Shearer's West

Targeted Vertebrate and Short-range Endemic Invertebrate Fauna Assessment

BHP Western Australia Iron Ore

8 January 2019

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EXECUTIVE SUMMARY

Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by BHP Western Australia Iron Ore (BHP WAIO) to undertake a targeted terrestrial vertebrate fauna survey and a single season terrestrial short-range endemic (SRE) invertebrate survey BHP WAIO's Shearers West tenement (hereafter referred to as the Study Area). The Study Area, which covers an area of approximately 15,000 hectares (ha), is located approximately 42 kilometres (km) east of Newman in the Pilbara region of Western Australia. The surveys will be used to inform future environmental approvals across the area although do not assess any specific development proposed by BHP WAIO. The objective of this assessment was to identify the potential occurrence of conservation significant vertebrate fauna, SRE invertebrate fauna and relevant habitats.

Vertebrate Fauna

Of the 431 species of vertebrate fauna previously recorded in the general area and/ or identified as having the potential to occur, 39 species are of conservation significance. During the field survey (29 April to 4 May 2018), a total of 51 vertebrate fauna species, comprising 17 mammal species (four of which are introduced species), 28 bird species, five reptile species and one amphibian species were recorded. No vertebrate species of conservation significance were recorded, although five were considered "likely" or "highly likely" to occur based on habitats present: Brush-tailed Mulgara, Long-tailed Dunnart, Western Pebble-mound Mouse, Spotted Ctenotus and Pilbara Flat-headed Blind-snake.

Typical Pilbara habitat types were recorded in the Study Area, consisting of Major Drainage Line, Stony Plain, Hillcrest/ Hillslope, Mulga and Sand Plain. The condition of habitats within the Study Area ranged from Very Good to Pristine. The Sand Plain habitat was deemed to be of significance as it is likely to provide suitable habitat for the conservation listed Brush-tailed Mulgara, which has previously been recorded from adjacent Sand Plain. The Sand Plain habitat may also provide suitable habitat for the Greater Bilby, although there is no recent or historical evidence from within the Study Area to suggest that this species currently utilises the Study Area.

Two habitat features were recorded, a shallow cave and a dry water feature in the central western part of the Study Area. Caves are a potential habitat resource for conservation significant bat species such as Ghost Bat, whilst water features may provide a source of water as well as breeding, foraging, and dispersal habitat for local conservation significant species and migratory waterbirds. No conservation significant species were recorded at either habitat feature during the current survey. The Major Drainage Line was deemed to have a moderate-high significance as it may provide dispersal and foraging habitat for the Pilbara Olive Python and Ghost Bat, as well as the Northern Quoll and Pilbara Leaf-nosed Bat, if present. The Hillcrest/ Hillslope was considered to be of moderate significance as it may provide potential habitat for the Northern Quoll, if present, as well as providing habitat for the priority species Western Pebble-Mound Mouse. The Stony Plain was also considered to be of moderate significance as it has the potential to provide habitat for a suite of Priority fauna. The Mulga Woodland was considered to be of low significance as it is generally common and widespread throughout the region and no species of conservation significance are likely to be dependent on its occurrence.

Short Range Endemic Invertebrate Fauna

The database searches identified 502 records of arachnids, myriapods and molluscs within 20 km of the Study Area. The total comprised 64 individual taxa from groups prone to short-range endemism: 24 mygalomorph spiders, 17 scorpions, 16 pseudoscorpions, three selenopid spiders, two millipedes and two land snails.

No previous records are known from the Study Area and only 15 taxa had been recorded within 5 km of the Study Area. Only two of these are regarded as Confirmed SREs; *Aname* 'MYG205' and *Kwonkan* 'MYG006', while the remainder were regarded as either Data Deficient or Uncertain.

SRE invertebrate sampling was undertaken at 15 sites located across the Study Area during the field survey. The majority of the fauna habitats occurring within the Study Area were assessed as being of low to low/moderate suitability for SRE invertebrate fauna due to the fact they provide little protection and complexity and are widespread and continuous through the landscape – thus promoting dispersal from invertebrates that occupy such niches. This was the case for the Major Drainage Line, Stony Plain, Mulga Woodland and Sand Plain habitats.

The Hillcrest/ Hillslope habitat was assessed as of moderate suitability for SRE fauna, providing a moderate degree of complexity and protective microhabitats in the form of rocky cracks, crevices, soil pockets and leaf litter accumulations.

The survey collected 63 invertebrate specimens from microhabitats in leaf litter, soil, under rocks, woody debris and trapdoor spider burrows. A total of eleven taxa were identified, with the most common (5) being pseudoscorpions, Gastropoda (land snails), scorpions, isopods and mygalomorph spiders (trapdoor spiders).

No Confirmed SRE species were recorded; however, three taxa were regarded as Potential SRE fauna and four indeterminate taxa were categorised as Data deficient. All three taxa regarded as Potential SRE have been recorded within 10 km of the Study Area, all to the north within Orebodies 17, 18, 19, 31 and Wheelarra North. Indeterminate taxa *Synsphyronus* sp. indet may also occur beyond the Study Area; however, the indeterminate nature of the specimen and the lack of records in close proximity to the Study Area (only one approximately 5 km to the north) provides less certainty regarding its possible extent beyond the Study Area. These specimens may be the same taxon, but further work would be required to confirm this.

1 INTRODUCTION

1.1 Background

Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by BHP Western Australia Iron Ore (BHP WAIO) to undertake a targeted terrestrial vertebrate fauna survey and a single season terrestrial short-range endemic (SRE) invertebrate survey BHP WAIO's Shearers West tenement (hereafter referred to as the Study Area). The Study Area, which covers an area of approximately 15,000 hectares (ha), is located approximately 42 kilometres (km) east of Newman in the Pilbara region of Western Australia. The surveys will be used to inform future environmental approvals across the area although do not assess any specific development proposed by BHP WAIO.

1.2 Objectives

The objective of this assessment was to identify the potential occurrence of conservation significant vertebrate fauna, SRE invertebrate fauna and relevant habitats. Specifically, this report provides:

- a review of vertebrate fauna recorded within the vicinity of the Study Area as an indication of species that are likely to occur within the Study Area;
- a review of SRE fauna recorded in the vicinity of the Study Area;
- a field survey targeting vertebrate fauna of conservation significance and sampling for SRE groups;
- mapping of broad fauna habitat types occurring across the Study Area; and
- an assessment of the importance of potential habitats for conservation-significant species
- an assessment on the presence, or likely presence, of vertebrate fauna currently considered to be of conservation significance (under state and federal legislation).

160,000 180,000 200,000 220,000 240,000 260,000

7,440,000 7,420,000 7,400,000 7,380,000

PERMITS MAY BE REQUIRED FOR ENTRY INTO OR TRAVELLING THROUGH ABORIGINAL LANDS & COMMUNITIES

NUMEROUS CLEARED LINES MAY POSE A NAVIGATION HAZARD

23°30'

120°30'

QV RV RV
QU RU RU
SQ TQ
SP TP

Legend

Study Area

WA Location

biologic Environmental Survey

N

1:300,000

0 5 10 15 km

BHP - Shearers West

Two Phase Verterbrate Fauna Study

Fig. 1.1: Study Area and Regional Location

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 11/10/2018

1.3 Background to Protection of Fauna

1.3.1 Conservation Significance

Within Western Australia, native fauna is protected under the *Wildlife Conservation Act 1950* (WC Act) and at a national level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action that has the potential to impact native fauna needs to be approved by relevant state and/or federal departments as dictated by the state *Environmental Protection Act 1986* (EP Act).

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 deemed to be of conservation significance. A summary of applicable legislation and status codes is provided in Table 1-1 and additional information on status codes is provided in Appendix A. A number of migratory bird species are also prioritised for conservation under international agreements and therefore protected under the EPBC Act and WC Act as Migratory.

For some species, there is insufficient information to determine their conservation status. These species are generally considered by the Environmental Protection Agency (EPA) and the Department of Biodiversity, Conservation and Attraction's (DBCA) as being of conservation significance for all development related approvals and are listed on a 'Priority List' that is regularly reviewed and maintained by the DBCA (Table 1-1).

Table 1-1: Definitions and terms for fauna of conservation significance

Agreement, Act or List	Status Codes
Federal	
***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)** The Department of the Environment and Energy (DoEE) lists threatened fauna, which are determined by the Threatened Species Scientific Committee (TSSC) per criteria set out in the Act. The Act lists fauna that are considered to be of conservation significance under one of eight categories (listed under 'Status Codes').	• Extinct (Ex) • Extinct in the Wild (EW) • Critically Endangered (Cr) • Endangered (En) • Vulnerable (Vu) • Conservation Dependent (CD) • Migratory (Mi) • Marine (Ma)
State	
***Wildlife Conservation Act 1950* (WC Act)** At a state level, native fauna is protected under the *Wildlife Conservation Act 1950*. Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.	• Schedule 1 (Critically Endangered) (S1) • Schedule 2 (Endangered) (S2) • Schedule 3 (Vulnerable) (S3) • Schedule 4 (Extinct) (S4) • Schedule 5 (Migratory) (S5) • Schedule 6 (Conservation Dependent) (S6) • Schedule 7 (Other Specially Protected) (S7)
DBCA Priority List DBCA produces a list of Priority species that have not been assigned statutory protection under the *Wildlife Conservation Act 1950*. This system gives a ranking from Priority 1 to Priority 4.	• Priority 1 (Poorly-known species) (P1) • Priority 2 (Poorly-known species) (P2) • Priority 3 (Poorly-known species) (P3) • Priority 4 (Rare, Near Threatened, and other species in need of monitoring) (P4)

1.3.2 Short-range Endemism

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national or local scale, the latter being commonly referred to as short-range endemism (Allen, Midgley, & Allen, 2006; Harvey, 2002). Short-range endemism is influenced by several factors including life history, physiology, habitat requirements, dispersal capabilities, biotic and abiotic interactions and historical conditions which not only influence the distribution of a species, but also the tendency for differentiation and speciation (Ponder & Colgan, 2002).

In recent years a number of taxonomic groups of invertebrates have been highlighted as comprising a high proportion of species likely to be regarded as SREs (i.e. Harvey, 2002; terrestrial snails, Johnson et al., 2004; Mygalomorph spiders, Main, Samprey, & West, 2000; freshwater snails, Ponder & Colgan, 2002). This identification of restricted taxonomic groups has led to SRE invertebrate fauna being recognised as a potentially significant biodiversity issue, and that SRE fauna "may be at a greater risk of changes in conservation status as a result of habitat loss or other threatening processes" (EPA, 2016b).

Harvey (2002) proposed a range criterion for terrestrial short-range endemic (SRE) species at less than 10,000 km^2 (or 100 km x 100 km), which has been adopted by regulatory authorities in Western Australia (EPA, 2016b). SRE invertebrate species often share similar biological, behavioural and life history characteristics that influence their restricted distributions and limit their wider dispersal (Harvey, 2002). For example, burrowing taxa such as mygalomorph spiders and *Urodacus* scorpions may only leave their burrows (or a narrow home territory around the burrow) as juveniles dispersing from the maternal burrow, or when males search for a mate. In other cases, SRE taxa are dispersal-limited because of their slow pace of movement and cryptic habitats (such as isopods, millipedes and snails), while some specialised taxa can be limited by very specific habitat requirements, such as selenopid spiders within fractured rocky outcrops.

An increasingly large number of terrestrial invertebrates are discovered to exhibit short-range endemism in Western Australia. While protection for listed species (species of conservation significance) and/ or Threatened or Priority Ecological Communities is provided under state and federal legislation, the majority of SRE species and communities are not currently listed. This is due largely to incomplete taxonomic or ecological knowledge. As such, the assessment of conservation significance for SRE is guided primarily by expert advice provided by the Western Australian Museum (WAM) and other taxonomic experts.

1.3.3 SRE Status Categorisation

The SRE status categories used in this report broadly follow the WAM's revised categorisation for SRE invertebrates. This system is based upon the 10,000km^2 range criterion proposed by Harvey (2002), and uses three broad categories to deal with varying levels of taxonomic certainty that may apply to any given taxon (Table 1-2).

Under this system, "Potential SRE" status is the default categorisation for species within the typical SRE taxonomic groups including mygalomorph spiders, selenopid spiders, land snails, pseudoscorpions,

scorpions, and isopods, unless sufficient evidence exists to confirm widespread or confirmed SRE status.

Table 1-2: SRE categorisation used by WAM taxonomists

Distribution	Taxonomic Certainty	Taxonomic Uncertainty
< 10,000 km^2	Confirmed SRE • A known distribution of < 10,000km2. • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling.	Potential SRE • Patchy sampling has resulted in incomplete knowledge of geographic distribution. • Incomplete taxonomic knowledge. • The group is not well represented in collections. • Category applies where there are significant knowledge gaps. **SRE Sub-categories may apply:** A) Data Deficient B) Habitat Indicators C) Morphology Indicators D) Molecular Evidence E) Research & Expertise
> 10,000 km^2	Widespread (not an SRE) • A known distribution of > 10,000km2. • The taxonomy is well known. • The group is well represented in collections and/ or via comprehensive sampling.	

Potential SRE status is sub-categorised by what is currently known about the species in question; *i.e.* whether there are B) habitat indicators, C) morphology indicators, D) molecular evidence, or E) a weight of general knowledge and experience with the group that suggests a reasonable likelihood that the species could be SRE. In terms of SRE likelihood, the more evidence that exists under sub categories 'B', 'C', 'D', and 'E', the greater the likelihood that further investigation would confirm that the species is an SRE.

However, the Potential SRE category 'A' - data deficient is unique; this category indicates that the current information is insufficient to adequately assess the SRE status of the species in question. In such cases, where the SRE status cannot be confirmed, a conservative approach would be unable to consider the SRE risk to be higher than average where:

A. the taxonomy of the genus (or family) requires significant review in order to make any statement on SRE status, and/or

B. the genus is not known to include any confirmed SRE species within the region (subject to the extent of prior sampling / taxonomic effort).

To avoid confusion with other Potential SRE species for which there is some certainty and/or some precedent for their SRE status, this report represents the WAM's "Potential SRE - category 'A' - data deficient" only as "data deficient". The results from taxonomists are also presented within the broader context of the results from habitat assessment, desktop review, habitat connectivity, and other ecological information collected during the survey. This approach aims to provide a more holistic assessment of SRE likelihood at scales relevant to the project, as well as the standard SRE range criterion of <10,000km^2 (Harvey, 2002).

2 ENVIRONMENT

2.1 Biogeography

The Study Area falls within the Pilbara and the Gascoyne biogeographical region as defined by the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway & Cresswell, 1995). The Study Area is predominantly within the Gascoyne bioregion (80% or 1,114 ha).

The Gascoyne bioregion is characterised by low, rugged ranges and broad, flat valleys. The vegetation is dominated by open mulga low woodlands (N.L. McKenzie, May, & McKenna, 2002). Within the Gascoyne bioregion the Study Area is located within the Augustus subregion (GAS03). The Augustus subregion is characterised by rugged low Proterozoic sedimentary and granite ranges divided by broad flat valleys (Desmond, Kendrick, & Chant, 2001). The subregion also comprises the Narryera Complex and Bryah Basin of the Proterozoic Capricorn Orogen (on northern margin of the Yilgarn Craton), as well as the Archaean Marymia and Sylvania Inliers (Desmond et al., 2001). The Gascoyne River System provides the main drainage of this subregion and it is also the headwaters of the Ashburton and Fortescue Rivers. Mulga woodlands with *Triodia* species occur on shallow stony loams on rises, while the shallow earthy loams over hardpan on the plains are covered by Mulga parkland (Desmond et al., 2001).

The Pilbara bioregion is characterised by vast coastal plains and inland mountain ranges with cliffs and deep gorges (Thackway & Cresswell, 1995). Vegetation is predominantly mulga low woodlands or snappy gum over bunch and hummock grasses (Bastin, 2008). Within the Pilbara bioregion the Study Area is located within the Fortescue subregion (PIL02) and the Hamersley subregion (PIL03). The Fortescue subregion is characterised by alluvial plains and river frontage (Kendrick, 2001a). The Fortescue subregion contains extensive salt marsh, mulga-bunch grass and short grass communities on alluvial plains, and river gum woodlands fringing major drainage lines (Kendrick, 2001a). The significant and dominant feature of this subregion is the Fortescue Marsh. This drainage feature, 100 km long, is effectively the terminus of the upper Fortescue River. The lower Fortescue River arises from streams draining the Chichester and Hamersley Ranges below the Marsh and west of the Goodiadarrie Hills (N.L. McKenzie et al., 2002).

The Hamersley subregion contains the southern section of the Pilbara Craton and consists of mountainous areas of Proterozoic sedimentary ranges and plateaux's, dissected by gorges of basalts, shales and dolerite (Kendrick, 2001b). The vegetation of the Hamersley subregion is predominantly mulga low woodlands over bunch grass on fine textured soils in valley floors and *Eucalyptus leucophloia* over *Triodia brizoides* (and other *Triodia* spp.) on skeletal soils of the ranges (Kendrick, 2001b). The Hamersley subregion drains into either the Fortescue River to the north, the Ashburton River to the south, or the Robe River to the west (Kendrick, 2001b).

2.2 Climate

The Pilbara bioregion has a semi-desert to tropical climate, with rainfall occurring sporadically throughout the year, although mostly during summer (Beard, 1990; Thackway & Cresswell, 1995). Summer rainfall in the Pilbara is usually the result of tropical storms in the north or tropical cyclones

that impact upon the coast and move inland (Leighton, 2004). 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 200-350 mm, although there are significant fluctuations between years (BoM, 2018), with up to 1200 mm falling in some locations in some years (N. L. McKenzie, van Leeuwen, & Pinder, 2009). The Gascoyne bioregion has an arid climate (Beard, 1990) with predominantly winter rainfall in the west, and summer rainfall in the east. Spatially averaged median rainfall for the region is 202 mm (April to March rainfall year) (BoM, 2018). A desert climate with bimodal rainfall characterises the Augustus subregion (Desmond et al., 2001).

Long-term rainfall data was available for Newman Airport (Station 7176; BoM, 2018), 35 km west of the Study Area. The long-term average (LTA) annual rainfall at Newman Airport is 332.6 mm (BoM, 2018) (Figure 2.1). The average monthly maximum temperature ranges from 22.9°C in July to 39°C in December and January. Average monthly minimum temperature ranges from 6.4°C in July to 25°C in January (BoM, 2018) (Figure 2.1).

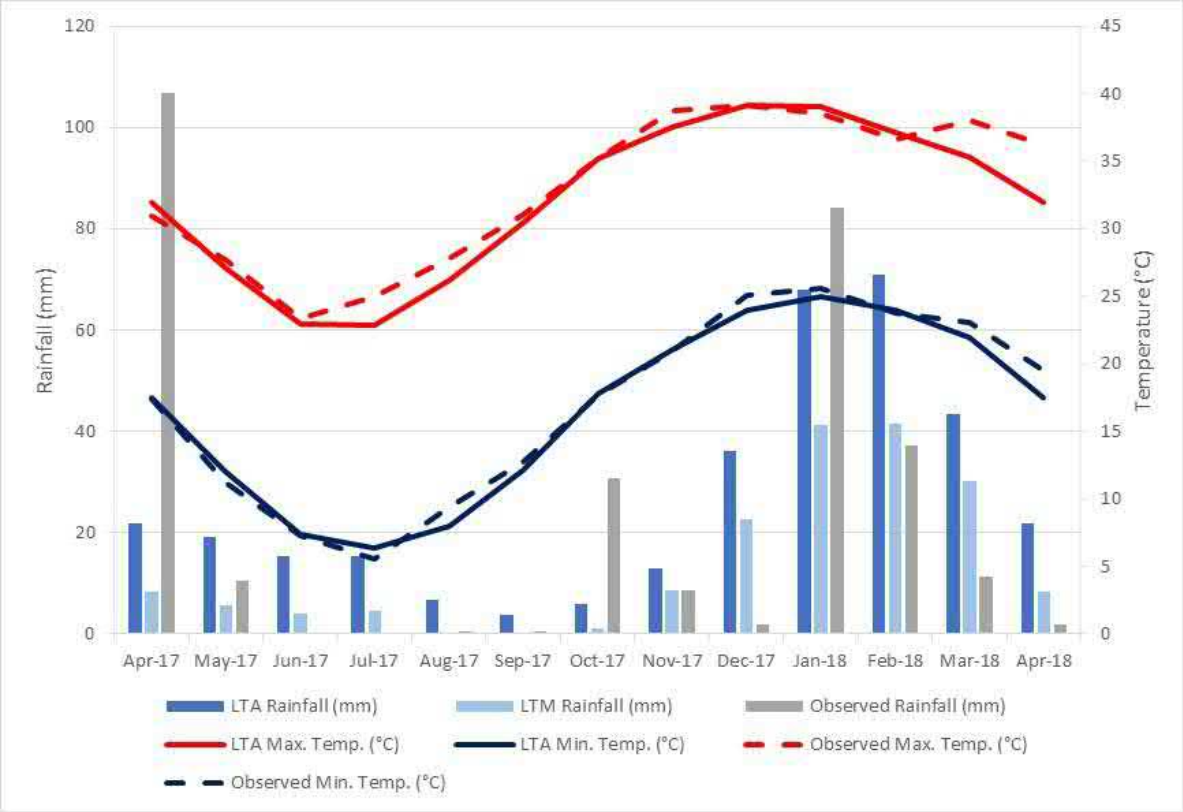

Figure 2.1: Long-term average (LTA), long-term median (LTM), observed monthly rainfall, LTA minimum and maximum temperature and observed minimum and maximum temperature data (station 7176, BoM, 2018)

2.3 Vegetation

Beard (1975) broadly (1:1,000,000) mapped the major structural vegetation types of Western Australia. The Study Area is located on the boundary between the Hamersley Plateau (Fortescue Botanical District) and the Ashburton Botanical District, straddling the Pilbara and Gascoyne Bioregions (Beard, 1975). Shepherd, Beeston, and Hopkins (2002) attempted to reinterpret and update the vegetation association mapping to reflect the National Vegetation Information System (NVIS) standards (ESCAVI,

2003). The update also accounts for extensive clearing since Beard (1975) mapping. Some of Beard's vegetation associations have been separated to remove mosaic vegetation associations; however, some mosaics still occur. To assist with the removal of mosaic vegetation, Shepherd et al. (2002) created a series of "Systems".

The Study Area occurs within two systems, the Fortescue Valley and Kumarina Hills, as delineated by Shepherd et al. (2002). The Study Area overlaps three vegetation associations (Table 2-1; Figure 2.2), of which one association (216) occurs within both systems. Vegetation association 216 is the most extensive across the Study Area (Table 2-1).

Table 2-1: Vegetation system associations across the Study Area

System	Vegetation associations	Descriptions	Within Study Area	
			Ha	%
Fortescue Valley	82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	190	13
	216	Low woodland; mulga (with spinifex) on rises	<1	<1
Kumarina Hills	216	Low woodland; mulga (*Acacia aneura*)	1200	86
		Total	**1,390**	**100**

NB: values have been rounded to the nearest whole number

204,000
206,000
208,000
210,000
7,410,000
7,408,000
216
82
82
82
216

Legend

Study Area

Vegetation Association

216

82

WA Location

biologic Environmental Survey

N

1:20,000

0 200 400 600 800 1,000 m

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Fig. 2.2: Vegetation of the Study Area

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 11/10/2018

2.4 Land Systems

The land systems of the Pilbara region are classified according to similarities in landform, soil, vegetation, geology and geomorphology, following van Vreeswyk, Payne, Leighton, and Hennig (2004). Seven (7) land systems are mapped across the Study Area, categorised by six distinct land types (Table 2-2; Figure 2.3). The most dominant land system within the Study Area is the Sylvania land system, defined as gritty surfaced plains and low rises on granite supporting *Acacia-Eremophila-Senna* shrublands, and occurs across 51% of the Study Area. After the Sylvania land system (and associated stony plains land type), the hills and ranges (with *Acacia* shrublands or hummock grasslands) and the mesas, breakaways and stony plains with *Acacia* or *Eucalyptus* woodlands and halophytic shrublands, occurring across 43% of the Study Area, are the next most dominant landscape feature in the Study Area.

Table 2-2: Land Systems of the Study Area

Land System	Land Type	Description	Extent in Study Area	
			ha	%
Divide	Sandplains, and occasional sand dunes	Gently undulating sandplains with minor dunes, supporting hard spinifex hummock grasslands with numerous shrubs.	8	1
Jamindie	Hardpan wash plains	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.	72	5
Laterite	Mesas, breakaways and stony plains	Low lateritic plateaux, mesas, buttes and gravelly rises and plains supporting Mulga shrublands and short grass forbs.	122	9
McKay	Hills and ranges	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands with acacias and occasional eucalypts.	257	19
Newman	Hills and ranges	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	34	2
Prairie	Hills and ranges	Gently undulating stony plains and granite hills supporting *Acacia-Eremophila-Senna* shrublands and minor soft spinifex grasslands.	182	13
Sylvania	Stony plains	Gritty surfaced plains and low rises on granite supporting *Acacia-Eremophila-Cassia* shrublands.	715	51
		Total	**1,390**	**100**

NB: values have been rounded to the nearest whole number.

204,000 206,000 208,000 210,000

7,410,000

7,408,000

Mine

Boolgeeda

Newman

Boolgeeda

Newman

Divide

McKay

McKay

Jamindie

Laterite

Prairie

Sylvania

Prairie

Sylvania

Prairie

Legend

- Study Area

Land Systems

- Boolgeeda Land System
- Divide Land System
- Jamindie Land System
- Laterite Land System
- McKay Land System
- Newman Land System
- Prairie Land System
- Sylvania Land System

N

1:20,000

0 200 400 600 800 1,000 m

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Fig. 2.3: Land Systems of the Study Area

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 11/10/2018

3 METHODOLOGY

3.1 Compliance

The survey was carried out in a manner consistent with the Western Australian Environmental Protection Authority (EPA), DBCA, Department of the Environment and Energy (DoEE), and BHP guidelines for the environmental surveying and reporting of fauna. The documents and guidelines with which this assessment has taken consideration of, include:

- Environmental Protection Authority (EPA, 2016a) Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna;
- EPA (2016b) Technical Guideline: Sampling of short-range endemic invertebrate fauna;
- EPA (2016c) Technical Guidance: Terrestrial Fauna Surveys;
- DPaW (2017) Interim guidelines for the preliminary surveys of Night Parrot (*Pezoporus occidentalis*) in Western Australia;
- DSEWPaC (2011a) Survey guidelines for Australia's threatened mammals;
- DSEWPaC (2011b) Survey guidelines for Australia's threatened reptiles;
- DEWHA (2010) Survey guidelines for Australia's threatened bats;
- BHPBIO (2016) Biological survey spatial data requirements (SPR-IEN-EMS-015); and
- BHPBIO (2017) Guidance for vertebrate fauna surveys in the Pilbara region Ver. 6.0 (SPR-IEN-EMS-012).

3.2 Desktop Assessment

3.2.1 Literature Review

The vertebrate fauna desktop assessment was conducted via reviewing literature relevant to the Study Area and conducting a number of database searches. The literature reviewed was provided by BHP and included a number of vertebrate fauna surveys (30 surveys) and SRE surveys (four surveys).

A review of all available literature relevant to the Study Area was undertaken to compile a list of vertebrate and SRE invertebrate fauna species with the potential to occur with the Study Area. This list comprised 30 vertebrate fauna reports, including four which were undertaken partially within the Study Area, and four SRE invertebrate fauna reports (Table 3-1). The 30 vertebrate fauna reports include, four desktop reviews, two targeted surveys (Table 3-1; incorporating one already mentioned report that was a desktop and targeted survey), two biological surveys, ten Level 1 survey reports and 13 Level 2 fauna survey reports within the vicinity of the Study Area (Table 3-1). The four SRE reports include one desktop assessment and three sampling surveys (Table 3-1).

Table 3-1: Literature sources used for the review

Survey Title	Reference	Survey Type	Distance from Study Area (km)
Vertebrate Fauna Surveys			
Jimblebar Mine Site Biological Survey	BHP (1994)	Biological Survey	Within

Survey Title	Reference	Survey Type	Distance from Study Area (km)
Jimblebar Marra Mamba Exploration Biological Survey	ecologia, Environment (2006b)	Biological Survey	Within
Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment	Outback Ecology Services (2009a)	Level 2 Fauna Survey	Within
Jimblebar Iron Ore Project Pebble-mound Mouse *Pseudomys chapmani* site survey	ecologia, Environment (1996)	Targeted	Within
South-West Jimblebar Vertebrate Fauna Survey	Biologic (2013b)	Level 2 Fauna Survey	Adjacent west
BHPBIO Hashimoto Terrestrial Vertebrate Fauna Assessment	ecologia, Environment (2007)	Level 2 Fauna Survey	~1 km east
Jimblebar-Wheelarra Hill 3 Flora and Fauna Assessment	Biota (2004)	Level 1 Fauna Survey	~1 km north
Jimblebar-Wheelarra Hill Biological Survey	ecologia, Environment (2004a)	Level 2 Fauna Survey	~1 km north
Wheelarra Hill Iron Ore Modification Flora and Fauna Assessment	Outback Ecology Services (2009c)	Level 2 Fauna Survey	~1 km north
Construction water supply pipeline and ammonium nitrate storage facility, Fauna Assessment	ENV Australia (2010)	Level 1 Fauna Survey	~4.5 km north-west
Wheelarra Hill North Fauna Assessment	ENV Australia (2012)	Level 2 Survey Fauna Survey	~5 km north
Tenement E52/2238 Level 1 Flora and Vegetation and Level 1 Vertebrate Fauna Survey	Onshore (2015b)	Level 1 Vertebrate Fauna Survey	~5 km north north-west
Report for Mesa Gap Biological Survey	(GHD, 2008)	Level 1 Fauna Survey	~5 km north-west
Jimblebar Linear Development Terrestrial Vertebrate Fauna Assessment	Outback Ecology Services (2009b)	Level 2 Fauna Survey	~5 km north-west
West Jimblebar Lease Fauna Assessment	ENV Australia (2007c)	Level 2 Fauna Survey	~5 km west
Orebody 18 Fauna Assessment Phase II	ENV Australia (2007b)	Level 2 Fauna Survey	~6.7 km north-west
Newman to Jimblebar Transmission Line and Newman Town Substation Terrestrial Fauna Assessment	Australia (2009)	Level 1 Fauna Survey	~7.2 km north-west
OB17 and 18 Vertebrate Fauna Habitats	Biologic (2013a)	Desktop	~7.5 km north-west
Satellite Orebodies: Orebody 18 Flora and Fauna Review	ecologia (2004)	Desktop	~7.5 km north-west
Orebodies 18, 23 & 25 Flora and Fauna Review	ecologia, Environment (2004b)	Desktop & Targeted	~7.5 km north-west
Orebody 18 Biological Assessment Survey	ecologia (1995)	Level 2 Fauna Survey	~7.5 km north-west
Orebody 31 Vertebrate Fauna Survey	Biologic (2014d)	Level 2 Fauna Survey	~8 km north
Orebody 31 Fauna Assessment	ENV (2011)	Level 1 Fauna Survey	~8 km north

Survey Title	Reference	Survey Type	Distance from Study Area (km)
OB31 Jimblebar Access Track VCP Level 1 Flora & Vegetation Survey and Vertebrate Fauna Assessment	Onshore (2015a)	Level 1 Fauna Survey	~8.5 km north
Jimblebar Spur 2 Fauna Assessment	ENV (2009)	Level 1 Fauna Survey	~8.5 km north-west
Orebody 19 Level 2 Vertebrate Survey	Biologic (2014c)	Level 2 Fauna Survey	~10 km north-west
Dynasty Level 1 Vertebrate Fauna Survey	Biologic (2016a)	Level 1 Fauna Survey	~10 km west
Dynasty Level 2 Vertebrate Fauna Survey	Biologic (2016b)	Level 2 Fauna Survey	~10 km west
Dynasty tenement – desktop review of vertebrate fauna and habitats	Biologic (2014a)	Desktop	~10 km west
Jimblebar Wye Rail Junction (Borrow Areas) Fauna Assessment	ENV Australia (2007a)	Level 1 Fauna Survey	~10 km north-west
SRE Invertebrate Fauna Surveys			
Jimblebar Iron Ore Project Terrestrial Invertebrate Short-range Endemic Assessment	Outback Ecology (2009)	SRE Survey	Within
South-west Jimblebar Short Range Endemic Invertebrate Survey	Biologic (2013a)	SRE Survey	Adjacent west
Orebody 19-31 Short-range Endemic Invertebrate Survey	Biologic (2014b)	SRE Survey	~5 km north
Dynasty Desktop Assessment of Short-range Endemic Invertebrates	Biologic (2014a)	SRE Desktop	~10 km west

3.2.2 Database Searches

Eight fauna databases were searched (Table 3-2); one solely for vertebrate fauna, three solely for invertebrate fauna and four that incorporate both vertebrate and invertebrate fauna. Of the eight fauna databases, three are to obtain information on all species previously recorded (ALA, 2018; Birdlife Australia, 2018; DBCA, 2018a), one is to identify species of conservation significance previously recorded (DBCA, 2018b), three are to identify potential SRE invertebrate fauna species (WAM, 2018a, 2018c, 2018d), and one is to identify species of conservation significance known or likely to occur within the region (DoEE, 2018).

Table 3-2: Details of database searches conducted

Provider	Reference	Fauna Group	Database	Parameters
Department of Biodiversity, Conservation and Attractions	NatureMap Database	Vertebrate and Invertebrate Fauna	DBCA (2018a)	Circle of radius 40 km centred on the coordinates: -23.407750°, 120.132940°
Department of Biodiversity, Conservation and Attractions	Threatened and Priority Fauna Database	Vertebrate and Invertebrate Fauna	DBCA (2018b)	Circle of radius 40 km centred on the coordinates: -23.408974°, 120.134664°
BirdLife Australia	Birdata Bird Atlas	Vertebrate Fauna	Birdlife Australia (2018)	Circle of radius 40 km centred on the coordinates: -23.408974°, 120.134664°
Department of Environment and Energy	Protected Matters Database	Vertebrate and Invertebrate Fauna	DoEE (2018)	Circle of radius 40 km centred on the coordinates: -23.407750°, 120.132940°°
Atlas of Living Australia	Species Occurrence	Vertebrate and Invertebrate Fauna	ALA (2018)	Circle of radius 10 km centred on the coordinates: -23.407750°, 120.132940°
Western Australian Museum	Arachnids and Myriapods	Invertebrate Fauna	WAM (2018a)	10,000 km^2 search area surrounding Study Area: NW: -22.958114°, 119.636030° SE: -23.858301°, 120.609137°
Western Australian Museum	Crustaceans	Invertebrate Fauna	WAM (2018c)	10,000 km^2 search area surrounding Study Area: NW: -22.958114°, 119.636030° SE: -23.858301°, 120.609137°
Western Australian Museum	Molluscs	Invertebrate Fauna	WAM (2018d)	10,000 km^2 search area surrounding Study Area: NW: -22.958114°, 119.636030° SE: -23.858301°, 120.609137°

3.3 Field Survey

A targeted vertebrate fauna and SRE field survey was undertaken by Biologic personnel from the 29th of April to the 4th of May 2018. In the six months prior to the Survey (November 2017 to April 2018), Newman Airport recorded 145 mm of rainfall. This was well below the long-term annual average rainfall for the same period (253.1 mm; BoM, 2018). Minimum temperatures during the Survey ranged from 13.3ºC to 22.6ºC, with an average minimum of 17.1ºC, and maximum temperatures ranged from 25.5ºC to 33.2ºC with an average maximum of 29.9ºC (Biologic, 2013b) (Table 3-3). No rain fell during the Survey period, while the remainder of the weather conditions (humidity and wind speed) was considered normal for the Pilbara in Autumn (Biologic, 2013b) (Table 3-3). Conditions experienced prior to and during the Survey, were typical for the time of year and suitable for the type and level of the Survey undertaken.

Table 3-3: Weather conditions during the field component of the assessment

Date	Min. Temp. (°C)	Max. Temp. (°C)	Rainfall (mm)	Relative Humidity (%)		Wind Speed (km/hr)	
				9 am	3 pm	9 am	3 pm
29/04/2018	19.6	30.0	0	44	19	17	6
30/04/2018	13.4	32.6	0	28	16	9	11
1/05/2018	22.6	33.2	0	25	16	17	26
2/05/2018	19.3	31.7	0	30	19	13	20
3/05/2018	14.4	25.5	0	28	17	31	20
4/05/2018	13.3	26.2	0	21	15	24	11
Average / Total / Max.	**17.1**	**29.9**	**0**	**44**	**19**	**31**	**26**

3.4 Survey Team and Licensing

The vertebrate and SRE fauna sampling for this survey was conducted under a DBCA Regulation 17 "Licence to Take Fauna for Scientific Purposes" (08-002132-1) issued to B. Downing. The following personnel were involved in the field component of the project:

- Mr Morgan O'Connell (Principal Zoologist);
- Ms Brighton Downing (Graduate Zoologist)

3.5 Vertebrate Fauna Survey

3.5.1 Habitat Assessments and Mapping

Habitat assessments were undertaken at numerous locations across the Study Area, including at every targeted search, song meter (ultrasonic and acoustic recorders) and motion camera location (Figure 3.1). Habitats in the Study Area were assessed using methodology and terminology modified from the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009). The characteristics recorded during the habitat assessments were:

- site information, photo and location.;
- landform: slope, relative inclination of slope, morphological type and landform type;
- vegetation: leaf litter %, twig litter %, wood litter, dead stags and hollow bearing trees, broad floristic formation, vegetation structure (tall, mid and low), and dominant species;
- land surface: micro relief, sheet erosion, rill erosion, gully erosion, gully depth, abundance and size of coarse fragments, rock outcropping, water bodies, comments on nests, burrows, roosts and diggings;
- soil: texture, colour;
- substrate: bare ground, rock size, rock type, rock outcropping; and
- disturbance: time since last fire, evidence of weeds, grazing, or human disturbances.

Fauna habitats were assessed for the likelihood that they may support conservation significant fauna. All major fauna habitats present within the Study Area were rated (High, Moderate or Low) per the criteria in Table 3-4.

3.5.2 Targeted Trapping

A total of five trapping sites were established in the first season dry survey, with sites covering Sandplain and Mulga Woodland habitat types, and arranged to spatially cover all of the Study Area (Figure 3.1). Each trap site consisted of ten Elliott traps opened for between 3 to 5 nights, for a total of 190 trap nights. The traps were placed in niches likely to be attractive to small non-volant mammals and reptiles (*i.e*. area of cover and shade). Traps were baited with “universal bait” (a mixture of oats, peanut butter and sardines) and checked daily.

3.5.3 Targeted Searches

Targeted searches were undertaken to identify the occurrence of fauna of conservation significance and to search for important habitat features, such as water features and caves. Targeted searches were conducted within the most prospective areas in terms of habitat features and habitats suitable for species of conservation significance. During the targeted searches, and while traversing the Study Area, the team recorded all vertebrate fauna species of conservation significance encountered, either from primary (*i.e.* direct observation) or secondary (*e.g.* burrows, scratching’s, diggings and scats) evidence.

Table 3-4: Fauna habitat significance assessment criteria

Score	Possible criteria (score results from any possible criterion being met)
High	Fauna listed as threatened on the EPBC Act or WC Act have been recorded within the habitat type in the Study Area.
	If habitat is in good condition (or better), is known to be suitable core habitat for EPBC listed species, and there are records of the species within 50 km. Core habitat is defined as containing the critical habitat elements for survival and reproduction of a species (Bingham & Noon, 1997)) If survey work in the vicinity of the Study Area has been limited, then the species will be considered likely to be present, using a precautionary approach.
	Habitat is uncommon (regionally) and considered critical for DBCA listed Priority fauna. For example, if the habitat for a Priority species is limited in the region and the extent within the Study Area forms a large proportion of the known habitat, it would be scored 'high'.
	Habitat that only occurs in small, isolated geographic areas.
Moderate	Habitat in the Study Area is known to support DBCA listed Priority fauna that do not occur in any of the other habitat types.
	Habitat that supports EPBC Act listed Migratory fauna. Habitat may be used by EPBC Act listed fauna, but it is not their core habitat *(i.e.* may be used periodically/ seasonally or for dispersal).
	Habitat supports a particularly diverse and uncommon faunal assemblage. Habitat that occurs throughout region, and does not occur in small or isolated areas, is excluded.
Low	Habitat is widespread, common, and does not solely support any significant fauna.

3.5.4 Ultrasonic Recordings – Bats

Overnight recordings of bat echolocation calls were undertaken using SM4BAT+ (SM4; Wildlife Acoustics, USA) fitted with an external, omnidirectional SMX-US ultrasonic microphone. The location of each SM4 unit was selected based on prospective bat foraging grounds, such as at overhangs. The unit was positioned to provide shelter from direct sun or rain, whilst retaining an unobstructed 'line of sight' between the microphone and the likely bat flyway. Each SM4 was preconfigured to activate at astronomical sunset each day and deactivate at astronomical sunrise the following morning. Jumper settings, audio settings, selectable filters and selectable triggers used to preconfigure each SM4 unit, and hence define the volume and frequency ranges sought, followed the manufacturer's recommendations for bat detection (Wildlife Acoustics, 2017).

SM4 units were deployed at five locations across the Study Area for a total of nine recording nights (Figure 3.1; Appendix B). Bat calls were analysed by Robert Bullen of Bat Call WA.

204,000

206,000

208,000

210,000

7,410,000

7,408,000

Legend

- Study Area

Survey Sampling

- Acoustic Recorder
- Habitat Assessment only
- Motion Camera
- Trapping site
- Ultrasonic Recorder
- SRE Sample Site
- Walk Track

biologic Environmental Survey

N

1:20,000

0 200 400 600 800 1,000 m

BHP - Shearers West

Two Phase Verterbrate Fauna Study

Fig. 3.1: Survey Sampling Locations

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 11/10/2018

3.5.5 Acoustic Recordings – Night Parrot

Overnight recordings using SM4 units were also undertaken for the Night Parrot. SM4 units were fitted with SMX-II acoustic microphones and set to record between 0-500 Hz each night. Units were deployed within long unburnt spinifex hummock grasslands and in accordance with interim guidelines developed by DPaW (2017).

The units were deployed across the Study Area at five locations for a total of seven recording nights (Figure 3.1; Appendix C). All recordings were analysed by Robert Bullen of Bat Call WA. The SM4 acoustic recorders were deployed in potential habitat recommended within the *Interim Guideline for Preliminary Surveys of Night Parrot (Pezoporus occidentalis) in Western Australia* (DPaW, 2017) – "stands of large, old clumps of spinifex (*Triodia*)... especially so if the identified area is part of a paleo-drainage system or contains healthy stands of samphire."

3.5.6 Motion Cameras

Bushnell Trophy Cam motion cameras were deployed to survey for species of conservation significance, specifically Northern Quoll (*Dasyurus hallucatus*) and Long-tailed Dunnart (*Sminthopsis longicaudata*). Motion cameras were deployed at nine locations for a total of 23 recording nights. The resulting footage was analysed manually by Biologic personnel. One site comprised one motion camera (SW-07), another comprised two cameras (SW-12) and the final site comprised three motion cameras (SW-01). Sites were selected based on the likelihood for detecting fauna of conservation significance, in this case within Breakaway/ Cliff and Hillcrest/Hillslope habitat types.

3.5.7 Opportunistic Vertebrate Fauna Records

Opportunistic records of vertebrate species encountered during the survey were documented. Birds were recorded on a presence/absence basis, determined by call identification, visual identification and/or tracks and traces.

3.5.8 Taxonomy and Nomenclature

BHP WAIO's checklist of vertebrate fauna was followed for nomenclature and taxonomy of mammal, birds, reptile and amphibian. This list broadly follows the latest checklist published by the Western Australian Museum (WAM, 2018b) (for mammals, reptiles and amphibians), and the current checklist of Australian birds maintained by Birds Australia (based on, Christidis & Boles, 2008).

3.6 Assessment on Occurrence

Conservation significant fauna species recorded from the databases and previous reports were assessed for their likelihood to occur within the Study Area using the decision matrix below (Table 3-5).

Table 3-5: Species likelihood of occurrence decision matrix

Range categories:	Habitat Categories				
	Core habitat known to occur	Foraging habitat known to occur	Dispersal habitat known to occur	Potential dispersal habitat	No known habitat occurs
Species recorded <5 km	Highly Likely	Likely	Likely	Possible	Possible
Species recorded 5-10 km	Likely	Likely	Possible	Possible	Rarely
Species recorded 10-40 km	Likely	Possible	Possible	Rarely	Unlikely
Species recorded >40 km	Possible	Possible	Rarely	Rarely	Unlikely
Species rarely recorded in region	Possible	Rarely	Unlikely	Unlikely	Highly Unlikely

This decision matrix is only intended to be an indicative guide, and was applied with the following considerations:

- The range categories are subject to interpretation based on the known range of each species and its natural dispersal capabilities (for example, >50 km range may be a significant distance for a fossorial skink, but not a migratory bird);
- Both the range categories and the habitat categories can vary markedly for different types of fauna such as birds, reptiles, mammals, and amphibians, and fauna with different ecological niches within each of these groups;
- The degree of habitat specificity for each species is a major determining factor for each of the habitat categories, and this in turn is dependent on the current state of ecological knowledge of the species;
- The amount and location of previous sampling is a major factor influencing the applicability of the range categories, as well as the amount of effort that has been expended in (and the accessibility of) the area in question for sampling;
- The current state of taxonomy is another major factor for species that are poorly known taxonomically and thus difficult to identify accurately, as well as for any recent changes of classification and/or conservation category. Such taxonomic changes can affect the reliability of previous records within fauna databases, the conservation status of the newly defined species/ populations, and the assumptions regarding species ranges and habitat preferences;
- The language used in each of the habitat and range categories may be useful for some taxa and not for others (for example, ‘rarely’ occurrences may be useful for describing birds or fauna which can traverse large distances, but in the case of fauna with more limited dispersal capabilities such as reptiles, there is no basis for ‘rarely’ occurrences. Such likelihoods are more likely to represent range extensions.

3.7 SRE Invertebrate Fauna Survey

3.7.1 Site Selection

Sites were chosen according to Guidance Statement 20 (EPA, 2016b). Habitats considered suitable for SRE terrestrial invertebrates were targeted. To provide adequate geographical coverage and local context, several reference sites in less suitable habitat types were also assessed.

Sampling was undertaken during the field survey (29 April to 4 May 2018) at 15 sites located across the Study Area (Figure 3.1).

3.7.2 Active foraging

Active foraging was undertaken at each sampling site for an average of approximately one (1) person hour and involved various techniques relevant to the following microhabitats:

- Under rocks, within cracks and crevices: suitably sized rocks were over turned, and rocky microhabitats were actively searched for rock dwelling species;
- Woody debris: larger logs and woody debris were investigated and over turned searching for detritivores;
- Vegetation and tree bark: significant vegetation (*e.g.* Mulga, and fig trees) were actively searched, including underneath sheets of bark; and
- Burrow searching: active searches were undertaken for mygalomorph spider and scorpion burrows within suitable habitats. Note: searches for burrows are undertaken during foraging time and also whilst walking through the Study Area, but time taken to excavate burrows is additional to foraging time.

3.7.3 Leaf litter searching

Leaf litter, humus and topsoil (to approximately 5 cm below surface) was placed in a sieve at the site and agitated to divide the sample into three grades (>7 mm, >3 mm, >1.4 mm, <1.4 mm). Each grade was thoroughly searched for target SRE species such as pseudoscorpions, millipedes, snails, and small scorpions. The maximum volume of litter in the sieve was approximately 4,808 cm^3, with a minimum of one sift conducted at each site (excluding sites SW02 and SW05), providing sufficient leaf litter and humus was available.

3.7.4 Specimen preservation

All specimens were euthanised in 100% ethanol to preserve DNA for sequencing. The pseudoscorpion and millipede specimens collected were sent directly to Dr Erich Volschenk for identification prior to vouchering at the WAM. The isopods were sent to Dr Simon Judd for identification.

3.7.5 SRE Invertebrate Habitat Assessments

The habitat assessments were aimed at determining the significance of each site as Potential SRE habitat, and hence the likelihood that each site may contain SRE fauna. The habitat assessment was based on three major factors influencing the significance of habitats for SRE species; isolation, protection and habitat complexity, as briefly outlined below and illustrated in Figure 3.2.

***Isolation*:** based on the level of connectivity between sites, which share similar habitat characteristics. Isolation is the most important factor when it comes to the level of risk, as any fauna with limited dispersal characteristics, regardless of the habitat preference, will likely be, at least, an isolated population. Examples include islands and mountaintops; in the Pilbara, peaks like Mt Meharry have been shown to harbour significant SRE species (Durrant, 2011).

***Protection*:** this primarily relates to protection from solar exposure; however, protection from disturbance is also very important for the long-term viability of SRE habitats and communities, *i.e.* protection from fire, flood and invasive species.

Protection is provided at two levels; the site level where the structural composition of the site (aspect, slope *etc.*) can provide protection from exposure and disturbance by providing physical barriers (*e.g.* gorges and gullies); and the habitat level where certain microhabitat characteristics, associated with habitat complexity, provide more direct protection, particularly from exposure (*i.e.* leaf litter, rocky substrates, canopy cover and soil depth).

***Habitat complexity*:** this factor drives species richness and often abundance at a site, *i.e.* the more complex a site is, the more species and individuals it is likely to contain. This is particularly important, as a number of SRE groups are predators; therefore, the richness and abundance of prey species are critical to their survival.

Complexity, with respect to SREs, is based around a number of microhabitat types:

- Leaf litter: both depth and structural variation;
- Rocky substrates: loose rocks and crevices;
- Vegetation variation: flora richness and structural variation; and
- Soil: depth and structural variation.

Likewise, the complexity of the habitat is important to detritivore SRE taxa (such as isopods, millipedes and some snails) which rely upon decaying leaf litter, woody debris and organic matter for survival. Examples in the Pilbara include deep gullies and gorges, where many of these areas contain most of the above microhabitat types, and therefore tend to be the richest areas. Isolation is the most important factor when it comes to the level of risk, as any fauna with limited dispersal characteristics, regardless of the habitat preference, will likely be, at least, an isolated population. Examples include islands and mountaintops; in the Pilbara, peaks like Mt Meharry have been shown to harbour significant SRE species (Durrant, 2011).

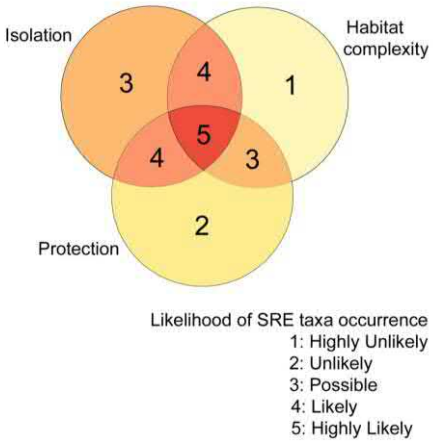

Figure 3.2: Factors influencing the suitability of habitats for SRE invertebrate fauna

3.8 Potential Limitation and Constraints

The EPA (2016c) outlines several potential limitations to fauna surveys. These aspects are assessed and discussed in Table 3-6 below.

Table 3-6: Survey limitations and constraints

Potential limitation or constraint	Applicability to this survey
Experience of personnel	The field personnel involved in the survey have a combined total of more than 14 years of fauna survey experience in the Pilbara.
Scope (faunal groups sampled and whether any constraints affect this)	The scope was a targeted vertebrate fauna and SRE invertebrate fauna survey and was conducted within that framework. No nocturnal work was undertaken by the field personal; this reduced the ability for opportunistic detection of nocturnally active species.
Proportion of fauna identified	All observed fauna were identified at the point of observation. All recorded bat calls were successfully identified.
Sources of information (recent or historic) and availability of contextual information	A significant amount of survey work (30 separate vertebrate fauna surveys and four SRE invertebrate fauna surveys located in or within 10 km of the Study Area) has been undertaken in the wider local area and the surrounding region, with these previous survey results available for review.
Proportion of the task achieved	A targeted vertebrate fauna and SRE invertebrate fauna survey of the Study Area was completed and related to the results of surveys in the broader area.
Disturbances (e.g. fire or flood)	Conditions experienced during the survey were acceptable for recording conservation significant species targeted. The main targeted species are identified from burrows therefore evidence for these species is recorded regardless of seasonality.
Intensity of survey	A targeted vertebrate fauna and SRE invertebrate fauna survey was determined to be the most appropriate survey methodology for this survey following discussions between BHP and Biologic.

Potential limitation or constraint	Applicability to this survey
Completeness of survey	The survey was adequately completed to meet the requirements of a targeted vertebrate fauna and SRE invertebrate fauna survey.
Resources (e.g. degree of expertise available)	All resources required to complete the survey were available.
Remoteness or access issues	The majority of the Study Area was accessible either by vehicle or on foot, thus the sampling techniques used during this survey were unconstrained by accessibility or remoteness.

4 RESULTS AND DISCUSSION

4.1 Desktop Assessment

4.1.1 Vertebrate Fauna

The literature review and database searches identified a total of 431 species of vertebrate fauna, which have previously been recorded and/ or have the potential to occur within the Study Area. This comprised 54 native mammals, nine non-native mammals, 216 native birds, one non-native bird, 137 reptiles, 12 amphibians and two fish (Appendix B). Note that some of these species are unlikely to occur in the Study Area as the database searches were undertaken over a larger area than the Study Area itself, therefore containing habitats that do not necessarily occur within the Study Area. Additionally, many species tend to be patchily distributed even where appropriate habitats are present, and many species of birds can occur as regular migrants, occasional visitors or vagrants.

Of the 431 species of vertebrate fauna identified as being previously recorded and/ or having the potential to occur, 39 species are of conservation significance (Table 4-1). However, taxonomic changes have confirmed that one these species does not occur in the Pilbara – the Crest-tailed Mulgara (*Dasycercus cristicauda*) which has a distribution confined to the Northern Territory (Woinarski, Burbidge, & Harrison, 2014). Therefore all *D. cristicauda* records has been merged with *Dasycercus blythi* (Priority 4) for this report. Two species are considered regionally extinct and therefore not considered in this review; the Western Quoll (*Dasyurus geoffroii*; van Dyck & Strahan, 2008) - listed as Vulnerable under the EPBC Act and Schedule 3 under the WC Act; and the Black-flanked Rock-wallaby (Petrogale lateralis lateralis; D. Pearson, 2013) - listed as Endangered under the EPBC Act and Schedule 2 under the WC Act).

A further additional species is listed as Extinct under the EPBC Act and Schedule 4 under the WC Act and therefore was not considered in this review; the Burrowing Bettong (*Bettongia lesueur graii*).

Table 4-1: Species of conservation significance identified during the desktop assessment

Scientific name	Common name	Conservation Status			
		EPBC	WCA	DBCA	IUCN
Mammals					
Dasycercus blythi	Brush-tailed Mulgara			P4	
Dasyurus hallucatus	Northern Quoll	En	S2		EN
Lagorchestes conspicillatus subsp. *leichardti*	Spectacled Hare-Wallaby			P4*	
Leggadina lakedownensis	Short-tailed Mouse			P4	
Macroderma gigas	Ghost Bat	Vu	S3		VU
Macrotis lagotis	Greater Bilby	Vu	S3		VU
Pseudomys chapmani	Western Pebble-mound Mouse			P4	
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	Vu	S3		
Sminthopsis longicaudata	Long-tailed Dunnart			P4	
Birds					
Anas querquedula	Garganey	Mi	S5		
Apus pacificus	Fork-tailed Swift	Mi	S5		

Scientific name	Common name	Conservation Status			
		EPBC	WCA	DBCA	IUCN
Calidris acuminata	Sharp-tailed Sandpiper	Mi	S5		
Calidris ferruginea	Curlew Sandpiper	Cr/Mi	S3/5		NT
Calidris melanotos	Pectoral Sandpiper	Mi	S5		
Calidris ruficollis	Red-necked Stint	Mi	S5		NT
Calidris subminuta	Long-toed Stint	Mi	S5		
Charadrius veredus	Oriental Plover	Mi	S5		
Falco hypoleucos	Grey Falcon		S3		VU
Falco peregrinus	Peregrine Falcon		S7		
Hirundo rustica	Barn Swallow	Mi	S5		
Macronectes giganteus	Southern Giant Petrel	En/Mi	S5		
Motacilla cinerea	Grey Wagtail	Mi	S5		
Motacilla flava	Yellow Wagtail	Mi	S5		
Pandion haliaetus	Eastern Osprey	Mi	S5		
Pezoporus occidentalis	Night Parrot	En	S1		EN
Plegadis falcinellus	Glossy Ibis	Mi	S5		
Polytelis alexandrae	Princess Parrot	Vu		P4	NT
Tringa glareola	Wood Sandpiper	Mi	S5		
Tringa hypoleucos	Common Sandpiper	Mi	S5		
Tringa nebularia	Common Greenshank	Mi	S5		
Tringa stagnatilis	Marsh Sandpiper	Mi	S5		
Tringa totanus	Common Redshank	Mi	S5		
Reptiles					
Anilios ganei	Pilbara Flat-headed Blind-snake			P1	
Ctenotus uber subsp. *johnstonei*	Spotted Ctenotus			P2	
Lerista macropisthopus subsp. *remota*				P2	
Liasis olivaceus subsp. *barroni*	Pilbara Olive Python	Vu	S3		
Liopholis kintorei	Great Desert Skink	Vu	S3		VU

4.1.2 SRE Invertebrate Fauna

The database searches identified 502 records of arachnids, myriapods and molluscs within 20 km of the Study Area. The total comprised 64 individual taxa of which there were 24 mygalomorph spiders, 17 scorpions, 16 pseudoscorpions, three selenopid spiders, two millipedes and two land snails.

No previous records are known from the Study Area and only 15 taxa are known from immediately adjacent to the Study Area (within 5 km), shown in Table 4-2. Only two of these are regarded as Confirmed SREs; *Aname* 'MYG205' and *Kwonkan* 'MYG006', while several others are regarded as either Data Deficient or Uncertain.

The lack of records obtained within and in the immediate vicinity of the Study Area demonstrates the lack of sampling effort conducted in the area, which reduces the regional context available and our ability to assess the significance of SRE taxa recorded.

Table 4-2: Terrestrial invertebrate taxa recorded adjacent to the Study Area

Higher Taxon	Family	Taxa	SRE Status
Mygalomorphae	Nemesiidae	*Aname* 'MYG004'	Widespread
		Aname 'MYG205'	Confirmed SRE
		Aname mellosa	Widespread
		Aname sp. indet.	Data Deficient
		Kwonkan 'MYG006'	Confirmed SRE
	Idiopidae	*Anidiops* 'MYG286-DNA'	Widespread
		Gaius tealei	Uncertain SRE
		Idiosoma 'MYG085'	Uncertain SRE
	Barychelidae	*Idiommata* 'MYG128'	Uncertain SRE
Pseudoscorpiones	Olpiidae	*Austrohorus* sp. indet.	Data Deficient
		Euryolpium sp. indet.	Data Deficient
		Olpiidae sp. indet.	Data Deficient
	Atemnidae	*Oratemnus* sp. indet.	Data Deficient
Scorpiones	Buthidae	*Lychas* 'harveyi group'	Data Deficient
	Urodacidae	*Urodacus megamastigus*	Widespread

4.2 Fauna Habitats

4.2.1 Fauna Habitats

Typical Pilbara habitat types were mapped in the Study Area, consisting of Major Drainage Line, Stony Plain, Hillcrest/ Hillslope, Mulga Woodland and Sand Plain. Potential significant habitats and features (water features and caves) are detailed in section 4.2 and 4.3. The condition of habitats within the Study Area ranged from Very Good to Pristine. The largest disturbance was caused by mining explorations, grazing by Cattle (**Bos taurus*) and clearing of road/ access tracks. The occurrence of weeds, particularly Buffel Grass (**Cenchrus ciliaris*), was apparent in the Major Drainage Line. Table 4-3 provides habitat descriptions for each of the habitat types mapped in the Study Area.

Table 4-3: Fauna habitat descriptions

Habitat type	Distinguishing habitat characteristics	Extent of the habitat	Conservation Significant Species	Photo
Major Drainage Line **Significance:** Moderate to High **SRE Suitability:** Low/Moderate	Major Drainage Lines comprise mature River Red Gums/ Coolabahs over dry river pools. Open, sandy or gravelly riverbeds characterise this habitat type. In non-grazed areas, the vegetation adjacent to the main channel or channels is denser, taller and more diverse than adjacent terrain. Buffel Grass (**Cenchrus ciliaris*) occurs in varying densities along the banks of the major drainage line. May hold temporary waterbodies (days to weeks) following significant rainfall.	This habitat type is the lowest in the landscape and flows south to north through the eastern portion of the study area, to join the Fortescue River near the marsh. Common habitat throughout the Pilbara and are generally associated with all major rivers in the Pilbara, such as the Fortescue, De Grey, Yule and Turner rivers. However, because they tend to be relatively narrow, linear features, they only represent a small proportion of the total land area.	Potential suitable habitat for: • Northern Quoll (foraging and dispersal) • Pilbara Olive Python (foraging and dispersal) • Ghost Bat and Pilbara Leaf-nosed Bat (foraging and dispersal) • Pilbara Flat-headed Blind Snake Important dispersal corridors for SRE fauna.	
Stony Plain **Significance:** Moderate **SRE Suitability:** Low	These are erosional surfaces of gently undulating plains, ridges and associated footslopes. Mainly support hard spinifex (and occasionally soft spinifex) with a mantle of gravel and pebbles.	Occurs sporadically in the Study Area, generally associated with the footslopes of the hill and crests. Common habitat throughout the Pilbara, especially in the south east. Occurs within National Parks in the Pilbara.	Potential suitable habitat for: • Western Pebble-mound Mouse • Spectacled Hare-wallaby • Short-tailed Mouse • *Ctenotus uber* subsp. *johnstonei*	

Habitat type	Distinguishing habitat characteristics	Extent of the habitat	Conservation Significant Species	Photo
Hillcrest / Hillslope **Significance:** Moderate **SRE Suitability:** Moderate	These fauna habitats tend to be more open and structurally simple due to their position in the landscape than other fauna habitats and are dominated by varying species of hummock grasses. A common feature of these habitats is a rocky substrate, often with exposed bedrock, and skeletal red soils. These are usually dominated by *Eucalyptus* woodlands, *Acacia* and *Grevillea* scrublands and *Triodia* low hummock grasslands.	The Hillcrest/ Hillslope habitat was extensive, with large extents occurring in the central and western portion of the Study Area. The habitat occurred in association with high relief. Hill crests and hill slopes occur extensively throughout the Pilbara with various land tenure, including National Parks and unallocated crown land.	Potential suitable habitat for: • Western Pebble-mound Mouse • Northern Quoll (limited denning) Can contain important microhabitats for SRE fauna, such as outcropping and boulders, and pockets of soil and leaf litter.	
Mulga Woodland **Significance:** Low **SRE Suitability:** Low/Moderate	This habitat includes woodlands and other ecosystems in which Mulga is dominant, either as the principal *Acacia* species or mixed with others. It consists of broad groves on stony or sandy soils, with little undergrowth.	This habitat occurred in bands or groves or as open woodlands throughout the Study Area. The Mulga is taller than 2 metres in height and has formed in moderately dense groves in some locations - suggesting that it has remained unburnt for a reasonably long time. Mulga woodlands occur extensively in the southern portions of the Pilbara bioregion, extending south through the Gascoyne and Murchison bioregions.	Potential suitable habitat for: • None. Mulga Woodland is listed as potential habitat for Greater Bilby (C. Pavey, 2006) (Pavey, 2006); however records in the Pilbara, and especially the region of the Study Area, are restricted to Sandplain where the substrate of sand, soil, sandy clay, or sandy gravel is suitable for burrowing (Dziminski & Carpenter, 2017). • Can contain important microhabitats for SRE fauna, such as deep soils and leaf litter.	

Habitat type	Distinguishing habitat characteristics	Extent of the habitat	Conservation Significant Species	Photo
Sand Plain **Significance:** High **SRE Suitability:** Low	Sand Plain habitat is characterised by relatively deep sandy soils supporting dense spinifex grasslands and sparse low shrubs. This habitat transitions into patches of Mulga in places. This habitat often occurs as terraces along Major Drainage Lines and extensive plains.	This habitat occurred throughout the majority of the Study Area, with greater concentrations in the southeast and southwest. Common habitat throughout the Fortescue and Chichester sub-regions of the Pilbara, especially in the north and east. Also common within the Augustus sub-region of the Gascoyne, which extends south and east of the Study Area.	Potential suitable habitat for: • Greater Bilby. As well as always being found in areas where the substrate of sand, soil, sandy clay, or sandy gravel is suitable for burrowing, there is an association with particular *Acacia* spp. that bilbies use for food resources (Dziminski & Carpenter, 2017). • Brush-tailed Mulgara • Spectacled Hare-wallaby • Night Parrot	

204,000 206,000 208,000 210,000

7,410,000

7,408,000

Legend

- Study Area

Habitat Type

- Hillcrest/ Hillslope
- Major Drainage Line
- Mulga Woodland
- Sand Plain
- Stony Plain

biologic Environmental Survey

N

1:20,000

0 200 400 600 800 1,000 m

BHP - Shearers West

Two Phase Verterbrate Fauna Study

Fig.4.1: Fauna Habitats Occuring Within the Study Area

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 11/10/2018

4.3 Vertebrate Fauna Habitat Features

A cave was recorded towards the south-western corner of the Study Area. The cave (SW01) is located on the upper slopes of a hillside with north to west aspect. The Common Sheath-tailed Bat (*Taphozous georgianus*) and Finlayson's Cave Bat (*Vespadelus finlaysoni*) were observed within the cave system. No scats from the conservation listed Ghost Bat (*Macroderma gigas*) or Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) were identified from the cave floor. The ultrasonic recorders that were deployed across the Study Area did not record the presence of any Ghost Bats or Pilbara Leaf-nosed Bat. The cave was a suitable depth and size for roosting Ghost Bat, given this and the fact that ecologia (2006a) recorded an individual foraging Ghost Bat 5 km to the east of the creek at Hashimoto (overlapping the Study Area) and there were other obligate cave-dwelling bat species recorded at SW01, the cave may represent a potential day roost for the Ghost Bat.

Plate 4-1: Cave (SW01) located within the Study Area

Water sources are a limiting factor for many ecosystems (James, Landsberg, & Morton, 1995), particularly within arid-zone ecosystems such as the Pilbara (A. H. Burbidge, Johnstone, & Pearson, 2010; Doughty, Rolfe, Burbidge, Pearson, & Kendrick, 2011) and often represent areas of comparatively high productivity (Murray, Zeppel, Hose, & Eamus, 2003). These features are highlighted because they may provide important sources of shelter (for roosting, breeding, or dispersal), food and water for species of conservation significance. One dry potentially semi-permanent water feature was recorded within the Study Area during the survey. This water feature may hold surface water following substantial rainfall events and depending on the amount of rainfall and occurrence it is possible that the soak could

retain surface water majority of the year. Mammals and birds have endothermic metabolisms thus require relatively continuous sources of food and moisture, while water for amphibians provides opportunities to forage (*i.e.*, suitably wet periods) and breed (*i.e.,* when water pools for long enough for them to complete the life cycle) (James et al., 1995). Although no species of conservation significance were recorded at the water feature during the current survey period, there is potential that the feature may provide a resource for such species at other times of the year, such as when water is scarce in landscape and/or conditions are generally hotter and drier.

204,000

206,000

208,000

210,000

7,410,000

7,408,000

Legend

Study Area

Habitat Feature

Cave

Waterhole

WA Location

biologic Environmental Survey

N

1:20,000

0 200 400 600 800 1,000 m

BHP - Shearers West

Two Phase Verterbrate Fauna Study

Fig.4.2: Significant Fauna Features

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 11/10/2018

4.4 Potential Significance of Habitats Recorded in the Study Area

4.4.1 Vertebrate Fauna

The Sand Plain habitat was deemed to be of high significance as it is likely to provide suitable habitat for the conservation listed Brush-tailed Mulgara (P4), which has previously been recorded from adjacent Sand Plain habitats (Biologic, 2016b). The Sand Plain habitat may also provide suitable habitat for the Greater Bilby, although there is no recent or historical evidence from within the Study Area to suggest that this species currently utilises the Study Area (Table 4.4), and the structure of the Sandplain within the Study Area (containing a high amount of alluvial material) makes it less suitable for burrowing compared to deep Sandplains. The Night Parrot and Spectacled Hare-wallaby may also utilise the Sand Plain habitat, although both species are only deemed to possibly occur in the Study Area due to the lack of recent nearby records. In addition, for the Night Parrot, the Sandplain within the Study Area is not of age nor is it located near foraging habitat. The Major Drainage Line habitat was deemed to be of Moderate-High significance as it may provide suitable habitat for migratory birds and migratory waders (Table 4.4). The Major Drainage Line habitat may also provide marginally suitable habitat for nesting and foraging for the Peregrine Falcon, while also potentially representing key dispersal habitat for Pilbara Olive Python and the Pilbara Flat-headed Blind Snake (Table 4.4).

Two of the remaining habitats recorded (i.e. Stony Plain and Hillcrest/ Hillslope) were considered to be of moderate significance. Stony Plain habitat provides potential habitat for the Spectacled Hare-wallaby, Western Pebble-mound Mouse, Short-tailed Mouse and *Ctenotus uber* subsp. *johnstonei* (Table 4.4). The Hillcrest/ Hillslope habitat contains small rocky breakaways that could provide marginal additional denning habitat for transient Northern Quoll, although it is unlikely as such features are small in extent and sparsely distributed and there are no records in the immediate vicinity. It also provides and potential stony crest habitat for the Western Pebble-mound Mouse. The remaining habitat, Mulga Woodland, was deemed to have a low significance as they either do not support species of high conservation value and/ or such species are not dependent on these habitats at the broad-scale (Table 4.4). Mulga woodland does contain a number of bird and reptile species that use the habitat exclusively. Descriptions of the distinguishing characteristics and the occurrence inside and outside of the Study Area for each of these habitat types are presented in Table 4-3 and the significance of each habitat type is summarised in Table 4.4.

Table 4.4: Potential Significance of Fauna Habitat Types and Justification for Significance

Habitat type	Significance	Conservation Significant Species Potentially Supported	Justification for significance
Sand Plain	High	• Brush-tailed Mulgara • Greater Bilby • Night Parrot • Spectacled Hare-wallaby	Provides potential core habitat for multiple conservation listed species that are unlikely to be found in other habitat types in the region. • Brush tailed Mulgara are recorded in this habitat type in adjacent area 20 km from Study Area • Greater Bilby have been recorded 20 km from the Study Area, however Sandplain within the Study Area contains a high amount of alluvial material and is only moderately suitable. • For Night Parrot, the Sandplain present within the Study Area is not of age nor is it located near foraging habitat. However, these species would have the capability to access the Sandplain within the Study Area from other areas if required. Night Parrot have been recorded flying up to 30 km per night foraging (Night Parrot Recovery Team, 2017) • For the Spectacled Hare-Wallaby potential habitat within the Study Area is the Sand Plain and Stony Plain habitat types, and the Study Area falls within its current distribution.
Major Drainage Line	Moderate-High	• Northern Quoll (foraging and dispersal) • Pilbara Olive Python (foraging and dispersal) • Ghost Bat and Pilbara Leaf-nosed Bat (foraging and dispersal) • Pilbara Flat-headed Blind Snake • Important dispersal corridors for SRE fauna.	Provides habitat for a number of different conservation listed species listed under the EPBC Act, and in addition provides a range of habitat uses (dispersal, foraging etc) for these species. Major Drainage Lines are important dispersal corridors for SRE fauna. As a narrow, linear feature, they make up a small proportion of the total land area. The Major Drainage Line is not in excellent condition but is in Good condition (Table 3.4), and this is not expected to change the likelihood of conservation listed species occurring.
Stony Plain	Moderate	• Western Pebble-mound Mouse • Spectacled Hare-wallaby • Short-tailed Mouse • *Ctenotus uber* subsp. *Johnstonei*	Provides potential habitat for some conservation listed species, however they are “Priority” species listed by DBCA and none of the potential species are EPBC listed. This habitat is a relatively common habitat type throughout both the Pilbara and the local area. The conservation listed species are not restricted to the habitat type but may use it for foraging or dispersal.

Habitat type	Significance	Conservation Significant Species Potentially Supported	Justification for significance
Hillcrest/ Hillslope	Moderate	• Western Pebble-mound Mouse • Northern Quoll (limited denning) • Can contain important microhabitats for SRE fauna, such as outcropping and boulders, and pockets of soil and leaf litter.	Provides potential habitat for some conservation listed species, however the number supported is lower than that of other habitat types present. In addition, these conservation species are not restricted to the habitat type. The habitat is not considered to be as important for denning for species such as Quolls in comparison to other habitat types due to the lower quantity and quality of overhangs and breakaways. Hillcrest/hillslope is also a relatively common habitat type throughout the both the Pilbara and the local region. The Hillcrest/hillslope is in "Good" condition (Table 3.4), but this is not expected to change the likelihood of conservation listed species occurring
Mulga Woodland	Low	• None Can contain important microhabitats for SRE fauna, such as deep soils and leaf litter.	Does not support conservation listed species at the broad scale, or any conservation species occurring are not restricted to this habitat type The Mulga Woodland is not in excellent condition, but this is not expected to change the likelihood of conservation listed species occurring

4.4.2 SRE Invertebrates

The majority of the fauna habitats occurring within the Study Area were assessed as being of low to low/moderate suitability for SRE invertebrate fauna due to the fact they provide little protection and complexity, and the majority of these habitats are widespread and continuous through the landscape – thus promoting dispersal from invertebrates that occupy such niches. This was the case for the Major Drainage Line, Stony Plain, Mulga Woodland and Sand Plain habitats.

The Hillcrest/ Hillslope habitat was assessed as of moderate suitability for SRE fauna, providing a moderate degree of complexity and protective microhabitats in the form of rocky cracks, crevices, soil pockets and leaf litter accumulations. This habitat occurred within the Study Area as isolated features with low connectivity to the more substantial rocky hills, ranges and crests located to the north of the Study Area, which are known to support potential SRE species (Biologic, 2014b).

4.5 Fauna Recorded

4.5.1 Vertebrate Fauna

A total of 51 vertebrate fauna species, comprising 17 mammal species (four of which are introduced species), 28 bird species, five reptile species and one amphibian species were recorded within the Study Area directly or via secondary evidence (Table 4-5, Appendix C).

All 51 species are known to occur within the wider region and were recorded within the desktop assessment (Section 4.1). The number of species recorded during this survey is lower than many other surveys conducted within the vicinity of the Study Area (Table 4-5); however, these surveys were predominantly trapping surveys and employed much broader techniques for sampling general fauna. As such, species that are generally not elusive, diurnal and lacking in distinctive secondary traits were

generally observed during the current survey. The number of species recorded is comparable to other surveys of similar scope conducted within the vicinity of the Study Area.

Table 4-5: Summary of fauna species recorded or reported from the literature review database searches within the vicinity of the Study Area.

Source	Mammals	Birds	Reptiles	Amphibians	Fish	Total species
Literature Sources						
Caramulla Exploration Area Flora and Vegetation Survey and Fauna Assessment (Biologic, 2018)	6	26	2	0	0	34
Wheelarra Hill North Fauna Assessment (ENV Australia, 2012)	22	59	55	2	0	138
Orebody 31 Terrestrial Vertebrate Fauna Survey (Biologic, 2014d)	22	39	42	0	0	103
South-West Jimblebar Vertebrate Fauna Survey (Biologic, 2013b)	16	55	39	2	0	112
Orebody 19 Level 2 Vertebrate Survey (Biologic, 2014c)	25	62	48	1	0	136
Orebody 18 Fauna Assessment Phase II (ENV Australia, 2007b)	15	55	42	0	0	112
Tenement E52/2238 Level 1 Flora and Vegetation and Level 1 Vertebrate Fauna Survey (Onshore, 2015b)	11	21	5	0	0	37
Jimblebar Mine Site Biological Survey (BHP, 1994)	10	26	21	0	0	57
Orebody 18 Biological Assessment Survey (ecologia, 1995)	9	0	0	0	0	9
Jimblebar-Wheelarra Hill 3 Biological Survey (ecologia, Environment, 2004a)	9	85	52	5	0	151
BHPBIO Hashimoto Terrestrial Vertebrate Fauna Assessment (ecologia, Environment, 2007)	24	64	24	1	0	113
Jimblebar Marra Mamba Exploration Biological Survey (ecologia, Environment, 2006b)	10	59	30	1	0	100
West Jimblebar Lease Fauna Assessment (ENV Australia, 2007c)	8	55	42	0	0	105
West Jimblebar Lease Fauna Assessment (GHD, 2008)	4	82	49	4	0	139

Source	Mammals	Birds	Reptiles	Amphibians	Fish	Total species
Jimblebar Spur 2 Fauna Assessment (ENV, 2009)	15	41	9	1	0	66
Jimblebar Iron Ore Project Terrestrial Vertebrate Fauna Assessment (Outback Ecology Services, 2009a)	13	46	27	2	0	88
Jimblebar Linear Development Terrestrial Vertebrate Fauna Assessment (Outback Ecology Services, 2009b)	16	59	31	5	0	111
Wheelarra Hill Iron Ore Modification Flora and Fauna Assessment (Outback Ecology Services, 2009c)	23	0	39	2	0	64
Orebody 31 Fauna Assessment (ENV, 2011)	7	38	6	0	0	51
Dynasty Level 1 Vertebrate Fauna Survey (Biologic, 2016a)	14	27	2	0	0	43
Dynasty Level 2 Vertebrate Fauna Survey (Biologic, 2016b)	15	39	31	2	0	87
Dynasty tenement – desktop review of vertebrate fauna and habitats (Biologic, 2014a)	0	0	0	0	0	0
Jimblebar-Wheelarra Hill 3 Flora and Fauna Assessment (Biota, 2004)	0	0	0	0	0	0
Newman to Jimblebar Transmission Line and Newman Town Substation Terrestrial Fauna Assessment (Australia, 2009)	15	58	14	1	0	88
Satellite Orebodies: Orebody 18 Flora and Fauna Review (ecologia, 2004)	0	0	0	0	0	0
Orebodies 18, 23 & 25 Flora and Fauna Review (ecologia, Environment, 2004b)	1	0	0	0	0	1
Jimblebar Wye Rail Junction (Borrow Areas) Fauna Assessment (ENV Australia, 2007a)	0	0	0	0	0	0
OB17 and 18 Vertebrate Fauna Habitats (Biologic, 2013a)	0	0	0	0	0	0
Database Searches						

Source	Mammals	Birds	Reptiles	Amphibians	Fish	Total species
DBCA NatureMap (DBCA, 2018a)	41	94	97	9	2	243
DoEE Protected Matters (DoEE, 2018)	13	17	1	0	0	31
DBCA Threatened and Priority Fauna Database (DBCA, 2018b)	13	20	4	0	0	37
BirdLife (Birdlife Australia, 2018)	0	164	0	0	0	164
Current Survey	**17**	**28**	**5**	**1**	**0**	**51**
Total species	**63**	**217**	**137**	**12**	**2**	**431**
Species of conservation significance	**10**	**23**	**5**	**0**	**0**	**38**

4.5.2 SRE Invertebrate Fauna

The survey collected 63 invertebrate specimens from microhabitats in leaf litter, soil, under rocks, woody debris and trapdoor spider burrows. A total of eight taxa were identified, with the most common (5) being pseudoscorpions, followed by Gastropoda (land snails), scorpions, isopods and mygalomorph spiders (trapdoor spiders).

No Confirmed SRE species were detected; however, three taxa are regarded as Potential SRE fauna and four indeterminate taxa were categorised as Data deficient. The key faunal results are detailed below and can be viewed in Figure 4.2:

Pseudoscorpions

Atemnidae

Oratemnus sp. indet.

Eight specimens (one male, four females and three juveniles) from this genus were recorded from three sites; two mulga woodland sites and one major drainage line site. There is limited taxonomic knowledge of this genus in the Pilbara, so further taxonomic resolution would require molecular analysis.

As such, this taxon is regarded as **Data deficient**.

Garypidae

Synsphyronus sp. indet.

One juvenile specimen was collected from a granite outcrop on a hillslope (SW02). While this taxon lacks taxonomic resolution, there are confirmed SRE representatives in the Pilbara. Based on what is known of the genus as a rocky habitat specialist, it is likely to require the macrohabitat of outcropping and boulders within the Study Area, and within this the microhabitat of rocks cracks and crevices.

As such, it is regarded as a **Potential SRE** (WAM Categories 'A' Data deficient and 'E' Research and experience) and molecular analysis could further resolve this deficiency.

Olpiidae

Austrohorus sp. indet.

One male specimen of this genus was recorded from ironstone outcrops on a hillslope. There is little taxonomic knowledge of this genus, so further taxonomic resolution would require molecular analysis.

As such, this taxon is regarded as **Data deficient**.

Beierolpium sp. '8/3'

Ten specimens (three males and seven females) of this species were recorded at two sites; ironstone outcrops and boulders/rockpiles.

This taxon is known from throughout the Pilbara, up to 700 km west of the Study Area and is therefore regarded as **Widespread**.

Indolpium sp. indet.

Two specimens (one female and one juvenile) from this genus were collected at two sites in ironstone outcrops on a hillslope.

There is limited taxonomic knowledge of this genus in the Pilbara, so further taxonomic resolution would require molecular analysis.

As such, this taxon is regarded as **Data deficient.**

Mygalomorphae: Idiopidae

Idiopidae sp. indet.

The excavated specimen from site SW04 was determined to be a female and thus lacked the necessary features for identification; however, two nearby specimens (approximately 1 km away) from the same habitat (mulga woodland in a drainage area) with similar looking burrows (see Plate 4-2) have had DNA analysis completed. It was revealed that both specimens from SWJ06 and SWJ18 belonged to a single species known as *Anidiops* 'MYG286-DNA', with a genetic divergence of approx. 0.2% (COI) (Biologic 2013). The DNA analyses also showed that *Anidiops* 'MYG286-DNA' is known to occur more than 260 km north west of the Study Area and is therefore regarded as Widespread.

While not confirmed that this specimen is *Anidiops* 'MYG286-DNA', it can be considered very likely. As such, this taxon can be regarded as **Widespread**.

Plate 4-2: Burrow from the current Study Area (left) and from 900m to the west of the Study area (right).

Scorpions: Buthidae

Lychas 'bituberculatus complex'

One juvenile specimen was collected from a Major Drainage Line habitat (site SW15) and other representatives of this complex have been recorded to the north of the Study Area in Wheelarra North and Jimblebar on a rocky slope descending down to a large river line below. Major Drainage Line habitats are important dispersal corridors for invertebrate fauna but do not tend to provide stable, long-term microhabitats.

This complex is currently regarded as likely to contain SRE species (E. Volschenk pers. comm.), therefore this taxon is regarded as a **Potential SRE** (WAM Categories 'A' Data deficient and 'E' Research and experience).

Isopoda: Armadillidae

Buddelundia sp. '14CR'

One male specimen of this taxon was collected from a Mulga Woodland habitat (site SW04). This taxon is currently considered a possible species complex and may contain at least two distinct species. Several specimens have been recorded within 10 km of the north of the Study Area, within Orebodies 17, 18, 19 and 31 in a range of habitats such as Drainage Line, Shallow Gully, and Gully. The Mulga Woodland habitat would provide important microhabitats for this species, such as leaf litter accumulations, but is a widespread, continuous habitat.

As such, this species is regarded as a **Potential SRE** (WAM Categories 'A' Data deficient and 'E' Research and experience).

204,000 206,000 208,000 210,000

7,410,000

7,408,000

Legend

- Study Area

Habitat Type

- Hillcrest/ Hillslope
- Major Drainage Line
- Mulga Woodland
- Sand Plain
- Stony Plain

SRE Observations

- *Buddelundia* sp. '14'
- Idiopidae sp. indet.
- *Lychas* sp. 'bituberculatus'
- *Austrohorus* sp. indet.
- *Indolpium* sp. indet.
- *Oratemnus* sp. indet.
- *Synsphyronus* sp. indet.

biologic Environmental Survey

N

1:20,000

0 200 400 600 800 1,000 m

BHP - Shearers West

Two Phase Verterbrate Fauna Study

Fig.4.3: Records of Species of Conservation Significance in the Study Area

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

Size A3. Created 11/10/2018

Table 4-6: Summary of invertebrate fauna species recorded or reported from the literature review and database searches within the vicinity of the Study Area (please note that some of the records within the WAM database or ALA will also be counted within the local SRE surveys).

Source	Pseudoscorpions	Mygalomorphs	Isopods	Molluscs	Selenopid	Scorpions	Myriapods
Dynasty SRE Invertebrate Fauna Desktop Assessment (Biologic, 2014a)	3	12	10	0	3	0	6
Jimblebar Iron Ore Project Terrestrial Invertebrate SRE Assessment (Outback Ecology, 2009)	2	13	0	33	0	5	12
OB19-31 SRE Survey (Biologic, 2014b)	10	4	5	4	2	5	3
South West Jimblebar SRE Invertebrate Fauna Survey (Biologic, 2013a)	97	2	24	32	0	0	0
DBCA NatureMap (DBCA, 2018a)							
DoEE Protected Matters (DoEE, 2018)	0	0	0	0	0	0	0
WAM Invertebrate Fauna Database (WAM, 2018a, 2018d)	16	24	0	2	3	17	2
Atlas of Living Australia (ALA, 2018)	8	19	0	6	0	3	8
Current Survey	**5**	**1**	**1**	**0**	**0**	**1**	**0**

4.6 Vertebrate Fauna of Conservation Significance

Based on the results of the desktop assessment, a total of 39 conservation significant species have the potential to occur within the Study Area (Table 4-1). At the time of the field survey, no conservation significant vertebrate fauna species were recorded from the Study Area. Each of the 39 conservation significant species have been given a likelihood of occurrence, detailed in Table 4-7.

Only two species were “highly likely” to occur: the Western Pebble-mound Mouse and Brush-tailed Mulgara. Three species were “likely” to occur: the Long-tailed Dunnart, the Pilbara Flat-headed Blind-snake and Spotted Ctenotus. The remaining species were given a likelihood of occurrence of possible, unlikely or highly unlikely (Table 4-7).

Table 4-7: Conservation significant species likelihood assessment

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Mammals							
Northern Quoll (*Dasyurus hallucatus*)	EN	S2	The species tends to inhabit rocky habitats which offer protection from predators and are generally more productive in terms of availability of resources (Braithwaite & Griffiths, 1994; Oakwood, 2000). Other microhabitat features important to the species include: rock cover; proximity to permanent water and time-since last fire (Woinarski et al., 2008).	Some potential habitat within the Study Area includes the Major Drainage Line (foraging) and Hillcrest/Hillslope (limited denning)	Yes	No	Unlikely – although within the distribution there is limited denning habitat available and no nearby records (nearest record is 50 km to the north).
Greater Bilby *Macrotis lagotis*	VU	S3	Extant population of the Greater Bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils. It occupies three major vegetation types; open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate, 1990).	Potential habitat within the Study Area is the Sand Plain	Yes	No	Possible – although one single very old and inactive burrow was recorded at Caramulla (20 km to the east). Sand Plain habitat present not highly suited to species (prefer deep sands)
Ghost Bat *(Macroderma gigas)*	VU	S3	Ghost Bats roost in deep, complex caves beneath bluffs of low, rounded hills, granite rock piles and abandoned mines (Armstrong & Anstee, 2000). These features often occur within habitats including gorge/gully, hill crest/hill slope and low hills (Armstrong & Anstee, 2000).	Yes - Potential foraging habitat exists in the Major Drainage Line, Mulga Woodland and the cave recorded.	Yes	No	Possible - a cave exists (no presence recorded) and some foraging habitat
Pilbara Leaf-Nosed Bat *(Rhinonicteris aurantia)*	VU	S3	Species roosts within caves and abandoned mines with high humidity (95%) and temperature (32 °C) (Armstrong, 2001). Species forages in caves and along waterbodies with fringing vegetation (TSSC, 2016).	Yes - Potential foraging habitat exists in the Major Drainage Line.	Yes	No	Unlikely - some foraging habitat present but not known from area

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Spectacled Hare-wallaby *(Lagorchestes conspicillatus leichardti)*	-	P4	Within the Pilbara the Spectacled Hare-wallaby is known to occur in tussock and hummock grasslands and *Acacia* shrublands (Ingleby & Westoby, 1992).	Yes - Potential habitat within the Study Area is the Sand Plain and Stony Plain habitat types.	Yes	No	Possible – some potential habitat exists and within current known distribution
Long-tailed Dunnart *(Sminthopsis longicaudata)*	-	P4	Typically occurs on plateaus near breakaways and scree slopes, and on rugged boulder-strewn scree slopes (Gibson & McKenzie, 2012). Once considered rare but now shown to be relatively common and widespread in rocky habitats (A. A. Burbidge, McKenzie , & Fuller, 2008).	Yes - Potential habitat includes the Stony Plain habitat.	Yes	No	Possible – some potential habitat exists and within current known distribution
Western Pebble-mound Mouse *(Pseudomys chapmani)*	-	P4	This species 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 (Anstee, 1996; Start, Anstee, & Endersby, 2000).	Yes - Potential habitat within the Study Area includes the Hillcrest/hillslope and Stony Plain habitat types.	Yes	No	Highly Likely – potential habitat exists, nearby records of the species, and within its distribution
Brush-tailed Mulgara *(Dasycercus blythi)*	-	P4	Prefers *Triodia* spp. grasslands on sand plains and the swales between low dunes (C. R. Pavey, Nano, Cooper, Cole, & McDonald, 2012; Woolley, 2006). Mature spinifex hummocks appear to be important for protection from introduced predators (Körtner, Pavey, & Geiser, 2007).	Yes - Potential habitat includes the Sand Plain habitat.	Yes	No	Highly Likely – suitable habitat is present and there are nearby records
Short-tailed Mouse (*Leggadina lakedownensis)*	-	P4	The species occupies a diverse range of habitats from the monsoon tropical coast to semiarid climates, including spinifex and tussock grasslands, samphire and sedgelands, *Acacia* shrublands, tropical eucalypt and *Melaleuca* woodlands and stony ranges; however, the species is usually found in seasonally inundated habitats on red or white sandy-clay soils (Moro & Kutt, 2008).	Yes - Potential habitat includes the Stony Plain	Yes	No	Possible – some potential habitat exists and within current known distribution

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Northern Marsupial Mole (*Notoryctes caurinus*)	-	P4	The kakarratul inhabits sand dunes and, to a lesser extent, adjacent swales where there is suitable deep, loose sand (Bennison, Clayton, Godfree, Pavey, & Wilson, 2014). Trenching surveys have shown that potential habitat appears to be simply described as aeolian dunes.	No - Although the Study Plain contains Sand Plain habitat, it lacks the dune characteristics required by the species.	No	No	Highly Unlikely – no potential habitat exists in the Study Area
Birds							
Curlew Sandpiper *(Calidris ferruginea)*	CR/MI	S5	Inhabits intertidal mudflats in sheltered coastal areas (i.e. estuaries, bays, inlets and lagoons) (Geering, Agnew, & Harding, 2007). This rare species generally roosts on bare dry shingle, shell or sand beaches, sandspits and islets in or around coastal or near-coastal lagoons and other wetlands (Geering et al., 2007).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Night Parrot *(Pezoporus occidentalis)*	EN	S1	The Night Parrot prefers sandy/stony plain habitat with old-growth spinifex (*Triodia*) for roosting and nesting in conjunction with native grasses and herbs for foraging (DPaW, 2017).	Yes - In the Study Area potential habitat occurs in the Sand Plain and Stony Plain.	Yes	No	Unlikely – marginally suitable roosting habitat present although not in proximity to foraging habitat and few records from the region.
Southern Giant Petrel (*Macronectes giganteus*)	EN/MI	S5	The Southern Giant-Petrel is marine bird that occurs in Antarctic to subtropical waters (R Johnstone & Storr, 1998). In summer, it mainly occurs over Antarctic waters, and it is widespread south as far as the pack-ice and onto the Antarctic continent (R Johnstone & Storr, 1998). It occurs in both pelagic and inshore waters. It is attracted to land at sewage outfall (R Johnstone & Storr, 1998).	No	No	No	Highly Unlikely – no potential habitat and not within distribution. The record in this desktop from the database search is likely erroneous.

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Peregrine Falcon (*Falco peregrinus*)		S7	The Peregrine Falcon is found throughout Australia and it is typically absent from treeless and waterless deserts and dense forests (BirdLife Australia, 2012). In arid areas it is most often encountered along cliffs above rivers, ranges and wooded watercourses where it hunts birds (R Johnstone & Storr, 1998).	Yes - Potential foraging habitat within the Major Drainage Line.	Yes	No	Possible – some potential foraging habitat exists.
Grey Falcon (*Falco hypoleucos*)	-	S3	Timbered lowlands, particularly Acacia shrubland and along inland drainage systems. Also frequent spinifex and tussock grassland (A. H. Burbidge et al., 2010; Olsen & Olsen, 1986).	Yes - Potential foraging habitat within the Major Drainage Line.	Yes	No	Possible – some potential foraging habitat exists.
Princess Parrot (*Polytelis alexandrae*)	VU	P4	It is restricted to the arid zone of Western Australia, the Northern Territory and South Australia. The Princess Parrot inhabits sand dunes and sand flats. It occurs in open savanna woodlands and shrublands that usually consist of scattered stands of *Eucalyptus*, *Casuarina* or *Allocasuarina* trees. It also frequents Eucalyptus or Allocasuarina trees in riverine or littoral areas.	Yes - Potential habitat could include the Sand Plain and Stony Plain.	Yes	No	Highly Unlikely – no records in the vicinity, and preferred habitat is more sand dunes than Sand Plain (as found in the Study Area)
Barn Swallow (*Hirundo rustica*)	MI	S5	The Barn Swallow is a non-breeding summer visitor to the Pilbara. It favours areas near water (R. E. Johnstone, Burbidge, & Darnell, 2013).	Yes - Potential habitat could include Major Drainage Line.	Yes	No	Highly Unlikely unless present as a temporary visitor
Common Sandpiper (*Actitis hypoleucos*)	MI	S5	Estuaries and deltas of streams, as well as banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans (R Johnstone & Storr, 1998).	No	Yes	No	Highly Unlikely – no potential habitat within Study Area
Fork-tailed Swift (*Apus pacificus*)	MI	S5	Inhabits dry/open habitats, inclusive of riparian woodlands and tea-tree swamps, low scrub, heathland or saltmarsh, as well as treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes (R Johnstone & Storr, 1998).	Yes - Potential habitat includes the Major Drainage Line, Sand Plain, and Stony Plain.	Yes	No	Possible – some potential habitat and within known distribution

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Oriental Plover (*Charadrius veredus*)	MI	S5	A variety of habitats, including coastal habitats, such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches as well as open inland environments such as, semi-arid or arid grasslands, where the grass is short and sparse (R. Johnstone & Storr, 2004).	Yes	Yes	No	Highly Unlikely – although broad habitat type is potential on a transient basis, it probably does not represent appropriate core habitat as species is generally coastal.
Pectoral Sandpiper (*Calidris melanotos*)?	MI	S5	Coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands (R. Johnstone & Storr, 2004; R. E. Johnstone et al., 2013). It prefers wetlands with open fringing mudflats and low, emergent or fringing vegetation (Geering et al., 2007).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Sharp-tailed Sandpiper (*Calidris acuminata)*	MI	S5	Favours flooded samphire flats and grasslands, mangrove creeks mudflats, beaches, river pools, saltwork ponds, sewage ponds and freshwater soaks (R. E. Johnstone et al., 2013).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Grey Wagtail (*Motacilla cinereal*)	MI	S5	An uncommon visitor to the inland Pilbara areas (R. E. Johnstone et al., 2013).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Yellow Wagtail (*Motacilla flava)*	MI	S5	An uncommon but regular visitor to the Pilbara region (R. E. Johnstone et al., 2013). Occupies a range of damp or wet habitats with low vegetation although favours edges of fresh water, especially sewage ponds (Oakwood, 2000)	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Osprey (*Pandion haliaetus)*	MI	S5	Occurs mainly in sheltered seas around islands, tidal creeks, estuaries and saltwork ponds, also large river pools (R. E. Johnstone et al., 2013).	Yes - Some potential habitat in the Major Drainage Line in the Study Area.	No	No	Unlikely – not within the species distribution

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Common Greenshank *(Tringa nebularia)*	MI	S5	Species occurs as a non-breeding summer migrant which occurs throughout the region. Occurs mainly in Tidal mudflats, mangrove creeks, flooded samphire flats, beaches, river pools, and saltwork and sewage ponds (R. E. Johnstone et al., 2013).	Np	Yes	No	Highly Unlikely – no potential habitat in the Study Area
Wood Sandpiper (*Tringa glareola)*	MI	S5	Species occurs as a non-breeding summer migrant which occurs throughout the region. Occurs mainly in river pools, sewage ponds, flooded claypans, freshwater lagoons and bore overflows (R. E. Johnstone et al., 2013).	No	Yes	No	Highly Unlikely – no potential habitat in the Study Area
Garganey (*Anas querquedula*)	MG	S5	Garganey is small teal. This duck is a rare visitor to Australia recorded from lakes and inland waterbodies (R Johnstone & Storr, 1998).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Red-necked Stint (*Calidris ruficollis*)	MG	S5	Mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats. It mostly forages on bare wet mud on intertidal mudflats or sandflats, or in very shallow water; mostly in areas with a film of surface water and mostly close to edge of water. This species roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle, sometimes in saltmarsh or other vegetation. They occasionally roost on exposed reefs or shoals (R Johnstone & Storr, 1998).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Long-toed Stint (*Calidris subminuta*)	MG	S5	They prefer shallow freshwater or brackish wetlands but are also fond of muddy shorelines, growths of short grasses, weeds, sedges, low or floating aquatic vegetation, reeds, rushes and occasionally stunted samphire. The Long-toed Stint also frequents permanent wetlands and forages on wet mud or in shallow water, often among short grass, weeds and other vegetation on islets or around the edges of wetlands. They roost or loaf in sparse vegetation at the edges of wetlands and on damp mud near shallow water. It also roosts in small depressions in the mud (R Johnstone & Storr, 1998).	No	No	No	Highly Unlikely – no potential habitat and not within distribution

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Marsh Sandpiper (*Tringa stagnatilis*)	MG	S5	Lives in permanent or ephemeral wetlands of varying salinity, and also regularly at sewage farms and saltworks. They are recorded less often at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes. In Western Australia they prefer freshwater to marine environments. The species usually forages in shallow water at the edge of wetlands and roost or loaf on tidal mudflats, near low saltmarsh, and around inland swamps (R Johnstone & Storr, 1998).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Common Redshank (*Tringa totanus*)	MG	S5	It is found at sheltered coastal wetlands with bare open flats and banks of mud or sand. They are also found around salt lakes, freshwater lagoons, artificial wetlands and salt works and sewage farms. The species has been observed feeding in shallow water, on wet bare mud or sand, or on algal deposits and roosting on small elevated areas such as estuarine sandbars and muddy islets surrounded by water (R Johnstone & Storr, 1998).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Glossy Ibis *(Plegadis falcinellus)*	-	S5	Freshwater wetlands, irrigated areas, margins of dams, floodplains, brackish and saline wetlands, tidal mudflats, pastures, lawns and public gardens (R. E. Johnstone et al., 2013).	Yes - Some potential habitat within the Major Drainage Line and at the waterbody recorded when water is present.	Yes	No	Unlikely – waterbodies may not persist long enough for species persistence
Reptiles							
Pilbara Olive Python *(Liasis olivaceus barroni)*	VU	S3	Associated with drainage systems, including areas with localised drainage and watercourses (D. J. Pearson, 1993). In the inland Pilbara the species is most often encountered near permanent waterholes in rocky ranges or among riverine vegetation (D. J. Pearson, 1993).	Yes - Potential dispersal habitat in the Major Drainage Line	Yes	No	Possible – some potential dispersal habitat exists and within current distribution

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Great Desert Skink (*Liopholis kintorei*)	VU	S3	Endemic to the Australian arid zone in the western deserts' region. Occurs on red sandplains and sand ridges. In Western Australia it occurs on sites dominated by *Triodia basedowii* and *Triodia schinzii* with some *Eremophila leucophylla* shrubs. Regenerating vegetation appears to be a critical habitat requirement. The Skink appears to prefer a mosaic landscape of different aged vegetation and inhabit sites that have been burnt in the previous three to fifteen years Preferred habitat has at least 50% bare ground. Regenerating areas may provide ample food while unburnt patches provide shelter (McAlpin, 2001).	No	No	No	Highly Unlikely – no potential habitat and not within distribution
Pilbara Flat-headed Blind-snake (*Anilios ganei*)	-	P1	Little is known of the species' ecology but this species is often associated with moist soils and leaf litter within gorges and gullies (S. Wilson & Swan, 2014), and potentially within a wide range of other stony habitats. The species has been recorded from numerous habitats but is most likely to be present in rocky terrain and along drainage lines (DBCA, 2018a), such as that found in the Study Area.	Yes - Potential habitat is found in the Major Drainage Line habitat.	Yes	No	Likely – potential habitat exists and within current distribution
Spotted Ctenotus (*Ctenotus uber subsp. johnstonei*)		P2	As a precautionary approach, the Pilbara taxon is treated as the Priority 2 subspecies. Within the Pilbara, the taxon is known from *Triodia* on hillslopes, *Acacia xiphophylla* over chenopods, and *Acacia xiphophylla* scattered tall shrubs to high open shrubland (Cogger, 2014).	Yes - Potential habitat exists in the Stony Plain habitat within the Study Area.	Yes	No	Likely – potential habitat exists and within current distribution

Species	Conservation Status		Preferred Broad Habitats Within Region	Potential Habitat Within Study Area	Within Current Known Distribution	Recorded Within Study Area	Likelihood of Occurrence
	EPBC Act	WC Act					
Lerista macropisthopus subsp. remota		P2	Woodlands and semi-arid scrubs with sandy substrate (Cogger, 2014). This central/ interior subspecies typically occurs in the northern Goldfields and central arid zone of Western Australia, and the only official records outside of this area were probably the result of misidentified specimens collected at Orebody 35 (as reported in Biologic, 2011). These misidentifications may not have been corrected within relevant databases, and therefore the subspecies is likely to have been reported outside of its known range.	Yes - Potential habitat includes the Stony Plain and Sand Plain.	Yes	No	Unlikely – no nearby records and habitat (while potential) is not ideal.

4.6.1 EPBC Matters

The sections below provide summaries on the Program Matters identified in the approved Program for BHP's Strategic Assessment (Greater Bilby, Northern Quoll, Pilbara leaf-nosed Bat, Ghost Bat and Pilbara Olive Python) as well as the Night Parrot.

Northern Quoll

The species tends to inhabit rocky habitats which offer protection from predators and are generally more productive in terms of availability of resources (Braithwaite & Griffiths, 1994; DoE, 2016; Oakwood, 2000). Other microhabitat features important to the species include: rock cover; proximity to permanent water and time-since last fire (Woinarski et al., 2008). The nearest confirmed record of the species was identified as being >50 km north of the Study Area by DBCA (2018b). While potential habitat does occur within the Study Area, in the form of Hillcrest/ Hillslope and Major Drainage Lines, these habitats do not form part of the species core habitat type – which is typically rocky breakaways and major gorges and gullies (DoE, 2016). Due to the lack of core habitat and the lack of recent records within the vicinity of the Study Area, it is unlikely that this species occurs within the Study Area.

Greater Bilby

Extant population of the Greater Bilby occur in a variety of habitats, usually on landforms with level to low slope topography and light to medium soils (Southgate, 1990). It can occupy three major vegetation types; open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas (Southgate, 1990). Within the Pilbara region the species is recorded within spinifex sandplains where the substrate of sand, soil, sandy clay, or sandy gravel is suitable for burrowing (Dziminski & Carpenter, 2017), Within these sandplain habitats, there is also an association with particular *Acacia* spp. that bilbies use for food resources (Dziminski & Carpenter, 2017).

The nearest record of this species is located approximately 20 km east of the Study Area at BHP's Caramulla tenement (Biologic, 2018).

Potential habitat for the species is present within the Study Area in the form of Sand Plain habitat. However, in the Study Area this habitat was noted as containing a high amount of alluvial material making it less suitable for burrowing compared to deep Sand Plains – for that reason it is considered moderately suitable habitat for the species. Based on the presence of the moderately suitable habitat and the lack of multiple recent records within the vicinity of the Study Area, the species was assessed as being possible to occur in the Study Area.

Ghost Bat

Ghost Bats roost in deep, complex caves beneath bluffs of low, rounded hills, granite rock piles and abandoned mines (Armstrong & Anstee, 2000). These features often occur within habitats including gorge/gully, hill crest/hill slope and low hills (Armstrong & Anstee, 2000).

Potential foraging habitat exists in the Major Drainage Line, and Mulga Woodland habitats of the Study Area, as well as the cave (SW01). The nearest record of the species was recorded byecologia,

Environment (2006a), an individual foraging Ghost Bat 5 km to the east of the Study Area, east of the creek at Jimblebar. Additional records are located <10 km north of the Study Area from around Orebody 35 (DBCA, 2018b). While cave SW01 did not contain any Ghost Bat scats, it may provide potential roosting habitat for the species, given its depth and interior size. As such the species was assessed to possibly occur within the Study Area.

Pilbara Leaf-nosed Bat

This species limited ability to conserve heat and water (Armstrong, 2001) means it requires warm (28 – 32ºC) and very humid (85 – 100%) roost sites in caves (Armstrong, 2001; Churchill, 1991) and/or mine shafts as these enable the individuals to persist in arid climates by limiting water loss and energy expenditure (van Dyck & Strahan, 2008). Such caves are relatively uncommon in the Pilbara (Armstrong, 2001), which limits the availability of diurnal roosts for this species. Pilbara Leaf-nosed Bats roost in undisturbed caves, deep fissures or abandoned mine shafts. The species forages in caves and along waterbodies with fringing vegetation (TSSC, 2016).

No suitable diurnal roosting features were recorded within the Study Area. Suitable foraging habitat for the species is present in the Study Area, in the form of the Major Drainage Line habitat. The cave SW01 is suitable in its characteristics to be potential foraging habitat *i.e.* a nocturnal refuge for the species; however the nearest confirmed records of the species are located approximately 40 km north-west of the Study Area. This distance is beyond the typical foraging distance of the species (Bullen, 2013) and therefore it is unlikely that that species would occur within the Study Area.

Pilbara Olive Python

This species is often associated with drainage systems, including areas with localised drainage and watercourses (D. J. Pearson, 1993). In the inland Pilbara the species is most often encountered near permanent waterholes in rocky ranges or among riverine vegetation (D. J. Pearson, 1993). The nearest DBCA (2018b) record of the species is located approximately 20 km west of the Study Area from 2015. Suitable dispersal habitat is present in the form of the Major Drainage Line habitat. As such it is possible that the species may occur within the Study Area.

Night Parrot

Based on accepted records, the habitat of the Night Parrot consists of *Triodia* grasslands in stony or sandy environments (McGilp, 1931; North, 1898; Whitlock, 1924; H. Wilson, 1937), and of samphire and chenopod shrublands, including genera such as *Atriplex*, *Bassia* and *Maireana*, on floodplains and claypans, and on the margins of salt lakes, creeks or other sources of water (McGilp, 1931; H. Wilson, 1937). The current interim guidelines for preliminary surveys of Night Parrot in Western Australia suggest this species requires old-growth (often more than 50 years unburnt) spinifex (*Triodia*) for roosting and nesting (DPaW, 2017). Although little is known about foraging sites, habitats that comprise various grasses and herbs are thought to be suitable.

The Night Parrot is known from a few historical records within the Pilbara, the nearest contemporary record within the Pilbara region from April 2005 was located at Minga Well approximately 120 km north-

west of the Study Area, on the northern side of the Fortescue (Davis & Metcalf, 2008). While Sand Plain habitat may provide potential habitat for the species, that within the Study Area is not of age nor is it located near foraging habitat. For these reasons and the lack of recent records in the region, it is deemed unlikely that this species would occur within the Study Area.

4.6.2 Species "Highly Likely" to Occur in Study Area

Brush-tailed Mulgara (*Dasycercus blythi*)

The Brush-tailed Mulgara (DBCA Priority 4) is a small carnivorous marsupial occurring from south-western Queensland across the Simpson, Tanami, and Great Sandy Deserts and central Western Australia, including parts of the Pilbara (DSEWPaC, 2011a). The Brush-tailed Mulgara occurs in *Triodia* sand plain and gibber plain habitats (C. R. Pavey et al., 2012). The taxonomy and nomenclature of *Dasycercus* in the Pilbara has been recently revised using molecular and morphological characters by Adams, Cooper, and Armstrong (2000). Mulgara are renowned for using multiple burrow systems within a home-range and changing these frequently. A study in Kata Tjuta National Park found that on average burrows were used for only 3.2 days by one individual over a 55-day period, and numerous burrows were used by a single individual, indicating little burrow fidelity (Körtner et al., 2007).

This species has not been recorded in the Study Area, however evidence of the Brush-tailed Mulgara was recorded on 16 occasions (from nine locations) within Sand Plain habitat 20 km to the east of the Study Area at Caramulla (Biologic, 2018). Records also exist of this species to the immediate west of the Study Area (Biologic, 2013). These nearby records, combined with the presence of suitable Sand Plain habitat within the Study Area, suggests that this species almost certainly occurs in the Study Area from time to time.

Long-tailed Dunnart (*Sminthopsis longicauda*)

This species is currently listed as Priority 4 by the DBCA. It is a nocturnal and agile species that is distributed through the Pilbara, north eastern goldfields and Gibson desert, south to the Nullarbor Plain, to central Northern Territory and western South Australia (van Dyck & Strahan, 2008). Its core habitat includes rocky scree slopes with hummock grass and shrubs, and tall open *Acacia* shrubland and woodlands (N. McKenzie, Woinarski, & Burbidge, 2008)

The nearest record of this species is located approximately 15 km north east of the Study Area from 2006 (DBCA, 2018a). There are a further 7 records within 125 km of the Study Area (DBCA, 2018a). Owing to the occurrence of suitable habitats of Hillcrest/ hillslope with outcropping rock slopes it is considered highly likely the species occurs within the Study Area.

Western Pebble-mound Mouse (*Pseudomys chapmani*)

This species is listed as Priority 4 by the DBCA. The Western Pebble-mound Mouse has experienced a significant decline in their range through the Gascoyne and Murchison and is now considered endemic to the Pilbara (Start et al., 2000). 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 (Anstee & Armstrong, 2001).

Records exist for this species within close proximity (10 km) to the north of the Study Area (Biologic, 2014a; 2014b). Although not recorded during the survey, it is considered highly likely that the species occurs in the Study Area, particularly within the Hillcrest/ Hillslope habitat.

Spotted Ctenotus (*Ctenotus uber* subsp. *johnstonei*)

The subspecies *johnstonei* of this species of skink was first described in 1980 (Storr, 1980) from Balgo Hill in the far north east of Western Australia and is listed as Priority 2 by the DBCA. Little is known of this taxon, and its taxonomic status is uncertain. Specimens from the Pilbara may be grouped with *Ctenotus uber* subsp*. johnstonei*, or they may belong to an undescribed taxon, in which case they would have no official conservation status. As a precautionary approach, the Pilbara taxon is treated as the Priority 2 subspecies. Within the Pilbara, the taxon is known from *Triodia* on hillslopes, *Acacia xiphophylla* over chenopods, and *Acacia xiphophylla* scattered tall shrubs to high open shrubland (Cogger, 2014).

Within the Dynasty Tenement (to the immediate west of the Study Area), five individuals were recorded by Biologic (2016b) in a variety of suitable habitat, including Sand Plain, Hardpan Plain and Mulga woodland. A further individual was trapped in a funnel trap within the Sand Plain habitat by (Biologic, 2016b) within the Dynasty tenement. Given the presence of Stony Plain habitat type within the Study Area this species is highly likely to occur within the Study Area.

Pilbara Flat-headed Blind-snake (*Anilios ganei*)

Given the Pilbara Flat-headed Blindsnake has a 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 (Cogger, 2014). The Pilbara Flat-headed Blindsnake is associated with moist gorges and gullies (Cogger, 2014), and potentially with a wide range of other stony habitats.

This species has been recorded nearby at OB31 (Biologic, 2014d) approximately 10 km to the north west within Hillcrest/ Hillslope habitat type. Given that it has been recorded in a number of habitats occurring within the Study Area and is reasonably widespread, this species is likely to occur in the Study Area.

5 DISCUSSION

No vertebrate species of conservation significance were recorded during the survey, however conservation significant species were considered “likely” or “highly likely” to occur based on habitats present in the Study Area, these were: Brush-tailed Mulgara, Long-tailed Dunnart, Western Pebble-mound Mouse, Spotted Ctenotus and Pilbara Flat-headed Blind-snake. None of these species are listed under federal legislation and based on results from previous surveys in the vicinity and throughout the Pilbara, could be considered widespread in the region and surrounds. Three species listed as Threatened under the EPBC Act were assessed as possibly occurring with the Study Area (Greater Bilby, Ghost Bat and Pilbara Olive Python). The Night Parrot, Northern Quoll, Pilbara Leaf-nosed Bat are unlikely to be present in the Study Area based on the lack of records in the vicinity and the lack of quality core habitat for these species.

Typical Pilbara habitat types were recorded in the Study Area: Major Drainage Line, Stony Plain, Hillcrest/ Hillslope, Mulga and Sand Plain. The Sand Plain habitat was deemed to hold a high significance as it is likely to provide suitable habitat for the conservation listed Brush-tailed Mulgara. Although this habitat type is also considered core habitat for the Greater Bilby, the structure of the Sandplain within the Study Area (containing a high amount of alluvial material) makes it less suitable for burrowing compared to deep Sandplains. It is therefore not ideal for the species, and no evidence of Greater Bilby was recorded during the current survey. The Major Drainage Line was deemed to have a moderate-high significance as it may provide dispersal and foraging habitat for the Pilbara Olive Python and Ghost Bat, as well as the Northern Quoll and Pilbara Leaf-nosed Bat, if present. The Hillcrest/ Hillslope was considered to be of moderate significance as it may provide potential habitat for the Northern Quoll if present, as well as providing habitat for the priority species the Western Pebble-Mound Mouse. The Stony Plain was also considered to be of moderate significance as it provides habitat for a suite of Priority fauna. The Mulga Woodland was considered to be of low significance as it is generally common and widespread throughout the region and no species of conservation significance are likely to be dependent on its occurrence.

One cave (SW01) was recorded during the survey, although no conservation listed species were recorded within. The presence of other obligate cave-dwelling bat species and the caves large dimensions implies that it could potentially be used as a day roost by the Ghost Bat, particularly given the species was recorded 10 km to the east of the creek at Jimblebar.

There are no habitats regarded as highly suitable for SRE invertebrate fauna and the habitat regarded as moderately suitable (rock outcropping and boulders on the hillcrest and hillslopes) are likely too small to support populations of restricted SRE invertebrate species on their own. It is likely that any SRE invertebrate species that occur within these habitats are capable of moving between occurrences of the habitat and dispersing well beyond the Study Area. The remaining habitat types (Sand Plain and Stony Plain) are all of low to low/moderate suitability and all extend well beyond the Study Area.

All three taxa regarded as Potential SRE have been recorded within 10 km of the Study Area, all to the north within Orebodies 17, 18, 19, 31 and Wheelarra North. Despite being regarded as Potential SRE species, *Lychas* ‘*bituberculatus’* and *Buddelundia* ‘14CR’ are very likely to occur well beyond the Study

Area and likely to be the same species as those recorded to the north due to the continuity of the habitats they were collected in (Major Drainage Line and Mulga Woodland). The *Synsphyronus* sp. indet may also occur beyond the Study Area; however, the indeterminate nature of the specimen and the lack of records in close proximity to the Study Area (only one approximately 5 km to the north) provides less certainty regarding its possible extent beyond the Study Area. These specimens may be the same taxon, but further work would be required to confirm this and verify that this taxon occurs beyond the Study Area.

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7 APPENDICES

Appendix A: Conservation listings

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 (Ex)	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 (Cr)	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 (Cr)	Taxa facing an extremely high-risk of extinction in the wild in the immediate future.
Endangered (En)	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable (Vu)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Migratory (Mi)	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 or likely to become extinct, as critically endangered fauna.
Schedule 2 (S2)	Rare or likely to become extinct, as endangered fauna.
Schedule 3 (S3)	Rare or likely to become extinct, as vulnerable fauna.
Schedule 4 (S4)	Being fauna that is presumed to be extinct.
Schedule 5 (S5)	Birds that are subject to international agreements relating to the protection of migratory birds.
Schedule 6 (S6)	Special conservation need being species dependent on ongoing conservation intervention.
Schedule 7 (S7)	In need of special protection, otherwise than for the reasons pertaining to Schedule 1 through to Schedule 6 Fauna.

Department of Biodiversity, Conservation and Attractions Priority Definitions

Category	Definition
Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4 (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection but could be if present circumstances change.

Appendix B: Vertebrate Fauna Identified in the Desktop Assessment

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Amphibians																																				
Cyclorana australis																									•											
Cyclorana maini					•						•									•				•	•			•					•	•		
Cyclorana platycephala					•						•																						•		
Litoria rubella					•						•	•	•			•	•	•	•	•								•	•				•		•	•
Neobatrachus centralis																			•														•	•		
Neobatrachus kunapalari					•											•																	•			
Neobatrachus sutor																																	•			
Notaden nichollsi					•														•														•	•		
Platyplectrum spenceri					•						•								•					•									•	•		
Pseudophryne douglasi					•											•																				
Uperoleia russelli					•						•					•		•	•														•	•		
Uperoleia saxatilis					•																															
Birds																																				
Acanthagenys rufogularis					•			•	•		•	•	•		•	•	•		•		•	•	•	•	•	•	•	•	•				•		•	•
Acanthiza apicalis					•				•			•				•		•								•	•									
Acanthiza chrysorrhoa					•			•			•	•				•							•													
Acanthiza robustirostris					•			•			•																•								•	
Acanthiza uropygialis					•			•			•	•				•			•		•	•	•	•			•		•				•			•
Accipiter cirrocephalus					•			•														•	•						•				•			
Accipiter fasciatus					•			•			•	•	•			•			•			•		•				•	•				•		•	

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Acrocephalus australis					•			•								•																			•	
Actitis hypoleucos						•	•	•																											
Aegotheles cristatus					•			•			•		•	•	•	•	•				•				•	•	•			•			•		
Amytornis striatus subsp. striatus					•		•	•																											
Amytornis striatus subsp. whitei					•																					•	•			•			•		
Amytornis striatus whitei											•		•	•	•	•	•	•	•		•														
Anas gracilis					•			•																											•
Anas querquedula	Mi	S5					•															•							•						
Anas rhynchotis								•																											
Anas superciliosa								•																											
Anhinga melanogaster																																		•	
Anhinga novaehollandiae								•								•																			
Anseranas semipalmata								•																											
Anthus australis subsp. australis					•							•												•	•	•			•						
Anthus novaeseelandiae								•			•		•	•	•	•		•	•		•												•	•	
Aphelocephala nigricincta					•																														
Apus pacificus	Mi	S5				•	•						•				•																•		
Aquila audax					•			•	•		•	•			•	•	•	•	•			•	•			•			•	•			•		
Ardea alba						•		•																											
Ardea ibis						•		•																											

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Ardea intermedia								•																												
Ardea novaehollandiae					•						•					•			•														•			•
Ardea pacifica					•			•			•					•						•		•					•				•			
Ardeotis australis					•			•			•	•		•		•	•	•				•		•	•	•	•	•	•				•			
Artamus cinereus					•			•	•		•	•	•		•	•	•	•	•		•	•	•	•		•	•		•	•			•		•	•
Artamus minor					•			•			•		•	•	•		•		•		•					•	•			•			•		•	
Artamus personatus					•			•	•			•						•				•							•							
Artamus superciliosus								•																												
Aythya australis								•																												
Biziura lobata								•																												
Burhinus grallarius					•			•							•			•	•			•							•	•			•			
Cacatua roseicapilla					•																				•	•	•		•	•			•		•	•
Cacatua roseicapillus								•			•	•	•	•	•	•	•		•		•	•		•												
Cacatua sanguinea					•			•			•		•	•		•		•	•					•									•		•	
Cacomantis pallidus					•			•			•	•	•	•	•	•	•						•			•				•			•			
Calidris acuminata						•	•	•																												
Calidris ferruginea	Cr/Mi	S3/S5		NT		•	•	•																												
Calidris melanotos	Mi	S5				•	•																													
Calidris ruficollis	Mi	S5		NT			•	•																												
Calidris subminuta	Mi	S5					•	•																												

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Centropus phasianinus subsp. highami											•					•																				
Certhionyx variegatus					•			•			•	•		•																			•			
Chalcites basalis								•	•		•	•	•	•		•	•		•			•														
Chalcites osculans											•					•																				
Charadrius ruficapillus								•																												
Charadrius veredus	Mi	S5				•	•																													
Chenonetta jubata					•			•			•																									
Cheramoeca leucosterna								•			•	•				•		•	•		•												•			
Chlidonias hybrida								•																												
Chrysococcyx basalis					•																								•				•			
Chrysococcyx osculans					•																					•							•			
Cincloramphus cruralis								•									•		•			•											•			
Cinclosoma castanotus																						•														
Cinclosoma castaneothorax					•																															
Cinclosoma clarum																													•							
Circus approximans								•																												
Circus assimilis					•			•			•	•	•	•												•							•			
Cladorhynchus leucocephalus								•																												
Climacteris melanura								•			•																									
Colluricincla harmonica subsp. rufiventris					•			•	•		•	•	•	•	•	•	•	•	•		•				•	•				•			•			

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Columbia livia						•																														
Conopophila whitei																•																	•			
Coracina maxima								•			•								•			•							•				•			
Coracina novaehollandiae subsp. subpallida					•			•	•		•	•	•	•	•	•	•	•	•		•	•	•	•		•	•		•	•			•		•	
Corvus bennetti					•			•			•																								•	
Corvus orru subsp. cecilae					•			•	•		•	•	•		•	•		•	•		•	•	•	•	•	•	•		•	•			•		•	•
Coturnix pectoralis					•			•																		•										
Coturnix ypsilophora								•			•		•																				•		•	
Cracticus nigrogularis					•			•	•		•	•	•	•	•	•	•	•	•		•	•		•		•	•		•	•			•		•	
Cracticus tibicen					•			•	•			•	•		•	•	•	•	•		•		•	•		•				•			•		•	
Cracticus torquatus					•			•			•	•					•		•		•	•		•	•	•			•				•			
Cygnus atratus								•											•														•			
Dacelo leachii subsp. leachii					•			•			•					•																	•		•	
Daphoenositta chrysoptera					•																															
Dendrocygna arcuata								•								•																				
Dendrocygna eytoni								•																												
Dicaeum hirundinaceum					•			•			•	•	•	•		•			•									•					•			
Dromaius novaehollandiae					•			•						•	•	•					•								•				•		•	
Egretta garzetta								•																												
Egretta novaehollandiae								•																												

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Elanus caeruleus subsp. axillaris								•				•		•	•												•			•					•	
Elseyornis melanops								•			•					•						•							•							
Emblema pictum					•			•			•	•	•	•	•	•	•		•							•	•	•		•					•	
Ephippiorhynchus asiaticus																													•							
Ephippiorhynchus asiaticus subsp. australis																						•														
Epthianura tricolor					•			•			•	•		•	•	•						•			•				•	•			•			
Eremiornis carteri					•							•	•	•	•			•	•		•	•				•			•	•			•			
Eurostopodus argus					•			•			•	•	•	•	•		•					•	•	•		•			•	•			•			
Falco berigora					•			•	•		•	•	•	•	•	•	•	•	•			•		•	•	•	•		•	•			•		•	•
Falco cenchroides					•			•			•	•	•	•	•	•	•	•	•		•	•			•	•	•		•	•			•		•	•
Falco hypoleucos		S3		V U			•																													
Falco longipennis					•			•			•		•			•			•			•				•			•				•		•	
Falco peregrinus		S7			•		•	•																									•			
Fulica atra								•																												
Gallinula ventralis											•											•														
Gallirallus philippensis								•																												
Gavicalis virescens								•	•		•	•	•	•	•	•	•	•	•		•	•	•	•		•	•	•	•	•			•		•	•
Gelochelidon macrotarsa								•																												
Geopelia cuneata					•			•			•	•	•	•	•	•	•		•		•	•		•		•	•		•	•			•		•	•

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Geopelia striata subsp. placida					•			•			•		•			•							•										•		•	
Geophaps plumifera subsp. ferruginea					•			•	•		•	•	•	•	•	•	•	•	•		•	•			•	•	•		•	•			•			
Gerygone fusca					•			•	•			•			•	•		•					•	•	•					•			•		•	
Grallina cyanoleuca					•			•	•		•	•	•		•	•		•	•			•	•	•	•				•	•			•		•	•
Haliaeetus leucogaster								•																												
Haliastur sphenurus					•			•			•	•	•	•	•	•		•				•				•	•		•	•			•		•	•
Hamirostra isura													•																							
Hamirostra melanosternon					•			•			•	•	•		•	•		•								•	•			•			•		•	
Hieraaetus morphnoides								•			•							•															•		•	
Himantopus himantopus								•																												
Hirundo neoxena	Mi	S5						•																												
Hirundo rustica						•																														
Hydroprogne caspia								•																												
Lacustroica whitei					•																															
Lalage tricolor					•			•			•	•		•	•	•	•		•			•	•			•			•	•			•		•	
Larus novaehollandiae								•																												
Lichmera indistincta					•			•			•	•	•	•	•	•	•		•		•					•				•			•		•	
Lophoictinia isura								•																									•			
Macronectes giganteus	En/ Mi	S5					•																													

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Malacorhynchus membranaceus								•																												
Malurus lamberti subsp. assimilis					•			•	•		•	•	•	•	•	•	•	•	•		•	•	•	•		•	•		•	•			•			
Malurus leucopterus subsp. leuconotus					•																					•		•	•				•		•	
Malurus leucopterus subsp. leucopterus					•			•			•	•	•			•		•	•			•		•												
Malurus splendens					•											•																				
Manorina flavigula					•			•	•		•	•	•		•	•	•	•	•		•			•	•	•	•	•		•			•		•	•
Megalurus cruralis																													•				•			
Megalurus gramineus								•																												
Megalurus mathewsi								•			•	•			•	•	•		•			•	•	•		•			•	•			•			
Melanodryas cucullata								•			•	•	•	•	•		•	•	•		•	•				•			•	•			•			
Melithreptus gularis subsp. laetior					•																												•			
Melithreptus gularis subsp. latior								•								•			•																	
Melopsittacus undulatus					•			•			•	•	•	•	•	•	•	•			•	•	•			•		•	•	•			•		•	•
Merops ornatus					•	•		•	•		•	•	•			•		•	•			•		•		•	•	•	•				•		•	•
Microcarbo melanoleucos								•																												
Milvus migrans					•			•				•			•	•		•												•						•
Mirafra javanica					•			•	•		•							•																		
Motacilla cinerea	Mi	S5				•																														
Motacilla flava	Mi	S5				•																														

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Neochmia ruficauda subsp. subclarescens					•			•								•																		•	
Neopsephotus bourkii											•													•											
Ninox boobook								•			•		•			•		•			•					•	•					•			
Ninox connivens								•																											
Ninox sp.																									•										
Nycticorax caledonicus subsp. australasiae								•																											
Nymphicus hollandicus					•			•			•	•	•		•	•	•					•	•	•		•			•	•			•		•	•
Ocyphaps lophotes					•			•			•	•	•		•	•	•	•	•		•	•	•	•	•	•	•		•	•			•		•	•
Oreoica gutturalis					•			•	•		•	•	•	•	•	•	•		•		•	•		•		•			•	•			•			
Oreoica gutturalis subsp. pallescens					•																														•	
Pachycephala rufiventris subsp. rufiventris					•			•			•	•	•	•	•	•	•	•	•			•	•	•	•	•	•		•	•			•		•	•
Pandion haliaetus	Mi	S5					•																													
Pardalotus rubricatus					•			•			•	•			•	•			•							•	•			•			•			
Pardalotus striatus subsp. murchisoni					•			•					•	•		•			•														•		•	
Pelecanus conspicillatus								•																												
Petrochelidon ariel								•							•	•														•			•			
Petrochelidon nigricans								•					•			•								•									•		•	
Petroica goodenovii					•			•	•		•	•	•			•		•			•	•		•					•				•		•	•
Pezoporus occidentalis	En	S1		EN		•																														

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Phalacrocorax carbo								•																												
Phalacrocorax sulcirostris					•			•			•					•																				
Phalacrocorax varius subsp. hypoleucos								•																										•		
Phaps chalcoptera					•			•			•		•		•	•	•		•		•	•	•	•		•	•		•	•			•		•
Platalea flavipes								•								•																				
Platalea regia								•																												
Platycercus zonarius subsp. zonarius					•			•			•	•	•	•		•		•	•			•	•	•	•	•	•		•				•		•	•
Plegadis falcinellus	Mi	S5					•	•																												
Podargus strigoides					•			•			•				•				•						•	•				•			•			
Podiceps cristatus								•																												
Poliocephalus poliocephalus								•																												
Polytelis alexandrae	Vu		P4	NT		•	•																													
Pomatostomus superciliosus					•			•				•																					•			
Pomatostomus temporalis subsp. rubeculus								•	•		•	•	•		•	•	•	•	•			•	•	•	•	•	•		•	•			•		•	•
Podocytes carteri								•																												
Porphyrio porphyrio								•																												
Porzana pusilla								•																												
Porzana tabuensis								•																												

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Psephotus varius																											•									
Psophodes occidentalis								•																												
Ptilonorhynchus maculatus subsp. guttatus					•			•			•		•						•			•		•		•	•		•				•		•	
Ptilotula keartlandi								•				•	•	•	•	•		•	•		•					•				•			•		•	
Ptilotula pencillata								•																		•			•	•			•			•
Ptilotula penicillatus											•	•			•	•		•	•		•	•													•	
Ptilotula plumulus																					•												•			
Purnella albifrons														•							•						•						•			
Pyrrholaemus brunneus																										•							•			
Recurvirostra novaehollandiae								•																												
Rhipidura albiscapa								•																									•			
Rhipidura leucophrys subsp. leucophrys					•			•	•		•	•	•	•	•	•		•	•		•	•	•	•	•	•	•		•	•			•		•	•
Rostratula australis						•																														
Rostratula benghalensis						•																														
Smicrornis brevirostris					•			•	•		•	•	•		•	•	•	•	•		•			•	•	•	•			•			•		•	
Stictonetta naevosa								•																												
Stiltia isabella								•																												
Stipiturus ruficeps					•			•			•																								
Stomiopera unicolor								•																												

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Sugomel niger								•			•	•		•		•										•		•					•		•	
Tachybaptus novaehollandiae								•																												
Tadorna tadornoides								•			•																									
Taeniopygia guttata subsp. castanotis					•			•	•		•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•			•		•	•
Threskiornis molucca								•																												
Threskiornis spinicollis					•			•																												
Todiramphus pyrrhopygius								•			•	•		•	•	•	•	•	•						•	•	•			•			•		•	•
Todiramphus sanctus					•			•			•		•			•						•			•				•				•		•	
Tribonyx ventralis								•																						•						
Tringa glareola	Mi	S5					•	•																												
Tringa hypoleucos	Mi	S5																												•						
Tringa hypoleucos	Mi	S5													•																					
Tringa nebularia	Mi	S5					•	•																												
Tringa stagnatilis	Mi	S5					•	•																												
Tringa totanus	Mi	S5					•																													
Turnix velox					•			•			•	•	•	•	•	•	•					•				•	•		•	•			•		•	
Tyto alba					•			•										•	•														•			
Mammals																																				
**Bos taurus*					•	•				•		•	•			•		•	•	•	•	•	•		•	•		•		•			•	•		•
**Camelus dromedarius*					•	•				•			•							•		•	•	•	•	•	•	•					•	•		•

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*Canis familiaris					•	•				•										•		•	•				•	•							•
*Equus asinus					•	•						•							•	•	•		•			•	•							•		
*Equus caballus						•			•	•									•			•						•						•		
*Felis catus					•	•						•	•			•	•	•	•	•		•	•		•		•	•	•	•			•	•	•	•
*Mus musculus					•	•			•	•	•	•			•		•	•	•	•		•			•	•		•	•				•	•		
*Oryctolagus cuniculus					•	•			•											•						•								•	•	•
*Vulpes vulpes						•											•																	•	•	
Austronomus australis																														•						•
Bettongia lesueur graii							•																													
Canis dingo					•				•			•	•			•		•	•	•		•			•	•		•	•	•			•	•	•	
Chaerephon jobensis subsp. colonicus					•																				•	•		•	•	•				•	•	•
Chaerophon jobensis subsp. colonicus																				•		•	•	•												
Chalinolobus gouldii					•							•	•				•			•	•	•		•	•	•		•	•	•			•	•	•	•
Chalinolobus morio																																		•		
Dasycercus blythi			P 4		•		•																			•										
Dasycercus blythi			P 4				•															•	•	•												
Dasycercus sp.					•																							•	•							
Dasykaluta rosamondae					•				•		•	•						•	•	•		•		•	•			•	•				•	•		•
Dasyurus geoffroii							•																													

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Dasyurus hallucatus	En	S2		EN		•	•																										•		
Lagorchestes conspicillatus subsp. leichardti			P3		•		•																										•		
Leggadina lakedownensis			P4				•																										•		
Macroderma gigas	Vu	S3		VU	•	•	•					•																	•				•			
Macrotis lagotis	Vu	S3		VU	•	•	•																													
Mormopterus beccarii																																	•	•	•	
Mormopterus planiceps																																	•			
Ningaui ridei																																	•			
Ningaui timealeyi					•						•	•			•														•			•	•			
Notomys alexis					•							•					•					•	•	•				•	•				•			
Nyctophilus geoffroyi					•							•					•					•	•	•	•	•		•				•				
Osphranter robustus subsp. erubescens					•				•	•	•	•	•		•		•	•	•	•					•	•			•	•		•	•	•	•	
Osphranter rufus					•					•		•	•					•	•	•	•	•	•		•			•					•		•	
Ozimops lumsdenae												•					•					•			•	•		•							•	
Petrogale lateralis subsp. lateralis					•		•																													
Petrogale rothschildi					•										•		•			•									•						•	
Petrogale sp.					•						•																									
Planigale ingrami																																	•			

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Planigale maculata															•																		•	•		
Planigale sp. 1																									•											
Pseudantechinus macdonnellensis									•						•																		•			
Pseudantechinus roryi					•																															
Pseudantechinus woolleyae					•																							•					•		•
Pseudomys chapmani			P 4		•		•		•		•		•			•		•	•	•	•				•				•			•	•	•		
Pseudomys desertor					•						•	•					•					•		•		•		•	•				•	•		
Pseudomys hermannsburgensis					•				•		•	•			•		•	•	•	•		•		•	•	•		•	•				•	•		
Rhinonicteris aurantia	Vu	S3				•	•					•																								
Saccolaimus flaviventris					•							•								•		•	•	•	•	•		•		•			•	•	•	
Scotorepens balstoni																																	•	•		
Scotorepens greyii					•							•	•				•			•	•	•	•	•	•	•		•	•				•	•	•	•
Sminthopsis crassicaudata					•							•						•	•										•							
Sminthopsis longicaudata			P 4		•		•																											•		
Sminthopsis macroura					•							•						•	•			•						•	•				•	•		
Sminthopsis ooldea					•																					•							•	•		
Sminthopsis youngsoni					•													•	•	•		•		•	•	•		•	•				•	•		
Tachyglossus aculeatus					•														•	•									•					•	•	
Tadarida australia																																		•	•	

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Taphozous georgianus					•							•					•			•			•	•	•	•			•	•			•		•	•
Taphozous hilli					•																			•		•			•				•			
Taphozous sp.																									•											
Vespadelus finlaysoni					•					•		•	•				•	•		•	•	•	•	•	•	•		•	•	•			•		•	•
Zyzomys argurus					•				•	•	•	•			•		•		•	•					•	•			•	•			•			•
Reptiles																																				
Acanthophis wellsi																																		•		
Amphibolurus longirostris					•						•	•	•			•			•	•				•	•	•		•						•	•	
Anilios ammodytes																•									•									•		
Anilios ganei			P 1				•								•	•													•					•		
Anilios grypus											•		•	•	•	•			•						•				•				•	•		
Anilios hamatus									•		•					•		•								•			•					•		
Anilios pilbarensis																																		•		
Antaresia perthensis					•						•		•	•		•			•	•					•			•	•				•			
Antaresia stimsoni					•											•			•														•	•	•	
Aspidites melanocephalus					•						•																							•		
Brachyurophis approximans					•										•	•			•	•					•	•		•					•	•		
Carlia munda					•						•	•				•										•								•		
Carlia triacantha					•				•						•	•			•	•				•	•	•		•					•	•	•	
Chelodina steindachneri					•						•					•			•	•								•					•	•	•	

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Crenadactylus ocellatus																																	•		
Cryptoblepharus buchananii					•																			•											
Cryptoblepharus carnabyi													•		•																	•	•		
Cryptoblepharus plagiocephalus														•	•																		•		
Cryptoblepharus ustulatus					•																							•							
Ctenophorus caudicinctus subsp. caudicinctus					•				•		•	•	•	•	•	•	•	•	•	•				•	•	•		•	•	•			•	•	•
Ctenophorus isolepis subsp. isolepis					•							•		•		•	•			•				•	•	•	•	•					•	•	•
Ctenophorus nuchalis					•				•		•			•		•		•		•								•					•	•	
Ctenophorus reticulatus					•							•			•					•				•	•			•						•	
Ctenotus ariadnae					•								•		•					•				•				•	•				•	•	
Ctenotus duricola					•				•		•		•		•	•		•	•	•					•	•		•	•				•	•	
Ctenotus grandis					•				•		•		•		•	•		•		•				•									•		
Ctenotus grandis subsp. titan					•																				•			•						•	
Ctenotus hanloni																																		•	
Ctenotus helenae					•																				•	•		•	•	•			•	•	•
Ctenotus inornatus									•		•		•	•	•	•		•	•	•															
Ctenotus leonhardii					•									•	•	•			•		•												•	•	
Ctenotus pantherinus					•				•		•	•		•	•	•		•	•	•				•									•	•	
Ctenotus pantherinus subsp. ocellifer					•																				•	•		•	•					•	•

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Ctenotus piankai																																	•		
Ctenotus quattuordecimlineatus					•								•	•																		•			
Ctenotus rubicundus					•																							•					•		
Ctenotus rutilans					•						•		•												•			•				•	•		
Ctenotus saxatilis					•				•		•	•	•	•	•	•	•	•	•					•	•	•		•				•	•	•	•
Ctenotus schomburgkii					•						•														•								•		
Ctenotus serventyi																																	•		
Ctenotus uber					•				•		•					•		•							•	•							•		
Ctenotus uber subsp. johnstonei			P 2		•															•				•				•							
Ctenotus uber subsp. uber					•																														
Cyclodomorphus branchialis														•							•														
Cyclodomorphus melanops					•						•		•			•																	•	•		
Cyclodomorphus melanops subsp. melanops					•							•												•	•	•			•							
Delma butleri					•										•					•				•				•	•				•	•		
Delma desmosa					•																														
Delma elegans					•						•														•				•					•		
Delma haroldi					•						•		•												•								•	•		
Delma nasuta					•									•	•				•					•	•				•				•	•		
Delma pax					•				•		•	•	•	•	•	•		•	•					•		•			•				•	•		

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Delma tincta					•													•							•									•		
Demansia psammophis					•						•				•	•																	•		
Demansia psammophis subsp. cupreiceps					•																				•	•			•						
Demansia psammophis subsp. cupreiceps					•							•																							
Demansia rufescens															•														•				•		
Diplodactylus conspicillatus					•				•		•		•	•		•		•		•					•	•		•	•				•	•	
Diplodactylus mitchelli																																		•		
Diplodactylus pulcher					•																													•		
Diplodactylus savagei					•										•	•													•					•		
Diplodactylus stenodactylum																																	•	•		
Diplodactylus wombeyi																																	•	•		
Diporiphora amphiboluroides																				•								•						•		
Diporiphora valens					•										•										•									•		
Diporiphora winneckei																																		•		
Egernia cygnitos					•																					•			•						•
Egernia depressa					•				•		•		•			•				•				•				•					•			•
Egernia formosa					•																															
Egernia pilbarensis																																		•		
Eremiascincus fasciolatus																																		•		

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Eremiascincus richardsonii					•						•		•						•					•									•	•		
Furina ornata					•																								•					•		
Gehyra pilbara					•									•											•								•	•		
Gehyra punctata					•						•	•	•	•	•	•	•	•		•	•			•	•	•		•	•	•			•		•	
Gehyra purpurascens											•																							•		
Gehyra variegata					•				•		•	•		•	•	•	•	•	•	•	•			•	•	•		•	•	•			•		•	
Gowidon longirostris																																	•			
Heteronotia binoei					•						•		•	•	•	•	•	•	•						•				•				•	•		
Heteronotia spelea					•						•		•		•		•		•						•	•			•				•			
Lerista bipes					•						•					•										•								•		
Lerista chalybeia														•																						
Lerista flammicauda					•																				•									•		
Lerista jacksoni																									•											
Lerista labialis																																		•		
Lerista macropisthopus subsp. remota			P 2				•																											•		
Lerista muelleri					•				•		•	•		•	•	•		•							•				•				•	•		
Lerista neander					•						•	•		•	•	•		•	•	•				•		•		•	•	•			•	•		
Lerista timida					•															•				•	•	•		•								
Lerista zietzi					•						•		•		•	•			•						•				•				•	•		
Lialis burtonis					•						•	•						•	•	•				•		•		•					•	•		

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Liasis olivaceus subsp. barroni	Vu	S3			•	•	•																					•					•		
Liopholis kintorei	Vu	S3		VU			•																												
Lucasium stenodactylum					•				•		•		•		•	•		•	•	•					•	•		•	•						
Lucasium wombeyi					•						•		•		•				•						•	•			•						
Menetia greyii					•						•	•	•	•	•	•		•							•	•			•				•	•	
Menetia surda subsp. surda																																		•	
Moloch horridus					•																					•									
Morethia ruficauda					•						•			•	•						•												•		
Morethia ruficauda subsp. exquisita					•								•			•			•							•			•				•	•	
Nephrurus levis subsp. pilbarensis																																		•	
Nephrurus milii																																		•	
Nephrurus wheeleri subsp. cinctus					•							•																						•	
Notoscincus ornatus subsp. ornatus					•																														
Oedura fimbria													•			•	•								•	•			•						
Oedura marmorata					•																												•	•	•
Parasuta monachus																																		•	
Pogona minor					•						•	•		•	•					•				•								•	•		
Pogona minor subsp. minor					•																				•	•		•	•						

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Proablepharus reginae																																	•		
Pseudechis australis					•						•	•						•	•										•				•	•	
Pseudonaja mengdeni					•				•		•					•		•		•			•	•	•	•		•	•						
Pseudonaja modesta					•						•									•						•		•	•				•		
Pseudonaja nuchalis					•																												•		
Pygopus nigriceps					•				•		•					•																	•		
Ramphotyphlops (Anilios) waitii																													•				•		
Rhynchoedura ornata					•						•			•	•	•				•				•	•			•				•	•		
Strophurus ciliaris subsp. aberrans																																	•		
Strophurus elderi					•										•	•			•					•	•							•	•		
Strophurus jeanae					•															•					•	•		•					•		
Strophurus wellingtonae					•						•				•	•				•				•	•	•		•	•				•		
Suta fasciata					•																				•								•		
Suta punctata					•							•								•						•		•					•		
Tiliqua multifasciata					•				•		•	•			•	•		•	•	•				•	•	•		•	•			•	•		•
Tympanocryptis cephalus																																	•		
Varanus acanthurus					•						•	•	•	•	•	•	•	•	•	•					•	•		•	•				•	•		
Varanus brevicauda					•															•					•			•					•		
Varanus caudolineatus					•				•			•				•		•		•				•	•			•					•		
Varanus eremius					•										•										•	•							•		

Genus, Species	EPBC Act 1999	WC Act 1950	DBCA Priority	IUCN	DBCA NatureMap	DoE Protected Matters	DBCA Threatened sp.	Birdlife Birdata	BHP Iron Ore 1994	Ecologia 1995	Ecologia 2004a	Ecologia 2006a	Ecologia 2006b	ENV 2007a	ENV 2007b	GHD 2008	ENV 2009	Outback Ecology 2009a	Outback Ecology 2009b	Outback Ecology 2009c	ENV 2011	Biologic 2013	Biologic 2016a	Biologic 2016b	ENV Australia 2012	Biologic 2014a	Onshore, 2015	Biologic 2013	Biologic 2014b	Onshore Environmental 2014	Biota 2004	Ecologia 1996 (Pebble)	Ecologia 2004 (18,23,25 etc.)	ENV 2007 (Wye Rail)	ENV 2009b (Transmission)	Current Assessment
Varanus giganteus					•						•			•						•				•	•			•	•				•			
Varanus gilleni																																	•			
Varanus gouldii					•						•		•		•	•		•		•					•	•		•					•	•		
Varanus panoptes					•						•								•	•				•	•	•		•					•	•		
Varanus pilbarensis					•									•															•				•			
Varanus tristis					•				•		•	•	•	•	•	•		•	•		•			•									•	•		
Varanus tristis subsp. tristis																										•			•							
Vermicella snelli					•											•									•								•			
Fish																																				
Leiopotherapon unicolor					•																															
Melanotaenia australis					•																															

Appendix C: Caves recorded during the survey

Entrance				Cave Morphology			Additional Features					
Type	**Shape**	**Width**	**Height**	**Depth**	**# Chambers**	**Height**	**Water**	**Scat Count**	**Comments**	**Latitude**	**Longitude**	**Photo**
Cavity	Horizontal	7	1.4	5	1	2.5	None	0	Potential feeding roost for Ghost Bat. *Vespadelus finlaysoni*, *Taphozous georgianus* present	-23.410	120.112	

Appendix D: Water Features recorded during the survey

Latitude	Longitude	ID	Date	Type	Aquatic veg present	Permanent	Width (m)	Length (m)	Depth (m)	Notes	Photo
-23.4	120.1	SW WB 01	1/05/2018	Soak	No	No	1	30	0.1	Dry soak, impacted by cattle grazing