			•	•										•						•		
<b>ANHINGIDAE</b>																									



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)
<b>BURHINIDAE</b>																									
<i>Burhinus grallarius</i>																									
<b>RECURVIROSTRIDAE</b>																									
<i>Himantopus himantopus</i>																									
<b>CHARADRIIDAE</b>																									
<i>Charadrius veredus</i>	MG	S5																							
<i>Erythronyx cinctus</i>																									
<i>Elsayornis melanops</i>																									
<b>SCOLOPACIDAE</b>																									
<i>Calidris ferruginea</i>	CR	S3																							
<i>Tringa glareola</i>	MG	S5																							
<i>Tringa nebularia</i>																									
<b>ROSTRATULIDAE</b>																									
<i>Rostratula australis</i>	EN	EN																							
<b>TURNICIDAE</b>																									
<i>Turnix velox</i>																									
<b>CACATUIDAE</b>																									
<i>Cacatua roseicapilla</i>																									
<i>Cacatua sanguinea</i>																									
<i>Nymphicus hollandicus</i>																									
<b>PSITTACIDAE</b>																									
<i>Platycercus zonarius zonarius</i>																									
<i>Platycercus varius</i>																									
<i>Melopsittacus undulatus</i>																									
<i>Neopsephotus bourkii</i>																									
<i>Neophema elegans</i>																									
<i>Pezoporus occidentalis</i>	CR	S1			CE																				
<b>CUCULIDAE</b>																									
<i>Centropus phasianinus</i>																									
<i>Chalcites basalis</i>																									
<i>Chalcites osculans</i>																									
<i>Cacomantis pallidus</i>																									
<b>STRIGIDAE</b>																									

Species	Conservation status					Online Databases		Studies overlapping Study Area		Studies within 10 km of the Study Area														Current Survey	
	EPBC	WCA	DFBC	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)
<i>Ninox connivens</i>						•			•															•	
<i>Ninox boobook</i>									•		•		•		•				•				•	•	•
<b>TYTONIDAE</b>																									
<i>Tyto alba</i>						•			•																
<i>Tyto javanica</i>													•										•		
<b>HALCYONIDAE</b>																									
<i>Dacelo leachii leachii</i>						•				•		•				•	•				•	•	•	•	
<i>Todiramphus pyrrhopygius</i>						•				•		•	•		•	•	•	•			•	•	•	•	
<i>Todiramphus sanctus</i>						•			•			•				•							•	•	
<b>MEROPIIDAE</b>																									
<i>Merops ornatus</i>		MG	S5			•	•	•	•	•	•	•			•	•	•	•			•	•	•	•	
<b>CLIMACTERIDAE</b>																									
<i>Climacteris melanura</i>											•	•													
<b>PTILINORHYNCHIDAE</b>																									
<i>Ptilonorhynchus maculatus guttatus</i>						•		•	•		•	•	•		•	•	•	•				•	•	•	
<b>MALURIDAE</b>																									
<i>Amytornis striatus whitei</i>						•		•		•	•	•	•			•	•	•				•	•	•	
<i>Malurus lamberti assimilis</i>						•		•	•	•	•	•	•		•	•	•	•			•	•	•	•	
<i>Malurus leucopterus leuconotus</i>						•		•		•	•	•	•		•	•	•	•				•	•	•	
<i>Malurus splendens</i>																		•						•	
<i>Stipiturus ruficeps</i>						•				•	•		•					•				•		•	
<b>ACANTHIZIDAE</b>																									
<i>Pyrrholaemus brunneus</i>						•													•						
<i>Smicromis brevirostris</i>						•		•	•	•	•		•		•	•	•	•			•	•	•	•	
<i>Gerygone fusca</i>						•			•	•	•		•				•	•			•	•	•	•	
<i>Acanthiza apicalis</i>						•					•		•				•	•				•	•	•	
<i>Acanthiza chrysorrhoa</i>						•					•							•						•	
<i>Acanthiza robustirostris</i>											•		•					•						•	
<i>Acanthiza uropygialis</i>						•			•		•							•						•	
<b>PARDALOTIDAE</b>																									
<i>Pardalotus rubricatus</i>						•		•		•	•	•			•	•	•	•			•	•	•	•	
<i>Pardalotus striatus murchisoni</i>						•		•		•	•	•	•		•	•	•	•			•	•	•	•	
<b>MELIPHAGIDAE</b>																									

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)
<i>Acanthagenys rufogularis</i>						•		•	•		•		•		•	•	•	•			•	•	•	•	
<i>Certhionyx variegatus</i>												•			•										•
<i>Lacustroica whitei</i>						•											•						•		
<i>Ptilotula keartlandi</i>						•		•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•
<i>Ptilotula plumula</i>																									•
<i>Ptilotula penicillata</i>									•	•	•	•				•	•	•			•	•	•	•	•
<i>Gavicalis virescens</i>						•		•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•
<i>Lichmera indistincta</i>						•		•	•		•	•	•		•	•	•				•	•	•	•	
<i>Melithreptus gularis</i>						•			•	•	•		•					•				•	•	•	•
<i>Purnella albifrons</i>						•																	•		
<i>Sugomel niger</i>								•				•												•	•
<i>Manorina flavigula</i>						•		•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•
<i>Epthianura tricolor</i>						•		•				•			•			•					•	•	•
<b>POMATOSTOMIDAE</b>																									
<i>Pomatostomus superciliosus</i>						•			•		•							•						•	
<i>Pomatostomus temporalis rubeculus</i>						•		•	•	•	•	•				•	•	•			•	•	•	•	•
<b>CINCLOSOMATIDAE</b>																									
<i>Cinclosoma castaneothorax</i>																									
<i>Psophodes occidentalis</i>																									•
<b>NEOSITTIDAE</b>																									
<i>Daphoenositta chrysoptera</i>																									
<b>CAMPEPHAGIDAE</b>																									
<i>Coracina maxima</i>						•					•				•			•					•	•	•
<i>Coracina novaehollandiae subpallida</i>						•		•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•
<i>Lalage tricolor</i>						•		•	•		•	•	•	•	•	•	•	•					•	•	•
<b>PACHYCEPHALIDAE</b>																									
<i>Pachycephala rufiventris rufiventris</i>						•			•	•	•	•	•	•	•	•	•	•			•	•	•	•	•
<i>Colluricincla harmonica rufiventris</i>						•		•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•
<i>Oreoica gutturalis</i>						•		•	•		•	•	•	•	•	•	•	•			•	•	•	•	•
<b>ARTAMIDAE</b>																									
<i>Artamus cinereus</i>						•		•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•
<i>Artamus cyanopterus</i>																									•
<i>Artamus minor</i>						•		•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•

Species	Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey		
	EPBC	WCA	DFBC	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)	
<i>Artamus personatus</i>						•		•			•				•						•		•	•		
<i>Cracticus nigrogularis</i>						•		•	•	•	•	•	•		•	•	•	•					•	•	•	•
<i>Cracticus tibicen</i>						•			•	•	•	•	•		•	•	•	•					•	•	•	•
<i>Cracticus torquatus</i>						•			•	•	•	•	•		•	•	•	•					•	•	•	•
<b>HIRUNDINIDAE</b>																										
<i>Hirundo rustica</i>	MG	S5					•																			
<b>RHIPIDURIDAE</b>																										
<i>Rhipidura albiscapa</i>						•			•	•	•		•		•			•					•	•	•	•
<i>Rhipidura leucophrys leucophrys</i>						•		•	•	•	•	•	•		•	•	•	•			•		•	•	•	•
<b>MOTACILLIDAE</b>																										
<i>Motacilla cinerea</i>	MG	S5																								
<i>Motacilla flava</i>	MG	S5																								
<b>CORVIDAE</b>																										
<i>Corvus bennetti</i>						•					•					•		•								
<i>Corvus coronoides</i>						•																				
<i>Corvus orru</i>						•		•	•	•		•	•		•	•	•	•					•	•	•	•
<i>Corvus orru ceciliae</i>						•																				•
<b>MONARCHIDAE</b>																										
<i>Grallina cyanoleuca</i>						•			•	•	•	•	•		•	•	•	•			•		•	•	•	•
<b>PETROICIDAE</b>																										
<i>Petroica goodenovii</i>						•					•				•	•		•					•	•	•	•
<i>Melanodryas cucullata</i>						•		•	•	•	•	•	•		•	•	•	•			•		•	•	•	•
<b>ALAUDIDAE</b>																										
<i>Mirafra javanica</i>						•																		•	•	•
<b>ACROCEPHALIDAE</b>																										
<i>Acrocephalus australis</i>						•																		•	•	•
<b>MEGALURIDAE</b>																										
<i>Cincloramphus cruralis</i>																								•	•	•
<i>Cincloramphus mathewsi</i>															•		•						•	•	•	•
<i>Eremiornis carteri</i>						•		•	•	•	•	•	•		•	•	•					•	•	•	•	•
<i>Megalurus gramineus</i>										•																
<b>HIRUNDINIDAE</b>																										
<i>Cheramoeca leucosterna</i>																										

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)		
<i>Hirundo neoxena</i>																											
<i>Petrochelidon ariel</i>									•			•														•	•
<i>Petrochelidon nigricans</i>						•				•	•	•										•			•	•	
<b>NECTARINIIDAE</b>																											
<i>Dicaeum hirundinaceum</i>						•		•	•		•															•	•
<b>ESTRILDIDAE</b>																											
<i>Emblema pictum</i>						•		•	•	•	•	•	•												•	•	•
<i>Neochmia ruficauda</i>						•				•			•												•		
<i>Taeniopygia guttata castanotis</i>						•		•	•	•	•	•	•												•	•	•
<b>MOTACILLIDAE</b>																											
<i>Anthus novaeseelandiae</i>						•																			•	•	
<b>REPTILES</b>																											
<b>CHELUIDAE</b>																											
<i>Chelodina steindachneri</i>																											•
<b>AGAMIDAE</b>																											
<i>Amphibolurus longirostris</i>						•			•	•	•	•	•												•	•	•
<i>Caimanops amphiboluroides</i>											•															•	•
<i>Ctenophorus caudicinctus caudicinctus</i>						•		•	•	•	•	•	•												•	•	•
<i>Ctenophorus isolepis</i>						•			•		•	•	•												•	•	•
<i>Ctenophorus nuchalis</i>						•																					
<i>Ctenophorus reticulatus</i>						•																					•
<i>Diporiphora valens</i>									•				•													•	•
<i>Diporiphora winneckeii</i>									•																		
<i>Pogona minor</i>						•					•		•												•	•	•
<i>Tympanocryptis cephalus</i>																											•
<b>DIPLODACTYLIDAE</b>																											
<i>Crenadactylus ocellatus horni</i>						•		•	•																	•	•
<i>Diplodactylus conspicillatus</i>						•			•																		
<i>Diplodactylus pulcher</i>						•																					•
<i>Diplodactylus savagei</i>						•					•														•	•	•
<i>Lucasium stenodactylum</i>						•			•				•												•	•	•
<i>Lucasium wombeyi</i>						•			•		•														•	•	•
<i>Oedura fimbria</i>																											•

Species	Conservation status					Online Databases		Studies overlapping Study Area			Studies within 10 km of the Study Area													Current Survey		
	EPBC	WCA	DFCA	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)	Marilliana 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)	Marilliana 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)	
<i>Oedura marmorata</i>						•		•	•	•	•		•		•	•	•				•	•	•	•		
<i>Rhynchoedura ornata</i>						•			•			•				•	•					•	•	•	•	
<i>Strophurus ciliaris</i>																										
<i>Strophurus elderi</i>						•			•							•							•		•	
<i>Strophurus jeanae</i>						•																		•		
<i>Strophurus stenodactylum</i>																•										
<i>Strophurus strophurus</i>																										
<i>Strophurus wellingtonae</i>						•			•						•			•					•		•	
<b>CARPHODACTYLIDAE</b>																										
<i>Nephrurus wheeleri</i>						•																	•	•	•	
<i>Underwoodisaurus seorsus</i>																							•		•	
<b>GEKKONIDAE</b>																										
<i>Gehyra montium</i>																										•
<i>Gehyra pilbara</i>						•			•		•												•	•		
<i>Gehyra punctata</i>						•		•	•		•	•	•		•	•		•					•	•	•	•
<i>Gehyra purpurascens</i>						•																			•	
<i>Gehyra variegata</i>						•		•	•		•	•	•		•	•							•	•	•	•
<i>Heteronotia binoei</i>						•			•		•	•	•		•	•	•	•					•	•	•	•
<i>Heteronotia spelea</i>						•			•				•		•		•	•					•	•	•	•
<b>PYGOPODIDAE</b>																										
<i>Delma butleri</i>									•		•														•	
<i>Delma elegans</i>						•																	•			
<i>Delma haroldi</i>						•			•				•													
<i>Delma nasuta</i>						•							•								•	•	•	•	•	
<i>Delma pax</i>						•		•			•	•				•	•	•			•	•	•	•	•	•
<i>Delma tincta</i>						•					•						•					•	•	•	•	
<i>Lialis burtonis</i>						•		•	•			•			•	•		•				•	•	•	•	•
<i>Pygopus nigriceps</i>						•			•																	
<b>SCINCIDAE</b>																										
<i>Carlia munda</i>						•		•	•	•	•	•			•	•	•	•			•	•	•	•	•	•
<i>Carlia triacantha</i>						•																•	•			
<i>Cryptoblepharus buehananii</i>						•																		•		
<i>Cryptoblepharus plagioccephalus</i>						•		•																•		•

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)	Marilliana 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)	Marilliana 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)
<i>Cryptoblepharus ustulatus</i>						•			•													•	•	•	•
<i>Cryptoblepharus sp.</i>								•			•		•		•		•	•						•	
<i>Ctenotus ariadnae</i>																									
<i>Ctenotus duricola</i>						•				•	•	•				•							•	•	•
<i>Ctenotus grandis</i>						•																			
<i>Ctenotus hanloni</i>						•				•						•					•				
<i>Ctenotus helenae</i>						•			•				•		•	•							•	•	•
<i>Ctenotus inornatus</i>																									•
<i>Ctenotus leonhardii</i>											•					•									•
<i>Ctenotus pantherinus ocellifer</i>	Leopard Ctenotus					•			•		•	•	•		•	•	•	•			•	•	•	•	•
<i>Ctenotus piankai</i>											•														
<i>Ctenotus rubicundus</i>						•		•			•		•			•		•			•	•	•	•	•
<i>Ctenotus rutilans</i>	Pilbara Rusty Ctenotus					•			•		•												•		
<i>Ctenotus saxatilis</i>	Rock Ctenotus					•		•	•	•	•		•		•	•	•	•				•	•	•	•
<i>Ctenotus schomburgkii</i>	Barred Wedge-tailed Ctenotus					•					•		•					•					•	•	
<i>Ctenotus serventyi</i>						•						•										•		•	
<i>Ctenotus uber</i>																								•	
<i>Cyclodomorphus branchialis</i>	Gunther's Skink																								
<i>Cyclodomorphus melanops</i>	Slender Blue-tongue					•			•		•	•			•	•	•	•			•	•	•	•	•
<i>Egernia cygnitos</i>	Pygmy Spiny-tailed Skink (western)					•																		•	
<i>Egernia depressa</i>	Pygmy Spiny-tailed Skink					•					•		•										•	•	
<i>Egernia formosa</i>	Crevice Skink					•			•		•				•		•						•	•	•
<i>Egernia pilbarensis</i>	Pilbara Skink							•																	
<i>Eremiascincus fasciolatus</i>	Narrow-banded Sand Swimmer					•					•						•					•	•	•	
<i>Eremiascincus isolepis</i>																									•
<i>Eremiascincus pallidus</i>	Western Narrow-banded Skink																								•
<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer								•													•		•	
<i>Lerista bipes</i>						•																			
<i>Lerista labialis</i>						•																			
<i>Lerista muelleri</i>						•		•	•		•							•				•	•	•	•
<i>Lerista neander</i>						•					•				•										
<i>Lerista timida</i>																									
<i>Lerista zietzi</i>						•		•			•	•	•									•	•	•	•

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)	
<i>Menetia greyii</i>	Dwarf Skink						•		•		•								•					•	•	•	
<i>Menetia surda</i>							•																				•
<i>Morethia ruficauda exquisita</i>	Fire-tailed Skink						•	•			•						•	•	•					•	•	•	•
<i>Notoscincus ornatus</i>																											
<i>Proablepharus reginae</i>							•																				•
<i>Tiliqua multifasciata</i>	Central Blue-tongue						•				•					•	•		•					•	•	•	
<b>VARANIDAE</b>																											
<i>Varanus acanthurus</i>	Spiny-tailed Monitor						•		•		•	•	•				•	•	•					•	•	•	•
<i>Varanus brevicauda</i>	Short-tailed Pygmy Monitor						•											•							•	•	
<i>Varanus bushi</i>	Pilbara Mulga Monitor						•				•				•			•						•	•	•	
<i>Varanus caudolineatus</i>	Stripe-tailed Monitor						•											•								•	
<i>Varanus eremius</i>	Desert Pygmy Monitor						•																				
<i>Varanus giganteus</i>	Perentie						•	•		•	•						•	•	•					•	•	•	•
<i>Varanus gilleni</i>	Pygmy Mulga Monitor						•		•			•															
<i>Varanus gouldii</i>	Bungarra or Sand Monitor						•																			•	•
<i>Varanus hamersleyensis</i>	Southern Pilbara Rock Goanna						•																				
<i>Varanus panoptes</i>	Yellow-spotted Monitor						•	•	•		•	•	•				•							•	•	•	•
<i>Varanus pilbarensis</i>	Pilbara Rock Monitor						•	•	•	•	•							•		•				•	•	•	•
<i>Varanus tristis tristis</i>	Racehorse Monitor						•										•		•	•	•			•	•	•	•
<b>TYPHLOPIDAE</b>																											
<i>Anilius ammodytes</i>																											•
<i>Anilius ganei</i>			P1				•									•									•	•	
<i>Anilius grypus</i>									•																•	•	
<i>Anilius hamatus</i>																		•						•	•	•	
<b>BOIDAE</b>																											
<i>Antaresia perthensis</i>	Pygmy Python						•				•					•	•							•	•	•	•
<i>Antaresia stimsoni</i>	Stimson's Python						•			•								•		•					•	•	•
<i>Aspidites melanocephalus</i>	Black-headed Python						•				•														•	•	
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	VU				•	•				•						•								•	
<b>ELAPIDAE</b>																											
<i>Acanthophis wellsi</i>	Pilbara Death Adder						•										•		•							•	
<i>Brachyuropsis approximans</i>							•		•																•	•	•
<i>Demansia psammophis cupreiceps</i>	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)	Marilliana 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)	Marilliana 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)		
<i>Demansia rufescens</i>						•					•	•					•	•				•	•	•	•		
<i>Furina ornata</i>						•									•	•	•	•					•	•	•	•	
<i>Parasuta monachus</i>						•										•							•		•		
<i>Pseudechis australis</i>						•		•	•		•				•	•								•	•	•	
<i>Pseudonaja mengdeni</i>						•											•							•	•	•	
<i>Pseudonaja modesta</i>						•			•														•	•	•		
<i>Pseudonaja nuchalis</i>						•										•										•	
<i>Suta fasciata</i>						•			•	•													•		•		
<i>Suta punctata</i>						•																					
<i>Vermicella snelli</i>																											
<b>AMPHIBIANS</b>																											
<b>HYLIDAE</b>																											
<i>Cyclorana maini</i>						•				•	•					•	•	•					•		•		
<i>Cyclorana platycephala</i>																											
<i>Litoria rubella</i>						•		•	•		•				•	•	•						•		•	•	
<b>MYOBATRACHIDAE</b>																											
<i>Pseudophryne douglasi</i>						•																	•				
<i>Uperoleia russelli</i>						•										•							•				
<i>Uperoleia saxatilis</i>						•																				•	
<b>LIMNODYNASTIDAE</b>																											
<i>Neobatrachus sutor</i>																									•		

**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]