

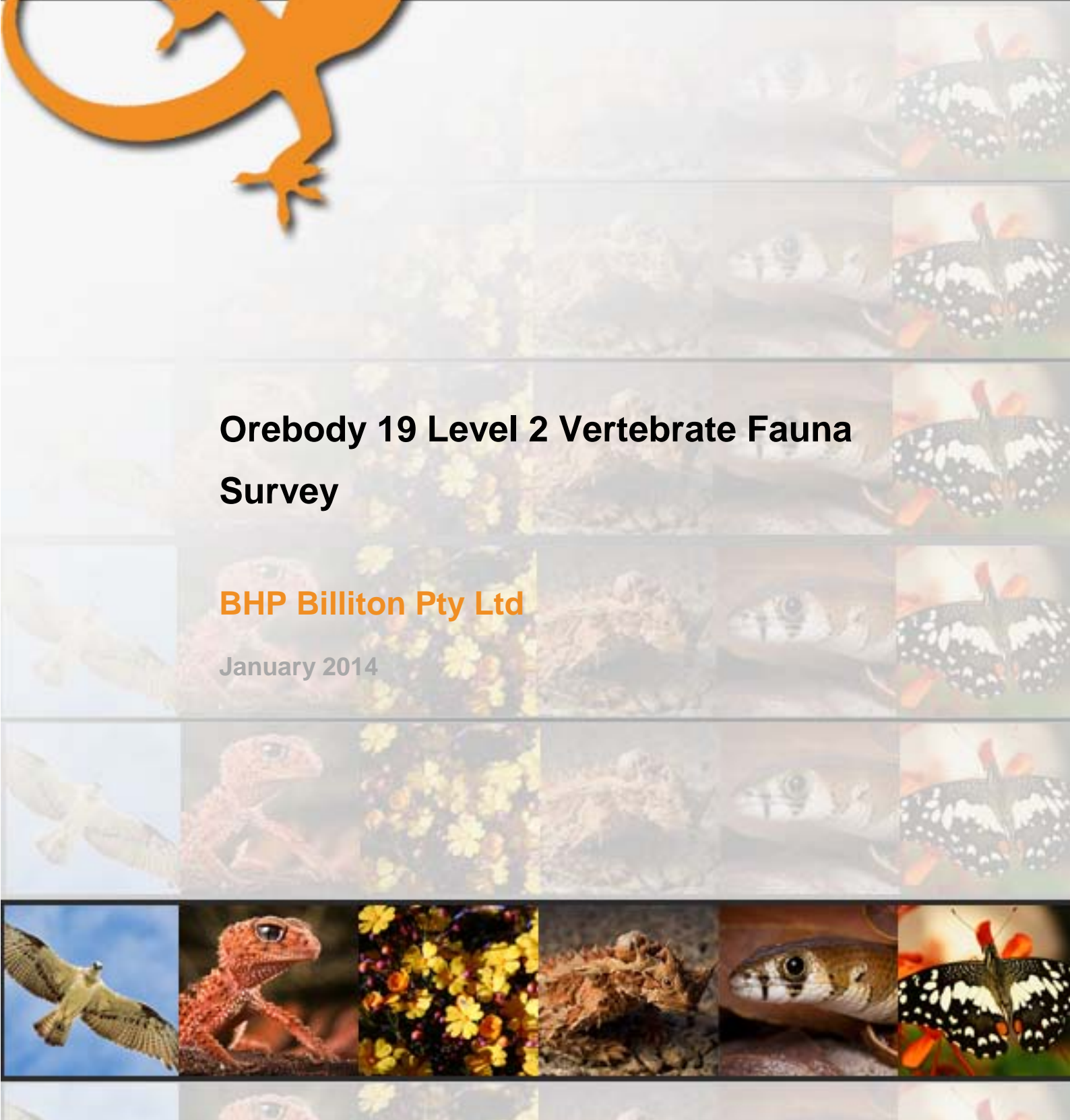


biologic

**Orebody 19 Level 2 Vertebrate Fauna
Survey**

BHP Billiton Pty Ltd

January 2014





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EXECUTIVE SUMMARY

Biologic Environmental Survey (Biologic) was commissioned by BHP Billiton Iron Ore Pty Ltd (BHPBIO) to undertake a two-season Level 2 vertebrate fauna survey of BHPBIO's Orebody (OB) 19 tenement. The tenement (hereafter referred to as the Study Area) is located in the south-eastern Pilbara, directly west and north-west respectively of the existing mining operations at OB 18 and Jimblebar/ Wheelarra Hill.

The purpose of the survey was to:

1. Undertake a comprehensive fauna database review for the Study Area for Threatened, Specially Protected and Priority Fauna.
2. Undertake a comprehensive literature review of previous fauna surveys and records within and close to the Study Area.
3. Undertake a fauna habitat assessment of the Study Area, including mapping of fauna habitats present and identification of any habitats suitable to support conservation significant species.
4. Undertake a two-season Level 2 (as per EPA Guidance Statement 56) vertebrate fauna survey, targeted surveys for conservation significant species and provide a map showing the locations of species recorded during the survey, and previous records of conservation significant fauna determined via the literature and database reviews.

Field surveys were conducted from 24 May-6 June 2013 (season 1) and 27 August-6 September 2013 (season 2) with additional night sampling on the 3 and 5 December 2013. Weather during the surveys was generally consistent with the long-term average values for the respective months.

A total of 264 vertebrate fauna species may occur in the Study Area, of which 170 have been recorded within the Study Area or in the immediate vicinity to date. 136 native fauna species were recorded during the current study.

Six conservation significant species have been recorded within the Study Area to date. All species were recorded during the current survey, with some also previously recorded from the Study Area:

- Brush-tailed Mulgara *Dasyercus blythi* - Listed as Priority 4 by the Department of Parks and Wildlife (DPaW). Status under review by Department of Environment (DoE) (DSEWPaC 2012);
- Ghost Bat *Macroderma gigas* - DPaW Priority 4;



- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;
- Rainbow Bee-eater *Merops ornatus* – Listed as Migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and on Schedule 3 of the *Wildlife Conservation Act 1950* (WC Act);
- Pilbara Olive Python *Liasis olivaceus barroni* – EPBC Act Vulnerable, WC Act Schedule 1; and
- Pilbara Flat-headed Blind Snake *Ramphotyphlops ganei* – DPaW Priority 1.

According to online databases and previous surveys in the vicinity, an additional 12 conservation significant species have been recorded from adjoining areas. Of these, only the Australian Bustard (likely), Bush Stone-curlew (likely), Fork-tailed Swift (likely), Oriental Plover (possible), and Star Finch (possible) may potentially occur within the Study Area due to availability of suitable habitats.

Five broad fauna habitats were identified within the Study Area:

- Sand Plain;
- Stony Plain;
- Minor Drainage Line;
- Crest/ Slope; and
- Gorge/ Gully.

The habitats of greatest significance are the Sand Plain and the Gorge/ Gully habitat. Both of these provide potential habitat for one or more conservation significant fauna, including but not limited to, the Brush-tailed Mulgara and Pilbara Olive Python.



1 INTRODUCTION

Biologic Environmental Survey (Biologic) was commissioned by BHP Billiton Iron Ore Pty Ltd (BHPBIO) to undertake a Level 2 vertebrate fauna survey (as per the EPA's Guidance Statement 56) covering Orebody 19 (OB 19), hereafter referred to as the 'Study Area' (Figure 1.1). The Study Area is located approximately 3 km north east of Newman in the Pilbara region of Western Australia. BHPBIO's Orebody 18 is directly east of the Study Area and Jimblebar/Wheelarra Hill mining operations are located to the south-east.

The results from this survey will be used to inform future environmental approvals across the area, although it does not assess any specific development proposed by BHPBIO.

This report provides:

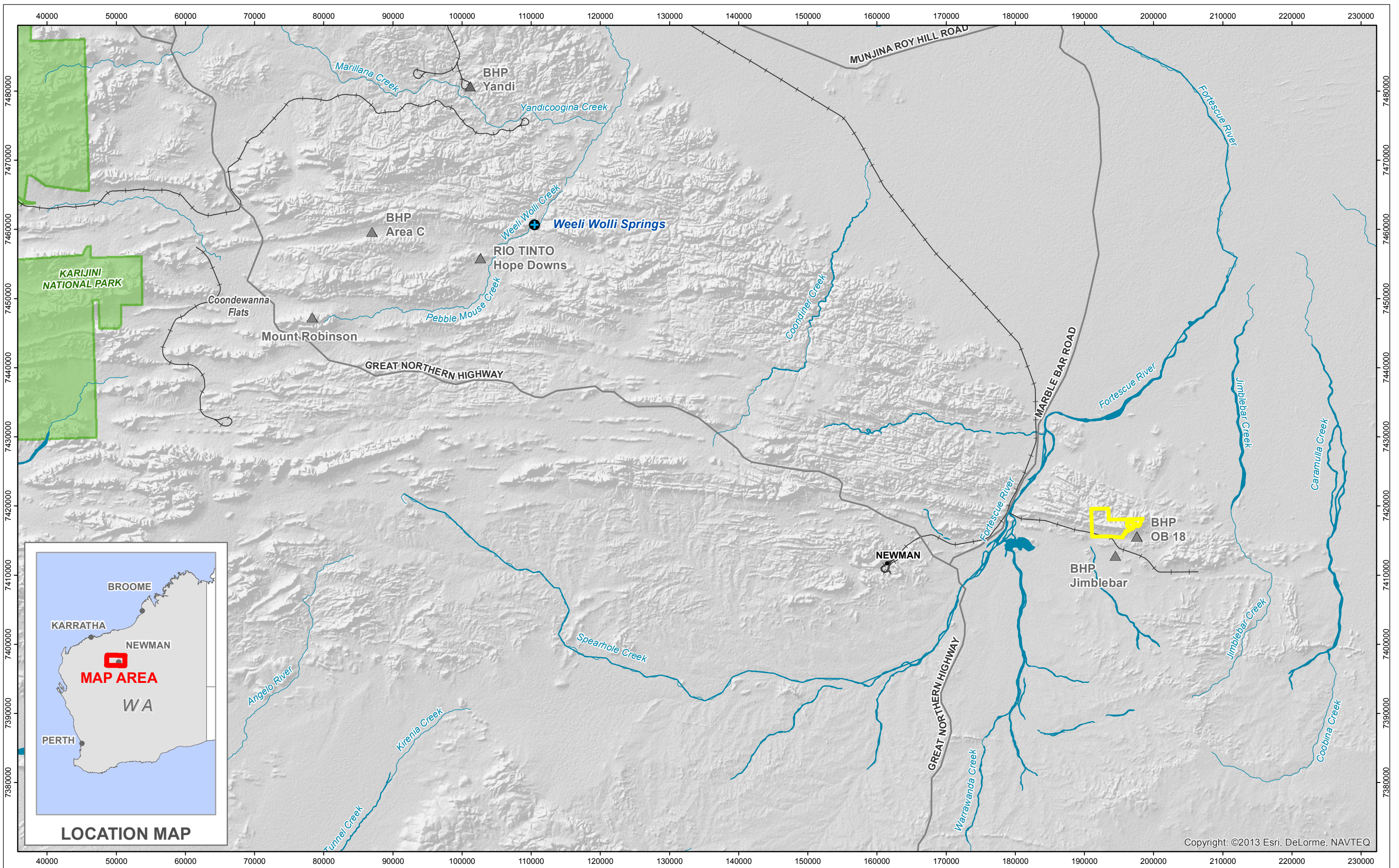
1. A comprehensive fauna database review for the Study Area considering:
 - Threatened fauna listed under the International Union for the Conservation of Nature's (IUCN) Red List;
 - Threatened fauna or migratory species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC);
 - Declared Threatened Fauna and Other Specially Protected Fauna listed under the West Australian *Wildlife Conservation (Specially Protected Fauna) Notice 2012(2)*; and
 - Priority Fauna recognised by the Department of Parks and Wildlife (DPaW).

The databases reviewed were:

- Commonwealth Department of the Environment (DoE) Protected Matters database;
 - DPaW's Threatened Fauna database; and
 - DPaW and WA Museum's (WAM) NatureMap.
2. A review of all previous vertebrate fauna surveys undertaken within the Study Area or immediate surrounds.
 3. A fauna habitat assessment describing and mapping fauna habitat within the Study Area. Additionally, significant fauna habitats or features (e.g. caves, waterholes) are mapped.
 4. An assessment of the likelihood of habitat within the Study Area to support conservation significant species listed in point 1 above.



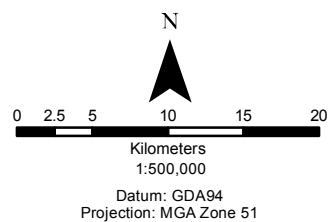
5. A list of all fauna species recorded, via primary or secondary evidence, within the Study Area, including those recorded during previous surveys; and
6. The results of a two-season Level 2 (as per the Environment Protection Authority's Guidance Statement 56 [EPA 2004]) survey and a targeted survey for species of conservation significance (as listed in point 1, above).



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**BHPBIO
OB19**

**Regional location
Figure 1.1**

Legend

- Study Area
- Nature Conservation Reserve
- Watercourses
- Roads
- Railways

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2 ENVIRONMENT

2.1 Biogeography

The Study Area falls within the Hamersley sub-region (PIL-3) of the Pilbara bioregion as defined by the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Creswell 1995). The Study Area lies at the eastern extremity of the Hamersley sub-region, ~2 km south of the Fortescue sub-region (PIL-2) and ~2 km north of the Augustus sub-region (GAS-3) of the Gascoyne bioregion.

The Hamersley sub-region forms the southern section of the Pilbara Craton. It is a mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite) (Kendrick 2001).

2.2 Climate

The Pilbara region has a semi-desert to tropical climate. Rainfall events within the region are often sporadic and can occur within both summer and winter months, but mostly during the summer. 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 200-350 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).

Temperatures vary significantly throughout the year with average maximum summer temperatures reaching 35-40 °C and winter temperatures generally fluctuating between 22 °C and 30 °C.

The climate of the Study Area is semi-arid, hot and mostly dry, with an average annual rainfall of 317.8 mm at Newman Aero (located approximately ~9 km south-east of the Study Area; Figure 2.1). Most rainfall generally occurs in the summer rain season from December to June with occasional major deluge events from cyclones. Scattered thunderstorms provide the majority of non-cyclonic rain and an average of 15 to 20 thunderstorms occur each year, mostly during summer. Infrequent and unreliable winter rain also occurs. Daily temperatures are often greater than 40 °C for extended periods during summer.

Massive rainfall is associated with the summer cyclone season. These large rainfall events can result in flash flooding and extensive overland flooding. Watercourses are generally dry for most



of the year and only flow after significant rainfall events. Creek flows subside rapidly, often within a few days to a week. River systems can flow for several weeks to a month before drying up; however, water can be retained in waterholes along the watercourses and in rock pools in gorges for many months into the dry season.

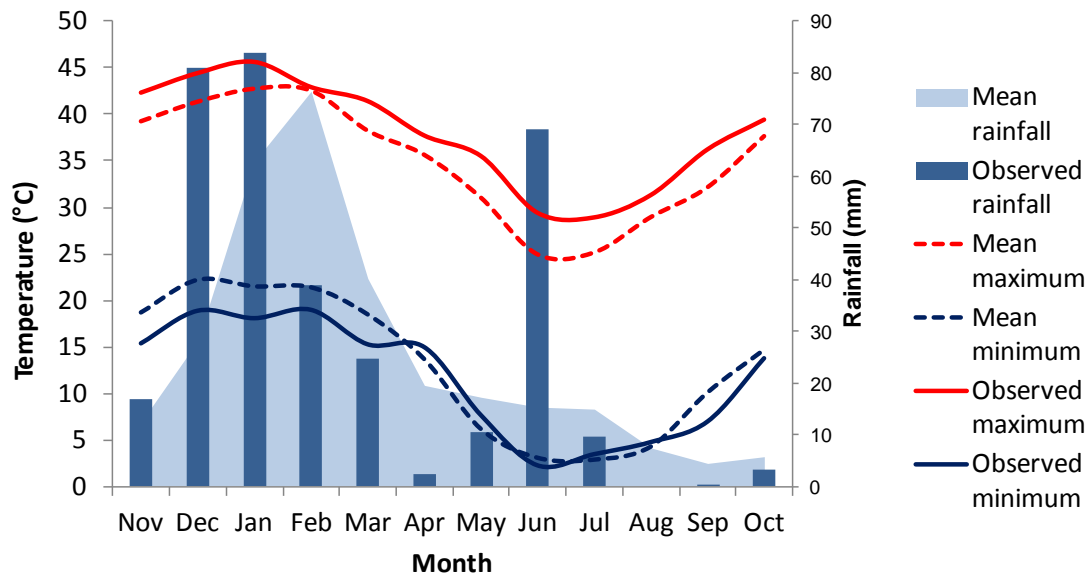


Figure 2.1 Average monthly temperature and rainfall observations at Newman Aero from November 2012 to October 2013, compared with longer-term climatic averages (Bureau of Meteorology 2013).

2.3 Physical environment

The Study Area is located close to the south-eastern boundary of the Ophthalmia Ranges, which form part of the Hamersley Ranges to the north and west. The Newman region, characterised by Banded Iron Formations (BIFs) and Late Archaean greenstones, occurs to the west, giving way to the Early Archaean granitoids and metagabbro intrusions of the Augustus region to the south.

The Study Area itself is mostly flat in the southern section, covered in Cainozoic colluvial and alluvial plains. It is crossed by a horizontal ridgeline along the middle and contains a series of north-south heading gullies and gorges. The colluvial deposits consist of weathered rock fragments in a matrix of gravel, sand and clay. Older colluvium is commonly cemented by iron oxides and to a lesser extent calcium carbonate; younger deposits are loose and unconsolidated. Alluvial deposits include a mixture of gravel, sand, silt and clay, with cobbles along active watercourses (Thorne and Tyler 1997). The top two thirds of the Study Area consists of the Newman landsystem and the remainder consists of the Boolgeeda landsystem.



2.4 Vegetation

Limited specific information regarding the vegetation and flora of the Study Area is currently available. Vegetation mapping of the Pilbara region was completed on a broad scale (1:1,000,000) by Beard (1975). 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 ranges are described as a tree steppe of the *Eucalyptus-Triodia* association with a change to *Eucalyptus* mallee at the summits. The valley plains mainly carry Mulga low woodlands to shrubland (*Acacia aneura*) with some areas of open *Triodia* grassland. Shepherd *et al.* (2002) re-assessed the mapping of Beard (1975), updated the vegetation boundaries to account for clearing in the intensive land use zone, and divided some larger vegetation units into small units. Vegetation type 82, described by Shepherd *et al.* (2002) corresponds with 'ranges and valley plains' of Beard (1975) as described above.

2.5 Surface Hydrology

The Study Area is located in the upper portion of the Fortescue River catchment, which drains to the Fortescue Marsh (RPS Aquaterra 2012). Jimblebar Creek, which drains north, is the major drainage line to the east of the Study Area, while Shovelanna Creek (running west) drains the south and western parts. Due to climatic conditions, these creeks are ephemeral with typically one to three flow events per year (RPS Aquaterra 2012). The broad central valley running central/ west to east throughout the Study Area forms a palaeodrainage channel which is filled with clay soils and shows evidence of periodic flooding/ sheet flows.

The average annual rainfall at Newman is approximately 310 mm, but rainfall occurs mainly as tropical summer storms, and annual totals vary widely. Drainage lines flow only after prolonged heavy rain, as short-duration flooding with rapid peaks and slightly less rapid decline. Along major watercourses, including the Fortescue River, water tends to pond and may persist as pools for several weeks to months.

2.6 Existing land use

The dominant land uses in the region including pastoralism and mining, but also include conservation, urban areas recreation and tourism (Kendrick 2001). Several iron ore mines and their associated infrastructure are currently active in the area in close proximity to the Study Area, including Jimblebar, Wheelarra, and Hashimoto, and more are expected to come online in the next few years. The Study Area is covered by the mineral lease AML7000244. It is also part of the Sylvania pastoral station, and evidence of cattle grazing is present.



3 METHODS

3.1 Compliance

This literature and database review and field survey was carried out in a manner consistent with the EPA, DPaW and BHPBIOs' requirements for the environmental surveying and reporting of fauna, including the following documents:

- EPA Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002, or its revision);
- EPA Guidance No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004, or its revision);
- Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (WA Department of Environment and Conservation [DEC]/EPA, 2010);
- Department of the Environment, Water, Heritage and the Arts (2010) Survey Guidelines for Australia's Threatened Bats;
- Department of the Environment, Water, Heritage and the Arts (2010) Survey Guidelines for Australia's Threatened Birds;
- Department of the Environment, Water, Heritage and the Arts (2010) Survey Guidelines for Australia's Threatened Mammals;
- Department of the Environment, Water, Heritage and the Arts (2010) Survey Guidelines for Australia's Threatened Reptiles;
- Department of the Environment, Water, Heritage and the Arts (2010) Survey Guidelines for Australia's Threatened Frogs;
- BHPBIO (2011) Guidance for Vertebrate Fauna Surveys in the Pilbara (SPR-IEN-EMS-012);
- BHPBIO (2010) Terrestrial Fauna Habitat Assessment Proforma (FRM-IEN-EMS-003);
- BHPBIO (2011) Biological Survey Spatial Data and Digital Photography Requirements (SPR-IEN-EMS-015); and
- BHPB Western Australia Projects Biological Survey Data Templates (FRM-IEN-EMS-002).

3.2 Literature and database review

A review of all publicly available literature relevant to the Study Area, and additional reports commissioned and held by BHPBIO, was undertaken in September 2013. The reports reviewed are listed in Table 3.1.

**Table 3.1** Reports used for the review.

Survey Title	Consultant	Year	Survey Type
Jimblebar Mine Site Biological Survey (BHP Iron Ore Pty Ltd 1994)	BHP Iron Ore	1994	1 season with trapping
Orebody 18 Biological Assessment Survey (ecologia Environmental 1995)	ecologia	1995	1 season with trapping
Jimblebar Wheelarra Hill 3 Flora and Fauna Assessment (Biota 2004)	Biota	2004	1 season no trapping
Jimblebar-Wheelarra Hill Expansion Biological Survey (ecologia Environmental 2004)	ecologia	2004	1 season with trapping
Jimblebar East Exploration Project Biological Survey (ecologia Environmental 2005)	ecologia	2005	1 season no trapping
Jimblebar Hashimoto Vertebrate Fauna Assessment (ecologia Environmental 2006a)	ecologia	2006	2 season with trapping
Jimblebar Marra Mamba Exploration Biological Survey (ecologia Environmental 2006b)	ecologia	2006	1 season no trapping
Orebody 18 Fauna Assessment Phase II (ENV Australia 2007a)	ENV Australia	2007	1 season with trapping
West Jimblebar Fauna Assessment (ENV Australia 2007b)	ENV Australia	2007	1 season with trapping
Jimblebar Wheelarra Hill Flora and Fauna Assessment (Outback Ecology Services 2009c)	Outback Ecology	2009	2 season with trapping
Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment (Outback Ecology Services 2009a)	Outback Ecology	2009	2 season with trapping
Orebody 31 Fauna Assessment (ENV Australia 2011)	ENV Australia	2011	1 season no trapping
Wheelarra Hill North Fauna Assessment (ENV Australia 2012)	ENV Australia	2012	2 seasons with trapping

Three databases were searched to obtain information on species previously recorded during field surveys or species of conservation significance likely to occur within the Study Area (Table 3.2):

- DPaW's NatureMap database – to determine threatened fauna recorded from the region which also incorporates the results of the Pilbara Biological Survey (DEC 2011).
- DPaW's Threatened Fauna Database - to determine the most up to date threatened fauna recorded from the region.



- DoE Protected Matters Database – to determine matters of national environmental significance likely to occur within the area based on bioclimatic modelling.

Table 3.2 Databases used for the review.

Provider	Database	Parameters
Department of Parks and Wildlife & WA Museum	NatureMap. Accessed 25 September 2013	Circle of radius 5 km centred on the point - 120° 00' 42" E, 23° 19' 23" S
Department of the Environment	Protected Matters Database Search Tool. Accessed 25 September 2013	Circle of radius 5 km centred on the point - 120° 00' 42" E, 23° 19' 23" S
Department of Parks and Wildlife	Threatened Fauna Database search	Circle of radius 30 km centred on the point - 119° 56' 17 " E, 23° 18' 24" S

3.3 Field assessment

A two season field assessment was undertaken by Biologic from 24 May-6 June 2013 (season 1) and 27 August-6 September 2013 (season 2). Additional nocturnal surveys were conducted on the 3 and 5 December 2013. The purpose of the surveys 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 a two season Level 2 (baseline) trapping survey and targeted surveys for fauna of conservation significance. The vertebrate fauna sampling for this survey was conducted under the "Licence to Take Fauna for Scientific Purposes" No. SF00918 issued to M. O'Connell.

3.3.1 Survey team

Mr Morgan O'Connell	Principal Zoologist
Mr Jeff Turpin	Principal Zoologist
Mr Thomas Rasmussen	Senior Zoologist
Mr Brad Maryan	Senior Zoologist
Mr Ray Lloyd	Senior Zoologist
Dr Ruchira Somaweera	Senior Zoologist

Mr Bob Bullen of Bat Call WA, analysed the recordings from the Songmeter SM2BAT and Echometer detector systems used during the survey.

3.3.2 Climatic conditions

Data recorded at the Newman Aero weather stations during the survey periods are presented in Figure 3.1 and long-term meteorological data at Newman Aero are presented in Figure 2.1. Weather during the surveys was generally consistent with the long-term average values for the



respective months. An isolated shower due to cyclonic activity was present during the last day (6 November 2013) of the survey.

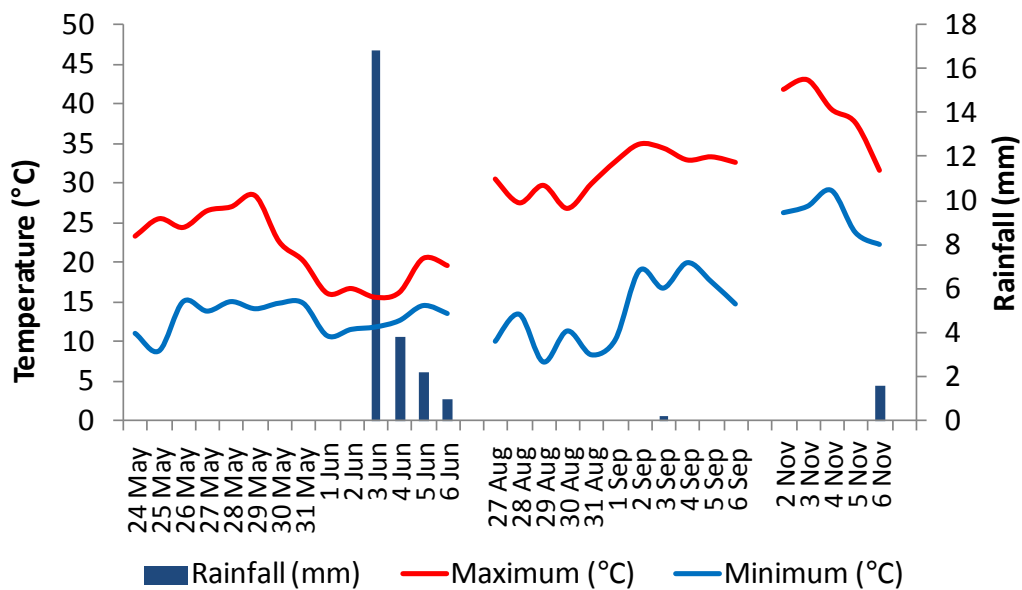


Figure 3.1 Daily temperatures and rainfall at Newman Aero during the current study.

3.3.3 Bat surveys

Forty eight overnight recordings of bat echolocation calls were made using four SM2BAT+ detectors (Wildlife Acoustics, USA); 32 nights during season 1 and 16 during season 2. Recorders were placed in habitats deemed more likely to be used by foraging bats, such as water pools and woodlands (Department of Environment 2010). Twenty-four locations were surveyed during the two surveys (Figure 3.2- Bat Recordings; Appendix A). 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.

3.3.4 Motion sensitive cameras

Motion sensitive video cameras were used to survey larger mammals, including introduced predators. Ten cameras were utilised, set at 26 locations, such as beside a water pool and outside burrows (Figure 3.2- Remote Cameras; Appendix A). A total of 1248 hrs of motion camera survey footage was collected from the Study Area. The resulting footage was analysed visually.



3.3.5 Trapping

Traps for live fauna were installed at six sites during Season 1 and reopened in Season 2 (Figure 3.2- Trapping; Appendix A). Site locations were chosen to represent all fauna habitats present in the Survey Area, based on aerial photography, prior knowledge of the area and proximity to access tracks.

At each site, traps were arranged as a linear transect of discrete trap units through the habitat being targeted. Each site consisted of 10 trap units. Each trap unit consisted of a pitfall trap (either a 20 L bucket or a 50 cm length of stormwater PVC pipe with a diameter of 160 mm) dug in to the ground, and bisected by a 6 m long, 30 cm high fence impermeable to ground-dwelling fauna. At both ends of the fence, funnel traps were placed. Twenty Elliott traps (9 x 9 x 32 cm) were placed in a line adjacent to the line of trap units. One cage trap (20 x 20 x 40 cm) was set at each end of the trap transect. The Elliott and cage traps were baited daily with universal bait (a mixture of rolled oats, sardines and peanut butter). Each trap site therefore consisted of 52 traps (five bucket, five pipe, 20 funnel, 20 Elliott and two cage traps). Shade covers were used over funnel and Elliot traps which reduce the likelihood of exposure related trap death, and all traps were cleared by no later than three hours after sunrise.

Traps were left open for seven nights during each Season at each site (a total of 4368 trap nights during the survey). Details of the six trapping sites installed are provided in Appendix A and their locations are shown in Figure 3.2.

3.3.6 Targeted fauna survey

Targeted transects

Targeted transect locations were selected to represent all the major habitat types present within the Study Area (Figure 3.2: Targeted Transects). During the targeted transects the team recorded all vertebrate fauna species encountered, either from primary (*i.e.* direct observation) or secondary (e.g. burrows, scratchings, diggings and scats) evidence of significant species. Habitats were actively searched for secondary evidence. When diggings, burrows or scats were observed, a general search of the area determined the extent of burrows.

Nocturnal survey

Two night surveys, each with 4 observers, were conducted between 18:00 and 22:00 in December 2013. Surveys utilised two vehicles and traversed roads within the Study Area at low speed with spotlights searching for fauna. Searches were also undertaken on foot along Gorge/Gully habitats and among Sand Plain habitats (Figure 3.2: Nocturnal Surveys). Nocturnal



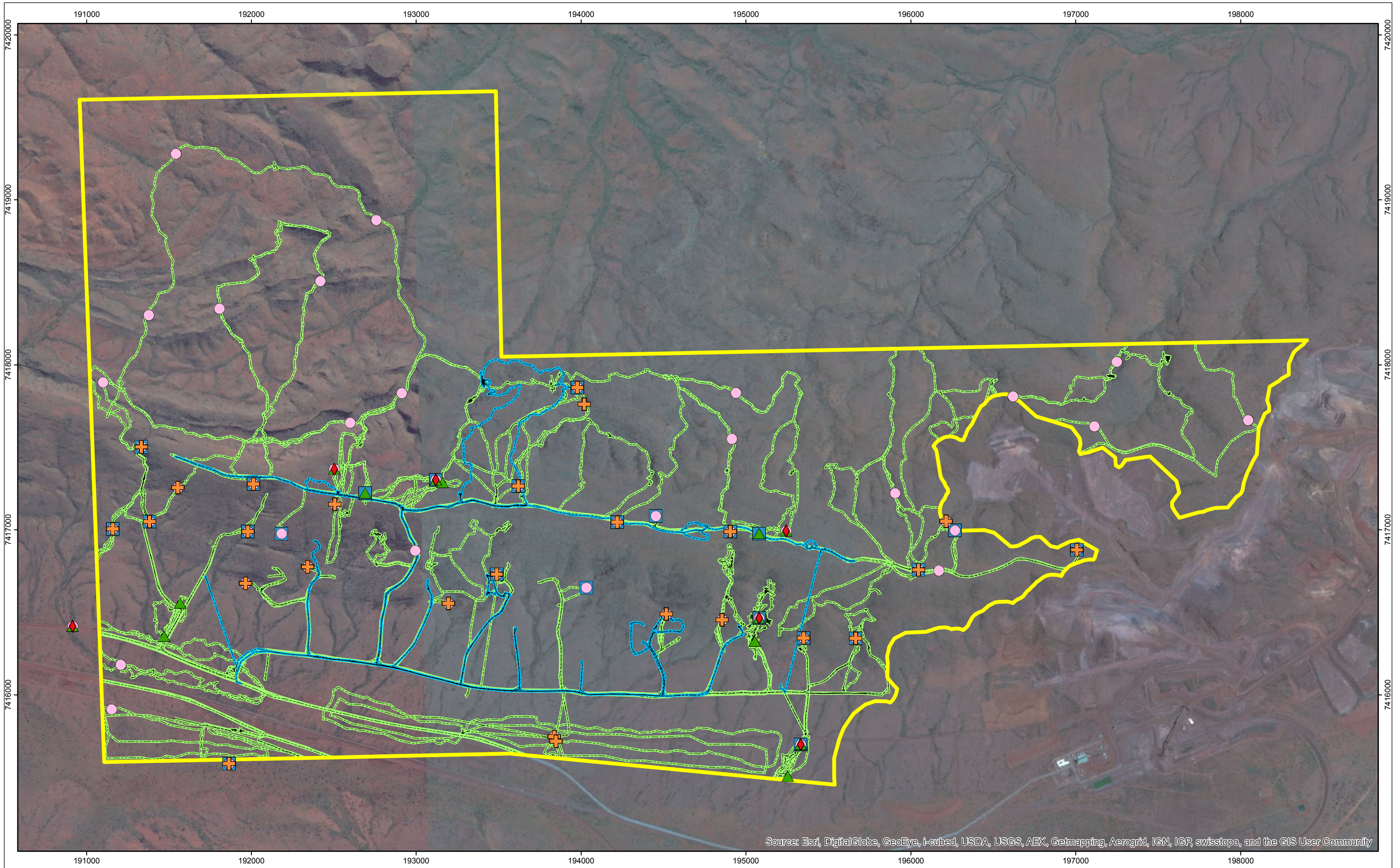
searches targeted crepuscular or highly nocturnal fauna such as night birds, mammals, amphibians and reptiles such as snakes and geckos that may be largely hidden during the day.

Bird surveys

Four bird surveys, each lasting 20 min, were conducted at each of the six trapping sites. All bird surveys were completed by 10.00 a.m to ensure coverage of the period of greatest bird activity (Figure 3.2: Birding; Appendix A). Additional 20 min surveys were conducted at eight other locations. Surveys were conducted by walking through the habitat and recording all birds visually with binoculars and by calls.

3.3.7 Incidental records

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 indirect evidence such as tracks, scats and any other traces, as well as incidental sightings of live animals. Efforts were made to target likely microhabitats, by turning rocks, logs and anthropogenic debris such as discarded tyres, plywood sheets etc.



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
0 250 500 750 1,000

Meters
1:20,997
Datum: GDA94
Projection: MGA Zone 51

**BHPBio
OB 19
SAMPLING EFFORT DURING
THE CURRENT SURVEY**

FIGURE 3.2

Legend

 Bat call recorders	 Habitat Assessment	 Day
 Birding	 Remote cameras	 Night
	 Trapping site	
	 Study Area	

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3.3.8 Habitat assessment

Fifty three fauna habitat assessments were conducted, 45 of them during Season 1 (Figure 3.2- Habitat Assessment; Appendix D). Habitats in the Study Area were assessed using methodology and terminology adapted from the *Australian Soil and Land Survey Field Handbook* (Commonwealth Scientific and Industrial Research Organisation 2009) and modified to suit the survey requirements according to BHPBIO 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: disturbance, condition, leaf litter %, twig litter %, wood litter, dead stags and hollow bearing trees, broad floristic formation, tree structure (tall, mid and low), shrub structure (tall, mid and low), grass structure (tall, mid and low), dominant trees, shrubs, mistletoes, grasses and herbs;
- land surface: microrelief, 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; and
- substrate: bare ground, rock size, rock type, rock outcropping.

Fauna habitats were also assessed for the likelihood that they may support conservation significant fauna. All major fauna habitats present within the Study Area were sampled and scored for significance (High, Medium or Low) according to the criteria shown Table 3.3 below. Conservation significant habitats are discussed in Section 6.

3.3.9 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 1,000 repetitions; and
- Upper abundance limit for rare taxa set to 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, Jackknife 1 and Bootstrap), and this was then used to assess what proportion of the predicted total number of species was detected during the survey.

The resulting $S(\text{est})$ 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 Assessment of fauna habitat significance

Fauna habitats were also assessed for the likelihood that they may support conservation significant fauna. All major fauna habitats present within the Study Area were sampled and scored for significance (High, Medium or Low) according to the criteria shown Table 3.3 below. Conservation significant habitats are discussed in Section 6.



Table 3.3 Fauna habitat significance assessment criteria.

Score	Criteria
High	Habitat supports EPBC listed threatened fauna. <i>OR</i> Habitat for species listed as above is present in the Study Area, and there are records of that species within 50 km of the Study Area. If limited surveys have been undertaken in the vicinity of the Study Area then a precautionary approach will be used and the species will be considered likely to be present. <i>OR</i> Uncommon habitat is critical habitat for a population of DPaW listed Priority fauna. For example, if habitat is limited in the region and the habitat in the Study Area forms a significant portion of the known habitat for a Priority species, it would be scored as High significance. <i>OR</i> Habitat that only occurs in small isolated geographic areas.
Medium	Habitat supports DPaW listed Priority fauna that are largely restricted to that habitat type within the Study Area. <i>OR</i> Habitat supports EPBC listed Migratory fauna. <i>OR</i> Habitat supports a particularly diverse and uncommon faunal assemblage. Habitat that occurs throughout region, and does not occur in small or isolated areas, is excluded.
Low	Habitat is widespread, common, and does not solely support any significant fauna.

3.4.1 Potential limitations and constraints

EPA Guidance Statement No. 56 (EPA, 2004) 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 each had five or more years of fauna survey experience.
Scope	The scope was a two season Level 2 survey and was conducted within that framework. A separate survey included nocturnal work. The survey scope was suitable for a Level 2 survey.
Proportion of fauna identified	All 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 were identified to species level.



Potential limitation or constraint	Applicability to this survey
Sources of information (recent or historic) and availability of contextual information	Although no other recent survey covered the complete area surveyed under the current study, a number of studies have been previously undertaken in the immediate vicinity, some partially overlapping the Study Area along the borders. DPaW has also completed 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, and related to the results of surveys in the broader area.
Disturbances (e.g. fire or flood)	Heavy rain prevented the sampling between 12:00-18:00 on 6 December, but did not affect the intended night work during the trip. No other disturbances affected the outcomes of the survey.
Intensity of survey	A two-season Level 2 survey was identified by BHPBIO as the requirement for this survey. The survey undertaken fully met the requirements for a Level 2 survey.
Completeness of survey	The two-season Level 2 survey is complete.
Resources (e.g. degree of expertise available)	All resources required to complete the survey were available.
Remoteness or access issues	All sections in the tenement were accessible either by vehicle or on foot; all habitats within the Study Area were surveyed and all habitats considered to be suitable for conservation significant species were surveyed.

3.5 Taxonomy and nomenclature

The latest checklist of mammals, reptiles and amphibians published by the WA Museum (Western Australian Museum 2013) were used as a guide to the current taxonomy and nomenclature of these groups. This updated list in turn is formulated using up-to-date taxonomical literature. For birds, the current checklist of Australian birds, maintained by Birds Australia, was used. The bird list is based on the most recent review of the systematics and taxonomy of Australian birds by (Christidis and Boles 2008).

3.6 Assessment of conservation significance

Within Western Australia, all native fauna is protected under the *Wildlife Conservation Act 1950* (WCA) 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 *State Environmental Protection Act 1986* and the *Federal Environment Protection and Biodiversity Conservation Act 1999* (EPBC).

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 Status Codes is provided in Appendix B.

A number of migratory bird and marine species are prioritised for conservation under the EPBC or international agreements. In addition the International Union for the Conservation of Nature (IUCN) compiles a 'Red List' upon which species at risk of extinction are listed.

For some species there is insufficient information to determine their status. These species are generally considered by the EPA/DPaW as of 'conservation significance' for all development related approvals and are listed on a 'Priority List' which is regularly reviewed and maintained by the DPaW.

DPaW also identifies 'Threatened Ecological Communities' (TECs) that are naturally occurring biological assemblages found to fit into one of the four categories (Table 3.5). Possible threatened ecological communities that do not meet these survey criteria are added to DPaW's 'Priority Ecological Communities' (PECs) lists under Priorities 1, 2 and 3.



Table 3.5 Conservation significance assessment guidelines.

Level	Agreement, Act or List	Status Codes
<p>International</p>	<p>The IUCN Red List lists species at risk under nine categories (listed under ‘Status Codes’).</p> <p>Migratory taxa listed under the following international conventions are generally listed as Migratory or Marine under the federal <i>Environment Protection and Biodiversity Conservation Act 1999</i> (see below):</p> <ul style="list-style-type: none"> • Japan-Australia Migratory Bird Agreement (JAMBA); • China-Australia Migratory Bird Agreement (CAMBA); • Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and, • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). 	<p>IUCN Extinct IUCN Extinct in the Wild IUCN Critically Endangered IUCN Endangered IUCN Vulnerable IUCN Near Threatened IUCN Least Concern IUCN Data Deficient IUCN Not Evaluated</p> <p>Generally listed as Migratory or Marine under the federal <i>Environment Protection and Biodiversity Conservation Act 1999</i></p>
<p>Federal</p>	<p><i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC)</i> DSEWPaC 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>	<p>Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Conservation Dependent Migratory Marine</p> <p>Critically Endangered Endangered Vulnerable</p>
<p>State</p>	<p><i>Wildlife Conservation Act 1950 (WCA)</i> At a state level, native fauna are protected under the <i>Wildlife Conservation Act 1950</i>. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.</p>	<p>Schedule 1 Schedule 2 Schedule 3 Schedule 4</p>



Level	Agreement, Act or List	Status Codes
State	DPaW Priority list (DPaW) The DPaW produces a list of Priority species and ecological communities (e.g. Priority Ecological Communities (PECs) or Threatened Ecological Communities (TECs)) that have not been assigned statutory protection under the <i>Wildlife Conservation Act 1950</i> . This system gives a ranking from Priority 1 to Priority 5.	Priority 1 Priority 2 Priority 3 Priority 4 Priority 5



4 RESULTS

4.1 Desktop review

4.1.1 Previous surveys

A total of 13 fauna surveys have been completed within and in the vicinity of the Study Area since 1994 (Table 4.1; Figure 4.1). These comprise one desktop review (database search and review of previous relevant surveys), three Level 1 surveys (desktop review as well as a reconnaissance field survey), five single-season Level 2 surveys (desktop review with a more robust field sampling programme including trapping over a single season) and four two-season Level 2 surveys (desktop review with a robust field sampling programme including trapping over two seasons). Four of the studies at OB 18 partially overlapped with the current Study Area or were in the immediate vicinity (<10 km) of the Study Area.



Table 4.1 Survey effort for surveys in the vicinity of OB 19

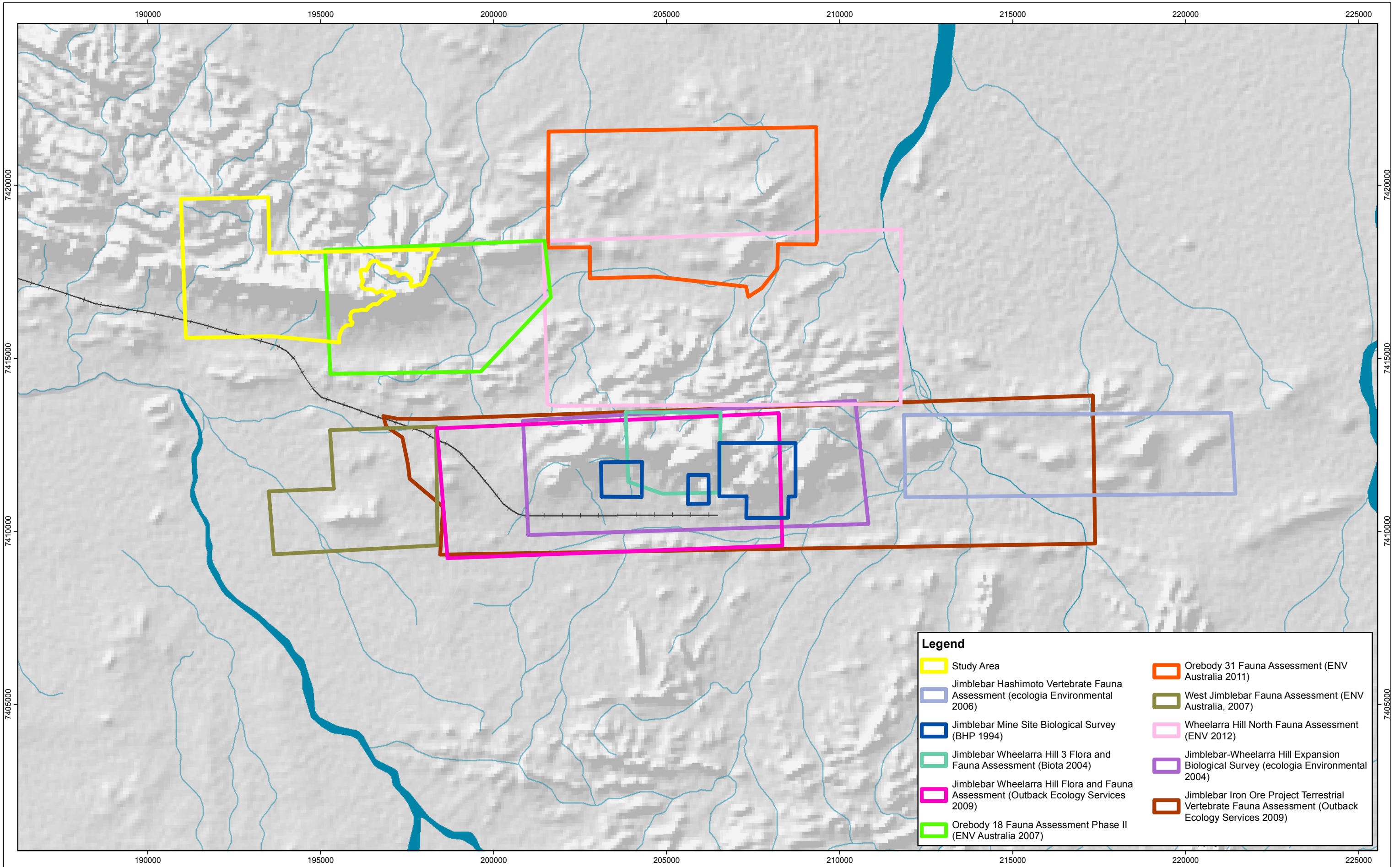
Survey	Jimlebar Biological Survey	Orebody 18 Biological Assessment Survey	Jimlebar Wheelarra Hill 3 Flora and Fauna Assessment	Jimlebar-Wheelarra Hill Expansion Biological Survey	Jimlebar East Exploration Project Biological Survey	Jimlebar Hashimoto Vertebrate Fauna Assessment	Jimlebar Marra Mamba Exploration Biological Survey	Orebody 18 Fauna Assessment Phase II	Jimlebar West Fauna Assessment	Jimlebar Wheelarra Hill Flora and Fauna Assessment	Jimlebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment	Orebody 31 Fauna Assessment	Wheelarra Hill North Fauna Assessment	Current survey
Consultant	BHP Iron Ore	ecologia	Biota	ecologia	ecologia	ecologia	ecologia	ENV Australia	ENV Australia	Outback Ecology	Outback Ecology	ENV Australia	ENV Australia	Biologic
Year	1994	1995	2004	2004	2005	2006	2006	2007	2007	2009	2009	2011	2012	2013
Type	1 season with trapping Level 2	1 season with trapping Level 2	Desktop review	1 season with trapping Level 2	1 season No trapping Level 1	2 season with trapping Level 2	1 season No trapping Level 1	1 season with trapping Level 2	1 season with trapping Level 2	2 season with trapping Level 2	2 season with trapping Level 2	1 season No trapping Level 1	2 season with trapping Level 2	2 season with trapping Level 2
Distance to Study Area	~12 km SE	Partially overlap in east	~8.5 km SE.	~13 km SE	~28 km E	~24 km SE	~7 km SE	Partially overlap in east	~6.5 km south	~12 km SE	~15 km SE	~12.5 km NE	~13.5 km E	Study Area
Duration	11-22 Jun 1994	10 – 19 Aug 1995	28,29 Aug 2003 ¹	9 Feb – 13 Mar 2004	8 Feb – 14 Feb 2005	26 Aug – 16 Sep 2005, 6 – 15 Feb 2006	2-28 May 2006	18 - 29 Sep 2006	14-21 May 2007	4-15 Jun 2008, 25 Sep – 2 Oct 2008	4 to 15 Jun 2008, 27 Sep -3 Oct 2008	28 Feb – 2 Mar 2011, 29 Mar – 1 Apr 2011	7 – 18 Apr, 4 –13 Oct 2011	24 May – 6 Jun 2013, 27 Aug – 6 Sep 2013
No. of trapping sites	18	6	No field component on fauna	5	45	6	none	5	1	5	9	none	7	6
Site type	Varied. Most were 10 Medium Elliott and 5 pitfalls	2 lines of 10 medium Elliott traps plus 10 pitfalls open between 7 and 10 nights.		2 trap lines of 20 Elliott, 10 pitfall, 4 funnel	none	trap lines of 20 Elliott, 10 pitfall, 2 funnel, 2 cage traps	none	5 cage traps, 10 medium Elliott traps, 20 funnel traps, 20 pot traps open for 9 nights	10 Elliott and 10 funnel traps (Trap lines also opened at Coodiner)	2 trap lines of 5 buckets, 5 pipes, 20 Elliott, 20 funnel traps and 2 cage traps.	2 trap lines of 20 Elliott, 10 pitfall, 4 funnel, 2 cage traps	none	trap lines of 10 Elliott, 1 pitfall, 2 funnel, 2 cage traps	Each trap site with trap lines of 10 pitfall (5 buckets and 5 pipes), 20 funnel, 20 Elliott and 2 cage traps
Trap nights	675 Elliott 175 Pitfall	840 Elliott trap 359 Pitfalls		620 Elliott 307 pitfall 260 funnel	none	2640 Elliott 1220 pitfall 1320 funnel 360 cage traps	none	225 cage traps 450 Elliott 675 Funnel 630 pot traps	30 Elliott, 30 Funnel	520 Elliott 260 Pitfall 216 Funnel 52 Cage	1330 Elliott 250 pitfall 322 funnel 126 cage	none	176 Elliott 980 pitfall 1,960 funnel 316 cage	1680 Elliott 840 pitfall 1680 funnel 168 cage
Diurnal search (hrs)	18	Not specified		15	246	59	42	Not specified	35	12	22	Not specified	60	>500

¹ No fauna sampling was conducted except recording fauna habitats



Survey	Jimblebar Biological Survey	Orebody 18 Biological Assessment Survey	Jimblebar Wheelarra Hill 3 Flora and Fauna Assessment	Jimblebar-Wheelarra Hill Expansion Biological Survey	Jimblebar East Exploration Project Biological Survey	Jimblebar Hashimoto Vertebrate Fauna Assessment	Jimblebar Marra Mamba Exploration Biological Survey	Orebody 18 Fauna Assessment Phase II	Jimblebar West Fauna Assessment	Jimblebar Wheelarra Hill Flora and Fauna Assessment	Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment	Orebody 31 Fauna Assessment	Wheelarra Hill North Fauna Assessment	Current survey
Nocturnal search (hours)	Not specified	Not specified	No field component for fauna	Not specified	48	19	19	5 nights (hours not specified)	12	5.5	18.75	Not specified	19	80
Bird surveys (hrs)	9	29		12.3	Not specified.	45	19.7	19 hours	34	8	19	Not specified	49	11
Bird Survey method	30 minute census	1 hour census and opportunistic		20 minute census	20 minute census	20 minute census	20 minute census	opportunistic	Opportunistic	60 minute census	20 minute 100 m radius census	opportunistic	15 minute census	Four 20 min surveys at each site
Bat recording nights	none	none		25	2	30	15	6	3	1	(By Specialized Zoology)	none	2	48
Bat recording hours	none	none		Not specified	4	Not specified	Not specified	13.7	4	6	none	none	5	576
Bat recording method	none	none		Anabat	Anabat	Anabat	Anabat	Anabat	Anabat	Anabat	none	none	Anabat & SM2BAT	SM2BAT
Mammals (native)	6	10		8	8	18	6	12	5	9	10	5	19	22
Mammals (introduced)	6	4	1	2	5	4	3	4	4	6	2	4	2	
Birds	40	44	62	41	85	64	55	72	26	47	42	59	64	
Reptiles	11	31	31	17	57	24	42	27	21	27	9	55	48	
Amphibians	0	0	5	0	5	1	0	0	0	2	1	2	1	
Conservation Significant species	Western Pebble-mound Mouse, Australian Bustard	none	None	Bush Stone-Curlew, Rainbow Bee-eater	Australian Bustard, Rainbow Bee-eater	Australian Bustard, Rainbow Bee-eater ²	Western Pebble-mound Mouse, Australian Bustard, Rainbow Bee-eater	Common Sandpiper, Bush Stone-curlew, <i>Ramphotyp hlops ganei</i>	Australian Bustard, Rainbow Bee-eater	Western Pebble-mound Mouse, Rainbow Bee-eater	Western Pebble-mound Mouse, Australian Bustard, Bush Stone-Curlew, Rainbow Bee-eater	None	Western Pebble-mound Mouse, Australian Bustard, Rainbow Bee-eater	Brush-tailed Mulgara, Pilbara Olive Python, Western Pebble-mound Mouse, Rainbow Bee-eater, Pilbara Flat-headed Blindsnake

² Ghost Bat and Pilbara Leaf-nosed Bat were recorded, but these are likely to be erroneous (Outback Ecology 2009)

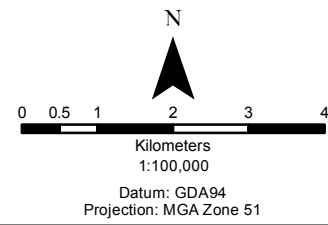


Legend

Study Area	Orebody 31 Fauna Assessment (ENV Australia 2011)
Jimblebar Hashimoto Vertebrate Fauna Assessment (ecologia Environmental 2006)	West Jimblebar Fauna Assessment (ENV Australia, 2007)
Jimblebar Mine Site Biological Survey (BHP 1994)	Wheelarra Hill North Fauna Assessment (ENV 2012)
Jimblebar Wheelarra Hill 3 Flora and Fauna Assessment (Biota 2004)	Jimblebar-Wheelarra Hill Expansion Biological Survey (ecologia Environmental 2004)
Jimblebar Wheelarra Hill Flora and Fauna Assessment (Outback Ecology Services 2009)	Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment (Outback Ecology Services 2009)
Orebody 18 Fauna Assessment Phase II (ENV Australia 2007)	



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**BHPBIO
OB19**

**Location of previous studies within and in the immediate vicinity of the Study Area
Figure 4.1**

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4.1.2 Database searches

DPaW NatureMap

A NatureMap search, based on a circle of 5 km radius from the point 120°00'42" E, 23°19'23" S (centre of the Study Area), reported a total of nine mammal species (including one naturalised species), 56 bird species and 33 reptile species, totalling 98 vertebrate species (see Appendix C). The conservation significant species identified by NatureMap comprise:

Mammals

- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;

Birds

- Bush Stone-Curlew *Burhinus grallarius* - DPaW Priority 4;
- Common Sandpiper *Actitis hypoleucos* - EPBC Migratory, WCA Schedule 3; and
- Rainbow Bee-eater *Merops ornatus* – EPBC Migratory, WCA Schedule 3.

EPBC Protected Matters Report

The EPBC Protected Matters Report, based on a circle of 5 km radius from the point 120°00'42" E, 23°19'23" S listed four threatened species and five migratory species.

Mammals

- Northern Quoll *Dasyurus hallucatus* – EPBC Endangered, WCA Schedule 1, IUCN Endangered;
- Greater Bilby *Macrotis lagotis* – EPBC Vulnerable, WCS Schedule 1, IUCN Vulnerable;
- Northern Marsupial Mole *Notoryctes caurinus* – EPBC Endangered, WCA Schedule 1;
- Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* – EPBC Vulnerable, WCA Schedule 1;

Birds (Migratory species)

- Fork-tailed Swift *Apus pacificus* – EPBC Migratory, WCA Schedule 3;
- Eastern Great Egret *Ardea modesta* – EPBC Migratory, WCA Schedule 3;
- Cattle Egret *Bubulcus ibis* – EPBC Migratory, WCA Schedule 3;
- Rainbow Bee-eater *Merops ornatus* – EPBC Migratory, WCA Schedule 3; and
- Oriental Plover *Charadrius veredus* – EPBC Migratory, WCA Schedule 3.

DPaW Threatened Fauna Database search

A DPaW Threatened Fauna Database Search based on a circle of 30 km radius from the point 119°45'17" E, 23°18'24" S (centre of the Eastern Ophthalmia mining area), reported one mammal and one reptile of conservation significance from the Study Area.

Mammals



- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4; and

Reptiles

- Pilbara Flat-headed Blindsnake *Ramphotyphlops ganeii* – DPaW Priority 1.

4.2 Current Field Survey

A total of 134 native vertebrate fauna species, comprising 23 native mammals (plus two introduced species), 62 birds, 48 reptiles and one amphibian (Appendix C) were recorded during the field survey. Ten species had not been previously recorded from the general area. Six conservation significant species were recorded during the survey:

Mammals

- Brush-tailed Mulgara *Dasyercus blythi* - DPaW Priority 4; Status under review by DoE (DSEWPaC 2012);
- Ghost Bat *Macroderma gigas* - DPaW Priority 4;
- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;

Birds

- Rainbow Bee-eater *Merops ornatus* – EPBC Migratory, WCA Schedule 3;

Reptiles

- Pilbara Olive Python *Liasis olivaceus barroni* – EPBC Vulnerable, WCA Schedule 1; and
- Pilbara Flat-headed Blindsnake *Ramphotyphlops ganeii* – DPaW Priority 1.

4.3 Fauna species recorded within the Study Area

A total of 264 species of vertebrate fauna (35 species of native mammals, nine species of introduced mammals, 123 species of birds, 90 species of reptiles and seven species of amphibians) may potentially occur within the Study Area (Appendix C). Of these, 170 native vertebrate fauna species have been recorded from within the Study Area or in the immediate vicinity. This comprises 25 species of native mammals (plus three introduced species), 76 species of birds, 68 species of reptiles and one species of amphibian.

Some species identified during the database searches as potentially occurring within the Study Area have not been recorded to date, despite suitable habitat being present. The absence of these records may be for a few reasons, including: 1) some species are transient and may only be present on rare occasions and thus have not been recorded during the field survey; 2) some species may occur in similar ecological niches to other species present within the Study Area, and thus are not present despite suitable habitat being available; and 3) some species are



extremely difficult to detect even if they are present due to their cryptic behaviours and specific niches (e.g. species that are completely fossorial).

The databases report a number of migratory waders that were recorded at the Ophthalmia Dam, ~9.5 km west of the Study Area. Despite the close proximity, suitable habitat for these species does not occur within the Study Area, thus it is highly unlikely that these species will occur within the Study Area.

4.3.1 Native mammals

Of the 35 native mammals that may potentially occur within the Study Area, 25 species (71 %) from eight families have been recorded to date in the Study Area and the immediate vicinity. The current survey recorded 23 species of native mammals. Of these, the records of Brush-tailed Mulgara *Dasyercus blythi*, Woolley's Pseudantechinus *Pseudantechinus woolleyae* and Hill's Sheath-tail-bat *Taphozous hilli* are the first from the general area (note however that Brush-tailed Mulgara was recorded at adjoining OB 31 by Biologic during a subsequent study).

4.3.2 Birds

A total of 123 species of birds may potentially occur in the Study Area, of which 76 (62 %) have been recorded to date within the Study Area boundaries and immediate vicinity. The current study recorded 62 species but none were new records for the area.

4.3.3 Reptiles

Of the 90 species of reptiles that may occur in the Study Area, 78 (87 %) have been recorded to-date in the Study Area and the immediate vicinity. Forty eight species were recorded during the current study, including five species not reported in the general area before: *Cryptoblepharus ustulatus* (a recent taxonomic split), *Ctenotus rubicundus*, Western Pygmy Spiny-tailed Skink *Egernia cygnitos* (a recent taxonomic split- previously clumped under *E. depressa*), *Ramphotyphlops waitii* and Pilbara Olive Python *Liasis olivaceus barroni*.

4.3.4 Amphibians

Only one of the seven potentially occurring amphibians, Desert Tree Frog *Litoria rubella*, has been recorded to date within the Study Area and was recorded during the current study.

4.3.5 Introduced fauna

Three species of introduced mammals have been recorded from the Study Area or its immediate vicinity, out of which the Cat **Felis catus* and House Mouse **Mus musculus* were recorded during the current survey. The Red Fox **Vulpes vulpes* was recorded during a previous survey



within the Study Area. A further six species may occur as they have been recorded within 50 km of the Study Area: European Cattle **Bos taurus*, Dromedary Camel **Camelus dromedaries*, Dog **Canis lupus*, Donkey **Equus asinus*, Horse **Equus caballus* and Rabbit **Oryctolagus cuniculus*. The Dingo *Canis lupus dingo* is categorised as a native mammal in this report following Corbett (1995). However, it is highly likely that the individuals occurring in the area are hybrids with feral dogs.

4.4 Data Analysis

An estimate of species richness in an area is one objective of faunal surveys. In particular it is desirable to have an indication of the adequacy of the sampling programme, and this is a requirement for fauna surveys undertaken in Western Australia (see EPA, 2004). 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).

Fitting mathematical asymptotic functions, such as the Michaelis Menten function is generally not recommended, as they have been shown to not work well in practice, despite the advantage that they make no assumptions about sampling schemes or species abundance distributions (Gotelli and Colwell 2011). However they have been frequently used (ecologia 2006, 2009) as a stopping rule, and in this case appear to be in agreement with results from extrapolation and other indicators, as shown in Table 4.2.

Table 4.2 Mean estimates of total species richness for the trapping and bird survey programmes.

Richness estimators	Total species estimate		
	Trapping programme for reptiles	Trapping programme for non-volant mammals	Bird surveys
Observed	35	11	57
Extrapolation to double survey effort	41.9	13.2	63.5
Abundance Coverage-based Estimator (ACE)	51.8	17	62.9
Chao 1	43.25	12.5	58.9
Bootstrap	41.71	12.3	63.4
Michaelis Menten (1 run)	46.05	12.04	65.5



4.4.1 Reptile trapping data

A total of 127 capture records were used in the analysis, with a total observed catch of 35 reptile species

S(est) is the observed total species number, while ACE, Chao 1, Jack 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 80 % and 90.9 % of the species (Figure 4.2).

An extrapolation of the data to 110 samples (doubling the sample effort) estimates that an additional seven species would be captured (Figure 4.3). Other indicators range from an additional 7 to 17 species (Table 4.2). This indicates that the trapping programme is estimated to have recorded at least 83.3 % of the species. The use of the Michaelis Menten function as a stopping point indicates 76.1% of species were recorded. These figures are certainly adequate for a two-season survey. It is important also to note that the species richness calculated here is for the trappable species at these particular six trapping sites, and the total number of trappable species within the Study Area will be greater than this. Opportunistic records added a further 13 species of reptiles.

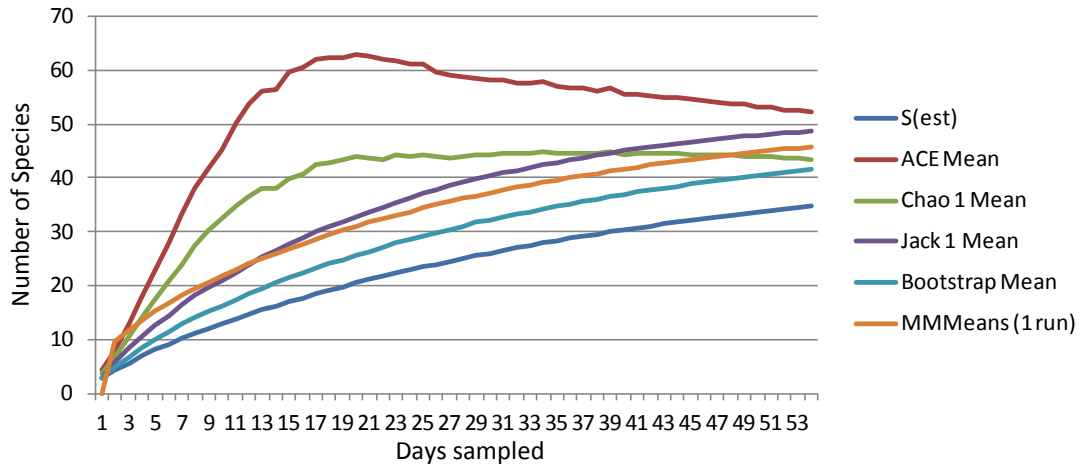


Figure 4.2 Accumulation curves for reptiles computed for the 55 trap samples.

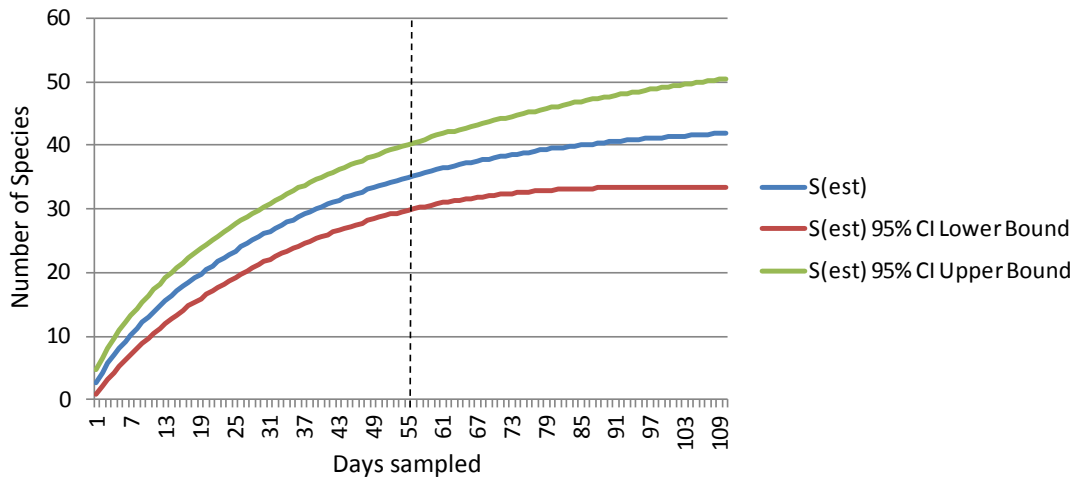


Figure 4.3 Extrapolation of S (est) and 95% confidence boundaries for reptiles to 110 trap samples. Those right of the broken line are extrapolated values.

4.4.2 Non-volant mammal trapping data

A total of 113 capture records were used in the analysis, with a total observed catch of 11 non-volant mammal species. Curves indicate that the trapping survey recorded between 77.7 % and 87.5 % of the species (Figure 4.4).

An extrapolation of the data to 94 samples (doubling the sample effort) estimates that an additional seven species would be captured (Figure 4.5). Other indicators range from an additional 1 to 6 species (Table 4.2). This indicates that the trapping programme is estimated to have recorded at least 61.1 % of the species. The use of the Michaelis Menten function as a stopping point indicates 64.7 % of species were recorded. These figures are adequate for a two-season survey. The species richness calculated here is for the trappable species at these



particular six trapping sites, and the total number of trappable species within the Study Area will be greater than this. Opportunistic records added a further 11 species of mammals.

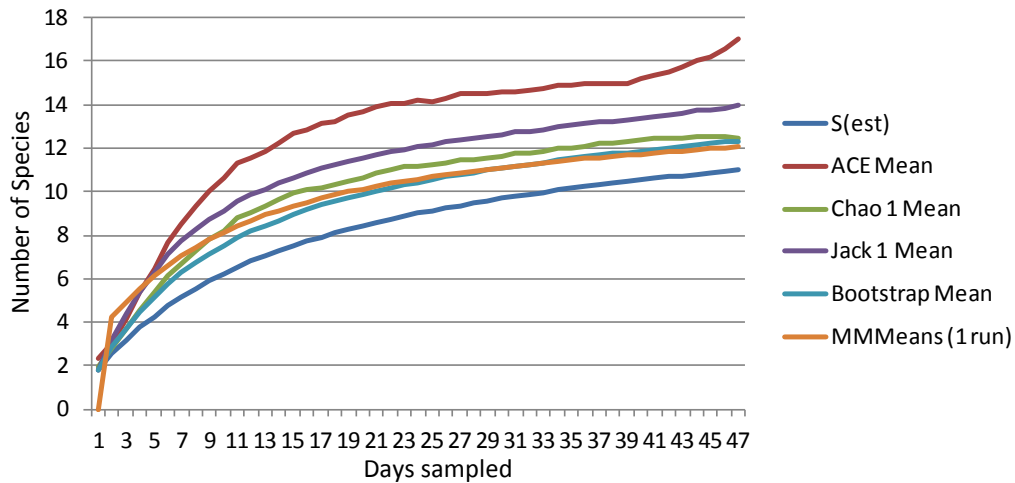


Figure 4.4 Accumulation curves for non-volant mammals computed for the 55 trap samples.

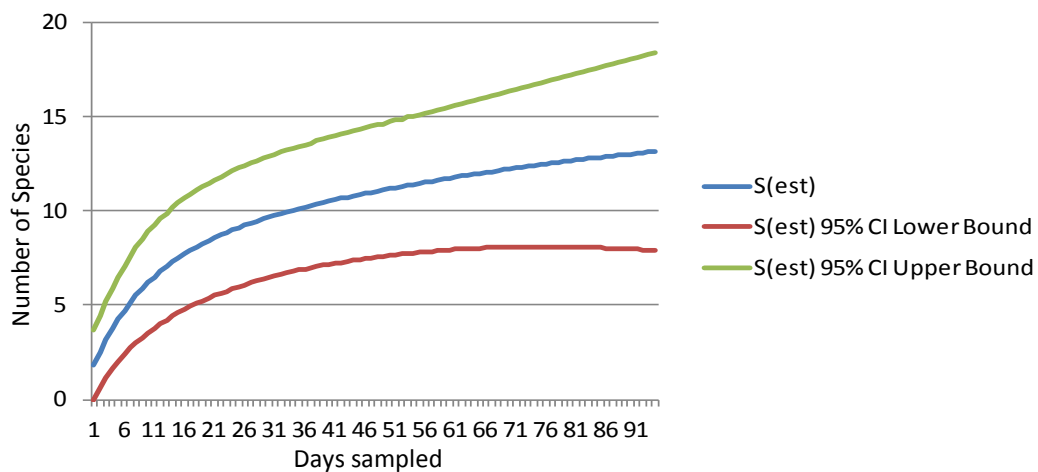


Figure 4.5 Extrapolation of $S(\text{est})$ and 95% confidence boundaries for non-volant mammals to 110 tapping samples. Those right of the broken line are extrapolated values.

Bird survey data

After removing species that were recorded only once, 57 samples were used in the analysis, each being a 20 minute bird census, with a total of 98 species being recorded. Curves indicate that the survey recorded between 77.7 % and 87.5 % of the species (Figures 4.6 and 4.7).

An extrapolation of the data to 80 samples (doubling the sample effort) estimates that an additional seven species would be recorded (Table 4.2). Other indicators range from an additional 2 to 9 species (Table 4.2). This indicates that the 2013 survey programme is estimated to have recorded at least 83.8 % of the species. The use of the Michaelis Menten function as a



stopping point indicates 86.4 % of species were recorded. These figures are certainly adequate for a two-season survey. It is important also to note that the species richness calculated here is for the bird species at these particular six survey sites, and hence the total number of species within the Study Area will be greater than this. Opportunistic bird records added a further seven species.

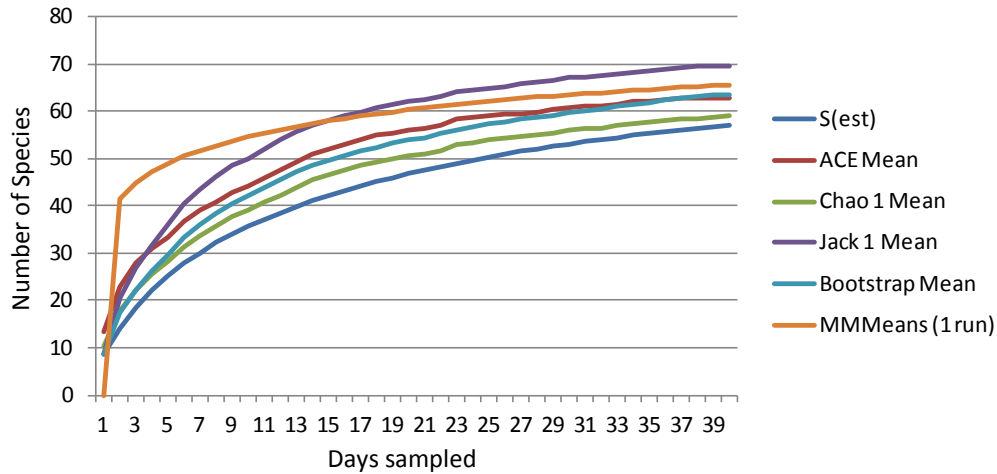


Figure 4.6 Accumulation curves for birds computed for the 55 trap samples.

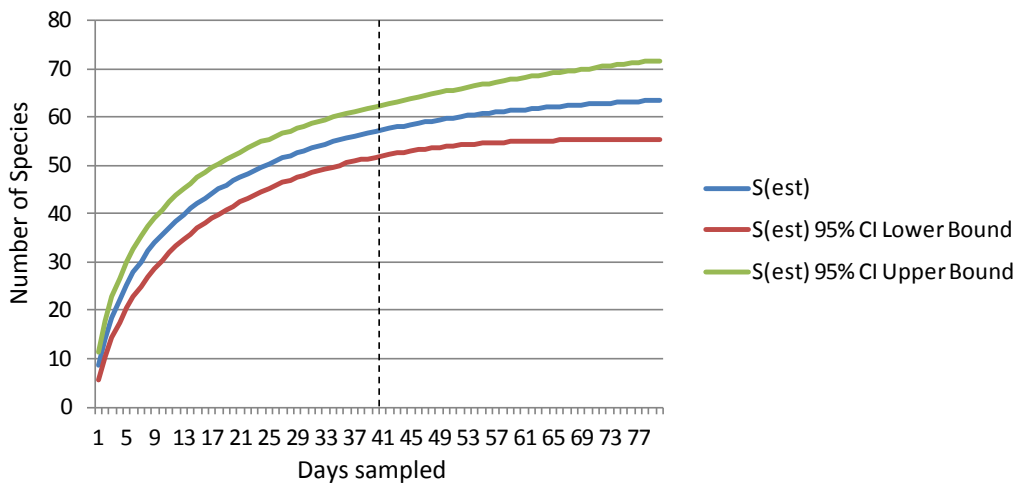
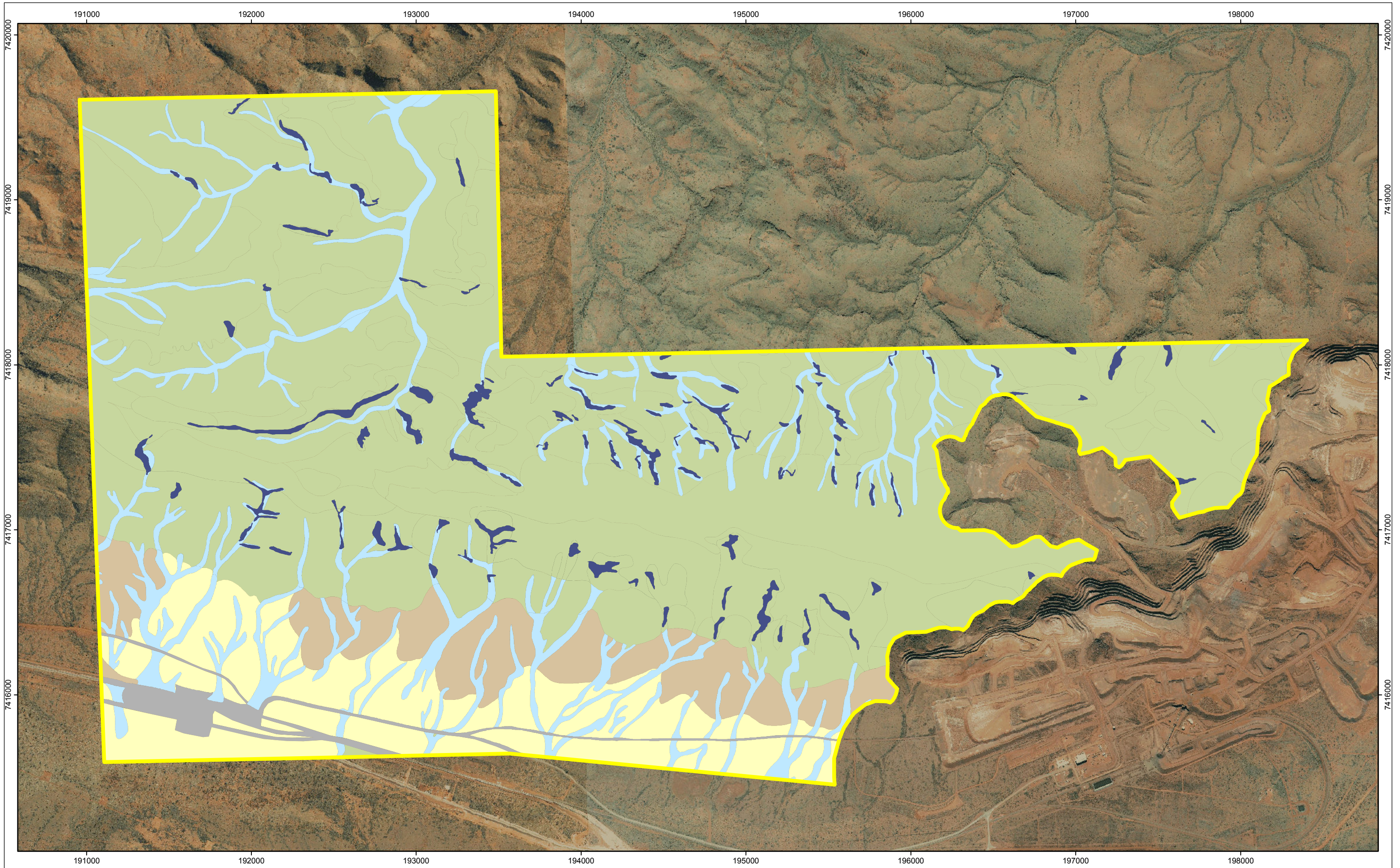


Figure 4.7 Extrapolation of S (est) and 95% confidence boundaries for birds to 110 tapping samples. Those right of the broken line are extrapolated values.

4.5 Fauna habitats within the Study Area

Five major fauna habitats were identified within the Study Area: Minor Drainage Line; Sand Plain; Stony Plain; Crest/ Slope and Gorge/ Gully (Table 4.3; Figure 4.8; Appendix D).




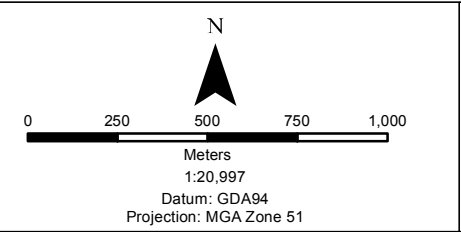
biologic 








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**BHPBIO
OB 19
FAUNA HABITATS**

FIGURE 4.8

Legend





 Study Area	 Gorge/ Gully
Fauna Habitats	 Minor Drainage Line
 Cleared	 Sand Plain
 Crest/ Slope	 Stony Plain

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Table 4.3 Major fauna habitat descriptions

Habitat	Description and habitat characteristics	Extent within the Study Area	Extent outside Study Area	Significant species associated with habitat	Photo
Crest/ Slope	The Crest/Slope habitats tend to be more open and structurally simple than other fauna habitats, and are dominated by various species of spinifex. A common feature of these habitats is a rocky substrate, often with exposed bedrock, and skeletal red soils. Crests and slopes are dominated by <i>Eucalyptus</i> woodlands, <i>Acacia</i> and <i>Grevillea</i> shrublands and <i>Triodia</i> spp. low hummock grasslands. Rocky outcrops are scattered within this habitat.	This is the most common habitat type within the Study Area and is widespread in the central and northern parts of the Study Area.	Extensive areas of Crest/Slope habitat are common in the vicinity of the Study Area and throughout the Pilbara.	Crest/Slope habitat supports local populations of Western Pebble-mound Mouse which is largely restricted to this habitat type. The Pilbara Flat-headed Blindsnake, Australian Bustard (not recorded) and Long-tailed Dunnart (not recorded) may also utilise this habitat. Pilbara Olive Python may pass through this habitat during dispersal and may also occasionally den. Ghost Bats may forage in this habitat, as may Peregrine Falcons (not recorded).	
Gorge/Gully	Gorges/Gullies are deeply incised, rugged, steep-sided valleys cut into the surrounding landscape. 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.	One prominent gorge occurs towards the central-western section of the Study Area. Many minor gullies occur within the Crest/ Slope habitats in the Study Area, through which Minor Drainage Lines flow.	Gorges (and gullies) are a common feature of the Pilbara (especially within the Hamersley Range), but because they tend to be narrow, linear features, they represent a small proportion of the total land area.	The Gorge/Gully habitat in the Study Area provides habitat for Pilbara Olive Python and potentially for Ghost Bat, Northern Quoll, and Long-tailed Dunnart (none recorded). Minor Gullies could harbour Pilbara Olive Pythons and Pilbara Flat-headed Blindsnake.	
Minor Drainage Line	Characterised by low and sparse vegetation compared to Major Drainage Lines. Located within the minor gullies and depressions through the Crest/ Slope habitat. Consists of <i>Acacia</i> low woodland sometimes with scattered <i>Eucalyptus xerothermica</i> and <i>Corymbia hamersleyana</i> . The understorey generally lacks density and often consists solely of sparse tussock grassland, (in particular the introduced Buffel Grass * <i>Cenchrus ciliaris</i>). The substrate can be sandy in places but generally consists of a loam gravel or stone.	Widespread within the Crest/ Slope habitat. Most span from north to south.	A common habitat in the Hamersley Range adjacent to the Study Area.	Minor Drainage Lines provide habitat for a number of conservation significant fauna. Bush Stone-curlew (not recorded) may shelter during the day in areas of thicker vegetation associated with drainage areas and the Pilbara Flat-headed Blindsnake is likely to utilise this habitat type as living space.	
Sand Plains	Sand Plain habitat is characterised by relatively deep sandy soils supporting dense spinifex grasslands and sparse shrubs. This habitat transitions into patches of Mulga in places.	Areas of this habitat occur along the southern border of the Study Area, intermixed with Stony Plains.	Large areas of this habitat are located at the border of the Hamersley and Fortescue subregions and then extensively within the Chichester subregion.	Mulgara and potentially Greater Bilby (not recorded) utilise the finer sandy habitats for burrows and foraging. Australian Bustard (not recorded) is frequently encountered foraging in this habitat. The Pilbara Flat-headed Blindsnake also occurs in this habitat type.	



Habitat	Description and habitat characteristics	Extent within the Study Area	Extent outside Study Area	Significant species associated with habitat	Photo
Stony Plain	These are erosional surfaces of gently undulating plains, ridges and associated footslopes. Mainly supports hard spinifex (and occasionally soft spinifex). There are localised deposits of sand within this habitat.	This habitat occurs mainly in the south-western section of the Study Area, intermixed with Sand Plains.	Common habitat throughout the Pilbara.	Very stony areas may support local populations of Western Pebble-mound Mouse. The blind snake <i>Ramphotyphlops ganei</i> also could occur in this habitat type. Australian Bustard (not recorded) is frequently encountered foraging in this habitat.	



5 CONSERVATION SIGNIFICANT FAUNA

Species are defined as 'Conservation Significant' if they are listed under agreements at international (e.g. IUCN, JAMBA, CAMBA, Bonn), regional (EPBC) or state (WCA, Priority list of DPaW) level. Explanations of conservation status under these Acts and Agreements are provided in Table 3.5 and Appendix B.

Based on the review of regional surveys, and database searches (Section 3.2), and the habitats present in the Study Area, it was determined that 18 species (five native mammals, nine birds and two reptiles) of conservation significance have the potential to occur in the Study Area. Of these species, six have been recorded in the Study Area to date, all during the current survey. These are:

- Brush-tailed Mulgara *Dasyercus blythi* - DPaW Priority 4 (status under review by DoE (DSEWPaC 2012));
- Ghost Bat *Macroderma gigas* – DPaW Priority 4;
- Western Pebble-mound Mouse *Pseudomys chapmani* – DPaW Priority 4;
- Rainbow Bee-eater *Merops ornatus* – EPBC Migratory, WCA Schedule 3;
- Pilbara Olive Python *Liasis olivaceus barroni* – EPBC Vulnerable, WCA Schedule 1; and
- Pilbara Flat-headed Blind Snake *Ramphotyphlops ganei* – DPaW Priority 1.

A further 12 species were identified by database and literature searches to occur in the immediate vicinity of the Study Area and the adjoining areas. These are:

Mammals

- Northern Quoll *Dasyurus hallucatus* – EPBC Endangered, WCA Schedule 1, IUCN Endangered;
- Greater Bilby *Macrotis lagotis* – EPBC Vulnerable, WCA Schedule 1, IUCN Vulnerable;
- Pilbara Leaf-nosed Bat *Rhinioncteris aurantia* – EPBC Vulnerable, WCA Schedule 1;
- Northern Marsupial Mole *Notoryctes caurinus* – EPBC Endangered, WCA Schedule 1;

Birds

- Australian Bustard *Ardeotis australis* – DPaW Priority 4;
- Bush Stone-curlew *Burhinus grallarius* – DPaW Priority 4;
- Common Sandpiper *Actitis hypoleucos* - EPBC Migratory, WCA Schedule 3;
- Eastern Great Egret *Ardea modesta* – EPBC Migratory, WCA Schedule 3;
- Cattle Egret *Ardea ibis* – EPBC Migratory, WCA Schedule 3;
- Fork-tailed Swift *Apus pacificus* – EPBC Migratory, WCA Schedule 3;



- Oriental Plover *Charadrius veredus* – EPBC Migratory, WCA Schedule 3; and
- Star Finch *Neochmia ruficauda subclarescens* – DPaW Priority 4.

Table 5.1 shows the conservation significant species recorded from adjacent areas and those that potentially occur within the Study Area. Locations of conservation significant fauna recorded within the Study Area are presented in Figure 5.1 and Appendix E.

To simplify the classification of pebble mounds, they have been characterised as active/ recently active or inactive. Active or recently active indicates that the mounds are either currently used or the mound structure is clearly evident and therefore may be used again in the future. Inactive mounds are those that are weathered, flat and appear completely abandoned.



Table 5.1 Summary of conservation significant fauna recorded in or adjacent to the Study Area and those that may potentially occur in the Study Area.

Species	Common Name	CONSERVATION STATUS				DATABASE SEARCHES			SURVEYS												
		EPBC	WCA	DPaW	IUCN	Nature Map	EPBC	DPaW Threat. species	A	B	C	D	E	F	G	H	I	J	K	L	M
Mammalia																					
<i>Dasyercus blythi</i>	Brush-tailed Mulgara			P4																	•
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S 1		EN		•														
<i>Rhinonictis aurantius</i>	Pilbara Leaf-nosed Bat	VU	S 1				•										•*				
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4		•		•		•		•	•	•				•		•	•
<i>Macroderma gigas</i>	Ghost Bat			P4													•*				•
<i>Macrotis lagotis</i>	Greater Bilby	VU	S 1		VU		•														
<i>Notoryctes caurinus</i>	Northern Marsupial Mole	EN	S1				•														
Aves																					
<i>Ardea alba</i>	Eastern Great Egret	MI	S 3				•														
<i>Ardea ibis</i>	Cattle Egret	MI	S 3				•														
<i>Ardeotis australis</i>	Australian Bustard			P4				•	•			•	•	•			•	•	•	•	
<i>Burhinus grallarius</i>	Bush Stone-curlew			P4		•					•			•	•						
<i>Charadrius veredus</i>	Oriental Plover	MI	S 3				•														
<i>Actitis hypoleucos</i>	Common Sandpiper	MI	S 3			•					•										
<i>Merops ornatus</i>	Rainbow Bee-eater	MI	S 3			•	•		•	•				•	•		•		•	•	•
<i>Apus pacifica</i>	Fork-tailed Swift	MI	S 3				•					•									
<i>Neochmia ruficauda</i>	Star Finch			P4																	•
Reptilia																					
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S 1																		•
<i>Ramphotyplops ganei</i>	Pilbara Flat-headed Blindsnake			P1				•				•								•	•

* Pilbara Leaf-nosed Bat and Ghost Bat records from Hashimoto may be erroneous (Outback Ecology 2009)

Database Searches

DPaW Naturemap search within 5 km buffer

EPBC Protected Matters search with 5 km buffer

DPaW Threatened Species Database search records within the Study Area

Surveys

A West Jimblebar Fauna Assessment (ENV Australia 2007)

B Wheelarra Hill North Fauna Assessment (ENV Australia 2012)

C Orebody 18 Biological Assessment Survey (ecologia Environmental 1995)

D Orebody 18 Fauna Assessment Phase II. E (ENV Australia 2007a)

E Orebody 31 Fauna Assessment. (ENV Australia 2011)

F Jimblebar Mine Site Biological Survey. BHP (BHP Iron Ore Pty Ltd 1994)

G Jimblebar Iron Ore Project: Terrestrial Vertebrate Fauna Assessment. (Outback Ecology Services 2009a)

H Jimblebar - Wheelarra Hill Biological Survey. (ecologia Environmental 2004)

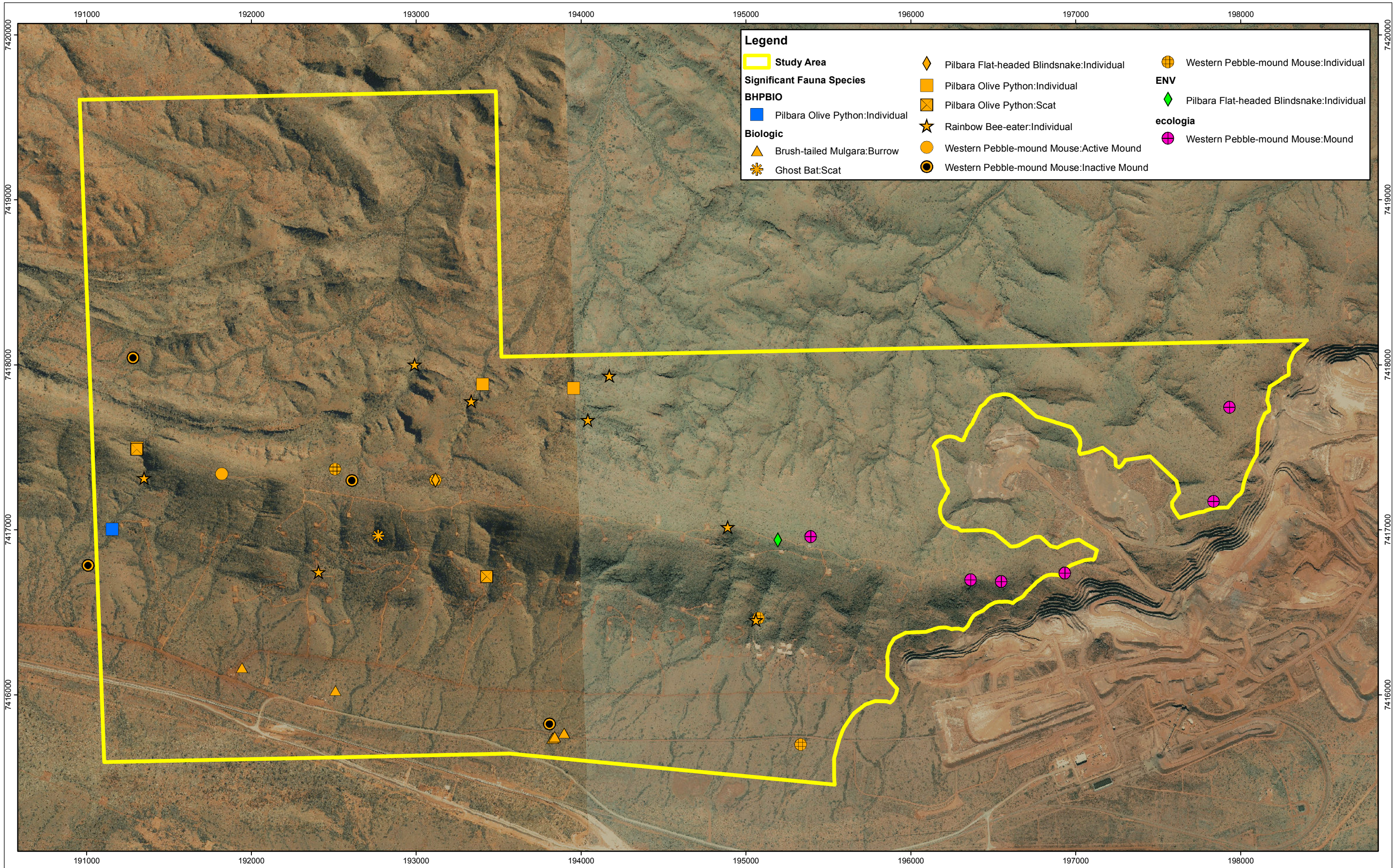
I BHPBIO Hashimoto Terrestrial Vertebrate Fauna Assessment. (ecologia Environmental 2006a)

J Jimblebar Marra Mamba Exploration Biological Survey. (ecologia Environmental 2006b)

K Jimblebar East Exploration Project Biological Survey (ecologia Environmental 2005)

L Jimblebar Linear Development Terrestrial Vertebrate Assessment. (Outback Ecology Services 2009b)

M Current Study





5.1 Conservation Significant Fauna Recorded from the Study Area

Six species of conservation significant fauna have been recorded in the Study Area to-date. Each of the species recorded is presented in taxonomic order and discussed in the following section. Significant fauna species localities are shown on Figure 5.1 and presented in Appendix E.

5.1.1 Mammals

Brush-tailed Mulgara (*Dasyercus blythi*)

Brush-tailed Mulgara (*Dasyercus blythi*) is closely associated with *Triodia* Sand Plains and swales between low dunes from south-western Queensland across the Simpson, Tanami, and Great Sandy Deserts of southern and central Northern Territory and central Western Australia, including parts of the Pilbara (DSEWPaC 2011b; Pavey et al. 2012). Brush-tailed Mulgara is currently listed as Priority 4 by the DPaW; however it is currently under consideration for listing under the EPBC (DSEWPaC 2012). A possible outcome of this is that both species of Mulgara (*Dasyercus blythi* and *D. cristicauda*) will have the same status of Vulnerable under the EPBC.

Seven burrows of the Brush-tailed Mulgara were located in Sand Plain habitat along the southern section of the Study Area (Figure 5.1). The burrows were old but at least two could have been potentially active. However, no scat or foot prints were observed at any of the burrows and no individuals were trapped during the survey. The southern section of the Study Area contains extensive areas of Sand Plain habitat suitable for this species. Mulgara were not recorded in any of the previous surveys in the immediate vicinity of the Study Area, but Biologic recorded at South Jiblebar (Biologic 2013) and Orebodies 24 and 31 (in prep.) located approximately 7 km south and 15 km west respectively.

Ghost Bat (*Macroderma gigas*)

Ghost Bats are listed as a Priority 4 species under the DPaW Priority list and Vulnerable under the IUCN Red List. They formerly occurred over a wide area of central, northern and southern Australia but have declined significantly in the southern parts of their range in the last 200 years (van Dyck and Strahan, 2008). Within W.A., Ghost Bats are now confined to the Kimberley and Pilbara regions.

The distribution of Ghost Bats is influenced by the availability of suitable caves and mines for roost sites. The preferred roosting habitats of Ghost Bats in the Pilbara are deep, complex caves beneath bluffs of low rounded hills composed of Marra Mamba Iron Formation, Brockman Iron Formation, granite rock piles and abandoned mines (Armstrong and Anstee, 2000). Armstrong



and Anstee (2000) note that most caves used by Ghost Bats have narrow entrances (less than 0.5 m²) that open into larger chambers. Ghost Bats move between a number of caves seasonally, or as dictated by weather changes, and roost either individually or in colonies of up to 1500 (Churchill, 2008). During breeding, female Ghost Bats congregate in maternity roosts, generally selecting very warm caves during pregnancy and lactation (Hutson *et al.*, 2001).

A pile of very old Ghost Bat scat, in the form of a ~50 cm high stalagmite, was found at cave 'obcave3' in the central section of the Study Area (Figure 5.1; Appendix F). The scats were completely decayed and combined into a solid mass. It is likely that this cave was used by Ghost Bats historically but not in recent times. All caves visited at the Study Area were assessed as potential feeding roosts (Appendix F) but no evidence for their use existed. No calls of this species were recorded on SM2 recorders.

This species has also been recorded at the nearby Hashimoto area, ~15 km south-east of the Study Area (ecologia 2006). Several Ghost Bats were present at a mine adit and a hunting Ghost Bat was observed a few kilometres from the roost (ecologia 2006). Nevertheless, Specialised Zoological (2008) found no evidences for the existence of this species in the adit, thus Outback Ecology (2009) mentioned that the previous record could be erroneous.

Western Pebble-mound Mouse (*Pseudomys chapmani*)

The Western Pebble-mound Mouse is currently listed as Priority 4 by the DPaW. 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).

One active and four inactive mounds were located in the Crest/ Slope habitats across the central part of the Study Area and 13 individuals were caught in the traps (three in pipes, five in Buckets, three in Elliots and two in Funnel traps) at four sites (Figure 5.1). A total of 91 mounds, of which less than a fifth were active, were located during a previous study at OB 18 (ecologia 1995) and six of these records overlapped with the current Study Area. However, no captures were recorded during a more recent trapping survey at OB 18 (ENV 2007). There are several records from other areas in the vicinity of the Study Area (see Table 5.1).



5.1.2 Birds

Rainbow Bee-eater (*Merops ornatus*)

The Rainbow Bee-eater is listed as Migratory under the EPBC and Schedule 3 under the WCA. This species has broad habitat preferences and lives almost anywhere suitable for hawking insects. The demographics of the species are complex, with populations in WA being resident, breeding visitors, post-nuptial nomads, passage migrants and winter visitors (Johnstone and Storr 1998). Many individuals move northwards to overwinter in Indonesia.

This species is common within the Study Area and was recorded by eight individuals from three habitats (Crest/ Slope, Gorge/ Gully and Minor Drainage Line) along the central section of the Study Area (Figure 5.1). Potential nesting habitat for this ground-nesting species exists in the Study Area, with this species most likely to nest in the banks of the Minor Drainage Line habitat. However, no evidences for nesting were observed during the survey. There are several records from other areas in the vicinity of the Study Area (see Table 5.1).

5.1.3 Reptiles

Pilbara Olive Python (*Liasis olivaceus barroni*)

The Pilbara Olive Python is listed as Vulnerable under the EPBC and Schedule 1 under the WCA. 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). 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 subregion, 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).

This species occurs throughout the Pilbara (Bush and Maryan 2011) but none of the previous surveys in the area recorded this species. During the first season of the current survey, an individual was found in a rock pool within the Gorge/ Gully habitat in the western side of the Study Area and scat of this species was observed in a cave close-by (Figure 5.1). Another individual was recorded ~500 m south from this location within the same Gorge/ Gully habitat during a field visit (Paul Taylor, pers. comm.). During night sampling in December 2013, two individuals each were found at two water holes at Gorge/ Gully habitats in the northern section of the Study Area (Figure 5.1). It is noteworthy that these were among the only water bodies left in the Study Area at the time of sampling. Shed skin and scat of this species was found among



boulders close to a Minor Drainage Line at the central section of the Study Area during the same trip (Figure 5.1). Suitable habitat for this species occurs close to water pools within the Gorge/Gully habitats within the Study Area.

Pilbara Flat-headed Blindsnake *Ramphotyphlops ganei*

The Pilbara Flat-headed Blindsnake *Ramphotyphlops ganei* is listed as Priority 1 by the DPaW and is endemic to the Pilbara. Given its cryptic fossorial habit, this species is rarely encountered. Little is known of this species' ecology but like most other blind snakes, it is insectivorous, feeding on termites and their eggs, and larvae and pupae of ants (Wilson and Swan 2010). *Ramphotyphlops ganei* is associated with moist gorges and gullies (Wilson and Swan 2010), and potentially with a wide range of other stony habitats.

Two individuals were caught in funnel traps at a single site within Crest Slope habitat in the central section of the Study Area during the current survey (Figure 5.1). During a previous survey, this species was recorded twice within the same rocky hilltop habitat within the central section of the Study Area (ENV 2007) (Figure 5.1). It has been also recorded within Alluvial Plain habitat at Jimblebar, ~10 km south-east (Outback Ecology 2009).



Table 5.2 Conservation significant fauna occurring in the Study Area.

Species	Significance	Preferred habitat	Extent of the habitat in the Study Area and the region	Records
Brush-tailed Mulgara <i>Dasyercus blythi</i>	DPaW: Priority 4 (under review by DoE)	Arid, sandy areas, preferring mature spinifex on sandy soils. Brush-tailed Mulgara inhabit spinifex grasslands with medium to dense cover.	Sand Plain habitats along the southern border of the Study Area represent suitable habitat for this species. Sand Plains are also present in areas surrounding the Study Area.	<ul style="list-style-type: none"> Seven burrows of the Brush-tailed Mulgara were located in Sand Plain habitat along the southern section of the Study Area. Biologic recorded at South Jimblebar (Biologic 2013) and OB 24 (in prep) located approximately 7 km south and 15 km west respectively.
Ghost Bat <i>Macroderma gigas</i>	DPaW: Priority 4	Roosts in deep complex caves beneath bluffs of low rounded hills, granite rock piles and abandoned mines (Armstrong and Anstee, 2000).	All caves visited at the Study Area were assessed as potential feeding roosts but no evidence for their use existed. The Gorge/ Gully and Drainage Line habitats provide suitable foraging areas for this species.	<ul style="list-style-type: none"> A pile of very old Ghost Bat scat was found at cave 'obcave3' in the central section of the Study Area. ecologia (2006) recorded several animals at the nearby Hashimoto area, ~15 km south-east of the Study Area, but Specialised Zoological (2008) found no evidences for the existence of this species in the said location.
Western Pebble Mound Mouse <i>Pseudomys chapmani</i>	DPaW: Priority 4	Gentler slopes of rocky ranges where ground is covered with a stony mantle and vegetated by spinifex, often with sparse overstorey of eucalypts and scattered shrubs (Van	The Crest/ Slope habitat preferred by this species is the most dominant habitat type within the Study Area as well as in the surrounding areas/	<ul style="list-style-type: none"> One active and four inactive mounds were located in the Crest/ Slope habitats across the central part of the Study Area and 13 individuals were caught in the traps at four sites. ecologia (1995) recorded six mounds within the current Study Area.



Species	Significance	Preferred habitat	Extent of the habitat in the Study Area and the region	Records
		Dyck and Strahan, 2008).		
Rainbow Bee-eater <i>Merops ornatus</i>	EPBC: Migratory WCA: Schedule 3	Lightly wooded, preferably sandy country near water (Johnstone and Storr, 1998).	Suitable habitat (Drainage Lines, Gorge/ Gully etc.) is common within the Study Area and surrounding region. Potential nesting habitat exists in the Minor Drainage Line habitat.	<ul style="list-style-type: none"> • Eight individuals observed at separate locations along the central section of the Study Area. • There are several records from other areas in the vicinity of the Study Area.
Pilbara Olive Python <i>Liasis olivaceus barroni</i>	EPBC: Vulnerable WCA: Schedule 1	Associated with drainage systems, including areas with localised drainage and semi-permanent watercourses (Bush and Maryan 2011).	Suitable habitat occurs within the survey area, as many of the gorges contain rock pools, many of which may be permanent. These are a common feature in mountain ranges within the Pilbara. Water pools within Minor Drainage Lines may also provide suitable habitat.	<ul style="list-style-type: none"> • Six individuals were found in rock pools at four locations and scat was recorded from two other locations, all within or in close proximity to Gorge/ Gully habitat.
Pilbara Flat-headed Blindsnake <i>Ramphotyphlops ganei</i>	DPaW: Priority 4	Associated with moist gorges and gullies (Wilson and Swan 2010) and potentially with a wide range of other stony habitats. Recently found on an alluvial plain north	As this species can apparently live in a range of habitats from alluvial plains to hillsides, its range is likely to include several habitat types within the Study Area and vicinity.	<ul style="list-style-type: none"> • Two individuals were caught in funnel traps at a single site within Crest Slope habitat in the central section of the Study Area during the current survey. • Two individuals recorded previously at a rocky hilltop habitat within the central section of the Study Area (ENV 2007). • One individual recorded within Alluvial Plain habitat



Species	Significance	Preferred habitat	Extent of the habitat in the Study Area and the region	Records
		of Ophthalmia dam (Outback Ecology Services 2009b) and on hillside in OB 17 (Biologic unpublished).		at Jimblebar, ~10 km south-east (Outback Ecology 2009).



5.2 Conservation Significant Fauna potentially occurring in the Study Area

5.2.1 Mammals

Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll is listed as Endangered under the EPBC, on Schedule 1 under the WCA and as Endangered by the IUCN. Northern Quolls have experienced significant declines in eastern and northern Australia, mainly due to an expansion of the Cane Toad's (**Rhinella marina*) range; these are ingested resulting in death (Tidemann et al. 1985). At present Northern Quolls are locally common in the northern part of the Pilbara region (generally within 150 km of the coast) but are uncommon in more southern areas.

Northern Quolls favour rocky areas such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, Major Drainage Lines and treed creek lines, as well as structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs (DSEWPaC 2011a). Rocky habitats are usually of high relief, often rugged and dissected but can also include tor fields or caves in low lying areas such as in Western Australia. Dens are made in rock crevices, tree holes or occasionally termite mounds (Threatened Species Scientific Committee, 2005). In the Pilbara region, the species tends to prefer the Rocklea, Macroy and Robe land systems (Biota Environmental Sciences 2008). The Northern Quoll has also been recorded in other land systems which comprise sandstone and dolomite hills and ridges, shrublands, sandy plains, clay plans and tussock grasslands and coastal fringes including dunes islands and beaches.

Online databases identify the Northern Quoll to occur in the general area. No signs of Northern Quolls were located during the present survey and no records of this species were made in any survey in the vicinity of the Study Area. This species is unlikely to occur within the Study Area as little suitable habitat is present and the Study Area is at the southern extent of the species' range.

Greater Bilby (*Macrotis lagotis*)

The Greater Bilby is listed as Vulnerable under the EPBC, on Schedule 1 under the WCA and as Vulnerable by the IUCN due to range reduction; it now occupies less than 20% of its original range (Southgate 1990a), inhabiting arid and semi-arid regions throughout most of the Australian mainland in disjunct populations (Johnson 2008). The Greater Bilby utilises a variety of habitats, usually on landforms with level to slow slope topography and light to medium soils



(Worthington Wilmer et al. 1999). Three major vegetation types associated with the Greater Bilby are listed by Southgate (1990b) including: open tussock grassland on uplands and hills, Mulga woodland/scrubland on ridges and rises, and hummock grassland in plains and alluvial areas. Other habitats used by the species include stony downs, cracking clays, desert Sand Plains and dune fields, spinifex grassland, and *Acacia* spp. scrublands on red earths (Johnson, 2008). Home ranges may be temporary, and there is some suggestion that Greater Bilbies are nomadic, following food availability (Johnson, 2008).

There are no recent records in the vicinity of the Study Area and no traces were found during the current survey. Hence it is highly unlikely that the species occurs. The nearest record is from the vicinity of Jiggalong nearly 70 km to the east.

Northern Marsupial Mole (*Notoryctes caurinus*)

The Northern Marsupial Mole is listed as Endangered under the EPBC. It is a blind marsupial which is adapted to living underground. It occasionally comes to the surface, apparently more frequently after rain (Maxwell et al. 1996).

The Northern Marsupial Mole lives underground in sand dunes, inter-dunal flats and sandy soils along river flats. Despite online databases predicting its occurrence in the area, there are no confirmed records of this species in the Study Area or the surrounds. Also, the preferred sandy habitats do not occur within the Study Area.

Pilbara Leaf-nosed Bat (*Rhinonictis aurantia*)

The Pilbara Leaf-nosed Bat is classified as Vulnerable under the EPBC and on Schedule 1 under the WCA. This species requires warm (28 – 32 °C) and highly humid (96 – 100%) roost sites in caves and/or mine shafts. This is a result of their limited ability to conserve heat and water (Armstrong 2001). Such caves are relatively uncommon in the Pilbara (Armstrong and Anstee 2000; Armstrong 2001), which limits the availability of diurnal roosts for this species. The few known roosts of this species are concentrated in mine shafts in the eastern Pilbara, and at Barlee Range Nature Reserve (Department of Environment 2010) which are thought to contain most of the region's population.

This species has been recorded at the nearby Hashimoto area, ~15 km south-east of the Study Area (ecologia 2006). Several individuals were recorded at a mine adit at Site 2, which is one of the south-easternmost roosts of this species in the Pilbara (ecologia 2006). Nevertheless, Specialised Zoological (2008) found no evidences for the existence of this species in the adit,



thus Outback Ecology (2009) mentioned that the previous record could be erroneous. No suitable roost sites occur in the Study Area or its immediate vicinity though this species may utilise a foraging home range that extends over the Study Area.

5.2.2 Birds

Australian Bustard (*Ardeotis australis*)

The Australian Bustard is listed as Priority 4 by the DPaW and as Least Concern by the IUCN. It occurs across most of mainland Australia, but is listed in WA primarily due to a decline in its range in the south of the state. It is a nomadic species occurring in a wide variety of habitats including gravel plains, riverine habitats and open or lightly wooded grasslands (including *Triodia* spp. Sand Plains) (Johnstone and Storr 1998).

Suitable habitat in the Study Area includes Sand Plains and Stony Plains, but the species was not recorded within the Study Area. However, this species was recorded in numerous surveys in the vicinity of the Study Area (Table 5.1).

Bush Stone-curlew (*Burhinus grallarius*)

The Bush Stone-curlew is listed as Priority 4 by DPaW. It is patchily distributed across much of mainland Australia; inhabiting areas of open forest and woodland with open areas, fallen dead timber or leaf litter (del Hoyo et al. 2006). Inland, this species is associated with watercourses. Bush Stone-curlews are nocturnal and often difficult to detect, being highly cryptic.

Suitable habitat in the Study Area includes open areas fringed by denser riparian vegetation (e.g. closer to Minor Drainage Lines). The species was recorded ~1.9 km east of the Study Area at OB18 (ENV 2007).

Cattle Egret (*Ardea ibis*)

Cattle Egrets are listed as Migratory under the EPBC and Schedule 3 under the WCA. It is a widespread and common species according to migration movements and surveys of breeding localities. Two major distributions have been located; from north-east Western Australia to the Top End of the Northern Territory and around south-east Australia. In Western Australia and the Northern Territory, the Cattle Egret is located from Wyndham to Arnhem Land. The Cattle Egret utilises a variety of natural and anthropogenic habitats and occurs in tropical and temperate grasslands, inland wetlands, wooded lands and farm lands. It has also been seen in arid and semi-arid regions; however this is extremely rare. This species has a symbiotic relationship with grazers.



Online databases identified this species as likely to occur in the area. This species could occur within the Study Area as a foraging visitor or a temporary resident during the wet season when temporary water pools provide suitable habitat.

Eastern Great Egret (*Ardea modesta*)

The Eastern Great Egret is listed as Migratory under the EPBC and Schedule 3 under the WCA. This species is described as dispersive and migratory in parts of its range (DEWHA, 2010d), with some regular seasonal movements. Non-breeding birds have been recorded across most of Australia, but avoid the driest regions of the western and central deserts (Marchant and Higgins 1993). Favoured breeding habitat relevant to the Study Area includes wooded swamps and river pools with *Eucalyptus camaldulensis* and *Melaleuca argentea* (Johnstone and Storr 1998). During the wet season and after heavy rain, however, egrets could be attracted to temporary pools throughout the Study Area, including man-made water bodies.

Online databases identified this species as likely to occur in the area. This species could occur within the Study Area as a foraging visitor or a temporary resident during the wet season when temporary water pools provide suitable habitats.

Oriental Plover (*Charadrius veredus*)

The Oriental Plover is listed as Migratory under the EPBC and Schedule 3 under the WCA. It is a non-breeding visitor to Australia, where it occurs in both coastal and inland areas. Along the coast the Oriental Plover inhabits estuarine mudflats, beaches and near coastal grasslands. Inland it occurs in flat, open, semi-arid or arid grasslands (DEWHA, 2010). On migration to Northern Australia (September – November), Oriental Plovers gather in flocks on open, thinly vegetated, grassland plains (Morcombe 2004).

Online databases identified this species as likely to occur in the area. There are few records of the Oriental Plover in the Pilbara (Birds Australia 2013) and it is possible that this species may be an infrequent transient visitor to the Study Area.

Common Sandpiper (*Actitis hypoleucos*)

The Common Sandpiper breeds across most of temperate and subtropical Europe and Asia, and migrates to Africa, southern Asia and Australia in winter. In Australia, this species is mainly found in muddy edges or rocky shores in coastal or inland wetlands. During the breeding season in the northern hemisphere, it prefers freshwater lakes and shallow rivers. It is a gregarious bird



and is usually seen in large flocks. No large water bodies are found in the vicinity of the Study Area; the nearest being the Ophthalmia Dam ~9.5 km to the west.

A single individual was recorded ~2 km east of the Study Area at OB 18 (ENV 2007). This species is unlikely to utilise the Study Area to any great extent, but may occasionally occur on a transient basis within the Study Area.

Fork-tailed Swift (*Apus pacificus*)

This species is entirely aerial within the Pilbara and thus does not utilise the terrestrial surface. It is listed as Migratory under the EPBC and Schedule 3 under the WCA, as it breeds in north-east and east Asia, wintering in Australia and southern New Guinea (Johnstone and Storr 1998).

Fifteen individuals were recorded flying overhead at OB 31, ~3.5 km east of the Study Area (ENV, 2011). This species is expected to utilize the skies above the Study Area sporadically in the summer months, being attracted to thunderstorms and cyclonic systems (Johnstone and Storr 1998).

Star Finch (western subspecies) (*Neochmia ruficauda subclarescens*)

The 'western' population of the Star Finch (western subspecies) is considered by the DPaW to represent a separate subspecies (*N. r. subclarescens*), distinct from Kimberley and Northern Territory birds (*N. r. clarescens*). These birds are generally uncommon and patchily distributed in the Pilbara and are listed as Priority 4 by the DPaW and as Near Threatened by the IUCN. The Star Finch prefers areas of dense vegetation, such as reedbeds (Johnstone and Storr 2004) and woodlands near water (Armstrong and Anstee 2000).

This species was recorded near the Ophthalmia Dam (~9.5 km west), and in Mulga immediately south of the Study Area (Outback Ecology Services 2009b). Suitable habitat for this species may be available at the Minor Drainage Lines and Gorge/ Gully in the Study Area, though they are quite limited in extent.



Table 5.3 Conservation significant fauna potentially occurring in the Study Area.

Species	Conservation Significance	Preferred Habitat	Extent of the habitat in the Study Area	Likelihood
Northern Quoll <i>Dasyurus hallucatus</i>	EPBC: Endangered WCA: Schedule 1 IUCN Endangered	Northern Quolls favour rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, Major Drainage Lines and treed creek lines, as well as structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs (DSEWPac 2011a).	The Study Area does not contain any Major Drainage Lines but contain rock outcrops and Gorge/ Gully habitats preferred by this species.	Unlikely- little suitable habitat present and the Study Area is at the southern extent of the species' range.
Greater Bilby <i>Macrotis lagotis</i>	EPBC: Vulnerable WCA: Schedule 1	Greater Bilbies prefer landforms with level to low slope topography and light to medium soils. Habitats include open tussock grassland on uplands and hills, Mulga woodland/ scrubland on ridges and rises and hummock grassland in plains and alluvial areas. Other habitats used by the species include stony downs, cracking clays, desert Sand Plains and dune fields, spinifex grassland and <i>Acacia</i> spp. scrublands on red earths (Johnson 2008; Southgate 1990a).	Sand Plains and Stony Plains are potential habitats and are widespread along the southern border of the Study Area.	Unlikely- the Study Area is at the southern end of the species' range.
Pilbara Leaf-nosed Bat <i>Rhinonictis aurantius</i>	EPBC: Vulnerable WCA: Schedule 1	This species requires warm (28–32 °C) and highly humid (96–100%) roost sites in caves and/or mine shafts. This is a result of their limited ability to conserve heat and water (Armstrong 2001).	No suitable roosting caves exist within the Study Area and this species has not been recorded in the immediate vicinity.	Unlikely- no known roost sites suitable for this species in the vicinity.
Northern Marsupial Mole <i>Notoryctes caurinus</i>	EPBC: Endangered WCA: Schedule 1	Sand dunes, inter-dunal flats and sandy soils along river flats.	No suitable habitat within the Study Area, though suitable habitat does occur further to the east.	Very unlikely- no suitable habitat present
Australian Bustard <i>Ardeotis australis</i>	DPaW: Priority 4 IUCN: LC	Open or lightly wooded grasslands (Johnstone and Storr, 1998).	Suitable habitat (Sand Plain, Stony Plain) common within the southern section of the Study Area and surrounding region.	Likely- suitable habitat present.
Bush Stone-curlew <i>Burhinus grallarius</i>	DPaW: Priority 4 IUCN: Near threatened	Inhabits areas of open forest and woodland with open areas, fallen dead timber or leaf litter. Inland, it is associated with watercourses.	Suitable habitat in the Study Area includes drainage areas and open areas fringed by denser woodland, such as the grooved woodlands within the Crest/Slope habitats.	Likely- suitable habitat present. The species was recorded ~1.9 km east of the Study Area at OB18 (ENV 2007).
Cattle Egret <i>Bubulcus ibis</i>	EPBC: Migratory WCA: Schedule 3	Prefers inundated grasslands and wetlands and occasionally use swamps with tall emergent vegetation, e.g. <i>Typha</i> sp. or wooded swamps (Johnstone and Storr 1998).	Preferred habitat of inundated grasslands and wetlands for this species are uncommon in the surrounding region. The nearest major water body is Ophthalmia Dam ~9.5 km west of the Study Area.	Unlikely- suitable habitat not present.
Eastern Great Egret <i>Ardea modesta</i>	EPBC: Migratory WCA: Schedule 3	This species occurs in shallows of rivers and freshwater wetlands, breeding in wooded swamps and river pools with <i>Eucalyptus camaldulensis</i> and <i>Melaleuca argentea</i> (Johnstone and Storr 1998).	The drainage lines across the Study Area do not have suitable pools or wooded swamps.	Unlikely- suitable habitat not present.
Oriental Plover <i>Charadrius veredus</i>	EPBC: Migratory WCA: Schedule 3	Inhabits dry grassland and thinly vegetated plains with much hard bare ground in inland. This includes areas that have been recently burnt, and areas of hard, stony, bare ground (Johnstone and Storr 1998).	The sparsely-vegetated open Stony Plains in the Study Area are marginally suitable for this species.	Possible- marginally suitable habitat present, and there is a single record within 30 km in the DPaW Threatened Species Database
Common Sandpiper <i>Actitis hypoleucos</i>	EPBC: Migratory WCA: Schedule 3	Mainly found in muddy edges or rocky shores in coastal or inland wetlands (Johnstone and Storr 1998).	No large water bodies are found in the vicinity of the Study Area; however small water bodies may occur along Minor Drainage Lines and within Gorge/ Gully habitats.	Unlikely- limited suitable habitat. A single individual was recorded ~2 km east of the Study Area at OB 18 (ENV 2007).
Fork-tailed Swift	EPBC: Migratory	This species is entirely aerial within the Pilbara. Fork-tailed Swifts may forage	It is likely that this species forage in most of	Likely- probable fly-over.



Species	Conservation Significance	Preferred Habitat	Extent of the habitat in the Study Area	Likelihood
<i>Apus pacificus</i>	WCA: Schedule 3	above many habitat types.	the habitat types in the area.	
Star Finch (western subspecies) <i>Neochmia ruficauda subclarescens</i>	DPaW: Priority 4 IUCN: Near Threatened	Prefers areas of dense vegetation, such as reed beds and woodlands near water (Johnstone and Storr 2004).	Suboptimal habitat could be present along Minor Drainage Lines and within Gorge/Gully habitats.	Possible - marginally suitable habitat present, though limited in extent. Recorded near Ophthalmia Dam, and in Mulga to the south of the Study Area (Outback Ecology Services 2009b).



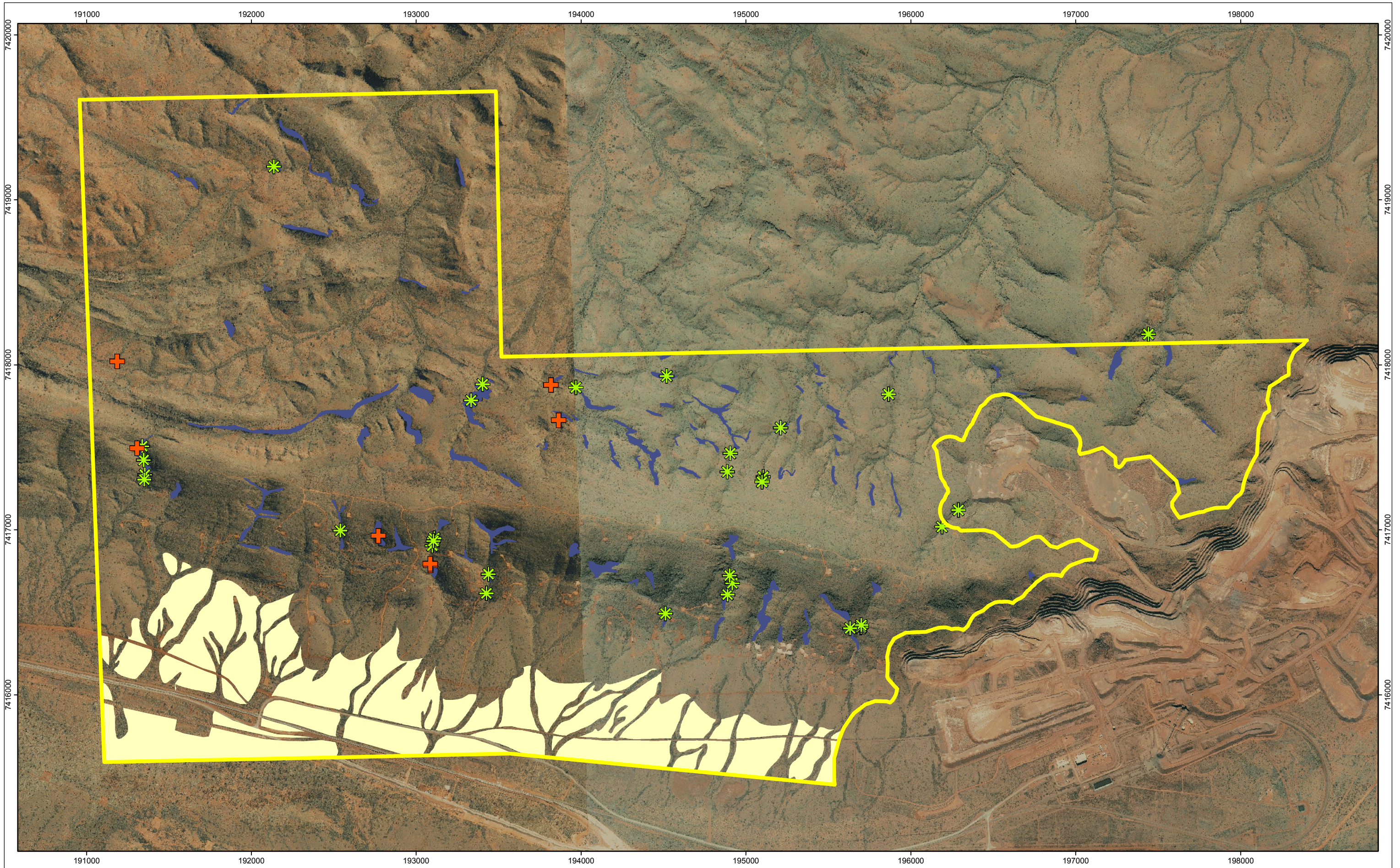
6 IMPORTANT FAUNA HABITATS

The expected faunal richness in an area is proportional to the amount of habitat variation and floristic diversity, since both of these factors influence the number of different habitats available for fauna. Accordingly, an area with high variation of habitat types is likely to harbour a higher diversity of fauna and *vice versa*. The OB 19 Study Area has relatively low habitat diversity with only five different habitats described.

Each of the fauna habitats identified in Section 4.5 was given a significance score of High, Medium or Low based on criteria outlined in Table 3.3. Sand Plains and Gorge/ Gully habitats were considered to be of High significance because they are most likely to support or provide areas of core habitat for a number of conservation significant species (Table 6.1). The important fauna habitats and features (caves and water pools) within the Study Area are shown on Figure 6.1.

Table 6.1 Fauna habitats with high significance scores.

Fauna habitat	Score	Rationale
Sand Plain	High	This habitat supports Brush-tailed Mulgara, providing suitable substrate for burrows and adequate food and shelter. It could also provides habitat for Greater Bilby (although unlikely), Australian Bustard, Bush Stone Curlew and Spotted Ctenotus.
Gorge/Gully	High	Gorge/Gully habitats within the Study Area represent habitat for Pilbara Olive Python. This habitat type also contains potential feeding areas for local populations of Ghost Bats and Pilbara Leaf-nosed Bats as they retain water during the dry season. They may also support the Pilbara Flat-headed Blind snake.





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FIGURE:	6.1	Date:	16 JAN. 2014
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Projection: MGA Zone 51

**BHPBIO
OB 19
SIGNIFICANT FAUNA HABITATS**

FIGURE 6.1

Legend

 Study	Significant Fauna Habitat Locations
 Cave	 Gorge/ Gully
 Rock Pool	 Sand Plain

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7 SUMMARY

The present survey is one of the 14 faunal studies conducted at and in the immediate vicinity of OB 19. There have been several additional faunal surveys of adjacent and nearby areas and a number of significant species have been recorded in the general area.

Upon completion of the current study, a total of 170 native vertebrate taxa have been recorded within the Study Area. This comprises 25 native mammal species, 76 bird species, 68 reptile species and one amphibian species. A further three species of introduced mammals have also been recorded. The current study recorded 136 species of native fauna (23 mammal, 62 bird, 48 reptile and one amphibian species) as well as two species of introduced mammals.

Six conservation significant species have been recorded within the Study Area: Brush-tailed Mulgara *Dasyercus blythi*, Ghost Bat *Macroderma gigas*, Western Pebble-mound Mouse *Pseudomys chapmani*, Rainbow Bee-eater *Merops ornatus*, Pilbara Olive Python *Liasis olivaceus barroni* and Pilbara Flat-headed Blind Snake *Ramphotyphlops ganei*. Based on records from the adjoining areas, an additional 12 species of conservation significant species comprising four species of mammals and eight species of birds, have been recorded in the vicinity of the Study Area. However, of these, only the Australian Bustard (likely), Bush Stone-curlew (likely), Fork-tailed Swift (likely), Oriental Plover (possible), and Star Finch (possible) may potentially occur within the Study Area due to availability of suitable habitats.

Of the five fauna habitats described, the most important were considered to be the Gorge/ Gully and Sand Plain habitats due to their importance for a number of conservation significant species including Brush-tailed Mulgara, Pilbara Olive Python, Ghost Bat and Pilbara Flat-headed Blind Snake.

Sufficient survey work has been undertaken to gain a good understanding of the species communities and habitats present within the Study Area. As with any fauna survey, a proportion of species that use the Study Area would not have been recorded, due to temporal and spatial changes in their distribution and the efficacy of survey techniques used. It is considered very likely that there are additional conservation significant species that use the Study Area, either permanently or seasonally, that have not yet been recorded. Additional surveys over a range of seasonal conditions are likely to determine the presence, and importance of the habitat for this species, within the Study Area.



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Appendix A Survey site locations

Methodology	Location	
Bat call recorders	-23.334272	120.0239
Bat call recorders	-23.327755	119.988
Bat call recorders	-23.331205	120.008
Bat call recorders	-23.327454	119.98
Bat call recorders	-23.325781	119.995
Bat call recorders	-23.325142	119.9992
Bat call recorders	-23.328442	120.0183
Bat call recorders	-23.333069	120.0182
Bat call recorders	-23.340027	120.0205
Bat call recorders	-23.32299	119.9818
Bat call recorders	-23.328304	120.0166
Bat call recorders	-23.330599	120.0277
Bat call recorders	-23.325569	120.0041
Bat call recorders	-23.329679	120.0371
Bat call recorders	-23.327662	120.0099
Bat call recorders	-23.325159	119.9884
Bat call recorders	-23.334211	120.0208
Bat call recorders	-23.330359	120.0027
Bat call recorders	-23.340425	119.9866
Bat call recorders	-23.327099	119.9822
Bat call recorders	-23.320255	120.0077
Bat call recorders	-23.328491	120.0299
Bat call recorders	-23.327372	120.0122
Bat call recorders	-23.327909	119.99
Birding	-23.341736	120.0197
Birding	-23.340027	120.0205
Birding	-23.334326	120.0179
Birding	-23.333374	119.9829
Birding	-23.331583	119.9839
Birding	-23.328442	120.0183
Birding	-23.325781	119.995
Birding	-23.325296	119.9996
Birding	-23.32443	119.9932
Birding	-23.325142	119.9992
Birding	-23.333069	120.0182
Birding	-23.340027	120.0205
Birding	-23.328329	120.0199
Birding	-23.332724	119.9775
Habitat Assessment	-23.32192	119.9942
Habitat Assessment	-23.32526	119.9839
Habitat Assessment	-23.334272	120.0239
Habitat Assessment	-23.327755	119.988



Habitat Assessment	-23.33066	120.0289
Habitat Assessment	-23.323231	120.0168
Habitat Assessment	-23.331909	119.9998
Habitat Assessment	-23.33057	119.9878
Habitat Assessment	-23.333113	120.016
Habitat Assessment	-23.331205	120.008
Habitat Assessment	-23.327454	119.98
Habitat Assessment	-23.322954	120.0383
Habitat Assessment	-23.322786	120.0474
Habitat Assessment	-23.319441	120.0397
Habitat Assessment	-23.321228	120.0335
Habitat Assessment	-23.32443	119.9932
Habitat Assessment	-23.325142	119.9992
Habitat Assessment	-23.334892	119.9803
Habitat Assessment	-23.333069	120.0182
Habitat Assessment	-23.319414	119.9796
Habitat Assessment	-23.320715	120.0171
Habitat Assessment	-23.332735	120.0127
Habitat Assessment	-23.320362	119.9973
Habitat Assessment	-23.325569	120.0041
Habitat Assessment	-23.328304	120.0166
Habitat Assessment	-23.330599	120.0277
Habitat Assessment	-23.32299	119.9818
Habitat Assessment	-23.32638	120.0264
Habitat Assessment	-23.320255	120.0077
Habitat Assessment	-23.329744	119.9915
Habitat Assessment	-23.315792	119.9824
Habitat Assessment	-23.307007	119.9842
Habitat Assessment	-23.310869	119.996
Habitat Assessment	-23.329679	120.0371
Habitat Assessment	-23.327662	120.0099
Habitat Assessment	-23.325159	119.9884
Habitat Assessment	-23.315531	119.9866
Habitat Assessment	-23.31414	119.9926
Habitat Assessment	-23.340027	120.0205
Habitat Assessment	-23.328329	120.0199
Habitat Assessment	-23.326366	119.9932
Habitat Assessment	-23.328979	119.9979
Habitat Assessment	-23.339319	120.0059
Habitat Assessment	-23.332724	119.9775
Habitat Assessment	-23.337309	119.9797
Habitat Assessment	-23.334211	120.0208
Habitat Assessment	-23.330359	120.0027
Habitat Assessment	-23.340425	119.9866
Habitat Assessment	-23.327099	119.9822



Habitat Assessment	-23.328491	120.0299
Habitat Assessment	-23.327372	120.0122
Habitat Assessment	-23.327909	119.99
Habitat Assessment	-23.327986	120.0294
Remote cameras	-23.334272	120.0239
Remote cameras	-23.327755	119.988
Remote cameras	-23.331909	119.9998
Remote cameras	-23.33057	119.9878
Remote cameras	-23.333113	120.016
Remote cameras	-23.327454	119.98
Remote cameras	-23.326366	119.9932
Remote cameras	-23.332735	120.0127
Remote cameras	-23.325569	120.0041
Remote cameras	-23.328304	120.0166
Remote cameras	-23.330599	120.0277
Remote cameras	-23.32299	119.9818
Remote cameras	-23.329744	119.9915
Remote cameras	-23.329679	120.0371
Remote cameras	-23.327662	120.0099
Remote cameras	-23.325159	119.9884
Remote cameras	-23.339319	120.0059
Remote cameras	-23.334211	120.0208
Remote cameras	-23.330359	120.0027
Remote cameras	-23.339563	120.006
Remote cameras	-23.340425	119.9866
Remote cameras	-23.327099	119.9822
Remote cameras	-23.32526	119.9839
Remote cameras	-23.321167	120.0081
Remote cameras	-23.320255	120.0077
Remote cameras	-23.327986	120.0294
Trapping site	-23.32443	119.9932
Trapping site	-23.325142	119.9992
Trapping site	-23.333069	120.0182
Trapping site	-23.340027	120.0205
Trapping site	-23.328329	120.0199
Trapping site	-23.332724	119.9775

**Appendix B** Conservation status codes**International Union for Conservation of Nature**

Category	Definition
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CE)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future
Data Deficient (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

**Environment Protection and Biodiversity Conservation Act 1999**

Category	Definition
Extinct (EX)	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild (EW)	Taxa known to survive only in captivity.
Critically Endangered (CE)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (VU)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Migratory (MG)	Consists of species listed under the following International Conventions: Japan-Australia Migratory Bird Agreement (JAMBA) China-Australia Migratory Bird Agreement (CAMBA) Convention on the Conservation of Migratory Species of Wild animals (Bonn Convention)

Wildlife Conservation Act 1950

Category	Definition
Schedule 1 (S1)	Rare and Likely to become Extinct.
Schedule 2 (S2)	Extinct.
Schedule 3 (S3)	Migratory species listed under international treaties.
Schedule 4 (S4)	Other Specially Protected Fauna.

Department of Environment and Conservation Priority codes

Category	Definition
Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4 (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.



Appendix C Fauna recorded in the Study Area and region

EPBC Protected Matters search with 5 km buffer

DPaW Threatened Species Database search within 5 km buffer

Surveys

- A West Jimblebar Fauna Assessment (ENV Australia 2007)
- B Orebody 18 Biological Assessment Survey (ecologia Environmental 1995)
- C Orebody 18 Fauna Assessment Phase II (ENV Australia 2007a)
- D Orebody 31 Fauna Assessment. (ENV Australia 2011)
- E Jimblebar Mine Site Biological Survey. BHP (BHP Iron Ore Pty Ltd 1994)
- F Wheelara Hill Iron Ore Mine Modification: Fauna and Flora Assessment, (Outback Ecology Services 2009c)
- G Jimblebar Iron Ore Project: Terrestrial Vertebrate Fauna Assessment. (Outback Ecology Services 2009a)
- H Jimblebar - Wheelara Hill Biological Survey. (ecologia Environmental 2004)
- I BHPBIO Hashimoto Terrestrial Vertebrate Fauna Assessment. (ecologia Environmental 2006a)
- J Jimblebar Marra Mamba Exploration Biological Survey. (ecologia Environmental 2006b)
- K East Jimblebar Exploration Project Biological Survey. (ecologia Environmental 2005)
- L Current survey

Mammals

Family and Species	Common Name	EPBC	WCA	DPaW	IUCN	DPaW Nature Map	EPBC Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L	
TACHYGLOSSIDAE																				
<i>Tachyglossus aculeatus</i>	Echidna														•					•
DASYURIDAE																				
<i>Dascycercus sp.</i>	Mulgara																			•
<i>Dasykaluta rosamondae</i>	Little Red Kaluta					•						•	•	•	•	•				•
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1		EN		•													
<i>Ningau timealeyi</i>	Pilbara Ningau					•			•						•	•				•
<i>Planigale maculata</i>	Common Planigale								•											
<i>Pseudantechinus roryi</i>	Rory's Pseudantechinus					•														
<i>Pseudantechinus macdonnellensis</i>	Fat-tailed Antechinus								•			•								
<i>Pseudantechinus woolleyae</i>	Woolley's Pseudantechinus					•														•
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart												•	•		•				•
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart												•	•		•				•
<i>Sminthopsis youngsoni</i>	Lesser Hairy-footed Dunnart					•							•	•						•
THYLACOMYIDAE																				



<i>Macrotis lagotis</i>	Bilby, Dalgyte	VU	S1		VU		•												
NOTORYCIDAE																			
<i>Notoryctes caurinus</i>	Northern Marsupial Mole	EN	S1		EN		•												
MACROPODIDAE																			
<i>Macropus robustus</i>	Common Wallaroo							•	•	•		•	•	•	•	•	•	•	•
<i>Macropus rufus</i>	Red Kangaroo, Marlu							•			•		•	•		•	•	•	
<i>Petrogale sp.</i>	Rock-wallaby													•					
<i>Petrogale rothschildi</i>	Rothschild's Rock-wallaby								•	•									•
MEGADERMATIDAE																			
<i>Macroderma gigas</i>	Ghost Bat			P4	VU												•		•
HIPPOSIDERIDAE																			
<i>Rhinonicteris aurantia</i>	Pilbara Leaf-nosed Bat	VU	S1				•										•		
EMBALLONURIDAE																			
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat																•		•
<i>Taphozous georgianus</i>	Common Sheathtail-bat								•								•		•
<i>Taphozous hilli</i>	Hill's Sheathtail-bat																		•
MOLOSSIDAE																			
<i>Chaerephon jobensis</i>	Northern Freetail-bat																		•
<i>Mormopterus beccarii</i>	Beccari's Freetail-bat																•		
VESPERTILIONIDAE																			
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat									•	•						•	•	•
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat									•							•		•
<i>Scotorepens greyii</i>	Little Broad-nosed Bat									•	•						•	•	•
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat						•			•	•			•			•	•	•
MURIDAE																			
<i>*Mus musculus</i>	House Mouse						•	•	•	•		•	•	•	•	•	•		•
<i>Notomys alexis</i>	Spinifex Hopping-mouse									•							•		•
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4			•				•	•	•	•	•		•		•
<i>Pseudomys desertor</i>	Desert Mouse									•				•	•				•
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse						•			•	•		•	•	•	•	•		•
<i>Zyzomys argurus</i>	Common Rock-rat						•		•	•	•		•		•	•	•		•
BOVIDAE																			
<i>*Bos taurus</i>	European Cattle						•		•			•		•	•		•	•	
CANIDAE																			
<i>Canis lupus dingo</i>	Dingo												•	•	•		•	•	•
<i>*Canis lupus</i>	Dog						•	•											
<i>*Vulpes vulpes</i>	Red Fox						•			•									
CAMELIDAE																			



* <i>Camelus dromedarius</i>	Dromedary, Camel								•	•									•	
EQUIDAE																				
* <i>Equus asinus</i>	Donkey								•			•			•				•	
* <i>Equus caballus</i>	Horse								•	•				•						
FELIDAE																				
* <i>Felis catus</i>	Cat								•			•		•	•				•	•
LEPORIDAE																				
* <i>Oryctolagus cuniculus</i>	Rabbit								•					•						

Birds

Family and Species	Common Name	EPBC	WCA	DPaW	NDNI	DPaW Nature Map	EPBC Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L	
CASUARIIDAE																				
<i>Dromaius novaehollandiae</i>	Emu					•		•	•	•		•								
PHASIANIDAE																				
<i>Coturnix pectoralis</i>	Stubble Quail																		•	
<i>Coturnix ypsilophora</i>	Brown Quail															•				
ANATIDAE																				
<i>Chenonetta jubata</i>	Australian Wood Duck															•				
<i>Cygnus atratus</i>	Black Swan														•					
<i>Tadorna tadornoides</i>	Australian Shelduck															•				
RALLIDAE																				
<i>Gallinula ventralis</i>	Black-tailed Native-hen															•				
COLUMBIDAE																				
<i>Geophaps plumifera</i>	Spinifex Pigeon					•		•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Geopelia cuneata</i>	Diamond Dove					•		•	•	•	•	•			•	•	•	•	•	•
<i>Geopelia striata</i>	Peaceful Dove					•										•				
<i>Ocyphaps lophotes</i>	Crested Pigeon					•		•		•	•	•		•	•	•	•	•	•	•
<i>Phaps chalcoptera</i>	Common Bronzewing					•		•		•	•	•			•	•			•	•
PODARGIDAE																				
<i>Podargus strigoides</i>	Tawny Frogmouth					•				•					•	•			•	
EUROSTOPODIDAE																				
<i>Eurostopodus argus</i>	Spotted Nightjar					•		•	•	•	•					•	•	•	•	
AEGOTHELIDAE																				



<i>Aegotheles cristatus</i>	Australian Owlet-nightjar					•			•	•	•	•				•		•	•
APODIDAE																			
<i>Apus pacificus</i>	Fork-tailed Swift	MG	S3				•				•								
PHALACROCORACIDAE																			
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant															•			
ARDEIDAE																			
<i>Ardea ibis</i>	Cattle Egret	MG	S3				•												
<i>Ardea modesta</i>	Eastern Great Egret	MG	S3				•												
<i>Ardea pacifica</i>	White-necked Heron																	•	
<i>Egretta novaehollandiae</i>	White-faced Heron															•	•		
ACCIPITRIDAE																			
<i>Aquila audax</i>	Wedge-tailed Eagle					•		•		•	•		•	•	•	•	•	•	•
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk							•											•
<i>Accipiter fasciatus</i>	Brown Goshawk					•		•						•	•	•	•	•	•
<i>Circus assimilis</i>	Spotted Harrier								•							•	•	•	•
<i>Elanus axillaris</i>	Black-shouldered Kite							•	•	•								•	•
<i>Haliastur sphenurus</i>	Whistling Kite					•		•	•	•				•		•	•	•	•
<i>Milvus migrans</i>	Black Kite					•				•				•		•	•	•	•
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard					•				•				•		•	•	•	•
<i>Hieraetus morphnoides</i>	Little Eagle							•						•		•		•	
FALCONIDAE																			
<i>Falco berigora</i>	Brown Falcon					•		•	•	•	•		•	•	•	•	•	•	•
<i>Falco cenchroides</i>	Nankeen Kestrel					•		•	•	•	•	•		•	•	•	•	•	•
<i>Falco longipennis</i>	Australian Hobby															•	•		•
<i>Falco peregrinus</i>	Peregrine Falcon		S4					•											
OTIDIDAE																			
<i>Ardeotis australis</i>	Australian Bustard			P4	NT			•	•		•			•		•	•	•	
BURHINIDAE																			
<i>Burhinus grallarius</i>	Bush Stone-curlew			P4	NT	•				•				•	•				
CHARADRIIDAE																			
<i>Charadrius veredus</i>	Oriental Plover	MG	S3				•												
<i>Euseyonis melanops</i>	Black-fronted Dotterel																	•	
SCOLOPACIDAE																			
<i>Actitis hypoleucos</i>	Common Sandpiper	MG	S3			•				•									
TURNICIDAE																			
<i>Turnix velox</i>	Little Button-quail					•		•	•	•	•					•	•		•
CACATUIDAE																			
<i>Eolophus roseicapillus</i>	Galah					•		•	•	•	•	•				•	•	•	•



<i>Cacatua sanguinea</i>	Little Corella							•	•					•	•	•			
<i>Nymphicus hollandicus</i>	Cockatiel					•		•		•	•					•	•		
PSITTACIDAE																			
<i>Barnardius zonarius</i>	Australian Ringneck							•	•					•	•	•	•	•	•
<i>Psephotus varius</i>	Mulga Parrot							•											
<i>Melopsittacus undulatus</i>	Budgerigar					•		•	•	•	•	•		•		•	•	•	•
<i>Neopsephotus bourkii</i>	Bourke's Parrot							•								•			
CUCULIDAE																			
<i>Centropus phasianinus</i>	Pheasant Coucal																•		
<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo					•		•	•		•		•		•	•	•		
<i>Chalcites osculans</i>	Black-eared Cuckoo															•			
<i>Cacomantis pallidus</i>	Pallid Cuckoo					•		•	•	•	•					•	•		
STRIGIDAE																			
<i>Ninox novaeseelandiae</i>	Southern Boobook							•			•		•		•				
TYTONIDAE																			
<i>Tyto alba</i>	Barn Owl													•	•				•
HALCYONIDAE																			
<i>Dacelo leachii</i>	Blue-winged Kookaburra																•		
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher					•		•	•	•	•			•	•	•	•	•	•
<i>Todiramphus sanctus</i>	Sacred Kingfisher															•		•	
MEROPIIDAE																			
<i>Merops ornatus</i>	Rainbow Bee-eater	MG	S3			•	•	•					•	•	•	•	•	•	•
CLIMACTERIDAE																			
<i>Climacteris melanura</i>	Black-tailed Treecreeper																•		
PTILINORHYNCHIDAE																			
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird							•								•	•		•
MALURIDAE																			
<i>Amytornis striatus whitei</i>	Striated Grasswren					•			•	•	•	•		•	•	•			•
<i>Malurus lamberti</i>	Variiegated Fairy-wren					•		•	•	•	•	•	•	•	•	•	•	•	•
<i>Malurus leucopterus</i>	White-winged Fairy-wren					•		•						•	•	•	•	•	•
<i>Malurus splendens</i>	Splendid Fairy-wren							•											
<i>Stipiturus ruficeps</i>	Rufous-crowned Emu-wren																•		
ACANTHIZIDAE																			
<i>Pyrrholaemus brunneus</i>	Redthroat							•											
<i>Smicronis brevirostris</i>	Weebill					•		•		•	•	•	•	•	•	•	•	•	•
<i>Gerygone fusca</i>	Western Gerygone					•		•		•			•	•				•	•
<i>Acanthiza apicalis</i>	Inland Thornbill							•					•	•				•	•
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill					•		•									•	•	



<i>Artamus personatus</i>	Masked Woodswallow													•	•			•		•
<i>Cracticus nigrogularis</i>	Pied Butcherbird					•		•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Cracticus tibicen</i>	Australian Magpie					•		•		•	•	•	•	•	•			•		•
<i>Cracticus torquatus</i>	Grey Butcherbird							•			•	•				•	•	•	•	
RHIPIDURIDAE																				
<i>Rhipidura albiscapa</i>	Grey Fantail							•												
<i>Rhipidura leucophrys</i>	Willie Wagtail					•		•	•	•		•	•	•	•	•	•	•	•	•
CORVIDAE																				
<i>Corvus bennetti</i>	Little Crow																		•	
<i>Corvus coronoides</i>	Australian Raven																			•
<i>Corvus orru</i>	Torresian Crow					•		•		•		•	•	•	•	•	•	•	•	•
MONARCHIDAE																				
<i>Grallina cyanoleuca</i>	Magpie-lark					•		•		•			•	•	•	•	•	•	•	•
PETROICIDAE																				
<i>Petroica goodenovii</i>	Red-capped Robin					•		•				•	•	•			•	•	•	•
<i>Melanodryas cucullata</i>	Hooded Robin							•	•	•	•	•		•	•	•	•	•	•	•
ALAUDIDAE																				
<i>Mirafrja javanica</i>	Horsfield's Bushlark							•					•	•			•			
MEGALURIDAE																				
<i>Cincloramphus cruralis</i>	Brown Songlark							•			•					•				
<i>Cincloramphus mathewsi</i>	Rufous Songlark					•		•		•	•					•	•	•		•
<i>Eremiornis carteri</i>	Spinifexbird					•		•	•	•		•			•	•		•		•
HIRUNDINIDAE																				
<i>Cheramoeca leucosterna</i>	White-backed Swallow												•		•	•	•	•		
<i>Petrochelidon ariel</i>	Fairy Martin																			•
NECTARINIIDAE																				
<i>Dicaeum hirundinaceum</i>	Mistletoebird																	•	•	•
ESTRILDIDAE																				
<i>Emblema pictum</i>	Painted Finch					•		•	•	•	•					•	•	•		•
<i>Taeniopygia guttata</i>	Zebra Finch					•		•	•	•	•	•	•	•	•	•	•	•	•	•
MOTACILLIDAE																				
<i>Anthus australis</i>	Australasian Pipit																		•	•
<i>Anthus novaeseelandiae</i>	Richard's Pipit							•	•	•			•		•	•	•			



Reptiles

Family and Species	Common Name	EPBC	WCA	DPaW	IUCN	DPaW Nature Map	EPBC Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L
CHELUIDAE																			
<i>Chelodina steindachneri</i>	Flat-shelled Turtle															•	•		
AGAMIDAE																			
<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon							•	•	•	•		•	•	•	•	•	•	•
<i>Ctenophorus isolepis</i>	Crested Dragon					•			•		•						•	•	
<i>Ctenophorus nuchalis</i>	Central Netted Dragon							•	•				•	•		•			
<i>Ctenophorus reticulatus</i>	Western Netted Dragon									•							•		
<i>Diporiphora valens</i>										•									
<i>Lophognathus longirostris</i>	Long-nosed Dragon							•							•	•	•	•	
<i>Pogona minor</i>								•	•	•						•	•		•
DIPLODACTYLIDAE																			
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko					•			•				•	•		•		•	•
<i>Diplodactylus savagei</i>	Yellow-spotted Pilbara Gecko									•									•
<i>Lucasium stenodactylum</i>	Pale-snouted Ground Gecko					•		•		•			•	•	•	•		•	•
<i>Lucasium wombeyi</i>								•		•					•	•			•
<i>Oedura marmorata</i>	Marbled Velvet Gecko							•			•								•
<i>Rhynchoedura ornata</i>	Beaked Gecko					•			•	•						•		•	
<i>Strophurus ciliaris</i>																			•
<i>Strophurus elderi</i>										•					•				•
<i>Strophurus jeanae</i>																			•
<i>Strophurus wellingtonae</i>								•		•						•		•	•
CARPHODACTYLIDAE																			
<i>Nephrurus wheeleri</i>																		•	
GEKKONIDAE																			
<i>Gehyra pilbara</i>						•		•	•										
<i>Gehyra punctata</i>	Spotted Rock Dtella					•		•	•	•	•	•		•		•	•		•
<i>Gehyra purpurascens</i>																•			
<i>Gehyra variegata</i>	Tree Dtella					•		•	•	•	•	•	•	•	•	•	•	•	•
<i>Heteronotia binoei</i>	Bynoe's Gecko					•		•	•	•	•		•	•	•	•		•	•
<i>Heteronotia spelea</i>	Desert Cave Gecko									•	•				•	•			•
PYGOPODIDAE																			
<i>Delma butleri</i>	Unbanded Delma									•									•



<i>Menetia greyii</i>	Dwarf Skink					•			•	•				•		•	•		•
<i>Morethia ruficauda</i>	Fire-tailed Skink					•		•	•	•		•		•	•				•
<i>Tiliqua multifasciata</i>	Central Blue-tongue								•			•	•	•	•	•	•	•	•
VARANIDAE																			
<i>Varanus acanthurus</i>	Spiny-tailed Monitor					•		•	•	•	•			•	•	•	•		•
<i>Varanus caudolineatus</i>	Stripe-tailed Monitor							•					•	•			•		
<i>Varanus eremius</i>	Desert Pygmy Monitor							•		•									
<i>Varanus giganteus</i>	Perentie								•								•		•
<i>Varanus gouldii</i>	Bungarra or Sand Monitor					•		•		•				•		•			
<i>Varanus panoptes</i>	Yellow-spotted Monitor							•						•	•			•	
<i>Varanus pilbarensis</i>	Pilbara Rock Monitor					•			•										•
<i>Varanus tristis</i>	Black-headed Monitor								•	•		•	•	•	•	•	•		•
TYPHLOPIDAE																			
<i>Ramphotyphlops ammodytes</i>									•										
<i>Ramphotyphlops ganei</i>	Pilbara Flat-headed Blindsnake				1	•				•									•
<i>Ramphotyphlops grypus</i>						•			•	•				•	•				•
<i>Ramphotyphlops hamatus</i>													•	•		•			•
<i>Ramphotyphlops waitii</i>																			•
BOIDAE																			
<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	S1																•
ELAPIDAE																			
<i>Brachyuropsis approximans</i>														•					•
<i>Demansia psammophis</i>	Yellow-faced Whipsnake					•		•		•					•	•	•	•	•
<i>Demansia rufescens</i>	Rufous Whipsnake									•									•
<i>Furina ornata</i>	Moon Snake							•											•
<i>Pseudechis australis</i>	Mulga Snake												•	•	•	•	•		•
<i>Pseudonaja modesta</i>	Ringed Brown Snake														•				•
<i>Pseudonaja mengdeni</i>													•	•		•		•	•
<i>Suta punctata</i>	Spotted Snake																•		







Amphibians





Family and Species	Common Name	EPBC	WCA	DPaW	IUCN	DPaW Nature Map	EPBC Protected Matters	A	B	C	D	E	F	G	H	I	J	K	L
HYLIDAE																			
<i>Cyclorana maini</i>	Main's Frog															•		•	
<i>Cyclorana platycephala</i>	Water-Holding Frog															•			
<i>Litoria rubella</i>	Desert Tree Frog										•			•	•	•	•	•	•
MYOBATRACHIDAE																			
<i>Uperoleia russelli</i>	Russell's Toadlet													•	•	•		•	
LIMNODYNASTIDAE																			
<i>Neobatrachus centralis</i>	Desert Trilling Frog														•				
<i>Notaden nichollsi</i>	Desert Spadefoot														•				
<i>Platyplectrum spenceri</i>	Centralian Burrowing Frog														•	•		•	







Appendix D Habitat Assessment

Round	Site	Position	Fauna habitat type	Broad floristic formation	Photo	Density of trees (>5m)	Density of trees (2-5m)	Density of shrubs (2 m)	Density of shrubs (1-2 m)	Density of shrubs (0.5-1 m)	Density of spinifex	Density of soft grasses	Density of sedges	Density of herbs	Presence of mistletoes
1	1	-23.32192 119.99424	Gorge/ Gully	low spinifex grassland		2	2	2	6	2	50	2	0	2	0
1	2	-23.32526 119.983887	Gorge/ Gully	open spinifex grassland		2	2	2	6	2	20	6	0	2	0
1	3	-23.334272 120.02388	Gorge/ Gully	open low spinifex grassland		2	6	6	2	2	20	6	0	2	0
1	4	-23.327755 119.988007	Gorge/ Gully	low spinifex grassland		2	2	2	6	2	50	2	0	2	0







1	5	-23.33066 120.028938	Crest/ Slope	low open spinifex grassland		0	2	0	6	20	20	2	0	2	0
1	6	-23.323231 120.01683	Gorge/ Gully	mid spinifex grassland		2	2	2	6	2	50	2	2	0	0
1	7	-23.331909 119.999771	Crest/ Slope	low open woodland		0	20	6	6	2	50	2	0	2	0
1	8	-23.33057 119.987808	Minor Drainage Line	low open woodland		0	20	6	2	2	50	0	0	0	0







1	9	-23.333113 120.015953	Gorge/ Gully	open spinifex grassland		2	6	2	2	2	50	6	0	2	0
1	10	-23.331205 120.007973	Crest/ Slope	low spinifex grassland		0	6	0	2	2	50	2	0	2	0
1	11	-23.327454 119.97995	Minor Drainage Line	clustered mid shrubland		0	2	20	6	2	20	6	0	2	0
1	12	-23.322954 120.038345	Crest/ Slope	low spinifex grassland		0	2	2	2	20	50	0	0	0	0







1	13	-23.322786 120.047363	Crest/ Slope	low open spinifex grassland		0	6	2	6	6	50	0	0	0	0
1	14	-23.319441 120.03968	Gorge/ Gully	spinifex grassland		0	2	2	6	6	50	6	2	2	0
1	15	-23.321228 120.033516	Gorge/ Gully	sparse low soft grassland		2	2	2	0	2	6	20	0	2	0
1	16	-23.32443 119.993248	Crest/ Slope	low spinifex grassland		0	2	2	6	6	50	0	0	0	0







1	17	-23.325142 119.999184	Crest/ Slope	mid-low shrubland		0	0	20	6	20	20	0	0	2	0
1	18	-23.334892 119.980255	Stony Plain	low shrubland		0	2	6	50	6	20	6	0	2	0
1	19	-23.333069 120.01815	Gorge/ Gully	mid spinifex grassland		2	6	6	6	2	50	6	0	2	0
1	20	-23.319414 119.979591	Crest/ Slope	open acacia and eucaly pts with ftiodia pungens		0	6	6	20	50	85	0	0	0	0





1	21	-23.320715 120.017105	Gorge/ Gully	Small gorge with triodia		6	2	20	20	6	85	20	0	0	
1	22	-23.332735 120.012665	Gorge/ Gully	Corymbia open woodland		0	2	6	6	6	20	6	0	0	0
1	23	-23.320362 119.997284	Gorge/ Gully	mixed acacia shrubland		0	2	6	6	6	20	6	0	0	0
1	24	-23.325569 120.004135	Gorge/ Gully	spinifex grassland		0	0	2	6	6	50	0	0	0	0



1	25	-23.328304 120.016556	Crest/ Slope	spinifex grassland		0	0	2	2	2	50	0	0	0	0
1	26	-23.330599 120.027672	Crest/ Slope	spinifex grassland		0	0	2	6	20	50	0	0	0	0
1	27	-23.32299 119.981834	Gorge/ Gully	mixed acacia shrubland		0	0	6	6	6	2	20	0	0	0
1	28	-23.32638 120.026398	Gorge/ Gully	small fig thicket		0	50	0	0	0	0	6	0	0	0



1	29	-23.320255 120.007652	Crest/ Slope	spinifex grassland		0	2	0	2	2	20	0	0	0	0
1	30	-23.329744 119.991501	Crest/ Slope	spinifex grassland		0	2	0	2	6	50	0	0	0	0
1	31	-23.315792 119.982437	Crest/ Slope	spinifex grassland		0	0	2	2	6	50	2	0	2	0
1	32	-23.307007 119.98423	Crest/ Slope	spinifex grassland		0	2	2	2	2	50	0	0	0	0







1	33	-23.310869 119.99601	Minor Drainage Line	mixed acacia shrubland		0	2	20	6	6	0	50	0	2	1
1	34	-23.329679 120.03714	Crest/ Slope	spinifex grassland		0	0	2	2	2	20	0	0	0	0
1	35	-23.327662 120.009941	Crest/ Slope	spinifex grassland		0	2	2	2	6	50	0	0	0	0
1	36	-23.325159 119.988396	Gorge/ Gully	spinifex grassland		0	2	2	6	6	50	0	0	0	0



1	37	-23.315531 119.986641	Gorge/ Gully	spinifex grassland		0	2	2	2	2	50	2	0	2	0
1	38	-23.31414 119.992592	Crest/ Slope	spinifex grassland		0	2	2	2	6	50	0	0	0	0
1	39	-23.340027 120.020508	Stony/ Sand Plain	Mixed shrubland over spinifex		0	0	20	6	6	20	20	0	6	0
1	40	-23.328329 120.01992	Crest/ Slope	spinifex grassland		0	2	2	2	6	50	0	0	0	1







1	41	-23.326366 119.993233	Gorge/ Gully	spinifex grassland		0	2	2	6	6	50	0	0	2	0
1	42	-23.328979 119.997948	Gorge/ Gully	spinifex grassland		0	0	0	2	6	50	0	0	0	0
1	43	-23.339319 120.005943	Sand Plain	sof open grassland		0	0	6	6	6	0	50	0	6	0
1	44	-23.332724 119.977539	Stony Plain	spinifex grassland		0	0	6	6	6	50	0	0	0	0



1	45	-23.337309 119.979668	Sand Plain	spinifex grassland		0	2	2	6	6	50	6	0	2	0
2	1	-23.334211 120.020798	Gorge/ Gully	spinifex grassland		0	2	2	2	2	50	2	0	0	0
2	2	-23.330359 120.00267	Crest/ Slope	spinifex grassland		0	2	2	2	2	50	0	0	0	0
2	3	-23.340425 119.986641	Sand Plain	eucalyptus open woodland		0	20	20	6	6	20	0	0	0	0



2	4	-23.327099 119.982224	Crest/ Slope	spinifex grassland		0	2	2	2	2	50	2	0	0	0
2	5	-23.328491 120.029915	Crest/ Slope	loW spinifex grassland		0	2	0	6	20	50	0	0	0	0
2	6	-23.327372 120.012177	Crest/ Slope	loW spinifex grassland		2	6	2	6	20	50	2	0	0	0
2	7	-23.327909 119.990036	Crest/ Slope	loW spinifex grassland		2	6	2	6	6	50	0	0	2	0




2	8	-23.327986 120.029366	Gorge/ Gully	low open spinifex grassland		0	2	2	6	6	20	2	0	2	0
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Table contd.

Round	Site	Bare ground cover	Leaf litter cover	Twig litter cover	Logs cover	Hollow bearing trees	Landform	Soil type	Soil colour	Rock size	Rocky outcropping	Soil comments
1	1	50	2	2	0	3	Gully (GUL)	Loamy Sand	Brown	Small cobbles	Present	ironstone
1	2	40	30	5	5	1	Hillslope (HSL)	Sandy clay loam	Orange	Boulders	Present	
1	3	50	10	5	2	2	Gully (GUL)	Sandy clay loam	Brown	Boulders	Present	ironstone
1	4	50	5	2	0	0	Gully (GUL)	Clayey Sand	Orange	Large cobbles	Present	ironstone
1	5	50	2	0	0	0	Hillcrest (HCR)	Clayey Sand	Red	Small cobbles	Present	ironstone
1	6	40	5	2	0	0	Gully (GUL)	Clayey Sand	Orange	Small cobbles	Present	ironstone
1	7	50	10	5	2	0	Hillslope (HSL)	Sandy clay loam	Brown	Small cobbles	Present	ironstone
1	8	30	20	10	2	3	Hillslope (HSL)	Sandy clay loam	Brown	Coarse gravel	Present	ironstone
1	9	40	10	2	2	0	Gully (GUL)	Sandy clay loam	Brown	Boulders	Present	ironstone
1	10	50	2	0	0	1	Hillslope (HSL)	Sandy clay loam	Orange	Large cobbles	Present	ironstone
1	11	60	5	5	2	0	Gully (GUL)	Sandy clay loam	Orange	Boulders	Present	ironstone
1	12	40	2	2	0	0	Hillcrest (HCR)	Sandy clay loam	Orange	Coarse gravel	Present	ironstone
1	13	60	2	2	0	0	Hillslope (HSL)	Sandy clay loam	Orange	Coarse gravel	Present	ironstone
1	14	40	5	5	2	0	Gully (GUL)	Sandy clay loam	Brown	Boulders	Present	ironstone
1	15	70	5	2	2	0	Gully (GUL)	Sandy clay loam	Red	Boulders	Present	ironstone
1	16	40	2	0	0	0	Hillslope (HSL)	Sandy clay loam	Red	Coarse gravel	Absent	ironstone
1	17	50	10	5	5	0	Hillslope (HSL)	Sandy clay loam	Orange	Small cobbles	Present	ironstone
1	18	60	10	5	0	0	Plain (PLA)	Clayey Sand	Orange	Coarse gravel	Absent	quartz ironstone
1	19	30	10	5	5	5	Gully (GUL)	Clay loam	Orange	Boulders	Present	ironstone
1	20	30	0	2	0	0	Hillslope (HSL)	Clay loam, sandy	Red		Present	
1	21	40	0	0	2	1	Gully (GUL)	Loamy Sand	Red	Boulders	Present	
1	22	30	2	2	2	0	Gully (GUL)	Silty loam	Red	Large cobbles	Present	bif
1	23	20	2	5	5	1	Gully (GUL)	Silty loam	Red	Boulders	Present	bif
1	24	30	10	2	0	0	Gully (GUL)	Silty loam	Red	Boulders	Present	bif
1	25	30	2	2	0	0	Hillslope (HSL)	Silty loam	Red	Boulders	Present	bif
1	26	20	0	0	0	0	Hillslope (HSL)	Silty loam	Red	Small cobbles	Present	



1	27	20	2	2	0	0	Gully (GUL)	Silty loam	Red	Boulders	Present	bif
1	28	30	30	20	2	0	Gully (GUL)	Silty loam	Red	Large cobbles	Present	bif
1	29	50	0	0	0	0	Hillslope (HSL)	Silty loam	Red	Small cobbles		bif
1	30	30	0	0	0	0	Hillslope (HSL)	Silty loam	Red	Boulders	Present	bif
1	31	30	0	0	0	0	Hillcrest (HCR)	Silty loam	Brown	Large cobbles	Present	basalt
1	32	20	0	0	0	0	Hillslope (HSL)	Silty loam	Red	Small cobbles	Present	not sure about rock types
1	33	10	40	30	2	0	Bank (stream bank) (BAN)	Sandy loam	Red	Coarse gravel	Absent	mixed rock types mostly basalt
1	34	60	0	0	0	0	Hillcrest (HCR)	Silty loam	Red	Coarse gravel	Present	bif
1	35	40	0	2	0	0	Hillslope (HSL)	Silty loam	Red	Large cobbles	Present	bif
1	36	30	0	0	0	0	Gully (GUL)	Silty loam	Orange	Large cobbles	Present	bif
1	37	30	0	0	0	0	Hillslope (HSL)	Silty loam	Brown	Coarse gravel	Present	basalt
1	38	40	0	0	0	0	Hillslope (HSL)	Silty loam	Red	Small cobbles	Present	bif
1	39	30	10	10	0	0	Plain (PLA)	Sandy loam	Red	Coarse gravel	Absent	mixed rock types mostly bif
1	40	30	2	2	0	0	Hillcrest (HCR)	Silty loam	Red	Large cobbles	Present	bif
1	41	40	0	0	0	0	Gully (GUL)	Silty loam	Red	Large cobbles	Present	bif
1	42	30	0	0	0	0	Gully (GUL)	Silty loam	Red	Small cobbles	Present	bif
1	43	30	2	2	2	0	Plain (PLA)	Sand	Red		Absent	
1	44	30	2	2	0	0	Plain (PLA)	Silty loam	Red	Coarse gravel	Absent	mixed rock types mostly bif
1	45	30	2	2	0	0	Plain (PLA)	Loamy Sand	Red		Absent	
2	1	20	2	2	0	0	Gully (GUL)	Silty loam	Red	Boulders	Present	bif
2	2	20	0	0	0	0	Hillslope (HSL)	Silty loam	Red	Boulders	Present	bif
2	3	20	2	2	2	0	Plain (PLA)	Sand	Red		Absent	
2	4	30	2	2	0	0	Hillslope (HSL)	Silty loam	Red	Small cobbles	Present	bif
2	5	30	2	2	0	0	Hillslope (HSL)	Clay loam	Orange	Large cobbles	Present	bif
2	6	40	2	2	2	0	Hillslope (HSL)	Clay loam	Orange	Large cobbles	Present	bif
2	7	50	2	2	0	1	Hillslope (HSL)	Clay loam	Orange	Small cobbles	Present	bif
2	8	60	2	2	2	0	Gully (GUL)	Sandy clay loam	Orange	Boulders	Present	bif



Appendix E Conservation significant fauna recorded within the Study Area

Species	Location		Evidence	Survey
Ghost Bat	-23.328117	119.99572	Scat	Biologic
Western Pebble-mound Mouse	-23.324564	119.986526	Active Mound	Biologic
Western Pebble-mound Mouse	-23.329407	119.9785	Inactive Mound	Biologic
Western Pebble-mound Mouse	-23.325073	119.99424	Inactive Mound	Biologic
Western Pebble-mound Mouse	-23.318115	119.981415	Inactive Mound	Biologic
Western Pebble-mound Mouse	-23.338612	120.005646	Inactive Mound	Biologic
Western Pebble-mound Mouse	-23.340027	120.020508	Individual	Biologic
Western Pebble-mound Mouse	-23.32443	119.993248	Individual	Biologic
Western Pebble-mound Mouse	-23.325142	119.999184	Individual	Biologic
Western Pebble-mound Mouse	-23.333069	120.01815	Individual	Biologic
Western Pebble-mound Mouse	-23.328656	120.021355	Mound	ecologia, 1995
Western Pebble-mound Mouse	-23.331194	120.030778	Mound	ecologia, 1995
Western Pebble-mound Mouse	-23.331333	120.032583	Mound	ecologia, 1995
Western Pebble-mound Mouse	-23.330944	120.036361	Mound	ecologia, 1995
Western Pebble-mound Mouse	-23.322056	120.046333	Mound	ecologia, 1995
Western Pebble-mound Mouse	-23.327194	120.045278	Mound	ecologia, 1995
Brush-tailed Mulgara	-23.339384	120.005791	Burrow	Biologic
Brush-tailed Mulgara	-23.339392	120.005814	Burrow	Biologic
Brush-tailed Mulgara	-23.339338	120.005928	Burrow	Biologic
Brush-tailed Mulgara	-23.339115	120.006493	Burrow	Biologic
Brush-tailed Mulgara	-23.335173	119.98748	Burrow	Biologic
Brush-tailed Mulgara	-23.339302	120.005943	Burrow	Biologic
Brush-tailed Mulgara	-23.336523	119.993004	Burrow	Biologic
Pilbara Olive Python	-23.323112	119.981529	Scat	Biologic
Pilbara Olive Python	-23.327466	119.979968	Individual	BHPBIO
Pilbara Olive Python	-23.323048	119.981544	Individual	Biologic
Pilbara Olive Python	-23.319958	120.002098	Individual	Biologic
Pilbara Olive Python	-23.320284	120.007484	Individual	Biologic
Pilbara Olive Python	-23.330477	120.002113	Scat	Biologic
Rainbow Bee-eater	-23.328039	120.016441	Individual	Biologic
Rainbow Bee-eater	-23.324696	119.981918	Individual	Biologic
Rainbow Bee-eater	-23.333151	120.017998	Individual	Biologic
Rainbow Bee-eater	-23.31962	120.009605	Individual	Biologic
Rainbow Bee-eater	-23.330025	119.992142	Individual	Biologic



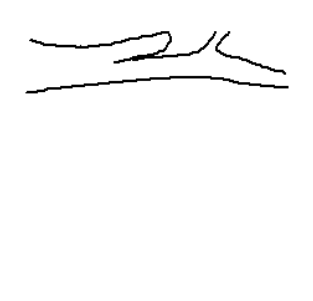


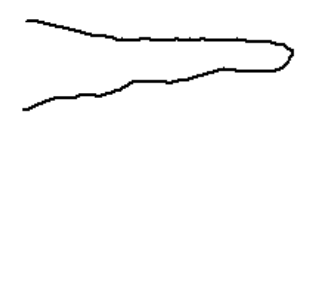

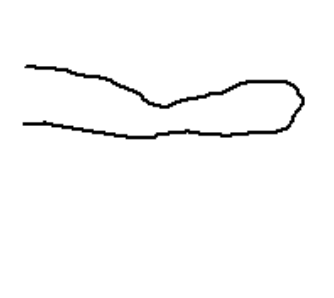



Species	Location		Evidence	Survey
Rainbow Bee-eater	-23.318798	119.998093	Individual	Biologic
Rainbow Bee-eater	-23.320866	120.001396	Individual	Biologic
Rainbow Bee-eater	-23.322025	120.008286	Individual	Biologic
Pilbara Flat-headed Blindsnake	-23.325142	119.999184	Individual	Biologic
Pilbara Flat-headed Blindsnake	-23.3288	120.0194	Individual	ENV, 2007



Appendix F Attributes of significant habitat features

Cave




Date	Cave ID	Position	Entrance width (m)	Entrance height (m)	Cave depth (m)	Cave position	Habitat	Bats present	Guano present	Ghost Bat guano abundance	Ghost Bat guano age	Photo	Vertical cross	Horizontal cross	Suitability for Ghost Bats
5/31/2013	OB 19_r1	-23.323048 119.981544	3	1.5	45	Mid-slope	Gorge/ Gully	<i>Taphozous georgianus</i> ; <i>Vespadelus finlaysoni</i> ;	<i>Taphozous georgianus</i> ; <i>Vespadelus finlaysoni</i> ;	N/A	N/A				possible feed roosts
6/2/2013	OB 19_r2	-23.329794 119.998779	4	1.5	9	Mid-slope	Gorge/ Gully	<i>Taphozous georgianus</i> ;	<i>Taphozous georgianus</i> ;	N/A	N/A				possible feed roosts
5/29/2013	trOB 19-1	-23.322014 120.006546	4	1.5	15	Upper slope	gully	<i>Taphozous georgianus</i> ;	<i>Taphozous georgianus</i> ;	N/A	N/A				possible feed roosts






Date	Cave ID	Position	Entrance width (m)	Entrance height (m)	Cave depth (m)	Cave position	Habitat	Bats present	Guano present	Ghost Bat guano abundance	Ghost Bat guano age	Photo	Vertical cross	Horizontal cross	Suitability for Ghost Bats
5/29/2013	obcave2	-23.320072 120.006149	1	0.6	10	Mid-slope	gully with triodia, mulga and eucalypts.	<i>Taphozous georgianus</i> ; <i>Vespadelus finlaysoni</i> ;	<i>Taphozous georgianus</i> ; <i>Vespadelus finlaysoni</i> ;	N/A	N/A				possible feed roosts
5/29/2013	obcave3	-23.328117 119.99572	5	1.5	30	Mid-slope	gully	<i>Taphozous georgianus</i> ; <i>Vespadelus finlaysoni</i> ;	<i>Macroderma gigas</i> ; <i>Taphozous georgianus</i> ; <i>Vespadelus finlaysoni</i> ;	Too old to separate	Very old				possible feed roosts
5/30/2013	obcave4	-23.318277 119.980469	5	2	15	Mid-slope	ridge	<i>Taphozous georgianus</i> ;	<i>Taphozous georgianus</i> ;	N/A	N/A				possible feed roosts
6/1/2013	obcave5	-23.329704 119.998764	3	1.2	9	Lower slope	bottom of very steep gully	<i>Taphozous georgianus</i> ;	<i>Taphozous georgianus</i> ;	N/A	N/A				possible feed roosts






Rock pools

Location	Width (m)	Length (m)	Depth (m)	Shape	Photo		Suitability for conservation significant species
-23.322948 119.98185	1	2	0.2	rectangular	w1		Pilbara Olive Python; Northern Quoll;
-23.323709 119.981934	1	2	0.3	triangle	w2		Pilbara Olive Python; Northern Quoll;
-23.324512 119.981979	1	2	0.4	rectangular	w3		Pilbara Olive Python; Northern Quoll;





Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.324772 119.981934	1	2.5	0.3	dumb-bell	w4	 <p>Pilbara Olive Python; Northern Quoll;</p>
-23.333687 120.024216	0.3	0.3	0.2	round	w5	 <p>Pilbara Olive Python; Northern Quoll;</p>
-23.333647 120.024239	0.9	3	0.4	dumb-bell	w6	 <p>Pilbara Olive Python; Northern Quoll;</p>






Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species	
-23.333549 120.024239	0.8	1.5	0.9	oblong	w7		Pilbara Olive Python; Northern Quoll;
-23.333704 120.023582	0.5	1.5	0.4	oblong	w8		Pilbara Olive Python; Northern Quoll;
-23.325008 120.016487	1	1.5	0.1	square	w9		Pilbara Olive Python; Northern Quoll;






Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.324007 120.016685	1	1	0.15	square	w10	 Pilbara Olive Python; Northern Quoll;
-23.319706 120.013023	0.8	1	0.2	square	w11	 Pilbara Olive Python; Northern Quoll;
-23.322664 120.019707	0.3	0.6	0.1	oblong	w12	 Pilbara Olive Python; Northern Quoll;






Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species	
-23.325321 120.0186	0.6	0.7	0.15	square	w13	 A square-shaped waterhole in a rocky landscape. The water is clear and reflects the sky and surrounding trees. The surrounding rock is reddish-brown.	Pilbara Olive Python; Northern Quoll;
-23.325541 120.018555	1	1	0.25	round	w14	 A round waterhole in a rocky landscape. The water is dark and reflects the sky. The surrounding rock is reddish-brown.	Pilbara Olive Python; Northern Quoll;
-23.325615 120.018524	0.7	1	0.1	oval	w15	 An oval-shaped waterhole in a rocky landscape. The water is dark and reflects the sky. The surrounding rock is reddish-brown.	Pilbara Olive Python; Northern Quoll;






Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.328268 120.029137	0.4	1	0.1	narrow	w16	 Pilbara Olive Python; Northern Quoll;
-23.327364 120.030128	1	1	0.2	round	w17	 Pilbara Olive Python; Northern Quoll;
-23.317961 120.041603	0.8	1.2	0.1	rectangle	w18	 Pilbara Olive Python; Northern Quoll;






Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.331734 120.016357	0.6	1.7	0.4	dumb bell	w19	 <p>Pilbara Olive Python; Northern Quoll;</p>
-23.331104 120.016647	0.4	0.4	0.15	round	w20	 <p>Pilbara Olive Python; Northern Quoll;</p>
-23.330688 120.016502	0.3	0.9	0.1	drumstick	w21	 <p>Pilbara Olive Python; Northern Quoll;</p>






Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.328707 119.998909	0.4	0.7	0.1	round	w22	 Pilbara Olive Python; Northern Quoll;
-23.328316 119.999039	0.6	0.7	0.2	round	w24	 Pilbara Olive Python; Northern Quoll;
-23.328466 119.998993	0.4	0.7	0.2	oblong	w23	 Pilbara Olive Python; Northern Quoll;





Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.332699 120.01265	2	1	0.5			Pilbara Olive Python;
-23.319942 120.002098	3	3	1			Pilbara Olive Python;
-23.320822 120.001396	5	6	1			Pilbara Olive Python;



Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.320227 120.007614	7	8	>3			Pilbara Olive Python;
-23.320955 120.026138	1.2	3.5	0.3	Elongate		Pilbara Olive Python; Northern Quoll; Bush Stone-curlew;
-23.307812 119.990005	2	1	0.5			Pilbara Olive Python;



Location	Width (m)	Length (m)	Depth (m)	Shape	Photo	Suitability for conservation significant species
-23.327791 119.993492	1	2	0.5			Pilbara Olive Python;
-23.33033 120.002213	4	4	1.5			Pilbara Olive Python;