Appendix B – Fauna Studies (Biologic)

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# **Greenbushes Level 1 Fauna Survey**

**Talison Lithium Australia Pty Ltd** 

November 2011





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## EXECUTIVE SUMMARY

Biologic Environmental Survey (Biologic) was commissioned by Talison Lithium to undertake a Level 1 vertebrate fauna survey and comprehensive literature and database review of the active mining area and all leases held by Talison Lithium to support the NCVP.

The purpose of the Level 1 fauna survey was to:

- Undertake a comprehensive literature and database review of previous fauna surveys and records within the Study Area;
- Undertake a field survey to map and describe fauna habitats present within the Study Area, including any of importance that may support conservation significant species; and
- Conduct targeted surveys for fauna of conservation significance within the Study Area, including habitat tree assessments for three threatened Black Cockatoo species potentially occurring.

Desktop assessments identified 196 vertebrate fauna species to have the potential to occur within the Study Area. This list comprises 25 native mammal species, nine introduced mammal species, 120 bird species, 30 reptile species and 12 amphibian species. Of these, the current survey recorded a total of 82 species of vertebrates; comprising eight native mammal species, six introduced mammal species, 59 bird species, four reptile species and five amphibian species.

Five species of native vertebrates of conservation significance were recorded from the Study Area:

- 1. Southern Brush-tailed Phascogale *Phascogale tapaotafa tapaotafa*: listed as Schedule 1 in WCA and as Near Threatened in IUCN;
- 2. Forest Red-tailed Black Cockatoo *Calyptorhynchus banskii naso*: listed as Schedule 1 in WCA and as Vulnerable in EPBC Act;
- 3. Baudin's Cockatoo *Calyptorhynchus baudinii*: listed as Schedule 1 in WCA, as Vulnerable in EPBC Act and as Endangered in IUCN;
- 4. Carnaby's Cockatoo *Calyptorhynchus latirostris*: listed as Schedule 1 in WCA, as Endangered in EPBC Act and as Endangered in IUCN; and
- 5. Rainbow Bee-eater *Merops ornatus*: listed in Schedule 3 in WCA and as Migratory in EPBC Act.

Based on the fauna habitats present in the Study Area, and their distribution in the surrounding region, an additional 13 conservation significant species could occur in the Study Area.

Six broad fauna habitats were identified within the Study Area:

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- 1. Jarrah/Marri forest [29.3% of total Study Area]
- 2. Jarrah (*Eucalyptus marginata*)/Marri (*Corymbia calophylla*) forest over Banksia dominated midstorey [10.13%]
- 3. Marri/Blackbutt (*Eucalyptus* patens) /Flooded Gum (*Eucalyptus* rudis) Woodland over Banksia dominated midstorey [2.26%]
- 4. Typha dense tall sedges [0.15%]
- 5. Leptospermum scrub [0.05%]
- 6. Disturbed/rehabilitated areas [29.42%]

Based on direct and indirect evidence, the Study Area is utilised by all three species of Black Cockatoo as foraging habitats. An area of 7027.61 ha (69.86% of the total Study Area) comprise potential foraging habitats for Black Cockatoos.

Most of the areas of remnant native Jarrah-Marri forest is considered potential breeding habitat for Black Cockatoos, thus an overall area of 5498.02 ha of land (54.65% of the Study Area) currently provide potential breeding habitats. A further 489.60 ha (4.87% of total Study Area) could transform to future breeding habitats.



#### **1** INTRODUCTION

#### 1.1 Background

Talison Lithium Australia Pty Ltd (Talison Lithium) mines and processes lithium bearing mineral spodumene directly south and immediate adjacent to the town of Greenbushes, approximately 250 km south of Perth (Figure 1.1). Talison Lithium Australia Pty Ltd is preparing a Native Vegetation Clearing Permit (NVCP) for the continued exploration, development and rehabilitation of the Greenbushes mine site within their active mining area.

Biologic Environmental Survey (Biologic) was commissioned by Talison Lithium to undertake a Level 1 vertebrate fauna survey and comprehensive literature and database review of the active mining area and all leases held by Talison Lithium, hereafter referred to as the Study Area, to support the NCVP.

#### **1.2** Objectives of the Survey

The purpose of the Level 1 fauna survey was to:

- Undertake a comprehensive literature and database review of previous fauna surveys and records within the Study Area;
- Undertake a field survey to map and describe fauna habitats present within the Study Area, including any of importance that may support conservation significant species; and
- Conduct targeted surveys for fauna of conservation significance within the Study Area, including habitat tree assessments for three threatened Black Cockatoo species potentially occurring.

The Study Area was divided into the active mining area and other areas within Talison Lithium's leases (Figure 1.2). The survey effort was focussed within the Active Mining Area, with less survey effort within the remaining lease areas.







#### 2 ENVIRONMENT

#### 2.1 Biogeography

The Study Area falls within the Jarrah Forest biogeographical region as defined by the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Cresswell, 1995). The Jarrah Forest is subdivided into two subregions, and the Study Area lies in the Southern Jarrah Forest subregion (JF2) (Hearn *et al.*, 2002). Approximately 54.7% of the Southern Jarrah Forest subregion lies within Department of Environment and Conservation (DEC; formerly CALM) estate, with five national parks. South of Collie, this plateau broadens and slopes gently to the south coast. The vegetation of the subregion comprises Jarrah-Marri forest in the west grading to Marri and Wandoo woodlands in the east. There are extensive areas of swamp vegetation in the south-east, dominated by Paperbarks and Swamp Yate. The understorey component of the forest and woodland reflects the more mesic nature of this area. The majority of the diversity in the communities occurs on the lower slopes or near granite soils where there are rapid changes in site conditions.

#### 2.2 Climate

Greenbushes has a warm temperate climate, characterised by warm and dry summers with cool, wet winters. Rainfall is from 1200 mm in the south-west of the subregion to 500 mm in the east (Hearn *et al.*, 2002).

Long-term rainfall data (1893-2011) are available for Greenbushes (Station 9552); however, temperature data are only available for Bridgetown (Station 9617) from 1998-2011 (BOM, 2011) (Figure 2.1). The average annual rainfall at Greenbushes is 932.8 mm, with January receiving the least amount of rain on average (15.1 mm) and July receiving on average the most rain (189 mm). The average monthly maximum temperature is warmest in January (29.7°C) and coolest in July (15.7°C). The average monthly minimum temperature is also coolest in July (4.4°C) and warmest in February (13.5°C).





Figure 2.1: Long-term average monthly temperatures (Bridgetown station 9617) and monthly rainfall (Greenbushes station 9552) data (BoM, 2011)

#### 2.3 Vegetation

Broad scale vegetation mapping indicates that six broad vegetation associations are present within the Shire of Bridgetown-Greenbushes (Shepherd *et al.*, 2002):

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- Tall forest; Karri (*Eucalyptus diversicolor*)
- Medium forest; Jarrah (*E. marginata*)-Marri (*Corymbia calophylla*)
- Low woodland; Paperbark (Melaleuca sp.)
- Medium forest; Jarrah and Wandoo (*E. wandoo*)
- Tall forest; Jarrah
- Tall forest; Karri and Marri

The main broad vegetation types identified and their relative abundance and distribution within reserves are shown in Table 2.1.

Table 2.1:	Native vegetation associations, their relative amount and distribution
	within reserves and public lands (Shepherd et al., 2002)

Vegetation Association	Pre- European extent remaining (ha)	Current extent (ha)	Remaining (%)	IUCN Class I – IV reserves (%)	Other Reserves (%)
Tall forest; Karri	87,394	57,843	66.2	41.9	52.6
Medium forest; Jarrah-Marri	3,046,385	2,197,837	72.1	10.1	67.9
Low woodland; Paperbark	161,222	106,631	66.1	39.9	29.9
Medium forest; Jarrah & Wandoo	147,246	33,046	22.4	4.3	5.4
Tall forest; Jarrah	5,643	4,267	75.6	1.4	98.6
Tall forest; Karri & Jarrah	201,527	140,235	69.7	24.6	74.5

#### 2.4 Geology and Soils

The Study Area is located within the Darling Plateau, which consists of an undulating dissected peneplain with gravelly, pale orange soils. Deep steeply-sided valleys occur throughout the area, occasionally punctuated by dome-shaped granite outcrops (Water Corporation, 2004).

Soils are predominantly gravels with occasional block laterite outcrops and some elevated areas of sands and sandy loams. In the deeper valleys, the soils are heavier alluvials (Water Corporation, 2004).

#### 2.5 Land Use

The dominant land uses in the subregion include grazing (improved pastures) and dry land agriculture, forestry (of native forest) and conservation. There are smaller but still significant areas of forestry (plantations), irrigated horticulture, mining, rural residential and easements (for roads, power lines, etc). Much of the Study Area consisted of the active lithium mine.



#### 3 METHODS

#### 3.1 Compliance

This review and field survey was carried out in a manner consistent with the Western Australian Environmental Protection Authority (EPA) and DEC requirements for the environmental surveying and reporting of fauna:

- Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3 (EPA, 2002);
- Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Guidance Statement No. 56. (EPA, 2004); and,
- Technical Guide Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC, 2010).

Survey guidelines released by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities<sup>1</sup> (DSEWPaC) for bats (DEWHA, 2010a), birds (DEWHA, 2010b), amphibians (DEWHA, 2010c), mammals (DSEWPaC, 2011a) and reptiles (DSEWPaC, 2011b) were also considered.

#### 3.2 Literature and Database Review

A number of databases were accessed to determine the potential fauna of the Study Area (Table 3.1). These were:

- DSEWPaC Protected Matters Database Search Tool (DSEWPaC, 2011c);
- DEC NatureMap, which incorporates threatened fauna (DEC, 2011); and,
- Birds Australia Birdata database (Birds Australia, 2011).

#### Table 3.1: Databases used for the review

Provider	Database	Parameters	
Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC, 2011c)	Protected Matters Database Search Tool. Accessed October 2011	Polygon and10 km buffer with coordinates: • -33.80519, 116.00605; • -33.80519, 116.11314; • -33.89619, 116.11314; and • -33.89619, 116.00605.	
Department of Environment and Conservation (DEC, 2011)	NatureMap. Accessed October 2011	Circle of radius 40 km centred on the point 33° 51' 43"S, 116° 01' 26"E.	
Birds Australia (Birds Australia, 2011)	Birdata. Accessed October 2011.	Ten minute square containing the point -33.86227, 116.02379.	

<sup>1</sup>Formerly the Department of Environment, Water, Heritage and the Arts (DEWHA)



A review was conducted of all vertebrate fauna surveys undertaken within region. The following surveys were reviewed for this report:

- Vertebrate Fauna in the Southern Forests of Western Australia, A Survey (Christensen *et al.*, 1985);
- A Draft Summary of the Fauna Values of the Kemerton Bushland (Dell, 2000);
- The Ground Vertebrate Fauna of the Coastal Areas between Busselton and Albany, Western Australia (How *et al.*, 1987);
- Edith Cowan University, South West Campus, Bunbury Fauna Assessment (ENV, 2008); and
- Roadside Conservation Values in the Shire of Bridgetown-Greenbushes (Roadside Conservation Committee, 2004).

#### 3.3 Field Survey

A fauna habitat assessment and targeted survey for conservation significant fauna was undertaken by Dr Jessica Oates and Dr Stewart Ford from 13-17<sup>th</sup> October 2011. The survey targeted species identified during the database review and other species considered likely to occur based on the experience of the zoologists.

#### 3.3.1 Fauna habitat assessments

Onshore (2012) has recently completed a review of vegetation and flora surveys conducted within the Study Area. Fauna habitat maps have been derived from vegetation boundaries defined by Onshore Environmental and are based on field observations and fauna habitat assessments conducted by Biologic (current study).

Twenty-nine fauna habitat assessments were conducted; 22 within the active mining area and seven within the remaining lease areas (Figure 3.1; Appendix A). Habitats in the Study Area were assessed using methodology and terminology adapted from the *Australian Soil and Land Survey Field Handbook* (CSIRO, 2009) and modified to suit the survey requirements. The characteristics recorded during the habitat assessments were:

- Site information, photo and location (WGS84);
- Vegetation: disturbance, condition, leaf litter %, twig litter %, wood litter, dead stags and hollow bearing trees per 2500m<sup>2</sup>, broad floristic formation, tree, shrub and grass structure (each at tall, mid and low strata), dominant trees, shrubs, grasses and herbs;
- Land surface: comments on nests, burrows, roosts and diggings;



#### 3.3.2 Black Cockatoo habitat assessments

#### Foraging assessment

During the field survey, flora that are known foraging resources (Appendix B) were recorded including their distribution throughout the Study Area, particularly species that are dominant on the site and a known food source. To determine if Black Cockatoos forage on the site, potential foraging plants were identified, and the ground under these plants was searched for any evidence of Black Cockatoo foraging.

In areas where Black Cockatoos have been feeding, the remains are characteristic of particular species. For example, one of the most important indicators is the fruit of the Marri tree (*Corymbia calophylla*). Marri fruit that has only minor damage to the outer lip of the fruit is a sign of visitation by Baudin's Cockatoo, which uses its long bill to access the seeds inside. Where the fruit is damaged more extensively, especially on the main body of the fruit, it is likely that Carnaby's Cockatoo or Forest Red-tailed Black Cocaktoo have been feeding. The severed new growth, developing flower heads and chewed seed pods of Banksias are also a good indicator of Black Cockatoo feeding. Recent damage to bark is regarded as Black Cockatoo feeding activity along with the stripping of pine needles and cones (Cale, 2003).





#### **Breeding assessment**

Breeding habitat is a particularly important aspect for any assessment of impacts upon Black Cockatoos. To determine the breeding habitat classification of the site in accordance with DSEWPaC's draft referral guidelines (2011d), a habitat assessment was undertaken.

Native trees that are greater than 50 cm DBH are classified as mature trees and have the potential for breeding hollows to develop in 50-150 years (DSEWPaC, 2011d). The density of mature trees was estimated by recording trees 50 cm or greater DBH within either 0.0625 or 1 ha plots (depending on size of habitat) at all locations where fauna habitat assessments were undertaken (Figure 3.1 and Appendix A). Sites were classified according to the level of breeding habitat they provide (Table 3.2). Other areas within the active mining area that were not part of a habitat assessment were also searched and trees encountered that were greater than 50 cm DBH were recorded.

#### Table 3.2: Breeding habitat classification criteria for Black Cockatoos

Breeding Habitat Classification	Classification Criteria	
Non breeding habitat	No mature trees of the type potentially used for breeding by Black Cockatoos, and no trees with suitable breeding hollows.	
Future breeding habitat	Any site which has 1.0 ha or more of habitat that contains 6 or more mature trees, but lacks trees with suitable breeding hollows.	
Potential breeding habitat	Any site with trees that have suitable breeding hollows, but actual breeding has not been confirmed.	
Actual breeding habitat	A site with suitable breeding hollows in which breeding by Black Cockatoos has been recorded.	

To determine if trees in the survey area have suitable breeding hollows, the following criteria were assessed for each mature tree encountered (based on Gibbons and Lindenmayer, 2002):

- Minimum entrance width of a hollow;
- Diameter of the branch on which the hollow occurred;
- Whether the branch was living, part dead or dead; and
- Whether the tree has multiple hollows.

All trees identified as having suitable breeding hollows within the Study Area are considered to be significant habitat trees. All other trees, with a DBH greater than 50 cm but no suitable trees were considered potential habitat trees. Every tree encountered over 50 cm in DBH had its GPS coordinates recorded.



#### 3.3.3 Nocturnal surveys

Nocturnal surveys were conducted throughout the Study Area (Figure 3.1). One vehicle, each with two personnel, traversed the Study Area searching the roads for fauna. Nocturnal searches targeted fauna that may be largely absent during the day, such as night birds, as well as mammals, amphibians and reptiles such as snakes and geckos. Nocturnal searches were carried out over three nights and a total of 14.7 hours were undertaken within the Study Area. During the nocturnal surveys, playback surveys for the Barking and Masked Owls were undertaken. This involved playing the calls of the species on speakers, waiting 10-15 minutes, before moving approximately 500 m further along the road transect and repeating the playback.

#### 3.3.4 Bat recordings

Bat records were undertaken at three locations over three nights to record bat species present within the Study Area (Figure 3.1; Appendix A). Units used were a Titley AnaBat<sup>™</sup> SD1 bat detector. The signals recorded on the detector were downloaded and analysed by Dr Kyle Armstrong (Specialised Zoological) and the report is attached as Appendix D. A total of 5.6 hours of bat recordings were undertaken within the Study Area.

#### 3.3.5 Motion cameras

Motion sensitive cameras were used to survey for larger mammals, such as Chuditch, possums, and introduced predators. A camera was set up and baited with either a mixture of peanut butter, rolled oats and honey, or sardines, at four different locations for one night each (Figure 3.1; Appendix A). A total of 49.4 hours of motion camera surveys were undertaken within the Study Area.

#### 3.3.6 Opportunistic Surveys

At all times while surveying, all records of note pertaining to species, particularly bird species, were recorded during the survey. These records included tracks, scats and any other traces of fauna, as well as incidental sightings of live animals.



#### 3.3.7 Potential limitations and constraints

EPA Guidance Statement No. 56 (EPA, 2004) outlines several potential limitations to fauna surveys. These are presented and discussed in Table 3.3 below.

#### Table 3.3: Survey limitations and constraints

Potential limitation or constraint	Applicability to this survey
Experience of personnel.	The field personnel involved in the survey had over ten years of fauna survey experience each.
Scope (what faunal groups were sampled and whether any constraints affect this).	Scope was a Level 1 survey and within that framework was completed. Habitat assessments for Black Cockatoos, nocturnal surveys and bat surveys were also conducted.
Proportion of fauna identified.	All fauna were identified at the point of capture or observation.
Sources of information (recent or historic) and availability of contextual information.	At the bioregion level, the South West has been the subject of many targeted biological surveys, primarily for the resource and residential development sector. Site-specific data are limited, but this is not considered a limiting factor for this survey.
Proportion of the task achieved.	A Level 1 survey of the Study Area was completed.
Disturbances (e.g. fire or flood).	There were no disturbances that had the potential to affect the completeness of the survey.
Intensity of survey.	A Level 1 survey was deemed appropriate considering the NVCP is for within the active mining area, that is considered to be totally disturbed by mining and the small areas to be cleared.
Completeness of survey.	The Level 1 survey is complete.
Resources (e.g. degree of expertise available).	All resources required to complete the survey were available.
Remoteness or access issues.	No restrictions to access were encountered.

#### 3.4 Level of Assessment

The level of survey undertaken was a Level 1 baseline fauna survey (EPA, 2004). In addition, a targeted survey for Black Cockatoo species was undertaken within the Study Area, which involved habitat assessments carried out in accordance with the draft referral guidelines for three threatened black cockatoo species (DSEWPaC, 2011d).

#### 3.5 Assessment of Conservation Significance

Within Western Australia, native fauna are protected under the *Wildlife Conservation Act* 1950 (WC Act), and in general terms, any action that has the potential to impact on native fauna or its habitat needs to be approved by relevant State and/or Federal departments as dictated by the Western Australian *Environmental Protection Act* 1986 and the Federal *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

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Certain fauna considered to be at risk of extinction or decline are afforded extra protection under these acts. For the purposes of this report, these species are called 'conservation significant species'. A summary of applicable legislation and status codes is provided in Table 3.4. Details of conservation status codes are provided in Appendix E. The WC Act was most recently updated with the *Wildlife Conservation (Specially Protected Fauna) Notice 2010*.

A number of migratory bird and marine species are prioritised for conservation under the EPBC Act or international agreements. In addition the International Union for Conservation of Nature (IUCN) compiles a Red List on which species at risk are listed (IUCN, 2011).

Some species for which there is insufficient information available for inclusion under the EPBC or WC Acts are listed as Priority fauna by the DEC. Priority fauna are generally considered by the EPA and the DEC as species of conservation significance for all environmental impact assessments.

Table 3.4: Conse	ervation significance	status	codes
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Level	Agreement, Act or List	Status Codes	
International	<ul> <li>The IUCN <i>Red List</i> lists species at risk under nine categories.</li> <li>Migratory taxa listed under the following international conventions are generally listed as Migratory or Marine under the federal <i>Environment Protection and Biodiversity Conservation Act 1999</i> (see below):</li> <li>Japan-Australia Migratory Bird Agreement (JAMBA);</li> <li>China-Australia Migratory Bird Agreement (CAMBA); and,</li> <li>Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).</li> </ul>	IUCN Extinct IUCN Extinct in the Wild IUCN Critically Endangered IUCN Endangered IUCN Vulnerable IUCN Near Threatened IUCN Least Concern IUCN Data Deficient IUCN Not Evaluated	
Federal	<b>Environment Protection and Biodiversity Conservation</b> <b>Act 1999</b> DSEWPaC lists threatened fauna, which are determined by the Threatened Species Scientific Committee (TSSC) according to criteria set out in the Act. The Act lists fauna that are considered to be of conservation significance under one of eight categories.	Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Conservation Dependent Migratory Marine	
State	<i>Wildlife Conservation Act 1950</i> At a state level, native fauna are protected under the <i>Wildlife</i> <i>Conservation Act 1950</i> . Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.	Schedule 1 Schedule 2 Schedule 3 Schedule 4	
State	<b>DEC Priority list</b> The DEC produces a list of Priority species and ecological communities (PECs) that have not been assigned statutory protection under the <i>Wildlife Conservation Act 1950</i> . This system gives a ranking from Priority 1 to Priority 5.	Priority 1 Priority 2 Priority 3 Priority 4 Priority 5	



## 3.6 Taxonomy and Nomenclature

Taxonomy and nomenclature of checklists of Western Australian mammals, reptiles and amphibians published by the Western Australian Museum (WAM) was adopted (WAM, 2009). For birds, the current Birds Australia checklist, based on the most recent review of the systematics and taxonomy of Australian birds (Christidis and Boles, 2008) was used.



### 4 VERTEBRATE FAUNA

#### 4.1 Review of Previous Surveys

Database searches and literature reviews indicated that 196 vertebrate fauna species have the potential to occur within the Study Area (Appendix F). This list comprises 25 native mammal species, nine introduced mammal species, 120 bird species, 30 reptile species and 12 amphibian species.

The review of previous surveys and databases suggested that 22 species of conservation significance have either been recorded or potentially occur within the Study Area. These species are discussed further in Section 4.3.

#### 4.2 Current Field Survey

During the current survey a total of 82 species were recorded; comprising at least eight native mammal species, six introduced mammal species, 59 bird species, four reptile species and five amphibian species.

Five of these; one mammal and four birds, were species of conservation significance and are discussed in Section 4.3.2.

#### 4.2.1 Native mammals

Of the eight species of native mammal recorded during the current survey, five of these were bat species. At least five species of bat were recorded during the bat echolocation-based surveys. Gould's Wattled Bat (*Chalinolobus gouldii*), Southern Forest Bat (*Vespadelus regulus*), Southern Freetail-bat (*Mormopterus* sp. 4) and White-striped Feetail-bat (*Tadarida australis*) were identified from their echolocation calls with high confidence (Appendix D). The calls of a *Nyctophilus* sp. were recorded, however, they could not be identified to species and could be attributed to the Lesser Long-eared Bat (*Nyctophilus gouldi*) or the Western Greater Long-eared Bat (*Nyctophilus major major*).

The three other native mammal species recorded were: the Western Grey Kangaroo (*Macropus fuliginosus*) from multiple observations during the survey, the Common Brushtail Possum (*Trichosurus vulpecula*) captured on a motion camera, and the Southern Brush-tailed Phascogale (*Phascogale tapaotafa tapaotafa*) from one individual observed during a nocturnal survey.

#### 4.2.2 Birds

A total of 59 bird species were recorded within the Study Area during the current survey. Two species, the Australian Owlet-nightjar (*Aegotheles cristatus*) and Southern Boobook Owl (*Ninox novaeseelandiae*) were recorded during nocturnal surveys. The most commonly Page 23 of 87



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recorded species was the Masked Woodswallow (*Artamus personatus*) (40 records), followed by the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) (9 records), Southern Boobook Owl (*N. novaeseelandiae*) (9 records), Little Black Cormorant (*Phalacrocorax sulcirostris*) (9 records), Little Pied Cormorant (*Microcarbo melanoleucos*) (6 records), Musk Duck (*Biziura lobata*) (5 records) and Welcome Swallow (*Hirundo neoxena*) (5 records).

Feeding signs of all three species of Black Cockatoos; Forest Red-tailed Black Cockatoo (*C. banksii naso*), Carnaby's Cockatoo (*C. latirostris*) and Baudin's Cockatoo (*C. baudinii*) were recorded within the Study Area. These species are discussed in further detail in Sections 4.3.2, 5.2 and 5.3.

#### 4.2.3 Reptiles

Due to the cool conditions experienced during the survey, only four species of reptile were recorded within the Study Area: the Oblong Turtle (*Chelodina oblonga*), Western Bobtail (*Tiliqua rugosa rugosa*), a skink (*Morethia obscura*) and Heath Monitor (*Varanus rosenbergi*).

#### 4.2.4 Amphibians

Five species of amphibian were recorded during the current survey based on their calls: the Quacking Frog (*Crinia georgiana*), Clicking Froglet (*Crinia glauerti*), Western Banjo Frog (*Limmnodynastes dorsalis*), Slender Tree Frog (*Litoria adelaidensis*) and Motorbike Frog (*Litoria moorei*). Individuals of the Western Banjo Frog and Quacking Frog were also observed during nocturnal surveys.

#### 4.2.5 Introduced fauna

Six introduced species were recorded within the Study Area during the current survey. The Dog (*Canis lupus*), Cat (*Felis catus*), European Cattle (*Bos Taurus*), Horse (*Equus caballus*) and Rabbit (*Oryctolagus cuniculus*) were all observed and the Fox (*Vulpes vulpes*) was captured on a motion camera.

#### 4.3 Conservation Significant Fauna

#### 4.3.1 Literature and database review

Based on database searches and previous surveys in the region, a total of 22 species of conservation significance comprising eight native mammals, 12 birds and two reptiles have the potential to occur in the Study Area. Native mammals identified in the review were:

- Chuditch, Dasyurus geoffroii
- Southern Brush-tailed Phascogale, Phascogale tapaotafa tapaotafa
- Red-tailed Phascogale, *Phascogale calura*



- Quenda, Isoodon obesulus fusciventer
- Western Brush Wallaby, Macropus irma
- Quokka, Setonix brachyurus
- Western False Pipistrelle, Falsistrellus mackenziei
- Water Rat, Hydromys chrysogaster

The following conservation significant birds potentially occur in the Study Area:

- Great Egret, Ardea alba
- Australasian Bittern, Botaurus poiciloptilus
- Black Bittern, Ixobrychus flavicollis australis
- Peregrine Falcon, Falco peregrinus
- Bush Stone-curlew, Burhinus grallarius
- Forest Red-tailed Black Cockatoo, Calyptorhynchus banksii naso
- Baudin's Cockatoo, Calyptorhynchus baudinii
- Carnaby's Cockatoo, Calyptorhynchus latirostris
- Barking Owl (southwest population), Ninox connivens connivens
- Masked Owl (southwest population), Tyto novaehollandiae novaehollandiae
- Fork-tailed Swift, Apus pacificus (EPBC Act Migratory, WC Act Schedule 3);
- Rainbow Bee-eater, Merops ornatus

Two conservation significant reptiles potentially occur in the Study Area:

- Dell's Skink, Ctenotus delli
- Carpet Python (southwest population), Morelia spilota imbricata

Of these potentially occurring species, one mammal and four bird species were recorded in the Study Area during the current survey (see Section 4.3.2). The remaining species have been classified according to their likelihood of occurrence in Sections 4.3.3 and 4.3.4.

#### 4.3.2 Conservation significant fauna recorded in the Study Area

Five species of conservation significant fauna were recorded in the Study Area. The locations at which they were recorded are shown on Figure 4.1 and presented in Appendix H. Each of the species recorded is presented in taxonomic order and discussed in the following section, with a summary provided in Table 4.1.

#### Mammals

#### • Southern Brush-tailed Phascogale (Phascogale tapaotafa tapaotafa)

The Southern Brush-tailed Phascogale is listed as Schedule 1 under the WC Act. Its present distribution is believed to have been reduced to approximately 50% of its former range and it is now known from Perth and south to Albany, west of Albany Highway. It occurs at low





densities in the northern Jarrah forest and in highest densities in the Perup/Kingston area, Collie River valley, and near Margaret River and Busselton. Records are less common from wetter forests.

This subspecies has been observed in dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover and relies on tree hollows as nest sites. The home range for a female is estimated at 20-70 ha, whilst that for males is estimated as twice that of females. In addition, they tend to utilise a large number (approximately 20) of different nest sites throughout their range (Soderquist and Rhind, 2008).

An individual Southern Brush-tailed Phascogale was recorded during a nocturnal survey within the Study Area (Figure 4.1). The individual was observed on the ground on 15<sup>th</sup> October 2011 within remnant regrowth Marri-Jarrah forest in the south of the Study Area (50H 414209mE, 6250502mN).

Birds

#### • Forest Red-tailed Black Cockatoo (Calyptorhynchus banksii naso)

The Forest Red-tailed Black Cockatoo is distributed through the humid and subhumid southwest of Western Australia from Gingin through the Darling Ranges to the southwest, from approximately Bunbury to Albany (Johnstone and Storr, 1998). Their population in the recent past has been estimated at approximately 15,000 birds (Johnstone and Kirkby, 1999). Although not nomadic like Carnaby's and Baudin's Cockatoos, the Forest Red-tailed Black Cockatoo has been known to exhibit extreme population fluctuations in response to food availability and fires. The Forest Red-tailed Black Cockatoo occurs in pairs or small flocks, or occasionally large flocks of up to 200 (Johnstone and Storr, 1998). The Forest Red-tailed Black Cockatoo inhabits dense Jarrah, Karri and Marri forests that receive more than 600 mm average annual rainfall (DSEWPaC, 2011d). This species breeds in the southwest of Western Australia between October and November, producing one or two eggs.

This species feeds primarily on Marri and Jarrah fruit (DSEWPaC, 2011d). They also have been known to feed on Blackbutt (*Eucalyptus patens*), Albany Blackbutt (*Eucalyptus staeri*), Karri, Sheoak (*Allocasuarina fraseriana*) and Snottygobble (*Persoonia longifolia*). Forest Red-tailed Black Cockatoos can obtain energy faster when feeding on Marri and Jarrah than other food sources (Cooper *et al.*, 2002), and these two plant species make up 90% of their diet (Johnstone and Kirkby, 1999).

A total of 22 individuals were observed at five locations within the Study Area (Appendix H) during the current survey (Figure 4.1). Numerous feeding signs of this species were observed on Marri nuts throughout the Study Area (Figure 4.1).



#### • Baudin's Cockatoo (Calyptorhynchus baudinii)

Baudin's Cockatoo is distributed through the south western humid and subhumid zones, from the northern Darling Range and adjacent far east of the Swan Coastal Plain (south of the Swan River), south to Bunbury and across to Albany (Johnstone and Storr, 1998). Baudin's Cockatoo usually occur in small flocks of up to 30, or occasionally up to 50, or rarely in aggregations of up to 1200 (Johnstone and Kirkby, 2008). The total population of Baudin's Cockatoo is estimated to be about 15,000 birds (Johnstone and Kirkby, 2008).

This species forages primarily in eucalypt forest, where it feeds on Marri seeds, flowers, nectar and buds (Johnstone and Kirkby, 2008). They also feed on a wide range of seeds of *Eucalyptus, Banksia* and *Hakea*, as well as the fruits of apples, pears, persimmons, pines, and beetle larvae from under the bark of trees (Johnstone and Kirkby, 2008; Johnstone and Storr, 1998). For Baudin's Cockatoo the seeds from Marri provide a high energetic yield because Marri seeds are a high energy food and Baudin's Cockatoo are able to quickly extract the seeds from the nut using their long bill (Cooper *et al.*, 2002).

Baudin's Cockatoo nests in tree hollows in the deep southwest of Western Australia. Primary nesting trees are Karri, Marri, and Wandoo (*Eucalyptus wandoo*). Baudin's Cockatoo is mostly a postnuptial nomad (Johnstone and Kirkby, 2008) and breed from around October to December. After breeding, Baudin's Cockatoos leave nesting areas and amalgamate to form large foraging flocks. These flocks generally migrate north to the main non breeding wintering area in the northern Darling Range between Collie and Mundaring (Johnstone and Kirkby, 2008).

Although no individuals were observed within the Study Area, feeding signs on Marri nuts of this species were recorded within the Study Area (Figure 4.1).

#### • Carnaby's Cockatoo (Calyptorhynchus latirostris)

Carnaby's Cockatoo is endemic to south west Western Australia, and is distributed from the Murchison River to Esperance and inland to Coorow, Kellerberrin and Lake Cronin (Cale, 2003). The species was once common, but the population has declined significantly in the last half century (Johnstone and Storr, 1998) and is now locally extinct in some areas (Shah, 2006). The total population of Carnaby's Cockatoo is currently estimated at 40,000 (Johnstone and Johnstone, 2008).

Carnaby's Cockatoos feed on seeds, nuts and flowers of a variety of native and exotic plants. Food plants include *Banksia* (including those previously included in the genus *Dryandra*), Pine trees (*Pinus* sp.), Marri, Jarrah, *Grevillea*, *Allocasuarina*, and *Hakea* (Shah, 2006). For Carnaby's Cockatoo the seeds from seed pods of *Banksia* and the cones of pine trees provide the highest energetic yield (Cooper *et al.*, 2002). Carnaby's Cockatoo are less efficient at extracting Marri seeds than Baudin's Cockatoo (Cooper *et al.*, 2002).

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Trees used as nest sites by Carnaby's Cockatoo are mature, hollow bearing trees, usually with a crown containing dead limbs and a sparse canopy (Cale, 2003; Chapman, 2007; Johnstone and Storr, 1998). They generally nest in hollows of smooth barked Eucalypts, especially Salmon Gum and Wandoo and on the Swan Coastal Plain most nests are in Tuart (Johnstone and Storr, 1998). However, they are said to nest in any species of Eucalypt with a suitable hollow (Saunders, 1979; Cale 2003). Breeding has been recorded from early July to mid-December and primarily occurs in the Wheatbelt (Johnstone and Storr, 1998). On the Swan Coastal Plain, Carnaby's Cockatoo are known to breed in small numbers at Regans Ford, Yanchep, Gingin, Mandurah and Bunbury (Johnstone and Johnstone, 2004).

Although no individuals were observed within the Study Area, feeding signs on *Banksia* cones of this species were recorded within the Study Area (Figure 4.1).

#### • Rainbow Bee-eater (Merops ornatus)

The Rainbow Bee-eater is listed as Migratory under the EPBC Act and Schedule 3 under the WC Act. The demographics of the species are complex, with populations in WA being resident, breeding visitors, post-nuptial nomads, passage migrants and winter visitors (Johnstone and Storr, 1998). Many individuals move northwards to overwinter in Indonesia. The Rainbow Bee-eater prefers lightly wooded, preferably sandy habitat near water (Johnstone and Storr, 1998).

The call of this species was heard within the Study Area on 15<sup>th</sup> October 2011 within the remnant regrowth Marri-Jarrah forest in the south of the Study Area (50H 414262mE, 6250545mN) (Figure 4.1).



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#### Table 4.1: Conservation significant fauna recorded in the Study Area

Name	Conservation Status	Preferred Habitat	Extent of habitat in the Study Area and region	Records			
Mammals							
Southern Brush-tailed Phascogale Phascogale tapaotafa tapaotafa	WC Act: Schedule 1 ICUN: Near Threatened	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover.	This habitat is common within the Study Area, particularly outside the active mining area. Habitat is also common in the surrounding region.	Individual recorded from remnant regrowth Marri-Jarrah forest in the south of the Study Area (50H 414209mE, 6250502mN).			
Birds	rds						
Forest Red-tailed Black Cockatoo Calyptorhynchus banskii naso	EPBC Act: Vulnerable WC Act: Schedule 1	Dense Jarrah, Karri and Marri forests that receive more than 600 mm average annual rainfall. Feeds mostly on Marri and Jarrah seeds.	This habitat was generally uncommon; although more open regrowth Jarrah and Marri forests were common within the Study Area, particularly outside of the active mining area. Dense Jarrah, Karri and Marri forests are more common in the region.	Nine individuals from two locations were recorded within the Study Area (50H 411753mE, 6253814mN; 50H 413024mE, 6254204mN). Feeding signs were also observed throughout the Study Area in Jarrah-Marri forest.			
Baudin's Cockatoo Calyptorhynchus baudinii	EPBC Act: Vulnerable WC Act: Schedule 1 IUCN: Endangered	Primarily in eucalypt forest and nests in Marri, Karri and Wandoo trees. Feeds on mostly Marri seeds.	Marri forest was common habitat within the Study Area, particularly outside the active mining areas. Karri and Wandoo forests were not present within the Study Area and are more common in the surrounding region.	Feeding signs of this species were observed throughout the Study Area in Jarrah-Marri forest.			
Carnaby's Cockatoo Calyptorhynchus latirostris	EPBC Act: Endangered WC Act: Schedule 1 IUCN: Endangered	Woodland or forest that contains live or dead trees of Salmon Gum, Wandoo, Tuart, Jarrah, Flooded Gum, Karri or Marri. Feeds on seeds, flowers and nectar of native proteaceous plant species (e.g. <i>Banksia</i> spp., <i>Dryandra</i> spp., <i>Grevillea</i> spp.), eucalypts and <i>Pinus</i> spp.	Marri-Jarrah forest with proteaceous understorey was fairly common within the Study Area, particularly in the south. Habitat is also common in surrounding region.	Feeding signs on <i>Banksia</i> cones were observed throughout the Study Area in Jarrah-Marri forest.			
Rainbow Bee-eater <i>Merops ornatus</i>	EPBC Act: Migratory WC Act: Schedule 3	Lightly wooded, preferably sandy country near water (Johnstone and Storr, 1998).	This habitat is generally uncommon in the Study Area.	The call of this species was recorded from remnant regrowth Marri-Jarrah forest in the south of the Study Area (50H 414262mE, 6250545mN).			



#### 4.3.3 Conservation significant fauna potentially occurring

Based on the fauna habitats present in the Study Area, and their distribution in the surrounding region, an additional 13 conservation significant species (five mammal, seven bird and one reptile species) were considered to have the potential to occur. These species are discussed below, and a summary is presented in Table 4.2.

#### Mammal

#### • Chuditch (Dasyurus geoffroii)

The Chuditch, or Western Quoll, is listed as Schedule 1 under the WC Act and as Vulnerable under the EPBC Act. It formerly occurred over nearly 70% of Australia; however, the Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of south-west Western Australia. The species also occurs in very low numbers in the Midwest, Wheatbelt and South Coast regions, with records from Moora to the north, Yellowdine to the east and south to Hopetoun.

Chuditch are known to have occupied a wide range of habitats from woodlands, dry sclerophyll (leafy) forests, riparian vegetation, beaches and deserts. Riparian vegetation appears to support higher densities of Chuditch, possibly because food supply is better or more reliable and better cover is offered by dense vegetation. The estimated home range of a male Chuditch is more than 15 km<sup>2</sup>, whilst that for females is 3-4 km<sup>2</sup> (Sorena and Soderquist, 2008).

This species is considered to possibly occur within the Study Area, as suitable habitat exists of a size large enough to support the home range of this species, e.g. areas of regrowth Jarrah-Marri forest in the western half of the Study Area.

#### • Quenda (Isoodon obesulus fusciventer)

The Quenda, or Southern Brown Bandicoot, is listed as Priority 5 by the DEC. It is widely distributed in the south-west from near Cervantes (north of Perth) to east of Esperance, patchy distribution through the Jarrah and Karri forest and on the Swan Coastal Plain, and inland as far as Hyden. The species inhabits dense scrubby, often swampy, vegetation with dense cover up to one metre high, often feeding in adjacent forest and woodland that is burnt on a regular basis, and in areas of pasture and cropland lying close to dense cover. Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses.

The Quenda may occur within the Study Area, albeit in low numbers as their preferred habitat of dense, swampy vegetation is not common within the Study Area.



#### • Western Brush Wallaby (Macropus Irma)

The Western Brush Wallaby is listed as Priority 4 by the DEC. The Western Brush Wallaby is distributed across the south-west of Western Australia from north of Kalbarri to Cape Arid. The optimum habitat of this species is open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets. It is also found in some areas of mallee and heathland, and is uncommon in Karri forest.

This species is considered to possibly occur within the Study Area as suitable habitat exists.

#### • Western False Pipistrelle (Falsistrellus mackenziei)

The Western False Pipistrelle is listed as Priority 4 by the DEC and is confined to south-west of Western Australia, south of Perth and east to the Wheatbelt. This species of bat occurs in high forest and coastal woodlands. Most records are from Karri forests, but they have also been recorded in wetter stands of Jarrah and Tuart woodlands on the Swan Coastal Plain (Menkhorst and Knight, 2001). It roosts in small colonies in tree hollows and forages at canopy level and in the cathedral-like spaces between trees.

Although not recorded during the survey, this species may be an inhabitant of the Study Area as suitable habitat is present.

#### • Water Rat (Hydromys chrysogaster)

The Water Rat is listed as Priority 4 by the DEC. The species is widely distributed around Australia and its offshore islands, New Guinea and some adjacent islands. It occurs in fresh brackish water habitats in the south-west of Western Australia, but occurs in marine environments along the Pilbara coastline and offshore islands. Surveys in the south-west suggest this species is relatively common and widespread, though difficult to capture (Christensen *et al.*, 1985; How *et al.*, 1987). The Water Rat occupies habitat near permanent water; fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams, as well as bodies of permanent water in the lower south west (Christensen *et al.*, 1985).

This species is likely to occur within the Study Area as a number of permanent water bodies (i.e. dams) are present.

#### Birds

#### • Great Egret (Ardea alba)

This species of egret is listed as Migratory under the EPBC Act and as Schedule 3 under the WC Act. The Great Egret is common and very widespread in any suitable habitat (Morcombe, 2003). Suitable habitat for this species includes wetlands, flooded pastures, dams, estuarine mudflats, mangroves and reefs (Morcombe, 2003).





This species is considered to possibly occur within the Study Area, due to the presence of suitable habitat, including a number of dams.

#### • Australasian Bittern (Botaurus poiciloptilus)

This species is listed as Endangered under the EPBC Act and by the IUCN and is a Schedule 1 species under the WC Act. In Western Australia, the Bittern was formerly widespread in the southwest, but now probably occurs only on the western coastal plain between Lancelin and Busselton, in the southern coastal region from Augusta to east of Albany and inland to some wetlands in the Jarrah forest belt (Marchant and Higgins, 1990). The Australasian Bittern occurs in terrestrial wetlands. It favours wetlands with tall dense vegetation, particularly sedges, rushes or reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bulboscoenus*).

The Australasian Bittern is extremely difficult to observe because of its preferred habitat and although there are no recent records of this species in the area, it may occur in the Study Area as suitable habitat is present.

#### • Black Bittern (Ixobrychus flavicollis australis)

The Black Bittern is listed as Priority 3 by the DEC. This species occurs north to Yanchep and Northan and east to Albany (Johnstone and Storr, 1998). It occurs in freshwater pools, swamps and lagoons that are well-screened by trees. They occasionally feed by day but mainly shelter in dense waterside vegetation (melaleucas, river gums, pandans and long grass).

The Black Bittern is extremely difficult to observe because of its preferred habitat and although there are no recent records of this species in the area, it may occur in the Study Area as suitable habitat is present.

#### • Peregrine Falcon (Falco peregrinus)

This species is listed as Schedule 4 under the WC Act. Individuals of this species are uncommon/rare but wide-ranging across Australia; moderately common at higher levels of the Stirling Range, uncommon in hilly, north-west Kimberley, Hamersley and Darling Ranges and rare or scarce elsewhere (Johnstone and Storr, 1998). Their habitat is diverse, ranging from rainforest to arid shrublands and from coastal heath to alpine, but are found mainly about cliffs along coasts, rivers and ranges and about wooded watercourses and lakes (Johnstone and Storr, 1998). The species utilises the ledges, cliff-faces and large hollows/broken spouts of trees for nesting. Also occasionally uses the abandoned nests of other birds of prey.

The species may utilise some sections of the Study Area as part of a much larger home range. Some tree hollows in the Study Area could be regarded as potential nest sites; however, no evidence of the species was recorded during the current survey.



#### • Barking Owl (Ninox connivens connivens)

The southwest population of the Barking Owl is listed as Priority 2 by the DEC. It is found north to Perth (formerly) and east to Northam, Katanning and nearly to Bremer Bay, but is considered to be declining in the southwest (Johnstone and Storr, 1998). It inhabits dense vegetation, especially forest and thickets of waterside vegetation such as Melaleucas and roosts in tree hollows (Johnstone and Storr, 1998).

Based on preferred habitat descriptions, this species potentially occurs within the areas of denser vegetation in the Study Area. The Barking Owl was not recorded during nocturnal playback surveys for this species in the current survey.

#### • Masked Owl (Tyto novaehollandiae novaehollandiae)

The southwest population of the Masked Owl is listed as Priority 3 by the DEC. It is found north to Yanchep and east to Yealering, Gnowangerup and Albany. It is considered locally common in the southwest, but generally uncommon (Johnstone and Storr, 1998). The Masked Owls roost and nest in heavy forest and hunt over open woodlands and farmlands, probably breeding in the forested deep southwest with some autumn–winter wanderings northwards (Johnstone and Storr, 1998).

The Masked Owl potentially frequents areas of densest vegetation within the Study Area. This species was not recorded during nocturnal playback surveys for this species in the current survey but is still considered likely to frequent the Study Area.

#### • Fork-tailed Swift (Apus pacificus)

The Fork-tailed Swift is listed as Migratory under the EPBC Act because it breeds in northeast and east Asia, wintering in Australia and southern New Guinea (Johnstone and Storr, 1998). It is also listed as Schedule 3under the WC Act. There are sparsely scattered records along the south coast, and are widespread in coastal and subcoastal areas between Augusta and Carnarvon. The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher.

Given the distribution of this species, it is considered likely to occur above the Study Area as it is an aerial species.

#### Reptiles

#### • Carpet Python (Morelia spilota imbricata)

The south-western population of the Carpet Python is classified as Priority 4 by the DEC, and is also listed in Schedule 4 under the WC Act. This subspecies has wide distribution in the south-west, but is uncommon. The Carpet Python occurs north to Geraldton and Yalgoo and east to Pinjin, Kalgoorlie, Fraser Range and Eyre (Storr *et al.*, 2002). This species has been



recorded from semi-arid coastal and inland habitats, banksia woodland, eucalypt woodlands, and grasslands and commonly utilises hollow logs for shelter.

This species is considered to possibly occur within the Study Area, as suitable habitat exists within the Study Area.


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#### Table 4.2: Conservation significant fauna potentially occurring in the Study Area

Name	Significance	Preferred Habitat	Likelihood of Occurrence within the Study Area
Mammals			
Chuditch Dasyurus geoffroii	EPBC Act: Vulnerable WC Act: Schedule 1 IUCN: Near Threatened	Jarrah forest and mixed Karri/Marri/Jarrah forest.	DEC records exist in the area and suitable habitat is present within the Study Area, therefore this species is considered likely to occur.
Quenda Isoodon obesulus fusciventer	DEC: Priority 5	Dense scrubby, often swampy, vegetation with dense cover up to one metre high, often feeding in adjacent forest and woodland that is burnt on a regular basis, and in areas of pasture and cropland lying close to dense cover. Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses.	There are no DEC records in the area, however, there is some suitable habitat within the Study Area, and therefore, this species may occur.
Western Brush Wallaby Macropus Irma	DEC: Priority 4	Open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets.	DEC records exist in the area and suitable habitat is present within the Study Area, therefore this species is considered likely to occur.
Western False Pipistrelle Falsistrellus mackenziei	Be Pipistrelle DEC: Priority 4 High forest and coastal woodlands. Most records are Karri forests, but they have also been recorded in weth stands of Jarrah and Tuart woodlands.		This species may occur within the Study Area as suitable habitat is present.
Water Rat Hydromys chrysogaster	gaster DEC: Priority 4 Habitat near permanent water; fresh, brackish or marine.		There are DEC records of this species within the area and suitable habitat is present within the Study Area, therefore this species is considered likely to occur.
Birds			
Great Egret <i>Ardea alba</i>	EPBC Act: Migratory WC Act: Schedule 3	Wetlands, flooded pastures, dams, estuarine mudflats, mangroves and reefs (Morcombe, 2003).	There are DEC records north of Kojonup and suitable habitat exists within the Study Area, therefore this species may occur.
Australasian Bittern <i>Botaurus poiciloptilus</i>	EPBC Act: Endangered WC Act: Schedule 1 IUCN: Endangered	Freshwater pools, swamps and lagoons, well-screened with trees (Johnstone and Storr, 1998).	There is a DEC record for this species south of Bridgetown. Given that the species is difficult to detect and that suitable habitat is present within the Study Area, this species may occur.
Black Bittern Ixobrychus flavicollis australis	DEC: Priority 3	Beds of tall dense <i>Typha, Baumea</i> and sedges in freshwater swamps (Johnstone and Storr, 1998).	There are no DEC records for this species in the area. However, given that the species is difficult to detect and that suitable habitat is present within the Study Area, this species may occur.



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Name	Significance	Preferred Habitat	Likelihood of Occurrence within the Study Area		
Peregrine Falcon       WC Act: Schedule 4       Cosmopolitan, will from a perch; ofte on rocky ledges in associated with d		Cosmopolitan, will hunt in any habitat, soaring at height or from a perch; often near cliffs (Slater <i>et al.</i> , 2009). Nests on rocky ledges in tall, vertical cliff faces and tall trees associated with drainage lines.	DEC records exist in the area and suitable habitat is present within the Study Area, therefore this species is considered likely to occur.		
Barking Owl Ninox connivens connivens	DEC: Priority 2	Dense vegetation, especially forest and thickets of waterside vegetation such as Melaleucas and roosts in tree hollows (Johnstone and Storr, 1998).	There are DEC records north of Kojonup and suitable habitat exists within the Study Area, therefore this species may occur.		
Masked Owl Tyto novaehollandiae novaehollandiae	I     DEC: Priority 3     Roosts and nests in heavy forest and hunt over open woodlands and farmlands (Johnstone and Storr, 1998).		There are a number of DEC records for this species, including Greenbushes and suitable habitat exists within the Study Area, therefore this species may occur.		
Fork-tailed Swift Apus pacificus	EPBC Act: Migratory WC Act: Schedule 3	Aerial species.	There is a DEC record of this species north of Donnybrook and is considered likely to occur over the Study Area.		
Reptiles					
Carpet Python Morelia spilota imbricata	DEC: Priority 4	Semi-arid coastal and inland habitats, banksia woodland, eucalypt woodlands, and grasslands and commonly utilises hollow logs for shelter.	There are DEC records from Boyup Brook and Bridgetown, and suitable habitat exists within the Study Area, therefore this species is considered likely to occur.		



#### 4.3.4 Other conservation significant fauna

A number of species identified as potentially occurring through searches of rare fauna databases were considered unlikely to occur and the rationale for these species not to occur are outlined in Table 4.3.

Table 4.3: Conservation significant fauna unlikely to occur within the Study A	Area
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Species	Classification	Rationale
Mammals		
Red-tailed Phascogale Phascogale calura	EPBC Act: Endangered WC Act: Schedule 1 IUCN: Near Threatened	Although recorded in a database search, this species is now restricted to the wheatbelt of Western Australia and the Study Area is outside of this distribution.
Quokka Setonix brachyurus	EPBC Act: Vulnerable WC Act: Schedule 1 IUCN: Vulnerable	This species is considered unlikely to occur within the Study Area as it is a habitat specialist and suitable habitat is absent from the Study Area.
Birds		
Bush Stone-curlew Burhinus grallarius	DEC: Priority 4	This species is considered to be locally extinct and therefore unlikely to occur within the Study Area.
Reptiles		
Dell's Skink Ctenotus delli	DEC: Priority 4	The Study Area outside the reported distribution of this species (occurs south to Collie) and limited habitat exists within the Study Area. Therefore, this species is unlikely to occur.



#### 5 FAUNA HABITATS

#### 5.1 Fauna Habitats of the Study Area

Five major natural fauna habitats are present within the Study Area (Table 5.1). Data from fauna habitat assessments are presented in Appendix F and the habitat map is presented in Figure 5.1. Within the Study Area, Jarrah/Marri Forests are the most dominant vegetation type and covers 4085.82 ha. Over 1400 ha portion of the land in the North East and South West corners harbour Jarrah/Marri Forest over *Banksia* dominated midstorey vegetation. The draining lines are often lined by Marri/Blackbutt/Flooded Gum Woodlands over a *Banksia*-dominated midstorey which are associated with water bodies. Habitats dominated by *Leptospermum* scrub and dense and tall *Typha* Sedges are scarce (each <25 ha in total area occupied) and the latter is only present within the active mining area.

Anthropogenic habitats are dominated by cleared farmlands (1950.32 ha) and plantations (1214.92 ha). Within the active mining area, the central disturbed area is bounded by mine rehabilitation vegetation.



#### Table 5.1:Fauna habitats of the Study Area

Habitat	Total area within Study Area (ha)	Area (ha) and % of Active Mining Area	Area (ha) and % of remaining Study Area	Description	Significant species associated with habitat	Vegetation type*
Jarrah ( <i>E. marginata</i> )/Marri ( <i>C. calophylla</i> ) forest over <i>Banksia</i> dominated midstorey	1412.20	316.08 (22.38%)	1096.13 (77.62%)	E E. marginata/C. calophylla forest over Banksia grandis/Persoonia longifolia dominated scrub on upper hill slopes and plateaux	C. calophylla E. marginata B. grandis P. longifolia	1a, 2a, 2b
Jarrah/Marri forest	4085.82	320.48 (7.84%)	3765.33 (92.16%)	E. marginata/C. calophylla forest over scrub on undulating hill slopes and drainage lines.		1b, 2d
Marri/Blackbutt ( <i>E. patens</i> ) /Flooded Gum ( <i>E. rudis</i> ) Woodland over <i>Banksia</i> dominated midstorey	314.68	8.7 (2.76%)	305.98 (97.24%)	Eucalyptus rudis, Corymbia calophylla and Eucalyptus patens woodland over Banksia littoralis woodland over Taxandria spp. heath along drainage lines and flats	C. calophylla E. rudis E. patens B. littoralis	2c
Leptospermum scrub	7.08	0 (0%)	7.08 (100%)	Leptospermum erubescens Scrub over heath on granite outcropping	None	3
Typha dense tall sedges	20.52	20.52 (100%)	0 (0%)	* <i>Typha orientalis</i> Dense Tall Sedges	None	10
Disturbed/rehabilitated areas	4102.48	850.23 (20.72%)	3252.25 (79.28%)	Includes mine disturbance, rehabilitation, plantation, cleared farmland and the townsite	Pinus spp.	4, 5, 6, 7, 8, 9





#### **Foraging Assessment**

Most of the areas of remnant native Jarrah-Marri forest is considered suitable foraging habitat for Black Cockatoos based on the tree density assessments (Figure 5.2). The canopy layer in the native vegetation is entirely comprised of Jarrah and Marri and the midstorey is dominated by *B. grandis* trees, all of which are known feeding resources for Black Cockatoos and are located throughout the Study Area (Figure 5.2).

A summary of the foraging habitat assessment results is shown in Table 5.2. The study area is utilised by all three species of Black Cockatoo as foraging habitat, as evidenced by chewed Marri nuts and *Banksia* cones. Signs of feeding Carnaby's Cockatoos and Buadin's Cockatoos were recorded at two sites each (Table 5.2). The most evidence of feeding signs was from the Forest Red-tailed Black Cockatoo (10 sites), and this was the only species of Black Cockatoo to also be observed within the Study Area.

Vegetation mapping depicts that an area of 657.65 ha (out of 1590.78 ha) within the active mining area and a further 6369.97 ha (out of 8469.02 ha) within the remaining lease areas are suitable for foraging habitats for Black Cockatoos.







#### Table 5.2: Summary of foraging habitat assessments for three Black Cockatoo species

Site	Location	GPS Coordinates	Suitable Foraging Habitat	Foraging Resources	Evidence of foraging
MIA-01	Active mining area	50H 414112mE, 6253947mN	FRBC, BC, CC	E. marginata, C. calophylla, Banksia grandis	FRBC
MIA-02	Active mining area	50H 414320mE, 6252631mN	FRBC, BC, CC	E. marginata, C. calophylla, B. grandis	
MIA-03	Active mining area	50H 413685mE, 6252526mN	FRBC, BC, CC	C. calophylla, B. grandis	
MIA-04	Active mining area	50H 413699mE, 6252693mN	FRBC, BC	E. marginata	
MIA-04A	Active mining area	50H 413765mE, 6252570mN	FRBC, BC	E. marginata	
MIA-05	Active mining area	50H 414046mE, 6251612mN	No	None	
MIA-06	Active mining area	50H 414033mE, 6251508mN	FRBC, BC, CC	C. calophylla, Banksia ilicifolia	
MIA-07	Active mining area	50H 415202mE, 6252799mN	FRBC, BC, CC	E. marginata, C. calophylla, Pinus sp.	FRBC
MIA-08	Active mining area	50H 414801mE, 6252890mN	FRBC, BC, CC	E. marginata, C. calophylla, B. grandis	
MIA-09	Active mining area	50H 415212mE, 6252739mN	сс	<i>E. marginata</i> (saplings), <i>C. calophylla</i> (saplings), <i>Banksia</i> spp., <i>Pinus</i> sp.	
MIA-10	Active mining area	50H 414799mE, 6252098mN	FRBC, BC	C. calophylla	
MIA-11	Active mining area	50H 414600mE, 6252098mN	FRBC, BC	E. marginata, C. calophylla, B. grandis	BC
MIA-12	Active mining area	50H 414305mE, 6250485mN	FRBC, BC, CC	C. calophylla, B. grandis	
MIA-13	Active mining area	50H 414572mE, 6252014mN	СС	Eucalyptus plantation	
MIA-14	Active mining area	50H 414212mE, 6251396mN	FRBC, BC, CC	C. calophylla	FRBC
MIA-15	Active mining area	50H 415499mE, 6251598mN	FRBC, BC, CC	E. marginata, C. calophylla	
GRN-16	Remaining lease areas	50H 416500mE, 6254002mN	FRBC, BC, CC	C. calophylla	FRBC, CC
MIA-17	Active mining area	50H 412192mE, 6252986mN	No	None	
MIA-18	Active mining area	50H 411701mE, 6252097mN	FRBC, BC	E. marginata	
MIA-19	Active mining area	50H 411805mE, 6252000mN	FRBC, BC, CC	E. marginata, C. calophylla, Banksia sp.	FRBC
MIA-20	Active mining area	50H 410903mE, 6251501mN	FRBC, BC	E. marginata, C. calophylla	FRBC

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Site	Location	GPS Coordinates	Suitable Foraging Habitat	Foraging Resources	Evidence of foraging
MIA-21	Active mining area	50H 411325mE, 6253558mN	No	None	
MIA-22	Active mining area	50H 411112mE, 6252599mN	FRBC, BC, CC	E. marginata, C. calophylla, Banksia sp.	FRBC
GRN-23	Remaining lease areas	50H 410209mE, 6250294mN	FRBC, BC, CC	E. marginata, C. calophylla, Banksia sp.	FRBC, BC
GRN-24	Remaining lease areas	50H 414803mE, 6256302mN	FRBC, BC	E. marginata	
GRN-25	Remaining lease areas	50H 411511mE, 6257697mN	FRBC, BC, CC	E. marginata, C. calophylla, B. grandis	FRBC, CC
GRN-26	Remaining lease areas	50H 409594mE, 6258613mN	FRBC, BC, CC	<i>E. marginata, C. calophylla, B. grandis, Banksia</i> sp.	FRBC
GRN-27	Remaining lease areas	50H 410075mE, 6255361mN	No	None	
GRN-28	Remaining lease areas	50H 410150mE, 6255445mN	FRBC, BC, CC	E. marginata	

FRBC – Forest Red-tailed Black Cockatoo; BC – Baudin's Cockatoo; CC – Carnaby's Cockatoo





#### 5.2 Breeding Assessment

The locations of all significant habitat trees encountered during the current survey are shown in Figure 5.3 and Appendix I.

A total of 22 tree density assessments were conducted within the active mining area and five within the remaining lease areas. A greater number of significant habitat trees were recorded within the remaining lease areas (188 trees) compared to within the active mining area (173 trees). Both areas had 21 significant habitat trees with hollows, resulting in a high proportion of trees with hollows within the active mining area (12%) compared to within the remaining lease areas (6%). The density of significant habitat trees, however, was much greater on average in the remaining lease areas (27 trees/ha) compared to within the active mining area (11 trees/ha). A higher number of Marri trees (177 trees) than Jarrah trees (137 trees) were recorded as significant habitat trees. A summary of the tree densities is presented in Table 5.4.

Using the breeding habitat classification, most of the areas of remnant native Jarrah-Marri forest is considered potential breeding habitat for Black Cockatoos based on the tree density assessments (Figure 5.3). Out of a total area of 1590.78 ha in the active mining area, an estimated 636.56 ha provide potential breeding habitats for Black Cockatoos, while a further 173.57 ha could be classified as future breeding habitats. Within the general survey area, 4861.46 ha and 316.03 ha could be categorised as potential breeding habitats and future breeding habitats for Black Cockatos for Black Cockatos, respectively.

Using all significant trees recorded within the Study Area (not just in the habitat assessment plots), a total of 75 significant habitat trees had suitable breeding hollows for Black Cockatoos (Appendix J). More hollows were recorded in Marri trees (51 trees) than Jarrah trees (23 trees). The height of hollows above the ground averaged 14.4 m (range 6-25 m) and the DBH of trees containing hollows averaged 106 m (range 50-270 cm). The average width of the hollow entrance was 38 cm (range 15-100 cm) and the depth of the hollows averaged 75 cm (range 30-250 cm). These dimensions of the hollows within the Study Area make them potentially suitable breeding hollows for all three species of Black Cockatoo, although, hollows within the Study Area tended to be higher above the ground than those reported for the Black Cockatoo species (Table 5.3). The total number of habitat (foraging or breeding) for the area is unknown, a tree count will need to take place to determine exact numbers.



## Table 5.3:Comparison of hollow characteristics for Black Cockatoo species with<br/>those recorded within the Study Area

Characteristics of Suitable Breeding Hollows	Height above the ground (m)	Entrance width (cm)	Hollow depth (cm)
Within the Study Area	6-25 (14.4)	15-100 (38)	30-250 (75)
Carnaby's Cockatoo (Saunders, 1979)	2-10 (6.3)	N/A	25-250 (110)
Baudin's Cockatoo (Saunders, 1974)	N/A	30-40	>30
Forest Red-tailed Black Cockatoo (Johnstone and Storr, 1998)	8-14	12-41	100-500







Site	Location	Area of assessment (ha)	Marri trees (50-100 cm)	Marri trees (>100 cm)	Jarrah trees (50-100 cm)	Jarrah trees (>100 cm)	Other trees (50-100 cm)	Other trees (>100 cm)	No. trees/ha	Breeding habitat classification
MIA-01	Active mining area	0.0625	0	0	1(1)	1(1)	0	0	32	Potential breeding habitat
MIA-02	Active mining area	0.0625	0	0	0	0	0	0	0	Non breeding habitat
MIA-03	Active mining area	0.0625	1 (1)	0	0	0	0	0	16	Potential breeding habitat
MIA-04	Active mining area	0.0625	0	0	0	1 (1)	0	0	16	Potential breeding habitat
MIA-04A	Active mining area	0.0625	0	0	0	0	0	0	0	Non breeding habitat
MIA-05	Active mining area	0.0625	0	0	0	0	0	0	0	Non breeding habitat
MIA-06	Active mining area	0.0625	0	1 (1)	0	0	0	0	16	Potential breeding habitat
MIA-07	Active mining area	1	1	0	0	0	0	0	1	Non breeding habitat
MIA-08	Active mining area	1	2	0	6	0	0	0	8	Future breeding habitat
MIA-09	Active mining area	1	0	0	0	0	0	0	0	Non breeding habitat
MIA-10	Active mining area	1	1	1	0	0	0	0	2	Non breeding habitat
MIA-11	Active mining area	1	6	0	1	0	0	0	7	Future breeding habitat
MIA-12	Active mining area	1	14 (3)	5 (1)	5	2	0	0	26	Potential breeding habitat
MIA-13	Active mining area	1	0	0	0	0	0	0	0	Non breeding habitat
MIA-14	Active mining area	1	11 (1)	1 (1)	6	1	0	0	19	Potential breeding habitat
MIA-15	Active mining area	1	15 (1)	0	22 (1)	0	0	1 (1)	38	Potential breeding habitat
GRN-16	Remaining lease areas	1	9	1	2 (1)	2 (1)	0	0	14	Potential breeding habitat
MIA-17	Active mining area	1	0	0	0	0	0	0	0	Non breeding habitat
MIA-18	Active mining area	1	3	0	4	0	0	0	7	Future breeding habitat

#### Table 5.4: Summary of breeding habitat assessments for three Black Cockatoo species

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Site	Location	Area of assessment (ha)	Marri trees (50-100 cm)	Marri trees (>100 cm)	Jarrah trees (50-100 cm)	Jarrah trees (>100 cm)	Other trees (50-100 cm)	Other trees (>100 cm)	No. trees/ha	Breeding habitat classification
MIA-19	Active mining area	1	3 (1)	3 (1)	2	0	0	0	8	Potential breeding habitat
MIA-20	Active mining area	1	14	8 (3)	11	1	0	1	34	Potential breeding habitat
MIA-21	Active mining area	0.0625	0	0	0	0	0	0	0	Non breeding habitat
MIA-22	Active mining area	1	2	0	15 (2)	1	0	0	18	Potential breeding habitat
GRN-23	Remaining lease areas	1	16 (1)	6 (1)	12 (2)	1 (1)	1	0	36	Potential breeding habitat
GRN-24	Remaining lease areas	1	6 (2)	0	31	0	2	0	39	Potential breeding habitat
GRN-25	Remaining lease areas	1	7 (3)	2 (1)	3	1	0	0	13	Potential breeding habitat
GRN-26	Remaining lease areas	1	26 (2)	2 (2)	9 (1)	1 (1)	0	0	38	Potential breeding habitat
GRN-27	Remaining lease areas	0.0625	0	0	0	0	0	0	0	Non breeding habitat
GRN-28	Remaining lease areas	0.0625	2 (1)	0	1 (1)	0	0	0	48	Potential breeding habitat

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Site Number	Survey Type	Zone	Easting	Northing
GRN-27	Habitat assessment	50H	410075	6255361
GRN-28	Habitat assessment	50H	410150	6255445
MIA-01	Habitat assessment	50H	414112	6253947
MIA-02	Habitat assessment	50H	414320	6252631
MIA-03	Habitat assessment	50H	413685	6252526
MIA-05	Habitat assessment	50H	414046	6251612
MIA-04	Habitat assessment	50H	413699	6252693
MIA-04a	Habitat assessment	50H	413765	6252570
MIA-06	Habitat assessment	50H	414033	6251508
MIA-08	Habitat assessment	50H	414801	6252890
MIA-10	Habitat assessment	50H	414799	6252098
MIA-07	Habitat assessment	50H	415202	6252799
MIA-09	Habitat assessment	50H	415212	6252739
MIA-11	Habitat assessment	50H	414600	6252098
MIA-13	Habitat assessment	50H	414572	6252014
MIA-12	Habitat assessment	50H	414305	6250485
MIA-14	Habitat assessment	50H	414212	6251396
MIA-15	Habitat assessment	50H	415499	6251598
GRN-16	Habitat assessment	50H	416500	6254002
MIA-17	Habitat assessment	50H	412192	6252986
MIA-19	Habitat assessment	50H	411805	6252000
MIA-20	Habitat assessment	50H	410903	6251501
MIA-21	Habitat assessment	50H	411325	6253558
MIA-22	Habitat assessment	50H	411112	6252599
GRN-23	Habitat assessment	50H	410209	6250294
MIA-18	Habitat assessment	50H	411701	6252097
GRN-24	Habitat assessment	50H	414803	6256302
GRN-25	Habitat assessment	50H	411511	6257697
GRN-26	Habitat assessment	50H	409594	6258613
MC-01	Motion Camera	50H	411611	6254080
SP-01	Nocturnal	50H	411769	6255198
BD-01	Bat Detector	50H	411730	6254599
MC-02	Motion Camera	50H	410837	6254546
BD-02	Bat Detector	50H	414190	6250556
MC-03	Motion Camera	50H	414359	6250397
SP-02	Nocturnal	50H	414365	6250304
BD-03	Bat Detector	50H	410414	6250194
SP-03	Nocturnal	50H	410414	6250193
MC-04	Motion Camera	50H	410403	6250179

### Appendix A: Location of survey sites within Study Area

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Appendix B:	Foraging and	breeding habitat	for Black C	ckatoos	(DSWEPaC.	2011d)
Appondix Di	i oraging ana	siooanig nasitat	Diable of	001111000	( <b>DOME</b> ) <b>40</b> ,	

	Baudin's Cockatoo	Carnaby's Cockatoo	Forest Red-tailed Black Cockatoo
Breeding season	Aug/Sept to Feb/Mar	July/Aug to Jan/Feb	Oct/Nov, possibly Mar/Apr
Distribution	Eucalypt forests of SW humid and sub-humid zones. From March, flocks migrate north to central and northern parts of the Darling Scarp for non- breeding. Some flocks also move onto southern SCP, Perth hills and south coast.	Semi-arid and sub-humid interior (Wheatbelt) and some locations along the south and west coasts. From late Jan/early Feb leave, moving west, south and east towards the coast.	Endemic to SW humid and sub-humid zones. They are also found on SCP.
Study Area is within	Predicted breeding range	Breeding range	Species may occur
Breeding habitat	Woodland or forest that contains live or dead trees of karri, marri, wandoo or tuart with either a diameter at breast height >500mm or presence of suitable nest hollow.	Woodland or forest that contains live or dead trees of salmon gum, wandoo, tuart, jarrah, flooded gum, karri or marri with either a diameter at breast height >500mm or presence of suitable nest hollow.	Woodland or forest that contains live or dead trees of marri, karri, wandoo, bullich or jarrah with either a diameter at breast height >500mm or presence of suitable nest hollow.
Roosting habitat	Generally in or near riparian environments or natural and artificial permanent water sources. Jarrah, marri, flooded gum, blackbutt, tuart and introduced eucalypts, incl. blue gum and lemon scented gum.	Generally in or near riparian environments or natural and artificial permanent water sources. Flat-topped yate, salmon gum, wandoo, marri, karri, blackbutt, tuart, introduced eucalypts.	Tall jarrah and marri trees within or on the edges of forests.
Foraging habitat	Eucalypt woodlands and forests, and proteaceous woodland and heath. During the breeding season feed primarily on native vegetation, particularly marri. Outside breeding season, may feed in pome fruit orchards and tips of <i>Pinus</i> spp.	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species e.g. <i>Banksia</i> spp., <i>Dryandra</i> spp., <i>Grevillea</i> spp. Forages in pine plantations. Eucalypt woodland and forest that contains foraging species. Also individual trees and small strands of these species.	Jarrah and marri eucalypt woodlands and forest within the range of the subspecies.
Foraging: common food items	Mostly marri (seeds, flowers, nectar and grubs) and proteaceous trees and shrubs. Also other native seeds and introduced fruits; insects and insect larvae; pith of kangaroo paw; juice of ripe persimmons; tips of <i>Pinus</i> spp.	Seeds, flowers and nectar of native proteaceous plant species (e.g. <i>Banksia</i> spp., <i>Dryandra</i> spp., <i>Grevillea</i> spp.) and eucalypts. Also seeds of introduced species including <i>Pinus</i> spp., <i>Erodium</i> spp., wild radish, canola, almonds, and pecan nuts; insects and insect larvae; occasionally flesh and juice of apples and persimmons.	Mostly seeds of marri and jarrah, also <i>Allocasuarina</i> cones. On SCP, often feed on introduced cape lilac ( <i>Melia azedarach</i> ).



#### Appendix C: Bat survey report (Specialised Zoological)



#### SUMMARY

Bat identifications from AnaBat echolocation call recordings are provided from near Greenbushes, Western Australia. At least five species were identified as being present (Table 1).

Some sequences could not be identified reliably to one species. The calls of *Nyctophilus* are typically difficult to identify to species, and those recorded may be attributed to the lesser long-eared bat *Nyctophilus geoffroyi*, Gould's long-eared bat *Nyctophilus gouldi* or the western greater long-eared bat *Nyctophilus major major*.

Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). A summary of pulse parameters is provided in Table 2, and representative call sequences are illustrated in Figure 1. Further data is available should verification be required.

#### METHODS

Signals as recorded with an AnaBat SD1 bat detector were downloaded and examined in AnalookW 3.7w software. The frequency division ratio was set to a factor of 8. Three call variables were measured on good quality search phase pulses in representative call sequences: pulse duration (milliseconds), maximum frequency (kHz) and characteristic frequency (kHz). Species were identified based on information in Fullard et al. (1991). Nomenclature follows Armstrong and Reardon (2006).

#### REFERENCES

- ABS (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australasian Bat Society Newsletter* 27: 6–9. [ISSN 1448-5877]
- Armstrong, K. and Reardon, T. (2006). Standardising common names of bats in Australia. *The Australasian Bat Society Newsletter* 26: 37–42.
- Fullard, J.H., Koehler, C., Surlykke, A. and McKenzie, N.L. (1991). Echolocation ecology and flight morphology of insectivorous bats (Chiroptera) in south-western Australia. *Australian Journal of Zoology* 39: 427–438.



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

		C. gouldii	Mormopterus sp. 4	Nyctophilus sp.	T. australis	V. regulus
Date	Site					
Serial 4868						
14/10/2011	Regrowth jarrah, Site 1	Н	Н		Н	Н
15/10/2011	Mixed jarrah - marri	Н	Н	NC	_	Н
16/10/2011	Mixed jarrah - marri	Н	_	NC	Н	Н

#### Definition of confidence level codes:

H High. Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.
 NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the Summary section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

Species	s,p <sup>1</sup>	Duration Max Frequency (msec) <sup>2</sup> (kHz) <sup>2</sup>		Char frequency (kHz) <sup>2</sup>
Gou attled at	2,31	7.3 ± 2.1	45.3 ± 8.4	30.9 ± 1.1
Chalinolobus gouldii		4.4 – 12.7	33.2 – 59.3	28.8 – 33.9
South-western free-tailed bat	2,15	12.4 ± 2.4	26.5 ± 2.7	24.2 ± 0.5
Mormopterus sp. (sp. 4, pop. O)		9.0 – 15.7	24.5 – 33.6	23.2 – 25.1
Unidentified long-eared bat	3,25	3.1 ± 0.7	55.2 ± 5.6	41.6 ± 3.2
Nyctophilus sp.		2.1 – 4.4	48.2 – 67.2	37.9 – 49.7
White-striped free-tailed bat	2,9	10.7 ± 1.9	18.4 ± 2.0	11.8 ± 0.6
Tadarida australis		8.1 – 13.2	14.0 – 20.5	11.0 – 12.8
Southern forest bat	3,49	6.6 ± 1.2	55.7 ± 9.4	40.6 ± 0.6
Vespadelus regulus		5.0 - 8.9	42.1 – 73.4	39.0 – 42.1

 TABLE 2.
 Summary of variables from representative call sequences.

<sup>1</sup> s,p: number of sequences measured, combined total number of pulses measured;

<sup>2</sup> Mean ± SD; range.





**FIGURE 1**. Representative call sequences of the species identified (time is compressed between pulses).





#### Appendix D: Conservation status codes

#### International Union for Conservation of Nature

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



#### Environment Protection and Biodiversity Conservation Act 1999

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

#### Schedules of the Wildlife Conservation Act 1950

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

#### Department of Environment and Conservation Priority codes

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



#### Appendix E: Fauna recorded in the Study Area and region

#### Mammals

		Conservation Status				Observed
Species	Common Name	EPBC Act	WCA	DEC	IUCN	within Study Area
TACHYGLOSSIDAE						
Tachyglossus aculeatus	Short-beaked Echidna					
DASYURIDAE						
Antechinus flavipes	Yellow-footed Antechinus, Mardo					
Dasyurus geoffroii	Western Quoll, Chuditch	VU	S1		NT	
Phascgale tapaotafa tapaotafa	Southern Brush-tailed Phascogale		S1		NT	+
Phascogale calura	Red-tailed Phascogale	EN	S1		NT	
Sminthopsis gilberti	Gilbert's Dunnart					
Sminthopsis griseoventer	Grey-bellied Dunnart					
PERAMELIDAE						
Isoodon obesulus fusciventer	Southern Brown Bandicoot, Quenda			P5		
MACROPODIDAE						
Macropus fuliginosus	Western Grey Kangaroo					+
Macropus irma	Western Brush Wallaby			P4		
Setonix brachyurus	Quokka	VU	S1		VU	
PHALANGERIDAE						
Trichosurus vulpecula	Common Brushtail Possum					+
BURRAMYIDAE						
Cercartetus concinnus	Western Pygmy-possum					
TARSIPEDIDAE						
Tarsipes rostratus	Honey Possum					
VESPERTILIONIDAE						
Chalinolobus gouldii	Gould's Wattled Bat					+
Chalinolobus morio	Chocolate Wattled Bat					
Falsistrellus mackenziei	Western False Pipistrelle			P4		
Nyctophilus geoffroyi	Lesser Long-eared Bat					?
Nyctophilus gouldi	Gould's Long-eared Bat					?
Nyctophilus major major	Western Greater Long-eared Bat					?
Vespadelus regulus	Southern Forest Bat					+
MOLOSSIDAE						
Mormopterus sp. 4	Southern Freetail-bat					+
Tadarida australis	White-striped Freetail-bat					+
MURIDAE						
Hydromys chrysogaster	Water Rat, Rakali			P4		
*Mus musculus	House Mouse					



		Cons	ervati	atus	Observed	
Species	Common Name	EPBC Act	WCA	DEC	IUCN	within Study Area
Rattus fuscipes	Western Bush Rat					
*Rattus rattus	Black Rat					
LEPORIDAE						
*Oryctolagus cuniculus	Rabbit					+
CANIDAE						
*Canis Iupis	Dog					+
*Vulpes vulpes	Fox					+
FELIDAE						
*Felis catus	Cat					+
SUIDAE						
*Sus scrofa	Pig					
BOVIDAE						
*Bos taurus	European Cattle					+
EQUIDAE						
*Equus caballus	Horse					+



#### Birds

		Conservation Status				Observed
Species	Common Name	EPBC Act	WCA	DEC	IUCN	within Study Area
CASUARIIDAE						
Dromaius novaehollandiae	Emu					+
PHASIANIDAE	•	•				
Coturnix pectoralis	Stubble Quail					
ANATIDAE						
Anas gracilis	Grey Teal					
Anas superciliosa	Pacific Black Duck					+
Biziura lobata	Musk Duck					+
Chenonetta jubuta	Australian Wood Duck					+
Cygnus atratus	Black Swan					+
Tadorna tadornoides	Australian Shelduck					
PODICIPEDIDAE						
Tachybaptus novaehollandiae	Australasian Grebe					
Poliocephalus poliocephalus	Hoary-headed Grebe					
ANHINGIDAE						
Anhinga novaehollandiae	Australasian Darter					
PHALACROCORACIDAE						
Microcarbo melanoleucos	Little Pied Cormorant					+
Phalacrocorax carbo	Great Cormorant					
Phalacrocorax sulcirostris	Little Black Cormorant					+
Phalacrocorax varius	Pied Cormorant					
ARDEIDAE						
Ardea alba	Great Egret	М	S3			
Ardea ibis	Cattle Egret					
Ardea pacifica	White-necked Heron					
Botaurus poiciloptilus	Australasian Bittern	EN	S1		EN	
Ixobrychus flavicollis australis	Black Bittern			P3		
Egretta novaehollandiae	White-faced Heron					
Nycticorax caledonicus	Rufous Night Heron					
THRESKIORNITHIDAE						
Platalea flavipes	Yellow-billed Spoonbill					
Threskiornis molucca	Australian White Ibis					
Threskiornis spinicollis	Straw-necked Ibis					
ACCIPITRIDAE						
Accipiter cirrocephalus	Collared Sparrowhawk					+
Accipiter fasciatus	Brown Goshawk					+
Aquila audax	Wedge-tailed Eagle					



Greenbushes	Level 1	Fauna	Survey

biologic						
		Greenbushes Level 1 Fauna Surve			auna Survey	
		Conservation Status				Observed
Species	Common Name	EPBC Act	WCA	DEC	IUCN	within Study Area
Aquila morphnoides	Little Eagle					
Circus approximans	Swamp Harrier					+
Elanus caeruleus	Black-shouldered Kite					
Haliastur sphenurus	Whistling Kite					
Hamirostra isura	Square-tailed Kite					+
FALCONIDAE					•	
Falco berigora	Brown Falcon					
Falco cenchroides	Australian Kestrel					
Falco longipennis	Australian Hobby					+
Falco peregrinus	Peregrine Falcon		S4			
RALLIDAE	•				•	
Fulica atra	Eurasian Coot					
Gallinula tenebrosa	Dusky Moorhen					
Porphyrio porphyrio	Purple Swamphen					
TURNICIDAE		I				
Turnix varia	Painted Button-quail					
BURHINIDAE	•				1	
Burhinus grallarius	Bush Stone-curlew			P4		
COLUMBIDAE	•				1	
Columba livia	Domestic Pigeon					
Ocyphaps lopphotes	Crested Pigeon					
Phasps chalcoptera	Common Bronzewing					+
Streptopelia senagalensis	Domestic Pigeon					
CACATUIDAE	•				•	
Cacatua sanguinea	Little Corella					
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	S1			+
Calyptorhynchus baudinii	Baudin's Cockatoo	VU	S1		EN	+
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	S1		EN	+
Eolophus roseicapilla	Galah					
PSITTACIDAE		1	I	L		
Glossopsitta porphyrocephala	Purple-crowned Lorrikeet					+
Neophema elegans	Elegant Parrot					+
Platycercus icterotis icterotis	Western Rosella					+
Platycercus spurius	Red-capped Parrot					+
Platycercus zonarius	Australian Ringneck					+
Polytelis anthopeplus	Regent Parrot					
CUCULIDAE						
Cacomantis flabelliformis	Fan-tailed Cuckoo					+
Chrysococcyx basalis	Horsfield's Bronze Cuckoo					
-	L	- 1	I	I	1	1



	Common Name	Cons	ervati	Observed within		
Species		00110				
		EPBC	WCA	DEC	IUCN	Study Area
Chrysococcyx lucidus	Shining Bronze Cuckoo					+
Cuculus pallidus	Pallid Cuckoo					
STRIGIDAE						
Ninox connivens connivens	Barking Owl (southwest population)			P2		
Ninox novaeseelandiae	Southern Boobook Owl					+
TYTONIDAE	<u> </u>	1		1	1	
Tyto alba	Barn Owl					
Tyto novaehollandiae novaehollandiae	Masked Owl (southwest population)			P3		
PODARGIDAE	I			1	1	
Podargus strigoides	Tawny Frogmouth					+
AEGOTHELIDAE						•
Aegotheles cristatus	Australian Owlet-nightjar					+
APODIDAE						•
Apus pacificus	Fork-tailed Swift	М	S3			
HALCYONIDAE						
Dacelo novaeguineae	Laughing Kookaburra					+
Todiramphus sanctus	Sacred Kingfisher					
MEROPIDAE						
Merops ornatus	Rainbow Bee-eater	М	S3			+
CLIMACTERIDAE						
Climacteris rufa	Rufous Treecreeper					+
MALURIDAE						
Malurus splendens	Splendid Fairy-wren					+
Malurus elegans	Red-winged Fariy-wren					+
ACANTHIZIDAE						
Acanthiza apicalis	Broad-tailed (inland) Thornbill					+
Acanthiza chrysorrhoa	Yellow-rumped Thornbill					
Acanthiza inornata	Western Thornbill					+
Gerygone fusca	Western Gerygone					+
Sericornis frontalis	White-browed Scrubwren					+
Smicrornis brevirostris	Weebill					
PARDALOTIDAE						
Pardalotus punctatus	Spotted Pardalote					+
Pardalotus striatus	Striated Pardalote					+
MELIPHAGIDAE						
Acanthorhynchus superciliosus	Western Spinebill					+
Anthochaera carunculata	Red Wattlebird					+
Anthochaera lunulata	Western Little Wattlebird					
Lichenostomus virescens	Singing Honeyeater					

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	Common Name	Cons	Conservation Status				
Species		EPBC Act	WCA	DEC	IUCN	within Study Area	
Lichmera indistincta	Brown Honeyeater					+	
Melithreptus chloropsis	Western white-naped Honeyeater						
Phylidonyris niger	White-cheeked Honeyeater						
Phylidonyris novaehollandiae	New Holland Honeyeater						
PETROICIDAE						•	
Eopsaltria australis griseogularis	Western Yellow Robin					+	
Eopsaltria georgiana	White-breasted Robin					+	
Petroica goodenovii	Red-capped Robin						
Petroica multicolor	Scarlet Robin					+	
POMATOSTOMIDAE						•	
Pomatostomus superciliosus	White-browed Babbler						
NEOSITTIDAE						•	
Daphoenositta chrysoptera	Varied Sittella					+	
PACHYCEPHALIDAE		•			•		
Colluricincla harmonica	Grey Shrike-thrush					+	
Pachycephala pectoralis	Golden Whistler					+	
Pachycephala rufiventris	Rufous Whistler						
DICRURIDAE							
Rhipidura fuliginosa	Grey Fantail					+	
Rhipidura leucophrys	Wille Wagtail					+	
Grallina cyanoleuca	Magpie-lark					+	
ESTRILIDIDAE		•			•		
Stagonopleura oculata	Red-eared Firetail						
CAMPEPHAGIDAE		•			•		
Coracina novaehollandiae	Black-faced Cuckoo-shrike					+	
Lalage sueurii	White-winged Triller						
ARTAMIDAE							
Artamus cinereus	Black-faced Woodswallow						
Artamus cyanopterus	Dusky Woodswallow						
Artamus personatus	Masked Woodswallow					+	
CRACTICIDAE							
Cracticus torquatus	Grey Butcherbird						
Strepera versicolor	Grey Currawong					+	
Cracticus tibicen	Australian Magpie					+	
CORVIDAE							
Corvus coronoides	Australian Raven					+	
HIRUNDINIDAE							
Hirundo neoxena	Welcome Swallow					+	
Hirundo nigricans	Tree Martin					+	

2 1

Greenbushes Level 1 Fauna Survey							
	Common Name	Conservation Status				Observed	
Species		EPBC Act	WCA	DEC	IUCN	within Study Area	
ZOSTEROPIDAE							
Zosterops lateralis	Grey-breasted White-eye, Silvereye					+	
SYLVIIDAE							
Acrocephalus australis	Australian Reed Warbler					+	
Cincloramphus cruralis	Brown Songlark						
Cincloramphus mathewsi	Rufous Songlark						
DICAEIDAE							
Dicaeum hirundinaceum	Mistletoebird					+	
MOTICILLIDAE							
Anthus novaeseelandiae	Australian Pipit						



#### Reptiles

	Common Name	Conservation Status				Observed
Species		EPBC Act	WCA	DEC	IUCN	within Study Area
CHELUIDAE						
Chelodina oblonga	Oblong Turtle					+
AGAMIDAE	•					
Pogona minor minor	Western Bearded Dragon					
DIPLODACTYLIDAE	•					
Diplodactylus polyophthalmus	Military Dragon					
CARPHODACTYLIDAE						
Nephrurus milli	Barking Gecko					
GEKKONIDAE						
Christinus marmoratus	Marbled Gecko					
PYGOPODIDAE						
Aprasia repens	Southwestern Sandplain Worm Lizard					
Lialis burtonis	Keeled Legless Lizard					
Pygopus lepidopodus	Common Scaly Foot					
SCINCIDAE						
Acritoscincus trilineatum	Southwestern Cool Skink					
Cryptoblepharus buchananii	Fence Skink					
Ctenotus catenifer	Chain-striped Heath Ctenotus					
Ctenotus delli	Dell's Skink			P4		
Ctenotus labillardieri	Red-legged Ctenotus					
Egernia kingii	King's Skink					
Egernia napoleonis	Southwestern Crevice Skink					
Hemiergis initialis initialis	Southern Five-toed Mulch Skink					
Hemiergis peronii peronii	Four-toed Mulch Skink					
Lerista distinguenda	Southwestern Four-toed Lerista					
Lerista microtis microtis	Southwestern Five-toed Lerista					
Menetia greyii	Common Dwarf Skink					
Morethia lineoocellata	West Coast Pale-flecked Morethia					
Morethia obscura	Shrubland Pale-flecked Morethia					+
Tiliqua rugosa rugosa	Western Bobtail					+
VARANIDAE						
Varanus rosenbergi	Heath Monitor					+
TYPHLOPIDAE						
Ramphotyphlops australis						
BOIDAE						
Morelia spilota imbricata	South-west Carpet Python		S4	P4		
ELAPIDAE						
Echiopsis curta	Bardick					



Black-backed Hooded Snake

Dugite

Parasuta nigriceps

Pseudonaja affinis


### Amphibians

		Cons	ervatio	on Sta	itus	Observed	
Species	Common Name	EPBC Act	WCA	DEC	IUCN	within Study Area	
MYOBATRACHIDAE							
Crinia georgiana	Quacking Frog					+	
Crinia glauerti	Clicking Frog					+	
Crinia pseudinsignifera	Bleating Froglet						
Crinia subinsignifera	South Coast Froglet						
Geocrinia leai	Ticking Frog						
Heleioporus eyrei	Moaning Frog						
Limnodynastes dorsalis	Western Banjo Frog					+	
Metacrinia nichollsi	Forest Toadlet						
Myobatrachus gouldii	Turtle Frog						
Pseudophryne guentheri	Gunther's Toadlet						
HYLIDAE							
Litoria adelaidensis	Slender Tree Frog					+	
Litoria moorei	Motorbike Frog					+	



#### Appendix F: Results of fauna habitat assessments

	Site Name	MIA-01	MIA-02	MIA-03	MIA-04	MIA-04a	MIA-05	MIA-06	MIA-07	MIA-08	MIA-09	MIA-10	MIA-11	MIA-12	MIA-13	MIA-14
	Date Time	13-10-2011 20:47	13-10-2011 10:42	13-10-2011 13:11	14-10-2011 13:21	14-10-2011 13:54	13-10-2011 14:25	14-10-2011 14:40	15-10-2011 08:23	15-10-2011 08:28	15-10-2011 08:41	15-10-2011 09:43	15-10-2011 09:43	15-10-2011 11:01	15-10-2011 10:02	15-10-2011 12:58
uo	Describing Persons	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	S. Ford;	S. Ford;	J. Oates;	S. Ford;	J. Oates; S. Ford;	S. Ford;	J. Oates; S. Ford;	S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;
rmati	Location (WGS84)	50H 414112 6253947	50H 414320 6252631	50H 413685 6252526	50H 413699 6252693	50H 413765 6252570	50H 414046 6251612	50H 414033 6251508	50H 415202 6252799	50H 414801 6252890	50H 415212 6252739	50H 414799 6252098	50H 414600 6252098	50H 414305 6250485	50H 414572 6252014	50H 414212 6251396
ufo	Area Dimensions (m)	25	25	25	25	25	25	25	100	100	100	100	100	100	100	100
Site I	Site Comments	small pocket win mine site	strip win minesite	strip within mine site	Fragmented		small pocket within minesite	Large fragment	large patch regrowth, gps from sw corner	Small fragment	small patch of early stage rehabilitation, gps from nw corner	NW corner. Small cleared area.	small pocket within active mining area	lqrge area about to be logged	small pocket	small patch win mine
	Disturbance	Complete clearing;	Complete clearing; Fire damage (1-5 years ago);	Weed infected; Complete clearing; Fire damage (1-5 years ago);	Extensive clearing; Fire damage (1-5 years ago);	Extensive clearing;	Highly weed infected; Extensive clearing;	Extensive clearing;	Regrowth; Weed infected;	Regrowth;	Rehabilitated; Weed infected;	Rehabilitated; Extensive clearing; Fire damage (1-5 years ago);	Rehabilitated; Regrowth; Weed infected; Highly weed infected; Limited clearing; Fire damage (less than 1 year ago);	Regrowth;	Rehabilitated; Weed infected;	Regrowth; Weed infected; Limited clearing; Fire damage (less than 1 year ago);
	Vegetation Condition, Growth, Stage	Advanced regeneration	Advanced regeneration	Advanced regeneration	Early regeneration	Uneven age	Early regeneration	Uneven age	Advanced regeneration	Advanced regeneration	Early regeneration	Uneven age	Advanced regeneration	Advanced regeneration	Advanced regeneration	Advanced regeneration
	Leaf Litter	70-100%	30-70%	70-100%	30-70%	2-10%	0-2%	2-10%	70-100%	70-100%	2-10%	10-30%	30-70%	70-100%	30-70%	30-70%
	Wood Litter	10-30%	10-30%	10-30%	2-10%	2-10%	0-2%	2-10%	30-70%	2-10%	2-10%	2-10%	2-10%	30-70%	10-30%	10-30%
	Dead Stags	0	1	0	5	1	0	1	0		0	0	0	0	0	1
	Significant Trees	2	0	1	1	0	0	1	1	8	0	2	7	26	0	19
	Hollow Bearing Trees	2	0	0	0	0	0	1	0	0	0	0	0	4	0	2
Vegetation	Broad Floristic Formation	low jarrah open forest over mid open shrubland over bracken fern	low open regrowth jarrah forest over euc saplings over macrozamia and herbs	low open regrowth marri/jarrah forest over banksia grandis over bracken fern	jarrah woodland	open eucalyptus woodland	scattered planted eucs over pampas grass and typha	marri open woodland over Banksia illcifolia over mixed herbs and sedges	low open regrowth jarrah forest over acacia sp mid open shrubland over herbs and isolated clumps of gladiolus	Open medium jarrah/marri forrest over medium open shrubs	low marri/jarrah saplings over mixed proteaceous/m yrtaceous low open shrubland	low open eucalyptus woodland over herbs	low open regrowth marri forest over mid open shrubland over herbs	low open marri forest over open jarah/b. grandis open over woodland over mixed shrubland over mixed herbs	wandoo? open woodland over Acacia sp. md open shrubland over herbs	low open regrowth marri/jarrah forest over saplings over mixed herbs and grasses
	Tree Structure Tall	None	None	None	None	None	None	Open woodland	None	None	None	None	None	None	None	None
	Tree Structure Mid	Isolated trees	None	None	Isolated trees	None	None	Open woodland	None	Open forest	None	None	None	Open forest	None	None
	Tree Structure Low	Open forest	Open forest	Open forest	Open woodland	Open woodland	Isolated trees	Open woodland	Open forest	Woodland	Open woodland	Open woodland	Open forest	Open woodland	Open forest	Open forest
	Shrub Structure Tall	None	None	None	None	None	None	shrubs	None	shrubland	None	None	shrubland	None	None	None
	Shrub Structure Mid	Open shrubland	None	None	Open shrubland	clumps of shrubs	None	Sparse shrubland	Open shrubland	None	None	None	Sparse shrubland	Open shrubland	Open shrubland	Isolated shrubs
	Shrub Structure Low	Open shrubland	Isolated shrubs	None	None	None	None	Open shrubland	Open shrubland	Open shrubland	Open shrubland	None	None	Sparse shrubland	Open shrubland	Isolated shrubs
	Grass Structure Tall	None	None	None	None	Isolated grasses	Open grassland	Isolated grasses	None	None	None	None	None	None	None	None
	Grass Structure Mid	None	None	None	None	None	Open grassland	None	None	None	None	None	None	None	None	None
	Grass Structure Low	None	None	None	None	Isolated clumps of	Open grassland	Isolated clumps of	None	None	None	None	None	Isolated clumps of	None	Isolated grasses

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	Site Name	MIA-01	MIA-02	MIA-03	MIA-04	MIA-04a	MIA-05	MIA-06	MIA-07	MIA-08	MIA-09	MIA-10	MIA-11	MIA-12	MIA-13	MIA-14
						grasses		grasses						grasses		
	Dominant Tree Species	Jarrah;	Jarrah;	Marri;	Jarrah;	Jarrah;	None	Marri;	Jarrah;	Jarrah; Marri;	Jarrah; Marri;	Marri;	Marri;	Marri;	Wandoo;	Marri;
	Dominant Shrub Species	bossia linefolia, banksia grandis	banksia grandi	b. grandis	Ferns	Bracken		Bossia lin. , Banksia illi	Acacia sp., Bossiea lin.	Boodonia?, Macrozamia	banksia sp, bossiea sp.		unknown,soft gren not proteaceous	b. grandis, persoonia	Acacia sp.	
	Dominant Grass Species		macrozamia ridlei		N/A	Pampas, sedges	typha and pampas grass	Unknown					bracken fern			xanthhorhea sp.
	Vegetation Comments	marri scattered trees				Non-natives cleared area			scattered pine, marri	Sedges, Banksia grandis in some parts.	scattered pine	Soft herb layer dominates ground cover	some jarrah, isolated B. grandis			
	Animals Present	Red-tailed Black- Cockatoo		Unknown					Red-tailed Black- Cockatoo				Baudin's Black- Cockatoo			Red-tailed Black- Cockatoo
	Signs	Feeding debris;		Feeding debris;					Feeding debris;				Feeding debris;			Feeding debris;
	Comments	marri nuts							marri nuts				marri nuts			marri nuts
una	Animals Present								Red-tailed Black- Cockatoo				wg kangaroos			
Ë	Signs								Feeding debris;				Feeding debris;			
	Comments								marri nuts							
	Animals Present															
	Signs															
	Comments															



Site	Name	MIA-15	GRN-16	MIA-17	MIA-18	MIA-19	MIA-20	MIA-21	MIA-22	GRN-23	GRN-24	GRN-25	GRN-26	GRN-27	GRN-28
	Date Time	15-10-2011 14:11	15-10-2011 15:22	16-10-2011 08:13	16-10-2011 08:48	16-10-2011 08:29	16-10-2011 10:09	16-10-2011 11:20	16-10-2011 11:41	16-10-2011 14:47	17-10-2011 08:14	17-10-2011 09:33	17-10-2011 10:09	13-10-2011 02:11	13-10-2011 02:20
n	Describing Persons	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;	J. Oates; S. Ford;
rmatio	Location (WGS84)	50H 415499 6251598	50H 416500 6254002	50H 412192 6252986	50H 411701 6252097	50H 411805 6252000	50H 410903 6251501	50H 411325 6253558	50H 411112 6252599	50H 410209 6250294	50H 414803 6256302	50H 411511 6257697	50H 409594 6258613	50H 410075 6255361	50H 410150 4255445
nfo	Area Dimensions (m)	100	100	100	100	100	100	25	100	100	100	100	100	25	25
Site I	Site Comments	large fragment	large patch	small marsh	Moderate fragment	large pocket within minesite	large area	small patch	large area	large area outside mining leas	small patch,trees stresed due to fire		large area outside active mining area, tree health due to fire	minimal	widespread
	Disturbance	Regrowth; Weed infected; Limited clearing; Fire damage (5- 10 years ago);	Rehabilitated; Weed infected; Limited clearing; Fire damage (1- 5 years ago);	Highly weed infected; Limited clearing;	Rehabilitated;	Rehabilitated; Weed infected; Complete clearing; Fire damage (1-5 years ago);	Rehabilitated; Weed infected; Complete clearing; Fire damage (1-5 years ago);	Weed infected; Limited clearing;	Regrowth; Weed infected; Complete clearing; Fire damage (1-5 years ago);	Regrowth; Weed infected; Limited clearing; Fire damage (less than 1 year ago);	Regrowth; Weed infected; Limited clearing; Fire damage (less than 1 year ago);	Regrowth; Weed infected; Extensive clearing; Fire damage (less than 1 year ago);	Regrowth; Weed infected; Complete clearing; Fire damage (1-5 years ago);	Limited clearing;	Complete clearing;
	Vegetation Condition, Growth, Stage	Advanced regeneration	Advanced regeneration	Advanced regeneration	Advanced regeneration	Advanced regeneration	Advanced regeneration	Mature phase	Advanced regeneration	Early regeneration	Advanced regeneration	Advanced regeneration	Advanced regeneration	Advanced regeneration	Advanced regeneration
	Leaf Litter	30-70%	30-70%	0-2%	30-70%	70-100%	70-100%	0-2%	30-70%	70-100%	30-70%	30-70%	10-30%	0-2%	30-70%
	Wood Litter	10-30%	10-30%	0-2%	2-10%	10-30%	30-70%	0-2%	30-70%	10-30%	10-30%	10-30%	10-30%	0-2%	2-10%
	Dead Stags	0	0	0	1	0	2	0	0	1	3	0	6	0	2
	Significant Trees	39	14	0	7	8	35	0	18	37	44	13	38	0	2
	Hollow Bearing	3	1	0	0	2	6	0	2	5	2	2	2	0	1
Vegetation	Broad Floristic Formation	low open regrowth marri/jarrah forest over acacia mid open shrubland over grasses and herbs	low open regrowth marri forest over low sparse shrubland over grasses and herbs	typha sp. and pampas grassland	low-medium Jarrah woodland over low open shrubs and grasses	low open regrowth marri/jarrah forest over euc saplings, scattered persoonia over open low proteaceous shrubland over mixed herbs and grasses	low open regrowth marri/jarrah forest over euc saplings and low proteaceous shrubland and Taxandria mid shrubland clumps of sedges and bracken fern, and mixed herbs	scattered b. ilicifolia over taxandria sp mid closed shrubland over sedgeland	low open jarrah/marri regrowth forest over euc saplings	low open regrowth marri/jarrah forest over euc saplings over proteaceous low open shrubland over tall isolated clumps of Xanthorroea sp. over low mixed herbs and grasses	low open jarrah/marri regrowth forest over low open shrubland over mixed herbs and grasses	low open regrowth jarrah/marri forest over lowb. grandis open woodland over mixed low open proteaceous shrubland over tall Xanthorhhoea sp. over mixed herb and grasses	low open regrowth jarrah/marri forest over B.gradis and B. lin tall open hrubland over low open mixed proteaceous shrubland over tall xanth sp. scattered rees over mixed herbs and grasses	low open shrubland over mixed herbs	low jarrah forest over mid proteaceous shrubland over mixed herbs
	Tree Structure Tall	None	None	None	None	None	None	None	None	None	None	None	None	None	None
	Tree Structure Mid	None	None	None	Open woodland	None	None	None	None	None	None	None	None	None	Isolated trees
	Tree Structure Low	Open forest	Open forest	None	Open woodland	Open forest	Open forest	Isolated trees	Open forest	Open forest	Open forest	Open forest	Open forest	Isolated trees	Open forest
	Shrub Structure Tall	None	None	None	None	None	None	None	None	None	None	None	Open shrubland	None	None
	Shrub Structure Mid	Open shrubland	None	None	None	None	None	Closed shrubland	None	None	None	None	None	None	Shrubland
	Shrub Structure Low	Open shrubland	Sparse shrubland	None	Open shrubland	Open shrubland	Open shrubland	None	Sparse shrubland	Open shrubland	Open shrubland	Open shrubland	Open shrubland	Open shrubland	Shrubland
	Grass Structure Tall	None	None	Closed grassland	Isolated grasses	None	None	None	None	Isolated clumps of grasses	None	Isolated grasses	Isolated grasses	None	Isolated grasses
	Grass Structure Mid	None	None	None	Open grassland	None	None	grassland	None	None	None	None	None	None	None
	Grass Structure Low	Isolated clumps of grasses	Isolated clumps of grasses	None	None	Isolated clumps of grasses	Isolated clumps of grasses	None	Isolated clumps of grasses	Isolated clumps of grasses	Isolated grasses	Isolated clumps of grasses	Isolated clumps of grasses	None	None
	Species	Jarrah; Marri;	Marri;	Jarrah; Marri;	Jarrah;	Jarrah; Marri;	Jarrah; Marri;		Jarrah; Marri;	Jarrah; Marri;	Jarrah;	Jarrah; Marri;	Jarrah; Marri;	Jarrah;	Jarrah;
	Dominant Shrub Species	Acacia sp.			Uunknown low shrub	persoonia sp., Banksia ground cover, Acacia stick, Hibbertia	Taxandria sp.,Banksia ground cover, Adenanthos sp.,	taxandria sp.	Hibbertia sp., B. ground cover, Gastrolobium sp.,	Hibbertia sp., Banksia ground cover	Hibbertia sp.	b. grandis,persoon ia long., taxandria sp.,	B. grandis, B. lin, Hibbertia sp., acacia fern leaf		

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Site	Name	MIA-15	GRN-16	MIA-17	MIA-18	MIA-19	MIA-20	MIA-21	MIA-22	GRN-23	GRN-24	GRN-25	GRN-26	GRN-27	GRN-28
						sp.	Acacia stick, Hibbertia sp., Gastrolobium sp.					hibbertia sp 1, sp2			
	Dominant Grass Species	Xanthorhhea sp.	macrozamia ridlei	typha sp., pampas grass	Xanthorrhoea sp.	xanthorhhoea sp., Macrozamia ridlei	Xanthorrhoea sp.k Macrozamia ridlei	sedge cyperus	Xanthorhoea sp., Macrozamia ridlei	Xanthorhhoea sp., Macrozamia ridlei	Macrozamia ridlei	xanthorhhoea sp.	Xanthorhhoea sp., Macrozamia ridlei, bracken fern		xanthorhhea
	Vegetation Comments									all stresed trees due to fire				granite outcropping, not suitable bc foraging	logged, foraging habitat all 3 species BC
	Animals Present		Red-tailed Black-Cockatoo			Red-tailed Black-Cockatoo	Red-tailed Black-Cockatoo		Red-tailed Black-Cockatoo	Baudin's Black- Cockatoo		Carnaby's Black-Cockatoo	Red-tailed Black-Cockatoo		
	Signs		Feeding debris;			Feeding debris;	Feeding debris;		Feeding debris;	Feeding debris;		Feeding debris;	Feeding debris;		
	Comments		mari nuts			mari nuts	mari nuts		mari nuts	mari nuts		bankia cones	marri nuts		
Ina	Animals Present		Carnaby's Black-Cockatoo							Red-tailed Black-Cockatoo		Red-tailed Black-Cockatoo			
Fau	Signs		Feeding debris;							Feeding debris;		Feeding debris;			
	Comments		banksia cones							mari nuts		marri nuts			
	Animals Present		Baudin's Black- Cockatoo												
	Signs		Feeding debris;												
	Comments		marri nuts												



Species	Observation	Zone	Easting	Northing
Baudin's Cockatoo	Feeding signs	50H	414010	6253743
Baudin's Cockatoo	Feeding signs	50H	414892	6252856
Baudin's Cockatoo	Feeding signs	50H	411581	6257642
Carnaby's Cockatoo	Feeding signs	50H	414009	6253797
Carnaby's Cockatoo	Feeding signs	50H	414288	6251331
Carnaby's Cockatoo	Feeding signs	50H	414227	6250398
Carnaby's Cockatoo	Feeding signs	50H	414222	6250396
Rainbow Bee-eater	Call	50H	414262	6250545
Forest Red-tailed Black Cockatoo	Individuals (2)	50H	411267	6251655
Forest Red-tailed Black Cockatoo	Individuals (4)	50H	414229	6250396
Forest Red-tailed Black Cockatoo	Individuals (7)	50H	410012	6255236
Forest Red-tailed Black Cockatoo	Individuals (7)	50H	411753	6253814
Forest Red-tailed Black Cockatoo	Feeding signs	50H	414897	6252066
Forest Red-tailed Black Cockatoo	Call	50H	415005	6252851
Forest Red-tailed Black Cockatoo	Individuals (2)	50H	413024	6254204
Forest Red-tailed Black Cockatoo	Feeding signs	50H	411581	6257643
Forest Red-tailed Black Cockatoo	Feeding signs	50H	409690	6258621
Southern Brush-tailed Phascogale	Individual	50H	414209	6250502
Red-tailed Black-Cockatoo	Feeding signs	50H	414112	6253947
Red-tailed Black-Cockatoo	Feeding signs	50H	415202	6252799
Baudin's Black-Cockatoo	Feeding signs	50H	414600	6252098
Red-tailed Black-Cockatoo	Feeding signs	50H	414212	6251396
Red-tailed Black-Cockatoo	Feeding signs	50H	416500	6254002
Red-tailed Black-Cockatoo	Feeding signs	50H	411805	6252000
Red-tailed Black-Cockatoo	Feeding signs	50H	410903	6251501
Red-tailed Black-Cockatoo	Feeding signs	50H	411112	6252599
Baudin's Black-Cockatoo	Feeding signs	50H	410209	6250294
Carnaby's Black-Cockatoo	Feeding signs	50H	411511	6257697
Red-tailed Black-Cockatoo	Feeding signs	50H	409594	6258613
Carnaby's Black-Cockatoo	Feeding signs	50H	416500	6254002
Red-tailed Black-Cockatoo	Feeding signs	50H	410209	6250294
Red-tailed Black-Cockatoo	Feeding signs	50H	411511	6257697

### Appendix G: Locations of conservation significant fauna recorded



### Appendix H: Locations of significant habitat trees recorded

Tree	Species	Zone	Easting	Northing
Significant tree	Marri	50H	410104	6255355
Significant tree (with hollow)	Jarrah	50H	410120	6255360
Significant tree (with hollow)	Marri	50H	410194	6255406
Significant tree (with hollow)	Jarrah	50H	414034	6253906
Significant tree (with hollow)	Jarrah	50H	414030	6253881
Significant tree (with hollow)	Marri	50H	413988	6253861
Significant tree (with hollow)	Marri	50H	414006	6253854
Significant tree (with hollow)	Jarrah	50H	414020	6253844
Significant tree (with hollow)	Marri	50H	413981	6253834
Significant tree (with hollow)	Marri	50H	413982	6253817
Significant tree (with hollow)	Marri	50H	414015	6253744
Significant tree (with hollow)	Marri	50H	414031	6253748
Significant tree (with hollow)	Jarrah	50H	414277	6252573
Significant tree (with hollow)	Marri	50H	414346	6252413
Significant tree (with hollow)	Marri	50H	414386	6252401
Significant tree (with hollow)	Marri	50H	414374	6252463
Significant tree (with hollow)	Marri	50H	414399	6252380
Significant tree (with hollow)	Jarrah	50H	414401	6252435
Significant tree (with hollow)	Jarrah	50H	414416	6252485
Significant tree (with hollow)	Marri	50H	414354	6252485
Significant tree (with hollow)	Marri	50H	413644	6252609
Significant tree (with hollow)	Marri	50H	413625	6252643
Significant tree (with hollow)	Jarrah	50H	413657	6252533
Significant tree (with hollow)	Jarrah	50H	413660	6252522
Significant tree (with hollow)	Marri	50H	413690	6252473
Significant tree (with hollow)	Marri	50H	414084	6251445
Significant tree (with hollow)	Marri	50H	415573	6251555
Significant tree (with hollow)	unknown	50H	415563	6251532
Significant tree (with hollow)	Jarrah	50H	416572	6253944
Significant tree (with hollow)	Marri	50H	414329	6250478
Significant tree (with hollow)	Marri	50H	414345	6250479
Significant tree (with hollow)	Marri	50H	414361	6250403
Significant tree (with hollow)	Marri	50H	414364	6250401
Significant tree (with hollow)	Marri	50H	414263	6251312
Significant tree (with hollow)	Marri	50H	414288	6251312
Significant tree (with hollow)	Marri	50H	415500	6251570
Significant tree (with hollow)	Jarrah	50H	415561	6251520
Significant tree (with hollow)	Jarrah	50H	416559	6253956
Significant tree (with hollow)	Marri	50H	411898	6251905

Tree	Species	Zone	Easting	Northing
Significant tree (with hollow)	Marri	50H	411831	6251946
Significant tree (with hollow)	Marri	50H	410912	6251502
Significant tree (with hollow)	Jarrah	50H	410905	6251485
Significant tree (with hollow)	Marri	50H	410952	6251471
Significant tree (with hollow)	Marri	50H	410926	6251453
Significant tree (with hollow)	Jarrah	50H	411125	6252493
Significant tree (with hollow)	Jarrah	50H	410227	6250258
Significant tree (with hollow)	Marri	50H	410238	6250227
Significant tree (with hollow)	Jarrah	50H	410971	6251455
Significant tree (with hollow)	Jarrah	50H	411157	6252588
Significant tree (with hollow)	Marri	50H	410282	6250210
Significant tree (with hollow)	Jarrah	50H	410294	6250216
Significant tree (with hollow)	Jarrah	50H	410287	6250304
Significant tree (with hollow)	Marri	50H	411506	6257619
Significant tree (with hollow)	Marri	50H	411569	6257610
Significant tree (with hollow)	Marri	50H	409648	6258568
Significant tree (with hollow)	Marri	50H	409626	6258514
Significant tree (with hollow)	Marri	50H	414889	6256255
Significant tree (with hollow)	Marri	50H	414884	6256231
Significant tree (with hollow)	Marri	50H	411566	6257647
Significant tree (with hollow)	Marri	50H	411598	6257646
Significant tree (with hollow)	Jarrah	50H	409659	6258581
Significant tree (with hollow)	Marri	50H	409670	6258551
Significant tree (with hollow)	Marri	50H	409657	6258518
Significant tree (with hollow)	Jarrah	50H	409643	6258525
Significant tree	Marri	50H	410140	6255356
Significant tree	Jarrah	50H	410290	6255417
Significant tree	Jarrah	50H	409888	6252170
Significant tree	Marri	50H	414032	6253914
Significant tree	Jarrah	50H	414039	6253920
Significant tree	Jarrah	50H	414036	6253884
Significant tree	Jarrah	50H	414042	6253886
Significant tree	Jarrah	50H	414049	6253891
Significant tree	Jarrah	50H	414021	6253833
Significant tree	Jarrah	50H	413999	6253824
Significant tree	Jarrah	50H	413965	6253823
Significant tree	Marri	50H	413953	6253821
Significant tree	Marri	50H	413942	6253854
Significant tree	Marri	50H	413940	6253850
Significant tree	Jarrah	50H	413929	6253814
Significant tree	Marri	50H	413985	6253799
Significant tree	Marri	50H	414023	6253781

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Tree	Species	Zone	Easting	Northing
Significant tree	Jarrah	50H	414052	6253770
Significant tree	Jarrah	50H	414022	6253726
Significant tree	Marri	50H	414046	6253747
Significant tree	Marri	50H	414034	6253734
Significant tree	Marri	50H	414065	6253757
Significant tree	Marri	50H	414082	6253800
Significant tree	Jarrah	50H	414292	6252562
Significant tree	Jarrah	50H	414257	6252522
Significant tree	Jarrah	50H	414259	6252507
Significant tree	Marri	50H	414250	6252490
Significant tree	Jarrah	50H	414272	6252436
Significant tree	Jarrah	50H	414365	6252460
Significant tree	Jarrah	50H	414297	6252470
Significant tree	Marri	50H	414288	6252437
Significant tree	Jarrah	50H	414318	6252420
Significant tree	Marri	50H	414359	6252385
Significant tree	Jarrah	50H	414356	6252411
Significant tree	Marri	50H	414355	6252411
Significant tree	Marri	50H	414344	6252446
Significant tree	Jarrah	50H	414405	6252361
Significant tree	Jarrah	50H	414427	6252278
Significant tree	Jarrah	50H	414375	6252496
Significant tree	Jarrah	50H	414357	6252492
Significant tree	Marri	50H	414320	6252503
Significant tree	Marri	50H	414304	6252525
Significant tree	Marri	50H	414348	6252610
Significant tree	Marri	50H	413669	6252519
Significant tree	Marri	50H	413609	6252631
Significant tree	Marri	50H	413621	6252675
Significant tree	Jarrah	50H	413667	6252502
Significant tree	Jarrah	50H	413670	6252487
Significant tree	Marri	50H	413681	6252482
Significant tree	Marri	50H	413711	6252422
Significant tree	Marri	50H	413680	6252453
Significant tree	Jarrah	50H	414309	6252454
Significant tree	Jarrah	50H	414341	6252451
Significant tree	Jarrah	50H	414343	6252421
Significant tree	Marri	50H	414376	6252421
Significant tree	Marri	50H	414392	6252415
Significant tree	Marri	50H	414406	6252392
Significant tree	Marri	50H	414419	6252326
Significant tree	Jarrah	50H	414404	6252430

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Tree	Species	Zone	Easting	Northing
Significant tree	Jarrah	50H	414396	6252431
Significant tree	Jarrah	50H	414376	6252464
Significant tree	Marri	50H	414345	6252476
Significant tree	Marri	50H	414330	6252480
Significant tree	Jarrah	50H	414318	6252482
Significant tree	Marri	50H	413694	6252697
Significant tree	Marri	50H	413807	6252733
Significant tree	Jarrah	50H	413813	6252680
Significant tree	Marri	50H	413784	6252673
Significant tree	Marri	50H	413774	6252672
Significant tree	Marri	50H	413800	6252654
Significant tree	Marri	50H	413810	6252640
Significant tree	Marri	50H	413806	6252635
Significant tree	Jarrah	50H	413800	6252563
Significant tree	Jarrah	50H	413739	6252605
Significant tree	Marri	50H	414027	6251504
Significant tree	Marri	50H	414050	6251486
Significant tree	Jarrah	50H	414787	6252891
Significant tree	Jarrah	50H	414772	6252890
Significant tree	Jarrah	50H	414728	6252873
Significant tree	Marri	50H	414726	6252862
Significant tree	Jarrah	50H	414707	6252862
Significant tree	Marri	50H	414707	6252856
Significant tree	Jarrah	50H	414737	6252826
Significant tree	Jarrah	50H	414762	6252859
Significant tree	Marri	50H	414883	6252093
Significant tree	Marri	50H	414861	6252015
Significant tree	Jarrah	50H	414346	6250490
Significant tree	Jarrah	50H	414354	6250501
Significant tree	Jarrah	50H	414363	6250487
Significant tree	Jarrah	50H	414379	6250479
Significant tree	Marri	50H	414377	6250483
Significant tree	Marri	50H	414368	6250464
Significant tree	Jarrah	50H	414366	6250461
Significant tree	Marri	50H	414381	6250453
Significant tree	Marri	50H	414386	6250447
Significant tree	Jarrah	50H	414389	6250446
Significant tree	Marri	50H	414383	6250437
Significant tree	Marri	50H	414385	6250422
Significant tree	Marri	50H	414392	6250419
Significant tree	Marri	50H	414400	6250412
Significant tree	Marri	50H	414357	6250437

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Tree	Species	Zone	Easting	Northing
Significant tree	Marri	50H	414275	6251387
Significant tree	Marri	50H	414277	6251387
Significant tree	Marri	50H	414289	6251374
Significant tree	Jarrah	50H	414281	6251358
Significant tree	Marri	50H	414290	6251352
Significant tree	Jarrah	50H	414256	6251343
Significant tree	Marri	50H	414286	6251332
Significant tree	Jarrah	50H	414296	6251338
Significant tree	Jarrah	50H	415561	6251578
Significant tree	Jarrah	50H	415576	6251583
Significant tree	Jarrah	50H	415583	6251584
Significant tree	Jarrah	50H	415597	6251571
Significant tree	Jarrah	50H	415585	6251565
Significant tree	Jarrah	50H	415560	6251560
Significant tree	Jarrah	50H	415565	6251555
Significant tree	Jarrah	50H	415588	6251549
Significant tree	Jarrah	50H	415589	6251544
Significant tree	Jarrah	50H	415568	6251545
Significant tree	Jarrah	50H	415568	6251531
Significant tree	Marri	50H	415575	6251524
Significant tree	Marri	50H	415579	6251523
Significant tree	Jarrah	50H	415581	6251514
Significant tree	Jarrah	50H	415590	6251496
Significant tree	Marri	50H	416562	6253940
Significant tree	Marri	50H	416559	6253930
Significant tree	Jarrah	50H	416564	6253920
Significant tree	Marri	50H	416590	6253926
Significant tree	Marri	50H	415152	6252906
Significant tree	Marri	50H	414675	6252024
Significant tree	Marri	50H	414659	6252030
Significant tree	Jarrah	50H	414667	6252051
Significant tree	Marri	50H	414610	6252015
Significant tree	Marri	50H	414632	6252011
Significant tree	Marri	50H	414638	6252022
Significant tree	Marri	50H	414659	6252000
Significant tree	Marri	50H	414333	6250480
Significant tree	Marri	50H	414339	6250465
Significant tree	Marri	50H	414349	6250456
Significant tree	Marri	50H	414361	6250443
Significant tree	Marri	50H	414358	6250405
Significant tree	Jarrah	50H	414339	6250390
Significant tree	Marri	50H	414335	6250391

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Tree	Species	Zone	Easting	Northing
Significant tree	Marri	50H	414230	6251393
Significant tree	Marri	50H	414241	6251383
Significant tree	Jarrah	50H	414240	6251365
Significant tree	Jarrah	50H	414243	6251338
Significant tree	Marri	50H	414233	6251336
Significant tree	Marri	50H	414264	6251326
Significant tree	Jarrah	50H	414269	6251332
Significant tree	Jarrah	50H	414237	6251303
Significant tree	Marri	50H	414222	6251295
Significant tree	Jarrah	50H	415518	6251591
Significant tree	Jarrah	50H	415513	6251586
Significant tree	Marri	50H	415502	6251576
Significant tree	Marri	50H	415507	6251568
Significant tree	Marri	50H	415513	6251557
Significant tree	Jarrah	50H	415521	6251558
Significant tree	Marri	50H	415516	6251551
Significant tree	Marri	50H	415507	6251532
Significant tree	Jarrah	50H	415506	6251525
Significant tree	Jarrah	50H	415499	6251527
Significant tree	Marri	50H	415506	6251524
Significant tree	Marri	50H	415517	6251556
Significant tree	Marri	50H	415528	6251556
Significant tree	Marri	50H	415544	6251550
Significant tree	Jarrah	50H	415559	6251518
Significant tree	Jarrah	50H	415539	6251497
Significant tree	Jarrah	50H	415514	6251495
Significant tree	Marri	50H	415566	6251492
Significant tree	Marri	50H	415576	6251501
Significant tree	Marri	50H	415576	6251505
Significant tree	Marri	50H	416550	6253972
Significant tree	Marri	50H	416515	6253939
Significant tree	Marri	50H	416522	6253936
Significant tree	Marri	50H	416522	6253920
Significant tree	Marri	50H	416555	6253916
Significant tree	Jarrah	50H	416533	6253905
Significant tree	Marri	50H	416525	6253900
Significant tree	Marri	50H	416570	6253905
Significant tree	Marri	50H	411807	6251990
Significant tree	Marri	50H	411822	6251951
Significant tree	Jarrah	50H	411846	6251965
Significant tree	Marri	50H	411834	6251972
Significant tree	Marri	50H	411802	6251970

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Tree	Species	Zone	Easting	Northing
Significant tree	Jarrah	50H	411811	6251987
Significant tree	Marri	50H	410908	6251490
Significant tree	Marri	50H	410907	6251481
Significant tree	Jarrah	50H	410926	6251478
Significant tree	Marri	50H	410932	6251479
Significant tree	Jarrah	50H	410934	6251476
Significant tree	Marri	50H	410942	6251476
Significant tree	Marri	50H	410955	6251487
Significant tree	Marri	50H	410944	6251463
Significant tree	Jarrah	50H	410942	6251464
Significant tree	Jarrah	50H	410935	6251461
Significant tree	Marri	50H	410921	6251442
Significant tree	Jarrah	50H	410905	6251428
Significant tree	Marri	50H	410916	6251417
Significant tree	Marri	50H	410938	6251427
Significant tree	Marri	50H	410936	6251415
Significant tree	Jarrah	50H	410943	6251417
Significant tree	Blackbutt	50H	410951	6251410
Significant tree	Jarrah	50H	411124	6252552
Significant tree	Jarrah	50H	411104	6252553
Significant tree	Jarrah	50H	411119	6252539
Significant tree	Jarrah	50H	411126	6252536
Significant tree	Jarrah	50H	411132	6252515
Significant tree	Jarrah	50H	411121	6252501
Significant tree	Jarrah	50H	411110	6252506
Significant tree	Jarrah	50H	410213	6250291
Significant tree	Marri	50H	410213	6250284
Significant tree	Jarrah	50H	410236	6250269
Significant tree	Marri	50H	410228	6250252
Significant tree	Marri	50H	410237	6250252
Significant tree	Marri	50H	410242	6250245
Significant tree	Jarrah	50H	410223	6250240
Significant tree	unknown	50H	410215	6250234
Significant tree	Jarrah	50H	410255	6250227
Significant tree	Jarrah	50H	410253	6250215
Significant tree	Jarrah	50H	410222	6250220
Significant tree	Marri	50H	410220	6250215
Significant tree	Marri	50H	410215	6250208
Significant tree	Marri	50H	410211	6250198
Significant tree	Marri	50H	410249	6250190
Significant tree	Marri	50H	410273	6250202
Significant tree	Jarrah	50H	411712	6252099

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Tree	Species	Zone	Easting	Northing
Significant tree	Jarrah	50H	411749	6252096
Significant tree	Marri	50H	411777	6252093
Significant tree	Marri	50H	411785	6252074
Significant tree	Jarrah	50H	411796	6252008
Significant tree	Marri	50H	411772	6252002
Significant tree	Jarrah	50H	411718	6252001
Significant tree	Jarrah	50H	410978	6251408
Significant tree	Marri	50H	410977	6251423
Significant tree	Marri	50H	410973	6251425
Significant tree	Jarrah	50H	410970	6251420
Significant tree	Jarrah	50H	410954	6251404
Significant tree	Marri	50H	410967	6251456
Significant tree	Marri	50H	410970	6251462
Significant tree	Jarrah	50H	410980	6251475
Significant tree	Marri	50H	410987	6251475
Significant tree	Marri	50H	411002	6251452
Significant tree	Marri	50H	410970	6251477
Significant tree	Marri	50H	410977	6251498
Significant tree	Marri	50H	411000	6251492
Significant tree	Marri	50H	411160	6252562
Significant tree	Jarrah	50H	411198	6252546
Significant tree	Jarrah	50H	411171	6252535
Significant tree	Jarrah	50H	411164	6252537
Significant tree	Jarrah	50H	411171	6252505
Significant tree	Jarrah	50H	411168	6252505
Significant tree	Jarrah	50H	411201	6252508
Significant tree	Jarrah	50H	411187	6252524
Significant tree	Marri	50H	411177	6252532
Significant tree	Marri	50H	410271	6250204
Significant tree	Jarrah	50H	410274	6250206
Significant tree	Marri	50H	410292	6250213
Significant tree	Marri	50H	410292	6250222
Significant tree	Marri	50H	410289	6250232
Significant tree	Marri	50H	410281	6250237
Significant tree	Marri	50H	410272	6250243
Significant tree	Marri	50H	410281	6250257
Significant tree	Marri	50H	410287	6250264
Significant tree	Jarrah	50H	410294	6250289
Significant tree	Marri	50H	410260	6250293
Significant tree	Marri	50H	410260	6250280
Significant tree	Jarrah	50H	410270	6250272
Significant tree	Jarrah	50H	410260	6250225



Tree	Species	Zone	Easting	Northing
Significant tree	Marri	50H	410260	6250220
Significant tree	Marri	50H	414834	6256277
Significant tree	Jarrah	50H	414828	6256279
Significant tree	Jarrah	50H	414816	6256275
Significant tree	Marri	50H	414838	6256273
Significant tree	Jarrah	50H	414852	6256262
Significant tree	Marri	50H	414849	6256252
Significant tree	Jarrah	50H	414829	6256261
Significant tree	Jarrah	50H	414829	6256263
Significant tree	Jarrah	50H	414812	6256269
Significant tree	Jarrah	50H	414811	6256260
Significant tree	Marri	50H	414818	6256250
Significant tree	Jarrah	50H	414855	6256240
Significant tree	Jarrah	50H	414856	6256239
Significant tree	Jarrah	50H	414852	6256226
Significant tree	Jarrah	50H	414804	6256227
Significant tree	Jarrah	50H	414794	6256230
Significant tree	Jarrah	50H	414786	6256234
Significant tree	unknown	50H	414804	6256208
Significant tree	Marri	50H	414816	6256209
Significant tree	Jarrah	50H	414819	6256218
Significant tree	Jarrah	50H	414822	6256227
Significant tree	unknown	50H	414826	6256222
Significant tree	Jarrah	50H	414831	6256222
Significant tree	Jarrah	50H	414878	6256196
Significant tree	Jarrah	50H	414894	6256209
Significant tree	Jarrah	50H	411517	6257694
Significant tree	Marri	50H	411517	6257693
Significant tree	Marri	50H	411527	6257678
Significant tree	Marri	50H	411534	6257655
Significant tree	Marri	50H	411522	6257627
Significant tree	Jarrah	50H	411518	6257619
Significant tree	Jarrah	50H	411512	6257603
Significant tree	Marri	50H	409624	6258588
Significant tree	Marri	50H	409648	6258597
Significant tree	Marri	50H	409654	6258596
Significant tree	Marri	50H	409650	6258571
Significant tree	Jarrah	50H	409638	6258558
Significant tree	Marri	50H	409638	6258560
Significant tree	Marri	50H	409646	6258555
Significant tree	Marri	50H	409639	6258544
Significant tree	Marri	50H	409623	6258529

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Tree	Species	Zone	Easting	Northing
Significant tree	Jarrah	50H	409622	6258533
Significant tree	Jarrah	50H	409618	6258524
Significant tree	Jarrah	50H	409619	6258518
Significant tree	Marri	50H	409630	6258529
Significant tree	Jarrah	50H	409637	6258531
Significant tree	Marri	50H	409638	6258516
Significant tree	Jarrah	50H	409634	6258504
Significant tree	Marri	50H	409628	6258498
Significant tree	Jarrah	50H	409637	6258501
Significant tree	Marri	50H	409638	6258501
Significant tree	Marri	50H	409696	6258514
Significant tree	Jarrah	50H	414876	6256294
Significant tree	Jarrah	50H	414871	6256268
Significant tree	Jarrah	50H	414871	6256268
Significant tree	Jarrah	50H	414882	6256265
Significant tree	Marri	50H	414877	6256279
Significant tree	Marri	50H	414891	6256273
Significant tree	Jarrah	50H	414852	6256240
Significant tree	Jarrah	50H	414884	6256242
Significant tree	Marri	50H	414891	6256236
Significant tree	Jarrah	50H	414897	6256245
Significant tree	Jarrah	50H	414896	6256231
Significant tree	Jarrah	50H	414863	6256222
Significant tree	Jarrah	50H	414874	6256223
Significant tree	Jarrah	50H	414867	6256211
Significant tree	Marri	50H	414872	6256201
Significant tree	Jarrah	50H	414894	6256198
Significant tree	Jarrah	50H	414893	6256221
Significant tree	Marri	50H	411554	6257678
Significant tree	Jarrah	50H	411581	6257655
Significant tree	Marri	50H	409655	6258577
Significant tree	Jarrah	50H	409670	6258575
Significant tree	Marri	50H	409680	6258577
Significant tree	Marri	50H	409692	6258568
Significant tree	Marri	50H	409683	6258556
Significant tree	Marri	50H	409663	6258569
Significant tree	Marri	50H	409666	6258531
Significant tree	Marri	50H	409658	6258524
Significant tree	Marri	50H	409661	6258503
Significant tree	Marri	50H	409670	6258509
Significant tree	Marri	50H	409694	6258503
Significant tree	Marri	50H	409691	6258553

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Jarah50H4109062502807521-25Resprouting (free)11150H50HJarah50H41667262585190525Uhknownstress118241037Jarah50H4102962585810021-25Alive11501507Jarah50H4102962585810016-20Alive11503077Jarah50H4102762584810021-25Alive12077Jarah50H410276258410021-25Alive12077Jarah50H4105962502010021-25Alive12077Jarah50H41659625020120225Dead122257Jarah50H4165962502010021-25Dead1122257Jarah50H4165962502010021-25Dead11201025Jarah50H4165962502010021-25Dead112014.87.1025Jarah50H4165962502010021-25Dead114303050Jarah50H4140462538110021-25Uhknowstress1110304050Jarah50H41405625395155 <th>Species</th> <th>Zone</th> <th>Easting</th> <th>Northing</th> <th>DBH (cm)</th> <th>(m)</th> <th>Tree Health</th> <th>Hollows</th> <th>ground (m)</th> <th>width (cm)</th> <th>(cm)</th>	Species	Zone	Easting	Northing	DBH (cm)	(m)	Tree Health	Hollows	ground (m)	width (cm)	(cm)
Jarah50H41657262585590>225Unknowstress11840?Jarah50H4096896258529521-25Alive1151515?Jarah50H4102462514510016.20Alive11630.0??Jarah50H4109762528810021-25Alive120????Jarah50H4096362513211016.20Alive120????Jarah50H4165962524810021-25Alive120????Jarah50H4096362513211016.20Alive12214.8????Jarah50H4115762588110021-25Alive11530.0???Jarah50H4115762584110021-25Alive11530.0???Jarah50H4140362538110016.20Dead11430.030.0\$\$Jarah50H4140262514710016.20Alive11430.0\$\$\$\$Jarah50H414026251871521-25Unknowstres11016\$\$\$\$\$\$\$\$ <td>Jarrah</td> <td>50H</td> <td>410905</td> <td>6250280</td> <td>75</td> <td>21-25</td> <td>Resprouting (fire)</td> <td>1</td> <td>11</td> <td>50</td> <td>60</td>	Jarrah	50H	410905	6250280	75	21-25	Resprouting (fire)	1	11	50	60
Jarah50H4096596258529521·25Alive115159Jarah50H41024462514510016·20Alive11630?Jarah50H41097162528810021·25Dead11530??Jarah50H41028762513211016·20Alive120???Jarah50H410596250201016·20Dead120???Jarah50H4165962502012022·5Dead12225??Jarah50H4165462584110022·5Dead18300500Jarah50H4165462584110021·5Dead18300500Jarah50H4164462584110021·5Dead18300500Jarah50H4140462584110021·5Dead114.430.4500Jarah50H4140462584110021·5Unknowstres111.414.030.4100Jarah50H4140462584315525.5Unknowstres111.640.030.4100Jarah50H414416254356016·2Alive116.040.0??Jarah50H414416	Jarrah	50H	416572	6258551	90	>25	Unknown stress	1	18	40	?
Jarah50H410294625145510016-20Aliven111630?Jarah50H4109762528810021-25Dead111530??Jarah50H4102862539410021-25Aliven120??Jarah50H4102862515211016-20Dead214.8?.10?.50Jarah50H41659625020120?25Dead12225??Jarah50H41115625881120?1-25Dead11686???Jarah50H41115625881120?1-25Dead11430\$\$?Jarah50H4110462538110016-20Dead11430\$\$\$Jarah50H414026251713021-25Unknowstres1113400\$\$\$Jarah50H4140262518116021-25Unknowstres1116400\$\$\$Jarah50H414036254915021-25Unknowstres1116400\$	Jarrah	50H	409659	6258525	95	21-25	Alive	1	15	15	?
Jarah50H41097162528810021-25Dead11530???Jarah50H4102762539410021-25Alive120??Jarah50H4096362513211016-20Dead214,8?,10?,50Jarah50H41659625020120>25Dead1222526?Jarah50H4115762585110021.25Dead115600250Jarah50H41654625201100252Alive18300501Jarah50H41654625301100252Alive18300501Jarah50H4140362538110016-20Dead116.014.0300501Jarah50H4140362538110016-20Dead114.0300501Jarah50H414026251713021-25Unknowstress113.040.0500Jarah50H414026251815021-25Unknowstress110.030.030.0Jarah50H4140362584316016-20Dead116.040.030.0Jarah50H4140462584516021-25Dead116.040.030.0Jarah50H4144162584580	Jarrah	50H	410294	6251455	100	16-20	Alive	1	16	30	?
Jarrah50H410287625394410021-25Alive120??Jarrah50H409643625153211016-20Dead214.8?,10?,50Jarrah50H41859625010120225Dead1122255?Jarrah50H41157625858112021-25Dead115660250Jarrah50H41656462524011003-25Alive183050Jarrah50H4162062538110016-20Dead114.43050Jarrah50H41402062517013021-25Unknownstress113.340.050Jarrah50H41402062513215021-25Unknownstress112.240.0100Jarrah50H41402062513215021-25Unknownstress110.240.050Jarrah50H41402062513215021-25Unknownstress110.05040.0Jarrah50H41403062584316016-20Dead110.05040.0Jarrah50H4140306254335021-25Unknownstress1164050Jarrah50H4140306254335021-25Alive116607Jarrah50H414030<	Jarrah	50H	410971	6252588	100	21-25	Dead	1	15	30?	?
Jarrah $50H$ $409643$ $625152$ $110$ $16-20$ Dead $2$ $14.8$ $?,10$ $?,50$ Jarrah $50H$ $416559$ $6250210$ $120$ $>25$ $Dead$ $1$ $22$ $25$ $?$ Jarrah $50H$ $411157$ $6258581$ $120$ $21-25$ $Dead$ $1$ $150$ $600$ $2500$ Jarrah $50H$ $416564$ $6252401$ $100$ $>25$ $Alive$ $1$ $8$ $30$ $50$ Jarrah $50H$ $414034$ $625381$ $100$ $16-20$ $Dead$ $1$ $14$ $30$ $50$ Jarrah $50H$ $41402$ $6251570$ $130$ $21-25$ $Unknowstress$ $1$ $13$ $400$ $50$ Jarrah $50H$ $41020$ $625132$ $150$ $21-25$ $Unknowstress$ $1$ $12$ $40$ $100$ Jarrah $50H$ $41020$ $625132$ $150$ $21-25$ $Unknowstress$ $1$ $10$ $50$ $40$ Jarrah $50H$ $41020$ $625132$ $150$ $21-25$ $Unknowstress$ $1$ $10$ $40$ $50$ Jarrah $50H$ $414401$ $625360$ $50$ $21-25$ $Unknowstress$ $1$ $16$ $40$ $50$ Jarrah $50H$ $414401$ $625360$ $60$ $16-20$ $Alive$ $1$ $15$ $80$ $?$ Jarrah $50H$ $414401$ $625493$ $80$ $21-25$ $Alive$ $1$ $10$ $40$ <	Jarrah	50H	410287	6253944	100	21-25	Alive	1	20	?	?
Jarrah50H41659625010120>25Dead12225?Jarrah50H411157625858112021-25Dead11560250Jarrah50H416646252401100>25Alive183050Jarrah50H414034625386110016-20Dead1143050Jarrah50H4140262517013021-25Unknowstress11334050Jarrah50H41012625131215021-25Unknowstress111240100Jarrah50H41561625396155>25Unknowstress11015040Jarrah50H4140162581416016-20Dead1164050Jarrah50H41401625854155>25Unknowstress11064050Jarrah50H414016258545021-25Dead1164050Jarrah50H414036252435021-25Dead116407Jarrah50H414166253606016-20Alive115807Jarrah50H414166253606016-20Alive1104050Jarrah50H4142762512090>25Unknowstr	Jarrah	50H	409643	6251532	110	16-20	Dead	2	14, 8	?, 10	?, 50
Jarrah50H411157625858112021-25Dead11560250Jarrah50H4165646252401100>25Alive183050Jarrah50H414034625386110016-20Dead1143050Jarrah50H41402062517013021-25Unknown stress113340050Jarrah50H41020625131215021-25Unknown stress112400100Jarrah50H4145616253956155>25Unknown stress1164060Jarrah50H4145362543316016-20Dead1164060Jarrah50H414616253606016-20Dead115807Jarrah50H4141416254335021-25Dead115807Jarrah50H4141406254938021-25Dead115807Jarrah50H4141406254938021-25Alive115807Jarrah50H414276254858021-25Alive110407Jarrah50H4142762549390>25Unknown stress1104050Jarrah50H4112562519290>25<	Jarrah	50H	416559	6250210	120	>25	Dead	1	22	25	?
Jarrah50H4165646252401100>25Alive183050Jarrah50H414034625386110016-20Dead1143050Jarrah50H41402062517013021-25Unknown stress113340050Jarrah50H410120625395615521-25Unknown stress112400100Jarrah50H415616253956155>25Unknown stress1105040Jarrah50H4140362583416016-20Dead1164050Jarrah50H414636253956155>25Dead1164050Jarrah50H414036254345021-25Dead11550100Jarrah50H414166253966016-20Alive1156060Jarrah50H414166254348021-25Alive110407Jarrah50H414276254858021-25Alive1104060Jarrah50H414276254848021-25Unknown stress1104050Jarrah50H4142762539990>25Unknown stress1103040Jarrah50H4136562519890	Jarrah	50H	411157	6258581	120	21-25	Dead	1	15	60	250
Jarrah50H414034625386110016-20Dead1143050Jarrah50H41402062517013021-25Unknown stress113340050Jarrah50H410120625131215021-25Unknown stress112400100Jarrah50H415616253956155>25Unknown stress1105040Jarrah50H4140162581416016-20Dead1164050Jarrah50H414036252435021-25Dead112550010Jarrah50H414036252435021-25Dead115807Jarrah50H414166253066016-20Alive115807Jarrah50H414276252438016-20Alive115807Jarrah50H414276252438016-20Alive110407Jarrah50H41125625438021-25Alive1104050Jarrah50H411276252438021-25Alive1104050Jarrah50H4112562515290>25Unknown stress1104050,50Jarrah50H4102762539390>25<	Jarrah	50H	416564	6252401	100	>25	Alive	1	8	30	50
Jarrah50H414020625157013021-25Unknown stress1134050Jarrah50H410120625131215021-25Unknown stress112400100Jarrah50H415616253956155>25Unknown stress1105040Jarrah50H41440162581416016-20Dead1164050Jarrah50H416336252635021-25Dead12550100Jarrah50H4144166253606016-20Alive11580?Jarrah50H4144166253606016-20Alive11580?Jarrah50H4144166253606016-20Alive11580?Jarrah50H4144166254398021-25Alive11580?Jarrah50H4140306252438021-25Alive11040?Jarrah50H4142776254858021-25Alive11040?Jarrah50H4112562515290>25Unknown stress1104050Jarrah50H4102762539390>25Unknown stress1103040Jarrah50H413667625198901	Jarrah	50H	414034	6253861	100	16-20	Dead	1	14	30	50
Jarrah50H410120625131215021-25Unknown stress11240100Jarrah50H415616253956155>25Unknown stress1105040Jarrah50H41440162581416016-20Dead1164050Jarrah50H41653362526435021-25Dead12550100Jarrah50H4144166253606016-20Alive11580?Jarrah50H41403062524938016-20Alive11580?Jarrah50H41403062524938016-20Alive11040?Jarrah50H41427762524858021-25Alive1156060Jarrah50H41427762524938021-25Alive11040?Jarrah50H4142776254858021-25Unknown stress1104050Jarrah50H410227625193990>25Unknown stress1104050Jarrah50H41365762519469016-20Unknown stress1103040Jarrah50H41365762519469016-20Unknown stress1103040Jarrah50H413657625194	Jarrah	50H	414020	6251570	130	21-25	Unknown stress	1	13	40	50
Jarrah $50H$ $41551$ $6253956$ $155$ $>25$ Unknown stress $1$ $10$ $50$ $40$ Jarrah $50H$ $414401$ $6258514$ $160$ $16-20$ $Dead$ $1$ $16$ $40$ $50$ Jarrah $50H$ $41633$ $6252633$ $50$ $21-25$ $Dead$ $1$ $25$ $50$ $100$ Jarrah $50H$ $414416$ $625360$ $60$ $16-20$ $Alive$ $1$ $15$ $80$ $?$ Jarrah $50H$ $414030$ $6252493$ $80$ $16-20$ $Alive$ $1$ $10$ $40$ $?$ Jarrah $50H$ $414030$ $6252493$ $80$ $16-20$ $Alive$ $1$ $10$ $40$ $?$ Jarrah $50H$ $414277$ $6252493$ $80$ $21-25$ $Alive$ $1$ $10$ $40$ $?$ Jarrah $50H$ $414277$ $6252493$ $80$ $21-25$ $Alive$ $1$ $10$ $40$ $90$ Jarrah $50H$ $41125$ $6251520$ $90$ $21-25$ $Alive$ $1$ $10$ $40$ $50$ Jarrah $50H$ $41125$ $625192$ $90$ $255$ $Unknown stress$ $1$ $10$ $40$ $50,50$ Jarrah $50H$ $413657$ $625194$ $90$ $16-20$ $Unknown stress$ $1$ $10$ $30$ $40$ Jarrah $50H$ $413650$ $625198$ $90$ $16-20$ $Unknown stress$ $1$ $10$ $10$	Jarrah	50H	410120	6251312	150	21-25	Unknown stress	1	12	40	100
Jarrah50H414401625851416016-20Dead1164050Jarrah50H41653362526435021-25Dead12550100Jarrah50H41441662553606016-20Alive11580?Jarrah50H41403062524938016-20Alive11040?Jarrah50H41427762524858021-25Alive11040?Jarrah50H41125625152090>25Unknown stress1104050Jarrah50H41027762533990>25Unknown stress217,2025,2550,50Jarrah50H41365762519469016-20Unknown stress1103040Jarrah50H4136606250198950-10Unknown stress1103040Jarrah50H4136606250198950-10Unknown stress1184060cm	Jarrah	50H	415561	6253956	155	>25	Unknown stress	1	10	50	40
Jarrah50H41653362526435021-25Dead12550100Jarrah50H41441662553606016-20Alive11580?Jarrah50H41403062524938016-20Alive11040?Jarrah50H41427762524858021-25Alive1156060Jarrah50H41125625152090>25Unknown stress1104050Jarrah50H410227625393990>25Unknown stress217,2025,2550,50Jarrah50H41365762519469016-20Unknown stress1103040Jarrah50H4136606250198950-10Unknown stress1184060cm	Jarrah	50H	414401	6258514	160	16-20	Dead	1	16	40	50
Jarrah50H41441662553606016-20Alive11580?Jarrah50H41403062524938016-20Alive11040?Jarrah50H41427762524858021-25Alive1156060Jarrah50H411125625152090>25Unknown stress1104050Jarrah50H410227625393990>25Unknown stress217,2025,2550,50Jarrah50H41365762519469016-20Unknown stress1103040Jarrah50H4136606250198950-10Unknown stress1184060cm	Jarrah	50H	416533	6252643	50	21-25	Dead	1	25	50	100
Jarrah         50H         414030         6252493         80         16-20         Alive         1         10         40         ?           Jarrah         50H         414277         6252485         80         21-25         Alive         1         15         60         60           Jarrah         50H         41125         6251520         90         >25         Unknown stress         1         10         40         50           Jarrah         50H         410227         6253939         90         >25         Unknown stress         2         17,20         25,25         50,50           Jarrah         50H         413657         6251946         90         16-20         Unknown stress         2         17,20         25,25         50,50           Jarrah         50H         413657         6251946         90         16-20         Unknown stress         1         10         30         40           Jarrah         50H         413660         6250198         95         0-10         Unknown stress         1         18         40         60cm	Jarrah	50H	414416	6255360	60	16-20	Alive	1	15	80	?
Jarrah         50H         414277         6252485         80         21-25         Alive         1         15         60         60           Jarrah         50H         411125         6251520         90         >25         Unknown stress         1         10         40         50           Jarrah         50H         41027         6253939         90         >25         Unknown stress         2         17,20         25,25         50,50           Jarrah         50H         413657         6251946         90         16-20         Unknown stress         1         10         30         40           Jarrah         50H         413660         6250198         95         0-10         Unknown stress         1         18         40         60cm	Jarrah	50H	414030	6252493	80	16-20	Alive	1	10	40	?
Jarrah         50H         41125         6251520         90<         >25         Unknown stress         1         10         40         50           Jarrah         50H         410227         6253939         90         >25         Unknown stress         2         17,20         25,25         50,50           Jarrah         50H         413657         6251946         90         16-20         Unknown stress         1         10         30         40           Jarrah         50H         413660         6250198         95         0-10         Unknown stress         1         18         40         60cm	Jarrah	50H	414277	6252485	80	21-25	Alive	1	15	60	60
Jarrah         50H         410227         6253939         90         >25         Unknown stress         2         17,20         25,25         50,50           Jarrah         50H         413657         6251946         90         16-20         Unknown stress         1         10         30         40           Jarrah         50H         413660         6250198         95         0-10         Unknown stress         1         18         40         60cm	Jarrah	50H	411125	6251520	90	>25	Unknown stress	1	10	40	50
Jarrah         50H         413657         6251946         90         16-20         Unknown stress         1         10         30         40           Jarrah         50H         413660         6250198         95         0-10         Unknown stress         1         18         40         60cm	Jarrah	50H	410227	6253939	90	>25	Unknown stress	2	17, 20	25, 25	50, 50
Jarrah         50H         413660         6250198         95         0-10         Unknown stress         1         18         40         60cm	Jarrah	50H	413657	6251946	90	16-20	Unknown stress	1	10	30	40
	Jarrah	50H	413660	6250198	95	0-10	Unknown stress	1	18	40	60cm

### Appendix I: Summary of significant habitat trees with suitable breeding hollows for Black Cockatoos

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Species	Zone	Easting	Northing	DBH (cm)	Tree Height (m)	Tree Health	No. Hollows	Height above ground (m)	Estimated entrance width (cm)	Estimated depth (cm)
Marri	50H	414329	6251514	60	21-25	Alive	1	10	40	50
Marri	50H	414889	6256265	80	21-25	Alive	1	20	30	?
Marri	50H	411566	6250304	90	>25	Alive	1	20	?	?
Marri	50H	414345	6253930	90	>25	Alive	1	12	40	30
Marri	50H	414884	6256231	90	21-25	Alive	1	12	15	150
Marri	50H	410238	6256255	90	21-25	Dead	1	23	40	200
Marri	50H	415573	6257647	100	21-25	Alive	1	20	10	?
Marri	50H	410282	6251555	100	21-25	Alive	1	20	12	?
Marri	50H	411598	6257646	110	0-10	Dead	1	6	45	?
Marri	50H	414084	6251445	120	16-20	Dead	1	10	15	?
Marri	50H	411506	6258518	140	>25	Alive	1	25	20	?
Marri	50H	409670	6250216	200	>25	Resprouting (fire)	1	18	40	?
Marri	50H	414031	6253906	100	>25	Alive	1	15	30	50
Marri	50H	411569	6252380	100	>25	Alive	1	10	50	50
Marri	50H	409648	6257610	100	>25	Alive	1	12	30	30
Marri	50H	411831	6250227	100	11-15	Dead	1	10	60	40
Marri	50H	410912	6257619	100	11-15	Unknown stress	1	10	40	50
Marri	50H	414361	6250401	100	11-15	Dead	1	11	40	150
Marri	50H	410194	6251485	100	11-15	Unknown stress	1	12	30	60
Marri	50H	416525	6256208	100	11-15	Dead	1	21	40	100
Marri	50H	410952	6250479	100	21-25	Alive	1	15	30	30
Marri	50H	411898	6253817	105	>25	Alive	1	15	15	100
Marri	50H	413625	6251471	110	16-20	Unknown stress	1	16	20	40
Marri	50H	414374	6253748	120	>25	Alive	1	20	50	100
Marri	50H	414386	6253854	130	>25	Alive	1	20	40	100

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Species	Zone	Easting	Northing	DBH (cm)	Tree Height (m)	Tree Health	No. Hollows	Height above ground (m)	Estimated entrance width (cm)	Estimated depth (cm)
Marri	50H	413981	6251502	130	0-10	Dead	1	10	60	?
Marri	50H	413644	6253744	140	>25	Alive	1	15	40	80
Marri	50H	414006	6253844	150	>25	Alive	1	15	40	100
Marri	50H	416562	6252522	150	>25	Alive	1	8	20	80
Marri	50H	416522	6252435	160	>25	Alive	1	20	60	100
Marri	50H	413988	6250403	170	>25	Unknown stress	1	12	40	50
Marri	50H	416559	6251453	170	21-25	Alive	1	8	50	70
Marri	50H	414364	6253834	100	21-25	Alive	1	10	40	100
Marri	50H	414263	6251905	200	16-20	Unknown stress	1	18	40	100
Marri	50H	416550	6252413	270	11-15	Dead	1	6	100	?
Marri	50H	413690	6253881	50	11-15	Alive	1	10	15	?
Marri	50H	414288	6252473	60	11-15	Dead	1	11	50	?
Marri	50H	409626	6255406	60	11-15	Alive	1	15	15	50
Marri	50H	414346	6258501	65	16-20	Unknown stress	1	16	50	100
Marri	50H	415500	6250478	67	16-20	Unknown stress	1	12	40	50
Marri	50H	413982	6256209	75	0-10	Dead	1	12	40	?
Marri	50H	416590	6252463	75	0-10	Dead	1	9	50	100
Marri	50H	414354	6257627	80	21-25	Unknown stress	1	15	50	150
Marri	50H	410926	6252609	80	21-25	Alive	1	18	60	100
Marri	50H	416522	6252485	85	>25	Dead	1	20	40	50
Marri	50H	416555	6250258	85	16-20	Unknown stress	1	8	50	50
Marri	50H	409657	6252453	85	21-25	Alive	1	21	15	?
Marri	50H	416570	6251312	90	16-20	Unknown stress	1	8	50	50
Marri	50H	414399	6252533	90	21-25	Dead	1	10	20	50
Marri	50H	416515	6252573	90	21-25	Alive	1	20	40	?

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Greenbushes Level 1 Fauna Survey

Species	Zone	Easting	Northing	DBH (cm)	Tree Height (m)	Tree Health	No. Hollows	Height above ground (m)	Estimated entrance width (cm)	Estimated depth (cm)
Marri	50H	414015	6258568	95	16-20	Alive	1	13	40	50
Unknown	50H	415563	6252030	70	21-25	Unknown stress	3	12, 15, 17	80, 20, 25	?,?,?





# Greenbushes Vertebrate, SRE and Subterranean Fauna Desktop Assessment

Talison Lithium Limited 10 July 2018



DOCUMENT STATUS									
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2	B. Downing	C. Knuckey	L. Perenzin	03/04/18					
3	C. Knuckey	C. Knuckey	L. Perenzin	10/04/18					
4	C. Knuckey	C. Knuckey	C. Griffen	10/07/18					

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#### EXECUTIVE SUMMARY

Talison Lithium Limited (Talison) mines and processes lithium bearing mineral spodumene at the Greenbushes Mine, located directly south of the Greenbushes town approximately 250 kilometres (km) south of Perth, Western Australia. Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Talison to undertake a desktop assessment for terrestrial vertebrate, short-range endemic invertebrate (SRE) and subterranean fauna within and surrounding the Greenbushes Mine. The Study Area comprised 1,989 hectares (ha), including the current mining area and an indicative future disturbance area. The overarching objective of the assessment was to update information provided within previous fauna assessments and to assess the likelihood of occurrence for SRE and subterranean fauna to advise on the need for future surveys.

#### Vertebrate Fauna

The vertebrate fauna desktop assessment was conducted via reviewing literature relevant to the Study Area and conducting several database searches. A total of seven literature sources were reviewed and four databases were searched.

A total of eight fauna habitats have previously been recorded and mapped across the Study Area, comprising four naturally occurring habitat types (Jarrah/Marri Forest, Jarrah/Marri Forest over Banksia, Marri/Blackbutt/Flooded Gum Woodland over Banksia, and Waterbodies). The desktop assessment identified a total of 291 species of vertebrate fauna which have previously been recorded and/or have the potential to occur within the Study Area. This comprised 31 native mammals, 10 non-native mammals, 169 native, six non-native birds, 45 reptiles, 19 amphibians and 11 fish species. Of the 291 species of vertebrate fauna identified, 44 species are of conservation significance, of which seven have been recorded within the Study Area:

- Carnaby's Cockatoo (Calyptorhynchus latirostris) Endangered (EPBC Act, WC Act);
- Baudin's Cockatoo (Calyptorhynchus baudinii) Endangered (EPBC Act, WC Act),
- Western Quoll (Dasyurus geoffroii) Vulnerable (EPBC Act and WC Act);
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) Vulnerable (EPBC Act, WC Act);
- Wambenger Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) Conservation Dependent (WC Act);
- Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) Priority 4 (DBCA Priority List); and
- Western Brush Wallaby (Notamacropus irma) Priority 4 (DBCA Priority List).

A further species, Western Ringtail Possum (*Pseudocheirus occidentalis*, Vulnerable, EPBC Act), Critically Endangered, WC Act), has possibly been recorded in the Study Area. Based on distribution, previous records and the habitats present, a further species was deemed highly likely, two likely, seven possible, one rarely, seven unlikely and eighteen highly unlikely to occur in the Study Area.



#### Short-range Endemic Invertebrate Fauna

Five databases were searched for SRE invertebrate fauna records within and surrounding the Study Area to determine the likely SRE fauna values. Broad fauna habitats were also reviewed for their ability to support SRE species.

Of the four naturally occurring habitats present in the Study Area, three were assessed as having a moderate potential for SRE fauna: Jarrah/ Marri Forest, Jarrah/Marri Forest over Banksia, Marri/Blackbutt/Flooded Gum Woodland over Banksia - aquatic habitats were not assessed. Historically, these habitats were widespread throughout the landscape, which would have allowed most invertebrate species the opportunity to disperse reasonably widely, even if sensitive to desiccation. However, habitat loss and fragmentation due to human impacts has likely reduced the distribution and opportunities for dispersal of most dispersal-limited invertebrate taxa (including SRE taxa) occurring in these types of forest/ woodland habitats.

Only one terrestrial invertebrate (a widespread species) has previously been recorded within the Study Area to date, highlighting a lack of sampling effort. Database searches revealed 29 records of taxa belonging to taxonomic groups which are known to include SRE fauna (comprising isopods, scorpions, mygalomorph spiders, millipedes and terrestrial snails) within 25 km of the Study Area. However, none of these records were confirmed SRE fauna or invertebrate fauna of conservation significance.

Given the nearby occurrence of higher taxa known to include SRE species, and the presence of habitats regarded as moderately suitable for SRE fauna, it is possible that SRE fauna occur within the Study Area. As such a pilot SRE survey is recommended to confirm habitat suitability and extent and facilitate a more detailed assessment of the SRE status of the invertebrate species occurring within the Study Area and surrounds.

#### Subterranean Fauna

Five databases were searched for subterranean fauna records. All records were filtered based on collection methods, habitat and known stygofauna/ troglofauna taxonomic groups where information on subterranean status (*i.e.* hypogean subterranean/ soil fauna/ surface fauna) was not present. Geology and hydrogeology of the Study Area was also reviewed.

Three broad surface geology types have been mapped across the Study Area. The dominant geological groups being the undivided sediments and ferruginous duricrust, both of which are sedimentary in nature. Five bedrock geologies that are of metamorphic and igneous origin have been recognised throughout the Study Area. Granulite and migmatite (A-xmno-mni-YSW) as well as granatic gneiss (A-mgn-YSW) and amphibolite (A-mwa-YSW) dominate the Study Area with smaller pockets of pegmatite (A-gp-YSW) and metagabbro/metaperidotite (A-xmo-ma-YSW) have also been recognised.

The Study Area is situated in the Blackwood River catchment within the Karri groundwater sub-area. Department of Water (DoW) recognises three sub-catchments within the Study Area, Norilup Brook which dominates the area as well as Hester Brook bordering the east and Bridgetown-Blackwood to the south.



Based on the available geological and hydrogeological information, it appears a number of prospective habitats for troglofauna (above water table) and stygofauna (below water table) may potentially occur within the Study Area. However, the occurrence of such species would be dependent on the extent of suitable habitat relative to the water table. Information suitable to infer extent and suitability of habitat for subterranean fauna (drill cores, bore logs, geological/hydrological modelling) was not available at the time of writing this report and thus a detailed assessment beyond stating that subterranean fauna may occur, is not possible. Further uncertainty surrounding the occurrence of subterranean fauna is due to the lack of subterranean fauna sampling within the vicinity of the Study Area and/or greater South-West region and the level of detail provided from relevant databases searched.

Biologic recommend Talison conduct a Pilot subterranean fauna survey to determine whether subterranean fauna are present. Our understanding to date is that no subterranean surveys have been conducted within the vicinity of the Study Area and are very limited in the greater South-West region generally. Only sampling of the Study Area and surrounds will reveal the presence or lack thereof a subterranean fauna assemblage.



#### 1 INTRODUCTION

### 1.1 Background

Talison Lithium Limited (Talison) mines and processes lithium bearing mineral spodumene at the Greenbushes Mine, located directly south of the Greenbushes town, approximately 250 kilometres (km) south of Perth, Western Australia (Figure 1.1). Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Talison to undertake a desktop assessment for terrestrial vertebrate, short-range endemic invertebrate (SRE) and subterranean fauna within and surrounding the Greenbushes Mine. The area considered for this assessment (hereafter referred to as the Study Area) comprised 1,989 hectares (ha) and included the current mining area and an indicative future disturbance area (Figure 1.1). Biologic are of the understanding that the assessment is required to assist Talison with approval for further expansions to the current mine.

### 1.2 Objectives

The overarching objective of this assessment was to update information provided within previous assessments (i.e. in light of recent taxonomic and listing changes) and to assess the likelihood of occurrence for SRE and subterranean fauna to advise on the need for future surveys. Specifically, this report provides:

- a review of vertebrate fauna recorded (through current database searches and recent surveys) within Study Area and surrounding area and update with regard to recent changes in taxonomy and conservation status;
- an assessment on the presence, or likely presence, of vertebrate fauna currently considered to be of conservation significance (under state and federal legislation);
- a review of SRE fauna recorded within the vicinity of the Study Area and broad habitats in the Study Area, to indicate whether SRE species are likely to occur; and
- a review of subterranean fauna recorded within the vicinity of the Study Area and of the broad geology's that comprise the Study Area, to indicate whether subterranean fauna are likely to occur.

This assessment was carried out in a manner consistent with the following documents from the Western Australian Environmental Protection Authority (EPA):

- Environmental Protection Authority (EPA, 2016a) Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna;
- EPA (2016d) Technical Guidance: Terrestrial Fauna Surveys;
- EPA (2016b) Technical Guidance: Sampling of Short-range Endemic Invertebrate Fauna;
- EPA (2016c) Technical Guidance: Subterranean Fauna Survey;





### 1.3 Background to Protection of Fauna

#### 1.3.1 Conservation Significance

Within Western Australia, native fauna are 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 on 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 status. These species are generally considered by the 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).

Agreement, Act or List	Status Codes				
Federal					
<b>Environment Protection and Biodiversity</b> <b>Conservation Act 1999 (EPBC Act)</b> 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!)	<ul> <li>Extinct (EX)</li> <li>Extinct in the Wild (EW)</li> <li>Critically Endangered (CE)</li> <li>Endangered (EN)</li> <li>Vulnerable (VU)</li> <li>Conservation Dependent (CD)</li> <li>Migratory (MG)</li> <li>Marine (MA)</li> </ul>				
State					
<i>Wildlife Conservation Act 1950</i> (WC Act) At a state level, native fauna are protected under the <i>Wildlife Conservation Act 1950</i> . Species in need of conservation are given a ranking ranging from Critically Endangered to Vulnerable.	<ul> <li>Schedule 1 (Critically Endangered) (S1)</li> <li>Schedule 2 (Endangered) (S2)</li> <li>Schedule 3 (Vulnerable) (S3)</li> <li>Schedule 4 (Extinct) (S4)</li> <li>Schedule 5 (Migratory) (S5)</li> <li>Schedule 6 (Conservation Dependent) (S6)</li> <li>Schedule 7 (Other Specially Protected) (S7)</li> </ul>				
<b>DBCA Priority List</b> DBCA produces a list of Priority species that have not been assigned statutory protection under the <i>Wildlife</i> <i>Conservation Act 1950</i> . This system gives a ranking from Priority 1 to Priority 4.	<ul> <li>Priority 1 (Poorly-known species) (P1)</li> <li>Priority 2 (Poorly-known species) (P2)</li> <li>Priority 3 (Poorly-known species) (P3)</li> <li>Priority 4 (Rare, Near Threatened, and other species in need of monitoring) (P4)</li> </ul>				

#### Table 1.1 Definitions and terms for fauna of conservation significance



#### 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 *et al.*, 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 (Table 1.2). 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).

Phylum	Class	Order	Relevant Generic Group	
Mollusca	Bivalvia	Unionoida	Freshwater mussels	
	Costropodo	Sorbeoconcha	Freshwater snails	
	Gastropoua	Eupulmonata	Land snails	
Annelida Oligochaeta		Haplotaxida	Earthworms	
Onychophora Onychophora		Onychophora	Velvet worms	
		Araneae	Trapdoor spiders	
	Arachnida	Pseudoscorpiones	Pseudoscorpions	
		Schizomida	Schizomids	
		Acari	Mites	
Arthropodo	Malagastraga	Isopoda	Slaters	
Anthropoda	Malacostraca	Decapoda	Freshwater crayfish	
		Polydesmida	Millipedes	
	Distancedo	Sphaerotheriida	Pill Millipedes	
	Dipiopoda	Polyzoniida	Sucking Millipedes	
		Spirostreptida	Spirostreptid Millipedes	

Table	1.2:	Taxonomic (	aroups	with	known	or likely	SRE taxa	in \	Nestern	Australia	(EPA.	2016b)
I UDIC			gioups			or meery				Austranu	( _ , _ ,	20100/

Harvey (2002) proposed a range criterion for terrestrial short-range endemic (SRE) species at less than 10,000 km<sup>2</sup> (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 (see Section 1.3.1), 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 Subterranean Fauna

Subterranean fauna are animals that live underground. In Western Australia, subterranean fauna are mainly invertebrates such as crustaceans, insects, arachnids, myriapods, worms, and snails, but a small number of vertebrate taxa such as fish and reptiles have also been recorded (EPA, 2016c; Humphreys, 1999). Subterranean fauna are grouped into two major ecological categories:

- stygofauna aquatic animals that inhabit groundwater in caves, aquifers and water-saturated interstitial voids; and
- troglofauna air breathing animals that inhabit air-filled caves and smaller voids above the water table.

Terrestrial and sub-surface habitats exist within a series of environmental gradients from fully aquatic (groundwater) to fully terrestrial (air-filled cavities), as well as fully above-ground (epigean) to fully below-ground (hypogean). There are some types of fauna that move between these habitats at different times in their life cycles (trogloxenes and stygoxenes), and others that can be found within any of these habitat strata at any given time (troglophiles or stygophiles) (Christiansen, 2012; Stanford & Ward, 1993). The EPA (2016c) assessment guidelines consider only obligate subterranean fauna during environmental impact assessment (EIA); comprising troglobites and stygobites (i.e. animals which live their entire lives in the hypogean zone).

Obligate subterranean species, which cannot occur on the surface or in soil habitats, are considered most likely to be short-range endemic (SRE), based on the often-restricted extent of their geological or hydrogeological habitats (Harvey, 2002; Howarth, 1983; Humphreys *et al.*, 2009). This high propensity for short-range endemism in troglobites and stygobites increases the possibility that species may be negatively impacted as a result of a proposed development (EPA, 2016c).

Troglobites and stygobites often display evolutionary adaptations to underground life, for example reduced pigment, reduced or vestigial wings, reduced cuticle thickness, elongation of sensory appendages, and reduced eyes or eyelessness. Additional adaptations to underground life can include changes to physiology, lifecycle, metabolism, feeding and behaviour (Christiansen, 2012; Coineau, 2000; Gibert & Deharveng, 2002).

Western Australia's subterranean fauna is considered globally significant due to an unprecedented richness of species and high levels of short-range endemism (EPA, 2016c). While protection for listed species (species of conservation significance) and/ or Threatened or Priority Ecological Communities is provided under state and federal legislation (see Section 1.3.1), the majority of subterranean 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 WAM and other taxonomic experts. Consideration of range-restricted subterranean fauna is therefore important, as these have a higher potential of being short-range endemic (SRE) species (following Eberhard *et al.*, 2009; and Harvey, 2002).



### 2 ENVIRONMENT

#### 2.1 Biogeography

The Study Area falls within the Jarrah Forest biogeographical region as defined by the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway & Cresswell, 1995). The Jarrah Forest region is subdivided into two subregions, the Study Area lies within the Southern Jarrah Forest subregion (JF2) (Hearn *et al.*, 2002). The vegetation of the subregion comprises Jarrah-Marri forest in the west grading to Marri and Wandoo woodlands in the east (McKenzie *et al.*, 2002). There are extensive areas of swamp vegetation in the south-east, dominated by Paperbarks and Swamp Yate (Hearn *et al.*, 2002). The understorey component of the forest and woodland reflects the more mesic nature of this area (Hearn *et al.*, 2002). Most of the diversity in the communities occurs on the lower slopes or near granite soils where there are rapid changes in site conditions. Approximately 54.7% of the Southern Jarrah Forest subregion lies within DBCA managed conservation estate, as represented by five national parks (Hearn *et al.*, 2002).

#### 2.2 Climate

Greenbushes has a warm temperate climate, characterised by warm and dry summers with cool, wet winters. Rainfall ranges from 1200 millimetres (mm) in the south-west of the subregion to 500 mm in the east (Hearn *et al.*, 2002). Long-term rainfall data was available for Greenbushes (Station 9552; BoM, 2018); however, the nearest weather station documenting a long-term dataset of temperatures was Bridgetown (Station 9617; BoM, 2018) located 14 km south-east of the Study Area. The long-term average (LTA) annual rainfall at Greenbushes is 928.7 mm, with January and February receiving the least amount of rain on average (16 and 15.5 mm, respectively) and July receiving the most rain on average (167 mm; Figure 2.1). The average monthly maximum temperature ranges from 30°C in January to 15.7°C in July. Average monthly minimum temperature ranges from 4.5°C in July to 13.5°C in February.



Figure 2.1: Long-term average monthly rainfall) and temperature data (BoM, 2018)



#### 2.3 **Pre-European Vegetation**

Broad scale vegetation mapping indicates that there are five vegetation complexes which occur within the Study Area (Mattiske & Havel, 1998). Vegetation is dominated by open forest of Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) occasionally with Bull Banksia (*Banksia grandis*) (Table 2.1)

Vegetation	on Overstery Second Shruhs Herb			Within Study		
Complex	Overstory	Storey		Ha	ea %	
Dwellingup	Open Forest of Eucalyptus marginata and Corymbia calophylla	Allocasuarina fraseriana, Banksia grandis and Persoonia longifolia	Acacia browniana, Hovea chorizemifolia, Leucopogon propinquus, Lasiopetalum floribundum, Leucopogon verticillatus and Macrozamia riedlei	1,266	64	
Goonaping	Open Woodland of Corymbia calophylla, Banksia attenuata, Banksia ilicifolia with some Melaleuca preissiana on wet sites	No second storey	Stirlingia latifolia, Daviesia preissii, Leucopogon glabellus Leptocarpus tenax, Petrophile linearis, Patersonia occidentalis and Dasypogon bromeliifolius	434	22	
Grimwade	Open Forest of <i>Eucalyptus marginata</i> and <i>Corymbia calophylla</i>	Persoonia longifolia	Xanthorrhoea preissii, Pteridium esculentum, Leucopogon australis subsp. acutifolius, Macrozamia riedlei, Hibbertia commutata, Austrodanthonia setacea, Phyllanthus calycinus, Leucopogon capitellatus and Leucopogon verticillatus	120	6	
Catterick	Open Forest of Corymbia calophylla, Eucalyptus marginata on upper slopes, Eucalyptus patens on lower slopes and Eucalyptus rudis on drainage line	Second storey poorly developed, some <i>Persoonia</i> <i>longifolia</i> on slopes	Taxandria linearifolia, Astartea fascicularis, Hypocalymma angustifolium on valley floor, Hakea lissocarpha, Bossiaea ornata, Macrozamia riedlei, Phyllanthus calycinus on slopes	107	5	
Hester	Open Forest of <i>Eucalyptus</i> <i>marginata</i> and <i>Corymbia calophylla</i>	Good development of Banksia grandis, Allocasuarina fraseriana and Persoonia longifolia	Leucopogon verticillatus, Leucopogon propinquus, Bossiaea ornata, Hakea lissocarpha and Macrozamia riedlei	61	3	
i otal				1,989	100	

#### Table 2.1: Vegetation complexes within the Study Area (Mattiske & Havel, 1998)


## 2.4 Land Use

The dominant land uses in the Southern Jarrah Forest subregion include grazing (improved pastures) and dry land agriculture, forestry (of native forest) and conservation (Hearn *et al.*, 2002). There are smaller but still significant areas of forestry (plantations), irrigated horticulture, mining, rural residential and easements (for roads, power lines, etc.; Hearn *et al.*, 2002).

Much of the Study Area consists of the active lithium mine (1,052.7 ha, 53%). A substantial portion of the Study Area overlaps with the Greenbushes State Forest (Figure 2.3). A further 12 State Forests are also known to occur within the surrounding 30 km (Figure 2.3), the nearest being Hester State Forest (immediately south of the Study Area). There are also two Conservation Parks (Hester Conservation Park and Kerr Conservation Park), three National Parks (the nearest Dalgarup National Park, 7.7 km south-west), and four Nature Reserves (the nearest Greenbushes Nature Reserve 5.2 km west) within 30 km of the Study Area (Table 4.3).

Name	Distance from Study Area					
Conservation Park						
Hester Conservation Park	6 km east					
Kerr Conservation Park	12 km north					
Nature Park						
Dalgarup National Park	8 km south-west					
Powlalup National Park	8 km west					
Greater Kingston National Park	24 km south-east					
Nature Reserve						
Greenbushes Nature Reserve	5 km west					
Nollajup Nature Reserve	20 km east					
Wilga Nature Reserve	22 km north-east					
Donnybrook Boyup Brook Road Nature Reserve	25 km north-east					
State Forest						
Greenbushes State Forrest	Within Study Area					
Hester State Forest	Contacts southern border					
Wilga State Forest	1 km north					
Nannup State Forest	7 km south-west					
Mullalyup State Forest	10 km north-west					
Yornup State Forest	10 km south					
North Donnelly State Forest	10 km south-west					
Ellis Creek State Forest	15 km south-west					
East Kirup State Forest	16 km north-west					
Jarrahwood State Forest	18 km east					
Palgarup State Forest	23 km east					
South East Nannup State Forest	24 km south-west					
Milyeannup State Forest	28 km south-west					

#### Table 2.2: Conservation estate within 50 km of the Study Area







## 3 METHODOLOGY

## 3.1 Vertebrate Fauna

## 3.1.1 Desktop Assessment

The vertebrate fauna desktop assessment was conducted via reviewing literature relevant to the Study Area and conducting a number of database searches.

A review of all available literature relevant to the Study Area was undertaken to compile a list of vertebrate fauna species with the potential to occur with the Study Area. This list comprised seven surveys, including two which were undertaken within the Study Area, two large regional-scale surveys and three publicly available Level 1 survey reports conducted within the close vicinity of the Study Area (Table 3.1).

Survey Title	Reference	Survey Type	Distance from Study Area (km)
Target Vertebrate Survey of the Greenbushes Mine	Biologic (2018)	Target Survey	within
Greenbushes Level 1 Fauna Survey	Biologic (2011)	Level 1 Fauna Survey	within
Greenbushes to Kirup Pipeline Route Vegetation, Flora and Fauna Assessment	Astron (2013)	Level 1 Fauna Survey	~1 km north to 20 km north- west
Greenbushes to Kirup Link Biological Assessment	GHD (2017)	Level 1 Fauna Survey	~5 km north- west to 21 km north-west
Edith Cowan University, South West Campus Fauna Assessment	ENV Australia (2008)	Level 1 Fauna Survey	~65 km north- west
Vertebrate Fauna in the Southern Forests of Western Australia	Christiensen <i>et al.</i> (1985)	Regional Level 2 (equivalent) Survey	0-215 km from Study Area
The Ground Vertebrate Fauna of the Coastal Areas between Busselton and Albany, Western Australia	How <i>et al.</i> (1987)	Regional Level 2 (equivalent) Survey	~65 km west

Four fauna databases were searched (Table 3.2); two to obtain information on all species previously recorded (Birdlife Australia, 2018; DBCA, 2018a), one to identify species of conservation significance previously recorded (DBCA, 2018b), and one to identify species of conservation significance known or likely to occur within the region (DoEE, 2018).

Table 3.2: Details	of database	searches	conducted
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Provider	Database	Reference	Parameters
Department of Biodiversity, Conservation and Attractions	NatureMap Database	DBCA (2018a)	Circle of radius 25 km centred on the coordinates: -33.86903 S, 116.06204 E
Department of Biodiversity, Conservation and Attractions	Threatened and Priority Fauna Database	DBCA (2018b)	Circle of radius 25 km centred on the coordinates: -33.86903 S, 116.06204 E
BirdLife Australia	Birdata Bird Atlas	Birdlife Australia (2018)	Circle of radius 25 km centred on the coordinates: -33.86903 S, 116.06204 E
Department of Environment and Energy	Protected Matters Database	DoEE (2018)	Circle of radius 25 km centred on the coordinates: -33.86903 S, 116.06204 E

#### 3.1.2 Taxonomy and Nomenclature

The latest checklist of mammal, reptile and amphibian names published by the Western Australian Museum (WAM, 2017) was used as a guide to the current taxonomy and nomenclature of these groups. For birds, the current checklist of Australian birds maintained by Birdlife Australia (based on Christidis & Boles, 2008) was used in conjunction with the WAM species list (WAM, 2017).

## 3.1.3 Likelihood of Occurrence for Fauna of Conservation Significance

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 3.3).

	Habitat Categories					
Range categories:	Core habitat known toForaging habitat known to occurDispersal 		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	

Table 3.3: Species likelihood of occurrence decision mat
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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; and
- 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 may be more likely to represent range extensions.

## 3.2 Short-range Endemic Invertebrate Fauna

## 3.2.1 Desktop Assessment

Five databases were searched for SRE invertebrate fauna records within and surrounding the Study Area to determine the likely SRE fauna values (Table 3.4).

Within the WAM databases, a distribution criterion of 40,000 km<sup>2</sup> was applied (following Harvey, 2002), thereby selecting species within these groups where the known records occur within 40,000 km<sup>2</sup>. Indeterminate records were excluded, except where generic level characters and distribution information was sufficient to point to a high likelihood that the species could be SRE. Within these databases, records of mygalomorph spiders, selenopid spiders, pseudoscorpions, scorpions, millipedes, terrestrial snails, and isopods were targeted.



Custodian	Database	Reference	Parameters
Department of Biodiversity, Conservation and Attractions	NatureMap Database	DBCA (2018a)	Circle of radius 25 km centred on the coordinates: 116° 03' 43" E,33° 52' 09" S
Western Australian Museum (WAM)	Crustacea Collection Database	WAM (2018b)	Bounding Box (40,000km <sup>2</sup> ) using points: Northwest -32.86201°S, 115.143431°E Southeast -34.866185°S, 117.007636°E
Western Australian Museum	Mollusc Collection Database	WAM (2018c)	Bounding Box (40,000km <sup>2</sup> ) using points: Northwest -32.86201°S, 115.143431°E Southeast -34.866185°S, 117.007636°E
Western Australian Museum	Arachnid and Myriapod Collection Database	WAM (2018a)	Bounding Box (40,000km <sup>2</sup> ) using points: Northwest -32.86201°S, 115.143431°E Southeast -34.866185°S, 117.007636°E
Atlas of Living Australia	Australian Museums Specimens Database	ALA (2015)	Circle of radius 10 km centred on the coordinates: -33.86903 S, 116.06204 E

## Table 3.4: Databases used for the review

## 3.3 Subterranean Fauna

## 3.3.1 Desktop Assessment

Five databases were searched for subterranean fauna records (Table 3.5). All records were filtered based on collection methods, habitat and known stygofauna/ troglofauna taxonomic groups where information on subterranean status (*i.e.* hypogean subterranean/ soil fauna/ surface fauna) was not present.

Table 3	3.5: I	Datab	bases	searc	hed f	for su	bterran	iean fa	auna	record	S

Custodian	Database	Reference	Parameters
Department of Biodiversity, Conservation and Attractions	NatureMap Database	DBCA (2018a)	Circle of radius 25 km centred on the coordinates: 116° 03' 43" E,33° 52' 09" S
Western Australian Museum (WAM)	Crustacea and Worms Collection Database	WAM (2018b)	Bounding Box (40,000km²) using points: Northwest -32.86201°S, 115.143431°E Southeast -34.866185°S, 117.007636°E
Western Australian Museum	Mollusc Collection Database	WAM (2018c)	Bounding Box (40,000km <sup>2</sup> ) using points: Northwest -32.86201°S, 115.143431°E Southeast -34.866185°S, 117.007636°E
Western Australian Museum	Arachnid and Myriapod Collection Database	WAM (2018a)	Bounding Box (40,000km <sup>2</sup> ) using points: Northwest -32.86201°S, 115.143431°E Southeast -34.866185°S, 117.007636°E
Atlas of Living Australia	Australian Museums Arthropod Specimens	ALA (2015)	Circle of radius 10 km centred on the coordinates: -33.86903 S, 116.06204 E



# 4 RESULTS AND DISCUSSION

## 4.1 Vertebrate Fauna

## 4.1.1 Fauna Habitats

Onshore (2012) completed a review of vegetation and flora surveys conducted within the vicinity of Study Area. Fauna habitat maps were derived from vegetation communities delineated by Onshore (2012), and field observations and fauna habitat assessments conducted by Biologic (2011). A total of eight fauna habitats were recorded and mapped across the Study Area, comprising only three four that are naturally occurring (Jarrah/Marri Forest, Jarrah/Marri Forest over Banksia, Marri/Blackbutt/Flooded Gum Woodland over Banksia, Waterbodies) (Table 4.1).

Anthropogenic habitats comprised the greatest portion of the Study Area, contributing 62.5% (1,243 ha) of the overall Study Area. This comprised mining disturbance (1,052.7 ha), mine rehabilitation (129.4 ha) cleared farmland (52.1 ha), plantation (8.9 ha) and the Greenbushes townsite (<0.1 ha) (Table 4.1). Jarrah/Marri Forests were the most dominant habitat type within the Study Area, covering approximately 403.9 ha (20%). Drainage lines of the Study Area were often lined by Marri/Blackbutt/Flooded Gum Woodlands over a *Banksia*-dominated midstorey which were associated with water bodies.



# Table 4.1: Fauna habitat descriptions (Biologic, 2011)

Habitat	Description	Total area within Study Area							
		На	%						
Natural Habitats									
Jarrah/Marri Forest	<i>Eucalyptus marginata and Corymbia calophylla</i> forest over scrub on undulating hill slopes and drainage lines	403.9	20.3						
Jarrah/Marri Forest over Banksia	<i>Eucalyptus marginata and Corymbia calophylla</i> forest over <i>Banksia grandis/Persoonia longifolia</i> dominated scrub on upper hill slopes and plateaux	267.4	13.5						
Marri/Blackbutt/Flooded Gum Woodland over Banksia	Eucalyptus rudis, Corymbia calophylla and Eucalyptus patens woodland over Banksia littoralis woodland over Taxandria spp. heath along drainage lines and flats	<1	<1						
Waterbodies	Comprises large open water bodies of the study area, appear to be man-made structures	74.8	3.8						
Artificial or Disturbed Ha	bitats								
Mining Disturbance	All areas cleared for mining activity	1,052.7	52.9						
Mine Rehabilitation	All areas which have been rehabilitated within the Study Area	129.4	6.5						
Cleared Farmland	Open paddocks, sometimes containing remnant trees	52.1	2.6						
Plantation	Artificial pine plantations with the Study Area	8.9	0.4						
Townsite	Developed areas within the Study Area	<0.1	<0.1						
	Total	1,989	100						

# Legend Study Area Faun Habit Jarrah/Marri Forest Jarrah/Marri Forest over Banksia Marri/Blackbutt/Flooded Gum Woodland over Banksia Water Bodies Mine Rehabilitation Plantation Mine Disturbance Cleared Farmland 25. 57 Source: Esri, Digital Globe, GeolEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community Townsite

412500

407500

3250000

410000



## Talison Lithium Australia Greenbushes Fauna Desktop Assessment Figure 4.1: Fauna habitats mapped over the Study Area

415000

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



## 4.1.1 Vertebrate Fauna

The desktop assessment identified a total of 291 species of vertebrate fauna which have previously been recorded and/or have the potential to occur within the Study Area. This comprised 31 native mammals, 10 non-native mammals, 169 native, six non-native birds, 45 reptiles, 19 amphibians and 11 fish species (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.

## 4.1.2 Vertebrate Fauna of Conservation Significance

Of the 291 species of vertebrate fauna identified, 44 species are of conservation significance, comprising 13 mammals, 23 birds, two reptiles, one amphibian and five fish species (Table 4.2). Locations for species of conservation significance recorded by Birdlife Australia (2018); DBCA (2018b) are displayed in Figure 4.2 and Figure 4.3.

		Conservation Status			
Species	Common Name	EPBC Act	MCA	DBCA	IUCN
Mammals					
Bettongia penicillata ogilbyi	Brush-tailed Bettong, Woylie	EN	S1		CR
Myrmecobius fasciatus	Numbat, Walpurti	EN	S2		EN
Pseudocheirus occidentalis	Western Ringtail Possum, Ngwayir	VU	S1		CR
Setonix brachyurus	Quokka	VU	S3		VU
Macrotis lagotis	Bilby, Dalgyte	VU	S3		VU
Dasyurus geoffroii	Western Quoll, Chuditch	VU	S3		NT
Phascogale calura	Red-tailed Phascogale	VU	S6		NT
Phascogale tapoatafa wambenger	Wambenger Brush-tailed Phascogale		S6		NT
Isoodon obesulus fusciventer	Southern Brown Bandicoot, Quenda			P4	
Notamacropus eugenii derbianus	Tammar Wallaby			P4	
Notamacropus irma	Western Brush Wallaby			P4	
Falsistrellus mackenziei	Western Falsistrelle			P4	NT
Hydromys chrysogaster	Water Rat, Rakali			P4	
Birds					
Botaurus poiciloptilus	Australasian Bittern	EN	S2		EN
Calyptorhynchus baudinii	Baudin's Cockatoo	EN	S2		EN
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	S2		EN
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	S3		
Leipoa ocellata	Malleefowl	VU	S3		VU
Puffinus huttoni	Hutton's Shearwater		S2		EN

Table 4.2: Species	of conservation	significance	identified ar	nd their	conservation a	status
		Significance	iaciitiica ai		consci valion s	Julus



		C	IS		
Species	Common Name	EPBC Act	WCA	DBCA	IUCN
Numenius madagascariensis	Eastern Curlew	CR/MG	S3/S5		EN
Calidris ferruginea	Curlew Sandpiper	CR/MG	S3/S5		NT
Sterna caspia	Caspian Tern	MG	S5		
Pandion haliaetus	Osprey	MG	S5		
Calidris acuminata	Sharp-tailed Sandpiper	MG	S5		
Calidris melanotos	Pectoral Sandpiper	MG	S5		
Tringa glareola	Wood Sandpiper	MG	S5		
Tringa hypoleucos	Common Sandpiper	MG	S5		
Apus pacificus	Fork-tailed Swift	MG	S5		
Motacilla cinerea	Grey Wagtail	MG	S5		
Plegadis falcinellus	Glossy Ibis	MG	S5		
Sterna bergii	Crested Tern	MG	S5		
Falco peregrinus	Peregrine Falcon		S7		
Ixobrychus flavicollis australis	Black Bittern			P2	
Ninox connivens connivens	Barking Owl (southwest population)			P3	
Tyto novaehollandiae novaehollandiae	Masked Owl (southwest population)			P3	
Oxyura australis	Blue-billed Duck			P4	NT
Reptiles					
Elapognathus minor	Short-nosed Snake			P2	
Ctenotus delli	Dell's Skink			P4	
Amphibians					
Geocrinia lutea	Walpole Frog			P4	NT
Fish		L.			
Nannatherina balstoni	Balston's Pygmy Perch	VU	S3		DD
Galaxiella nigrostriata	Black-stripe Minnow		S2		NT (LR)
Lepidogalaxias salamandroides	Salamanderfish		S2		NT (LR)
Galaxiella munda	Mud Minnow, Western Dwarf Galaxias		S3		NT (LR)
Geotria australis	Pouched Lamprey			P1	DD



Of the 44 species identified during the desktop assessment, seven have been confirmed within the Study Area:

- Carnaby's Cockatoo (Calyptorhynchus latirostris) Endangered (EPBC Act, WC Act);
- Baudin's Cockatoo (Calyptorhynchus baudinii) Endangered (EPBC Act, WC Act);
- Western Quoll (Dasyurus geoffroii) Vulnerable (EPBC Act and WC Act);
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) Vulnerable (EPBC Act, WC Act);
- Wambenger Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) Conservation Dependent (WC Act);
- Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) Priority 4 (DBCA Priority List); and
- Western Brush Wallaby (Notamacropus irma) Priority 4 (DBCA Priority List).

A further species, Western Ringtail Possum (*Pseudocheirus occidentalis*, Vulnerable, EPBC Act), Critically Endangered, WC Act), has possibly been recorded in the Study Area. The species was possibly recorded via scats although the material cannot be distinguished from those of the Common Brushtail Possum (*Trichosurus vulpecula*).

Based on distribution, previous records and the habitats present, a further species was deemed highly likely, two likely, seven possible, one rarely, seven unlikely and eighteen highly unlikely to occur in the Study Area (Table 4.3). The Great Egret (*Ardea modesta*), Rainbow Bee-eater (*Merops ornatus*), Southwest Carpet Python (*Morelia spilota imbricata*) and Bush Stone-curlew (*Burhinus grallarius*) were previously listed as being of conservation significance by Biologic (2011). Each of these species has since been delisted and are therefore not considered within this report.





 Ialison Lithium Australia

 Greenbushes Fauna Desktop Assessment

 Figure 4.1: Mammals of Conservation Significance

 recorded in the vicnity of the Study Area

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018





#### Talison Lithium Australia Greenbushes Fauna Desktop Assessment Figure 4.3: Species of conservation significance recorded in the vicnity of the Study Area

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



Table 4.3 Conservation significant species likelihood assessment

	Conservation Status				Within	Distance to		Previous	Current Likelihood
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Mammals									
Brush-tailed Bettong, Woylie ( <i>Bettongia</i> <i>penicillata</i> <i>ogilbyi</i> )	EN	S1	Woodlands and adjacent heaths with a dense understorey of shrubs particularly <i>Gastrolobium</i> sp. (Woinarski <i>et al.</i> , 2014). Species confined to two indigenous colonies in south-west and a small number of reintroduced areas (Start <i>et al.</i> , 1995).	Yes	Yes	~11 km south (1998); 23 km north- east (2014) (DBCA, 2018b)	No	Not Assessed	Unlikely
Numbat, Walpurti ( <i>Myrmecobius</i> fasciatus)	EN	S2	Eucalypts forests and woodland, notably wandoo and jarrah woodland (Van Dyck & Strahan, 2008). Known from few localised populations (Friend & Page, 2015)	Yes	Yes	~5 km north (2006); 15 km south (1994) (Thackway & Cresswell, 1995)	No	Not Assessed	Possible
Western Ringtail Possum, Ngwayir ( <i>Pseudocheirus</i> occidentalis)	VU	S1	Coastal Agonis flexuosa forest or eucalypt woodland or forest with a midstorey of Agonis flexuosa (Burbidge & de Tores, 1998; Jones <i>et al.</i> , 1994)	Yes	Yes	<1 km north (DBCA, 2018b)	Possibly (secondary evidence)	Not Assessed	Possibly Confirmed– possible scats recorded in Study Area (Biologic, 2018)
Quokka (Setonix brachyurus)	VU	S3	Habitat varies, but prefer <i>Acacia</i> and <i>Melaleuca</i> thickets. In Jarrah Forest associated with tea-tree, <i>Taxandria linearifolia</i> (de Tores, 2008).	No	Yes	~11 km south-west (2004) (DBCA, 2018b)	No	Unlikely	Possible – recent surveys have identified a population in bushland which is connected to that in the Study Area
Bilby, Dalgyte ( <i>Macrotis lagotis</i> )	VU	S3	Sandy spinifex and tussock grasslands/shrublands throughout current distribution. In the southwest, mixture of woodland including Jarrah, Marri and Wandoo (Abbott, 2001)	No	No	~8 km south- east (1932); 12 km south- east (1929) (DBCA, 2018b)	No	Not Assessed	Highly Unlikely



	Conse St	ervation atus			Within	Distance to		Previous	Current Likelihood
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Western Quoll, Chuditch (Dasyurus geoffroii)	VU	S3	In the Jarrah forest, Chuditch occur in moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest particularly in Riparian vegetation (Orell & Morris, 1994)	Yes	Yes	<1 km north (1987) (DBCA, 2018b)	Yes (Biologic, 2018)	Likely	Confirmed (Biologic, 2018)
Red-tailed Phascogale ( <i>Phascogale</i> <i>calura</i> )	VU	S6	Wandoo-rock sheoak uplands, and lowland habitat with riverine fringing vegetation of swamp sheoak, York Gum and Wandoo (Short <i>et al.</i> , 2011).	No	No	~9 km south- east (date unknown (DBCA, 2018b)	No	Unlikely	Highly Unlikely
Wambenger Brush-tailed Phascogale (Phascogale tapoatafa wambenger)	-	S6	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Woinarski <i>et al.</i> , 2014).	Yes	Yes	<1 km north (2005, 2015) (DBCA, 2018b)	Yes (Biologic, 2018, 2011)	Confirmed	Confirmed (Biologic, 2018)
Southern Brown Bandicoot, Quenda ( <i>Isoodon</i> <i>obesulus</i> <i>fusciventer</i> )	-	P4	Jarrah Forest and swamp habitats, preferring dense vegetation around wetland fringes and heathland (Cooper, 1998; Woinarski <i>et al.</i> , 2014).	Yes	Yes	<1 km north (2015) (DBCA, 2018b)	Yes (Biologic, 2018)	Мау	Confirmed (Biologic, 2018)
Tammar Wallaby (Notamacropus eugenii derbianus)	-	P4	Dense, low vegetation for daytime shelter and open grassy areas for feeding. Inhabits coastal scrub, heath and dry sclerophyll forest (Woinarski <i>et</i> <i>al.</i> , 2014).	No	Yes	~45 km south-east (1994) (DBCA, 2018a)	No	Not Assessed	Unlikely
Western Brush Wallaby ( <i>Notamacropus</i> <i>irm</i> a)	-	P4	The species inhabits a wide-range of habitats including low Banksia woodlands, Jarrah/Marri woodlands and moist <i>Melaleuca</i> lowlands, favours open, grassy areas (Wann & Bell, 1997; Woinarski <i>et al.</i> , 2014).	Yes	Yes	<1 km north (1987, 2001) (DBCA, 2018b)	Yes (Biologic, 2018)	Likely	Confirmed (Biologic, 2018)



C		ervation atus			Within	Distance to		Previous	d Current Likelihood of Occurrence
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Western Falsistrelle ( <i>Falsistrellus</i> <i>mackenziei</i> )	-	P4	Tall forests and woodlands in the higher rainfall parts of the south-west, particularly Karri forests but also Tuart and Jarrah forests (Woinarski <i>et al.</i> , 2014).	Yes	Yes	~9 km south- west (2009) (DBCA, 2018b)	No	Мау	Likely – species has a large nightly range and has been recorded within the vicinity of the Study Area within similar habitats to what occurs
Water Rat, Rakali (Hydromys chrysogaster)	-	P4	Permanent bodies of fresh or brackish water, subalpine streams to lakes and farm dams and on sheltered coastal beaches, mangroves and offshore islands (Van Dyck & Strahan, 2008).	Yes	Yes	~10 km north (2016) (DBCA, 2018b)	No	Likely	Possible – Biologic (2011) assessed a larger area which contained suitable habitat. Habitats contained within this Study Area are less suitable for the species
Birds						•			
Australasian Bittern ( <i>Botaurus</i> <i>poiciloptilus</i> )	EN	S2	Beds of tall dense <i>Typha baumea</i> and sedges in freshwater swamps (Johnstone & Storr, 1998b).	No	Yes	~22 km south (1977) (DBCA, 2018b)	No	Мау	Unlikely – Biologic (2011) assessed a larger area which contained suitable habitat. No suitable habitats within this Study Area
Baudin's Cockatoo (Calyptorhynchus baudinii)	EN	S2	Species forages primarily in Eucalypt forest, feeding on Marri nuts, flowers, nectar and seeds (Johnstone & Storr, 1998b). Nesting trees are Karri, Marri, and Wandoo (Johnstone & Kirkby, 2008).	Yes	Yes	~6 km south- east (1996) (DBCA, 2018b)	Yes	Confirmed	Confirmed
Carnaby's Cockatoo (Calyptorhynchus latirostris)	EN	S2	Proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests (Johnstone & Storr, 1998b).	Yes	Yes	<1 km north (2011) (DBCA, 2018b)	Yes	Confirmed	Confirmed



Conservatio Status		ervation atus			Within	Distance to		Previous	Current Likelihood
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Forest Red-tailed Black Cockatoo (Calyptorhynchus banksii naso)	VU	S3	Eucalypts forests. Attracted to seeding Marri, Jarrah, Blackbutt, Karri and Sheoak (Johnstone & Storr, 1998b).	Yes	Yes	<1 km north (2016) (DBCA, 2018b)	Yes	Confirmed	Confirmed
Malleefowl (Leipoa ocellata)	VU	S3	Inhabits semi-arid shrublands and low woodlands dominated by mallee eucalypts and/or acacias (Benshemesh, 2007)	No	No	~22 km north (2005)- 'uncertain' sighting (DBCA, 2018b)	No	Not Assessed	Highly Unlikely
Hutton's Shearwater ( <i>Puffinus huttoni</i> )	-	S2	Marine species. Recorded in Western Australia as a passing migrant only and usually recorded well offshore (Johnstone & Storr, 1998a).	No	No	~85 km west (2011) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely
Eastern Curlew ( <i>Numenius</i> <i>madagascariensi</i> s)	CR/M G	S3/S5	Mainly tidal mudflats, also reef flats, sandy beaches and rarely near-coastal lakes including saltwork ponds (Johnstone & Storr, 1998a).	No	No	~85 km north (2000) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely
Curlew Sandpiper ( <i>Calidris</i> <i>ferruginea</i> )	CR/MI	S5	Inhabits intertidal mudflats in sheltered coastal areas (i.e. estuaries, bays, inlets and lagoons) (Geering <i>et al.</i> , 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 <i>et al.</i> , 2007).	No	No	~70 km north (2000) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely
Caspian Tern (Sterna caspia)	MG	S5	Mainly sheltered seas, estuaries and tidal creeks; occasionally near-coastal salt lakes (including saltwork ponds) and brackish pools in lower courses of rivers; rarely fresh water (Johnstone & Storr, 1998a).	No	No	~80 km west (2000) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely



Conservation Status		ervation atus			Within	Distance to		Previous	d Current Likelihood
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Crested Tern (Sterna bergii)	MG	S5	Favours sheltered seas, also estuaries and saltwork ponds. Rarely crosses the coastline and inland records generally involve birds driven by a storm or cyclone (Johnstone & Storr, 1998a).	No	No	~80 km west (2000) (DBCA, 2018a)	No	Not Assessed.	Highly Unlikely
Osprey (Pandion haliaetus)	MI	S5	Occurs mainly in sheltered seas around islands, tidal creeks, estuaries and saltwork ponds, also large river pools (Johnstone <i>et al.</i> , 2013)	No	No	~54 km west (1945); 80 km west (2014) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely
Sharp-tailed Sandpiper ( <i>Calidris</i> <i>acuminata</i> )	MI	S5	Coastal and inland areas saline and freshwater but prefers non-tidal fresh or brackish wetlands (Geering <i>et al.</i> , 2007)	No	No	~52 km west (2008) (Birdlife Australia, 2018; DBCA, 2018b)	No	Not Assessed	Highly Unlikely
Pectoral Sandpiper ( <i>Calidris</i> <i>melanotos</i> )	MI	S5	Mainly fresh waters i.e. swamps, lagoons, river pools, irrigation channels and sewage ponds (Johnstone & Storr, 1998b).	No	No	~158 km west (2004) (Birdlife Australia, 2018; DBCA, 2018b)	No	Not Assessed	Highly Unlikely
Wood Sandpiper ( <i>Tringa glareola)</i>	MI	S5	Freshwater wetlands and occasional brackish intertidal mudflats (Geering <i>et al.</i> , 2007).	No	No	~5 km west (2005) (DBCA, 2018b)	No	Not Assessed	Highly Unlikely
Common Sandpiper ( <i>Actitis</i> <i>hypoleucos</i> )	MI	S5	Edge of sheltered waters, salt or fresh, estuaries, river pools, claypans, drying swamps etc. (Johnstone & Storr, 1998b).	No	Yes	~38 km east (2006) (Birdlife Australia, 2018; DBCA, 2018b)	No	Not Assessed	Highly Unlikely



Conservation Status		ervation atus		Within		Diotonoo to		Previous	Current Likelihood
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Fork-tailed Swift ( <i>Apus pacificus</i> )	MI	S5	Aerial species, which forages high above the tree canopy and rarely lower (Johnstone & Storr, 1998b).	No	No	~130 km north (1956) (DBCA, 2018a)	No	Likely	Highly Unlikely – Data since 2011 enables a better understanding of this species movements within Australia. The species has not been recorded in the subregion previously (DBCA, 2018a).
Grey Wagtail ( <i>Motacilla</i> <i>cinerea</i> )	МІ	S5	A rare vagrant to Western Australia where it has been recorded within various habitats with open waterbodies (Johnstone & Storr, 2004).	No	No	>500 km north (2015) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely
Glossy Ibis (Plegadis falcinellus)	-	S5	Freshwater wetlands, irrigated areas, margins of dams, floodplains, brackish and saline wetlands, tidal mudflats, pastures, lawns and public gardens (Johnstone <i>et al.</i> , 2013).	No	Yes	~30 km south-west (2001) (Birdlife Australia, 2018; DBCA, 2018a)	No	Not Assessed	Highly Unlikely
Peregrine Falcon (Falco peregrinus)	_	S7	The species occurs along coastal cliffs, rivers and ranges as well as wooded watercourses and lakes nesting on cliffs, granite outcrops, quarries and in the wheatbelt, old Raven and Whistling Kite nests (Johnstone & Storr, 1998b).	Likely	Yes	~10 km north-west (2001); ~11 km south-east (2003) (Birdlife Australia, 2018; DBCA, 2018b)	No	Likely	Rarely – Biologic (2011) assessed a larger area which contained suitable habitat. Habitats contained within this Study Area are less suitable for the species
Black Bittern (Ixobrychus flavicollis australis)	-	P2	Freshwater pools, swamps and lagoons, well screened with trees (Johnstone & Storr, 1998b).	Yes	Yes	~10 km south-east (1931) (DBCA, 2018b)	No	Мау	Possible



	Conservation Status				Mithin	Distance to		Previous	d Current Likelihood
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Barking Owl (southwest population) ( <i>Ninox connivens</i> <i>connivens</i> )	-	P3	The southern subspecies occurs primarily in dry sclerophyll woodland, particularly that associated with riparian vegetation (Johnstone & Storr, 1998b).	Yes	Yes	~30 km east (1963) (DBCA, 2018a)	No	Мау	Possible
Masked Owl (southwest population) ( <i>Tyto</i> <i>novaehollandiae</i> <i>novaehollandiae</i> )	-	P3	Deep southwest forested areas (Johnstone & Storr, 1998b) and some dry woodland areas in the north of its range (Garnett & Crowley, 2000)	Yes	Yes	<1 km east (2001); <1 km north (2000) (DBCA, 2018b)	No	Мау	Highly Likely – new database search (DBCA, 2018b) has revealed the locality of recent/close records
Blue-billed Duck (Oxyura australis)	-	P4	Mainly deep freshwater swamps and lakes; occasionally salt lakes and estuaries freshened by flood waters (Johnstone & Storr, 1998b).	Yes	Yes	~15 km north-west (2005); 15 km west (1999) (DBCA, 2018b)	No	Not Assessed	Likely
Reptiles									
Short-nosed Snake ( <i>Elapognathus</i> <i>minor</i> )	-	P2	Favours heathlands margining swamps, though also known from wet sclerophyll forests (Cogger, 2014)	No	No	~70 km south (1998) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely
Dell's Skink ( <i>Ctenotus delli</i> )	-	P4	Dry sclerophyll forest on stony hills and ranges (Cogger, 2014), but otherwise undocumented.	Yes	Yes	~8 km east (1982) (DBCA, 2018b)	No	Unlikely	Possible – new database search (DBCA, 2018b) has revealed the locality of close records
Amphibians									
Walpole Frog (Geocrinia lutea)	-	P4	Confined to wet karri forest. Found in tunnels under streamside vegetation, or in and under rotting logs (Cogger, 2014)	No	No	~145 km south-east (2014) (DBCA, 2018a)	No	Not Assessed	Highly Unlikely

biologic

Conservation Status		ervation atus			Mithin	Diotonoo to		Previous	Current Likelihood
Species	EPBC Act	WC Act	Preferred Broad Habitats Within Region	Habitat Within Study Area	Current Known Distribution	Nearest Record - Year	Recorded Within Study Area	of Occurrence (Biologic, 2011)	of Occurrence (explanation where different from Biologic, 2011)
Fishes									
Balston's Pygmy Perch (Nannatherina balstoni)	VU	S3	Drainages and wetlands within 30 km of the south-western coast of WA between Margaret River and Albany. The species prefers shallow freshwater pools, streams and lakes in sandy areas, often acid and tannin stained (DEWHA, 2011)	No	No	~45 km south-west (2010) (DBCA, 2018a)	No	Not Assessed	Unlikely
Black-stripe Minnow (Galaxiella nigrostriata)	-	S2	Inhabits coastal ephemeral wetlands of south-west Western Australia (Bray & Gomon, 2018).	No	Yes	~13 km north (1986); ~15 km north (1985) (DBCA, 2018b)	No	Not Assessed	Unlikely
Salamanderfish (Lepidogalaxias salamandroides)	-	S2	Lives in small semi-permanent (ephemeral) pools and streams and (Bray & Gomon, 2018)	No	Yes	~13 km north (1986); ~15 km north (1985) (DBCA, 2018b)	No	Not Assessed	Unlikely
Mud Minnow, Western Dwarf Galaxias (Galaxiella munda)	-	S3	Creeks and streams of south-west Western Australia (Bray & Gomon, 2018)	No	Yes	~25 km west (2012) (DBCA, 2018b)	No	Not Assessed	Possible
Pouched Lamprey ( <i>Geotria</i> <i>australis</i> )	-	P1	Anadromous - adults spawn in the headwaters of freshwater rivers and streams (Bray & Gomon, 2018). When the ammocoetes hatch, they drift downstream and burrow into soft muddy sediments (Bray & Gomon, 2018).	No	No	~30 km south-west (2012) (DBCA, 2018a)	No	Not Assessed	Unlikely



## 4.2 Short-range Endemic Invertebrate Fauna

## 4.2.1 Habitat Mapping

Species considered SRE are often confined to specific microhabitats related to landforms, vegetation and soil types, and as such SRE habitat mapping is usually conducted at a finer scale to that for vertebrate fauna. Nevertheless, in some instances vertebrate fauna habitat mapping can be used as a preliminary indication of potential suitability for SRE species. The inferred SRE suitability of the existing vertebrate fauna habitat types defined by Biologic (2011) is detailed below in Table 4.4 and mapped in Figure 4.4. Although this assessment is based on limited data available to date and lacks confirmation by detailed SRE habitat assessment on-site, Table 4.4 shows that the habitat types described within the Study Area are expected to have some potential for SRE fauna to occur.

Hebitet	Description	SRE	Total Area		
Habitat	Description	Suitability	Hectares	%	
Jarrah/Marri Forest	<i>Eucalyptus marginata and Corymbia calophylla</i> forest over scrub on undulating hill slopes and drainage lines.	Moderate	403.9	20.3	
Jarrah/Marri Forest over Banksia	Eucalyptus marginata and Corymbia calophylla forest over Banksia grandis/Persoonia longifolia dominated scrub on upper hill slopes and plateaux	Moderate	267.4	13.5	
Marri/Blackbutt/Fl ooded Gum Woodland over Banksia	<i>Eucalyptus rudis, Corymbia</i> <i>calophylla</i> and <i>Eucalyptus patens</i> woodland over <i>Banksia littoralis</i> woodland over <i>Taxandria</i> spp. heath along drainage lines and flats	Moderate	<1	<1	
Waterbodies	Comprises large open water bodies of the study area, appear to be man- made structures	Not assessed	403.9	20.3	
Disturbed habitats	Comprising areas of mine disturbance, mine rehabilitation, cleared farmland, plantation and townsite	Low	1,243.1	62.5	
		Total	1,989	100	

## Table 4.4: Inferred suitability of vertebrate fauna habitats (Biologic 2011) for SRE fauna

## Low Suitability

Areas disturbed by mining, farming or plantation forestry would be expected to have a low suitability for SRE fauna due to the disturbance of the natural vegetation and soil. This does not mean that SRE fauna could never be found in such areas (especially if rehabilitated) but depending upon the magnitude and duration of impacts from human activity, the chances of SRE fauna persisting would be considered low. In a similar way, but not to the same degree, wetland areas that are seasonally flooded (such as areas dominated by *Typha* sedges) would be considered too frequently disturbed by natural disturbances to support terrestrial SRE fauna. These areas may form habitat for restricted aquatic species such as the



Threatened freshwater mussel *Westralunio carteri* (which is known to occur in the search area surrounding the Study Area), although aquatic species are not considered herein.

## Moderate Suitability

Owing mainly to high habitat complexity in leaf litter, woody debris and scattered rock formations, and the prevalence of shade offered by the dense vegetation, the three habitat types featuring Jarrah/ Marri forest and Marri/Blackbutt/Flooded Gum Woodland would be considered to have a moderate potential to host SRE fauna. Historically, these types of habitats were widespread throughout the landscape, which would have allowed most invertebrate species the opportunity to disperse reasonably widely, even if sensitive to desiccation. However, habitat loss and fragmentation due to human impacts has likely further reduced the distribution and opportunities for dispersal of most dispersal-limited invertebrate taxa (including SRE taxa) occurring in these types of forest/ woodland habitats. Patches of more mesic habitats (such as south facing slopes, gullies and drainage lines) are likely to occur within the more undulating forest habitat types that are even more likely to support SRE fauna.

## 4.2.2 Database Results

Only one terrestrial invertebrate (a widespread species) has been recorded within the Study Area to date, highlighting a lack of sampling effort.

The search of NatureMap online databases only revealed four records likely to represent SRE fauna (Appendix C), owing mainly to poor taxonomic resolution of most of the records within the NatureMap database. The Threatened freshwater mussel *Westralunio carteri* was recorded from the area, although aquatic species are not considered as part of the terrestrial SRE fauna herein.

The search of WAM databases revealed 29 records belonging to taxonomic groups which are known to include SRE fauna (comprising isopods, scorpions, mygalomorph spiders, millipedes and terrestrial snails) within the vicinity (25 km) of the Study Area (Appendix C). None of these records were confirmed SRE fauna or conservation significant invertebrate species (excluding *W. carteri* mentioned above) to the best of available knowledge, but most of the records represented specimens identified only to family or genus level, therefore confirmation of SRE status was not possible. Not all members of these taxonomic groups are regarded as SRE fauna: within each family or genus there may be a variety of more widely occurring species and more highly restricted species, but there is still a chance that some of these records may represent SRE fauna.

Largely due to the current lack of sampling, the likelihood of SRE species cannot be confirmed; however, based on the nearby occurrence of higher taxa known to include SRE species, and the presence of habitats regarded as moderately suitable for SRE fauna, it is not currently possible to infer that SRE fauna do not occur within the Study Area.





## 4.3 Subterranean Fauna

## 4.3.1 Geology and Hydrogeology

The Study Area is located within the Darling Plateau, which consists of an undulating dissected peneplain with gravelly, pale orange soils. Deep steeply-sided valleys occur throughout the area, occasionally punctuated by dome-shaped granite outcrops (Water Corporation, 2004). Soils are predominantly gravels with occasional block laterite outcrops and some elevated areas of sands and sandy loams. In the deeper valleys, the soils are heavier alluvial (Water Corporation, 2004).

Three broad surface geology types have been mapped (Figure 4.5) across the Study Area. The dominant geological groups being the undivided sediments and ferruginous duricrust, both of which are sedimentary in nature. Bordering the eastern edge and intruding from the west of the Study Area is granulite, gneiss surface geology (Figure 4.5). Five bedrock geologies that are of metamorphic and igneous origin have been recognised throughout the Study Area. Granulite and migmatite (A-xmno-mni-YSW) as well as granatic gneiss (A-mgn-YSW) and amphibolite (A-mwa-YSW) dominate the Study Area with smaller pockets of pegmatite (A-gp-YSW) and metagabbro/metaperidotite (A-xmo-ma-YSW) have also been recognised (Figure 4.5).

The Study Area is situated in the Blackwood River catchment within the Karri groundwater sub-area. Department of Water (DOW) recognises three sub-catchments within the Study Area, Norilup Brook which dominates the area as well as Hester Brook bordering the east and Bridgetown-Blackwood to the south (Figure 4.7). Department of Water and Environmental Regulation (DWER) identifies four levels of groundwater aquifers of the Karri sub-area, all of which are hosted in the Combined – Fractured Rock West Aquifer; Alluvium, Calcrete, Paleochannel and Fractured Rock (available at https://maps.water.wa.gov.au/#/webmap/register, accessed 09/03/2018). Localised at the Study Area, two aquifers dominated by fractured and weathered rocks ('An' and 'Ano') are present and are characterised with very minor or no groundwater resources with the subsurface generally weathered to clay (Figure 4.7). The geological and hydrological units of the Study Area have been summarised and their suitability to host subterranean fauna generalised in Table 4.5.

## 4.3.2 Potential Subterranean Fauna Habitat

Based on the available geological and hydrogeological information, it appears a number of prospective habitats for troglofauna (above water table) and stygofauna (below water table) may potentially occur throughout the Study Area (Table 4.5).

Potential troglofauna habitat of the Study Area would likely be confined to the surface geologies, given consideration of higher groundwater levels of the South-West. The most prospective habitats for troglofauna are likely to be the undivided sediments and ferruginous duricrust surface geologies that cover the majority of the Study Area (Figure 4.5). Both are sedimentary regolith in nature and have been characterised with; poorly consolidated sediments, colluvial/alluvium sediments, weathered rocks, nodular or vuggy laterite and calcretes. Such characteristics have shown to provide suitable habitat for subterranean fauna (troglofauna and stygofauna) throughout the Pilbara, Mid-West and Yilgarn bio-regions and therefore classified as medium suitability for subterranean fauna; however, the likelihood of



troglofauna (and stygofauna) occurrence within these geologies would be dependent on the extent of suitable habitat relative to the water table. Information inferring extent and suitability of habitat for troglofauna (drill cores, bore logs, geological/hydrological modelling) has not been available at the time of writing.

Unit Code	Description	Suitability to subterranean fauna (generalised)				
Surface Geology						
Granulite, gneiss 74316	High-grade metamorphic rock (felsic granulite, mafic granulite) - Mafic and felsic granulites: hornblende-plagioclase-hypersthene granulite, quartz-feldspar-biotite gneiss with lenses of schist, amphibolite, ultramafic rock, banded iron formation, quartzite; quartz-feldspar-hornblende layered gneiss	Low – unlikely to provide sufficient voids/ spaces (except possibly where fractured/ faulted)				
Undivided sediments 74488	Sedimentary, regolith (sedimentary rock, colluvial sediment, weathered material - unknown origin, sand - residual, silt - unknown origin) - Undivided poorly consolidated sediments: colluvium, weathered rocks, alluvium, sand, silt, clay, lacustrine and swamp deposits; silcrete, ferricrete, calcrete; shallow-marine sediments	Med - poorly consolidated sediments (colluvium, alluvium, shallow marine sediments) and weathered rock (silcrete, calcrete, ferricrete); clays less likely to be habitable. Likelihood of stygofauna/ troglofauna depends on habitat extent relative to water table.				
Ferruginous duricrust 38498	Regolith (lateritic duricrust) - Pisolitic, nodular or vuggy ferruginous laterite; some lateritic soils; ferricrete; magnesite; ferruginous and siliceous duricrusts and reworked products, calcrete, kaolinised rock, gossan; residual ferruginous saprolite	Med - vuggy ferruginous laterite, reworked ferruginous/ siliceous duricrust, and likely weathered rock (calcrete, ferricrete). Likelihood of stygofauna/ troglofauna depends on habitat extent relative to water table.				
Bedrock Ge	ology					
A-gp-YSW	Igneous granitic (Syntectonic, synmetamorphic zoned rare-metal pegmatite (includes Greenbushes Pegmatite))	Low – unlikely to provide sufficient voids/ spaces (except possibly where fractured/ faulted)				
A-mgn- YSW	Meta-igneous felsic intrusive (Granitic gneiss)	Low – unlikely to provide sufficient voids/ spaces (except possibly where fractured/ faulted)				
A-mwa- YSW	Meta-igneous mafic (Amphibolite)	Low – unlikely to provide sufficient voids/ spaces (except possibly where fractured/ faulted)				
A-xmno- mni-YSW	Metamorphic (Granulite and migmatite; high-grade metamorphic rock)	Low – unlikely to provide sufficient voids/ spaces (except possibly where fractured/ faulted)				
A-xmo-ma- YSW	Meta-igneous mafic intrusive (Metagabbro and metaperidotite, includes mafic/ultramafic igneous complexes)	Low – unlikely to provide sufficient voids/ spaces (except possibly where fractured/ faulted)				
Dolerite dykes	Numerous dolerite dykes are known to occur throughout the bedrock, in some cases extending to the surface (not shown on map)	Negligible – assumed to be impermeable and likely to provide potential barriers to species dispersal.				
Aquifers						
An	Fractured and weathered rocks - local aquifer, very minor or no groundwater resources (Granitoid gneiss, migmatite and minor schist; subsurface generally weathered to clay)	Low – limited or very localised groundwater resources (in fractured rocks) assumed to correspond to low suitability habitat for stygofauna				
Ano	Fractured and weathered rocks - local aquifer, very minor or no groundwater resources (Granitoid gneiss, migmatite and minor schist; subsurface generally weathered to clay)	Low – limited or very localised groundwater resources (in fractured rocks) assumed to correspond to low suitability habitat for stygofauna				

\*Unit codes reflective of labels in Figures 4.4 and 4.5.



Given higher groundwater levels of the South-West region, the prospective stygofauna habitat of the Study Area may potentially entail surface geologies, bedrock geologies as well as underlying aquifers of the Study Area. As mentioned previously, surface geologies of the undivided sediments and ferruginous duricrust may provide suitable stygofauna habitat where they are saturated (below groundwater table). Bedrock geology of the Study Area is assumed to be of low suitability for subterranean fauna as the bedrock layers are thought unlikely to provide sufficient voids/spaces (except possibly where fractured/faulted). Both aquifers of the Study Area are situated within fractured and weathered rocks characteristic of limited or very localised (in fractured rocks) groundwater reserves where the subsurface is generally weathered to clay. It is assumed these aquifers provide low suitability for stygofauna habitat. It is worth noting, that numerous dolerite dykes are known to occur throughout the Study Area, both in the bedrock and in cases extending to the surface. Whilst these are assumed to be impermeable and not suitable for subterranean fauna habitat, they are also likely to provide potential barriers to species dispersal if stygofauna are present.



Legend

Study Area Surface Geology (1:1,000,000)

ferruginous duricrust 38498 gneiss, granulite, migmatite 74310 granulite, gneiss 74316 undivided sediments 74488 N 1:50,000

Talison Lithium Australia Greenbushes Fauna Desktop Assessment Figure 4.5: Broad surface geology within the Study Area

2

km

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



3247500

Legend

Millstream

Norilup Creek

500

405000

Study Area		Hydrogeology description		
Hydrological sub-catchment			Very minor_localised aquifers -	
	Middle Blackwood		Very minor_localised aquifers -	
	Balingup Brook		Minor_localised aquifers - Grar	

407500

ogical sub-catchment	Very minor_localised aquifers - Granitoid gneiss, migmatite and minor schist
Middle Blackwood	Very minor_localised aquifers - Granitoid gneiss, migmatite and minor schist outcropping
Balingup Brook	Minor_localised aquifers - Granitoid rocks
Camp Brook	Aquiclude_no GW - Dolerite_Gabbro dyke or sill
Hester Brook	Minor fractured rock aquifer - Metamorphosed quartzite

410000

412500

lkm

N

1:60,000

0

0.5

415000

417500

Esrl, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, GIS User Community



Size A4. Created 12/03/2018

420000



## 4.3.3 Desktop Assessment

While subterranean fauna (troglofauna and stygofauna) appear to occur throughout Western Australia, there is considerable variation in species density at both regional and local scales (EPA, 2016c). The probability of determining the likely presence of subterranean fauna to occur within a region (and local geology) has been summarised by (EPA, 2016c) – see exert below.

Table 3.1. Probability that a site contains a rich subterranean fauna is largely determined by the region in which the site occurs and local geology. wery high, high, low.

Region	Geology	Stygofauna	Troglofauna
Kimberley	Karst, limestone, sandstone,		
2000000 EX	alluvium, islands		
Pilbara <sup>1</sup>	Most geologies		
	Barrow Island		
Inland deserts	Calcrete, alluvium		
Gascoyne/Murchiso	Calcrete, alluvium, banded ironstone		
n			
	Cape Range		
Yilgarn/Goldfields	Calcrete, alluvium, banded ironstone		
South-West	Most geologies		
	Karst		
Nullabor	Karst		

<sup>1</sup> Probability of a rich troglofauna assemblage is very high in parts of the Pilbara, e.g. Robe Valley.

The EPA guidance statement table above suggests that for most geologies of the South-West (with the exception of Karst geologies), the probability that a rich subterranean fauna assemblage exists is low. Having said this, the guidance statement (EPA, 2016c) also states;

Stygofauna and troglofauna have been recorded from few locations in the South-West, other than caves, although the existence of interstitial faunas has been documented and isolated studies have demonstrated the occurrence of subterranean communities, albeit not particularly rich, in a variety of settings. The occurrence of significant subterranean faunas in the South-West is likely to be associated with discrete geological features, particularly limestone formations (EPA, 2016c).

To assess the likely presence and composition of subterranean fauna in the Greenbushes region and likelihood within the Study Area, several databases were searched for subterranean records (Section 3.3.1). Due to a number of data fields being unpopulated/incomplete, high level identifications (not identified to species level) and poor taxonomic resolution within certain subterranean groups, some uncertainty exists to the subterranean status (hypogean subterranean/ soil fauna/ surface fauna) of some taxa. Where a level of uncertainty still exists, taxa potentially representing subterranean fauna (from groups where known subterranean variants exist), have been included and their potential subterranean status discussed. It can also be noted, at the time of writing, the WAM worm database was currently inaccessible and as such we were unable to query the worm database.



#### 4.3.4 Database Results

Results from the databases searches recognised numerous specimens that could potentially represent subterranean species. These belong to a variety of higher groups including worms, ostracods, amphipods, isopods, centipedes, millipedes, cockroaches and beetles (Table 4.6 and Table 4.7). Whilst it is unlikely many of these in fact represent true subterranean fauna (troglofauna and stygofauna), the level of identifications/morphospecies codes and lack of habitat and/or collection data means we are unable in many cases to determine their true subterranean status. To the best of our knowledge, previous subterranean surveys in the South-West have been extremely limited, particularly in the Darling Plateau and Karri sub-area regions.

WAM #	Latitude	Longitude	Site	Higher Group	Lowest ID	Habitat comments	Subterranean fauna status
15898	-33.966	116.067	Blackwood River Estuary	Amphipoda	Amphipoda sp.	(E) Estuarine	Unknown - likely estuarine species
15894	-33.966	116.067	Blackwood River Estuary	Amphipoda	Corophiidae sp.	(E) Estuarine	Unknown - likely estuarine species
15897	-33.966	116.067	Blackwood River Estuary	Amphipoda	Melita sp.	(E) Estuarine	Unknown - likely estuarine species
15895	-33.966	116.067	Blackwood River Estuary	Isopoda	lsopoda sp.	(E) Estuarine, substrate: Reed	Unknown - likely estuarine species
31566	-34.016	115.933	Dalgarup Nature Reserve	Isopoda	Spherillo sp. 5	(T) Terrestrial, under bark	Likely terrestrial species
32307	-34.066	116.1	CA. 15 km SW. of Bridgetown	Diplopoda	Diplopoda sp.	Under bricks in footpath	Unknown - likely epigean species
32308	-34.066	116.1	CA. 15 km SW. of Bridgetown	Diplopoda	Diplopoda sp.	Under bricks in footpath	Unknown - likely epigean species
143468	-33.966	116.1	Bridgetown, truffle orchard	Diplopoda	Brachyiulus sp.	Genus Brachyiulus often widespread, found in leaf- litter and top soil	Unknown - likely epigean species
25200	-34.066	116.1	15 km SW. of Bridgetown	Chilopoda	Geophilida sp.	In soil	Unknown - likely epigean species

#### Table 4.6: Potential subterranean taxa within the vicinity of the Study Area (WAM, 2018a,b, c)

Higher Group	Lowest ID	Potential Subterranean Fauna Status		
Worms				
Enchytraeidae	Enchytraeidae sp.	Potential stygofauna. Subterranean enchytraeidae species are known		
Naididae	Naididae sp.	Potential stygofauna. Subterranean naididae species are known		
Neoniphargidae	Neoniphargidae sp.	Potential stygofauna. Subterranean neoniphargidae species are known		
Oligochaeta	Oligochaeta sp.	Potential stygofauna. Subterranean oligochaeta species are known		
Phreodrilidae	Phreodrilidae sp.	Potential stygofauna. Subterranean phreodrilidae species are known		
Ostracods				
Ostracoda	Ostracoda (unident.)	Potential stygofauna. Subterranean ostracoda species are known		
Copopods				
	Calanoida sp.	Potential stygofauna. Subterranean calanoida species are known		
Copepoda	Copepoda sp.	Potential stygofauna. Subterranean copepoda species are known		
	Cyclopoida sp.	Potential stygofauna. Subterranean cyclopoida species are known		
Amphipods				
Paramelitidae	Paramelitidae sp.	Potential stygofauna. Subterranean paramelitidae species are known		
Isopods				
Oniscidae	Oniscidae sp.	Potential subterranean fauna. Subterranean oniscidae species are known		
Centipedes				
	Genus fc225 sp. fc225	Potential troglofauna. Family: Cryptopidae - troglofauna species are known		
Scolopendridae	Genus fc267 sp. fc267	Potential troglofauna. Family: Cryptopidae - troglofauna species are known		
Geophilidae	Genus fc1531 sp. fc1531	Potential troglofauna. Subterranenan geophildae species are known		
Millipedes				
le Pala	Genus fc259 sp. fc259	Potential troglofauna. Subterranenan julida species are known		
Julida	Genus fc260 sp. fc260	Potential troglofauna. Subterranenan julida species are known		
Cockroaches				
	Genus fc2662 sp. fc2662	Potential troglofauna. Subterranean blattidae species are known		
	Genus fc2672 sp. fc2672	Potential troglofauna. Subterranean blattidae species are known		
Plattidaa	Genus fc2970 sp. fc2970	Potential troglofauna. Subterranean blattidae species are known		
Diatticae	Genus fc2978 sp. fc2978	Potential troglofauna. Subterranean blattidae species are known		
	Genus fc508 sp. fc508	Potential troglofauna. Subterranean blattidae species are known		
	Genus fc936 sp. fc936	Potential troglofauna. Subterranean blattidae species are known		
Beetles				
	Carabidae sp.	Potential troglofauna. Subterranean carabidae species are known		
	Genus fc1442 sp. fc1442	Potential troglofauna. Subterranean carabidae species are known		
Carabidao	Genus fc2688 sp. fc2688	Potential troglofauna. Subterranean carabidae species are known		
Carabidae	Genus fc529 sp. fc529	Potential troglofauna. Subterranean carabidae species are known		
	Genus fc566 sp. fc566	Potential troglofauna. Subterranean carabidae species are known		
	Genus fc587 sp. fc587	Potential troglofauna. Subterranean carabidae species are known		
	Curculionidae sp.	Potential troglofauna. Subterranean curculionidae species are known		
	Genus fc156 sp. fc156	Potential troglofauna. Subterranean curculionidae species are known		
	Genus fc169 sp. fc169	Potential troglofauna. Subterranean curculionidae species are known		
	Genus fc199 sp. fc199	Potential troglofauna. Subterranean curculionidae species are known		
Curculionidae	Genus fc214 sp. fc214	Potential troglofauna. Subterranean curculionidae species are known		
	Genus fc2696 sp. fc2696	Potential troglofauna. Subterranean curculionidae species are known		
	Genus fc2973 sp. fc2973	Potential troglofauna. Subterranean curculionidae species are known		
	Genus fc2975 sp. fc2975	Potential troglofauna. Subterranean curculionidae species are known		
	Genus fc368 sp. fc368	Potential troglofauna. Subterranean curculionidae species are known		
Dytiscidae	Dytiscidae sp.	Potential stygofauna. Subterranean dytiscidae species are known		
Stanbylinidae	Genus fc628 sp. fc628	Potential troglofauna. Subterranean staphylinidae species are known		
Staphynnicae	Staphylinidae sp.	Potential troglofauna. Subterranean staphylinidae species are known		

# Table 4.7: Potential subterranean taxa within the vicinity of the Study Area (DBCA, 2018a)



# 5 CONCLUSIONS

The Study Area lies within the Southern Jarrah Forest. The dominant land uses in the Southern Jarrah Forest subregion include grazing (improved pastures) and dry land agriculture, forestry (of native forest) although a significant portion is currently covered within conservation estate.

## 5.1 Vertebrate Fauna

Four naturally occurring fauna habitats are known to occur within the Study Area: Jarrah/Marri Forest, Jarrah/Marri Forest over Banksia, Marri/Blackbutt/Flooded Gum Woodland over Banksia, and Waterbodies.

A large number of species (44) considered to be of conservation significance are known to occur within the vicinity of the Study Area. Two surveys targeting vertebrate fauna have been completed within the Study Area to date confirming that seven of these species occur within the Study Area:

- Carnaby's Cockatoo (Calyptorhynchus latirostris) Endangered (EPBC Act, WC Act);
- Baudin's Cockatoo (Calyptorhynchus baudinii) Endangered (EPBC Act, WC Act),
- Western Quoll (Dasyurus geoffroii) Vulnerable (EPBC Act and WC Act);
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) Vulnerable (EPBC Act, WC Act);
- Wambenger Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*) Conservation Dependent (WC Act);
- Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) Priority 4 (DBCA Priority List); and
- Western Brush Wallaby (*Notamacropus irma*) Priority 4 (DBCA Priority List).

A further species, Western Ringtail Possum (*Pseudocheirus occidentalis*, Vulnerable, EPBC Act), Critically Endangered, WC Act), has possibly been recorded in the Study Area. Based on distribution, previous records and the habitats present, a further species was deemed highly likely, two likely, seven possible, one rarely, seven unlikely and eighteen highly unlikely to occur in the Study Area. Further detail on the distribution and occurrence for species of conservation significance is documented by Biologic (2018).

## 5.2 Short-range Endemic Invertebrate Fauna

Only one terrestrial invertebrate (a widespread species) has been recorded within the Study Area to date, highlighting a lack of sampling effort. Database searches revealed 29 records of taxa belonging to taxonomic groups which are known to include SRE fauna (comprising isopods, scorpions, mygalomorph spiders, millipedes and terrestrial snails) within 25 km of the Study Area; however, none of these records were confirmed SRE fauna or invertebrate fauna of conservation significance.

Given the nearby occurrence of higher taxa known to include SRE species, and the presence of habitats regarded as moderately suitable for SRE fauna, it is possible that SRE fauna occur within the Study Area. As such a pilot SRE survey is recommended to confirm habitat suitability and extent and facilitate a more detailed assessment of the SRE status of the invertebrate species occurring within the Study Area and


surrounds. Further detail on the distribution and occurrence of SRE invertebrate fauna is documented elsewhere by (Biologic, 2018).

#### 5.3 Subterranean Fauna

Based on the available geological and hydrogeological information, it appears a number of prospective habitats for troglofauna (above water table) and stygofauna (below water table) may potentially occur within the Study Area. However, the occurrence of such species would be dependent on the extent of suitable habitat relative to the water table. Information suitable to infer extent and suitability of habitat for subterranean fauna (drill cores, bore logs, geological/hydrological modelling) was not available at the time of writing this report and thus a detailed assessment beyond stating that subterranean fauna may occur is not possible. Further uncertainty surrounding the occurrence of subterranean fauna is due to the lack of subterranean fauna sampling within the vicinity of the Study Area and/or greater South-West region and the level of detail provided from relevant databases searched.

Owing to the above limitations of the desktop study and in alignment with EPA (2016c) guidance statement:

*"In some cases, proponents may believe there is little likelihood of subterranean fauna occurring in a project area but desktop review does not provide convincing evidence to support this position. A pilot study may be an effective method of determining whether subterranean fauna occur "* 

Biologic recommend Talison conduct a Pilot subterranean fauna survey to determine whether subterranean fauna are present. Our understanding to date is that no subterranean surveys have been conducted within the vicinity of the Study Area and are very limited in the greater South-West region generally. Only sampling of the Study Area and surrounds will reveal the presence or lack thereof a subterranean fauna assemblage.



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## 7 APPENDICES

## Appendix A: Conservation listings

#### International Union for Conservation of Nature

Category	Definition
	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,
Extinct (EX)	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.
	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
Extinct in the Wild (EW)	exhaustive surveys in known and/or expected babitat 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 tayon's life cycle and life form
	A tayon is Critically Endengered when the best evolutions
	A taxon is chilically Endangered when the best available evidence
Critically Endangered (CR)	indicates that it meets any of the chiena A to E for Childrany Endangered
	(see Section V), and it is therefore considered to be facing an extremely
	high risk of extinction in the wild.
	A taxon is Endangered when the best available evidence indicates that it
Endangered (EN)	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.
	A taxon is Vulnerable when the best available evidence indicates that it
Vulnerable (VU)	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.
	A taxon is Near Threatened when it has been evaluated against the
Near Threatened (NT)	criteria but does not qualify for Critically Endangered, Endangered or
Near Theatened (NT)	Vulnerable now, but is close to qualifying for or is likely to qualify for a
	threatened category in the near future
	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
Data Deficient (DD)	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 elansed since the last record of the
	taxon throatonod status may well be justified
	laxon, uneateneu status may wen be justineu.



## Environment Protection and Biodiversity Conservation Act 1999

Category	Definition								
Extinct (EX)	Taxa not definitely located in the wild during the past 50 years.								
Extinct in the Wild (EW)	Taxa known to survive only in captivity.								
Critically Endangered (CE)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.								
Endangered (EN)	Taxa facing a very high risk of extinction in the wild in the near future.								
Vulnerable (VII)	Taxa facing a high risk of extinction in the wild in the medium-term								
	future.								
	Consists of species listed under the following International								
	Conventions:								
Migratory (MG)	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 <i>vulnerable</i> 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 codes

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



#### Appendix B: Vertebrate fauna recorded within and surrounding the Study Area

#### Mammals

	_	Co	onserva	tion Stat	tus			Ø	-	d þ	۵.	r, na	as A		
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databas	GHD 2017 – Greenbushes to Kirur Link Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora ar Fauna Assessment	Christensen et al. 1985 - Vertebrat Fauna in the Southern Forests of Western Australia, A Survey	ENV 2008 - Edith Cowan University South West Campus, Bunbury Faur Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Are between Busselton and Albany, W	Biologic 2011 – Greenbushes L1 Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Tachyglossidae															
Tachyglossus aculeatus acanthion	Short-beaked Echidna					+					+				
Dasyuridae															
Antechinus flavipes leucogaster	Yellow-footed Antechinus, Mardo					+					+				
Dasyurus geoffroii	Western Quoll, Chuditch	VU	S3		NT	+	Known to Occur	+			+				+
Phascogale tapoatafa wambenger	Wambenger Brush- tailed Phascogale		S6		NT	+		+			+			+	+
Phascogale calura	Red-tailed Phascogale	VU	S6		NT	+		+							
Sminthopsis gilberti	Gilbert's Dunnart					+									
Sminthopsis fuliginosus	Grey-bellied Dunnart				DD	+							+		
Peramelidae															
Isoodon obesulus fusciventer	Southern Brown Bandicoot, Quenda			P4		+		+		+	+	+	+		+
Thylacomyidae															
Macrotis lagotis	Bilby, Dalgyte	VU	S3		VU	+		+							
Potoroidae															



		Co	nservat	tion Stat	tus			0		þ	9	<i>ر</i> , اa	as A		
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Link Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora an Fauna Assessment	Christensen et al. 1985 - Vertebrat Fauna in the Southern Forests of Western Australia, A Survey	ENV 2008 - Edith Cowan University South West Campus, Bunbury Faur Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Are between Busselton and Albany, W.	Biologic 2011 – Greenbushes L1 Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Bettongia penicillata ogilbyi	Brush-tailed Bettong, Woylie	EN	S1		CR	+	May Occur	+			+				
Myrmecobiidae															
Myrmecobius fasciatus	Numbat, Walpurti	EN	S2		EN	+	Known to Occur	+			+				
Macropodidae															
Macropus fuliginosus	Western Grey Kangaroo					+			+	+	+	+	+	+	+
Notamacropus eugenii derbianus	Tammar Wallaby			P4							+				
Notamacropus irma	Western Brush Wallaby			P4		+		+			+		+		+
Setonix brachyurus	Quokka	VU	S3		VU	+	Known to Occur	+					+		
Phalangeridae															
Trichosurus vulpecula	Common Brushtail Possum					+			+		+	+	+	+	+
Pseudocheiridae															
Pseudocheirus occidentalis	Western Ringtail Possum, Ngwayir	VU	S1		CR	+	Known to Occur	+			+	+	+		Possible
Burramyidae															
Cercartetus concinnus	Western Pygmy- possum					+					+				+
Tarsipedidae															
Tarsipes rostratus	Honey Possum										+		+		
Vespertilionidae															



	_	Conservation Status						۵	a	d	Θ.,	y, na	as A		
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databas	GHD 2017 – Greenbushes to Kirul Link Biological Assessment	Astron 2013 – Greenbushes to Kirt Pipeline Route Vegetation, Flora ar Fauna Assessment	Christensen et al. 1985 - Vertebrat Fauna in the Southern Forests of Western Australia, A Survey	ENV 2008 - Edith Cowan Universit South West Campus, Bunbury Fau Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Are between Busselton and Albany, W	Biologic 2011 – Greenbushes L1 Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Chalinolobus gouldii	Gould's Wattled Bat					+					+			+	
Chalinolobus morio	Chocolate Wattled Bat					+					+				
Falsistrellus mackenziei	Western Falsistrelle			P4	NT	+		+			+		+		
Nyctophilus geoffroyi	Lesser Long-eared Bat					+					+			?	
Nyctophilus gouldii	Gould's Long-eared Bat													?	
Nyctophilus major	Western Greater Long- eared Bat										+			?	
Vespadelus regulus	Southern Forest Bat					+					+		+	+	
Molossidae															
Mormopterus sp. 4	Southern Freetail-bat													+	
Austronomus australis	White-striped Freetail- bat													+	
Muridae															
Hydromys chrysogaster	Water Rat, Rakali			P4		+		+	+						
*Mus musculus	House Mouse					+			+		+	+	+		+
Pseudomys albocinereus	Ash-grey Mouse												+		
Rattus fuscipes	Western Bush Rat					+			+		+		+		
*Rattus rattus	Black Rat					+					+	+	+		+
Leporidae															
*Oryctolagus cuniculus	Rabbit					+			+		+	+		+	+



		Co	onserva	tion Stat	tus			0	-	σp	۵	<i>ر</i> , ۱a	as A		
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Link Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora an Fauna Assessment	Christensen et al. 1985 - Vertebrat Fauna in the Southern Forests of Western Australia, A Survey	ENV 2008 - Edith Cowan University South West Campus, Bunbury Faur Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Are between Busselton and Albany, W.	Biologic 2011 – Greenbushes L1 Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Canidae															
*Canis familiaris	Dog/Dingo								+		+	+		+	
*Vulpes vulpes	Fox					+			+	+	+	+		+	+
Felidae															
*Felis catus	Cat					+			+		+	+		+	+
Suidae															
*Sus scrofa	Pig					+					+				+
Bovidae					-	-									
*Bos taurus	European Cattle								+					+	
*Capra hircus	Goat										+				
Equidae															
*Equus caballus	Horse					+					+			+	



#### Birds

		Con	servati	on Sta	tus	5		se		đ	rup and	ate of	ity, una	reas NA	+	
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kir Link Biological Assessment	Astron 2013 – Greenbushes to Ki Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Fa Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Al between Busselton and Albany, V	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Dromaiidae	1	1	T	T	1	F	1	1	1	1	1		1			
Dromaius novaehollandiae	Emu					+			+	+	+	+			+	+
Phasianidae			_													
Coturnix pectoralis	Stubble Quail											+				
Coturnix ypsilophora	Brown Quail											+				
Procellariidae																
Puffinus huttoni	Hutton's Shearwater		S2		EN							+				
Megapodiidae																
Leipoa ocellata	Malleefowl	VU	S3		VU	+		+				+				
Anatidae																
Anas gracilis	Grey Teal					+			+			+				
*Anas platyrhynchos	Mallard					+			+							
Anas rhynchotis	Australasian Shoveler					+			+			+				
Anas superciliosa	Pacific Black Duck					+			+		+	+	+		+	
Aythya australis	Hardhead					+			+							
Biziura lobata	Musk Duck					+			+			+			+	+
Chenonetta jubata	Australian Wood Duck					+			+			+	+		+	



		Con	servatio	on Sta	tus			e		d	dn u	f	ty, ina	eas VA	_	
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kiru Link Biological Assessment	Astron 2013 – Greenbushes to Kir Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Far Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Ar between Busselton and Albany, V	Biologic 2011 – Greenbushes L' Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Cygnus atratus	Black Swan					+			+			+			+	+
Malacorhynchus membranaceus	Pink-eared Duck					+										
Oxyura australis	Blue-billed Duck			P4	NT	+		+	+			+				
Stictonetta naevosa	Freckled Duck					+			+			+				
Tadorna tadornoides	Australian Shelduck					+			+		+	+				
Podicipedidae																
Tachybaptus novaehollandiae	Australasian Grebe					+			+			+				
Podiceps cristatus	Great Crested Grebe					+			+							
Poliocephalus poliocephalus	Hoary-headed Grebe					+			+			+				
Anhingidae																
Anhinga novaehollandiae	Australasian Darter					+			+			+				
Pandionidae																
Pandion haliaetus	Osprey	MG	S5				Likely to Occur					+				
Charadriidae																
Charadrius ruficapillus	Red-capped Plover											+				
Elseyornis melanops	Black-fronted Dotterel					+			+			+				
Vanellus tricolor	Banded Lapwing											+				



		Con	servati	on Sta	tus			ee		<u>e</u>	dn.	ite of	ty, ına	eas VA	_	
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DoEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kirr Link Biological Assessment	Astron 2013 – Greenbushes to Kii Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Fa Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Ar between Busselton and Albany, V	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Phalacrocoracidae				-												
Phalacrocorax melanoleucos	Little Pied Cormorant					+			+			+			+	
Phalacrocorax carbo	Great Cormorant					+			+			+				
Phalacrocorax sulcirostris	Little Black Cormorant					+			+			+			+	
Phalacrocorax varius	Pied Cormorant					+			+			+				
Ardeidae	·															
Ardea modesta	Great Egret					+			+		+	+				
Ardea novaehollandiae	White-faced Heron					+			+		+	+				+
Ardea ibis	Cattle Egret															
Ardea pacifica	White-necked Heron					+			+			+				
Botaurus poiciloptilus	Australasian Bittern	EN	S2		EN		May Occur	+				+				
lxobrychus flavicollis australis	Black Bittern (southwest pop)			P2				+	+			+				
Nycticorax caledonicus	Rufous Night Heron					+			+		+	+				
Threskiornithidae																
Plegadis falcinellus	Glossy Ibis	MG	S5			+										
Platalea flavipes	Yellow-billed Spoonbill					+			+							
Threskiornis molucca	Australian White Ibis								+			+				



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Threskiornis spinicollis	Straw-necked Ibis					+			+			+				
Accipitridae																
Accipiter cirrocephalus	Collared Sparrowhawk					+			+			+			+	
Accipiter fasciatus	Brown Goshawk					+			+			+	+		+	
Aquila audax	Wedge-tailed Eagle					+			+			+				+
Hieraaetus morphnoides	Little Eagle					+			+			+				
Circus approximans	Swamp Harrier								+						+	
Circus assimilis	Spotted Harrier					+			+			+				
Elanus caeruleus	Black-shouldered Kite					+			+			+				
Haliaeetus leucogaster	White-bellied Sea-Eagle					+			+			+				
Haliastur sphenurus	Whistling Kite					+			+			+	+			
Hamirostra isura	Square-tailed Kite					+			+			+			+	+
Otididae																
Ardeotis australis	Australian Bustard					+										
Falconidae																
Falco berigora	Brown Falcon					+			+			+				
Falco cenchroides	Australian Kestrel					+			+			+				
Falco longipennis	Australian Hobby					+			+			+			+	



		Con	servatio	on Sta	tus			se		dn	rup and	ate of	ity, una	reas NA	1	
Species (	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kir Link Biological Assessment	Astron 2013 – Greenbushes to Ki Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Fai Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal A between Busselton and Albany, V	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Falco peregrinus F	Peregrine Falcon		S7			+		+	+			+				
Rallidae																
<i>Fulica atra</i> E	Eurasian Coot					+			+			+				
Gallirallus philippensis E	Buff-banded Rail					+			+							
Gallinula tenebrosa	Dusky Moorhen					+			+			+				
Lewinia pectoralis clelandii I	Lewin's Rail	EX	S4			+		+								
Porphyrio porphyrio	Purple Swamphen					+			+		+	+				
Porzana tabuensis	Spotless Crake					+			+			+				
Tribonyx ventralis	Black-tailed Native Hen					+			+							
Scolopacidae																
Calidris acuminata	Sharp-tailed Sandpiper	MG	SS5				May Occur									
Calidris ferruginea (	Curlew Sandpiper	CR/ MG	S3/ S5		NT		May Occur					+				
Calidris melanotos	Pectoral Sandpiper	MG	S5				May Occur									
Numenius madagascariensis	Eastern Curlew	CR/ MG	S3/ S5		EN		May Occur									
Tringa glareola	Wood Sandpiper	MG	S5						+							
Tringa hypoleucos	Common Sandpiper	MG	S5				May Occur									
Laridae																
Larus novaehollandiae	Silver Gull					+						+				



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Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kiru Link Biological Assessment	Astron 2013 – Greenbushes to Kii Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Faı Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Ar between Busselton and Albany, V	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Larus pacificus	Pacific Gull											+				
Hydroprogne caspia	Caspian Tern	MG	S5									+				
Thalasseus bergii	Crested Tern	MG	S5									+				
Turnicidae																
Turnix varius	Painted Button- quail					+			+			+				
Turnix velox	Little Button-quail					+			+							
Burhinidae																
Burhinus grallarius	Bush Stone- curlew					+										
Haematopodidae																
Haematopus fuliginosus	Sooty Oystercatcher					+										
Recurvirostridae																
Himantopus himantopus	Black-winged Stilt					+										
Columbidae																
*Columba livia	Domestic Pigeon															
Ocyphaps lophotes	Crested Pigeon					+			+							
Phaps chalcoptera	Common Bronzewing					+			+		+	+	+		+	+
Phaps elegans	Brush Bronzewing								+			+				
*Spilopelia senagalensis	Laughing Turtle- Dove					+			+				+			



		Con	servati	on Sta	itus			se		dn	rup and	ate of	ity, una	reas NA	L.	
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kir Link Biological Assessment	Astron 2013 – Greenbushes to Ki Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebr Fauna in the Southern Forests ( Western Australia, A Survey	ENV 2008 - Edith Cowan Univers South West Campus, Bunbury Fa Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal A between Busselton and Albany, \	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Cacatuidae	1	1	[	1	1				1	1						
Cacatua sanguinea	Little Corella												+			
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	S3			+	Known to Occur	+	+	+	+	+			+	+
Calyptorhynchus baudinii	Baudin's Cockatoo	EN	S2		EN	+	Breeding Known to Occur	+	+	+	+	+			+	
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	S2		EN	+	Known to Occur	+	+	+			+		+	
Cacatua roseicapilla	Galah					+			+	+	+		+			
Psittacidae																
Parvipsitta porphyrocephala	Purple-crowned Lorikeet								+			+			+	+
Neophema elegans	Elegant Parrot					+			+			+			+	
Neophema petrophila	Rock Parrot											+				
Platycercus icterotis icterotis	Western Rosella					+			+	+		+	+		+	
Platycercus spurius	Red-capped Parrot					+			+	+		+	+		+	
Platycercus zonarius	Australian Ringneck					+			+	+	+	+	+		+	+
Polytelis anthopeplus	Regent Parrot					+				+			+			
*Trichoglossus moluccanus	Rainbow Lorikeet									+						
Cuculidae																
Cacomantis flabelliformis flabelliformis	Fan-tailed Cuckoo					+			+			+			+	



		Con	servati	on Sta	tus			se		dr	rup and	ate of	ty, una	reas VA	+	
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kir Link Biological Assessment	Astron 2013 – Greenbushes to Ki Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Fa Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal A between Busselton and Albany, \	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Chrysococcyx basalis	Horsfield's Bronze Cuckoo								+			+				
Chrysococcyx lucidus	Shining Bronze Cuckoo					+			+			+			+	
Cacomantis pallidus	Pallid Cuckoo					+			+	+		+				
Strigidae																
Ninox connivens connivens	Barking Owl (southwest population)			P3												
Ninox boobook	Boobook Owl								+			+			+	+
Tytonidae																
Tyto alba	Barn Owl					+			+			+				
Tyto novaehollandiae novaehollandiae	Masked Owl (southwest population)			P3		+		+	+			+				
Podargidae																
Podargus strigoides	Tawny Frogmouth					+			+			+			+	+
Caprimulgidae																
Eurostopodus argus	Spotted Nightjar											+				
Aegothelidae																
Aegotheles cristatus	Australian Owlet- nightjar					+			+			+			+	+
Apodidae																
Apus pacificus	Fork-tailed Swift	MG	S5				Likely to Occur									



		Con	servati	on Sta	tus			se		dn	rup and	ate of	ity, una	reas NA	1	
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Alcedinidae	1			•												
*Dacelo novaeguineae	Laughing Kookaburra					+			+	+	+	+	+		+	+
Todiramphus sanctus	Sacred Kingfisher					+			+			+	+			
Meropidae																
Merops ornatus	Rainbow Bee- eater					+			+			+			+	
Climacteridae																
Climacteris rufus	Rufous Treecreeper								+			+			+	
Maluridae																
Malurus splendens	Splendid Fairy- wren					+			+	+	+	+	+		+	
Malurus elegans	Red-winged Fairy-wren					+			+			+			+	+
Stipiturus malachurus	Southern Emu- wren											+				
Acanthizidae																
Acanthiza apicalis	Inland Thornbill					+			+			+	+		+	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill					+			+			+	+			+
Acanthiza inornata	Western Thornbill					+			+	+		+			+	
Calamanthus campestris	Rufous Fieldwren					+			+							
Gerygone fusca	Western Gerygone								+	+		+	+		+	+



		Con	servati	on Sta	tus			e		d	dn dn	f	ty, Ina	eas /A		
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Sericornis frontalis	White-browed Scrubwren					+			+			+			+	+
Smicrornis brevirostris	Weebill					+			+	+	+	+	+			
Pardalotidae																
Pardalotus punctatus	Spotted Pardalote					+			+			+			+	
Pardalotus rubricatus	Red-browed Pardalote										+					
Pardalotus striatus	Striated Pardalote					+			+	+		+	+		+	+
Pelecanidae																
Pelecanus conspicillatus	Australian Pelican					+			+							+
Meliphagidae																
Acanthorhynchus superciliosus	Western Spinebill					+			+		+	+	+		+	
Anthochaera carunculata	Red Wattlebird					+			+	+	+	+	+		+	+
Anthochaera lunulata	Western Little Wattlebird					+			+			+				
Epthianura albifrons	White-fronted Chat					+			+							
Gavicalis virescens	Singing Honeyeater								+	+	+		+			
Glyciphila melanops	Tawny Crowned Honeyeater											+				
Lichmera indistincta	Brown Honeyeater					+			+	+		+	+		+	
Manorina flavigula	Yellow-throated Minor											+				



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Melithreptus brevirostris	Brown-headed Honeyeater					+			+							
Melithreptus chloropsis	Western White- naped Honeyeater					+			+			+	+			
Phylidonyris nigra	White-cheeked Honeyeater					+			+	+		+				
Phylidonyris novaehollandiae	New Holland Honeyeater					+			+	+		+	+			+
Petroicidae																
Eopsaltria australis	Western Yellow Robin					+			+			+	+		+	+
Eopsaltria georgiana	White-breasted Robin					+			+			+			+	
Microeca fascinans	Jacky Winter								+							
Petroica goodenovii	Red-capped Robin					+			+			+				
Petroica boondang	Scarlet Robin					+			+	+	+	+	+		+	+
Pomatostomidae																
Pomatostomus superciliosus	White-browed Babbler					+			+			+				
Neosittidae																
Daphoenositta chrysoptera	Varied Sittella					+			+	+		+			+	
Pachycephalidae																
Colluricincla harmonica	Grey Shrike- thrush					+			+	+		+	+		+	
Falcunculus frontatus	Crested Shrike-tit					+			+			+				



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Pachycephala occidentalis	Western Golden Whistler								+		+	+	+		+	
Pachycephala rufiventris	Rufous Whistler					+			+	+	+	+	+			
Rhipiduridae																
Rhipidura albiscapa	Grey Fantail					+			+	+	+	+	+		+	+
Rhipidura leucophrys	Willie Wagtail					+			+	+	+	+	+		+	+
Monarchidae																
Grallina cyanoleuca	Magpie-lark					+			+	+	+	+	+		+	
Myiagra inquieta	Restless Flycatcher					+			+	+		+				
Estrilididae																
Stagonopleura oculata	Red-eared Firetail					+			+			+				
Campephagidae																
Coracina maxima	Ground Cuckoo- shrike					+			+							
Coracina novaehollandiae	Black-faced Cuckoo-shrike					+				+	+	+			+	
Lalage tricolor	White-winged Triller								+			+				
Artamidae																
Artamus cinereus	Black-faced Woodswallow					+			+							
Artamus cyanopterus	Dusky Woodswallow					+			+			+				+
Artamus personatus	Masked Woodswallow														+	



		Con	servati	on Sta	tus			e		đ	dn,	ite of	ty, una	eas VA	-	
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kiru Link Biological Assessment	Astron 2013 – Greenbushes to Kii Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Faı Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Ar between Busselton and Albany, V	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
Cracticidae											r					
Cracticus torquatus	Grey Butcherbird								+			+	+			
Strepera versicolor	Grey Currawong						+		+						+	
Cracticus tibicen	Australian Magpie						+		+	+	+	+	+		+	+
Corvidae																
Corvus coronoides	Australian Raven					+			+	+	+	+	+		+	+
Hirundinidae																
Hirundo neoxena	Welcome Swallow					+			+			+	+		+	+
Petrochelidon ariel	Fairy Martin					+			+							
Petrochelidon nigricans	Tree Martin					+			+			+	+		+	
Zosteropidae																
Zosterops lateralis	Silvereye					+			+			+	+		+	
Acrocephalidae																
Acrocephalus australis	Australian Reed Warbler					+			+			+			+	
Locustellidae																
Megalurus cruralis	Brown Songlark															
Megalurus gramineus	Little Grassbird					+			+			+				
Megalurus mathewsi	Rufous Songlark								+							
Sturnidae																



		Con	servatio	on Sta	tus			se		dr	rup and	ate of	ty, una	eas VA	1	
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DoEE	DBCA Threatened Fauna Databa	Birdlife	GHD 2017 – Greenbushes to Kiru Link Biological Assessment	Astron 2013 – Greenbushes to Kii Pipeline Route Vegetation, Flora a Fauna Assessment	Christensen et al. 1985 - Vertebra Fauna in the Southern Forests o Western Australia, A Survey	ENV 2008 - Edith Cowan Universi South West Campus, Bunbury Fa Assessment	How <i>et al.</i> , 1987 - The Ground Vertebrate Fauna of the Coastal Ar between Busselton and Albany, V	Biologic 2011 – Greenbushes L Fauna Survey	Biologic 2018 – Greenbushes Targeted Fauna Survey
*Sturnus vulgaris	Common Starling					+										
Dicaeidae																
Dicaeum hirundinaceum	Mistletoebird					+			+						+	
Motacillidae																
Anthus australis	Australian Pipit					+			+			+				
Motacilla cinerea	Grey Wagtail	MG	S5				May Occur									

Greenbushes Fauna Desktop Assessment

#### Reptiles

		Cons	ervatio	n Stat	us				ink	مە	una 1	outh	ate n	Ina	ed
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora an Fauna Assessment	Christensen et al. 1985 - Vertebrate Fa in the Southern Forests of Westerr	ENV 2008 - Edith Cowan University, Sc West Campus, Bunbury Fauna Assessment	How <i>et al.</i> , 1987 - The Ground Vertebr Fauna of the Coastal Areas betwee Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Fau Survey	Biologic 2018 – Greenbushes Target Fauna Survey
Cheluidae	-		-	-		-					-				
Chelodina oblonga	Oblong Turtle					+					+			+	
Agamidae															
Pogona minor	Western Bearded Dragon					+						+	+		
Diplodactylidae															
Diplodactylus lateroides	Spotted Sandplain Gecko														
Carphodactylidae															
Underwoodisaurus milli	Southern Barking Gecko														
Gekkonidae	-		-	-		-					-				
Christinus marmoratus	Marbled Gecko					+					+	+	+		
Pygopodidae										1	0				
Aprasia pulchella						+					+		+		
Aprasia repens	Southwestern Sandplain Worm Lizard														
Lialis burtonis	Keeled Legless Lizard														
Pygopus lepidopodus	Common Scaly Foot										+		+		
Scincidae				1	1	1									
Acritoscincus trilineatus	Southwestern Cool Skink					+					+	+	+		



		Cons	ervatio	n Stat	us				¥	مە	iuna 1	outh	n n	na	eq
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DoEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora an Fauna Assessment	Christensen et al. 1985 - Vertebrate Fa in the Southern Forests of Westerr	ENV 2008 - Edith Cowan University, S. West Campus, Bunbury Fauna Assessment	How et al., 1987 - The Ground Vertebi Fauna of the Coastal Areas betwee Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Fau Survey	Biologic 2018 – Greenbushes Target Fauna Survey
Cryptoblepharus buchananii	Fence Skink					+									
Cryptoblepharus plagiocephalus											+	+	+		
Ctenotus australis													+		
Ctenotus catenifer	Chain-striped Heath Ctenotus										+		+		
Ctenotus delli	Dell's Skink			P4		+		+							
Ctenotus impar						+					+		+		
Ctenotus labillardieri	Red-legged Ctenotus					+					+		+		
Delma fraseri											+				
Egernia kingii	King's Skink					+					+	+	+		
Egernia napoleonis	Southwestern Crevice Skink					+					+	+	+		+
Hemiergis initialis	Southern Five-toed Mulch Skink					+					+				
Hemiergis peronii	Four-toed Mulch Skink					+					+		+		+
Hemiergis quadrilineata												+	+		
Lerista distinguenda	Southwestern Four-toed Lerista					+					+		+		+
Lerista elegans											+		+		
Lerista microtis	Southwestern Five-toed Lerista					+					+		+		
Liopholis pulchra											+				
Lissolepis luctuosa	Western Swamp Skink										+		+		



		Cons	ervatio	n Stat	us				, Yu	مە	una L	outh	n n	a	ed
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora an Fauna Assessment	Christensen et al. 1985 - Vertebrate Fa in the Southern Forests of Westerr	ENV 2008 - Edith Cowan University, So West Campus, Bunbury Fauna Assessment	How <i>et al.</i> , 1987 - The Ground Vertebr Fauna of the Coastal Areas betwee Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Fau Survey	Biologic 2018 – Greenbushes Target Fauna Survey
Menetia greyii	Common Dwarf Skink					+					+		+		
Morethia lineoocellata	West Coast Pale-flecked Morethia					+					+	+	+		
Morethia obscura	Shrubland Pale-flecked Morethia					+					+			+	+
Tiliqua rugosa	Western Bobtail					+					+	+	+	+	+
Varanidae									_						
Varanus gouldii	Bungarra or Sand Goanna					+					+				
Varanus rosenbergi	Heath Monitor					+							+	+	+
Varanus tristis	Racehorse Goanna					+									
Typhlopidae															
Anilios australis											+		+		
Pythonidae															
Morelia spilota	Carpet Python					+									
Elapidae									_						
Echiopsis curta	Bardick										+		+		
Elapognathus coronatus	Crowned Snake										+		+		
Elapognathus minor	Short-nosed Snake			P2							+		+		
Notechis scutatus	Tiger Snake					+					+		+		+
Parasuta gouldii	Gould's Hooded Snake					+					+		+		
Parasuta nigriceps	Black-backed Hooded Snake												+		



									nk	9 9	una	outh	ate 1	na	pa
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DOEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kirul Pipeline Route Vegetation, Flora and Fauna Assossment	Christensen et al. 1985 - Vertebrate Fa in the Southern Forests of Western	ENV 2008 - Edith Cowan University, So West Campus, Bunbury Fauna Assessment	How <i>et al.</i> , 1987 - The Ground Vertebr Fauna of the Coastal Areas betweer Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Fau Survey	Biologic 2018 – Greenbushes Target Fauna Survey
Pseudonaja affinis	Dugite					+					+		+		
Rhinolophus bicolor	Square-nosed Snake										+				



#### Amphibians

		Cons	ervati	ion St	atus			0	ink	p nent	una ۱	', la	rate n	Ina	ed
Species	Common Name	EPBC Act	WCA	DBCA	INCN	NatureMap	DoEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora and Fauna Assessm	Christensen et al. 1985 - Vertebrate Fa in the Southern Forests of Westerr Australia, A Survey	ENV 2008 - Edith Cowan University South West Campus, Bunbury Faur Assessment	How <i>et al.</i> , 1987 - The Ground Vertebr Fauna of the Coastal Areas betwee Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Fau Survey	Biologic 2018 – Greenbushes Target Fauna Survey
Myobatrachidae															
Crinia georgiana	Quacking Frog					+			+	+	+		+	+	
Crinia glauerti	Clicking Frog					+			+	+	+	+	+	+	
Crinia insignifera	Squelching Froglet										+	+	+		
Crinia pseudinsignifera	Bleating Froglet					+					+				
Crinia subinsignifera	South Coast Froglet										+		+		
Geocrinia leai	Ticking Frog					+			+		+		+		
Geocrinia lutea	Walpole Frog			P4	NT						+				
Geocrinia rosea	Roseate Frog										+				
Metacrinia nichollsi	Forest Toadlet					+					+		+		
Myobatrachus gouldii	Turtle Frog														
Pseudophryne guentheri	Gunther's Toadlet					+					+		+		
Limnodynastidae															
Heleioporus eyrei	Moaning Frog					+			+	+	+	+	+		
Heleioporus inornatus	Whooping Frog										+		+		
Heleioporus psammophilus	Sand Frog										+		+		



		Cons	ervati	on Sta	atus			0	ink	p nent	una 1	', 1a	rate n	Ina	ed
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DoEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kiru Pipeline Route Vegetation, Flora and Fauna Assessm	Christensen et al. 1985 - Vertebrate Fa in the Southern Forests of Westerr Australia, A Survey	ENV 2008 - Edith Cowan University South West Campus, Bunbury Faur Assessment	How <i>et al.</i> , 1987 - The Ground Vertebi Fauna of the Coastal Areas betwee Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Fau Survey	Biologic 2018 – Greenbushes Target Fauna Survey
Limnodynastes dorsalis	Western Banjo Frog					+					+	+	+	+	
Neobatrachus albipes	White-footed Trilling Frog					+									
Neobatrachus pelobatoides	Humming Frog										+				
Pelodryadidae															
Litoria adelaidensis	Slender Tree Frog					+					+	+	+	+	+
Litoria moorei	Motorbike Frog					+					+		+	+	+

#### Fish

	_	Co	nservat	ion Stat	tus				¥	o ent	una	uth nent	ate	na	þé
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DoEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kirup Pipeline Route Vegetation, Flora and Fauna Assessm	Christensen et al. 1985 - Vertebrate Fa in the Southern Forests of Western Australia, A Survey	ENV 2008 - Edith Cowan University, So West Campus, Bunbury Fauna Assessn	How <i>et al.</i> , 1987 - The Ground Vertebr Fauna of the Coastal Areas between Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Faur Survey	Biologic 2018 – Greenbushes Targete Fauna Survey
Gobiidae															
Pseudogobius olorum	Blue spot Goby										+				
Galaxiidae															
Galaxiella nigrostriata	Black-stripe Minnow		S2		NT (LR)	+		+			+				
Galaxias occidentalis	Western Minnow					+					+				
Galaxiella munda	Mud Minnow, Western Dwarf Galaxias		S3		NT (LR)						+				
Lepidogalaxiidae															
Lepidogalaxias salamandroides	Salamanderfish		S2		NT (LR)	+		+			+				
Percichthyidae															
Bostockia porosa	Nightfish										+				
Nannoperca vittata	Western Pygmy Perch					+					+				
Nannatherina balstoni	Balston's Pygmy Perch	VU	S3								+				
Petromyzontidae															
Geotria australis	Pouched Lamprey			P1	DD						+				
Percidae															



		Conservation Status							nk		una	uth nent	ate	na	þé
Species	Common Name	EPBC Act	WCA	DBCA	IUCN	NatureMap	DoEE	DBCA Threatened Fauna Database	GHD 2017 – Greenbushes to Kirup Li Biological Assessment	Astron 2013 – Greenbushes to Kirur Pipeline Route	Christensen et al. 1985 - Vertebrate Fai in the Southern Forests of Western Australia, A Survey	ENV 2008 - Edith Cowan University, So West Campus, Bunbury Fauna Assessn	How <i>et al.</i> , 1987 - The Ground Vertebr Fauna of the Coastal Areas betweer Busselton and Albany, WA	Biologic 2011 – Greenbushes L1 Faur Survey	Biologic 2018 – Greenbushes Targete Fauna Survey
Perca fluviatilis	Redfin					+					+				
Mugilidae															
Mugil cephalus	Flathead Mullet										+				

## Appendix C: Records of fauna from SRE target groups around the Study Area Listings

Class	Order	Infraorder	Family	Genus	Species	Latitude	Longitude	Method	Year
	Isopoda	Ligiamorpha	Armadillidae	Spherillo	species 5 (judd 2002)	-34.0166	115.9330	Hand	-
Gastropoda			Bothriembryontidae	Bothriembryon	cf. naturalistarum	-33.8666	115.9830	Hand	2005
Gastropoda			Bothriembryontidae	Bothriembryon	sp.	-33.9833	116.0170	Hand	1972
	Scorpiones		Bothriuridae	Cercophonius	`sp.`	-34.1000	115.9833	-	1997
	Scorpiones		Buthidae	Lychas	`austroccidentalis`	-33.9666	116.1333	-	1984
	Scorpiones		Buthidae	Lychas	`austroccidentalis`	-34.0666	116.1000	Hand	1987
	Scorpiones		Buthidae	Lychas	`austroccidentalis`	-33.9666	116.1333	-	1984
Arachnida	Araneae	Mygalomorphae	Nemesiidae	Chenistonia	`tepperi`	-33.7500	116.2500	Hand	2014
Arachnida	Araneae	Mygalomorphae	Idiopidae	Euoplos	Festivus	-33.8403	115.9239	Burrow	2017
Arachnida	Araneae	Mygalomorphae	Idiopidae	Euoplos	Festivus	-33.9667	116.0667	Burrow	1917
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (female)`	-33.8666	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (female)`	-33.8665	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (female)`	-33.8665	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8664	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8664	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8666	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8665	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8666	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8666	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8665	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Gaius	`Voyager sp. (juvenile)`	-33.8664	116.3509	Burrow	2007
Arachnida	Araneae	Mygalomorphae	Idiopidae	Idiosoma	`rhaphiduca sp. group`	-33.7000	116.2833	Burrow	1999
Arachnida	Araneae	Mygalomorphae	Idiopidae	Idiosoma	rhaphiduca	-33.7866	115.9825	-	1982
Arachnida	Araneae	Mygalomorphae	Idiopidae	Idiosoma		-33.8794	115.8586	Burrow	2017
Arachnida	Araneae	Mygalomorphae	Idiopidae	Idiosoma		-33.8397	115.9236	Burrow	2017
Arachnida	Araneae	Mygalomorphae	Nemesiidae	Kwonkan	`MYG096`	-33.7500	116.2500	Hand	2014
Diplopoda	Polydesmida		Paradoxosomatidae	Akamptogonus	novarae	-33.9667	116.1000	-	2016
Diplopoda	Polydesmida		Paradoxosomatidae	Akamptogonus	novarae	-34.0666	116.1000	Hand	1990
Diplopoda	Polydesmida		Paradoxosomatidae	Antichiropus	`sp. Indet.`	-33.7500	116.2500	Hand	2014
			Nemesiidae	Chenistonia	sp. fc581				
			Nemesiidae	Genus fc1401	sp. fc1401				
			Nemesiidae	Genus fc502	sp. fc502				
			Nemesiidae	Genus fc887	sp. fc887				





# Greenbushes Targeted Vertebrate and SRE Invertebrate Fauna Survey

Talison Lithium Limited 10 July 2018



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# EXECUTIVE SUMMARY

Talison Lithium Limited (Talison) mines and processes lithium bearing mineral spodumene at the Greenbushes Mine, located directly south of the Greenbushes town, approximately 250 kilometres (km) south of Perth, Western Australia. Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Talison to undertake a targeted survey for vertebrate fauna of conservation significance and short-range endemic invertebrates (SRE) within and surrounding the Greenbushes Mine. The area considered for this assessment (hereafter referred to as the Study Area) comprised 1,989 hectares (ha) and included the current mining area and an indicative future disturbance area.

The overarching objective of the survey was to determine the occurrence for a selection of vertebrate fauna considered to be of conservation significance and SRE fauna within the Study Area. Vertebrate fauna species of interest for this survey were species listed as 'Threatened' (Critically Endangered, Endangered, Vulnerable) or Conservation Dependent (Schedule 6) under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) and/or *Wildlife Conservation Act 1950* (WC Act), and considered possible, likely, highly likely or confirmed within the Study Area: the Western Ringtail Possum, Ngwayir (*Pseudocheirus occidentalis*), Western Quoll, Chuditch (*Dasyurus geoffroii*), Quokka (*Setonix brachyurus*) and Wambenger Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*). The SRE component of the survey focussed on those taxonomic groups which are prone to endemism and commonly surveyed during SRE surveys for Environmental Impact Assessment (EIA): mygalomorph spiders, selenopid spiders, pseudoscorpions, scorpions, isopods, millipedes and terrestrial snails.

The survey was undertaken between the 12<sup>th</sup> and 21<sup>st</sup> of February 2018. Twelve motion camera sites were established in the Study Area, each consisting of five baited cameras. Twelve additional motion cameras were deployed opportunistically throughout the Study Area. Motion cameras were deployed at 24 individual locations for a total of 410 motion camera nights. Targeted searches for vertebrate fauna were conducted at 27 locations within the Study Area. Spotlighting searches were undertaken at ten locations over four nights. SRE sampling comprised sampling at 12 sites for a total of 18 personnel hours. Each site was subject to active foraging, leaf and soil sieving and burrow excavations (if found).

A total of 43 species were recorded during the survey directly and/or via secondary evidence, comprising 14 mammals (including six introduced species), 30 birds, seven reptiles and two amphibians. This total included five species considered of conservation significance:

- Western Quoll Vulnerable (EPBC Act and WC Act);
- Forest Red-tailed Black Cockatoo Vulnerable (EPBC Act, WC Act);
- Wambenger Brush-tailed Phascogale Vulnerable (WC Act);
- Southern Brown Bandicoot Priority 4 (DBCA Priority List); and
- Western Brush Wallaby Priority 4 (DBCA Priority List).

Scats possibly belonging to the Western Ringtail Possum (Vulnerable, EPBC Act; Critically Endangered, WC Act) were also recorded but could not be confirmed as belonging to the species.



Based on the results of the survey, it is likely that all vertebrate fauna species of conservation significance occurring within the Study Area would be somewhat impacted by the proposed development, particularly if the Jarrah/Marri Forest (404 ha, 20%) and/or Jarrah/Marri Forest over Banksia (267 ha, 13%) habitat types are impacted. Both habitats appear to be habitat critical to the survival of each of these species.

Three invertebrate taxa recorded during the survey were identified as 'Potential SRE'. In all three cases, a precautionary level of Potential SRE was allocated as a precise taxonomic identification could not be made. This comprised two specimens identified as Nemesiidae sp. indet, two specimens of Paradoxosomatidae sp. indet., and one specimen belonging to the family Siphonotidae. Although limited, the current information for these taxa indicates that there is a reasonable likelihood that they may be range restricted. In each instance, genetic analysis would be required to determine the species and/or if the specimens are unique to what has previously been recorded within the region. A review of the habitats present in surrounding area and their connectivity indicates that all taxa identified as 'Potential SRE' may potentially occur in synonymous habitats outside the Study Area. As such, development and clearing of habitats within the Study Area is unlikely to severely impact these species – although further survey work and genetic analysis would need to be conducted to confirm this.



# 1 INTRODUCTION

# 1.1 Background

Talison Lithium Limited (Talison) mines and processes lithium bearing mineral spodumene at the Greenbushes Mine, located directly south of the Greenbushes town, approximately 250 kilometres (km) south of Perth, Western Australia (Figure 1.1). Biologic Environmental Survey Pty Ltd (Biologic) was commissioned by Talison to undertake a targeted survey for vertebrate fauna of conservation significance and short-range endemic invertebrates (SRE) within and surrounding the Greenbushes Mine. The area considered for this assessment (hereafter referred to as the Study Area) comprised 1,989 hectares (ha) and included the current mining area and an indicative future disturbance area (Figure 1.1). Biologic are of the understanding that the assessment is required to assist Talison with approval for further expansions to the current mine.

A Level 1 vertebrate fauna survey was previously conducted over the Study Area (Biologic, 2011), which confirmed the occurrence of one species considered to be of conservation significance and identified the possible occurrence of several others. A desktop assessment was also conducted recently for the Study Area (Biologic, 2018) to update information provided within the previous assessment (i.e. in light of recent taxonomic and listing changes) and to assess the likelihood of occurrence for SRE fauna. The desktop assessment suggested that a survey targeting SRE and a selection of species of conservation significance be conducted to inform an impact assessment of future development.

# 1.2 Objectives

The overarching objective of this survey was to determine the occurrence for a selection of vertebrate fauna considered to be of conservation significance and SRE fauna within the Study Area. Vertebrate fauna species of interest for this survey were species listed as Threatened (Critically Endangered, Endangered, Vulnerable) or Conservation Dependent (Schedule 6) under the EPBC Act and/or WC Act, and considered possible, likely, highly likely or confirmed within the Study Area: Western Ringtail Possum, Ngwayir (*Pseudocheirus occidentalis*), Western Quoll, Chuditch (*Dasyurus geoffroii*), Quokka (*Setonix brachyurus*) and Wambenger Brush-tailed Phascogale (*Phascogale tapoatafa wambenger*). The SRE component of the survey focussed on those taxonomic groups which are prone to endemism and commonly surveyed during SRE surveys for Environmental Impact Assessment (EIA): mygalomorph spiders, selenopid spiders, pseudoscorpions, scorpions, isopods, millipedes and terrestrial snails.

# 1.3 Compliance

This assessment was carried out in a manner consistent with the following documents developed by the Western Australian Environmental Protection Authority (EPA) and the Department of Environment and Energy (DoEE), formally the Department of Sustainability, Water, Population, and Communities (DSEWPaC):

- (EPA, 2016a) Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna;
- EPA (2016c) Technical Guidance: Terrestrial Fauna Surveys;
- EPA (2016b) Technical Guidance: Sampling of Short-range Endemic Invertebrate Fauna; and
- DSEWPaC (2011) Survey Guidelines for Australia's Threatened Mammals



Jarrah/Marri Forest

Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018

km



# 2 SPECIES OF CONSERVATION SIGNIFICANCE

# 2.1.1 Conservation Significance

Within Western Australia, native fauna are 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 on 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 Appendix A. For some species, there is insufficient information to determine their status. These species are also considered by the 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 (Appendix A).

# 2.1.2 Species of Conservation Significance within the Study Area

The desktop assessment identified a total of 291 species of vertebrate fauna which have previously been recorded and/or have the potential to occur within the Study Area (Biologic, 2018). Of the 291 species of vertebrate fauna identified, 44 species are considered to be of conservation significance, comprising 13 mammals, 23 birds, two reptiles, one amphibian and five fish species (Biologic, 2018). The four species which were targeted during this survey are detailed below.

### 2.2 Western Ringtail Possum, Ngwayir (Pseudocheirus occidentalis)

The Western Ringtail Possum is currently listed as Vulnerable under the EPBC Act, Schedule 1 (Critically Endangered) under the WC Act and Critically Endangered by the International Union for Conservation of Nature and Natural Resources (IUCN).

### **Biology and Ecology**

The Western Ringtail Possum is a nocturnal species distinguishable by its slender prehensile white-tipped tail. It feeds on the leaves of Peppermint (*Agonis flexuosa*) Trees (near the coast) and Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) trees (further inland where such vegetation predominates) (Jones, 1995). While this species breeds throughout the year, pouch young are born predominantly during late autumn to winter (de Tores, 2008). Females usually only give birth to one individual, although there are rare occasions when a female has produced a litter of 2-3 young (Jones *et al.*, 1994). Young emerge from their mother pouch after three months and continue to suckle for a further 3-4 months (Jones *et al.*, 1994).

Throughout its range, this species shelters in dreys constructed from leaves (in coastal areas) and tree hollows (4 km inland from the coast) (Jones, 1995). None-the-less, tree hollows are important across this species' range, whereby hollow abundance is positively correlated with possum abundance in peppermint/tuart associations and makes up 70% of the refugia available to the Western Ringtail Possum in the jarrah forests (Williams *et al.*, 2017). Their home ranges vary between 0.5 and 2.5 hectares and



consists of 3-8 nesting sites (Jones, 1995) but may consist of a total of 20 throughout the year (Wayne *et al.*, 2005). While the species is solitary, the home ranges of adjacent individuals tend to overlap (Jones *et al.*, 1994).

# Distribution

This species was formerly distributed throughout much of the southwestern Australia (de Tores, 2008) but is now confined to five regional locations the near-coastal area between Bunbury and Augusta, the south coast between Walpole and Albany, the lower Collie River Valley, Harvey River, and at the Perup Nature Reserve and the surrounding forest blocks near Manjimup (de Tores, 2008; de Tores *et al.*, 2004) (Figure 2.1). The Western Ringtail Possum is threatened by habitat loss and fragmentation, predation by introduced predators, changing fire regimes, climate change, competition for nest hollows and timber harvesting (Woinarski *et al.*, 2014).

### Habitat

Habitat preference differs across its known range. The Western Ringtail Possum is associated with peppermint dominated forest and woodland with a tuart *Eucalyptus gomphocephala* canopy in some areas along the coast south of Bunbury, in peppermint forest in the Busselton area and in Jarrah, Wandoo (*Eucalyptus wandoo*) and Marri forest in inland localities (de Tores, 2008). Three management zones have been identified as areas know to currently or previously support large numbers of this species. Populations within these management zones are considered the most important extant populations at present. These zones include the (1) Swan Coastal Plain zone (2) Southern Forest zone and (3) South Coast zone (Williams *et al.*, 2017).



Study Area DoEE Species Distribution

Species or species habitat likely to occur

Species or species habitat may occur

biologic N 1:1,750,000

# Greenbushes Targeted Fauna Survey Figure 2.1: Western Ringtail Possum, Ngwayir, regional distribution

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



# 2.3 Western Quoll, Chuditch (Dasyurus geoffroii)

The Western Quoll is currently listed as Vulnerable under the EPBC Act, Schedule 3 (Vulnerable) under the WC Act and Near Threatened by the IUCN.

# Biology

The Western Quoll is the largest carnivorous marsupial in Western Australia. It is white spotted with brown pelage, large, rounded ears and a pointed muzzle (Smith *et al.*, 2004). This species is solitary, nocturnal and arboreal, although it will feed on the ground (Glen *et al.*, 2010). The Western Quoll dens in hollow logs, burrows and tree hollows with a diameter of 30 cm (Dunlop & Morris, 2012). Females may utilise up to 66 logs and 110 burrows within her home range (DEC, 2012a). Within Jarrah forests where foxes are present, male home ranges are 15 km<sup>2</sup> with a 'core area' (defined by den locations) of 4 km<sup>2</sup> (Rayner *et al.*, 2012). Female home ranges tend to be 3-4 km<sup>2</sup> with a 'core area of 0.9 km<sup>2</sup> (Rayner *et al.*, 2012). Males home ranges can overlap with other males and females; however, females defend their home ranges and seldom overlap with other females (Serena & Soderquist, 1989). Mating occurs in late Aprilearly July and females give birth to 2-6 pouch young after a gestation period of 17-18 days. Young are fully weaned by 4-5 months and will begin to disperse in December (de Tores *et al.*, 2007).

The Western Quoll opportunistically feeds on native mammals as well as birds, small lizards, bird and reptile eggs and invertebrates (Glen *et al.*, 2010).

### Distribution

The Chuditch formerly occurred over nearly 70% of Australia and occurred throughout arid and semi-arid regions; but it is now patchily distributed throughout the Jarrah forests and mixed Karri (*Eucalyptus diversicolor*), Marri, Jarrah forests of southwestern Australia (Dunlop & Morris, 2012) (Figure 2.2). The species also occurs in very low numbers in the Midwest, Wheatbelt and South Coast regions, with records from Moora to the north, Yellowdine to the east and south to Hopetoun (DEC, 2012a).

### Habitat

The species is known to occupy in a wide range of habitats from woodlands, dry sclerophyll (leafy) forests, riparian vegetation, beaches and deserts (DEC, 2012a). Riparian vegetation appears to support higher densities of Chuditch, possibly attributable to better, more reliable food sources and superior cover offered by dense vegetation (Serena & Soderquist, 2008).



Species or species habitat may occur

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

Size A4. Created 10/07/2018



# 2.4 Quokka (Setonix brachyurus)

The Quokka is currently listed as Vulnerable under the EPBC Act, Schedule 3 under the WC Act and Vulnerable by the IUCN.

# Biology

This nocturnal species resides in small colonies no larger than two dozen individuals (Hayward *et al.*, 2003). Their home ranges vary with locality and in the southern forests can be up to 71 ha (Hayward *et al.*, 2004). Males are very territorial and their core ranges barely overlap while females exhibit high shelter and group fidelity (Hayward *et al.*, 2003; Hayward *et al.*, 2004). Home ranges tend to be larger in summer and autumn compared to winter (most likely attributable to the relative availability of palatable and nutritional food) (Bain *et al.*, 2015). Moreover, males core ranges tend to be larger than that of females. Although mainland Quokkas breed throughout the year, the number of births significantly reduce during the summer months as female body weights declines (Hayward *et al.*, 2005a). None-the-less, females are capable of embryonic diapause and consistently wean two offspring a year and 17 offspring over a lifetime; however, recruitment to independence appears low (Hayward *et al.*, 2005a).

The Quokka is a browsing herbivore that consumes leaves and stems and they typically feed on early stages of vegetation (Hayward, 2005).

### Distribution

Historically, the Quokka was widespread and abundant throughout southwestern Australia, although is now confined to 10 locations and seven distinct subpopulations (Figure 2.3) (de Tores *et al.*, 2007). The seven subpopulations are severely fragmented with little to no migration. The seven populations include Rottnest Island, Northern Jarrah Forests (state forests between Serpentine to Jarrahdale), Central Jarrah Forests (state forests in the Harris River area), Southern Jarrah-Karri Forests, South Coast (Two Peoples Bay Nature Reserve, Mount Manypeaks Nature Reserve, Tinkelelup Nature Reserve and Albany area), Stirling Range National Park and Bald Island Nature Reserve (de Tores *et al.*, 2007). Since the 1930's, the area of occupancy on the mainland is thought to have decreased by 50% (de Tores *et al.*, 2007).

### Habitat

The Quokka is a habitat specialist, preferring complex vegetation structure with a minimum of three layers, low densities of woody debris and habitat patchiness (between 0 and 450 m to an alternative vegetation age) (Bain *et al.*, 2015). This species inhabits areas of dense, low understorey vegetation that provide refuge from predators and heat. The Quokka also requires water throughout the year and thus are often present in riparian and swamp habitat (Hayward *et al.*, 2005b). While the main habitat for mainland populations constitutes dense riparian vegetation, Quokka also use heath and shrubland, Swamp Peppermint (*Taxandria linearifolia*) dominated swamps in Jarrah forest, swampy shrublands, swordgrass-dominated understorey, regrowth areas of the Karri forest, Bullich (*Eucalyptus megacarpa*) swamp forest and Paperbark (*Melaleuca spp.*) swamp (Hayward *et al.*, 2005b). The draft Recovery Plan for the Quokka (DEC, 2013) identifies habitat critical to the survival of the species. In the southern forest, critical habitat comprises low-density of near-surface fuel, a complex vegetation structure and a varied fire-age mosaic.



Legend

Study Area DoEE Species Distribution

Species or species habitat likely to occur

Species or species habitat may occur

N 1:1,800,000

#### Talison Lithium Limited Greenbushes Targeted Fauna Survey Figure 2.3: Quokka regional distribution

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



# 2.5 Wambenger Brush-tailed Phascogale (Phascogale tapoatafa wambenger)

The Wambenger Brush-tailed Phascogale is currently listed as Schedule 6 under the WC Act and Near Threatened by the IUCN.

# Biology

The Wambenger Brush-tailed Phascogale is characterised by its large naked ears and black, 'bottlebrush' like tail. This nocturnal, opportunistic feeder forages among the tree canopy, removing bark from tress in pursuit of prey (DEC, 2010). It predominantly feeds on invertebrates, but also on nectar and rarely on small vertebrates (Scarff *et al.*, 1998). Male home ranges overlap with other individuals and increase in size during the breeding season. Conversely, female home ranges do not overlap with unrelated females and can span 20-70 hectares (DEC, 2010). In addition, they tend to utilise many different nest sites (approximately 20) throughout their range (van der Ree *et al.*, 2006), with a preference for more matures trees (DEC, 2008) approximately 225 years of age (Rhind, 1996).

Although the breeding season for this species varies with locality, it generally occurs over a three-week period from mid-May to early July. Mating often occurs within tree hollows (DEC, 2010), and is followed by a 30 day gestation period (DEC, 2010). Stress-induced male die-off typically occurs at the end of the breeding season. Females give birth to a litter of 7-8 young (Millis *et al.*, 1999) and, after seven weeks, the young leave the pouch and reside in a maternal nest. By mid-summer, young disperse and males move larger distance than females (DEC, 2010).

### Distribution

This subspecies was formerly distributed over a wide region of southwestern Australia, from Lake Hinds in the north to Kalgan in the southeast (Aplin *et al.*, 2015) (Figure 2.4). Its present distribution is believed to have reduced to approximately 50% of its former range and it is now known from Perth and south to Albany, west of Albany Highway. It occurs at low densities in the northern Jarrah forest and in highest densities in the Perup/Kingston area, Collie River valley, and near Margaret River and Busselton (Figure 2.4). The Wambenger Brushtail Phascogale is most likely impacted by habitat clearing and fragmentation, loss of tree hollows due to timber harvesting, mining, dieback disease and competition with feral bees, large and high intensity fires and environmental stress and disease (DEC, 2008).

#### Habitat

This subspecies has been observed in dry sclerophyll forests and open woodlands that contain hollowbearing trees and sparse ground cover (DEC, 2010). The species has been observed nesting in Jarrah, Marri, Flooded Gum (*Eucalyptus rudis*) and Wandoo; however, their preference for nesting habitat appears less dependent on the species of tree and more dependent on the availability of suitable hollows (Rhind, 1996). Records are less common from wetter forests (DEC, 2010).



Legend Study Area ALA Species Records



# Talison Lithium Limited Greenbushes Targeted Fauna Survey Figure 2.3: Wambenger Brush-tailed Phascogale regional distribution

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

Size A4. Created 10/07/2018



# 3 SHORT-RANGE ENDEMIC INVERTEBRATES

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 *et al.*, 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, several taxonomic groups of invertebrates have been highlighted as comprising a high proportion of species likely to be regarded as SREs (Table 3-1). 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).

Phylum	Class	Order	Relevant Generic Group
	Bivalvia	Unionoida	Freshwater mussels
Mollusca	Gastropoda	Sorbeoconcha	Freshwater snails
		Eupulmonata	Land snails
Annelida	Oligochaeta	Haplotaxida	Earthworms
Onychophora	Onychophora	Onychophora	Velvet worms
	Arachnida	Araneae	Trapdoor spiders
		Pseudoscorpiones	Pseudoscorpions
		Schizomida	Schizomids
		Acari	Mites
Arthropodo	Malacostraca	Isopoda	Slaters
Anthropoda		Decapoda	Freshwater crayfish
	Diplopoda	Polydesmida	Millipedes
		Sphaerotheriida	Pill Millipedes
		Polyzoniida	Sucking Millipedes
		Spirostreptida	Spirostreptid Millipedes

Table 3-1:	<b>Taxonomic groups</b>	with known or likely	SRE taxa in Weste	ern Australia (EPA,	, 2016b)
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Harvey (2002) proposed a range criterion for terrestrial short-range endemic (SRE) species at less than 10,000 km<sup>2</sup> (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 (see Section 2.1.1), 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.



# 4 FIELD SURVEY METHODOLOGY

The purpose of the field survey was to verify the data collated during the desktop assessment specifically the occurrence of target species and SRE species. Habitat assessments and habitat mapping has already been conducted over the Study Area (Biologic, 2011). Motion cameras, targeted searching and SRE sampling sites were the primary survey techniques utilised.

The survey was undertaken between the 12<sup>th</sup> and 21<sup>st</sup> of February 2018. by two experience zoologists, Michael Brown and Ray Lloyd. The survey was conducted under DBCA Regulation 17 license 08-001820-1 issued to C. Knuckey.

# 4.1 Timing and Weather

Greenbushes has a warm temperate climate, characterised by warm and dry summers with cool, wet winters. Rainfall ranges from 1200 millimetres (mm) in the south-west of the subregion to 500 mm in the east (Hearn *et al.*, 2002). Long-term rainfall data was available for Greenbushes (Station 9552; BoM, 2018); however, the nearest weather station documenting a long-term dataset of temperatures was Bridgetown (Station 9617; BoM, 2018) located 14 km south-east of the Study Area. Conditions experienced 6 months prior to (August 2017 to January 2018) were typical for the time of year. Greenbushes recorded 68.6 mm of rainfall, slightly higher than the long-term average for the same period (63.03 mm) (Figure 4.1).

Minimum temperatures during the survey ranged from 9.1°C to 17.3°C, with an average minimum of 12.9°C, and maximum temperatures ranged from 22.6°C to 33.7°C with an average maximum of 28.8°C (BoM, 2017) (Table 4-1). Only 0.8mm of rainfall was received during the survey, on the 20<sup>th</sup> of February 2018 (Table 4-1).

Data	Tempera	ture (°C)	Painfall (mm)	
Date	Min	Max	Rainian (mm)	
12/02/2018	9.1	29.9	0	
13/02/2018	9.9	24.7	0	
14/02/2018	11	29.6	0	
15/02/2018	12.8	33.7	0	
16/02/2018	15.3	33.5	0	
17/02/2018	14.8	31.7	0	
18/02/2018	17.3	31.4	0	
19/02/2018	16.5	22.6	0	
20/02/2018	10.8	23.9	0.8	
21/02/2018	11.5	27.4	0	
Average	12.9	28.84	0.08	
Source: (BoM. 2018)				

Table 4-1: Daily v	weather and re	corded near	the Study Are	a during the	Survey
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Figure 4.1: Long-term average and recent climatic data for the Study Area

# 4.2 Vertebrate Fauna

# 4.2.1 Motion Cameras

Twelve motion cameras transects were established across the Study Area (sites 1-12; Figure 4.2). Six of the transects were installed to target ground-dwelling species (sites 1-6), positioned on the ground, at log piles and fallen tree trunks (Appendix B). The remaining six transects (sites 7-12) targeted arboreal species, such as the Wambenger Brush-tailed Phascogale and Western Ringtail Possum (Appendix B). These cameras were deployed within trees and facing vertical tree trunks. Each transect consisted of five Bushnell Trophy Cams or Acorn motion cameras spaced ~50-100 m apart. Each camera was baited with universal bait, a mixture of oats, sardines and peanut butter. Cameras targeting ground dwelling species were deployed for seven nights while sites targeted arboreal species were deployed for six nights, equating to a total of 390 motion camera nights.

Additional cameras were also scattered elsewhere in the Study Area outside of the motion camera transects sites. Cameras were deployed at an additional twelve locations for 3-5 nights (Figure 4.2; Appendix B). Single motion cameras were deployed for a total of 50 nights. Cameras were targeted at ground-dwelling species and baited with universal bait.

Motion cameras were deployed at 24 distinct locations for a total of 410 motion camera nights (Figure 4.2; Appendix B).



# 4.2.2 Targeted Searches

Targeted searches were undertaken to identify the occurrence of fauna of conservation significance. Targeted searches were conducted within the most prospective areas in terms of microhabitat features and habitats suitable for species of conservation significance, although were spatially spread to ensure adequate coverage over all natural habitats within the Study Area.

Targeted searches were conducted at each of the twelve motion camera transects (12) as well as at 15 additional locations within the Study Area (Figure 4.3).

# 4.2.3 Spotlighting

Spotlighting was undertaken on four nights of the survey 15-18<sup>th</sup> February. Spotlighting consisted of both walked searches and driving along tracks. Spotlighting searches were undertaken at ten locations (Figure 4.3).

# 4.2.4 Opportunistic Records

During the targeted searches and while traversing the Study Area, the team recorded all vertebrate fauna species encountered, either from primary (i.e. direct observation) or secondary (e.g. burrows, scratching's, diggings and scats) evidence. The locations of all fauna of conservation significance were recorded.

# 4.2.5 Taxonomy and Nomenclature

The latest checklist of mammal, reptile and amphibian names published by the Western Australian Museum (WAM, 2018b) was used as a guide to the current taxonomy and nomenclature of these groups. For birds, the current checklist of Australian birds maintained by Birds Australia (based on Christidis & Boles, 2008) used in conjunction with the WAM species list (WAM, 2018b).







# 4.3 Short-range Endemics

A total of 12 SRE sites were sampled during the survey (Figure 4.4; Appendix B). Each site was sampled for approximately 1.5 hours equating to a total of 18 person hours (Figure 4.4; Appendix B). At each site, the following techniques were employed: active foraging, leaf litter sifting and soil sifting, and targeted searches for spider and scorpion burrows.

# 4.3.1 Active Foraging

Active foraging was the primary technique undertaken at sites and involved searching within various microhabitat features including:

- woody debris: larger logs and woody debris were investigated and overturned searching for detritivores;
- vegetation and tree bark: significant vegetation 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 whilst walking through the Study Area, but time taken to excavate burrows is additional to foraging time.

# 4.3.2 Leaf litter and Soil Sifting

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 4808 cm<sup>3</sup>, and up to two sifts were conducted at each site, providing sufficient leaf litter and humus was available.

# 4.3.3 Specimen Preservation and Taxonomic Identification

All specimens were euthanised in 100% ethanol to preserve DNA for sequencing.

Mygalomorph spiders, scorpions and myriapods were sent to Dr Erich Volschenk and isopods were sent directly to Dr Simon Judd for taxonomic identification prior to vouchering at the WAM.

# 4.4 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<sup>2</sup> 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 4-2).



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

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.

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 a 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 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<sup>2</sup> (Harvey, 2002).







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SRE Sample and Habitat Assessment



Talison Lithium Australia Greenbushes Targeted Fauna Survey Figure 4.4: SRE sampling sites

.6 Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



# 4.5 **Potential Limitation and Constraints**

# 4.5.1 Potential Limitation and Constraints

The EPA (2016b, 2016c) outlines several potential limitations to fauna surveys. These aspects are assessed and discussed in Table 4-3 below.

Potential limitation	Applicability to this survey			
or constraint				
Experience of	The field personnel involved in the survey are highly experienced in			
personnel.	surveying vertebrate and SRE throughout Western Australia. Both field			
	personnel have over 10 years' experience undertaking surveys of this nature.			
Scope (faunal groups	The primary objective of the survey was to determine the occurrence of			
sampled and	vertebrate fauna species listed as Threatened or Conservation Dependent,			
whether any	which were assessed to possibly occur within the Study Area. Additionally,			
constraints affect	SRE invertebrates were all surveyed due to the potential occurrence of such			
this)	species. No factors impacted the ability to undertake this work.			
identified	camera were identified readily and with confidence. Two piles of scats were recorded during the survey which were identified as possibly belonging to the Western Ringtail Possum; however, it is difficult to distinguish these from the			
	Southern Jarrah Forest without fresh material, and thus these scats were only deemed to 'possibly' belong to the species			
	Invertebrate specimens were sent to renowned taxonomic experts. Four specimens could not be identified to species level, due to absence of key diagnostic features (only present on adult males). Without a positive identification, these species were, as a precaution, assessed as 'Potential SRE'.			
Sources of	A significant amount of survey work has been undertaken within the region,			
information (recent or	including baseline and targeted surveys, and monitoring programs for the			
historic) and	species of interest. Most of the information is publicly available through			
availability of	reports, recovery plans and/or online databases – this information was			
contextual	obtained and reviewed by Biologic (2018).			
achieved	successfully and all objectives were answered effectively.			
Disturbances (e.g.	A large portion of the Study Area has been previously disturbed by mining			
fire or flood)	activity; however, these areas were not the focus of the assessment and thus			
	did not impede the survey. No other disturbances affected the outcomes of the			
Internetty of eveness	Survey.			
Intensity of survey	I he level of survey was adequate to address the aims of the assessment			
Completeness of	The targeted support was completed successfully and all objectives were			
Survey	answered effectively			
	All resources employed for the survey including site access using AWD			
degree of expertise	vehicle team make up and experience levels, equipment used (i.e. motion			
available)	cameras), logistics and safety support were suitable for the task.			
Remoteness or	The majority of the Study Area was accessible either by vehicle or on foot, thus			
access issues	the sampling techniques used during this survey were unconstrained by accessibility or remoteness.			



# 5 RESULTS AND DISCUSSION

# 5.1 Vertebrate Fauna Recorded

A total of 43 species were recorded during the survey directly and/or via secondary evidence, comprising 14 mammals (including six introduced species), 30 birds, seven reptiles and two amphibians (Table 5-1). Two species targeted during this survey were confirmed as occurring within the Study Area, the Western Quoll and the Wambenger Brush-tailed Phascogale (Figure 5.1; Appendix C). Scats possibly belonging to the Western Ringtail Possum were also recorded (Figure 5.1; Appendix C). Three additional species of conservation significance were also recorded within the Study Area, the Southern Brown Bandicoot (*Isoodon obesulus fusciventer*), Western Brush Wallaby (*Notamacropus Irma* - both species are listed as Priority 4 by DBCA) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso* - listed as Vulnerable under the EPBC Act and WC Act) (Figure 5.1; Appendix C). Details on the occurrence of fauna of conservation significance can be located below (Section 5.2), except for the Forest Red-tailed Black Cockatoo which was assessed separately outside of this assessment.

Common Name	Scientific name	Record Type	Conservation Status	
			EPBC Act	In WA
Mammals				
Western Ringtail Possum, Ngwayir	Pseudocheirus occidentalis	Sc*	VU	S1
Western Quoll, Chuditch	Dasyurus geoffroii	MC	VU	S3
Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC		S6
Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC		P4
Western Brush Wallaby	Notamacropus irma	MC		P4
Western Grey Kangaroo	Macropus fuliginosus	Ор		
Common Brushtail Possum	Trichosurus vulpecula	MC, Sc		
Western Pygmy-possum	Cercartetus concinnus	Ob		
Pig	*Sus scrofa	Di		
Fox	*Vulpes vulpes	MC, Sc		
Cat	*Felis catus	Tr		
Rabbit	*Oryctolagus cuniculus	Ob		
House Mouse	*Mus musculus	MC		
Black Rat	*Rattus rattus	MC		
Birds				
Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Ob, Sc	VU	S3
Emu	Dromaius novaehollandiae	Ob		
Musk Duck	Biziura lobata	Ob		
Black Swan	Cygnus atratus	Ob		
White-faced Heron	Ardea novaehollandiae	Ob		
Wedge-tailed Eagle	Aquila audax	Ob		
Square-tailed Kite	Hamirostra isura	Ob		

### Table 5-1: Vertebrate fauna recorded during the survey



Common Name	Scientific name	Record Type	Conservation	
			EPBC	
			Act	
Common Bronzewing	Phaps chalcoptera	MC, Ob		
Purple-crowned Lorikeet	Parvipsitta porphyrocephala	Ob		
Australian Ringneck	Platycercus zonarius	Ob		
Boobook Owl	Ninox boobook	Ob		
Tawny Frogmouth	Podargus strigoides	Ob		
Australian Owlet-nightjar	Aegotheles cristatus	Ob		
Laughing Kookaburra	Dacelo novaeguineae	Ob		
Red-winged Fairy-wren	Malurus elegans	MC, Ob		
Yellow-rumped Thornbill	Acanthiza chrysorrhoa	Ob		
Western Gerygone	Gerygone fusca	Ob		
White-browed Scrubwren	Sericornis frontalis	Ob		
Striated Pardalote	Pardalotus striatus	Ob		
Australian Pelican	Pelecanus conspicillatus	Ob		
Red Wattlebird	Anthochaera carunculata	Ob		
New Holland Honeyeater	Phylidonyris novaehollandiae	Ob		
Western Yellow Robin	Eopsaltria australis	MC		
Scarlet Robin	Petroica boondang	MC		
Grey Fantail	Rhipidura albiscapa	Ob		
Willie Wagtail	Rhipidura leucophrys	Ob		
Dusky Woodswallow	Artamus cyanopterus	Ob		
Australian Magpie	Cracticus tibicen	MC, Ob		
Australian Raven	Corvus coronoides	MC, Ob		
Welcome Swallow	Hirundo neoxena	Ob		
Reptiles		•		•
Southwestern Crevice Skink	Egernia napoleonis	Ob, Sc		
Four-toed Mulch Skink	Hemiergis peronii	Ob		
Southwestern Four-toed Lerista	Lerista distinguenda	Ob		
Shrubland Pale-flecked Morethia	Morethia obscura	Ob		
Western Bobtail	Tiliqua rugosa	MC, Ob		
Heath Monitor	Varanus rosenbergi	MC, Ob		
Tiger Snake	Notechis scutatus	Ob		
Amphibians	•			
Slender Tree Frog	Litoria adelaidensis	Ob		
Motorbike Frog	Litoria moorei	Ob		

MC = Motion Camera; Ob = Observation, Sc = Scat; Di = Digging; Tr = Tracks; \* = possible only





# Talison Lithium Australia Greenbushes Targeted Fauna Survey Figure 5.1: Species of conservation significance recorded during the survey

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



# 5.2 Occurrence of Targeted Vertebrate Fauna

# 5.2.1 Western Ringtail Possum, Ngwayir

#### **Previous Records**

Six records of Western Ringtail Possum have been recorded within the vicinity of the Study Area (DBCA, 2018). There are two records of the species approximately 320 m north of the Study Area from August and December 2014 (DBCA, 2018). The remaining four records are located within 20 km of the Study Area (DBCA, 2018). There is a notable density of NatureMap records between Balbarrup and Mayanup (~30km south east of the Study Area) as well as around Manjimup (~40 km south of the Study Area). Christensen *et al.* (1985) recorded Western Ringtail Possum in a pine plantation near Nannup (~30 km south west of the Study Area).

### **Records During Survey**

Scats possibly belonging to Western Ringtail Possum (owing to their size and shape) were found in two locations in the north-western portion of the Study Area. The scats could not be confirmed due to similarity with scats of the Common Brushtail Possum within this region of the state (Jarrah Forest vs. Peppermint Forest). Note the Common Brushtail Possum was abundant throughout the Study Area.

### Habitats within Study Area

The Study Area falls within the distribution of Western Ringtail Possum (Figure 2.1). Large expanses of undisturbed habitat located in the north west and south east of the Study Area are likely to support the species. The large portions of natural bush bisect the Study Area in the north-western portion of the Study Area. All potential Western Ringtail Possum scats were collected from Jarrah/Marri Forest habitat in the north-western portion of the Study. This is consistent with this species preference for Jarrah, Wandoo and Marri forest in inland localities (de Tores, 2008). The Jarrah/Marri Forest habitat constitutes 404 ha (20%) of the Study Area (Biologic, 2018).

### 5.2.2 Western Quoll, Chuditch

### **Previous Records**

The Study Area occurs well within the species' distribution (Figure 2.2). Thirty-five records of Western Quoll have been recorded within the vicinity of the Study Area (DBCA, 2018). The nearest record was captured approximately 577 m north of the Study Area from June 1987 (DBCA, 2018). The remain 34 records are within approximately 21 km of the Study Area, a majority of which are to the north of the Study Area (DBCA, 2018).

### **Records During Survey**

During the current survey, the species was recorded on five motion cameras set in a single targeted transect in the north-western portion of the Study Area (example Figure 5.2). Visually comparing spot patterning, it appears the captures may represent a single individual; however, a mark-capture-recapture survey would need to be conducted to confirm this and determine the population inhabiting the local area. This individual returned to three of the five motion cameras four consecutive nights in a row and to the fourth motion camera two consecutive nights in a row. It visited the fifth camera on only one night during



the survey. This suggest the individual is most likely a resident of the Study Area and that the Study Area (which falls well within the species distribution – refer to Figure 2.2) provides suitable habitat for the species.



Figure 5.2: Western Quoll recorded within the Study Area (Site 01)

# Habitats within Study Area

The Chuditch was captured within the Jarrah/Marri Forest habitat within the north-western portion of the Study Area. The species is known to occupy a wide range of habitats from woodlands, dry sclerophyll (leafy) forests, riparian vegetation, beaches and deserts (DEC, 2012a). Riparian vegetation appears to support higher densities of Chuditch, possibly attributable to better, more reliable food sources and superior cover offered by dense vegetation (Serena & Soderquist, 2008). Given that the Jarrah/Marri Forest habitat in the north-western portion of the Study Area is adjacent to two waterbodies further suggests that the Study Area contains core habitat for this species. The Jarrah/Marri Forest habitat constitutes 404 ha (20%) of the Study Area.

# 5.2.3 Quokka

### **Previous Records**

Forty-three records of Quokka have been recorded within the vicinity of the Study Area (DBCA, 2018). The nearest records were captured approximately 10.5 km, 11.1 km, 11.8 km and 12.3 km south west of the Study Area from December 2004, April 2005, February 2005 and April 2005 respectively (DBCA, 2018). The remaining 34 records are within 20 km of the Study Area to the south west (DBCA, 2018). There is a notable density of NatureMap records between Pemberton and Nannup (~30km south west of the Study Area). The Quokka was not recorded during the current survey although the Study Area occurs within the species' distribution (Figure 2.3).

### Habitats within Study Area

Quokkas occur in a variety of habitats, and there is a variable understanding of habitat critical to survival across its range. The quokka's habitat requirements in the northern jarrah forest have been well defined,



where they require a complex mosaic of recently burnt areas and long unburnt areas (de Tores *et al.*, 2004; Hayward *et al.*, 2007). In the southern forest, quokkas occupy a range of forest, woodlands and wetland ecotypes and their potential habitat is more continuous. A low density of near-surface fuel, a complex vegetation structure and a varied fire-age mosaic best predict the probability of occupancy of quokka in the southern forest (Bain *et al.*, 2014). All-natural habitats with the Study Area provide potential habitat for the species, although favoured habitats with a dense understorey, like that which occurs in natural wetlands, does not occur within the Study Area. Therefore, it is unlikely that the species will reside permanently within the Study Area, although may occasionally occur while dispersing through the landscape.

### 5.2.4 Wambenger Brush-tailed Phascogale

#### **Previous Records**

Biologic (2011) recorded one individual within the Study Area in remnant regrowth Marri-Jarrah forest during a nocturnal survey. A further sixty-seven records of Wambenger Brush-tailed Phascogale have been recorded within the vicinity of the Study Area (DBCA, 2018). Five records were captured north of the Study Area; one approximately 320 m (in March 2005), one approximately 323 m (in March 2015) and three approximately 516 m (no date provided) north (DBCA, 2018). The remain 62 records are within 20 km of the Study Area to the south west (DBCA, 2018). Christensen *et al.* (1985) recorded Wambenger Brush-tailed Phascogale in Karri forests on the Donnelly River.

#### **Records During Survey**

The Wambenger Brush-tailed Phascogale was recorded on 21 occasions and from 15 locations during the survey. The Study Area falls within the species' distribution (Figure 2.4), explaining its prevalence during the current survey.

#### Habitats within Study Area

The Wambenger Brush-tailed Phascogale was captured within the Jarrah/Marri Forest habitat (9 motion cameras), Jarrah/Marri Forest over Banksia Dominated Midstorey habitat (5 motion cameras) and, to a lesser extent, Mine Rehabilitation habitat (1 motion camera) within the Study Area. The Jarrah/Marri Forest habitat constitutes 404 ha (20%) of the Study Area while the Jarrah/Marri Forest over Banksia Dominated Midstorey habitat constitutes 267 ha (13%) and Mine Rehabilitation habitat constitutes 126.6 ha (6.4%). Phascogales require hollow-bearing trees for nesting (DEC, 2010) and have been observed nesting in Jarrah, Marri, Flooded Gum and Wandoo (Rhind, 1996). The Jarrah/Marri Forest habitat for this species. The Mine Rehabilitation site contained some moderate sized trees with potential hollows therefore, while it may provide some suitable habitat for this species, it is not considered core habitat.

#### 5.2.5 Southern Brown Bandicoot, Quenda

#### **Previous Records**

Fifty-five records of the Southern Brown Bandicoot have been recorded within the vicinity of the Study Area (DBCA, 2018). Thirty records were documented approximately 324m north of the Study Area from 2014 and 2015 (DBCA, 2018). The remaining 25 records are within 20 km of the Study Area to the south



west (DBCA, 2018). Astron (2013) recorded a Quenda digging during a Level 1 Survey of Greenbushes to Kirup.

# Records During Survey

During the current survey, the Southern Brown Bandicoot was recorded on two different motion cameras within the Study Area (one in the north-western portion of the Study Area near the northern most waterbody and the along the southern border of the Study Area). Considering the two cameras were located 3.65 km apart, it is likely that at least two unique individuals were observed between the cameras. Moreover, Quenda were photographed on multiple nights by both motion cameras suggesting the individuals are likely to be residents within the Study Area.

### Habitats within Study Area

This species inhabits a variety of habitats from coastal scrubs with sandy soils and scrubby ground-cover vegetation (particularly in area subjected to intermitted fire) (DSEWPaC, 2011) to dense scrubby, often swampy, vegetation with dense cover up to one metre high, often feeding in adjacent forest and woodland that is burnt on a regular basis, and in areas of pasture and cropland lying close to dense cover (DEC, 2012b). Fire helps to increase the diversity of food resources necessary for population growth and fecundity (Braithwaite, 1995). Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses (DEC, 2012b). During the current survey, Quenda were captured within Jarrah/Marri Forest habitat within the Study Area, which constitutes 404 ha (20%) of the Study Area. Therefore, this Jarrah/Marri Forest habitat could provide important foraging habitat for this species.

# 5.2.6 Western Brush Wallaby

### **Previous Records**

Sixteen records of Western Brush Wallaby have been recorded within the vicinity of the Study Area (DBCA, 2018). Three records were documented approximately 509 m (September 2001), 771 m (March 1987) 1.1km (September 1965) north of the Study Area (DBCA, 2018). Twelve records are located within 20 km of the Study Area and one record is located approximately 23 km north of the Study Area (DBCA, 2018).

### Records During Survey

Western Brush Wallaby were captured via six motion cameras within the north-western portion of the Study Area.

### Habitats within Study Area

The Western Brush Wallaby favours open grassy areas and inhabits open forest and woodland. It is also found in some areas of mallee, heathland, low open grasses, and scrubby thickets. The species is uncommon in Karri forests where there is a dense understorey (DEC, 2012c; Woinarski & Burbidge,



2016). During the current survey, Western Brush Wallaby were captured within Jarrah/Marri Forest habitat within the Study Area, which constitutes 404 ha (20%) of the Study Area.

# 5.3 Specimens of SRE Groups Recorded

Twenty specimens belonging to SRE groups were collected during the survey (Table 5-2). This comprised specimens from four broad taxonomic groups: Two Mygalomorph spiders, two isopods, four scorpions, and twelve millipedes (Table 5-2). At least one specimen was recorded from every SRE site, except sites SRE07 and SRE08 and from two of the naturally occurring habitats, Jarrah/Marri Forest and Jarrah/Marri over Banksia.

Group	Taxa identification	Site Collected	SRE Status	
Isopods	Buddelundia nitidissima	SRE07	Widespread	
Isopods	Laevophiloscia sp. indet.	SRE08	Widespread	
Millipede	Ommatoiulus moreletii	SRE10	Exotic (introduced)	
Millipede	Ommatoiulus moreletii	SRE6	Exotic (introduced)	
Millipede	Ommatoiulus moreletii	SRE2	Exotic (introduced)	
Millipede	Ommatoiulus moreletii	SRE4	Exotic (introduced)	
Millipede	Ommatoiulus moreletii	SRE5	Exotic (introduced)	
Millipede	Ommatoiulus moreletii	SRE6	Exotic (introduced)	
Millipede	Ommatoiulus moreletii	SRE9	Exotic (introduced)	
Millipede	Akamptogonus novarae	SRE4	Exotic (introduced)	
Millipede	Akamptogonus novarae	SRE4	Exotic (introduced)	
Millipede	Paradoxosomatidae sp. indet.	SRE1	Potential SRE	
Millipede	Paradoxosomatidae sp. indet.	SRE3	Potential SRE	
Millipede	Siphonotidae sp. indet.	SRE5	Potential SRE	
Mygalomorph Spider	Nemesiidae sp. indet.	SRE11	Potential SRE	
Mygalomorph Spider	Nemesiidae sp. Indet.	SRE5	Potential SRE	
Scorpion	Cercophonius sulcatus	SRE4	Widespread	
Scorpion	Lychas 'austroccidentalis'	SRE2	Widespread	
Scorpion	Lychas 'austroccidentalis'	SRE12	Widespread	
Scorpion	Lychas 'austroccidentalis'	SRE12	Widespread	

### Table 5-2: Invertebrates of SRE groups collected during the survey

From the 20 specimens collected, a total of eight taxa were identified; however, please note that some taxa contain multiple specimens that could not be identified to a species level and therefore it's possible that such taxa (Nemesiidae sp. Indet., Paradoxosomatidae sp. indet.) represent multiple species. Of the taxa identified, two were regarded as exotic/introduced species; *Ommatoiulus moreletii* and *Akamptogonus novaraei*. Two taxa were considered widespread species; *Lychas* 'austroccidentalis' and *Cercophonius sulcatus*. The remaining three taxa were identified as 'Potential SRE' based on the fact that they could not be identified to species level due to the absence of diagnostic features which are only present on mature male specimens (Figure 5.3). Further text on each of the taxa considered to represent 'Potential SRE' is detailed below (Section 5.3.1 - 5.3.3).



▲	Paradoxosomatidae sp. indet.
	Siphonotidae sp. indet.

Jarrah/Marri Forest over Banksia

Jarrah/Marri Forest

Disturbed



1.6

km

# Figure 5.3: Locations of 'Potential SRE' collected during the survey

Coordinate System: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994 Size A4. Created 10/07/2018



# 5.3.1 Nemesiidae sp. indet.

Two of the specimens collected during the survey were identified as Nemesiidae sp. Indet. Nemesiidae represents a wide-ranging family of Mygalomorph spider with a worldwide distribution which spans across four continents (WSC, 2018). In Australia, nemesiids are known as wishbone spiders because they often build forked burrows with two openings at the soil surface that would resemble a wishbone if viewed in cross section (Main, 1976). There are over 364 species described although many more undescribed (WSC, 2018). Approximately twelve genera are known to occur within Australia (WSC, 2018). Both specimens of Nemesiidae collected during the survey represented juveniles, thus not containing the diagnostic features for identification which are only apparent on adult males; however, the specimens are considered 'Potential SRE' as a precaution given that short-range endemics of this family have been recorded in the region previously. Two species of the family have been recorded previously within the 25 km of the Study Area, as identified by WAM (Biologic, 2018; WAM, 2018a): *Chenistonia* `tepperi` and *Kwonkan* `MYG096`.

Specimens were collected from sites SRE05 and SRE11, which were both located within the Jarrah/Marri Forest habitat type.

# 5.3.2 Paradoxosomatidae sp. indet.

Two specimens of Paradoxosomatidae sp. indet. were recorded in the Study Area. Paradoxosomatidae represents a family of millipedes which contains over 139 described species from 40 genera in Australia (Car *et al.*, 2013). Eight of these genera are known to occur in Western Australia, although four are represented by paradoxosomatid species that have been introduced to the region (Car *et al.*, 2013). It is very likely that both specimens belong to the genus *Antichiropus*, the most abundant and diverse millipede group in Western Australia (Car *et al.*, 2013). This genus was first named in 1911 and is now known to consist of over 160 species, ranging from the Pilbara region in the north, to the Nullarbor Plain and the Eyre Peninsula in South Australia (Car *et al.*, 2013). With the exception of *Antichiropus variabilis*, and *Antichiropus* 'PM1' from the northern Wheatbelt and the Geraldton sandplain, most species of the genus are known to be SRE's, and many are known from only a few hundred square kilometres (Harvey, 2002).

Both Paradoxosomatidae specimens collected during the survey represented juveniles that did not possess the diagnostic features for accurate identification - which are only found on adult males. Specimens may potentially represent the same or distinct species. One unidentified specimen of *Antichiropus* has previously been collected within 25 km of the Study Area and a further 19 taxa have been recorded in the surrounding 40,000 km<sup>2</sup>, as documented by WAM (Biologic, 2018; WAM, 2018a).

Specimens were collected from sites SRE01 and SRE03, which both occur within the Jarrah/Marri Forest over Banksia habitat type.

### 5.3.3 Siphonotidae sp. indet.

Siphonotidae is a family of millipede belonging to the order Polyzoniida. They are distinguished from other millipedes by their small, pointed head and flattened wide body segments (Harvey & Yen, 1989). The order Polyzoniida is widely distributed worldwide, although only represented within Australia by the one family, Siphonotidae. Siphonotidae was revised in a recent PhD thesis (Black, 1994) although papers


arising from this work are yet to be published and only five species from two genera have been formally described. It is likely that the family contains several SRE species (E. S. Volschenk *pers. comm.*).

Due to the taxonomic uncertainty of the family, the single specimen collected from this survey could not be identified beyond family, although it is likely that the specimen belongs to Black's (1994) unpublished genus 'Megalosiphon'. No taxa belonging to the family Siphonotidae have previously been recorded within 25 km of the Study Area according to WAM (2018a), although eight taxa have been recorded within 40,000 km<sup>2</sup> of the Study Area - the majority of records from the Margaret River and Pemberton regions.

The single specimen collected during this survey was from the Jarrah/Marri Forest habitat, site SRE05, where it was collected from soil under woody debris.

#### 5.4 Occurrence of Short-range Endemic Fauna

Owing to the poor state of taxonomy for many of the species collected, the current assessment is somewhat limited in its ability to assess the local and regional significance of the fauna collected.

The taxa currently regarded as 'indet.' (Nemesiidae, Paradoxosomatidae, Siphonotidae) cannot be fully assessed for SRE status until significant knowledge gaps are resolved at various taxonomic levels. Five specimens from these three groups were recorded within the Study Area. Although limited, the current information for these taxa indicates that there is a reasonable likelihood that they may be range restricted, therefore they are considered Potential SREs as a precaution. In each instance, genetic analysis would be required to determine the species and/or if the specimens are unique to what has previously been recorded within the region.

In the absence of firm taxonomic identifications, it is reasonable to use habitats as a surrogate to assess the potential impact of development posed to Potential SRE species. All three naturally occurring habitat types within the Study Area (Jarrah/ Marri Forest, Jarrah/Marri Forest over Banksia and Marri/Blackbutt/Flooded Gum Woodland) would be considered to have a moderate potential to host SRE fauna. Each contains high habitat complexity with abundant leaf litter, woody debris, scattered rock formations, and a high prevalence of shade offered by the dense vegetation. The potential to cater for SRE fauna is further supported by the degree of habitat loss and fragmentation within the subregion, which may have reduced the distribution and opportunities for dispersal of most dispersal-limited invertebrate taxa. Aerial photography indicates that each of the moderately suitable SRE habitat zones (comprising the Jarrah/ Marri Forest, Jarrah/Marri Forest over Banksia and Marri/Blackbutt/Flooded Gum Woodland) is, however, well represented beyond the Study Area boundaries. Many of these areas immediately beyond the Study Area have not yet been sampled for SRE fauna, although based on the habitats likely to be present, it would be reasonable to assume that many of the Potential SRE fauna present within the Study Area may also occur there.



## 6 CONCLUSION

A targeted vertebrate and SRE invertebrate fauna survey was completed over the Study Area in February 2018. Four vertebrate fauna species of conservation significance were confirmed occurring within the Study Area and another was possibly recorded via secondary evidence, the Western Ringtail Possum. Two of the species possibly/confirmed in the Study Area are regarded as Matters of National Environmental Significance (MNES) under the EPBC Act (Western Quoll and Western Ringtail Possum); one is regarded as 'Conservation Dependent' under the WC Act (Wambenger Brush-tailed Phascogale); and two are considered Priority fauna as defined by the DBCA (Southern Brown Bandicoot and Western Brush Wallaby).

The Western Ringtail Possum was possibly recorded via scats at two locations within the Study Area. The species has also been recorded ~320 m north of the Study Area (2014) in native vegetation that continues into the Study Area. Despite an extensive amount of survey effort, using both motion cameras and spotlighting, no individuals of the species were recorded in the Study Area. The species will use 3-8 nesting sites at a time and up to 20 throughout the year as conditions (i.e. population densities, food resources etc.) within their home-range fluctuate. With this is mind, it is possible that the species occurs in the Study Area in low numbers, or on a transient basis, as populations and resources fluctuate in the surrounding areas. Both the Jarrah/Marri Forest (404 ha, 20%) and Jarrah/Marri Forest over Banksia (267 ha, 13%) habitat types provide potential suitable habitat for the species, particularly in the northwestern section of the Study Area which adjoins a large block of undisturbed native forest. Any development within the Study Area resulting in the clearing of such habitats may potentially affect the local population of the species.

The Western Quoll was recorded on 21 occasions during the Survey, all via motion camera. The Study Area contains preferred habitats of the species and is located well within the species core-range. The survey was undertaken prior to the mating season (April to July), extinguishing the possibility that records represent transient or passing individuals. This is further supported by the number and frequency of the records obtained. All records were from the same site (Site 01) and potentially represented a single individual – although this is not confirmed. Both the Jarrah/Marri Forest (404 ha, 20%) and Jarrah/Marri Forest over Banksia (267 ha, 13%) habitat types provide suitable habitat for the species. Given the species typically large home-range (3 - 15 km<sup>2</sup>), it is possibly that the species may occur throughout the Study Area, although it appears that the north-west portion of the Study Area which adjoins a large waterbody and portion of undisturbed forest provides preferred habitat for individuals within the Study Area. Land clearing is currently seen as the largest impact to the species and any development within the Study Area would potentially impact the local population.

The Wambenger Brush-tailed Phascogale was recorded on 21 occasions and from 15 locations during the survey and appears to be common within the Study Area. The species was recorded in both the Jarrah/Marri Forest and Jarrah/Marri Forest over Banksia habitat types. Home-ranges during the non-breeding season span 20-70 ha and do not typically overlap, suggesting that the Study Area contains a sizeable population. Any clearing of the Jarrah/Marri Forest (404 ha, 20%) and Jarrah/Marri Forest over Banksia (267 ha, 13%) habitat types is likely to impact the species.



The Quokka was not recorded in the Study Area during the survey despite the extensive amount of survey effort. If present, it is likely that the species occurs in very low densities or on a transient basis only. The species preferred habitat comprises woodlands and shrublands with a dense vegetated understorey, which for the most part is not overly abundant within the Study Area. Based on this, it is unlikely that development within the Study Area will severely impact the local population of the species if present.

The Southern Brown Bandicoot and the Western Brush Wallaby were recorded abundantly throughout the Study Area during the survey, recorded on 10 and five occasions respectively. Both species are likely to occur throughout the Study Area in all naturally occurring habitats present: Jarrah/Marri Forest (404 ha, 20%) and Jarrah/Marri Forest over Banksia (267 ha, 13%) Marri/Blackbutt/Flooded Gum Woodland (8 ha, 0.4%). Both species are listed as Priority 4 fauna by the DBCA. Any clearing within the Study Area is likely to impact upon the local population of this species.

Based on the results of the survey, it is likely that all vertebrate fauna species of conservation significance occurring within the Study Area would be somewhat impacted by the proposed development, particularly if the Jarrah/Marri Forest (404 ha, 20%) and/or Jarrah/Marri Forest over Banksia (267 ha, 13%) habitat types are impacted. Both of these habitats appear to be habitat critical to the survival of each of these species, as defined by DoE (2013) – habitats utalised for activities such as foraging, breeding, roosting, or dispersal. Further survey work to determine populations and distribution would be required to accurately assess the level of impact for each species, as would a thorough impact assessment considering all factors of the proposed development (i.e. clearing footprint, secondary impacts etc). Secondary management initiatives may also need to be considered to avoid further impacts, including translocation surveys prior and during clearing activities.

Three invertebrate taxa recorded during the survey were identified as 'Potential SRE'. In all three cases, a precautionary level of Potential SRE was allocated as a precise taxonomic identification could not be made. This comprised two specimens identified as Nemesiidae sp. indet, two specimens of Paradoxosomatidae sp. indet., and one specimen belonging to the family Siphonotidae. Although limited, the current information for these taxa indicates that there is a reasonable likelihood that they may be range restricted. In each instance, genetic analysis would be required to determine the species and/or if the specimens are unique to what has previously been recorded within the region. A review of the habitats present in surrounding area and their connectivity indicates that all taxa identified as 'Potential SRE' may potentially occur in synonymous habitats outside the Study Area. As such, development and clearing of habitats within the Study Area is unlikely to severely impact these species – although further survey work and genetic analysis would need to be conducted to confirm this.



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# 8 APPENDICES



Appendix A

**Conservation Codes** 



#### International Union for Conservation of Nature

Category	Definition
	A taxon is Extinct when there is no reasonable doubt that the last
	individual has died. A taxon is presumed Extinct when exhaustive
Extinct (EX)	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.
	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
Extinct in the Wild (EW)	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.
	A taxon is Critically Endangered when the best available evidence
Critically Endangered (CP)	indicates that it meets any of the criteria A to E for Critically Endangered
Critically Endangered (CR)	(see Section V), and it is therefore considered to be facing an extremely
	high risk of extinction in the wild.
	A taxon is Endangered when the best available evidence indicates that it
Endangered (EN)	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.
	A taxon is Vulnerable when the best available evidence indicates that it
Vulnerable (VU)	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.
	A taxon is Near Threatened when it has been evaluated against the
Near Threatened (NT)	criteria but does not qualify for Critically Endangered, Endangered or
Near Threatened (NT)	Vulnerable now, but is close to qualifying for or is likely to qualify for a
	threatened category in the near future
	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
Data Deficient (DD)	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.

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

### Environment Protection and Biodiversity Conservation Act 1999

#### 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 <i>vulnerable</i> 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 codes

Category	Definition				
Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.				
Priority 2 (P2)Taxa with few, poorly known populations on conservation lands; o with several, poorly known populations not on conservation lands.					
Priority 3 (P3) Taxa with several, poorly known populations, some on consecutive 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

Locations of Sampling Sites



Camera Deployment	Date Deployed	Date Retrieved	Sampling Nights	Latitude	Longitude
		Motion Camera	Deploymen	ts	
Site 01.01	13/02/2018	20/02/2018	7	-33.863724	116.038495
Site 01.02	13/02/2018	20/02/2018	7	-33.863962	116.038849
Site 01.03	13/02/2018	20/02/2018	7	-33.864226	116.039182
Site 01.04	13/02/2018	20/02/2018	7	-33.864473	116.039719
Site 01.05	13/02/2018	20/02/2018	7	-33.864559	116.040356
Site 02.01	13/02/2018	20/02/2018	7	-33.869526	116.045869
Site 02.02	13/02/2018	20/02/2018	7	-33.869862	116.046114
Site 02.03	13/02/2018	20/02/2018	7	-33.870235	116.046585
Site 02.04	13/02/2018	20/02/2018	7	-33.870368	116.047373
Site 02.05	13/02/2018	20/02/2018	7	-33.870956	116.047637
Site 03.01	13/02/2018	20/02/2018	7	-33.888808	116.052813
Site 03.02	13/02/2018	20/02/2018	7	-33.889193	116.052473
Site 03.03	13/02/2018	20/02/2018	7	-33.889575	116.051766
Site 03.04	13/02/2018	20/02/2018	7	-33.889805	116.051169
Site 03.05	13/02/2018	20/02/2018	7	-33.889800	116.050553
Site 04.01	13/02/2018	20/02/2018	7	-33.890503	116.077764
Site 04.02	13/02/2018	20/02/2018	7	-33.890057	116.077153
Site 04.03	13/02/2018	20/02/2018	7	-33.889621	116.076768
Site 04.04	13/02/2018	20/02/2018	7	-33.889311	116.076317
Site 04.05	13/02/2018	20/02/2018	7	-33.889153	116.075702
Site 05.01	13/02/2018	20/02/2018	7	-33.881449	116.072974
Site 05.02	13/02/2018	20/02/2018	7	-33.881634	116.073686
Site 05.03	13/02/2018	20/02/2018	7	-33.881668	116.074583
Site 05.04	13/02/2018	20/02/2018	7	-33.881718	116.075199
Site 05.05	13/02/2018	20/02/2018	7	-33.881813	116.075814
Site 06.01	13/02/2018	20/02/2018	7	-33.870811	116.082020
Site 06.02	13/02/2018	20/02/2018	7	-33.870726	116.082680
Site 06.03	13/02/2018	20/02/2018	7	-33.870821	116.083295
Site 06.04	13/02/2018	20/02/2018	7	-33.870581	116.083817
Site 06.05	13/02/2018	20/02/2018	7	-33.870640	116.084422
Site 07.01	14/02/2018	20/02/2018	6	-33.871409	116.042074
Site 07.02	14/02/2018	20/02/2018	6	-33.871058	116.042165
Site 07.03	14/02/2018	20/02/2018	6	-33.870661	116.042137
Site 07.04	14/02/2018	20/02/2018	6	-33.870217	116.041817
Site 07.05	14/02/2018	20/02/2018	6	-33.869622	116.041954
Site 08.01	14/02/2018	20/02/2018	6	-33.872741	116.034761
Site 08.02	14/02/2018	20/02/2018	6	-33.872521	116.035521



Camera Deployment	Date Deployed	Date Retrieved	Sampling Nights	Latitude	Longitude
Site 08.03	14/02/2018	20/02/2018	6	-33.872270	116.035675
Site 08.04	14/02/2018	20/02/2018	6	-33.872302	116.036258
Site 08.05	14/02/2018	20/02/2018	6	-33.873190	116.036800
Site 09.01	14/02/2018	20/02/2018	6	-33.887542	116.044273
Site 09.02	14/02/2018	20/02/2018	6	-33.887791	116.044876
Site 09.03	14/02/2018	20/02/2018	6	-33.887958	116.045566
Site 09.04	14/02/2018	20/02/2018	6	-33.888091	116.046376
Site 09.05	14/02/2018	20/02/2018	6	-33.888015	116.047047
Site 10.01	14/02/2018	20/02/2018	6	-33.885235	116.067959
Site 10.02	14/02/2018	20/02/2018	6	-33.885597	116.068204
Site 10.03	14/02/2018	20/02/2018	6	-33.886076	116.068274
Site 10.04	14/02/2018	20/02/2018	6	-33.886647	116.068711
Site 10.05	14/02/2018	20/02/2018	6	-33.887203	116.068273
Site 11.01	14/02/2018	20/02/2018	6	-33.883416	116.080414
Site 11.02	14/02/2018	20/02/2018	6	-33.883113	116.079671
Site 11.03	14/02/2018	20/02/2018	6	-33.883208	116.079108
Site 11.04	14/02/2018	20/02/2018	6	-33.883764	116.078659
Site 11.05	14/02/2018	20/02/2018	6	-33.883615	116.078044
Site 12.01	14/02/2018	20/02/2018	6	-33.863145	116.086783
Site 12.02	14/02/2018	20/02/2018	6	-33.862784	116.086808
Site 12.03	14/02/2018	20/02/2018	6	-33.862189	116.086869
Site 12.04	14/02/2018	20/02/2018	6	-33.861884	116.087034
Site 12.05	14/02/2018	20/02/2018	6	-33.861196	116.086760
GR 01	15/02/2018	20/02/2018	5	-33.859788	116.040258
GR 02	15/02/2018	20/02/2018	5	-33.863301	116.044327
GR 03	15/02/2018	20/02/2018	5	-33.867585	116.046658
GR 04	15/02/2018	20/02/2018	5	-33.872440	116.044842
GR 05	15/02/2018	20/02/2018	5	-33.874936	116.038683
GR 06	16/02/2018	20/02/2018	4	-33.883693	116.056222
GR 07	16/02/2018	20/02/2018	4	-33.883125	116.051459
GR 08	16/02/2018	20/02/2018	4	-33.881667	116.043701
GR 09	16/02/2018	20/02/2018	4	-33.881248	116.082286
GR 10	17/02/2018	20/02/2018	3	-33.868710	116.032482
GR 11	17/02/2018	20/02/2018	3	-33.866827	116.084765
GR 12	17/02/2018	20/02/2018	3	-33.853709	116.084116
		SRE Samp	ling Sites		
SRE01	18/02/2018	-	-	-33.8806	116.0823
SRE02	18/02/2018	-	-	-33.8803	116.0749



Camera Deployment	Date Deployed	Date Retrieved	Sampling Nights	Latitude	Longitude
SRE03	18/02/2018	-	-	-33.8671	116.084
SRE04	18/02/2018	-	33.8529		116.0836
SRE05	19/02/2018	-	33.8833		116.0557
SRE06	19/02/2018	-	33.8812		116.0487
SRE07	19/02/2018	-	33.8752		116.0392
SRE08	19/02/2018	-	33.8712		116.0436
SRE09	19/02/2018	-	33.8526		116.0842
SRE10	19/02/2018	-	-	-33.8625	116.041
SRE11	20/02/2018	-	-	-33.8894	116.0522
SRE12	20/02/2018	-	-	-33.8906	116.0773



Appendix C Locations of Vertebrate Fauna of Conservation Significance



Site ID	Date	Common Name	Species Name	Record Types	No.	Latitude	Longitude
Site 01	14/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864473	116.039719
Site 01	14/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864473	116.039719
Site 01	15/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864473	116.039719
Site 01	15/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864473	116.039719
Site 01	16/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864473	116.039719
Site 01	17/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864473	116.039719
Site 01	14/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	14/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	14/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	15/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	15/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	15/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	16/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	17/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864559	116.040356
Site 01	14/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.863962	116.038849
Site 01	15/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.863962	116.038849
Site 01	14/02/2017	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864226	116.039182
Site 01	15/02/2017	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864226	116.039182
Site 01	16/02/2017	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864226	116.039182
Site 01	17/02/2017	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.864226	116.039182
Site 01	14/02/2018	Western Quoll, Chuditch	Dasyurus geoffroii	MC	1	-33.863724	116.038495
GR10	17/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.870600	116.033200
GR12	17/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Scats	5	-33.853200	116.083700
GR14	17/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.874000	116.086700
GR05	15/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	5	-33.874000	116.039400
GR08	16/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	5	-33.881700	116.043700
GR09	16/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.881800	116.082200
Орр	16/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	R	2	-33.869600	116.032600
Орр	17/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	R	1	-33.883000	116.083800



Site ID	Date	Common Name	Species Name	Record Types	No.	Latitude	Longitude
Site 10	14/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.885100	116.068000
Site 02	13/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	5	-33.870300	116.047400
Site 04	13/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.890500	116.077400
Site 05	13/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.881800	116.073600
Site 08	14/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.872500	116.035400
Site 09	14/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.887500	116.044400
Site 09	13/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.881700	116.074600
Site 09	14/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.887900	116.045700
Site 09	17/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.853700	116.084100
Site 09	14/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	2	-33.872000	116.042000
Site 09	15/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	3	-33.874100	116.039600
Site 09	17/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	3	-33.869900	116.034400
Site 09	19/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	3	-33.883500	116.055800
Site 09	13/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	5	-33.883700	116.066600
Site 09	16/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	5	-33.881300	116.042000
Site 09	20/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	6	-33.870400	116.045900
Site 09	16/02/2018	Forest Red-tailed Black Cockatoo	Calyptorhynchus banksii naso	Орр	1	-33.870300	116.032900
GR01	16/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	16/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	16/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	17/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	17/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	17/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	18/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	19/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
GR01	20/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.859788	116.040258
Site 03	15/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	16/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	18/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813



Site ID	Date	Common Name	Species Name	Record Types	No.	Latitude	Longitude
Site 03	18/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	19/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	20/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	20/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	20/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	20/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
Site 03	20/02/2018	Southern Brown Bandicoot, Quenda	Isoodon obesulus fusciventer	MC	1	-33.888808	116.052813
GR12	20/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.853709	116.084116
GR06	20/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.883693	116.056222
Site 10	15/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.886076	116.068274
Site 11	18/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.883208	116.079108
Site 11	17/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.883113	116.079671
Site 11	20/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.883113	116.079671
Site 11	21/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.883113	116.079671
Site 12	20/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.861196	116.086760
Site 12	15/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.862189	116.086869
Site 12	18/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.862189	116.086869
Site 12	16/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.862784	116.086808
Site 04	14/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.889621	116.076768
Site 04	15/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.889621	116.076768
Site 04	16/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.889621	116.076768
Site 04	19/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.890503	116.077764
Site 07	19/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.871409	116.042074
Site 08	16/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.872521	116.035521
Site 08	15/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.873190	116.036800
Site 08	19/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.873190	116.036800
Site 01	14/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.864559	116.040356
Site 02	15/02/2018	Wambenger Brush-tailed Phascogale	Phascogale tapoatafa wambenger	MC	1	-33.870956	116.047637
GR04	20/02/2018	Western Brush Wallaby	Macropus irma	MC	1	-33.872440	116.044842





Site ID	Date	Common Name	Species Name	Record Types	No.	Latitude	Longitude
Site 01	16/02/2017	Western Brush Wallaby	Macropus irma	MC	1	-33.864226	116.039182
Site 02	14/02/2018	Western Brush Wallaby	Macropus irma	MC	1	-33.869862	116.046114
Site 02	17/02/2018	Western Brush Wallaby	Macropus irma	MC	1	-33.870235	116.046585
Site 02	15/02/2018	Western Brush Wallaby	Macropus irma	MC	1	-33.869526	116.045869
Site 02	16/02/2018	Western Brush Wallaby	Macropus irma	MC	1	-33.870956	116.047637
Site 09	13/02/2018	Western Ringtail Possum	Pseudocheirus occidentalis	SP	1	-33.863600	116.038700
Site 09	15/02/2018	Western Ringtail Possum	Pseudocheirus occidentalis	SP	1	-33.866500	116.045700

MC = Motion Camera; Opp = Opportunistic, R = Roost; SP = Scat (possible only)