Callawa Level 2 Vertebrate Fauna Assessment

Prepared for
BHP Billiton Iron Ore

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Abbreviations

ABBREVIATION	DESCRIPTION
BHPBIO	BHP Billiton Iron Ore Pty Ltd
BoM	Bureau of Meteorology
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS)
CAMBA	China - Australia Migratory Bird Agreement
DAFWA	Department of Agriculture and Food WA
DEC	Department of Environment and Conservation
DEWHA	Department of Environment, Water, Heritage and the Arts (now SEWPaC – see below)
ELA	Eco Logical Australia
EP Act	*Environmental Protection Act 1986* (State)
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Federal)
ESA	Environmentally Sensitive Area
GDA	Geocentric Datum of Australia
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
JAMBA	Japan – Australia Migratory Bird Agreement
NP	National Park
NSW	New South Wales
OSA	Overburden Stockpile Areas
ROKAMBA	Republic of Korea – Australia Migratory Bird Agreement
SAC	Species Accumulation Curve
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities (formerly Department of Environment, Water, Heritage and the Arts DEWHA) (Federal)
TECs	Threatened Ecological Communities
WA	Western Australia
WAM	Western Australian Museum
WC Act	*Wildlife Conservation Act 1950* (State)

Executive Summary

BHP Billiton Iron Ore (BHPBIO) currently operates a number of open cut iron ore mines as part of the Goldsworthy Iron Ore Mining Operations located approximately 185 kilometres (km) east of Port Hedland in the north-eastern Pilbara, Western Australia. BHPBIO is seeking to amend the current approvals for mining at the Callawa deposit (Project area) and as part of the environmental approval processes; BHPBIO will be seeking approval for the expansion via a Section 45C application under the *Environmental Protection Act 1986*. Additional information on the vertebrate fauna of the area is required to support this application and as such BHPBIO commissioned Eco Logical Australia (ELA) to conduct a one-season Level Two vertebrate fauna assessment of the Project area.

This fauna survey involved a desktop review followed by a detailed survey in accordance with BHPBIO standards and the Environmental Protection Authority (EPA) fauna survey Guidance Statements as detailed in this report.

The desktop review identified 304 potentially occurring fauna species from the general area, comprising six amphibians, 100 reptiles, 145 birds and 53 mammals. A total of 34 conservation significant fauna species (three reptiles, 20 birds and 11 mammals) were identified as potentially occurring within the Project area.

The field survey was undertaken by six ecologists from ELA between the 19th and the 28th May 2012. Several survey methods were utilised throughout the survey, including trapping transects, bird census, bat call monitoring, motion cameras, targeted searches, hand searching, nocturnal searches, and opportunistic observations.

The main conclusions of the field survey were:

- Five fauna habitat types were identified within the Project area based on substrate and vegetation. These habitat types generally correspond to elevation within the landscape, geomorphology, and the associated dominant vegetation types. The five habitat types identified were:
    - Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays.
    - Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble.
    - Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays.
    - Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping.
    - Rocky hills and ridges supporting *Grevillea/Acacia* shrublands and *Triodia* hummock grasslands on ironstone / shallow clay.

- A total of 99 terrestrial vertebrate species were recorded within the Project area, including one amphibian, 27 reptiles, 50 birds and 18 mammals. An additional three introduced mammal species were recorded.
- Five conservation significant species as listed under either the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the state *Wildlife Conservation Act 1950* (WC Act), or as a Priority species by the Department of Environment and Conservation (DEC) were recorded within the Project area from the current survey and previous surveys:
    - *Ardeotis australis* (Australian Bustard): Listed as Priority 4 by the DEC;
    - *Burhinus grallarius* (Bush Stone-curlew): Listed as Priority 4 by the DEC;
    - *Macroderma gigas* (Ghost Bat): Listed as Priority 4 by the DEC;
    - *Dasyurus hallucatus* (Northern Quoll): Listed as Endangered under the federal EPBC Act and the state WC Act; and
    - *Merops ornatus* (Rainbow Bee-eater): Listed as Migratory under the EPBC Act.
- An additional five species of conservation significance are considered 'likely' to occur, and eight are considered to have the 'potential' to occur within the Project area.

Results of this survey are concluded to be similar to other surveys that have been conducted in the vicinity of the Project area. The fauna habitat was overall in excellent condition, although some creek lines and plains were slightly degraded due to cattle grazing. Areas that had not been accessed by cattle, such as the rocky hill slopes, ridges and gullies were in pristine condition.

All broad habitat types identified within the Callawa Project area were identified as being able to support Northern Quolls, as well as other conservation significant fauna species. Most of these habitats are considered extensive within the Pilbara bioregion, and also within adjacent areas such as the Great Sandy Desert region.

1 Introduction

1.1 PROJECT OVERVIEW

BHP Billiton Iron Ore (BHPBIO) currently operates a number of open cut iron ore mines as part of the Goldsworthy Iron Ore Mining Operations located approximately 200 kilometres (km) east of Port Hedland in the north-eastern Pilbara region of Western Australia (**Figure 1**). BHPBIO wishes to amend the current approvals for mining at the Callawa deposit (Project area) to enable direct rail loading and additional Overburden Stockpile Areas (OSA).

As part of environmental approvals processes, BHPBIO will be seeking approval for the expansion via a Section 45C application under the *Environmental Protection Act 1986* (EP Act). Additional information on the vertebrate fauna of the area is required to support this application. A portion of the area had been previously surveyed by *ecologia* (2005) and to a lesser extent Outback Ecology (2008). As such BHPBIO commissioned Eco Logical Australia (ELA) to conduct a one-season Level Two vertebrate fauna assessment of the Project area in order to meet EPA guidelines (EPA 2004, EPA and DEC 2010), and to provide sufficient survey coverage over the area and contemporary information on vertebrate fauna of the Project area.

1.2 LEGISLATIVE FRAMEWORK

Federal and State legislation applicable to the conservation of native fauna include, but are not limited to:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Federal)

  A Federal Act aimed at protecting matters of national environmental significance, promoting ecologically sustainable development through the conservation and ecologically sustainable use of natural resources and promoting the conservation of biodiversity. Under this Act, the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) lists threatened species in categories determined by criteria set out in the Act (Appendix A). Projects likely to cause impacts on matters of national environmental significance should be referred to SEWPaC for assessment under the Act.

- *Wildlife Conservation Act 1950* (WC Act) (State)

  State legislation that aims to provide for the conservation and protection of wildlife in Western Australia by formally recognising taxa identified by the Department of Environment and Conservation (DEC) as protected, and listing them according to classifications ranging from Schedule 1 to Schedule 4 depending upon their need for protection (Appendix A).

  The WC Act was developed to provide for the conservation and protection of wildlife in Western Australia. Under Section 14 of the WC Act, all flora and fauna within Western Australia is protected. The Minister may, via a notice published in the *Government Gazette*, declare a list of fauna identified as rare, likely to become extinct, or otherwise in need of special protection (Appendix A). The current listing was gazetted in February 2012.

- *Environmental Protection Act 1986* (EP Act) (State)

  Projects undertaken as part of the environmental impact assessment process are required to address guidelines produced by the Environmental Protection Authority (EPA). In regards to terrestrial fauna, this includes principles outlined in EPA Position Statement No. 3: *Terrestrial*

Biological Surveys as an Element of Biodiversity Protection (EPA 2002), as well as survey methodology guidelines within Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004) and the document *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010).

Under the EP Act, the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* contain ten principles by which applications to clear native vegetation are assessed. Significant habitat necessary for the maintenance of indigenous fauna species is one of these principles. In addition, threatened ecological communities (TECs) include fauna assemblages / communities, and have special status as Environmentally Sensitive Areas under this Act.

In addition to EPBC Act listed fauna and WC Act Schedules, the DEC has prepared a list of Priority species for protection. These are species that have not met the requirements to be formally listed as Threatened species under the WC Act, but are considered by the DEC to be rare and/or under threat (Appendix A).

Migratory birds are listed under the EPBC Act and Schedule 3 of the WC Act in recognition of species listed under international agreements; such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Species that are at the limit of their distribution, have a very restricted range and/or those that occur in breeding colonies can also be considered of conservation significance. This level of significance is recognised by the EPA (EPA 2004).

1.3 PROJECT OBJECTIVES (VERTEBRATE FAUNA)

The scope of works undertaken for the assessment of vertebrate fauna is to satisfy Level Two Vertebrate Fauna survey requirements (EPA 2004) in conjunction with the following:

- EPA Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002);
- EPA Guidance Statement No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004);
- EPA and DEC Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010);
- BHPBIO (2009) Guidance for Vertebrate Fauna Surveys in the Pilbara Region (SPR-IENEMS- 012);
- BHPBIO (2010) Terrestrial Fauna Habitat Assessment Pro Forma (FRM-IEN-EMS-003);
- Department of the Environment, Water, Heritage and the Arts (DEWHA) Matters of National Environmental Significance – Significant Impact Guidelines 1.1 (DEWHA 2009);
- DEWHA 2010 – Survey Guidelines for Australia's Threatened Bats;
- DEWHA 2010 – Survey Guidelines for Australia's Threatened Birds;
- DEWHA 2010 – Survey Guidelines for Australia's Threatened Frogs;
- DEWHA 2010 – Survey Guidelines for Australia's Threatened Mammals; and,
- DEWHA 2010 – Survey Guidelines for Australia's Threatened Reptiles.

The outline of this report is as follows:

- Describe background research and desktop review of:
  - Study site location, features and topography
  - All known conservation significant fauna, including Threatened, Priority and Migratory species relevant to the Project area.
- Summarise field survey findings including:
  - Description and mapping of fauna habitats within the Project area
  - Assessment of the likelihood of habitats within the Project area to support listed and/or specially protected fauna
  - Description of fauna assemblages within the Project area
  - Description and mapping of conservation significant fauna within the Project area
- Provide appendices including:
  - Explanation of conservation codes and classification systems
  - Species lists of all vertebrate species recorded during the survey, including those from previous surveys
  - Locations and photographs of conservation significant species, secondary evidence and/or habitat
  - Habitat assessment data sheets.

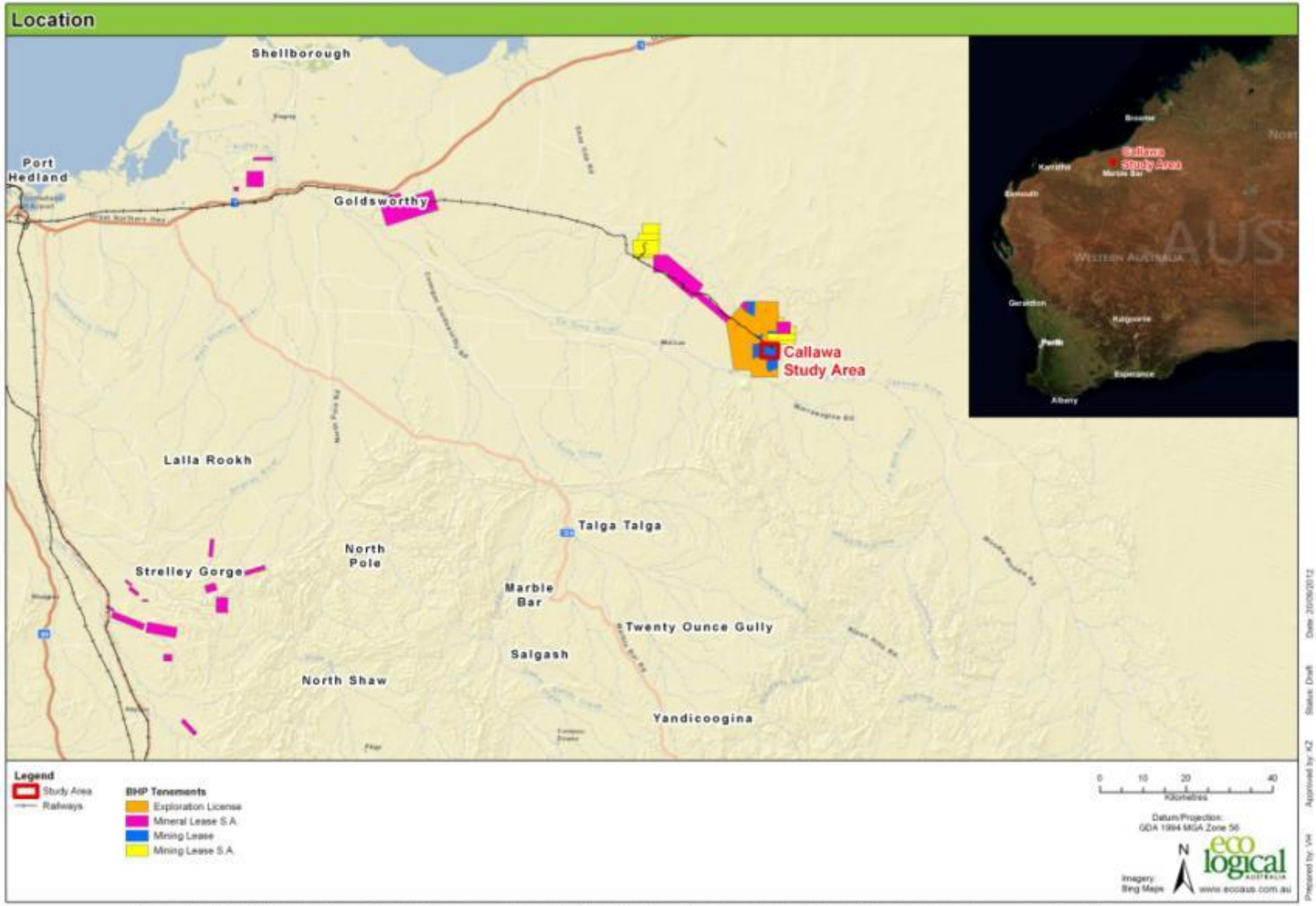


Figure 1: Callawa Project Location

2 Project area

The Project area lies approximately 185 km east of Port Hedland, in the Pilbara region of Western Australia (**Figure 1**). The Project area covers approximately 12 km².

2.1 CLIMATE

The Project area is situated in the Pilbara region of Western Australia which experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September. Temperatures are generally high, with summer temperatures frequently exceeding 40°C. Light frosts occasionally occur inland during July and August. The Project area is 9 km south-west of the Great Sandy Desert which experiences a similar climate to the Pilbara and is influenced by monsoonal activity (Graham 2001).

Rainfall is generally low and unpredictable in the Pilbara (some years have recorded zero rainfall) and temperatures are high, resulting in annual evaporation exceeding rainfall by as much as 500 mm per year. Most of the Pilbara has a bimodal rainfall distribution; from January to March; rains resulting from tropical storms producing sporadic thunderstorms, with tropical cyclones moving south also bringing heavy rains. From May to June, extensive cold fronts move eastwards across the state and sometimes reach the Pilbara. These fronts usually produce only light rains. Surface water can be found in some rock pools and springs all year round, although watercourses are episodic due to the short wet season (Beard 1975).

Rainfall in the Great Sandy Desert is very unpredictable, relying heavily on summer monsoonal patterns. The region tends to experience one year of above average rainfall, followed by a long period of drought. Average annual rainfall is usually 250 - 300 mm annually; during the summer months temperatures and humidity is high. Creeks and rivers only flow after heavy rainfall; however some permanent water bodies are present in the WA section of the bioregion.

The closest meteorological station to Callawa is located at Marble Bar (station number 4106), approximately 80 km south-west of the Project area.

Average annual rainfall recorded at the Marble Bar station is 28.6 mm, with most rainfall occurring during the wet season of January, February and March (

Figure 2) (BoM 2012). Mean monthly maximum temperatures range from 26.9 °C in June to 41.7 °C in December, and mean monthly minimum temperatures ranging from 12.2 °C in July to 26.7 °C in January (BoM 2012).

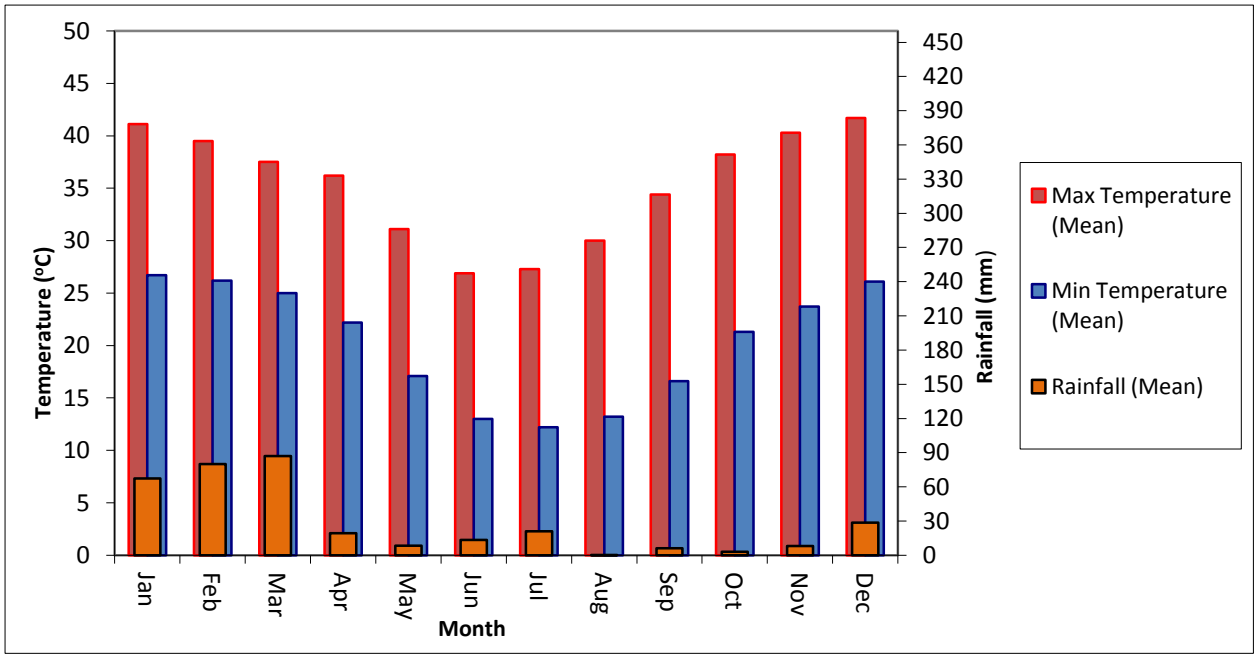


Figure 2: Average annual climate data for Marble Bar meteorological station (BoM 2012).

2.1.1 **Weather**

Additional weather information collected at Yarrie station, approximately 11km south-west of the Project area, indicated higher than average rainfall for January, February and March 2012 with a total of 604.8 mm recorded (BHPBIO 2012) (**Figure 3**). Only 10.8 mm was recorded during April and zero rainfall was recorded for the month of May in which the fauna survey was undertaken. The average daily maximum temperatures during February, March and April prior to the field survey were 38.3 °C, 33.8 °C and 34.9 °C respectively (**Figure 3**). The region experienced warm minimum temperatures, averaging 24.9 °C in February, 23.5 °C in March and 21.6 °C in April 2012. Mean maximum and minimum daily temperatures recorded at Yarrie in the months prior to survey are similar to average temperatures on record at Marble Bar meteorological station (**Figure 3** and **Figure 4**).

The fauna survey was undertaken between 19 and 28 May 2012. The weather during this time consisted of cool to warm, dry days with the highest temperature recorded as 32.1 °C on the 19 May (**Figure 4**). The lowest recorded minimum temperature was 9.5 °C on the 27 May. No rainfall was recorded during the survey period (BoM 2012).

By comparison, a previous Level 2 fauna survey was undertaken within the Project area by *ecologia* (2005a) between 9 and 28 June 2005. The Marble Bar weather station (4106) received just 5 mm of rainfall during this time. The highest maximum temperature recorded during the survey was 31.2 °C and the mean minimum daily temperature was 29.5 °C and the lowest recorded minimum was 8.2 °C (BoM 2012).

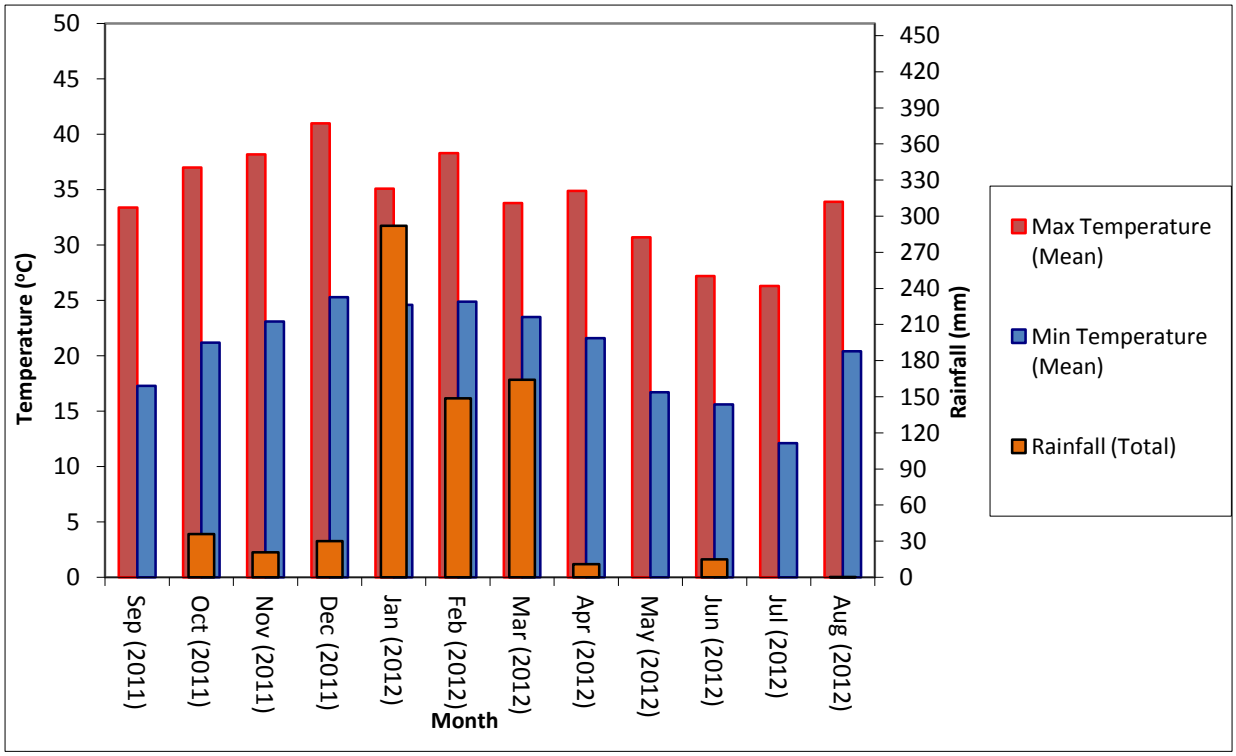


Figure 3: Climate data at Yarrie station for the September 2011 – August 2012 period (BHPBIO 2012)

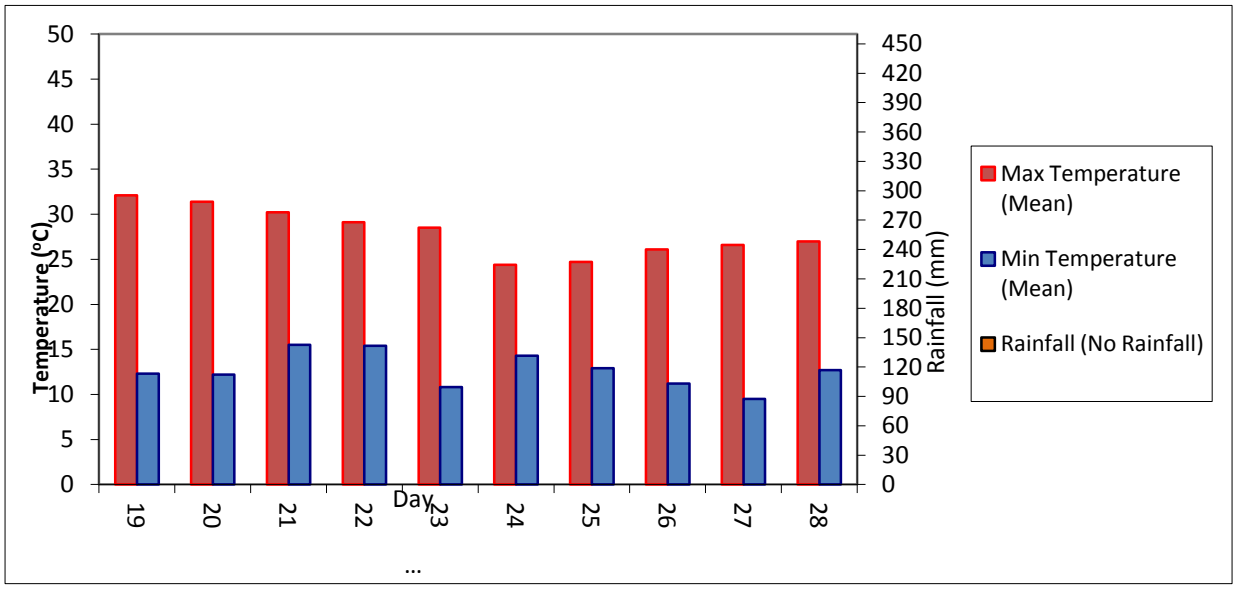


Figure 4: Climate data at Marble Bar meteorological station for survey period (BoM 2012)

2.2 LAND SYSTEMS

Land system mapping is based on regional patterns in topography, soils and vegetation. The most recent land system mapping of the Pilbara bioregion, in which the Project area lies, was completed by Van Vreeswyk *et al*. (2004).

The mapping classifies the Pilbara region into 102 land systems. The Project area lies within three land systems: Boolgeeda, Capricorn and Paradise. Their descriptions are listed below:

- BGD: Boolgeeda is made up of stony lower slopes and plains below hill systems that generally are not degraded or eroded.
- CPN: Capricorn is comprised of rugged hills and ridges on sedimentary rocks that are poorly accessible and generally not degraded or eroded.
- PDS: Paradise is comprised of alluvial plains supporting soft spinifex grasslands and tussock grasslands.

2.3 GEOLOGY AND TOPOGRAPHY

Geology of Western Australia has been mapped at a 1:100 000 scale as part of the Geological Survey of WA (Department of Mines and Petroleum 2011). Callawa is within the Muccan area, which lies in the north-eastern part of the Pilbara Craton. Muccan is described as mostly unexposed granite covered by Quaternary sediments (Williams 1999). The Project area lies predominately on plains and lower slopes surrounded by ridges, breakaways, mountains and hills. The following soil types were identified within the Project area based on 1:100 000 geological survey mapping (Williams 1999):

- AGn – Nimingarra Iron Formation – banded iron-formation, jaspilite, banded and ferruginous chert, and black carbonaceous shale; metamorphosed
- AGna - Basal pebble to cobble conglomerate, sandstone, siltstone, and shale; metamorphosed
- AgWc - Medium- to coarse-grained monzogranite, syenogranite, and granodiorite; pink-grey to cream
- PLph - Hornblende-feldspar-biotite porphyry dykes; trachyandesite and lamprophyre related to Pgh
- Qaa – alluvium – undivided clay, silt, sand and gravel in rivers and creeks
- Qc – Colluvium – sand, silt and gravel on outwash fans; scree and talus; proximal mass-wasting deposits.
- Qs – Eolian sand – light to dark-red sand in sheets on longitudinal (seif) chain dunes; quartz pebble)

2.4 WETLANDS

No wetlands of international significance (Ramsar wetlands) listed under the EPBC Act occur within a 10 km radius of the Project area. Eighty-Mile Beach is located approximately 80 km north and is currently listed as a Ramsar wetland (SEWPaC 2012a). Based on the search results of the Protected Matters Search Tool (SEWPaC 2012), the De Grey River occurs 4 km south of the Project area. The De Grey River is currently listed as a wetland of national significance (Australian Natural Resources Atlas 2009).

2.5 CONSERVATION RESERVES IN THE LOCALITY

No National Parks (NP) are located within 100 km of the Project area. Karijini NP is the closest conservation reserve to the Project area, being located approximately 190 km south-west of Port Hedland. Additionally, the Mungaroona Range Nature Reserve is located approximately 230 km south-west and the Rudall River NP lies approximately 280 km south-east of the Project area.

2.6 IBRA AND REGIONAL VEGETATION DESCRIPTIONS

The Interim Biogeographical Regionalisation for Australia (IBRA) recognises 89 bioregions within Australia. These bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna (SEWPaC 2012b). The Project area lies within the Pilbara bioregion (PIL) with an extent of 179,287 km². The Pilbara bioregion is further divided into four subregions:

- Chichester (PIL1): Archaean granite and basalt plains supporting shrub steppes of *Acacia pyrifolia* over *Triodia pungens* hummock grasses, with Snappy Gum (*Eucalyptus leucophloia*) steppes occurring on the ranges (Kendrick & McKenzie 2001);
- Fortescue Plains (PIL2): Alluvial plains and river frontages with salt marsh, Mulga-bunch grass and short grass communities on alluvial plains and River Gum (*Eucalyptus camaldulensis*) woodlands fringing drainage lines (Kendrick 2001a);
- Hamersley Plateau (PIL3): Mountainous area of Proterozoic ranges and plateaux with low Mulga (*Acacia aneura*) woodland over bunch grasses on fine textured soils, and Snappy Gum over *Triodia brizoides* on the skeletal sandy soils of the ranges (Kendrick 2001b); and
- Roebourne Plains (PIL4): Quaternary alluvial plains with a grass savannah and shrub steppe of *Acacia translucens* over *Triodia pungens* and marine alluvial flats with Samphire, Sporobolus and Mangal (Kendrick & Stanley 2001).

The Project area lies within the Chichester subregion (PIL1). The Chichester subregion comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is semi desert tropical and receives around 300 mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock). The subregional extent is 9,044,560 ha (Kendrick and McKenzie 2001).

The McLarty subregion, within the Great Sandy Desert bioregion, is approximately 10 km north east of the Project area. Other IBRA subregions that surround the Project area include Roebourne (PIL4) (approximately 45 km to the west), Mackay (GSD2) (approximately 40 km to the east), and Pindanland (DL2) (approximately 60 km to the north).

In reference to regional vegetation, the Project area occurs within the Fortescue Botanical District (Beard 1975). The Fortescue Botanical District is described as having between 1,500 and 2,300 flowering plants (Trudgen and Casson 1998). Hard red soils are found on the plains, whereas soils are shallow and skeletal on the ranges (Beard 1975).

Vegetation type and extent has been mapped at a regional scale by Beard (1975) who categorised vegetation into broad vegetation associations. Based on this mapping at a scale of 1:1,000,000, the Department of Agriculture and Food WA (DAFWA) has compiled a list of vegetation extent and types across WA (Shepherd *et al.* 2001). The vegetation types that occurred within the Project area prior to European settlement are vegetation associations 93 and 171:

- 171 is described as Hummock grasslands, low tree steppe; snappy gum over soft Spinifex and *Triodia brizoides*; and
- 93 is characterized by hummock grasslands and shrub steppe; kanji over soft spinifex (Shepherd *et al*. 2001).

As of 2011, the extent of these vegetation associations was over 3,040,641 ha (vegetation association 93) and 330,643 ha (vegetation association 171), with close to 100% of each vegetation association extent still remaining (DAFWA 2012; DEC 2012a). These figures are significantly above the 30% threshold level set for the retention of vegetation types by the EPA (EPA 2000).

3 Desktop review

3.1 PREVIOUS ECOLOGICAL SURVEYS

As a result of the large scale expansion of resource development projects occurring within the Pilbara, there has been an increase in site-specific ecological surveys. A number of fauna surveys of similar size and scope have been undertaken in the region to fulfil the statutory requirements of State and Federal legislation. The following ecological survey reports for sites close to the Project area were provided to and reviewed by ELA:

- Update report for Goldsworthy quarterly bat monitoring: October 2011 (Specialized Zoological 2011a);
- Update report for Goldsworthy quarterly bat monitoring: July 2011 (Specialized Zoological 2011b);
- Goldsworthy bat monitoring: July 2010 – April 2011 (Specialized Zoological 2011c);
- Shay Gap Aerodrome, Yarrie Area A and Yarrie Area B – Level 2 Flora and Vegetation Survey and Level 1 Fauna Survey (Onshore Environmental 2010);
- Goldsworthy Iron Ore Mining Operations – Cundaline and Callawa Mining Operations Targeted Fauna Assessment (Outback Ecology 2008);
- Callawa Biological Assessment Survey (*ecologia* 2005a);
- Cundaline Biological Assessment Survey (*ecologia* 2005b);
- Goldsworthy Extension Project Biological Assessment Survey (*ecologia* 2005c);
- Goldsworthy Extension Project Cattle Gorge Haul Road Biological Assessment Survey (*ecologia* 2005d); and
- Yarrie Biological and Soil Survey (*ecologia* 1999).

Two of these surveys have occurred within the Project area; 'Goldsworthy Iron Ore Mining Operations – Cundaline and Callawa Mining Operations Targeted Fauna Assessment' (Outback Ecology 2008) and 'Callawa Biological Assessment Survey' (*ecologia* 2005a).

3.2 DATABASE SEARCHES

The following Federal and State databases were searched for information relating to conservation significant fauna and ecological communities to target during the field survey:

- Federal EPBC Act Protected Matters search tool (SEWPaC 2012a);
- DEC and Western Australian Museum's NatureMap online database (DEC 2012b);
- DEC Threatened and Priority fauna database search for Scheduled fauna (DEC 2012c);
- Fauna listed on the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List (IUCN 2012); and
- Birds Australia's Birdata database (BirdLife Australia 2012).

A search of the above fauna databases was performed using a using a suitable buffer of 20 km around the point location 20.62138 Latitude (20˚ 37' 17") and 120.28527 Longitude (120˚ 17' 07") using Geocentric Datum of Australia (GDA) 94.

Results from database searches can be viewed in Appendix B. It should be noted that these lists will include species that have been recorded in the general region but may be unlikely to occur in the Project area due to a lack of suitable habitat (e.g. shore birds). This list has been refined to exclude highly unlikely species that are either erroneous records for the region or where there is no suitable habitat within or surrounding the Project area for that species. Many bird, mammal, reptile and amphibian species have specific habitat requirements that may be present in the general area but not in the specific Project area. As a result, many species will be included in the lists produced from database searches but will not be present in the actual Project area.

3.3 POTENTIAL FAUNA ASSEMBLAGES

A species list was compiled based on relevant previous studies that have occurred within the vicinity of the Project area and results from the database searches. It is important to note the results exclude species that are unlikely to occur due to unsuitable habitat. These results will be discussed in Section 5.1.1.

3.4 CONSERVATION SIGNIFICANT FAUNA

Records of conservation significant fauna from previous surveys, database searches and ELA's current survey are discussed in Section 5.1.2. A full species list including conservation significant species identified from previous studies that have occurred within the vicinity of the Project area and results from the database searches are provided as an Appendix.

3.4.1 **Likelihood of occurrence criteria**

Specific criteria were used to assess the likelihood of conservation significant fauna occurring. The likelihood of occurrence assessment was based on the species matching one or more of the criteria below.

- Likelihood: No
  - Species not known to occur within the bioregion
  - Project area lacks important habitat for a species that has highly selective habitat requirements
  - Species has been historically recorded within Project area or locally, however it is considered locally extinct due to significant habitat changes and introduced predators
- Likelihood: Unlikely
  - Species has been recorded within the bioregion based on literature review, but not recorded locally based on DEC database search, and adequate survey efforts (such as a standardised methodology) have not detected the species
  - Project area assessed as having marginally suitable or low quality habitat at best, or other factors such as high level of disturbance or lack of habit connectivity
- Likelihood: Potential
  - Extensive survey efforts have not detected the species, however the species is known to occur locally or regionally, has cryptic habits, and no effective standardised survey procedure is available
  - Project area assessed as having potentially suitable habitat based on species ecology and on-ground habitat assessment
  - Historical evidence of species occurrence within Project area
  - Species may be highly mobile and/or have extensive foraging range

- Likelihood: Likely
  - Core habitat or preferred habitat for the species occurs within the Project area either year-round or seasonally (for example this could be a host plant, seasonal wetland or roosting cave)
  - Species has been recorded in close proximity and in similar habitat to that which occurs within the Project area
- Likelihood: Yes
  - Recent (fresh) evidence of species positively identified by competent ecologist within the Project area such as scats, footprints or burrows
  - Species recorded within Project area recently and/or during current survey.

4 Field survey methodology

4.1 FIELD SURVEY TEAM

Field survey team members and their qualifications and experience are listed in **Table 1**.

Table 1: ELA staff involved with survey

NAME	QUALIFICATION	RELEVANT EXPERIENCE
Robert Browne-Cooper	BSc Biological Science	Extensive fauna surveys throughout most of the WA bioregions
Katrina Zeehandelaar	BSc (Hons) Conservation Biology and Management	Various fauna surveys within Pilbara, Mid-west and South West of WA
Rodney Armistead	PhD (Conservation Biology) BSc (Hons) Biological Science	Various fauna surveys throughout Pilbara and South West of WA, and in VIC and NSW
Enhua Lee	PhD (Ecology and Wildlife Management) BSc (Hons) Biological Science	Extensive fauna surveys throughout NSW
Natalia Gomez	BSc (Hons) Environmental Science	Fauna surveys throughout Queensland
James Taylor	BSc (Hons) Zoology	Fauna surveys in the Goldfields of WA

4.2 COMPLIANCE WITH GUIDANCE STATEMENTS

The survey design is aligned with methodology outlined in the EPA's Guidance Statement No. 56 (EPA 2004), Position Statement No. 3 (EPA 2002) and the document *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010). In addition, the following documents were referred to when planning survey methodology:

- DEWHA (2010) Survey Guidelines for Australia's Threatened Bats;
- DEWHA (2010) Survey Guidelines for Australia's Threatened Birds;
- DEWHA (2010) Survey Guidelines for Australia's Threatened Mammals;
- DEWHA (2010) Survey Guidelines for Australia's Threatened Reptiles;
- DEWHA (2010) Survey Guidelines for Australia's Threatened Frogs; and
- BHPBIO (2011) Guidance for Vertebrate Fauna Surveys in the Pilbara (SPR-IEN-EMS-012).

4.2.1 **Survey timing**

A single phase Level 2 vertebrate fauna survey was carried out in accordance with BHPBIO's guidance statements as provided to ELA, and the EPA guidance statements (EPA 2004; EPA and DEC 2010). The field survey was undertaken during the early dry season from 19 – 28 May 2012 (refer to Section 2.1.1 for weather data during the survey period). The EPA guidance statements advise the optimal timing for surveys is during the season immediately following the season of maximum rainfall (EPA 2004). EPA and DEC (2010) also state that for the Pilbara the "wet season is the period of highest vertebrate activity and planning should coincide with this period, or as soon after as practicable. The wet season may begin as early as November or December but as late as February". Survey timing therefore is not considered to be optimal as per EPA and DEC (2010) guidance; however May falls within the season immediately following on from the wet season. It is important to note that survey timing was optimal for detection of mammals and birds, including conservation significant species such as the Northern Quoll (*Dasyurus hallucatus*).

4.3 SAMPLING METHODS

The survey was undertaken using a variety of sampling techniques, and included both systematic and opportunistic methods. Systematic sampling refers to data methodically collected over a fixed time period in a discrete habitat type, using an equal or standardised sampling effort. Opportunistic sampling includes data collected non-systematically from both fixed sampling sites and as opportunistic records from chance encounters with fauna. In addition to systematic sampling at specific locations, opportunistic searching occurred throughout all areas of the Project area accessed during the field survey.

4.3.1 **Fauna habitats**

Broad habitat types within the Project area were identified and described (as per BHPBIO 2011), and included collection of information on:

- Location of the broad habitat type within the Project area (GPS co-ordinates)
- Landscape position
- Associated vegetation and dominant structure
- Hollow-bearing trees, including dead stags (e.g. average size and abundance of hollows)
- Description of rock and rocky outcrops
- Logs (e.g. abundance and size)
- Leaf and twig litter percentage
- Bare ground percentage
- Wetlands, creeks, rivers, dams and other water bodies
- Description of observed nests and roosts
- Subterranean roosts (e.g. caves, disused mineshafts)
- Associated fauna species observed using the habitat
- Ecological processes important to the habitat
- Disturbances
- Photo showing a typical example of the broad habitat type.

4.3.2 **Trapping**

An examination of land system and vegetation maps prior to the field survey ensured that trapping sites were placed in all major landforms and broad habitat types. On-ground reconnaissance at the start of the field survey further ensured suitable placement and geographic coverage of fauna sampling transects within all major fauna habitat types. Trapping sites (transects) were located to sample the major habitat types (vegetation - soil associations) and also within habitat types expected to support a

relatively high diversity of terrestrial fauna assemblages, based on knowledge of faunal habitat preference of the area. Traps were left out for seven consecutive nights and checked daily. Refer to **Figure 5** for the fauna trap configuration used.

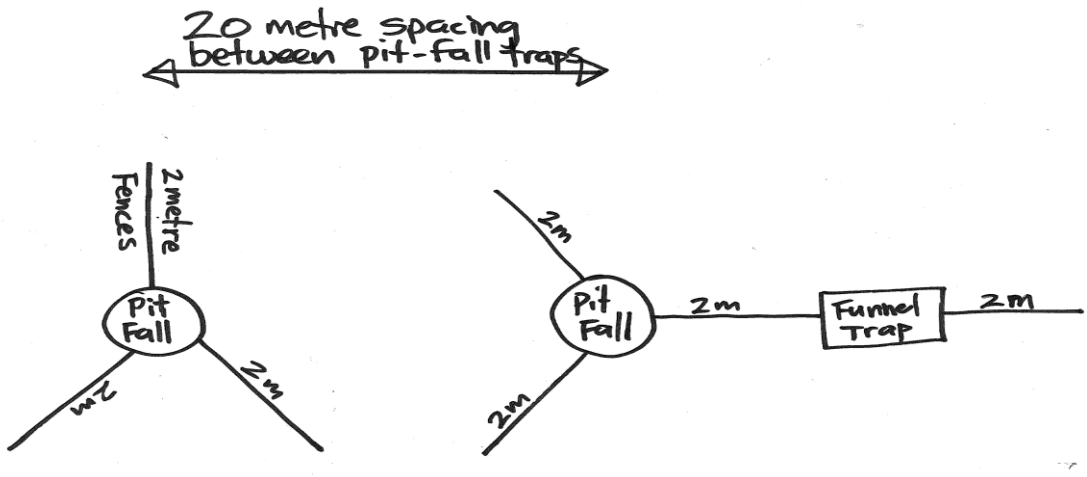
Trapping for terrestrial mammals and herpetofauna was undertaken using a standardised, systematic sampling format. Each trapping transect consisted of ten pit-fall traps placed approximately 20 metres apart and consisting of the alternating configuration shown below (**Figure 5**). At each pit-fall trap, three sections of drift fence were placed in a 'Mercedes star' formation. A funnel trap was placed at every second (alternating) pit-fall trap. A total of eight trapping sites (transects) were spread across the Project area. Each site comprised a combination of pit-fall traps, Elliot A box traps, funnel traps and Elliot B traps (cage traps), although not all sites could accommodate pitfall traps due to impenetrable rock outcroppings. Thus, at five of the eight transects, there was a total of 10 pit-fall traps (20 litre buckets), and at two of the eight transects, pit-fall traps were replaced with funnel traps. The remaining transect had two pit-fall traps, with eight pit-fall traps replaced with funnel traps.

Traps were baited with universal bait made from rolled oats, peanut butter and sardines and were re-baited at regular intervals to increase the chances of luring mammals into traps.

Table 2: Fauna trap configuration used at each of the sample transects

TRAP TRANSECT	PIT-FALL TRAPS	FUNNEL TRAP	ELLIOT A TRAPS	CAGE TRAPS
1	10	5	5	2
2	10	5	5	2
3	10	5	5	2
4	10	5	5	2
5	10	5	5	2
6	2*	13*	5	2
7	0*	15*	5	2
8	0*	15*	5	2

Figure 5: Trap configuration for each trapping transect.



The coordinates for each transect can be found in Appendix C. Descriptions and photographs of all trapping sites are provided in Appendix D. Location information for all sites is presented in **Table 3** and illustrated in **Figure 6**.

Table 3: Location of fauna survey sites

SITE	LATITUDE	LONGITUDE	BROAD HABITAT TYPE
Fauna Trapping Sites			
T1	-20. 632995	120. 282400	2. Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble
T2	-20. 632021	120.301213	1. Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays
T3	-20.632132	120.305681	2. Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble
T4	-20.641703	120.311548	3. Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays
T5	-20.629124	120.297477	1. Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays

SITE	LATITUDE	LONGITUDE	BROAD HABITAT TYPE
T6	-20.632620	120.286139	2. Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble
T7	-20.646462	120.295354	5. Rocky hills and ridges supporting *Grevillea/Acacia* shrublands and *Triodia* hummock grasslands on ironstone / shallow clay
T8	-20.647781	120.292935	4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping
AB2	-20.629221	120.297058	1. Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays
AB3	-20.642477	120.309654	3. Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays
AB4	-20.641559	120.289284	3. Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays
AB5	-20.631878	120.301287	1. Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays
AB6	-20.643318	120.297589	4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping
AB7	-20.647158	120.291502	4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping
CAM1	-20.642408	120.309645	3. Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays
CAM2	-20.648953	120.292011	4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping
CAM3	-20.641619	120.289260	3. Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays

SITE	LATITUDE	LONGITUDE	BROAD HABITAT TYPE
CAM4	-20.649549	120.299572	4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping
CAM5	-20.643470	120.297111	4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping

4.3.3 **Bird census**

A bird census was undertaken at each transect and consisted of listening for calls and visual detection. This was carried out during morning trap checks. All bird species were recorded for 5 minutes at each pit-fall trap location.

4.3.4 **Bat call recordings**

Bat echolocation calls were recorded using Anabat SDII systems (Titley Electronics, Ballina, NSW). The Anabat bat detectors together with specialised software are able to transform ultrasonic bat echolocation calls into a corresponding graphical representation for analysis. Dr Kyle Armstrong of Specialised Zoological identified acoustic calls to species level. Anabat Detectors were used when carrying out nocturnal searches, and also placed in set locations overnight. Bat call recordings were made in locations where bats were expected to be present, including open fly-ways such as gorges and creek beds (**Figure 6**).

4.3.5 **Motion cameras**

This technique is generally used to target a site where mammal species are expected to frequent, such as den sites, burrows, water holes, foraging sites or latrine areas. Five motion sensitive cameras were installed at sites suitable for capturing photographs of animals (at the base of rock faces, rocky outcrops, and waterholes) and left for a minimum of three nights per camera. At each camera location universal bait was placed in the camera's field of view to entice animals into the area.

4.3.6 **Targeted surveying**

Prior to the commencement of survey activity, the preferred habitats of the conservation significant species likely to occur in the study area were determined. These habitats were identified within the Project area and targeted using systematic searches. Tracks, diggings, scats and burrows were searched for evidence to indicate current or historic species presence within the Project area. Burrows and mounds, if identified, were classed as active or inactive based on age and activity around or within them. Specific searches for each species are outlined below and are summarised in **Table 4**.

Northern Quoll (Dasyurus hallucatus)

Northern Quolls were targeted using cage and Elliott traps set out along the trapping transects, as well as the use of motion cameras placed in potential foraging and denning habitat. Signs of Northern Quoll activity (scats and tracks) were also searched for opportunistically.

Bilby (Macrotis lagotis)

Bilbies were targeted using cage traps set out along the trapping transects and signs of Bilby activity were also searched for opportunistically by looking for burrows, scats and tracks.

Mulgara (Dasycercus blythi & D. cristicauda)

Mulgara were targeted using pit-fall, Elliot and cage traps set out along the trapping transects and signs of Mulgara activity were also searched for opportunistically by looking for burrows, scats and tracks.

Western Pebble-mound Mouse (Pseudomys chapmani)

Pebble-mound mice were targeted using pit-fall, Elliot and cage traps set out along the trapping transects and pebble-mounds were also searched for opportunistically by walking transects through suitable habitat.

Pilbara Leaf-nosed Bat (Rhinonicteris aurantius) and Ghost Bat (Macroderma gigas)

Pilbara Leaf-nosed and Ghost Bats were targeted by placing Anabat call detectors in suitable locations throughout the Project area to capture any calls made whilst flying over. Suitable cave habitat was also searched for however could not be searched for roosting signs due to prohibited access.

Pilbara Olive Python (Liasis olivaceus barroni)

Pilbara Olive Pythons were searched for by walking through gullies, gorges and canyons in search of waterholes, and leaving motion cameras set up for several consecutive nights. Nocturnal searches were also conducted.

Bush Stone-curlew (Burhinus grallius) and Australian Bustard (Ardeotis australis)

Signs of Bush Stone-curlews and Australian Bustards were searched for throughout the Project area in suitable habitat such as sandy plains and creek beds. Searching for footprints and listening for calls of these species were targeted due to the otherwise secretive nature of these birds.

Fork-tailed Swift (Apus pacificus), Peregrine Falcon (Falco peregrinus), and Rainbow Bee-eater (Merops ornatus)

These three birds were targeted through bird census along each trapping transect and opportunistic sightings throughout the survey. This was done by listening for calls and visual detection.

Table 4: Survey methods for conservation significant species

SCIENTIFIC NAME	COMMON NAME	SURVEY METHODS USED
Liasis olivaceus barroni	Pilbara Olive Python	Nocturnal searching, target surveys within gorges
Apus pacificus	Fork-tailed Swift	Bird census, opportunistic sighting
Ardea alba	Great Egret	Bird census, opportunistic sighting
Ardea ibis	Cattle Egret	Bird census
Ardea modesta	Eastern Great Egret	Bird census
Burhinus grallarius	Bush Stone-curlew	Nocturnal searching, opportunistic sightings, target

SCIENTIFIC NAME	COMMON NAME	SURVEY METHODS USED
		searching for footprints
Charadrius veredus	Oriental Plover	Bird census, opportunistic sighting
Heteromunia pectoralis	Pictorella Mannikin	Bird census, opportunistic sighting
Neochmia ruficauda subclarescens	Star Finch	Nocturnal searching, opportunistic sighting, target searching
Falco hypoleucos	Grey Falcon	Bird census, opportunistic sighting
Falco peregrines	Peregrine Falcon	Nocturnal searching, opportunistic sighting, target searching
Glareola maldivarum	Oriental Pratincole	Bird census, opportunistic sighting
Merops ornatus	Rainbow Bee-eater	Bird census, opportunistic sighting
Ardeotis australis	Australian Bustard	Nocturnal searching, opportunistic sightings, target searching for footprints
Tringa glareola	Wood Sandpiper	Bird census, opportunistic sighting
Tringa hypoleucos	Common Sandpiper	Bird census, opportunistic sighting.
Tringa nebularia	Common Greenshank	Bird census, opportunistic sighting
Tringa stagnatilis	Marsh Sandpiper	Bird census, opportunistic sighting
Plegadis falcinellus	Glossy Ibis	Bird census, opportunistic sighting
*Dasycercus cristicauda**	Crest-tailed Mulgara	Elliot trapping, target searching for burrows
Dasyurus hallucatus	Northern Quoll	Elliot trapping, cage trapping, target searching for scats and footprints, motion cameras
Macrotis lagotis	Greater Bilby	Target searching for foraging burrows and foraging signs
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat	Anabat, target searching for roosting caves (cave entry not permitted on this survey)
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby	Cage trapping, motion cameras
Macroderma gigas	Ghost Bat	Target searching for roosting caves (cave entry not permitted on this survey)
Leggadina lakedownensis	Lakeland Downs Mouse	Pit-fall trapping, Elliot trapping
Pseudomys chapmani	Western Pebble-mound Mouse	Target searching

4.3.7 **Hand searching**

Hand searching for cryptic and fossorial species comprised searching beneath the bark of dead trees, breaking open old logs, stumps and dead free-standing trees, investigating burrows, over-turning logs, stones and dumped rubbish, digging and raking through loose soil, leaf litter and other ground debris. Hand searching was done throughout the Project area and opportunistically along the trap transects comprising of up to six ecologists for approximately seven hours in total.

4.3.8 **Nocturnal searching**

The Project area was searched at night using a combination of road transects and opportunistic ground searches using head torches and hand held spotlights to record nocturnal species, including frogs geckos, snakes, birds and mammals. The nocturnal searching was conducted over two consecutive evenings (following sunset) comprising two ecologists searching for four hours.

4.3.9 **Opportunistic sampling and sightings**

Opportunistic fauna recording was an integral technique of this fauna study and was applied at all times during the field survey, such as whilst establishing and checking traps, as well as driving between transects. Opportunistic records formed a significant component of the reptile and bird observations. This method generally accounts for the majority of bird species sightings and calls heard during surveys. Tracks, diggings, scats, burrows and other signs of fauna activity were also used where possible.

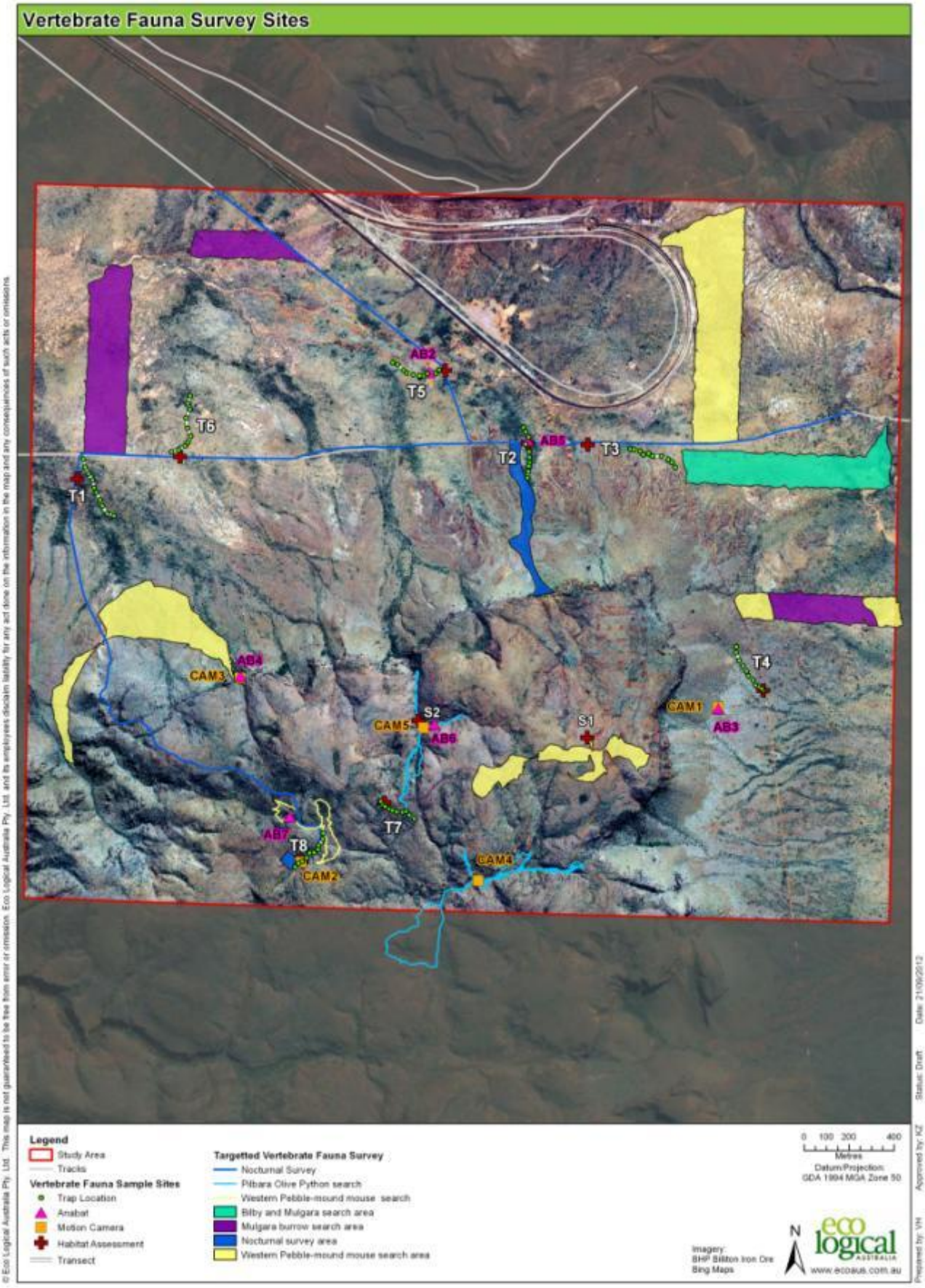


Figure 6: Vertebrate fauna survey sites

4.4 SURVEY EFFORT

The survey effort expended within the Project area is summarised in **Table 5** below.

Table 5: Survey effort within the Callawa Project area for the duration of the Level 2 vertebrate fauna survey

SURVEY TYPE	NUMBER OF TRAPS	SURVEY EFFORT
Pit fall traps	52	364 trap nights
Elliot traps	40	280 trap nights
Funnel traps	68	476 trap nights
Cage traps	16	112 trap nights
Bird census	20 minutes per transect	9.2 hours
Hand searching	n/a	7 hours
Nocturnal searches	n/a	2 nights totalling 16 hours
Motion cameras	5	29 nights
Anabat bat surveys	6	13 nights
Targeted species searches	n/a	62 hours
Opportunistic searching	n/a	90 hours

4.5 ANIMAL ETHICS

Surveying was conducted as per ELA's *Wildlife Procedure Manual (*Animal Care and Use Code Requirements), which conforms to Section 5 of the *Australian code of practice for the care and use of animals for scientific purposes* (NHMRC 2004) and is approved by the Edith Cowan University Animal Ethics Committee. In addition, the survey was conducted as per the DEC Regulation 17 licence conditions (Licence number SF008652), which relate to minimizing harm and stress to fauna. Animal ethics considerations focussed on the following considerations:

- Minimising the duration of time that animals are in traps
- Minimising trapped animals' exposure to harmful environmental conditions
- Minimising risk of introduction or spreading known fauna pathogens between populations
- Appropriate and minimal animal handling
- Appropriate release conditions
- Appropriate euthanasia.

Fauna were identified in the field and released at the point of capture.

4.6 TAXONOMY AND NOMECLATURE

Nomenclature used for fauna species within this report is based on the most up to date version of the Western Australian Museum's (WAM) Taxonomic checklist of the terrestrial vertebrate fauna for Western Australia (WAM 2012). Additional information on specific vertebrate fauna groups was found in the following:

- Amphibians: Tyler and Doughty (2009)
- Reptiles: Wilson and Swan (2010)
- Birds: Simpson and Day (2010)
- Mammals: Menkhorst and Knight (2011)

4.7 SURVEY LIMITATIONS

EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. Limitations of the survey are summarised in **Table 6**. The main limitations of the survey were identified as access limitations into caves for the detection of conservation significant bat species, restricted access to certain areas of the site such as the rail loop, and further work which might be required.

Table 6: Summary of survey limitations

CONSTRAINT	LIMITATION (YES / NO)	COMMENTS
Level of survey	No	One season Level 2 (reconnaissance survey, detailed survey and targeted survey). Survey intensity was deemed adequate to identify significant fauna and habitats occurring in the area. A previous single season Level 2 fauna survey was conducted by *ecologia* (2005a) within the Project area.
Competency / experience of the consultant carrying out the survey	No	All survey staff experienced in both general fauna survey techniques and in their individual specialised roles.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions?)	Yes	Frogs, reptiles, birds and mammals, were sampled. Bats were sampled using Anabat detectors, which have some limitations for recording calls of the Ghost Bat. However caves could not be searched for signs of roosting as entry into caves was not permitted. It should be noted that Ghost Bats have previously been recorded within the Project area.
Proportion of fauna identified, recorded and / or collected	No	All fauna were either identified in the field, except for bats, which were identified via call analysis by Dr Kyle Armstrong. No vertebrate species were collected.
Sources of information (previously available information as distinct from new data)	No	Sources included previous reports for the survey area and adjacent areas provided by BHPBIO. Database searches included Birds Australia, DEC, WAM, and EPBC protected matters search tool.

CONSTRAINT	LIMITATION (YES / NO)	COMMENTS
The proportion of the task achieved and further work which might be needed	Yes	The proposed methodology and tasks of this Level 2 fauna survey were achieved, given previous Level 2 fauna surveys have been undertaken within the Project area by other consultants. An additional Level 2 survey in late spring could provide a more complete species inventory; however it is not expected that additional conservation significant species would be identified.
Timing / weather / season / cycle	No	The field survey timing was during late May which is towards the end of the optimum fauna survey season for the biogeographic region. This timing coincided with peak activity level of the Northern Quoll and other mammal species; however, low maximum and minimum temperatures resulted in reduced activity and detectability of some reptile species. Previous Level 2 fauna survey of the Project area was conducted in June 2005 (*ecologia* 2005a).
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention)	No	No disturbances affected the survey.
Intensity (in retrospect was the intensity adequate)	No	Survey intensity was adequate to record conservation significant fauna and habitats. All habitat types were surveyed with a concentration of survey effort in habitats that were expected to support relatively high species diversity and richness. The combined pit-fall, funnel trap, and mammal trap intensity was 1408 trap nights. Note that caves and waterholes identified (**Figure 9**) are not exhaustive; significant fauna habitats cover areas that are highly likely to contain caves and/or rock pools, such as numerous caves that were observed along the ridge from below that were inaccessible due to safety and time constraints. It is highly likely that other caves and water holes are present within the Project area that were not recorded during this survey due to time constraints.
Completeness (e.g. was relevant area fully surveyed)	No	The Level 2 fauna survey was completed with 7 trap nights as per EPA requirements, and the survey site was extensively surveyed in terms of habitat and area coverage.
Resources (e.g. degree of expertise available in animal identification to taxon level)	No	Zoologists conducting the survey were suitably qualified and experienced in identification of fauna. All vertebrate species were identified to species (sometimes sub-species) level.

CONSTRAINT	LIMITATION (YES / NO)	COMMENTS
Remoteness and / or access problems	Yes	Most of the survey site was accessible via 4WD vehicle or on foot. In addition the survey site was relatively small being approximately 4 x 3 km in area with adequate road access. An inaccessible portion was a rail loop, for which permission to cross the rail line was not granted. In addition, entry into caves to search for bats was not permitted.
Availability of contextual (e.g. biogeographic) information on the region	No	Sufficient contextual information was available on the Callawa area with a number of previous fauna survey reports available and provided by BHPBIO and database searches providing relevant information.
Efficacy of sampling methods (i.e. any groups not sampled by survey methods)	No	Survey methods were suitable to record all vertebrate fauna groups.

5 Results

5.1 DESKTOP REVIEW

5.1.1 Potential fauna assemblages

Based on the literature review and database searches, a total of 304 vertebrate fauna species have been recorded or have been assessed as potentially occurring within or near the Project area. The total number of species comprised six frog, 100 reptile, 145 bird, and 53 mammal species.

The assessment of likelihood of occurrence has been determined by the authors of the source material and has not been refined based on the current survey's habitat assessment. Erroneous records (i.e. species not likely to be recorded in the Pilbara) and highly unlikely species have however been removed from this list.

Appendix E presents the complete list of potential and recorded fauna species identified in the desktop review and the source reference.

5.1.2 Conservation significant fauna

A total of 34 species of conservation significance have the potential to occur within or near the Project area according to the database searches and previous surveys in the area. These include three reptile, 20 bird and 11 mammal species.

Table 7 lists all potentially occurring conservation significant species and their likelihood of occurrence within the Project area based on the habitat types present and the likelihood criteria outlined in Section 3.4.1. Eighteen species are believed to have the potential to occur within the Project area, and of these ten are likely to occur. **Figure 7** illustrates conservation significant fauna records from the current Level 2 survey, as well as from previous fauna surveys.

Table 7: Conservation significant fauna likelihood of occurence

This table presents the conservation significant fauna species identified from database searches and literature review as potentially occurring within or near the Project area, together with an assessment of their likelihood of occurrence. Species highlighted in blue are considered likely to occur; species recorded during the field survey or during a previous survey of within the Project area are highlighted in green.

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
Reptiles						
Liasis olivaceus barroni	Pilbara Olive Python	NE	VU	S1	NatureMap Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 2005c, 2005d Onshore & Biologic 2010	**Likely**. Not recorded during the survey despite targeted nocturnal searches. Rocky habitats including rock pools, caves, cliffs and canyons represent potential habitat. Moloch Fauna Consultants (1992) reported a Pilbara Olive Python from a "rock pool at the head of a gully on the Callawa mesa". Also recorded approximately 30 km (*ecologia* 2005c) and 40 km west (*ecologia* 2005a) of the Project area.
Liopholis kintorei	Great Desert Skink	VU	VU	S1	NatureMap EPBC Act Protected Matters Onshore & Biologic 2010	Unlikely. Not recorded locally. The Project area is outside the known distribution of this species.
Ramphotyphlops ganei	Blind Snake			P1	NatureMap Outback Ecology 2008 *ecologia* 2005b, 2005c, 2005d	Unlikely. Not recorded locally. The Project area is located outside the known distribution of this species, however given the cryptic ecology of blind snakes and the presence of potentially suitable habitat, the occurrence of this species cannot be ruled out.
Birds						
Apus pacificus	Fork-tailed Swift	LC	M	S3	NatureMap EPBC Act Protected Matters Outback Ecology 2008 *ecologia* 1999, 2005c, 2005d Onshore & Biologic 2010	**Likely**. This species has previously been recorded at Cattle Gorge (*ecologia* 2005d) approximately 30 kilometres north west of the Project area. It is a relatively common seasonal trans-equatorial migrant throughout mainland Australia in October to April (Slater *et al*. 2003).

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
Ardea alba	Great Egret		M		NatureMap EPBC Act Protected Matters Outback Ecology 2008 *ecologia* 1999, 2005c, 2005d	Potential. Known to occur locally. The site lacks major significant riparian habitat, however flooding rains would create temporary conditions potentially suitable for foraging at least on an occasional basis.
Ardea ibis	Cattle Egret		M	S3	NatureMap EPBC Act Protected Matters Outback Ecology 2008	Potential. Known to occur locally. The site lacks major significant riparian habitat, however flooding rains would create temporary conditions potentially suitable for foraging at least on an occasional basis.
Ardea modesta	Eastern Great Egret		M	S3	NatureMap Outback Ecology 2008 Onshore & Biologic 2010	Potential. Could visit the episodic lake on an occasional basis when suitable foraging habitat is present. Similar species such as herons were recorded within the Project area.
Burhinus grallarius	Bush Stone-curlew	LC		P4	NatureMap DEC database Outback Ecology 2008 *ecologia* 1999, 2005c Onshore & Biologic 2010	**Yes**. Recorded within the Project area at the small ephemeral lake during a nocturnal survey. Footprints of this species were also identified at two locations (see Figure 7). Recorded in open shrubland plains and minor creeks habitat types.
Charadrius veredus	Oriental Plover	LC	M	S3	NatureMap EPBC Act Protected Matters Outback Ecology 2008 Onshore & Biologic 2010	Potential. Not recorded locally during previous surveys, however potentially suitable habitat (stony clay pans) occurs within the Project area.
Heteromunia pectoralis	Pictorella Mannikin	LC		P4	NatureMap Outback Ecology 2008 *ecologia* 2005a, 2005b, 2005c, 2005d	Potential. Has previously been recorded at Cattle Gorge (*ecologia* 2005d) approximately 30 km north-west of the Project area. Other occasional record noted for the Pilbara region includes a sighting near Port Hedland by Jeff Turpin (B. Barnett BHPBIO pers. comm.).

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
Neochmia ruficauda subclarescens	Star Finch	LC		P4	NatureMap Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 2005c, 2005d	Potential. Not recorded within the Project area and no potentially suitable nesting habitat was found during the survey (emergent reeds within creeks). However this species has been recorded locally, and potential nesting habitat may occur within Callawa Creek and other creeks associated with the Oakover River system. Therefore given the mobility of this species, it potentially forages within the Project area.
Falco hypoleucos	Grey Falcon	VU		P4	NatureMap DEC database Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 2005d	Potential. Not recorded during the survey or in the vicinity of the Project area, however open *Acacia* shrublands and minor seasonal creeks represent potentially suitable foraging habitat and this species is highly mobile.
Falco peregrinus	Peregrine Falcon	LC		S4	NatureMap Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b	**Likely**. Not recorded during the survey, however it has been recorded flying through the Cundaline study area approximately 17 km north-west of the Project area (*ecologia* 2005b). This species is very widely distributed throughout most of Australia including a range of arid and semi-arid scrubland habitats. It requires a secure nest site with an abundance of prey (Morcombe 2007). Cliffs within the Project area represent potentially suitable nesting habitat.
Glareola maldivarum	Oriental Pratincole	LC	M	S3	NatureMap EPBC Protected Matters Outback Ecology 2008 Onshore & Biologic 2010	Potential. Not recorded locally, or during the survey, however open plains represent potentially suitable habitat.
Hirundo rustica	Barn Swallow	LC	M	S3	NatureMap EPBC Protected Matters Onshore & Biologic 2010	Unlikely. Not recorded locally, or during the survey, however given the mobility and the broad habitat preferences of this species, its occurrence within the Project area on an infrequent or occasional basis cannot be ruled out.

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
Merops ornatus	Rainbow Bee-eater	LC	M	S3	NatureMap EPBC Protected Matters Birdata Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 200d Onshore & Biologic 2010	**Yes**. Recorded within the Project area during the survey within all broad habitat types across the Project area. Species would likely utilise all habitats to forage and fly over. Habitat types 1 and 2 could potentially provide nesting habitat, however no nesting activity was observed.
Ardeotis australis	Australian Bustard	LC		P4	NatureMap DEC database EPBC Protected Matters Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 2005c, 2005d Onshore & Biologic 2010	**Yes**. Recorded within the Project area during the survey within habitat types 1 and 2.
Numenius madagascariensis	Eastern Curlew	VU	M	S3	NatureMap Outback Ecology 2008	Unlikely. The Project area lacks suitable coastal tidal mud flats or estuarine habitat.
Tringa glareola	Wood Sandpiper	LC	M	S3	NatureMap Outback Ecology 2008 *ecologia* 2005b, 2005c	Potential. Not recorded during the survey, however has been recorded locally. Open plains and alluvial low-lying areas subject to occasional flooding within the Project area represent potentially suitable foraging habitat, and given the high mobility, its occurrence at least on an infrequent or occasional basis cannot be ruled out.
Tringa hypoleucos	Common Sandpiper	LC	M	S3	NatureMap Outback Ecology 2008 *ecologia* 2005b, 2005c	Potential. Not recorded during the survey, however has been recorded locally. Open plains and alluvial low-lying areas subject to occasional flooding within the Project area represent potentially suitable foraging habitat, and given the high mobility, and broad habitat preference its occurrence at least on an infrequent or occasional basis cannot be ruled out.

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
Tringa nebularia	Common Greenshank	LC	M	S3	NatureMap Outback Ecology 2008 *ecologia* 2005b, 2005c	Potential. Not recorded during the survey, however has been recorded locally. Open plains and alluvial low-lying areas subject to occasional flooding within the Project area represent potentially suitable foraging habitat, and given the high mobility, and broad habitat preference its occurrence at least on an infrequent or occasional basis cannot be ruled out.
Tringa stagnatilis	Marsh Sandpiper	LC	M	S3	NatureMap Outback Ecology 2008 *ecologia* 2005b, 2005c	Potential. Not recorded during the survey, however has been recorded locally. Open plains and alluvial low-lying areas subject to occasional flooding within the Project area represent potentially suitable foraging habitat, and given the high mobility, and broad habitat preference its occurrence at least on an infrequent or occasional basis cannot be ruled out.
Plegadis falcinellus	Glossy Ibis	LC	M	S3	NatureMap Outback Ecology 2008 *ecologia* 1999, 2005b, 2005c	Potential. Not recorded during the survey, however has been recorded locally. Open plains and alluvial low-lying areas subject to occasional flooding within the Project area represent potentially suitable foraging habitat, and given the high mobility, and broad habitat preference its occurrence at least on an infrequent or occasional basis cannot be ruled out.
Mammals						
*Dasycercus blythi**	Brush-tailed Mulgara	LC		P4	NatureMap DEC database EPBC Protected Matters Outback Ecology 2008 *ecologia* 1999, 2005c, 2005d Onshore & Biologic 2010	Potential. Not recorded during the survey during targeted Mulgara searches. However mulgara burrows have previously been recorded locally (*ecologia* 2005a-d) including within the Callawa area. There are currently two recognised species of Mulgara, the Crest-tailed Mulgara and the Brush-tailed Mulgara. Due to recent reclassifications there is some confusion in museum records and conservation status under legislation between the two. For some time only one species of mulgara (*D. cristicauda*) was recognised, however Woolley (2005) re-

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
*Dasycercus cristicauda**	Crest-tailed Mulgara	LC	VU	S1		assigned the species to the Brush-tailed Mulgara (*D. blythi*) and Crest-tailed Mulgara (*D. cristicauda*). The historical taxonomic confusion means that the distribution of the two mulgara species is unclear. It is possible that both species occur in proximity where their distributions overlap. The status of the species in Western Australia is unclear. It should be noted that at the date of this report, NatureMap has distinguished between the two species of *Dasycercus*; however the identification of records has yet to be fully resolved. SEWPaC have not yet updated the EPBC Act database and does not currently distinguish between the two species, however SEWPaC are currently considering listing this species under the EPBC Act.
Dasyurus hallucatus	Northern Quoll	EN	EN	S1	NatureMap DEC database EPBC Protected Matters Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 2005c, Onshore & Biologic 2010	**Yes**. Recorded within the Project area during the current and previous surveys (*ecologia* 2005a). Several individuals trapped, as well as tracks and scats recorded at a number of locations throughout the Project area in all five broad habitat types. Numbers were slightly higher on habitat types 4 and 5, which would provide denning habitat for the species. Given the location of recorded scats, footprints, and Northern Quolls trapped during the survey, all habitat types within the Project area are considered to be potential foraging habitat for this species.
Macrotis lagotis	Greater Bilby	VU	VU	S1	NatureMap EPBC Protected Matters IUCN Red List *ecologia* 1999 Onshore & Biologic 2010	Potential. Not recorded during the survey or during previous surveys despite targeted searches. However, known to occur very patchily as scattered sub-populations within the Pilbara bioregion. Open shrubland plains within the Project area represent potentially suitable habitat, and this species is known to forage widely. The occurrence of this species cannot be ruled out.
Sminthopsis longicaudata	Long-tailed Dunnart	LC		P4	NatureMap Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 2005c, 2005d	Unlikely. Not recorded during the survey or during previous surveys. Whilst rocky areas represent potentially suitable habitat, the Project area is on the northern limit of this species' known distribution.

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat	LC	VU	S1	NatureMap DEC database EPBC Protected Matters Outback Ecology 2008 Specialised Zoological 2011a, 2011b *ecologia* 1999, 2005a, 2005b, 2005c, 2005d Onshore & Biologic 2010	**Likely**. Not recorded during the survey, but this species has been previously recorded via audio recordings (*ecologia* 2005a, Specialised Zoological 2011c). It is likely that this species would forage over the Project area. The Project area has extensive cliffs and canyons that potentially have roosting caves, however caves could not be searched during the current survey for roosting as entry into caves was not permitted Specialised Zoological (2011a-c) identified one cavewithin the Project area which recorded Pilbara Leaf-nosed Bats. However could not be determined if Pilbara Leaf-nosed Bat roosted in this cave.
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby	LC		P3	NatureMap *ecologia* 2005c Onshore & Biologic 2010	Potential. Not recorded during the survey or during previous surveys. However, open shrubland and hummock grassland plains within the Project area represent potentially suitable habitat. The occurrence of this species cannot be ruled out.
Petrogale lateralis	Black-footed Rock-wallaby	NT	VU	S1	NatureMap *ecologia* 1999, 2005a, 2005b	Unlikely. Not recorded during the survey or during previous surveys. Whilst rocky areas represent potentially suitable habitat the Project area is outside the northern limit of this species' known distribution.
Macroderma gigas	Ghost Bat	VU		P4	NatureMap DEC database IUCN Red List Outback Ecology 2008 Specialised Zoological 2011a, 2011b *ecologia* 1999, 2005a, 2005b, 2005c, 2005d Onshore & Biologic 2010	**Yes.** Recorded during previous surveys (*ecologia* 2005a, Specialised Zoological 2011a-c). Not recorded during the current survey. The Project area has extensive cliffs and canyons that potentially have roosting caves, however caves could not be searched for roosting as entry into caves was not permitted.
Leggadina lakedownensis	Lakeland Downs Mouse	LC		P4	NatureMap DEC database Outback Ecology 2008 *ecologia* 1999, 2005c Onshore & Biologic 2010	Potential. Not recorded during the survey, however has been recorded locally. Open clay shrubland plains and stony hummock grassland represent potentially suitable habitat.

SPECIES NAME	COMMON NAME	CONSERVATION STATUS			SOURCE OF RECORD^	LIKELIHOOD OF OCCURRENCE WITHIN THE PROJECT AREA
		IUCN RED LIST	EPBC ACT	WC ACT / DEC		
Pseudomys chapmani	Western Pebble-mound Mouse	LC		P4	NatureMap DEC database Outback Ecology 2008 *ecologia* 1999, 2005a, 2005b, 2005c Onshore & Biologic 2010	**Likely**. No active pebble mounds were recorded however numerous inactive pebble mounds were recorded within the Project area and extensive areas of sandy clay plains and stony low hills that are potential habitat (Menkhorst and Knight 2011). Habitat types 2 and 3 represent potential foraging habitat.

* Current difficulties in identifying Mulgara species means that genetic analysis is required to distinguish between *Dasycercus cristicauda* and *D. blythi*.

WC Act = *Wildlife Conservation Act 1950*.
EPBC Act = *Environmental Protection and Biodiversity Conservation Act 1999*.
IUCN = International Union for Conservation of Nature and Natural Resources
DEC= Department of Environment and Conservation.
Conservation codes:
EN = species listed as 'endangered' under either the IUCN red List, EPBC Act or WC Act
VU = species listed as 'vulnerable' under either the IUCN Red List, EPBC Act or WC Act
LC = species listed as 'least concern' on the IUCN Red List
DD = species listed as 'data deficient' on the IUCN Red List
NE = 'Not Evaluated'. Species has not yet been evaluated by the IUCN Red List

M = species listed as 'migratory' under the EPBC Act.
S1 = fauna that is rare or is likely to become extinct under the WC Act
S3 = migratory birds protected under an international agreement under the WC Act
S4 = fauna listed as 'other specially protected fauna' under the WC Act.
P1 = Taxa with few, poorly known populations on threatened lands.
P2 = Taxa with few, poorly known populations on conservation lands.
P3 = Taxa with several, poorly known populations, some on conservation lands.
P4 = Taxa in need of monitoring.
P5= Taxa in need of monitoring.

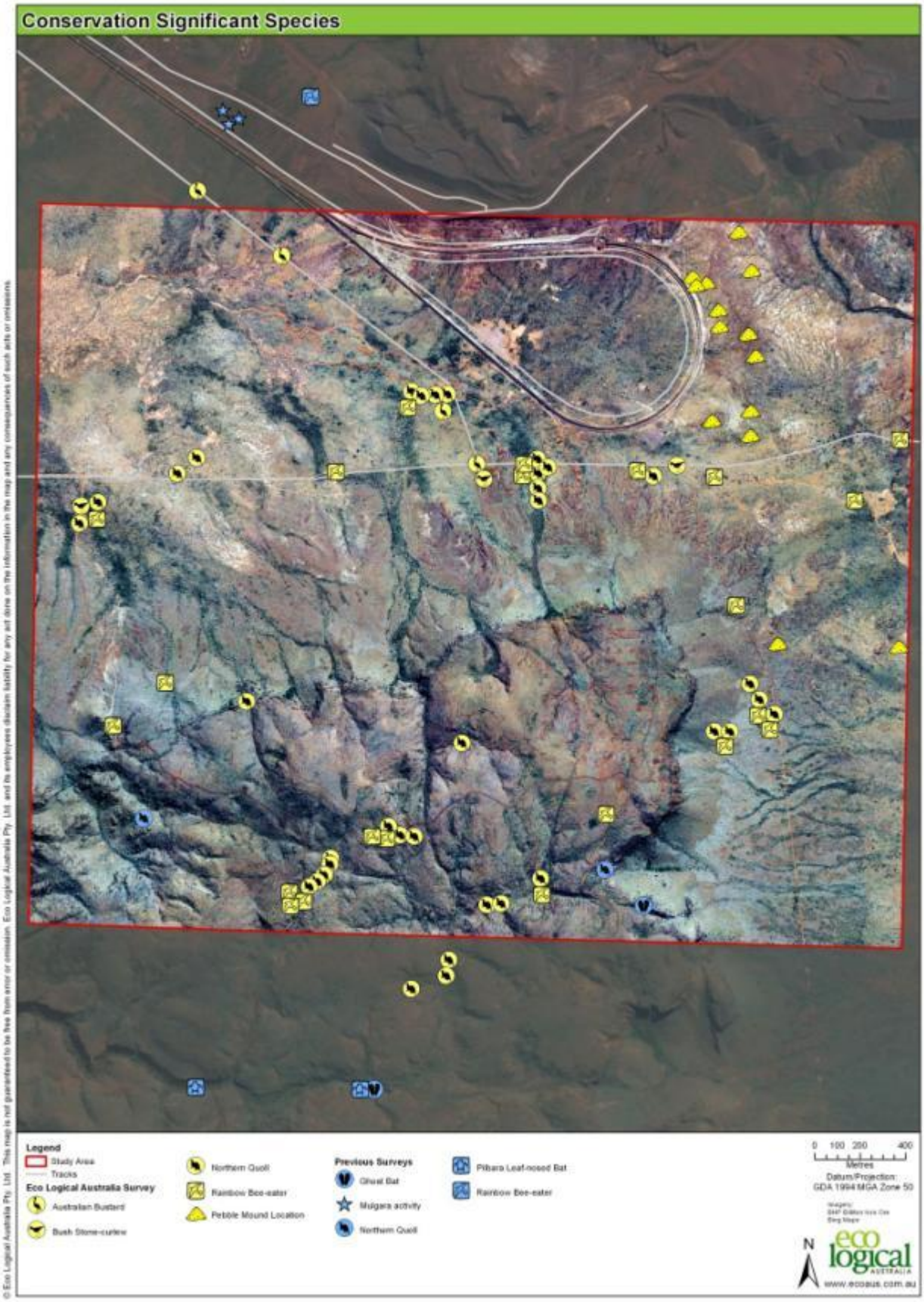


Figure 7: Conservation significant fauna species records from current and previous surveys

5.2 FAUNA SURVEY RESULTS

5.2.1 Broad habitat types

Five broad fauna habitat types were identified within the Project area and consisted of creek lines, gullies, ridges, hill slopes and plains. Plains and creek lines dominated the northern and south-east sections of the Project area, whereas gullies, ridges and hill slopes were found in the south-western portion of the Project area (**Figure 8**).

The condition of the habitat within the Project area overall was excellent, although some creek lines and plains were slightly degraded due to cattle grazing. Areas that had not been accessed by cattle, such as the rocky hill slopes, ridges and gullies were in pristine condition.

The following broad habitat types were identified at Callawa:

- Habitat type 1 – Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays.
- Habitat type 2 – Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble.
- Habitat type 3 – Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays.
- Habitat type 4 – Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping.
- Habitat type 5 – Rocky hills and ridges supporting *Grevillea/Acacia* shrublands and *Triodia* hummock grasslands on ironstone / shallow clay.

Habitat type 1 (Minor creeks) generally this habitat type had a diverse range of shrubs and low open woodlands which provide a range of niche and microhabitats for a diversity of birds and reptile species, as well as foraging habitat for mammal species such as Northern Quoll. Exposed sandy creek banks potentially provide nest burrow locations for the Rainbow Bee-eater. Most areas of this habitat type were in very good to excellent condition. Disturbance associated with this habitat type included some evidence of cattle activity and invasion of Buffel grass (**Cenchrus ciliaris*) associated with creeks.

Habitat type 2 (Plains) was the most extensively occurring broad habitat type within the Project area. This habitat type includes areas with the same vegetation and soil, but with some areas having additional gravel or pebble within the substrate. Most areas were assessed as being in very good to excellent condition; however, some disturbance caused by infrastructure was present including vehicle tracks. This habitat type is expected to support a diverse assemblage of reptile species including geckos, *Delma* legless lizards, *Ctenotus* skinks and elapid snakes. The emergent *Eucalyptus* and *Acacia* overstorey provides nesting habitat for a range of bird species and seasonal food for nectar-feeding species, and a range of locally abundant mammals including micro-chiropteran bats and small rodents. Conservation significant species known to be associated with open shrubland and hummock plains include the Mulgara, Bilby and Western Pebble-mound Mouse. The well formed substrates allow for burrowing of a range of arid ground dwelling reptiles.

Habitat type 3 (Stony rises, low stony hills and scree slopes) habitat condition was assessed as being excellent to pristine with the exception of small areas of rehabilitation following previous ground

disturbance activity. Some areas of this habitat potentially support the Priority 4 Western Pebble-mound Mouse based on the extent of this habitat within the Project area, and the occurrence of this species during previous surveys close to the Project area. Soils within this habitat type are poorly formed and too shallow for digging burrows.

Habitat type 4 (Canyons, breakaways and steep rocky gullies) was generally located at moderate to high elevations within the landscape of Callawa Ridge. It potentially supports a range of rocky habitat specialist species that have specific habitat requirements such as the cave roosting Ghost Bat and the Pilbara Leaf-nosed Bat. Other habitat specialists include the Pilbara Olive Python and Northern Quoll. This habitat type was noted to be in excellent to pristine condition.

Habitat type 5 (Rocky hills and ridges) would support a range of saxicoline (inhabiting rocky areas) lizards, as well as small mammal species, and foraging habitat for species mentioned under habitat type 4. This habitat type was noted as being in excellent condition; however, some locations were identified as slightly degraded due to disturbance from exploration drilling and vehicle tracks.

At a wider scale, Habitat type 2 (plains) appeared to dominate the landscape to the east of the Project area. Habitat types 3 and 5 (ridges and hill slopes) appeared to be the dominant habitat types to the west, south and north of the Project area. A more detailed description of each habitat type and details recorded during the habitat assessments can be found in Appendix I.

Figure 9 illustrates significant habitat for conservation significant species such as canyons and steep rocky gullies, cliffs and steep breakaways and creek lines. Note that thasjdgkuwervbf



Figure 8: Broad habitat types identified within the Project area.

5.2.2 **Fauna assemblages**

Including the previous survey conducted by *ecologia* (2005a), a total of 137 vertebrate fauna species have been recorded in the Project area, including 38 reptiles, 71 birds, and 21 mammals. Of these, 99 vertebrate fauna species comprising one amphibian, 27 reptiles, 50 birds and 21 mammals were recorded within the Project area from the current survey. The survey detected five conservation significant species within the Project area (**Figure** 7). An additional species that is likely to occur within the Project area based on evidence found during the survey is the Western Pebble-mound Mouse, and an additional four species were assessed as 'likely' to occur (see **Table 7**). Of all the mammals recorded during this and previous surveys conducted within the Project area, three are introduced species:

- *Bos taurus* (Cow)
- *Canis lupus* subsp. *dingo* (Dingo)
- *Felis catus* (Cat)

Appendix F presents a list of fauna recorded within the Project area and which broad habitat type they occurred in. Species recorded from the *ecologia* (2005a) survey only have not been placed into broad habitat types.

The following sections describe the fauna assemblages recorded during the vertebrate fauna surveys of the Project area.

Amphibians

Only one species of amphibian was recorded from the Project area, the Desert Tree Frog (*Litoria rubella*), from Habitat type 1. The species was heard calling from a small episodic lake within the centre of the Project area, and observed active at night within rocky canyons during nocturnal searches. Several additional species of common widespread, arid-adapted water-holding frogs (Genus *Cyclorana* and *Neobatrachus*) are expected to occur and be detectable in low-lying plains habitat following significant rainfall events. Additional arid-adapted frogs likely to occur include those recorded locally by *ecologia* (2005c) including the Centralian Burrowing Frog (*Platyplectrum spenceri*) and Main's Frog (*Cyclorana maini*) in the sandy minor creeks and associated areas of low elevation.

Reptiles

Thirty eight species of reptile were recorded during the current and previous surveys as a result of the trapping, hand searching, nocturnal surveying and opportunistic observations. From the current survey, the most commonly trapped reptile was the Striped Skink (*Ctenotus saxatilis*), which was recorded along every trapping transect and therefore within every broad habitat type within the Project area. The Central Military Dragon (*Ctenophorus isolepis isolepis*) was very common on the lower slopes and plains (Habitat types 1, 2 and 3). It was recorded along six trapping transects and was commonly observed opportunistically. Other species were recorded at single point locations such as the Blind Snake (*Ramphotyphlops ammodytes*) and Dwarf Skink (*Menetia surda*) which are cryptic species, and the Ground Gecko (*Diplodactylus savagei*) which is generally associated with specific habitat: stony hills and scree slopes (Doughty *et al*. 2010). All reptile species recorded are considered to be widespread and common within the Pilbara Bioregion.

No conservation significant reptile species were recorded within the Project area. One conservation significant reptile, the Pilbara Olive Python (*Liasis olivaceus* subsp*. barroni*), whilst not recorded, is likely to occur based on habitat available, known distribution and previous records in the vicinity (*ecologia* 2005b, 2005c, 2005d).

Birds

Seventy one bird species were recorded within the Project area through bird censuses along trapping transects, nocturnal surveys and opportunistic observations from both surveys. With regards to the current survey, the Black Honeyeater (*Certhionyx niger*) was recorded within all broad habitat types and along all eight trapping transects. Other commonly occurring species included the Brown Honeyeater (*Lichmera indistincta*), Black-breasted Buzzard (*Hamirostra melanosternon*) and Torresian Crow (*Corvus orru*) on the lower slopes and plains (Habitat types 1, 2 and 3). On the ridges and in the gullies, common species included the Brown Honeyeater (*Lichmera indistincta*), Grey Shrike-thrush (*Colluricincla harmonica*) and Rainbow Bee-eater (*Merops ornatus*) (EPBC Act Migratory).

Three conservation significant birds were recorded (Australian Bustard, Bush Stone Curlew, and Rainbow Bee-eater; **Figure 7**). These are discussed in detail in Section 5.2.3.

Mammals

Twenty-one species of mammal were recorded within the Project area through means of trapping, motion camera captures, Anabat recordings, targeted searches and opportunistic observations such as tracks and scats. The Northern Quoll (EPBC Act Endangered) was the most commonly trapped mammal within the Project area and was recorded along all eight trapping transects and within all five broad habitat types. Northern Quoll scats and tracks were commonly recorded, and several individuals were recorded on the motion cameras. In the plains (Habitat types 1 and 2) the Desert Mouse (*Pseudomys desertor*) was commonly trapped, and Euro (*Macropus robustus* subsp. *erubescens*) tracks and scats were commonly found on the slopes and plains (Habitat types 1, 2 and 3). On the slopes and ridges and in the gullies the Common Rock-rat (*Zyzomys argurus*) was frequently trapped and Rothschild's Rock-wallaby (*Petrogale rothschildi*) was observed on the motion cameras and was positively identified through scat identification (Habitat types 3, 4 and 5).

Target surveys for the Western Pebble-mound Mouse recorded ten inactive pebble mounds within the Project area (**Figure 7**) associated with stony plains and slopes (**Figure 8**).

Three species of conservation significant mammal, Northern Quoll, Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*) and Ghost Bat (*Macroderma gigas*); were recorded within the Project area from the current and previous surveys. These are discussed in detail in Section 5.2.3, and their locations are presented in **Figure 7**.

5.2.3 **Conservation significant fauna**

Four conservation significant species were recorded within the Project area during this survey (**Figure 7**; **Table 8**; Appendix G). An additional species, the Ghost Bat (*Macroderma gigas*) has previously been recorded within the Project area (*ecologia* 2005a).

In addition, ten mounds constructed by the Western Pebble-mound Mouse (*Pseudomys chapmani*) were recorded within the Project area (**Figure 7**). None of these could be confirmed as active mounds and therefore the likelihood of occurrence for the Western Pebble-mound Mouse within the Project area was assigned as 'likely'.

Figure 7 illustrates conservation significant vertebrate fauna recorded within and surrounding the Project area from the current and previous surveys. Previous survey records are shown in blue, and current survey records are indicated in yellow.

Figure 9 illustrates significant habitat for conservation significant species such as gullies, cliffs and creek lines.

Table 8 summarises the conservation significant species recorded within the Project area, their conservation status, and which broad habitat type they were recorded in. Each species is discussed in more detail below.

Table 8: Conservation significant species recorded within the Project area, and the broad habitat type in which they occur

SPECIES	IUCN RED LIST STATUS	EPBC ACT STATUS	WC ACT / DEC STATUS	BROAD HABITAT TYPE* IN WHICH THEY OCCUR
Australian Bustard (*Ardeotis australis*)	LC		P4	1
Bush Stone-curlew (*Burhinus grallarius*)	LC		P4	1, 2
Rainbow Bee-eater (*Merops ornatus*)	LC	M	S	1, 2, 3, 4, 5
Northern Quoll (*Dasyurus hallucatus*)	EN	EN	EN	1, 2, 3, 4, 5
Ghost Bat (*Macroderma gigas*)	LC		P4	4

*Refer to section 5.2.1 for broad habitat type descriptions

Australian Bustard (Ardeotis australis)

Conservation Status: DEC Priority 4

Distribution and Habitat: The Australian Bustard occurs widely over most of the mainland and utilises a number of open habitats, including open or lightly wooded grasslands, chenopod flats, plains and heathlands (Johnstone and Storr 1998).

Ecology: It is a nomadic species, ranging over very large areas and its abundance varies locally and seasonally from scarce to common, largely dependent on rainfall and food availability. The Australian Bustard has an omnivorous diet, feeding on grasses, seeds, fruit, insects and small vertebrates. Although the population size is still substantial, there has been a large historical decline in abundance, particularly south of the tropics, but also across northern Australia (Garnett and Crawley 2000). This is a result of hunting, degradation of its grassland habitat by sheep and rabbits and predation by foxes and cats (Frith 1976; Garnett and Crawley 2000). Bustards readily desert nests in response to disturbance by humans, sheep or cattle (Garnett and Crawley 2000).

Likelihood of Occurrence: This species was recorded during the survey within the Project area from positive identification of footprints within open shrubland plains over hummock grass (Habitat type 2), and an individual sighted within a minor creek line (Habitat type 1) (**Figure 7**). The Australian Bustard is a nomadic species and none of the observations from the current survey were of nesting individuals. Previous surveys have recorded this species nearby, but not within the Project area (*ecologia* 2005b, 2005c, 2005d, Onshore and Biologic 2010). .

Bush Stone-curlew (Burhinus grallarius)

Conservation Status: DEC Priority 4

Distribution and Habitat: The Bush Stone-curlew is widely distributed over much of mainland Australia. It is commonly associated with woodlands and shrublands along seasonal or permanent creeklines, and other water bodies including dams.

Ecology: A nocturnal and primarily insectivorous species that moves away stealthily when disturbed and has well-camouflaged plumage; it will often squat motionless to avoid detection. Breeding occurs during spring to summer.

Likelihood of Occurrence: Recorded during the survey within the Project area from positive identification of footprints and an active observation at night in open shrubland plains over hummock grass (Habitat type 2) (see **Figure 7**

for locations). It would potentially occur within Habitat type 1. This species has been recorded from one other survey in the area (*ecologia* 2005c).

Rainbow Bee-eater (Merops ornatus)

Conservation Status: EPBC Act Migratory

Distribution and Habitat: Rainbow Bee-eaters are commonly found during the summer throughout most of southern Australia excluding Tasmania (Barrett *et al*. 2003). They migrate north at the onset of cooler weather in autumn, spending the winter in northern Australia, New Guinea, and some of the southern islands of Indonesia. They occur in a wide range of habitats including open woodlands, shrublands, beaches, dunes, cliffs, mangroves, woodlands and parks and private gardens (Boland 2004).

Ecology: Rainbow Bee-eaters eat insects, mainly bees and wasps, as well as dragonflies, beetles, butterflies and moths. They catch flying insects on the wing and carry them back to a perch to eat. Bees and wasps are rubbed against the perch to remove the stings and venom glands (Boland 2004). Rainbow Bee-eaters gather in small flocks before returning to summer breeding areas after over-wintering in the north (apart from the resident northern populations). Both males and females select a suitable nesting site in a sandy bank and dig a long tunnel (average length: 89.4 cm) leading to a nesting chamber, which is often lined with grasses. Both parents incubate the eggs and both feed the young, sometimes with the assistance of auxiliaries (helpers) (Boland 2004). Nest holes are often located in disturbed areas such as bare sand batches and road sidings.

Likelihood of Occurrence: Recorded active flying above and perching within the Project area in several locations in all 5 broad habitat types (see **Figure 7**). This species requires sandy substrates to build nest burrows (Higgins 1999). The Rainbow Bee-eater has been recorded from several other surveys that have been conducted in the area (*ecologia* 1999, 2005a, 2005b, 2005d, Onshore and Biologic 2010). Some potential nesting habitat is present within Habitat type 1 which is characterised by alluvial sand, however the extensive harder sandy clay soil associated with Habitat type 2 - Spinifex shrubland plains having sandy clay soil is not considered to be potential breeding habitat.

Northern Quoll (Dasyurus hallucatus)

Conservation Status: Endangered under the EPBC Act and listed as Schedule 1 under WC Act.

Distribution and Habitat: The Northern Quoll formerly occurred across northern Australia from the Pilbara region in Western Australia to south-eastern Queensland. A 75% reduction of available habitat occurred during the 20th century, so that the species is now restricted to the Pilbara and north Kimberley in Western Australia with a few discreet populations across the Northern Territory and eastern Queensland (Braithwaite and Griffiths, 1994). Northern Quolls are most commonly found on dissected rocky escarpments, but are also sometimes present in eucalypt forest and woodland (Oakwood 2008). They are both arboreal and terrestrial and use a variety of den sites including termite mounds, rock crevices, logs, tree hollows and goanna burrows (Oakwood 2008).

Ecology: Northern Quolls are nocturnal and opportunistic omnivores feeding primarily on large insects, small vertebrates and soft fruits. Breeding in the Pilbara commences in winter with males becoming increasingly active in search for females. Birthing occurs in spring and early summer and weaning commences in summer extending through to early autumn. In most populations, males tend to die off post mating.

Likelihood of Occurrence: This species was recorded during the survey. It was detected via animal captures in all five broad habitat types (see **Figure 7** for locations). Significant habitat such as denning areas would likely be found in cliffs, gorges and canyons (**Figure 9**). Northern Quolls have been previously recorded in the area from several different surveys (*ecologia* 1999, 2005a, 2005c, Onshore and Biologic 2010), and are regularly seen around the Yarrie accommodation camp. Given the large number of individuals trapped within the Project area it is likely that there are a number of dens within these habitats.

Ghost Bat (Macroderma gigas)

Conservation Status: DEC Priority 4

Distribution and Habitat: The Ghost Bat is known from WA, the Northern Territory and north east Queensland (Menkhorst and Knight 2011). Within the Pilbara region they are found in gorges and canyons with suitable caves associated with Marra Mamba geology (Armstrong and Anstee 2000).

Ecology: This cave-roosting bat feeds primarily on small birds and mammals. They utilise undisturbed caves to roost and prefer cave systems with a narrow entrance opening into a larger chamber (Armstrong and Anstee 2000). They are known to roost in either natural or manmade systems such as mine shafts (Menkhorst and Knight 2011).

Likelihood of Occurrence: The species was not recorded during this survey; however, it was recorded from previous surveys within caves associated with rocky canyons (*ecologia* 2005a, Specialised Zoological 2011a-c). One cave surveyed within the Project area is considered be utilised by Ghost Bats on a regular basis since records began in 2008 (Specialised Zoological 2011a). Due to access restraints (i.e. confined spaces) these caves were not inspected (Habitat type 4; refer to **Figure 7**). Some bigger caves observed on site would be unsuitable to support day roosting for Ghost Bats due to the large open entrances; however numerous small inaccessible caves were noted along the ridges which could be suitable for day and night roosting. It is possible that all caves within the Project area are used in some way (i.e. foraging) if not for roosting. A targeted bat survey of the caves within the Project area would likely confirm the presence of this species.

5.2.4 **Other likely conservation significant fauna**

Based on the habitat characteristics identified and mapped within the Project area, and the proximity of previous survey records, an additional five species of conservation significance are assessed as likely to occur within the Project area (**Table 7**).

Pilbara Olive Python (*Liasis olivaceus barroni*): This species is listed as Vulnerable under the EPBC Act and as Schedule 1 under the WC Act. It was not recorded during the current or previous survey within the Project area, however suitable habitat is present. One record exists previously from the area: Moloch Fauna Consultants (1992) reported a Pilbara Olive Python from a "rock pool at the head of a gully on the Callawa mesa".

Fork-tailed Swift (*Apus pacificus*): Listed as Migratory under the EBPC Act. This species has been recorded previously approximately 30 km north-west of the Project area (*ecologia* 2005d). It is a relatively common seasonal trans-equatorial migrant throughout mainland Australia in October to April (Slater et al. 2003).

Peregrine Falcon (*Falco peregrinus*): Listed as Specially Protected Fauna under the WC Act. This species was recorded approximately 17 km north west of the Project area (*ecologia* 2005b). This species is very widely distributed throughout most of Australia including a range of arid and semi-arid scrubland habitats. It requires a secure nest site with an abundance of prey (Morcombe 2007). Cliffs within the Project area represent potentially suitable nesting habitat.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*): Listed as Vulnerable under the EPBC Act and Schedule 1 under the WC Act. This species has been previously recorded via Anabat call detection approximately 700 metres south of the Project area (*ecologia* 2005a). It is likely that this species would utilise the Project area for foraging and potentially for roosting.

Western Pebble-mound Mouse (*Pseudomys chapmani*): Listed as DEC Priority 4. Numerous inactive pebble mounds were recorded throughout the Project area (**Figure 7**), however no active mounds were found and no individuals recorded. Habitat types 2 and 3 represent potential habitat for this species.

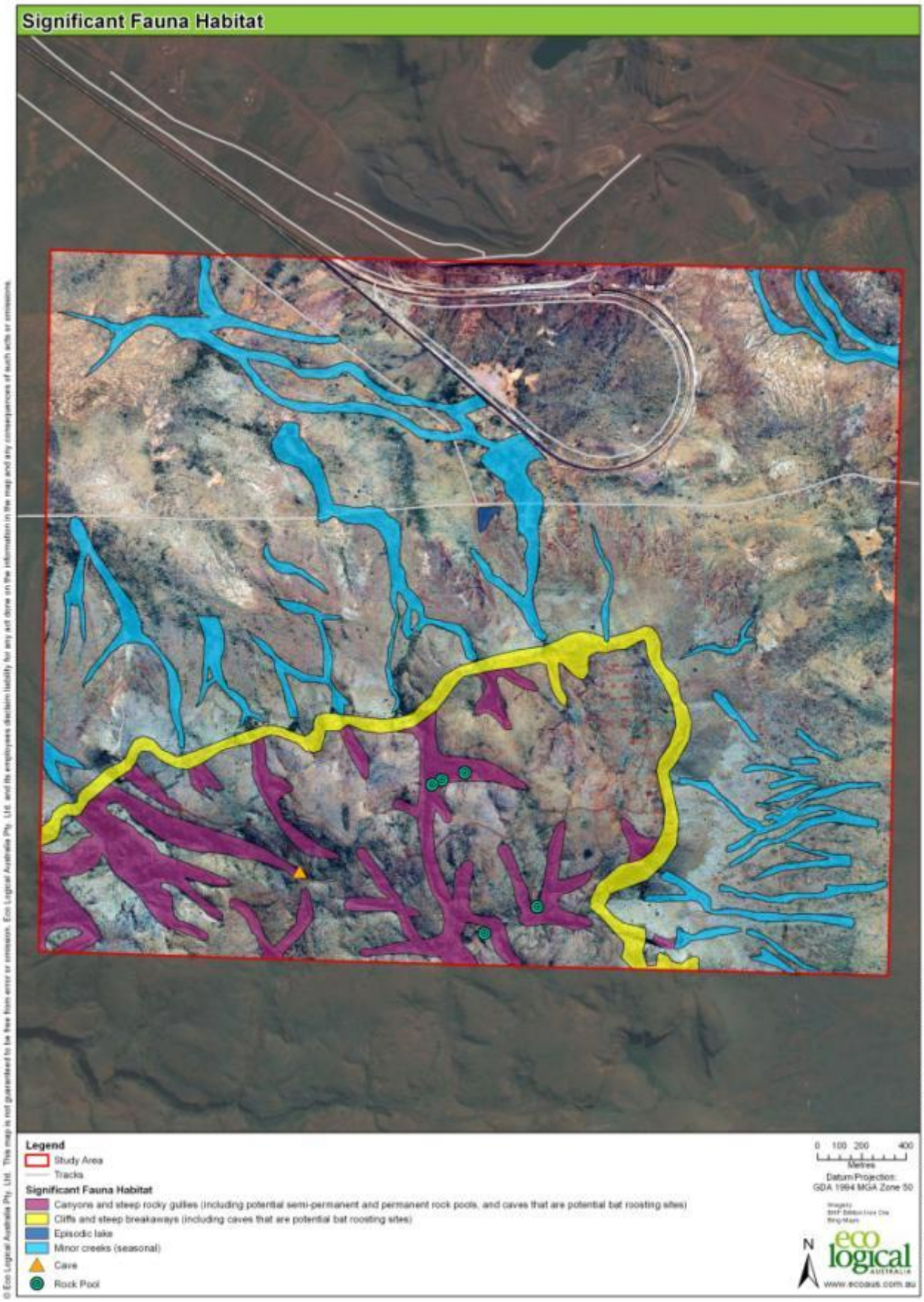


Figure 9: Significant fauna habitat identified within the Project area

5.3 SURVEY ADEQUACY AND DATA ANALYSIS

The EPA provides general and technical guidance on the types of analyses to be considered based on the objectives of any given fauna survey (EPA and DEC 2010). Treatment of data is an important consideration because factors such as survey methodology, and the types of statistical analyses used, will affect the reliability of data and data interpretation. For example, the total number of mammal species potentially occurring within the Project area is relatively low in comparison to birds and reptiles, and likely to be less statistically robust. For this reason, the species accumulation curves shown in Section 5.3.1 do not include mammals.

5.3.1 **Species accumulation curves**

For the purposes of this fauna survey, data analysis is used to help assess survey effort adequacy. Graphical representation of the cumulative number of species recorded against a measure of the sampling effort is termed the species accumulation curve (SAC). Survey effort can be measured as the number of successive trap nights (EPA and DEC 2010). As survey effort increases, gradually more and more of the species living in a habitat are expected to be caught, until eventually only the rarest species or occasional visitors remain unrecorded. In theory when this occurs, increased effort is unlikely to result in increased number of species recorded. That is, the species accumulation curve will have reached an asymptote.

It is important to note that a SAC provides a 'snap shot' of the number of species detectable based on the survey methods employed and the weather conditions at the time of the survey. The SACs presented for bird and reptile species do not give estimates of the number of species expected to occur, but rather, they provide an indication of the number of species detectable based on the survey methods used and the weather conditions observed, and are subject to the seasonal and annual patterns of movement and activity of fauna species.

The fauna species recorded during this survey represents a portion of the total number of species occurring within the Project area. The expected number of species will be greater than the number of species recorded, and less than the number of species listed in the desktop review.

A total of 18 reptile species were recorded via the standardised trapping methods (pit-fall and funnel traps) used in this survey. An additional eight reptile species not detected by standardised trapping were recorded only via non-standardised methods including night searching, hand-searching and opportunistic observations. The species recorded only via non-standardised methods accounts for 30 percent of all reptile species recorded.

A total of 31 bird species were recorded via the standardised bird census used in this survey. An additional 20 bird species not detected by standardised bird census were recorded only via non-standardised opportunistic observations and bird calls. The bird species recorded only via non-standardised methods accounts for approximately 40 percent of all species recorded.

Based on the importance of non-standardised methods for detection of reptiles and birds, particularly opportunistic observation, the SACs presented are derived from data for all fauna detection methods used during the survey.

The SAC for reptiles (**Figure 10**) shows a curve approaching asymptote by day 11. This indicates that survey duration (as a function of survey effort) was adequate to record those species of reptiles that were detectable at the time of the survey using the methods employed. The asymptote is significantly lower than the 103 reptile species listed as potentially occurring based on the desktop review indicating

that there is likely to be more reptile species present that were not detected. As mentioned the fauna species recorded during this survey represents a portion of the total number the species expected to occur within the Project area. The expected number of species occurring will be greater than the number of species recorded, and less than the number of species listed in the desktop review. An estimation of this number would require an assessment of the likelihood of occurrence of approximately 300 vertebrate fauna species recognised from the desktop review.

Similarly, the SAC for birds (**Figure 11**) of 49 species by day 13 is significantly lower than the 152 bird species identified through the desktop review. There are several factors that may account for this difference observed for both fauna groups mentioned, and these are discussed below.

1. Survey timing

The survey period in late autumn is considered to be during the optimum survey period for the Pilbara bioregion. Conditions leading up to the fauna survey included above average summer rainfall including cyclonic rain. These conditions are conducive to bird activity and detection, however, some bird species are seasonally nomadic. Therefore, some species are likely to be seasonally absent or uncommon. Surveys carried out over two trapping seasons typically record a greater number of the expected bird species. However, previous surveys within the local area should be taken into consideration, including two-season surveys reviewed within the desktop study.

Reptile activity and detectability is typically high with associated post-rain breeding, however, the maximum (diurnal) and minimum (nocturnal) temperatures by the end of May were relatively cool and not conducive to high levels of reptile activity. Whilst a number of day-active reptiles (dragons and skinks) were present, many nocturnal species (geckos, small elapid snakes and blind snakes) were expected to have had reduced activity due to low minimum temperatures at night. An additional survey during a warmer period such as mid to late spring could see an increase in the number of reptile species recorded.

Survey timing was conducive to mammal detectability and capture success due to the post-rain vegetation growth, and because the activity of mammals is not dictated as severely as reptiles. In addition the late autumn timing was optimal for detection of Northern Quolls, which was evident based on the high capture rates observed.

2. Data sources

The list of expected species has been compiled from a range of database searches and previous surveys including historical records, and species from a more diverse range and extent of habitat types than occurs in the Project area. Therefore the desktop list of 152 species includes a number of birds that are of low likelihood of occurrence.

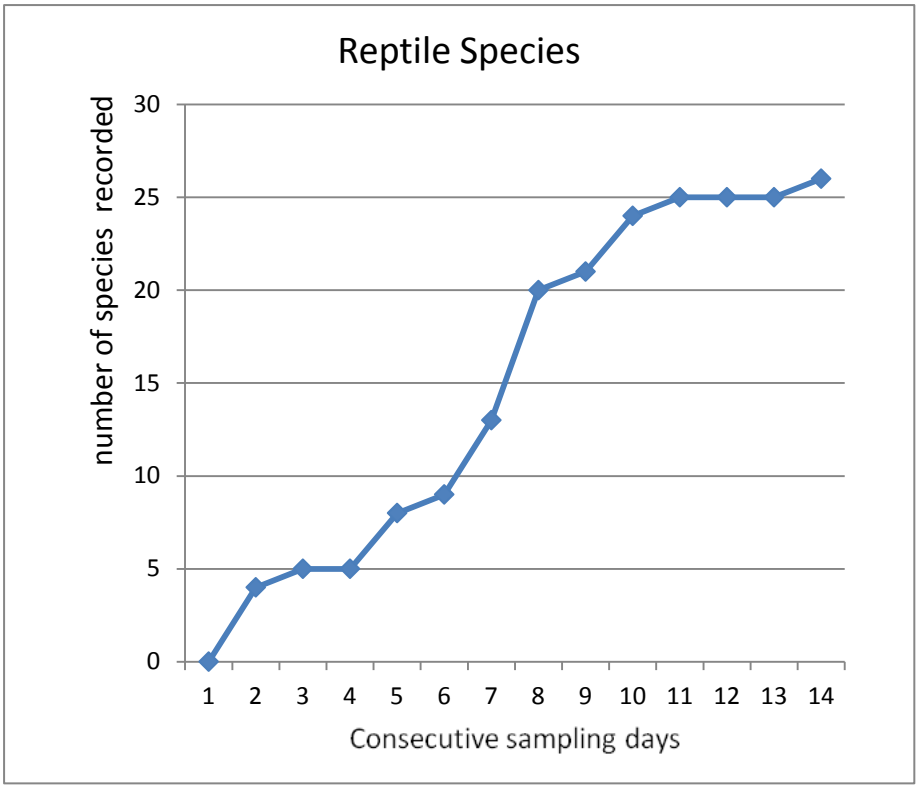


Figure 10: Species accumulation curve for reptiles

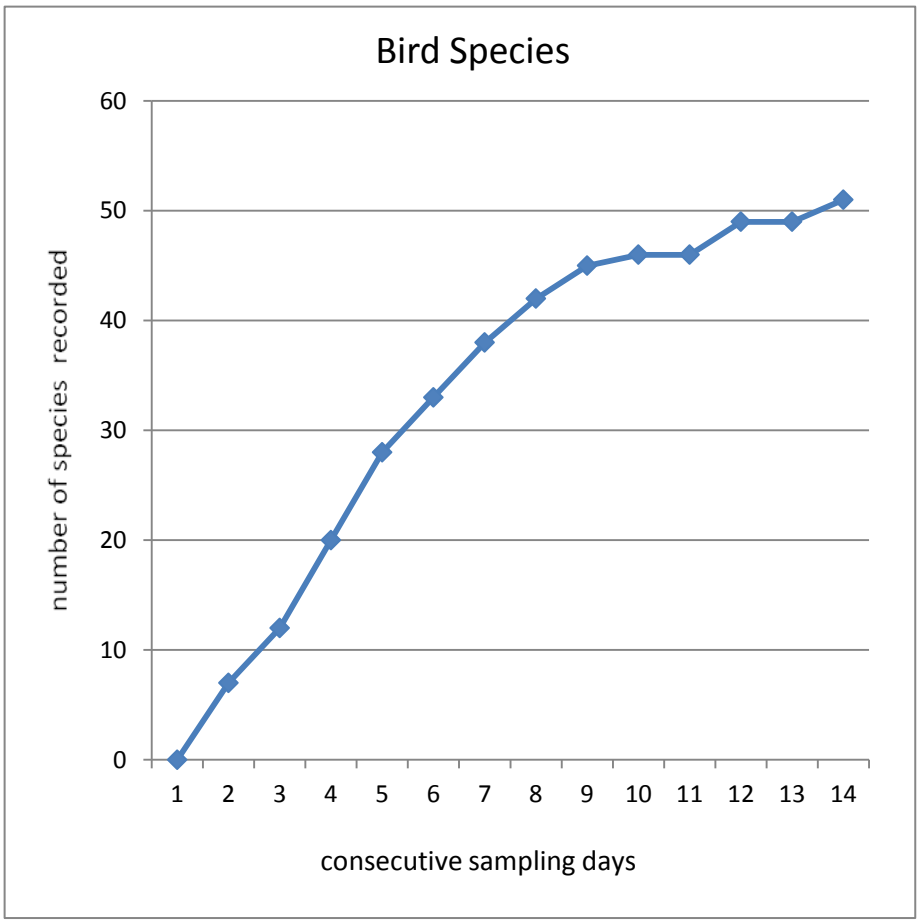


Figure 11: Species accumulation curve for birds

5.3.2 **Survey comparisons**

Five surveys with a similar Level 2 survey effort have previously been completed within, or in the vicinity of, the Project area (**Table 9**). A comparable number of frog, reptile, bird and mammal species were identified during all surveys. It is important to note that the findings from *ecologia* (2005c) were across four study sites which would account for the slightly higher numbers recorded. Other variables accounting for differences in fauna assemblages and recorded during these surveys will include survey effort, search area, habitat characteristics and survey season.

Appendix E gives a complete list of previous surveys in the area and the fauna that has the potential to occur in the area.

Table 9: Comparison of current survey results to similar previous surveys

REFERENCE	LEVEL OF SURVEY	SURVEY EFFORT	FROGS	REPTILES	BIRDS	NATIVE MAMMALS (INTRODUCED)
ecologia 1999: Yarrie Biological and Soil Survey (7 day survey conducted in June 1998)	L2 (single season)	Trap nights: 730 (pitfall, Elliott) Bird census: 15 hours Mist netting: 7 hours Nocturnal survey: 11.5 hours Hand searching: 400 minutes	3	24	43	13 (3)
***ecologia* 2005a: Callawa Biological Assessment Survey (20 day survey conducted in June 2005)**	**L2 (single season)**	**Trap nights: 2976 (pitfall, Elliott, funnel, cage)** **Bird survey: 50.25 hours** **Bat survey: 6.75 hours** **Nocturnal survey: 5 hours** **Hand searching: 46.16 hours**	**1**	**18**	**42**	**13 (3)**
ecologia 2005b: Cundaline Biological Assessment	L2 (single season)	Trap nights: 1209 (pitfall, Elliott, funnel, cage) Bird survey: 64 hours Bat survey: 11.25 hours Nocturnal survey: 13.5 hours Hand searching: 34 hours	1	17	40	12 (1)
ecologia 2005c: Goldsworthy Extension Project Biological Assessment Survey (survey includes 4 study sites)	L2 (each study site single season)	Trap nights: 4775 (pitfall, Elliott, funnel, cage) Bird census:7600 hours Bat survey: 1126 hours Nocturnal survey: 4902 hours Hand searching: 2227 hours	4	61	92	28 (3)

REFERENCE	LEVEL OF SURVEY	SURVEY EFFORT	FROGS	REPTILES	BIRDS	NATIVE MAMMALS (INTRODUCED)
ecologia 2005d: Goldsworthy Extension Project Cattle Gorge Haul Road Biological Assessment Survey	L2 (single season)	Trap nights: 740 (pitfall, Elliott, funnel) Bird survey: 2320 hours Bat survey: 280 hours Nocturnal survey: 780 hours Hand searching: 930 hours	2	25	68	10 (1)
ELA 2012 (this survey - 10 day survey conducted in May 2012)	**L2 (single season)**	Trap nights: 1232 (pitfall, Elliott, funnel, cage) Bird survey: 9.2 hours Bat survey: 13 nights Motion cameras: 29 nights Nocturnal survey: 16 hours Hand searching: 7 hours Targeted searching: 62 hours Opportunistic searching: 90 hours	**1**	**27**	**51**	**18 (4)**

Bold text indicates surveys conducted within Project area

5.3.3 **Sample transect comparisons**

A total of 18 reptile species were recorded by means of the standardised trapping methods (pit-fall and funnel traps) used in this survey. The sample transect that recorded the highest reptile species richness was transect number 5 (T5) located in Habitat type 1 (Minor creeks), with the lowest number of species recorded along T7 (Habitat type 5 – Rocky hills and ridges) and T8 (Habitat type 4 – Canyons, breakaways and steep rocky gullies) (**Table 10**). The highest number of individual reptiles recorded was along T1 (Habitat type 2 – Plains) and the lowest reptile capture rate was along T7 (Habitat type 5) (**Table 11**).

Differences in reptile species diversity observed within habitat types sampled can relate to differences in the reptile species ecology. Species diversity is not uniform across habitat types encountered due to differences in habitat preferences. Some habitats are known to have relatively high species diversity such as *Triodia* plains (Habitat type 2). These habitats provide suitable soils for many burrowing species as well as an abundance of hummock grassland habitats for a diverse range of reptile species (R. Browne-Cooper pers.obs). There can be a paucity of these micro-habitats in other habitat types such as stony rises (Habitat type 3) which can account for lower species diversity observed across different habitat types.

Twenty-nine species of birds were recorded during the systematic bird censuses, with an additional 21 species recorded opportunistically. T2 (Habitat type 1) and T4 (Habitat type 1; and Habitat type 3 – Stony rises, low stony hills and scree slopes), recorded the highest species richness for birds, as well as the highest number of individual records. The lowest bird species richness was recorded at T1 (**Table 10**). T6 (Habitat type 2) recorded the lowest number of individuals (**Table 11**).

Eleven mammal species were recorded using the survey trapping methodology and an additional 11 species were recorded opportunistically. Transect 3 (T3), within Habitat type 2, recorded the highest mammal species richness, whereas transects T2, T4 and T7 only recorded two species of mammal (**Table 10**). T8 (Habitat type 4) recorded the most mammal captures and T1 (Habitat type 2) recorded the lowest captures (**Table 11**).

Overall, T5 had the highest species richness with 22 species (seven reptiles, 10 birds and five mammals) recorded, followed by T2, and then TT3/T4, T6, T1, T8, and T7 (**Table 10**). This corresponded to Habitat type 1 (Minor creeks) supporting the highest species richness overall, followed by Habitat type 2 (Plains). Habitat type 3 (Stony rises, low stony hills and scree slopes) supported a moderate level of species richness overall. Habitat types 4 and 5 (Canyons, breakaways and steep rocky gullies, and rocky hills and ridges, respectively) supported the lowest species richness overall.

In contrast to overall species richness, no obvious patterns were observed between overall species abundance and broad habitat type. For example, the highest overall species abundance was recorded at T1 (Habitat type 2; Plains); however, the lowest overall species abundance was recorded in the same habitat type. Despite this, a high overall species abundance was recorded for both transects located in Habitat type 1 (Minor creeks), suggesting that this habitat type supported high overall species abundance.

It should be noted that the above comments on broad habitat types and their relationship with overall species richness and abundances are based on observations with little, and in some cases, no replication (Habitat types 3, 4 and 5). This was due to the survey maximising captures in the major habitat types and habitat types expected to support relatively high diversity of terrestrial fauna assemblages (see Section 4.3.2). Thus, comments relating relative overall species richness and abundances to broad habitat type should be read with caution.

Further, it should be noted that 22% of all the reptile species and 42% of all bird species were only recorded via opportunistic observations (not via standardised trapping or census methods) indicating the importance of opportunistic detection of vertebrate fauna during Level 2 fauna surveys.

Table 10: Fauna species richness along each trapping transect

TRAP TRANSECT	T1	T2	T3	T4	T5	T6	T7	T8
Number of reptile species recorded at each transect	6	6	5	5	**7**	6	3	3
Number of bird species recorded at each transect	7	**12**	8	**12**	10	8	8	8
Number of mammal species recorded at each transect	3	2	**6**	2	5	3	2	4
Total number of species recorded at each transect	16	20	19	19	**22**	17	13	15

Table 11: Fauna capture rates along each trapping transect

TRAP TRANSECT	T1	T2	T3	T4	T5	T6	T7	T8
Number of reptile individuals at each transect	**52**	22	14	17	34	31	10	13
Number of bird individuals at each transect	11	**26**	12	**26**	13	9	19	22
Number of mammal individuals at each transect	3	7	10	10	8	7	18	**20**
Total number of captures/records at each transect	**66**	55	36	53	55	47	47	55

Due to the large capture rates of Northern Quoll, a comparison of Northern Quoll capture rates for each trap type has been provided in **Table 12**. Although more individuals were caught in Elliot A traps, the capture rate in Elliot B traps is higher due to the fewer number of trap nights. This result indicates that both Elliot A and Elliot B traps are suitable for Northern Quoll surveys, and are adequate substitutes to wire mesh cage traps. A total of 51 Northern Quoll captures was made over eight transects and 392 trap nights. It is expected that a number of these captures were re-trapped animals. Several individuals were recognised as recaptures, based on the distinct characteristics of these animals (some were missing patches of fur, and one had no tail).

Table 12: Comparison of Northern Quoll capture rates

TRAP METHOD	TOTAL CAPTURES	TRAP NIGHTS	CAPTURE RATES
Elliot A traps (33 x 10 x 8 cm)	29	280	10.4%
Elliot B traps (cage) (64 x 20 x 16cm)	22	112	19.6%
Combined	51	392	13.0%

6 Discussion

A total of 137 vertebrate fauna species was recorded during the field survey, out of a total of 304 species potentially occurring based on the desktop review. Most of the species recorded are widespread and common either within or beyond the Pilbara and Great Sandy Desert biogeographic regions.

The main objective of the desktop review approach is to ensure thoroughness and for planning field survey methodology, particularly in the assessment of likelihood of occurrence for conservation significant species. The desktop review represents a collective of species based on the combined results from a number of different data sources over broad geographic and temporal limits. The actual number of species occurring within the Project area at the time of the survey is expected to be a sub-set of the desktop species list. The actual number of species present is difficult to quantify due to the complex and dynamic nature of species populations. This diversity is high due to biogeographical location as well as the diversity of habitat types present. An estimation of this number would require an assessment of the likelihood of occurrence of approximately 300 vertebrate fauna species recognised from the desktop review.

The results of this late autumn trapping exercise compared favourably with the results of several previous surveys in the area conducted in June by *ecologia* (1999, 2005a). This study recorded a higher number of reptiles and mammals than all other surveys. However the low maximum and minimum temperatures experienced are expected to influence reptile capture rates and observations of active species.

According to the database searches and previous surveys in the area, a total of 34 species of conservation significance have the potential to occur within or near the Project area. These include three reptiles, 20 birds and 11 mammals. These species were assessed based on the results of the Level 2 fauna survey in terms of the species assemblages recorded and the habitat characteristics identified and mapped within the Project area. The survey recorded five species of conservation significance either occurring or previously recorded within the Project area (**Table 8**). An additional five conservation significant species were assessed as likely to occur (**Table 7**). A large number of wader birds and ducks came up in the database searches, however the only area in which these species were observed, or are likely to occur is within and around the episodic lake in the centre of the Project area (**Figure 9**). Many of these species would be at best occasional or temporary visitors on a seasonal basis.

The fauna habitat characteristics identified and mapped throughout the Project area included areas that are both known to support, or are likely to support the conservation significant species mentioned. These areas include rocky canyons and cliffs that potentially have bat roost caves, den sites for Northern Quolls, Pilbara Olive Pythons shelter sites and potential foraging habitat for these and other species is presented in **Table 7**. Further targeted search effort in areas of suitable habitat may record these species.

7 Summary and Conclusions

The main conclusions of the survey were:

- The survey methods were consistent with the EPA Position Statement 3 (EPA 2002), Guidance Statement 56 (EPA 2004), *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010), as well as other guidance documents detailed in Section 1.3.
- Five broad fauna habitat types for fauna were present in the Project area:
    - Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays.
    - Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble.
    - Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays.
    - Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping.
    - Rocky hills and ridges supporting *Grevillea/Acacia* shrublands and *Triodia* hummock grasslands on ironstone / shallow clay.
- These broad habitat types were in excellent condition overall, although some creek lines and plains were slightly degraded due to cattle grazing. Areas that had not been accessed by cattle, such as the rocky hill slopes, ridges and gullies were in pristine condition.
- One hundred and thirty-seven terrestrial vertebrate species were recorded within the Project area, including one amphibian, 38 reptiles, 71 birds and 21 mammals (ELA 2012, *ecologia* 2005a). An additional three introduced mammals were recorded.
- Five conservation significant species were recorded within the Project area during this survey and from past surveys:
    - Australian Bustard (IUCN Least Concern, DEC Priority 4)
    - Bush Stone-curlew (IUCN Least Concern, DEC Priority 4)
    - Ghost Bat (EPBC Vulnerable, DEC Priority 4)
    - Northern Quoll (IUCN Endangered, EPBC Endangered, WC Act S1)
    - Rainbow Bee-eater (IUCN Least Concern, EPBC Migratory, WC Act S3)
    - One additional species, Western Pebble-mound Mouse (IUCN Least Concern, DEC Priority 4), is likely to occur due to numerous inactive pebble mounds recorded within the Project area

- An additional four species of conservation significance are considered 'likely' to occur, and 16 are considered to have the 'potential' to occur within the Project area.
- Results of this survey were similar to other surveys that have been conducted in the Goldsowrthy area.
- The main limitations of the survey were identified as access limitations into caves for the detection of conservation significant bat species, and restricted access to certain areas such as the rail loop.

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Appendix A: Conservation classification, codes and definitions for Western Australia

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the WA *Wildlife Conservation Act 1950* (WC Act).

CATEGORY	DEFINITION
Critically Endangered (CE)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Data Deficient (DD)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Endangered (EN)	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction
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
Least Concern (LC)	Taxa that are not Threatened
Migratory (M)	Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state; • the agreement between the Government of Australian and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their environment (CAMBA); • the agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); or • the agreement between Australia and the Republic of Korea to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (ROKAMBA).
Near Threatened (NT)	Taxa that risk becoming Vulnerable in the wild.
Not Evaluated (NE)	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.
Vulnerable (VU)	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.

Schedules under the *Wildlife Conservation Act 1950*

SCHEDULE	DEFINITION
Schedule 1 (S1)	Fauna which are rare or likely to become extinct are declared to be fauna that is in need of special protection. This includes species listed as CE, EN and VU.
Schedule 2 (S2)	Fauna which are presumed to be extinct are declared to be fauna that is in need of special protection. This includes species listed as EX and EW.
Schedule 3 (S3)	Birds which are subject to an agreement between the governments of Australia and Japan, China and Republic of Korea relating to the protection of migratory birds and birds in danger of extinction are declared to be fauna that is in need of special protection. This includes Migratory species.
Schedule 4 (S4)	Declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned above. This includes species that are listed as S.

Department of Environment and Conservation Priority Codes

SCHEDULE	DEFINITION
Priority 1 (P1)	*Taxa with few, poorly known populations on threatened lands.* Taxa which are known from few specimens or sight records from one or a few localities, on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2 (P2)	*Taxa with few, poorly known populations on conservation lands.* Taxa which are known from few specimens or sight records from one or a few localities, on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3 (P3)	*Taxa with several, poorly known populations, some on conservation lands.* Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 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 if present circumstances change. These taxa are usually represented on conservation lands.
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 B: Database search results

IUCN RED LIST SEARCH RESULTS

FAMILY	GENUS	SPECIES	COMMON NAMES	RED LIST STATUS
DASYATIDAE	*Himantura*	*dalyensis*	Freshwater Whipray	DD
NOTORYCTIDAE	*Notoryctes*	*caurinus*	Northern Marsupial Mole, Northwestern Marsupial Mole	DD
NOTORYCTIDAE	*Notoryctes*	*typhlops*	Marsupial Mole, Southern Marsupial Mole	DD
SCINCIDAE	*Pseudemoia*	*baudini*	Baudins Skink, Bight Coast Skink, Great Bight Cool-skink	DD
PHALANGERIDAE	*Wyulda*	*squamicaudata*	Ilangnalya, Scaly-tailed Possum	DD
MYRMECOBIIDAE	*Myrmecobius*	*fasciatus*	Banded Anteater, Numbat	EN
DASYURIDAE	*Parantechinus*	*apicalis*	Dibbler, Southern Dibbler	EN
AMBASSIDAE	*Ambassis*	*macleayi*	Macleayi's Glassfish, Macleay's Glassfish, Macleay's Glass Perchlet, Macleay's Perchlet	LC
AGAMIDAE	*Amphibolurus*	*norrisi*	Mallee Heath Lashtail	LC
ANGUILLIDAE	*Anguilla*	*bicolor*	shortfin eel	LC
DASYURIDAE	*Antechinomys*	*laniger*	Kultarr	LC
TYPHLOPIDAE	*Austrotyphlops*	*endoterus*	Interior Blind Snake	LC
TYPHLOPIDAE	*Austrotyphlops*	*hamatus*	Pale-headed Blind Snake	LC
TYPHLOPIDAE	*Austrotyphlops*	*kimberleyensis*	Kimberley Shallow-soil Blind Snake	LC
TYPHLOPIDAE	*Austrotyphlops*	*pilbarensis*		LC
TYPHLOPIDAE	*Austrotyphlops*	*waitii*	Beaked Blind Snake	LC
SCINCIDAE	*Bassiana*	*trilineatus*	Cool Skink, South-western Cool Skink, Western Three-lined Skink	LC
ELEOTRIDAE	*Butis*	*butis*	Crazy Fish, Crimson-tipped Flathead Gudgeon, Crimson-tipped Flathead-sleeper	LC
SCINCIDAE	*Carlia*	*gracilis*	Slender Rainbow Skink	LC
VESPERTILIONIDAE	*Chalinolobus*	*gouldii*	Gould's Wattled Bat	LC
TRIGLIDAE	*Chelidonichthys*	*kumu*	Bluefin Gurnard	LC
AGAMIDAE	*Ctenophorus*	*ornatus*	Ornate Crevice-dragon	LC
SCINCIDAE	*Ctenotus*	*burbidgei*	Plain-backed Kimberley Ctenotus	LC
SCINCIDAE	*Ctenotus*	*gemmula*	Jewelled South-west Ctenotus	LC
SCINCIDAE	*Ctenotus*	*helenae*	Clay-soil Ctenotus, Helen's Ctenotus	LC

FAMILY	GENUS	SPECIES	COMMON NAMES	RED LIST STATUS
SCINCIDAE	*Ctenotus*	*inornatus*	Bar-shouldered Ctenotus, Plain Ctenotus	LC
SCINCIDAE	*Ctenotus*	*leonhardii*	Leonhardi's Ctenotus	LC
SCINCIDAE	*Cyclodomorphus*	*celatus*	Western Slender Blue-tongue	LC
DASYURIDAE	*Dasycercus*	*cristicauda*	Crest-tailed Mulgara, Mulgara	LC
PYGOPODIDAE	*Delma*	*fraseri*	Fraser's Delma	LC
COLUBRIDAE	*Dendrelaphis*	*punctulatus*	Black Treesnake, Common Treesnake	LC
DIPLODACTYLIDAE	*Diplodactylus*	*granariensis*	Western Stone Gecko, Wheat-belt Stone Gecko	LC
DIPLODACTYLIDAE	*Diplodactylus*	*ornatus*	Ornate Stone Gecko	LC
AGAMIDAE	*Diporiphora*	*lalliae*	Lally's Two-line Dragon	LC
ELAPIDAE	*Drysdalia*	*mastersii*	Master's Snake	LC
SCINCIDAE	*Egernia*	*kingii*	King's Skink	LC
SCINCIDAE	*Eremiascincus*	*brongersmai*	Brown-sided Bar-lipped Skink	LC
GEKKONIDAE	*Gehyra*	*australis*	House Gecko, Northern Dtella, Top-end Dtella	LC
GEKKONIDAE	*Gehyra*	*pilbara*	Pilbara Dtella	LC
SCINCIDAE	*Hemiergis*	*quadrilineatum*	Two-toed Earless Skink	LC
KURTIDAE	*Kurtus*	*gulliveri*	Humphead, Incubator Fish, Nurseryfish	LC
TERAPONTIDAE	*Leiopotherapon*	*macrolepis*	Kimberley Spangled Perch, Large-scaled Grunter, Large-scale Grunter	LC
SCINCIDAE	*Lerista*	*allochira*	Cape Range Slider	LC
SCINCIDAE	*Lerista*	*connivens*	Blinking Broad-blazed Slider	LC
SCINCIDAE	*Lerista*	*kennedyensis*	Kennedy Range Broad-blazed Slider	LC
SCINCIDAE	*Lerista*	*onsloviana*	Onslow Broad-blazed Slider	LC
SCINCIDAE	*Lerista*	*taeniata*	Ribbon Lerista, Ribbon Slider	LC
SCINCIDAE	*Lerista*	*vermicularis*	Slender Duneslider	LC
SCINCIDAE	*Lerista*	*walkeri*	Coastal Kimberley Slider	LC
PYTHONIDAE	*Liasis*	*fuscus*	Brown Water Python, Water Python	LC
SCINCIDAE	*Liopholis*	*inornata*	Desert Egernia, Desert Skink, Rosen's Skink, Unadorned Desert-skink	LC
SCINCIDAE	*Liopholis*	*striata*	Night Skink, Nocturnal Desert Skink, Striated Egernia	LC
HYLIDAE	*Litoria*	*staccato*		LC

FAMILY	GENUS	SPECIES	COMMON NAMES	RED LIST STATUS
MACROPODIDAE	*Macropus*	*irma*	Kwoora, Western Brush Wallaby, Western Bush Wallaby	LC
SCINCIDAE	*Menetia*	*amaura*	Shark Bay Dwarf Skink	LC
SCINCIDAE	*Morethia*	*boulengeri*	Boulenger's Snake-eyed Skink, South-eastern Morethia Skink	LC
CARPHODACTYLIDAE	*Nephrurus*	*levis*	Common Knob-tailed Lizard, Smooth Knob-tailed Gecko, Three-lined Knob-tail	LC
CARPHODACTYLIDAE	*Nephrurus*	*stellatus*	Southern Knob-tailed Gecko, Stellate Knob-tail	LC
CARPHODACTYLIDAE	*Nephrurus*	*wheeleri*	Banded Knob-tail	LC
ELAPIDAE	*Notechis*	*scutatus*	Black Tiger Snake, Eastern Tiger Snake, Krefft's Tiger Snake, Mainland Island Snake, Western Tiger Snake	LC
VESPERTILIONIDAE	*Nyctophilus*	*gouldi*	Gould's Long-eared Bat	LC
SYNBRANCHIDAE	*Ophisternon*	*bengalense*	Bengal mudeel, One-gilled eel, Pygmy eel	LC
VESPERTILIONIDAE	*Pipistrellus*	*westralis*	Koopman's Pipistrelle, Northern Pipistrelle	LC
SCINCIDAE	*Proablepharus*	*reginae*	Spinifex Snake-eyed Snake, Western Soil-crevice Skink	LC
MURIDAE	*Pseudomys*	*bolami*	Bolam's Mouse	LC
MURIDAE	*Pseudomys*	*chapmani*	Pilbara Pebble Mouse, Western Pebble-mound Mouse, Western Pebble Mouse	LC
TYPHLOPIDAE	*Ramphotyphlops*	*bicolor*		LC
ELAPIDAE	*Rhinoplocephalus*	*bicolor*	Muller's Snake, Square-nosed Snake	LC
ELAPIDAE	*Rhinoplocephalus*	*pallidiceps*	Northern Small-eyed Snake, Western Carpentaria Snake	LC
VESPERTILIONIDAE	*Scotorepens*	*sanborni*	Northern Broad-nosed Bat	LC
ELAPIDAE	*Simoselaps*	*littoralis*	Coastal Burrowing Snake, West Coast Banded Snake	LC
DASYURIDAE	*Sminthopsis*	*griseoventer*	Boullanger Island Dunnart, Gray-bellied Dunnart, Grey-bellied Dunnart	LC
DIPLODACTYLIDAE	*Strophurus*	*ciliaris*	Northern Spiny-tailed Gecko	LC
DIPLODACTYLIDAE	*Strophurus*	*jeanae*	Southern Phasmid Gecko	LC
DIPLODACTYLIDAE	*Strophurus*	*michaelseni*	Robust Striped Gecko	LC
ELAPIDAE	*Suta*	*nigriceps*	Mallee Black-backed Snake, Mitchell's Short-tailed Snake	LC

FAMILY	GENUS	SPECIES	COMMON NAMES	RED LIST STATUS
TACHYGLOSSIDAE	*Tachyglossus*	*aculeatus*	Kangaroo Island Echidna, Short-beaked Echidna	LC
TERAPONTIDAE	*Terapon*	*theraps*	Largescaled Terapon	LC
NATRICIDAE	*Tropidonophis*	*mairii*	Common Keelback, Mair's Keelback	LC
VARANIDAE	*Varanus*	*glauerti*	Glauert's Monitor, Kimberley Rock Monitor	LC
VARANIDAE	*Varanus*	*rosenbergi*	Heath Monitor, Southern Heath Monitor	LC
VARANIDAE	*Varanus*	*scalaris*	Banded Tree Monitor, Spotted Tree Goanna	LC
ELAPIDAE	*Vermicella*	*snelli*	Pilbara Bandy Bandy	LC
VESPERTILIONIDAE	*Vespadelus*	*finlaysoni*	Finlayson's Cave Bat	LC
DASYURIDAE	*Dasyurus*	*geoffroii*	Chuditch, Western Quoll	NT
ELAPIDAE	*Echiopsis*	*curta*	Bardick	NT
MACROPODIDAE	*Petrogale*	*burbidgei*	Monjon, Warabi	NT
DASYURIDAE	*Phascogale*	*calura*	Red-tailed Phascogale, Red-tailed Wambenger	NT
MEGADERMATIDAE	*Macroderma*	*gigas*	Australian False Vampire Bat, Ghost Bat	VU
THYLACOMYIDAE	*Macrotis*	*lagotis*	Bilby, Dalgyte, Greater Bilby, Greater Rabbit-eared Bandicoot	VU
DASYURIDAE	*Phascogale*	*pirata*	Brush-tailed Phascogale, Northern Brush-tailed Phascogale	VU
PSEUDOCHEIRIDAE	*Pseudocheirus*	*occidentalis*	Western Ringtail, Western Ringtail Possum	VU
MACROPODIDAE	*Setonix*	*brachyurus*	Quokka, Short-tailed Wallaby	VU

DEC THREATENED AND PRIORITY FAUNA DATABASE SEARCH

FAMILY	GENUS	SPECIES	VERNACULAR	CONSV CODE	LOCALITY NAME
Dasyuridae	*Dasycercus*	*cristicauda*	Crest-tailed Mulgara	T	Marble Bar
Dasyuridae	*Dasyurus*	*hallucatus*	Northern Quoll	T	Marble Bar
Hipposideridae	*Rhinonicteris*	*aurantius*	Orange Leafnosed-bat	T	Marble Bar
Hipposideridae	*Rhinonicteris*	*aurantius*	Orange Leafnosed-bat	T	Marble Bar
Hipposideridae	*Rhinonicteris*	*aurantius*	Orange Leafnosed-bat	T	Marble Bar
Otididae	*Ardeotis*	*australis*	Australian Bustard	4	Marble Bar
Burhinidae	*Burhinus*	*grallarius*	Bush Stone-curlew	4	Marble Bar
Burhinidae	*Burhinus*	*grallarius*	Bush Stone-curlew	4	Marble Bar
Burhinidae	*Burhinus*	*grallarius*	Bush Stone-curlew	4	Marble Bar
Burhinidae	*Burhinus*	*grallarius*	Bush Stone-curlew	4	Marble Bar
Dasyuridae	*Dasycercus*	*blythi*	Brush-tailed Mulgara	4	Marble Bar
Falconidae	*Falco*	*hypoleucos*	Grey Falcon	4	Marble Bar
Muridae	*Leggadina*	*lakedownensis*	Short-tailed Mouse	4	Marble Bar
Muridae	*Leggadina*	*lakedownensis*	Short-tailed Mouse	4	Marble Bar
Muridae	*Leggadina*	*lakedownensis*	Short-tailed Mouse	4	Marble Bar
Megadermatidae	*Macroderma*	*gigas*	Ghost Bat	4	Marble Bar
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Marble Bar
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Marble Bar
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	*Pseudomys*	*chapmani*	Western Pebble-mound Mouse	4	Telfer
Muridae	Pseudomys	chapmani	Western Pebble-mound Mouse	4	Telfer
Muridae	Pseudomys	chapmani	Western Pebble-mound Mouse	4	Telfer

EPBC ACT PROETCED MATTERS SEARCH

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

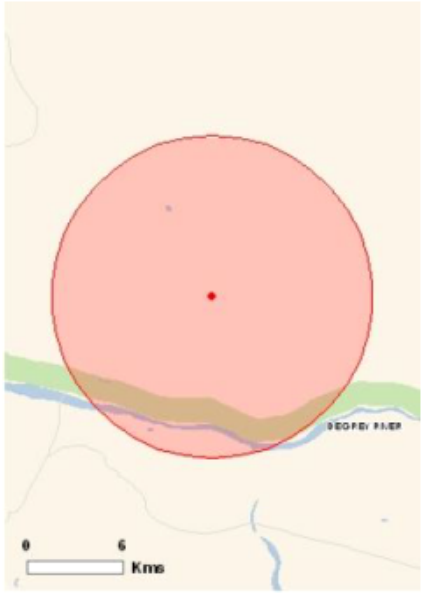
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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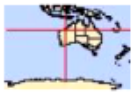
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	6
Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	8
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

Place on the RNE:	None
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	4
Nationally Important Wetlands:	1

Details

Matters of National Environmental Significance

Threatened Species		[Resource Information]
Name	Status	Type of Presence
MAMMALS		
Dasycercus cristicauda		
Mulgara [328]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dasyurus hallucatus		
Northern Quoll [331]	Endangered	Species or species habitat known to occur within area
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Notoryctes caurinus		
Karkarratul, Northern Marsupial Mole [295]	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat likely to occur within area
REPTILES		
Liopholis kintorei		
Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area

Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica		
Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum		
Oriental Pratincole [840]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum		
Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica		
Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Invasive Species		[Resource Information]
Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit.		
Name	Status	Type of Presence
Mammals		
Felis catus		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Sus scrofa		
Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes		
Red Fox, Fox [18]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
De Grey River	WA

Coordinates

-20.62139 120.28528

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia

-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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NATUREMAP SPECIES REPORT

NatureMap
Mapping Western Australia's Biodiversity

NatureMap Species Report

Created By Katrina Zeehandelaar on 11/05/2012

Kingdom Animalia
Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 120°17' 07" E,20°37' 17" S
Buffer 30km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	41323	*Actitis hypoleucos (Common Sandpiper)*		IA	
2.	25554	*Apus pacificus (Fork-tailed Swift)*		IA	
3.	24610	*Ardeotis australis (Australian Bustard)*		P4	
4.	24359	*Burhinus grallarius (Bush Stone-curlew)*		P4	
5.	24779	*Calidris acuminata (Sharp-tailed Sandpiper)*		IA	
6.	30903	*Dasyercus blythi (Brush-tailed Mulgara)*		P4	
7.	24089	*Dasyercus cristicauda (Crest-tailed Mulgara)*		T	
8.	24093	*Dasyurus hallucatus (Northern Quoll)*		T	
9.	24473	*Falco hypoleucos (Grey Falcon)*		P4	
10.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
11.	24792	*Gallinago megala (Swinhoe's Snipe)*		IA	
12.	24793	*Gallinago stenura (Pin-tailed Snipe)*		IA	
13.	24122	*Lagorchestes conspicillatus subsp. leichardti (Spectacled Hare-wallaby)*		P3	
14.	24217	*Leggadina lakedownensis (Short-tailed Mouse, Lakeland Downs Mouse, Kerakenga)*		P4	
15.	24180	*Macroderma gigas (Ghost Bat)*		P4	
16.	24596	*Merops ornatus (Rainbow Bee-eater)*		IA	
17.	24233	*Pseudomys chapmani (Western Pebble-mound Mouse, Ngadji)*		P4	
18.	24179	*Rhinonicteris aurantius (Orange Leafnosed-bat)*		T	
19.	24808	*Tringa nebularia (Common Greenshank)*		IA	

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

BIRDDATA CUSTOM SPECIES LIST

COMMON NAME	SCIENTIFIC NAME	SURVEY COUNT
Black Swan	*Cygnus atratus*	1
Pink-eared Duck	*Malacorhynchus membranaceus*	1
Grey Teal	*Anas gracilis*	1
Pacific Black Duck	*Anas superciliosa*	2
Spinifex Pigeon	*Geophaps plumifera*	1
Diamond Dove	*Geopelia cuneata*	1
Peaceful Dove	*Geopelia striata*	1
Spotted Nightjar	*Eurostopodus argus*	1
Australasian Darter	*Anhinga novaehollandiae*	1
Little Pied Cormorant	*Microcarbo melanoleucos*	1
Great Cormorant	*Phalacrocorax carbo*	1
Little Black Cormorant	*Phalacrocorax sulcirostris*	1
Australian Pelican	*Pelecanus conspicillatus*	1
Black-necked Stork	*Ephippiorhynchus asiaticus*	2
White-necked Heron	*Ardea pacifica*	1
White-faced Heron	*Egretta novaehollandiae*	1
Whistling Kite	*Haliastur sphenurus*	2
Black Kite	*Milvus migrans*	1
Little Eagle	*Hieraaetus morphnoides*	1
Nankeen Kestrel	*Falco cenchroides*	2
Black-fronted Dotterel	*Elseyornis melanops*	4
Galah	*Eolophus roseicapillus*	2
Little Corella	*Cacatua sanguinea*	2
Cockatiel	*Nymphicus hollandicus*	1
Pallid Cuckoo	*Cacomantis pallidus*	2
Barking Owl	*Ninox connivens*	1
Southern Boobook	*Ninox novaeseelandiae*	1
Eastern Barn Owl	*Tyto javanica*	1
Blue-winged Kookaburra	*Dacelo leachii*	3
Red-backed Kingfisher	*Todiramphus pyrrhopygius*	1
Sacred Kingfisher	*Todiramphus sanctus*	1
Rainbow Bee-eater	*Merops ornatus*	3
White-winged Fairy-wren	*Malurus leucopterus*	1
Variegated Fairy-wren	*Malurus lamberti*	1
Red-browed Pardalote	*Pardalotus rubricatus*	1
Singing Honeyeater	*Lichenostomus virescens*	2
Grey-headed Honeyeater	*Lichenostomus keartlandi*	1
White-plumed Honeyeater	*Lichenostomus penicillatus*	4
Yellow-throated Miner	*Manorina flavigula*	1
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	3
Grey Shrike-thrush	*Colluricincla harmonica*	1

COMMON NAME	SCIENTIFIC NAME	SURVEY COUNT
Black-faced Woodswallow	*Artamus cinereus*	2
Pied Butcherbird	*Cracticus nigrogularis*	1
Willie Wagtail	*Rhipidura leucophrys*	4
Torresian Crow	*Corvus orru*	2
Magpie-lark	*Grallina cyanoleuca*	5
Brown Songlark	*Cincloramphus cruralis*	1
Tree Martin	*Petrochelidon nigricans*	1
Zebra Finch	*Taeniopygia guttata*	4
Painted Finch	*Emblema pictum*	3
Australasian Pipit	*Anthus novaeseelandiae*	1

Appendix C: Survey sample points

SITE		LATITUDE (DECIMAL DEGREES)	LONGITUDE
Transect 1	1-1	-20.633	120.282
	1-2	-20.633	120.282
	1-3	-20.634	120.283
	1-4	-20.634	120.283
	1-5	-20.634	120.283
	1-6	-20.634	120.283
	1-7	-20.635	120.283
	1-8	-20.635	120.283
	1-9	-20.635	120.283
	1-10	-20.635	120.284
Transect 2	2-1	-20.632	120.301
	2-2	-20.632	120.301
	2-3	-20.633	120.301
	2-4	-20.633	120.301
	2-5	-20.633	120.301
	2-6	-20.633	120.301
	2-7	-20.633	120.301
	2-8	-20.632	120.301
	2-9	-20.632	120.301
	2-10	-20.631	120.301
Transect 3	3-1	-20.632	120.306
	3-2	-20.632	120.306
	3-3	-20.632	120.306
	3-4	-20.632	120.306
	3-5	-20.632	120.306
	3-6	-20.632	120.307

SITE		LATITUDE (DECIMAL DEGREES)	LONGITUDE
	3-7	-20.632	120.307
	3-8	-20.633	120.307
	3-9	-20.633	120.307
	3-10	-20.633	120.308
Transect 4	4-1	-20.642	120.312
	4-2	-20.642	120.311
	4-3	-20.642	120.311
	4-4	-20.641	120.311
	4-5	-20.641	120.311
	4-6	-20.641	120.311
	4-7	-20.641	120.311
	4-8	-20.641	120.310
	4-9	-20.640	120.310
	4-10	-20.640	120.310
Transect 5	5-1	-20.629	120.297
	5-2	-20.629	120.297
	5-3	-20.629	120.297
	5-4	-20.629	120.297
	5-5	-20.629	120.297
	5-6	-20.629	120.296
	5-7	-20.629	120.296
	5-8	-20.629	120.296
	5-9	-20.629	120.296
	5-10	-20.629	120.295
Transect 6	6-1	-20.633	120.286
	6-2	-20.633	120.286

SITE		LATITUDE (DECIMAL DEGREES)	LONGITUDE
	6-3	-20.632	120.287
	6-4	-20.632	120.287
	6-5	-20.632	120.287
	6-6	-20.632	120.287
	6-7	-20.631	120.287
	6-8	-20.631	120.287
	6-9	-20.631	120.287
	6-10	-20.630	120.287
Transect 7	7-1	-20.646	120.295
	7-2	-20.647	120.295
	7-3	-20.647	120.296
	7-4	-20.647	120.296
	7-5	-20.647	120.296
	7-6	-20.647	120.296
	7-7	-20.647	120.296
	7-8	-20.647	120.296
	7-9	-20.647	120.297
	7-10	-20.647	120.297
Transect 8	8-1	-20.648	120.293
	8-2	-20.648	120.293
	8-3	-20.648	120.293
	8-4	-20.648	120.293
	8-5	-20.649	120.293
	8-6	-20.649	120.292
	8-7	-20.649	120.292
	8-8	-20.649	120.292

SITE		LATITUDE (DECIMAL DEGREES)	LONGITUDE
	8-9	-20.649	120.292
	8-10	-20.649	120.292
Anabat Locations	AB2	-20.629	120.297
	AB3	-20.642	120.310
	AB4	-20.642	120.289
	AB5	-20.632	120.301
	AB6	-20.643	120.298
	AB7	-20.647	120.292
Camera Locations	CAM1	-20.642	120.310
	CAM2	-20.649	120.292
	CAM3	-20.642	120.289
	CAM4	-20.650	120.300
	CAM5	-20.643	120.297
Habitat Assessment Locations	S1	-20.644	120.304
	S2	-20.643	120.297
	T1	-20.634	120.282
	T2	-20.632	120.301
	T3	-20.632	120.304
	T4	-20.642	120.312
	T5	-20.629	120.298
	T6	-20.633	120.287
	T7	-20.647	120.296
	T8	-20.649	120.292

Appendix D: Survey transect site descriptions

VEGETATION AND FAUNA HABITAT DESCRIPTION	PHOTO
Transect 1: Broad habitat type: Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble. Vegetation association: Low open woodland of *Eucalyptus* spp. over open heath of *Acacia* spp. over closed hummock grassland of *Triodia* spp. on red sandy clay loam on alluvial plains.	
Transect 2: Broad habitat type: Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays. Vegetation association: Low woodland of *Eucalyptus* sp. over open scrub of *Acacia* spp. over closed hummock grassland of *Triodia* spp. on red alluvial sand on drainage lines.	
Transect 3: Broad habitat type: Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble. Vegetation association: Scattered trees of *Eucalyptus* sp. over high open shrubland of *Grevillea* and *Acacia* spp. over hummock grassland of *Triodia* spp. on red stony clay loam on plains and lower slopes.	

Transect 4: Broad habitat type: Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays. Vegetation association: Open shrubland of *Acacia* spp. over low shrubland of *Acacia* spp. over hummock grassland of *Triodia* spp. on red rocky clay on lower slopes.	
Transect 5: Broad habitat type: Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays. Vegetation association: Scattered Trees of *Eucalyptus* sp. over open scrub of *Acacia* spp. over hummock grassland of *Triodia* spp. on red alluvial sand on drainage lines.	
Transect 6: Broad habitat type: Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble. Vegetation association: Shrubland of *Acacia* spp. over low open shrubland of *Acacia* spp. over closed hummock grassland of *Triodia* spp. on red loamy clay on plains.	

Transect 7: Broad habitat type: Rocky hills and ridges supporting *Grevillea/ Acacia* shrublands and *Triodia* hummock grasslands on ironstone/ shallow clay. Vegetation association: High open shrubland of *Grevillea* and *Acacia* spp. over shrubland of *Grevillea* and *Acacia* spp. over hummock grassland of *Triodia* spp. on red stony clay on upper slopes and ridges.	
Transect 8: Broad habitat type: Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping. Vegetation association: High shrubland of *Grevillea* and *Acacia* spp. over shrubland of *Grevillea* and *Acacia* spp. over hummock grassland of *Triodia* spp. on red stony clay on gullies.	

Appendix E: Potential and recorded fauna assemblages from desktop review

SPECIES NAME	COMMON NAME	IUCN RED LIST	EPBC ACT	WC ACT/ DEC	Nature Map	EPBC Act Protected Matters	DEC database	IUCN Red list	Birdata	Outback Ecology Services 2008	Specialised Zoological 2011a	Specialised Zoological 2011b	Specialised Zoological 2012	Ecologia 1999	Ecologia 2005a	Ecologia 2005b	Ecologia 2005c	Ecologia 2005d	Onshore & Biologic 2010
Frogs																			
Cyclorana australis	Giant Frog														x				
Cyclorana maini	Sheep Frog				x					x				✓	x		✓	✓	x
Litoria rubella	Little Red Tree Frog, Desert Tree Frog				x					x				✓	✓	✓	✓	✓	x
Limnodynastes spenceri	Spencer's Frog									x				✓	x		✓	✓	
Notaden nichollsi	Desert Spadefoot				x														
Uperoleia glandulosa	Glandular Toadlet																✓	✓	
Reptiles																			
Amphibolurus longirostris	Long-nosed Water Dragon									x				✓	x	x	✓	✓	✓
Ctenophorus caudicinctus	Ring-tailed Dragon				x					x				✓	✓	✓	✓	✓	✓
Ctenophorus isolepis	Crested Dragon				x					x				✓			✓	✓	✓
Ctenophorus nuchalis	Central Netted Dragon				x					x				x			✓	✓	✓
Diporiphora winneckei	Blue-lined Dragon				x					x							✓		x
Moloch horridus	Thorny Devil													x					
Pogona minor mitchelli	Dwarf Bearded Dragon									x				x	✓	x	✓	✓	✓
Tympanocryptis cephalus	Pebble Dragon													x					
Aspidites melanocephalus	Black-headed Python													x					
Aspidites ramsayi	Woma													x					
Antaresia perthensis	Pygmy Python				x					x				x	x	✓	✓	✓	x
Antaresia stimsoni	Stimson's Python				x					x				x	x	x	✓	✓	
Liasis olivaceus barroni	Pilbara Olive Python	NE	VU	S1	x					x				x	x	✓	✓	✓	x
Chelodina steindachneri	Flat-shelled Turtle														x		✓	✓	

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Acanthophis pyrrhus	Desert Death Adder									x				x	x	x	✓	✓	
Acanthophis wellsi	Pilbara Death Adder														x	x			
Brachyurophis approximans	Shovel-nosed Snake				x					x					x	x	✓		
Demansia psammophis	Yellow-faced Whipsnake				x					x				✓	x	x	✓		
Demansia rufescens	Rufous Whipsnake				x					x				x	x	x	✓		
Furina ornata	Moon Snake				x					x				✓	x	x	✓		x
Pseudechis australis	Mulga Snake				x					x				✓	✓	x	✓	✓	
Pseudonaja modesta	Ringed Brown Snake				x					x				x	x	x	✓		
Pseudonaja mengdeni	Gwardar				x					x				x	x	x	✓	✓	
Suta fasciata	Rosen's Snake				x					x				x	✓	✓			
Suta punctata	Spotted Snake				x									x	x	x			
Simoselaps anomalus	Desert Banded Snake				x					x				x		x	✓		
Vermicella snelli	Bandy-bandy													x	x	x			
Crenadactylus ocellatus horni	Clawless Gecko				x					x				x	x	x	✓	✓	x
Diplodactylus conspicillatus	Fat-tailed Gecko				x					x				✓	x	x	✓	✓	x
Diplodactylus savagei	Gecko				x					x				x	✓	✓	✓	✓	
Lucasium stenodactylum	Sand Plain Gecko									x				x	x	x	✓	✓	
Lucasium wombeyi	Gecko									x					x	✓	✓	✓	x
Gehyra pilbara	Pilbara Dtella				x									x					
Gehyra punctata	Spotted Dtella				x					x				✓	✓	✓	✓	✓	✓
Gehyra purpurascens	Dtella				x					x				✓	x	x	✓	✓	x
Gehyra variegata	Variegated Dtella				x					x				x	✓	x	✓	✓	x

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Heteronotia binoei	Bynoe's Gecko				x					x				✓	x	x	✓	✓	
Heteronotia spelea	Desert Cave Gecko				x					x				✓	x	✓	✓	✓	x
Rhynchoedura ornata	Beaked Gecko				x					x				x	x	x	✓	✓	x
Strophurus ciliaris aberrans	Spiny-tailed Gecko				x					x				x	x	x	✓	✓	
Strophurus elderi	Jewelled Gecko				x									x	x	x			
Nephrurus levis	Knob-tailed Gecko				x					x				x	x	x	✓	✓	
Oedura marmorata	Marbled Velvet Gecko				x									x	x	x			x
Delma borea	Legless Lizard													x					
Delma elegans	Legless Lizard				x					x				x	✓	x	✓	✓	
Delma haroldi	Legless Lizard				x									x	x				x
Delma nasuta	Legless Lizard				x					x				x	✓	x			x
Delma pax	Legless Lizard				x					x				x	✓	x	✓	✓	
Delma tincta	Legless Lizard				x					x				x	x	x	✓	✓	x
Lialis burtonis	Burton's Legless Lizard									x				✓		x	✓	✓	
Pygopus nigriceps	Hooded Scaly-foot				x									x					
Carlia munda	Rainbow Skink				x					x				✓	✓	✓	✓	✓	x
Carlia triacantha	Keeled Rainbow Skink				x					x				x	x	x	✓	✓	
Cryptoblepharus carnabyi ^	Snake-eyed Skink													xx					
Cryptoblepharus plagiocephalus	Snake-eyed Skink									x				✓	✓	✓	✓	✓	
Cryptoblepharus ustulatus	Russet Snake-eyed Skink				x														
Ctenotus grandis	Titan Skink													x					
Ctenotus hanloni	Striped Skink				x														x

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Ctenotus helenae	Striped Skink				x					x				x			✓	✓	
Ctenotus pantherinus	Leopard Ctenotus				x					x				✓	x	x	✓	✓	x
Ctenotus piankai	Striped Skink									x				x	x	x	✓	✓	x
Ctenotus quattuordecimlineatus	Striped Skink				x									x					x
Ctenotus rubicundus	Ruddy Rock Skink				x					x				x	x	x	✓	✓	
Ctenotus rutilans	Golden Red Skink				x					x					x	✓			
Ctenotus saxatilis	Rock Ctenotus				x					x				✓	✓	✓	✓	✓	x
Ctenotus schomburgkii	Striped Skink				x														x
Cyclodomorphus melanops	Slender Blue-tongue				x					x				✓	✓		✓		x
Egernia cygnitos	Pygmy Spiny-tailed Skink				x					x				✓	✓		✓	✓	✓
Eremiascincus fasciolatus	Narrow-banded Sand Swimmer				x									x					
Eremiascincus richardsonii	Broad-banded Sand Swimmer				x									x	x	x			x
Eremiascincus musivus	Banded Sand-swimmer									x							✓		
Lerista bipes	Burrowing Skink				x					x				✓	x	x	✓	✓	x
Lerista zietzi	Burrowing Skink													x					
Lerista jacksoni	Burrowing Skink				x														x
Lerista muelleri	Burrowing Skink									x				x	✓	✓	✓	✓	
Lerista vermicularis	Burrowing Skink									x				✓			✓	✓	
Lerista verhmens	Burrowing Skink				x														
Liopholis kintorei	Great Desert Skink	VU	VU	S1	x	x													x
Liopholis striata	Night Skink				x									x					x
Menetia greyii	Dwarf Skink									x				x	x	x	✓	✓	

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Menetia surda surda	Dwarf Skink									x				x	✓	x			
Morethia ruficauda subsp. *ruficauda*	Fire-tailed Skink									x				✓			✓	✓	✓
Morethia ruficauda	Fire-tailed Skink				x										x	x			x
Notoscincus ornatus ornatus	Skink				x														x
Proablepharus reginae	Skink				x										x	x			
Tiliqua multifasciata	Central Blue-Tongued Lizard													x	x	x			
Ramphotyphlops ammodytes	Blind Snake				x										x	x			x
Ramphotyphlops ganei	Blind Snake			P1	x											x	x	x	
Ramphotyphlops grypus	Blind Snake				x					x				✓	x	✓	✓		x
Ramphotyphlops hamatus	Blind Snake													x					
Ramphotyphlops pilbarensis	Blind Snake				x										x				
Varanus acanthurus	Spiny-tailed Monitor				x					x				x	x	✓	✓	✓	
Varanus brevicauda	Short-tailed Monitor													x					
Varanus caudolineatus	Stripe-tailed Monitor									x					x	x	✓		
Varanus eremius	Pygmy Desert Monitor				x					x				x			✓		✓
Varanus giganteus	Perentie				x					x				x	x	✓	✓	✓	✓
Varanus gouldii	Bungarra, Sand Monitor				x					x				x	x	x	✓		x
Varanus panoptes	Yellow-spotted Monitor									x				✓		x	✓		x
Varanus pilbarensis	Pilbara Rock Monitor									x				✓	✓	✓	✓		
Varanus tristis	Black-tailed Monitor				x					x				x	x	x	✓	✓	
Birds																			
Smicrornis brevirostris	Weebill				x									✓					

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Haliastur sphenurus	Whistling Kite				x				x	x				✓	x	✓	✓	✓	✓
Hamirostra melanosternon	Black-breasted Buzzard													✓					✓
Accipiter cirrocephalus	Collared Sparrowhawk									x				✓	x	✓			
Accipiter fasciatus	Brown Goshawk				x					x				✓	x	✓	✓	✓	x
Aquila audax	Wedge-tailed Eagle				x					x				✓	✓	✓	✓		✓
Aquila morphnoides	Little Eagle				x				x	x				✓	✓	✓	✓	✓	x
Elanus caeruleus subsp. *axillaris*	Black-shouldered Kite									x				✓	x	x	✓		x
Circus assimilis	Spotted Harrier				x					x				✓	x	✓	✓	✓	x
Lophoictinia isura	Square-tailed Kite									x				✓	✓	✓			
Milvus migrans	Black Kite				x				x					✓					
Pandion haliaetus	Osprey									x							✓	✓	
Aegotheles cristatus	Australian Owlet-nightjar				x					x				✓	x	x	✓		
Mirafra javanica	Horsfield's Bushlark, Singing Bushlark				x					x				✓			✓	✓	
Anas gracilis	Grey Teal				x				x	x				✓			✓	✓	x
Anas superciliosa	Pacific Black Duck				x				x	x				✓			✓	✓	x
Aythya australis	Hardhead				x					x							✓	✓	x
Cygnus atratus	Black Swan				x				x										
Malacorhynchus membranaceus	Pink-eared Duck				x				x					✓					x
Anhinga melanogaster	Darter								x					✓					x
Apus pacificus	Fork-tailed Swift	LC	M	S3	x	x				x				x			✓	✓	x
Ardea alba	Great Egret		M		x	x				x				x			✓	✓	
Ardea ibis	Cattle Egret		M	S3	x	x				x									

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Ardea modesta	Eastern Great Egret		M	S3	x					x									x
Ardea pacifica	White-necked Heron				x				x					✓			✓	✓	x
Ardea novaehollandiae	White-faced Heron								x	x				✓			✓	✓	
Nycticorax caledonicus	Nankeen Night Heron				x														x
Artamus cinereus	Black-faced Woodswallow				x				x	x				✓	✓	✓	✓	✓	x
Artamus cyanopterus	Dusky Woodswallow																		
Artamus leucorynchus	White-breasted Woodswallow				x														
Artamus minor	Little Woodswallow				x					x				✓	✓	✓	✓	✓	x
Artamus personatus	Masked Woodswallow				x					x				✓	✓				
Cracticus nigrogularis	Pied Butcherbird				x				x	x				✓	✓	✓	✓	✓	
Cracticus tibicen	Australian Magpie				x					x				✓	✓				x
Burhinus grallarius	Bush Stone-curlew	LC		P4	x		x			x				x			✓		x
Cacatua roseicapilla	Galah				x				x	x				✓	x	✓	✓	✓	✓
Cacatua sanguinea	Little Corella				x				x	x				✓	✓	✓	✓	✓	x
Coracina novaehollandiae	Black-faced Cuckoo-shrike				x				x	x				✓	✓	✓	✓	✓	✓
Lalage tricolor	White-winged Triller									x				✓	✓	✓	✓	✓	x
Eurostopodus argus	Spotted Nightjar				x				x	x				✓	✓	x	✓	✓	x
Dromaius novaehollandiae	Emu													✓					
Centropus phasianinus	Pheasant Coucal				x					x							✓	✓	
Climacteris melanura	Black-tailed Treecreeper				x									✓					x
Charadrius ruficapillus	Red-capped Plover									x							✓		
Charadrius veredus	Oriental Plover	LC	M	S3	x	x				x									x

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Charadrius melanops	Black-fronted Dotterel								x	x				✓			✓	✓	x
Erythrogonys cinctus	Red-kneed Dotterel									x							✓	✓	
Ephippiorhynchus asiaticus	Black-necked Stork				x				x	x							✓	✓	
Nymphicus hollandicus	Cockatiel				x				x	x				✓	✓	✓			
Ocyphaps lophotes	Crested Pigeon				x					x				✓	x	x	✓	✓	✓
Geopelia cuneata	Diamond Dove				x				x	x				✓	✓	✓	✓	✓	✓
Geopelia striata	Peaceful Dove				x				x	x				✓			✓	✓	x
Geophaps plumifera	Spinifex Pigeon				x				x	x				✓	✓	✓	✓	✓	✓
Phaps chalcoptera	Common Bronzewing									x				✓	✓	x	✓		
Corvus bennetti	Little Crow									x				✓	✓				
Corvus orru	Torresian Crow				x				x	x				✓	✓	✓	✓	✓	✓
Cracticus torquatus	Grey Butcherbird				x									✓					x
Cuculus pallidus	Pallid Cuckoo								x	x				✓	x				x
Chrysococcyx basalis	Horsfield's Bronze-cuckoo									x				✓	x	✓	✓	✓	x
Chrysococcyx osculans	Black-eared Cuckoo													✓					
Dicaeum hirundinaceum	Mistletoebird				x					x				✓	✓	x	✓		
Emblema pictum	Painted Finch				x				x	x				✓	✓	✓	✓	✓	✓
Heteromunia pectoralis	Pictorella Mannikin	LC		P4	x					x					x	x	✓	✓	
Neochmia ruficauda subclarescens	Star Finch	LC		P4	x					x				✓	x	x	✓	✓	
Taeniopygia guttata	Zebra Finch				x				x	x				✓	✓	✓	✓	✓	✓
Falco berigora	Brown Falcon				x					x				✓	x	✓	✓	✓	x
Falco cenchroides	Australian, Nankeen Kestrel				x				x	x				✓	✓	✓	✓	✓	✓

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Falco hypoleucos	Grey Falcon	VU		P4	x		x			x				x	x	x		x	
Falco longipennis	Australian Hobby				x					x				✓	x	✓	✓	✓	x
Falco peregrinus	Peregrine Falcon	LC		S4	x					x				x	x	✓			
Glareola maldivarum	Oriental Pratincole	LC	M	S3	x	x				x									x
Stiltia isabella	Australian Pratincole													✓					
Dacelo leachii	Blue-winged Kookaburra				x				x	x				✓			✓	✓	
Todiramphus pyrrhopygia	Red-backed Kingfisher				x				x	x				✓	x	x	✓	✓	x
Todiramphus sanctus	Sacred Kingfisher				x				x	x				✓			✓	✓	x
Hirundo ariel	Fairy Martin									x				✓	x	✓	✓	✓	x
Hirundo neoxena	Welcome Swallow				x									✓					
Hirundo nigricans	Tree Martin								x	x				✓	x	x	✓		
Hirundo rustica	Barn Swallow	LC	M	S3	x	x													x
Cincloramphus cruralis	Brown Songlark				x				x	x				✓	✓		✓		x
Cincloramphus mathewsi	Rufous Songlark				x					x				✓	x	✓	✓	✓	x
Eremiornis carteri	Spinifex-bird				x					x				✓	✓	x	✓		x
Amytornis striatus	Striated Grasswren				x					x				✓	✓	✓	✓		x
Malurus lamberti	Variegated Fairy-wren				x				x	x				✓	✓	x	✓	✓	✓
Malurus leucopterus	White-winged Fairy-wren				x				x	x				✓	x	x	✓		✓
Malurus splendens	Splendid Fairy-wren																		
Certhionyx niger	Black Honeyeater																		x
Certhionyx variegatus	Pied Honeyeater				x									✓					x
Epthianura tricolor	Crimson Chat									x					✓	✓			

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Lichenostomus keartlandi	Grey-headed Honeyeater				x				x	x				✓	✓	✓	✓	✓	x
Lichenostomus ornatus	Yellow-plumed Honeyeater									x							✓		
Lichenostomus penicillatus	White-plumed Honeyeater				x				x	x				✓			✓	✓	✓
Lichenostomus plumulus	Grey-fronted Honeyeater									x				✓	x	✓	✓		
Lichenostomus virescens	Singing Honeyeater				x				x	x				✓	x	x	✓	✓	x
Lichmera indistincta	Brown Honeyeater				x					x				✓	✓	✓	✓	✓	x
Manorina flavigula	Yellow-throated Miner				x				x	x				✓	✓	✓	✓	✓	✓
Melithreptus gularis	Black-chinned Honeyeater									x				✓	✓	x	✓	✓	
Phylidonyris albifrons	White-fronted Honeyeater									x				✓	✓				
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				x									✓					✓
Merops ornatus	Rainbow Bee-eater	LC	M	S3	x	x			x	x				✓	✓	✓		✓	✓
Myiagra inquieta	Restless Flycatcher				x														
Grallina cyanoleuca	Magpie-lark				x				x	x				✓	✓		✓	✓	✓
Anthus australis subsp. australis	Australasian Pipit				x				x	x				✓	✓	✓	✓	✓	x
Daphoenositta chrysoptera	Varied Sittella													✓					
Ardeotis australis	Australian Bustard	LC		P4	x		x			x				x	x	✓	✓	✓	✓
Colluricincla harmonica	Grey Shrike-thrush				x				x	x				✓	✓	✓	✓		x
Oreoica gutturalis	Crested Bellbird													✓					x
Pachycephala rufiventris	Rufous Whistler				x					x				✓	✓	✓	✓		x
Gerygone fusca	Western Gerygone				x									✓					x
Pardalotus rubricatus	Red-browed Pardalote				x				x	x				✓	✓		✓	✓	x
Pardalotus striatus	Striated Pardalote				x					x				✓	✓		✓		

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Pelecanus conspicillatus	Australian Pelican				x				x	x							✓	✓	x
Petroica goodenovii	Red-capped Robin				x									✓					
Melanodryas cucullata	Hooded Robin													✓					
Phalacrocorax carbo	Great Cormorant				x				x										
Phalacrocorax melanoleucos	Little Pied Cormorant								x	x				✓			✓	✓	x
Phalacrocorax sulcirostris	Little Black Cormorant				x				x	x							✓		x
Coturnix ypsilophora	Brown Quail				x					x				✓			✓	✓	x
Podargus strigoides	Tawny Frogmouth				x									✓					x
Pomatostomus temporalis	Grey-crowned Babbler				x					x				✓	x	x	✓	✓	x
Barnardius zonarius	Australian Ringneck									x				✓	x	x	✓		x
Melopsittacus undulatus	Budgerigar				x									✓					x
Chlamydera guttata	Western, Spotted Bowerbird									x				✓	✓	x	✓	✓	x
Fulica atra	Eurasian Coot				x														x
Porzana fluminea	Spotted Crake									x							✓		
Rhipidura fuliginosa	Grey Fantail													✓					
Rhipidura leucophrys	Willie Wagtail				x				x	x				✓	✓	✓	✓		x
Calidris acuminata	Sharp-tailed Sandpiper				x														
Gallinago megala	Swinhoe's Snipe				x														x
Gallinago philippensis	Buff-banded Rail									x							✓		
Gallinago sp	Snipe				x					x							✓	✓	
Gallinago stenura	Pin-tailed Snipe				x														
Numenius madagascariensis	Eastern Curlew	VU	M	S3	x					x									

SPECIES NAME	COMMON NAME	IUCN RED LIST	EPBC ACT	WC ACT/ DEC	Nature Map	EPBC Act Protected Matters	DEC database	IUCN Red list	Birdata	Outback Ecology Services 2008	Specialised Zoological 2011a	Specialised Zoological 2011b	Specialised Zoological 2012	Ecologia 1999	Ecologia 2005a	Ecologia 2005b	Ecologia 2005c	Ecologia 2005d	Onshore & Biologic 2010
Tringa glareola	Wood Sandpiper	LC	M	S3	x					x							✓	✓	
Tringa hypoleucos	Common Sandpiper	LC	M	S3	x					x							✓	✓	
Tringa nebularia	Common Greenshank	LC	M	S3	x					x							✓	✓	
Tringa stagnatilis	Marsh Sandpiper	LC	M	S3	x					x							✓	✓	
Ninox connivens	Barking Owl				x				x					✓					
Ninox novaeseelandiae	Boobook Owl				x					x				✓	✓	✓	✓	✓	x
Platalea flavipes	Yellow-billed Spoonbill									x							✓		
Platalea regia	Royal Spoonbill									x							✓	✓	
Plegadis falcinellus	Glossy ibis	LC	M	S3	x					x				x			✓	✓	
Threskiornis spinicollis	Straw-necked Ibis				x					x							✓		x
Turnix velox	Little Button-quail				x					x				✓			✓		✓
Tyto alba	Barn Owl								x					✓					
Mammals																			
Dasycercus blythi	Brush-tailed Mulgara	LC		P4	x		x												x
Dasycercus cristicauda	Crest-tailed Mulgara	LC	VU	S1	x	x	x			x				x			✓	✓	x
Dasykaluta rosamondae	Little Red Kaluta				x					x				✓			✓		
Dasyurus hallucatus	Northern Quoll	EN	EN	S1	x	x	x			x				✓	✓	x	✓		✓
Macrotis lagotis	Greater Bilby	VU	VU	S1	x	x		x						x					x
Ningaui timealeyi	Pilbara Ningaui				x					x				✓	x	x	✓		x
Planigale ingrami	Long-tailed Planigale				x														
Planigale maculata	Common Planigale													✓					
Planigale sp.										x					✓	✓	✓		

SPECIES NAME	COMMON NAME	IUCN RED LIST	EPBC ACT	WC ACT/ DEC	Nature Map	EPBC Act Protected Matters	DEC database	IUCN Red list	Birdata	Outback Ecology Services 2008	Specialised Zoological 2011a	Specialised Zoological 2011b	Specialised Zoological 2012	Ecologia 1999	Ecologia 2005a	Ecologia 2005b	Ecologia 2005c	Ecologia 2005d	Onshore & Biologic 2010
Pseudantechinus roryi	Rory's Pseudantechinus				x										x	x			
Pseudantechinus woolleyae	Woolley's Pseudantechinus				x									✓					
Sminthopsis macroura	Stripe-faced Dunnart				x					x				✓			✓		
Sminthopsis ooldea	Ooldea Dunnart													✓					
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart				x					x				✓			✓		x
Sminthopsis longicaudata	Long-tailed Dunnart	LC		P4	x					x				x	x	x	x	x	
Saccolaimus flaviventris	Yellow-bellied Sheath Bat									x				✓	x	x	✓		✓
Taphozous georgianus	Common Sheathtail-bat				x					x				✓	x	✓	✓	✓	✓
Taphozous hilli	Hill's Sheathtail-bat				x					x				✓	x	x	✓		
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat	LC	VU	S1	x	x	x			x	✓	✓		x	✓	✓	✓	✓	x
Macropus robustus erubescens	Euro				x					x				✓	✓	✓	✓	✓	✓
Macropus rufus	Red Kangaroo				x					x				✓	✓	x	✓	✓	✓
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby	LC		P3	x												x		x
Petrogale lateralis	Black-footed Rock-wallaby	NT	VU	S1	x									x	x	x			
Petrogale rothschildi	Rothschild's Rock-wallaby									x					✓	✓	✓		
Macroderma gigas	Ghost Bat	VU		P4	x		x	x		x	✓	✓		x	✓	✓	x	✓	x
Chaerephon jobensis	Northern Freetail-bat									x				✓	x	x	✓	✓	
Chalinolobus gouldii	Gould's Wattled Bat									x				✓	x	x	✓	✓	✓
Tadarida australis	White-striped Freetail-bat													✓	x	x			
Mormopterus beccarii	Beccari's Freetail-bat													✓					
Leggadina lakedownensis	Lakeland Downs Mouse	LC		P4	x		x			x				x			✓		x
*Mus musculus**	House Mouse									x				✓	x	x	✓	✓	

SPECIES NAME	COMMON NAME	IUCN RED LIST	EPBC ACT	WC ACT/ DEC	Nature Map	EPBC Act Protected Matters	DEC database	IUCN Red list	Birdata	Outback Ecology Services 2008	Specialised Zoological 2011a	Specialised Zoological 2011b	Specialised Zoological 2012	Ecologia 1999	Ecologia 2005a	Ecologia 2005b	Ecologia 2005c	Ecologia 2005d	Onshore & Biologic 2010
Notomys alexis	Spinifex Hopping Mouse													✓					
Pseudomys chapmani	Western Pebble-mound Mouse	LC		P4	x		x			x				✓	x	✓	✓		✓
Pseudomys delicatulus	Delicate Mouse	LC			x					x				✓			✓		x
Pseudomys desertor	Desert Mouse	LC			x					x				✓			✓	✓	x
Pseudomys hermannsburgensi	Sandy Inland Mouse				x					x				✓			✓	✓	x
Zyzomys argurus	Common Rock-rat				x					x				✓	✓	✓	✓		x
Pteropus scapulatus	Little Red Flying-fox													✓					
Tachyglossus aculeatus	Echidna				x					x				✓	x	x	✓		
Vespadelus baverstocki	Inland Forest Bat									x					x	x	✓		
Vespadelus finlaysoni	Finlayson's Cave Bat				x					x				✓	x	✓	✓	✓	✓
Scotorepens balstoni	Inland Broad-nosed Bat													✓		✓			
Scotorepens greyii	Little Broad-nosed Bat									x				✓	x	✓	✓		✓
Nyctophilus bifax	Eastern Long-eared Bat													✓					
Nyctophilus geoffroyi	Lesser Long-eared Bat									x				✓	x	✓	✓	✓	
*Bos taurus**	Cow									x				✓	✓	x	✓		✓
*Camelus dromedarius**	Camel													✓					✓
Canis lupus subsp. *dingo*	Dingo									x				✓	✓	✓	✓		✓
*Equus asinus**	Donkey													✓					
*Felis catus**	Cat				x	x				x				✓	✓	x	✓		✓
*Oryctolagus cuniculus**	Rabbit													✓					
*Sus scrofa**	Pig					x													
*Vulpes vulpes**	Fox					x								✓					

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EPBC Act = Environmental Protection and Biodiversity Conservation Act 1999.
IUCN = International Union for Conservation of Nature and Natural Resources.
DEC= Department of Environment and Conservation.

CE = species listed as 'critically endangered' under the IUCN Red List, EPBC Act or WC Act
EN = species listed as 'endangered' under either the IUCN red List, EPBC Act or WC Act
VU = species listed as 'vulnerable' under either the IUCN Red List, EPBC Act or WC Act
LC = species listed as 'least concern' on the IUCN Red List
DD = species listed as 'data deficient' on the IUCN Red List
NE = 'Not Evaluated'. Species has not yet been evaluated by the IUCN Red List
M = species listed as 'migratory' under the EPBC Act
S1 = fauna that is rare or is likely to become extinct under the WC Act
S3= migratory birds protected under an international agreemtn under the WC Act
S4 = fauna listed as 'other specially protected fauna' under the WC Act
P1 = Taxa with few, poorly known populations on threatened lands
P2 = Taxa with few, poorly known populations on conservation lands
P3 = Taxa with several, poorly known populations, some on conservation lands
P4 = Taxa in need of monitoring
P5= Taxa in need of monitoring

^ = this species name is no longer current. This species has been split up into several other species.
# = *Ctenotus pantherinus* subsp. *ocellifer* has been merged with *C. pantherinus*
* = Introduced species
✓ = recorded during survey
x= not recorded during survey but noted within desktop review of this report

- Outback Ecology 2008: Goldsworthy Iron Ore Mining Operations – Cundaline and Callawa Mining Operations Targeted Fauna Assessment (Outback Ecology 2008);
- Specialized Zoological 2011a: Update report for Goldsworthy quarterly bat monitoring: July 2011 (Specialized Zoological 2011a);
- Specialized Zoological 2011b: Goldsworthy bat monitoring: July 2010 – April 2011 (Specialized Zoological 2011b);
- Specialized Zoological 2012: Update report for Goldsworthy quarterly bat monitoring: October 2011 (Specialized Zoological 2012);
- Onshore & Biologic 2010: Shay Gap Aerodrome, Yarrie Area A and Yarrie Area B – Level 2 Flora and Vegetation Survey and Level 1 Fauna Survey (Onshore Environmental 2010);
- *ecologia* 1999: Yarrie Biological and Soil Survey (*ecologia* 1999);
- *ecologia* 2005a: Callawa Biological Assessment Survey (*ecologia* 2005a);
- *ecologia* 2005b: Cundaline Biological Assessment Survey (*ecologia* 2005b);
- *ecologia* 2005c: Goldsworthy Extension Project Biological Assessment Survey (*ecologia* 2005c); and
- *ecologia* 2005d: Goldsworthy Extension Project Cattle Gorge Haul Road Biological Assessment Survey (*ecologia* 2005d).

Appendix F: Fauna species list

SPECIES NAME	COMMON NAME	IUCN RED LIST STATUS	EPBC ACT STATUS	WC ACT / DEC STATUS	ELA 2012 SURVEY	*ecologia* 2005a SURVEY	BROAD HABITAT TYPE
Frogs							
Litoria rubella	Little Red Tree Frog, Desert Tree Frog				✓	✓	1
Reptiles							
Amphibolurus longirostris	Long-snouted Water Dragon				✓		1
Aspidites melanocephalus	Black-headed Python				✓		3
Carlia munda	Rainbow Skink				✓	✓	1, 3, 4
Carlia triacantha	Keeled Rainbow Skink				✓		4, 5
Cryptoblepharus plagiocephalus	Snake-eyed Skink					✓	
Cryptoblepharus ustulatus	Russet Snake-eyed Skink				✓		5
Ctenophorus caudicinctus subsp. *caudicinctus*	Ring-tailed Dragon				✓	✓	3, 5
Ctenophorus isolepis subsp. *isolepis*	Military Dragon				✓		1, 2, 3
Ctenotus pantherinus	Leopard Ctenotus				✓		2
Ctenotus piankai	Striped Skink				✓		2
Ctenotus rutilans	Golden red Skink					✓	
Ctenotus saxatilis	Rock Ctenotus				✓	✓	1, 2, 3, 4, 5
Cyclodomorphus melanops subsp. *melanops*	Slender Blue-tongue				✓	✓	1, 3
Delma elegans	Legless Lizard					✓	
Delma nasuta	Legless Lizard				✓	✓	5
Delma pax	Legless Lizard				✓	✓	1
Demansia psammophis	Yellow-faced Whipsnake				✓		4
Diplodactylus savagei	Gecko				✓	✓	1, 3
Egernia cygnitos	Pygmy Spiny-tailed Skink					✓	
Gehyra punctata	Spotted Dtella					✓	
Gehyra sp.	Dtella				✓		4
Gehyra variegata	Variegated Dtella				✓	✓	1
Heteronotia binoei	Bynoe's Gecko				✓		2
Heteronotia spelea	Desert Cave Gecko				✓		4
Lerista bipes	Burrowing Skink				✓		1, 2
Lerista muelleri	Burrowing Skink					✓	
Lialis burtonis	Burton's Legless Lizard				✓		1
Lucasium stenodactylum (prev. *Diplodactylus stenodactylus*)	Sand Plain Gecko				✓		2
Menetia greyii	Dwarf Skink				✓		1, 2
Menetia surda subsp. *surda*	Dwarf Skink				✓	✓	1
Morethia ruficauda	Fire-tailed Skink				✓		2
Pogona minor mitchelli	Dwarf Bearded Dragon					✓	
Pseudechis australis	Mulga Snake					✓	
Ramphotyphlops ammodytes	Blind Snake				✓		2
Suta fasciata	Rosen's Snake					✓	

SPECIES NAME	COMMON NAME	IUCN RED LIST STATUS	EPBC ACT STATUS	WC ACT / DEC STATUS	ELA 2012 SURVEY	*ecologia* 2005a SURVEY	BROAD HABITAT TYPE
Varanus giganteus	Perentie				✓		2
Varanus pilbarensis	Pilbara Rock Monitor					✓	
Birds							
Accipiter fasciatus	Brown Goshawk				✓		2
Amytornis striatus	Striated Grasswren				✓	✓	
Anas superciliosa	Pacific Black Duck				✓		1
Anthus australis subsp. *australis*	Australasian Pipit				✓	✓	2
Aquila audax	Wedge-tailed Eagle				✓	✓	3
Aquila morphnoides	Little Eagle					✓	
Ardea novaehollandiae	White-faced Heron				✓		1
Ardea pacifica	White-necked Heron				✓		1
Ardeotis australis	Australian Bustard	LC		P4	✓		1
Artamus cinereus	Black-faced Woodswallow				✓	✓	2
Artamus minor	Little Woodswallow					✓	
Artamus personatus	Masked Woodswallow					✓	
Burhinus grallarius	Bush Stone-curlew	LC		P4	✓		1, 2
Cacatua roseicapilla	Galah				✓		2
Cacatua sanguinea	Little Corella				✓	✓	1
Certhionyx niger	Black Honeyeater				✓		1, 2, 3, 4, 5
Charadrius melanops	Black-fronted Dotterel				✓		1
Chlamydera guttata	Western Bowerbird					✓	
Cincloramphus cruralis	Brown Songlark					✓	
Cincloramphus mathewsi	Rufous Songlark				✓		2
Circus approximans	Swamp Harrier				✓		1
Circus assimilis	Spotted Harrier					✓	
Colluricincla harmonica	Grey Shrike-thrush				✓	✓	4, 5
Coracina novaehollandiae	Black-faced Cuckoo-shrike				✓	✓	1, 2, 3
Corvus bennetti	Little Crow					✓	
Corvus orru	Torresian Crow				✓	✓	1, 2, 3, 5
Coturnix pectoralis	Stubble Quail				✓		1
Cracticus nigrogularis	Pied Butcherbird				✓	✓	1, 2, 3, 4
Cracticus tibicen	Australian Magpie					✓	
Cuculus pallidus	Pallid Cuckoo				✓		2
Dacelo leachii	Blue-winged Kookaburra				✓		1
Dicaeum hirundinaceum	Mistletoebird					✓	
Elanus caeruleus subsp. *axillaris*	Black-shouldered Kite				✓		2
Emblema pictum	Painted Finch				✓	✓	5
Ephippiorhynchus asiaticus	Black-necked Stork				✓		1
Epthianura tricolor	Crimson Chat					✓	
Eremiornis carteri	Spinifex-bird				✓	✓	2

SPECIES NAME	COMMON NAME	IUCN RED LIST STATUS	EPBC ACT STATUS	WC ACT / DEC STATUS	ELA 2012 SURVEY	*ecologia* 2005a SURVEY	BROAD HABITAT TYPE
Eurostopodus argus	Spotted Nightjar					✓	
Falco berigora	Brown Falcon				✓		3
Falco cenchroides	Australian, Nankeen Kestrel				✓	✓	2
Geopelia cuneata	Diamond Dove				✓	✓	1, 2
Geophaps plumifera	Spinifex Pigeon				✓	✓	1, 3
Grallina cyanoleuca	Magpie-lark				✓	✓	1
Hamirostra melanosternon	Black-breasted Buzzard				✓		1, 2
Lalage tricolor	White-winged Triller					✓	
Lichenostomus keartlandi	Grey-headed Honeyeater				✓	✓	5
Lichenostomus penicillatus	White-plumed Honeyeater				✓		2
Lichenostomus virescens	Singing Honeyeater				✓		1, 2, 3
Lichmera indistincta	Brown Honeyeater				✓	✓	1, 2, 3, 4, 5
Lophoictinia isura	Square-tailed Kite					✓	
Malurus lamberti	Variegated Fairy-wren					✓	
Malurus leucopterus	White-winged Fairy-wren				✓		1
Malurus splendens	Splendid Fairy-wren				✓		2
Manorina flavigula	Yellow-throated Miner				✓	✓	1, 3, 4
Melithreptus gularis	Black-chinned Honeyeater					✓	
Melopsittacus undulatus	Budgerigar				✓		1, 2, 5
Merops ornatus	Rainbow Bee-eater	LC	M	S3	✓	✓	1, 2, 3, 4, 5
Ninox novaeseelandiae	Boobook Owl				✓	✓	1
Nymphicus hollandicus	Cockatiel				✓	✓	1, 2, 3
Ocyphaps lophotes	Crested Pigeon				✓		1
Pachycephala rufiventris	Rufous Whistler					✓	
Pardalotus rubricatus	Red-browed Pardalote					✓	
Pardalotus striatus	Striated Pardalote					✓	
Phaps chalcoptera	Common Bronzewing					✓	
Phylidonyris albifrons	White-fronted Honeyeater					✓	
Rhipidura leucophrys	Willie Wagtail				✓	✓	2
Smicrornis brevirostris	Weebill				✓		4
Taeniopygia guttata	Zebra Finch				✓	✓	1, 2, 3
Todiramphus pyrrhopygia	Red-backed Kingfisher				✓		2
Todiramphus sanctus	Sacred Kingfisher				✓		1, 3
Turnix velox	Little Button-quail				✓		1, 2, 3, 4
Mammals							
Chalinolobus gouldii	Gould's Wattled Bat				✓	✓	2
Dasykaluta rosamondae	Little Red Kaluta				✓		2
Dasyurus hallucatus	Northern Quoll	EN	EN	S1	✓	✓	1, 2, 3, 4, 5
Macroderma gigas	Ghost Bat			P4		✓	

SPECIES NAME	COMMON NAME	IUCN RED LIST STATUS	EPBC ACT STATUS	WC ACT / DEC STATUS	ELA 2012 SURVEY	*ecologia* 2005a SURVEY	BROAD HABITAT TYPE
Macropus robustus subsp. *erubescens*	Euro				✓	✓	1, 2, 3
Macropus rufus	Red Kangaroo				✓	✓	2
Ningaui timealeyi	Pilbara Ningaui				✓		1, 4
Nyctophilus geoffroyi	Lesser Long-eared Bat					✓	
Petrogale rothschildi	Rothschild's Rock-wallaby				✓	✓	3, 4
Planigale ingrami	Long-tailed Planigale				✓		2
Planigale maculata	Common Planigale				✓		1
Planigale sp.						✓	
Pseudomys chapmani	Western Pebble-mound Mouse	LC		P4	✓^	✓^	2
Pseudomys desertor	Desert Mouse				✓		1, 2
Pseudomys hermannsburgensi	Sandy Inland Mouse				✓		1
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat				✓		1, 3
Scotorepens greyii	Little Broad-nosed Bat				✓		1, 2
Sminthopsis macroura	Stripe-faced Dunnart				✓		2
Taphozous georgianus	Common Sheathtail-bat				✓	✓	1, 3, 4, 5
Vespadelus finlaysoni	Finlayson's Cave Bat				✓	✓	4
Zyzomys argurus	Common Rock-rat				✓	✓	1, 3, 4, 5
*Bos taurus**	Cow				✓		1, 2
*Canis lupus**	Wild Dog				✓	✓	2, 4
*Felis catus**	Cat				✓		2

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EPBC Act = Environmental Protection and Biodiversity Conservation Act 1999.
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DEC= Department of Environment and Conservation.

EN = species listed as ‘endangered’ under either the IUCN red List, EPBC Act or WC Act
LC = species listed as 'least concern' on the IUCN Red List
S1 = fauna that is rare or is likely to become extinct under the WC Act
S3= migratory birds protected under an international agreemtn under the WC Act
M = species listed as ‘migratory’ under the EPBC Act.
P4 = Taxa in need of monitoring.
^ = inactive mounds found only
* = Introduced species

Appendix G: Significant fauna species locations

COMMON NAME	SCIENTIFIC NAME	DESCRIPTION OF RECORD	LATITUDE	LONGITUDE
Australian Bustard	*Ardeotis australis*	tracks	-20.621367	120.286752
Australian Bustard	*Ardeotis australis*	tracks	-20.629124	120.297477
Australian Bustard	*Ardeotis australis*	tracks	-20.623878	120.290356
Australian Bustard	*Ardeotis australis*	tracks	-20.631993	120.29877
Bush Stone-curlew	*Burhinus grallarius*	observed	-20.631888	120.307225
Bush Stone-curlew	*Burhinus grallarius*	tracks	-20.634223	120.28200
Northern Quoll	*Dasyurus hallucatus*	tracks	-20.629273	120.296091
Northern Quoll	*Dasyurus hallucatus*	scat	-20.642425	120.309388
Northern Quoll	*Dasyurus hallucatus*	scat	-20.642435	120.309681
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.633819	120.282805
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.632327	120.301364
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.631745	120.301328
Northern Quoll	*Dasyurus hallucatus*	tracks	-20.634223	120.282
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.62927	120.29733
Northern Quoll	*Dasyurus hallucatus*	tracks	-20.629284	120.296964
Northern Quoll	*Dasyurus hallucatus*	tracks	-20.629164	120.295954
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.632021	120.301213
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.63291	120.30137
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.64893	120.292059
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646599	120.295456
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.633113	120.301351
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648573	120.292558
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.64858	120.292364
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646811	120.295859
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.640516	120.310492
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.641126	120.3109

COMMON NAME	SCIENTIFIC NAME	DESCRIPTION OF RECORD	LATITUDE	LONGITUDE
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.640516	120.310492
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.632621	120.28614
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646599	120.295456
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646764	120.295722
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646811	120.295859
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648573	120.292558
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.64893	120.292059
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.632621	120.28614
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646462	120.295355
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646599	120.295456
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646811	120.295859
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646848	120.296442
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648017	120.292914
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648435	120.292723
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648573	120.292558
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.629341	120.296366
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.641126	120.3109
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.640516	120.310492
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.63234	120.306238
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646462	120.295355
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646811	120.295859
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.647781	120.292936
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648017	120.292914
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648435	120.292723
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648573	120.292558
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.641703	120.311549

COMMON NAME	SCIENTIFIC NAME	DESCRIPTION OF RECORD	LATITUDE	LONGITUDE
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.641126	120.3109
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.640516	120.310492
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.631978	120.28694
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.632621	120.28614
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.648573	120.292558
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.64858	120.292364
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.64893	120.292059
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646462	120.295355
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646811	120.295859
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646848	120.296442
Northern Quoll	*Dasyurus hallucatus*	trapped	-20.646462	120.295355
Northern Quoll	*Dasyurus hallucatus*	Motion camera	20.641619	120.289260
Northern Quoll	*Dasyurus hallucatus*	scat	-20.648421	120.301817
Northern Quoll	*Dasyurus hallucatus*	scat	-20.649515	120.299578
Northern Quoll	*Dasyurus hallucatus*	scat	-20.651734	120.298015
Northern Quoll	*Dasyurus hallucatus*	scat	-20.652365	120.297914
Northern Quoll	*Dasyurus hallucatus*	scat	-20.652912	120.296448
Northern Quoll	*Dasyurus hallucatus*	scat	-20.649448	120.300174
Northern Quoll	*Dasyurus hallucatus*	scat	-20.643097	120.298389
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.627495	120.310444
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.62258	120.309625
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.624632	120.308295
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.625702	120.308827

COMMON NAME	SCIENTIFIC NAME	DESCRIPTION OF RECORD	LATITUDE	LONGITUDE
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.626357	120.308899
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.630105	120.308649
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.624399	120.307713
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.62474	120.307858
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.630658	120.310278
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.629693	120.310271
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.626633	120.310116
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.624109	120.310186
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.638916	120.311614
Western Pebble-mound Mouse	*Pseudomys chapmani*	Observed inactive mound	-20.63894	120.316729
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.63243	120.292823
Rainbow Bee-eater	*Merops ornatus*	2 x observed, heard	-20.634134	120.282904
Rainbow Bee-eater	*Merops ornatus*	1 x heard	-20.632021	120.301213
Rainbow Bee-eater	*Merops ornatus*	1 x heard	-20.631983	120.301139
Rainbow Bee-eater	*Merops ornatus*	1 x heard	-20.629273	120.296091
Rainbow Bee-eater	*Merops ornatus*	1 x heard	-20.642446	120.309684
Rainbow Bee-eater	*Merops ornatus*	2 x observed, heard	-20.646462	120.295355
Rainbow Bee-eater	*Merops ornatus*	1 x heard	-20.640953	120.285793
Rainbow Bee-eater	*Merops ornatus*	1 x heard	-20.641503	120.31122

COMMON NAME	SCIENTIFIC NAME	DESCRIPTION OF RECORD	LATITUDE	LONGITUDE
Rainbow Bee-eater	*Merops ornatus*	2 x observed, heard	-20.64858	120.292364
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.645823	120.304532
Rainbow Bee-eater	*Merops ornatus*	1 x observed, heard	-20.64893	120.292059
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.632132	120.305681
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.642697	120.283636
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.633147	120.314742
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.63232	120.308808
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.630694	120.316621
Rainbow Bee-eater	*Merops ornatus*	1 x observed, heard	-20.641703	120.311549
Rainbow Bee-eater	*Merops ornatus*	1 x observed, heard	-20.646462	120.295355
Rainbow Bee-eater	*Merops ornatus*	heard	-20.64893	120.292059
Rainbow Bee-eater	*Merops ornatus*	1 x observed	-20.637412	120.309842
Rainbow Bee-eater	*Merops ornatus*	3 x observed, heard	-20.649076	120.301885

Appendix H: Anabat analysis report

Bat call identification from Callawa, WA

Type:	Acoustic analysis
Prepared for:	Eco Logical Australia Pty Ltd
Date:	6 July 2012
Job No.:	SZ281
Prepared by:	Kyle Armstrong and Yuki Konishi Specialised Zoological ABN 92 265 437 422 Tel 0404 423 264 kyle.n.armstrong@gmail.com http://www.szool.com.au

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SUMMARY

Bat identifications from Anabat echolocation call recordings are provided from the Callawa Gorge area, near Yarrie in the Pilbara region of Western Australia. Five species were identified as being present (**Table 1**).

Some calls of the yellow-bellied sheath-tailed bat *Saccolaimus flaviventris* are similar to those of the northern free-tailed bat *Chaerephon jobensis*. In all cases the calls appeared to be from *S. flaviventris.*

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 SD2 bat detector were supplied as downloaded sequences, which were examined in AnalookW 3.8s software. The frequency division ratio was set to a factor of 8 to maximise resolution of short duration, low amplitude broadband calls (e.g. those of the ghost bat *Macroderma gigas*). Identification to species was made from two sets of Anabat data: 1. the individual sequence files produced during interpretation by CFC Read software, which are organised into folders representing a single night's recording; and 2. the continuous representation of the Anabat recordings in ZCA and MAP files, which show all of the signals detected by the Anabat microphone but which have not been parsed into individual sequence files according to default interpretation parameters. Species were identified based on information in McKenzie and Bullen (2009). 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). The analytical methods are consistent with those recommended in State and Commonwealth guidelines (DEWHA 2010; DSEWPC 2011; Environmental Protection Authority and Department of Environment and Conservation 2010). Nomenclature follows Armstrong and Reardon (2006).

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McKenzie, N.L. and Bullen, R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. *Records of the Western Australian Museum* Supplement 78: 123–155.

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

Date	Recording duration available	*C. gouldii*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
Serial 82243						
17/05/2012	21:45 – 21:54	—	NC	□	□	□
19/05/2012	19:13 – 06:22	□	—	□	□	□
21/05/2012	18:48 – 18:53	—	—	—	—	—
22/05/2012	20:00 – 03:22	□	NC	—	□	□
23/05/2012	19:54 – 00:06	—	—	□	□	□
24/05/2012	20:04 – 05:05	—	—	—	□	□
25/05/2012	19:51 – 04:43	—	NC	—	□	□
26/05/2012	18:10 – 00:15	—	—	—	□	□
Serial 82413						
20/05/2012	17:00 – 18:58	—	—	—	□	□
22/05/2012	17:49 – 05:57	—	NC	—	□	□
25/05/2012	17:53 – 20:49	□	NC	□	□	□

Definition of confidence level codes:

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.

TABLE 2. Summary of variables from representative call sequences (Mean ± SD, range; [1] s,p: number of sequences measured, combined total number of pulses measured).

Species	s,p[1]	Duration (msec)	Max Frequency (kHz)	Char frequency (kHz)
Gould's wattled bat	3,16	6.8 ± 1.5	34.0 ± 1.1	30.8 ± 1.2
Chalinolobus gouldii		3.7 – 9.5	32.5 – 36.0	29.6 – 33.6
Yellow-bellied sheath-tailed bat	2,17	12.1 ± 2.4	19.8 ± 0.8	15.7 ± 0.7
Saccolaimus flaviventris		8.3 – 15.4	18.2 – 21.2	14.7 – 17.0
Little broad-nosed bat	2,23	5.7 ± 1.1	46.5 ± 6.5	36.4 ± 0.9
Scotorepens greyii		3.5 – 7.7	38.1 – 66.7	34.8 – 38.5
Common sheath-tailed bat	5,24	11.9 ± 2.4	26.7 ± 0.9	24.3 ± 0.3
Taphozous georgianus		7.4 – 16.3	24.7 – 28.2	23.7 – 25.0
Finlayson's cave bat	1,14	6.8 ± 0.9	60.5 ± 2.0	55.5 ± 0.5
Vespadelus finlaysoni		4.2 – 7.6	56.7 – 64.5	54.8 – 56.3

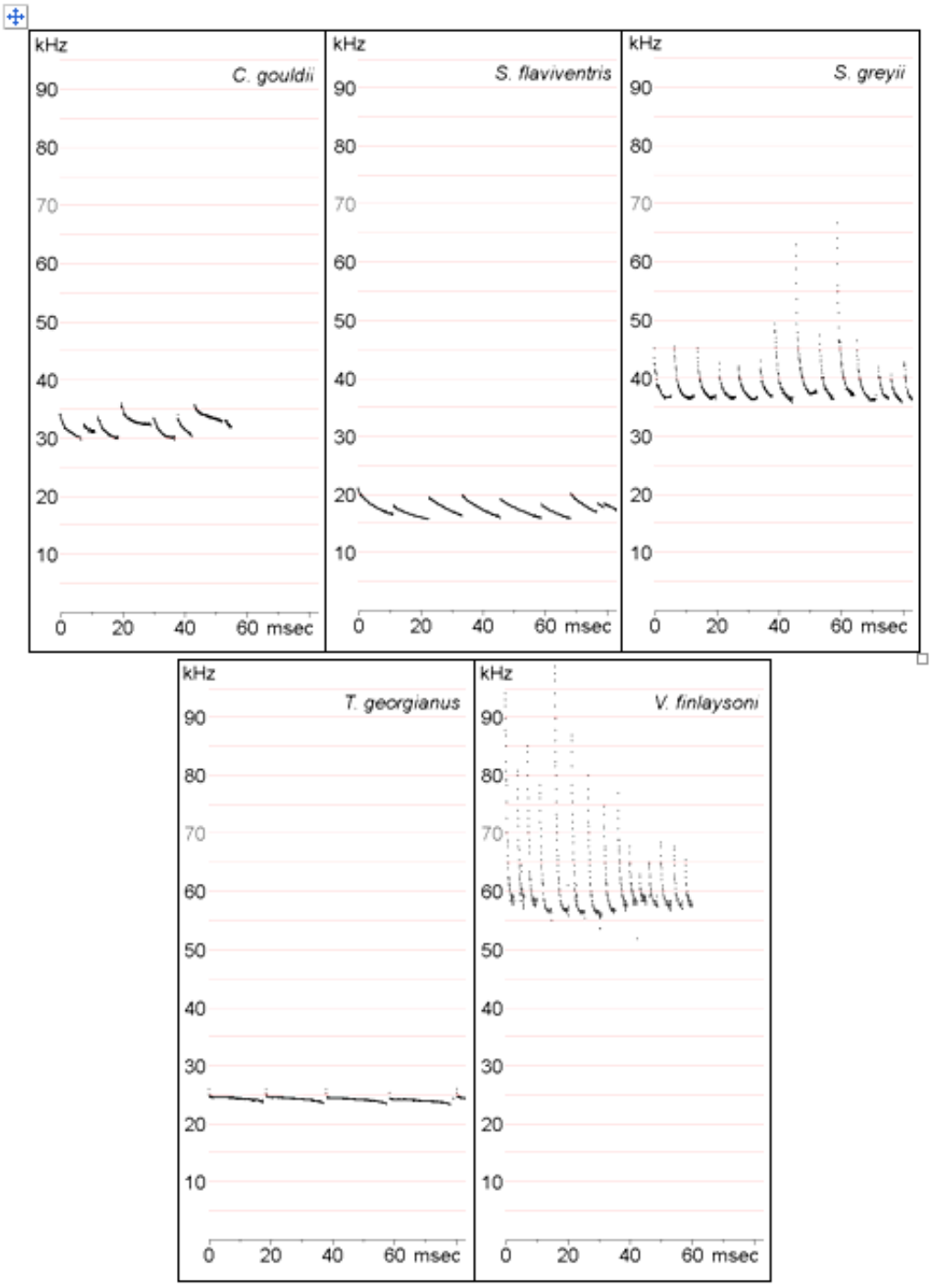


FIGURE 1. Representative call sequences of the species identified (time is compressed between pulses).

Appendix I: Fauna habitat assessment data sheets

FAUNA HABITAT SURVEY DATA SHEET 1

Location: Callawa **Site #**: Site 1 (S1) **Date:** 23/05/2012

Observer: RBC, KZ **GPS Location:** -20.643737 120.3041

Search time: 3:40pm **Photo #:** 600 Camera 1

Broad Habitat: 5. Rocky hills and ridges supporting *Grevillea/Acacia* shrublands and *Triodia* hummock grasslands on ironstone / shallow clay.

Vegetation association: Open shrubland of *Acacia* and *Grevillea* spp. over low scattered shrubs of *Acacia* spp. over open hummock grassland of *Triodia* spp. on red shallow clay on ridges.

Vegetation Condition: Pristine

Vegetation (% cover)
Trees >30m: 0
Trees 5-30m: 0
Trees <5m: 0
Mallees: 0
Shrubs >2m: 0
Shrubs 1 -2m: 2
Shrubs 0.5 – 1m: 1
Shrubs <0.5m: 2
Spinifex: 15
Soft grasses: <1
Sedges: 0
Herbs: <1



Photo 1: OTHER Habitat Type 5 Site S1 Callawa ELA 23052012

Landform (Drainage, footslope etc): Ridge
Soil type, depth & colour: very shallow red clay
Rock type & size: ironstone- gravel to stones
Rocky outcrops: 35%, ironstone

Leaf litter (% cover): 1 **Bare ground** (% cover): 55
Twig litter (% cover): <1 **Average size**: 5 mm
Fallen logs (% cover): <1 **Average size**: 5 cm
Dead stags (abundance)**:** 0 **Average Dimension:**0

Hollow-bearing trees (abundance) **& average size**: nil

Water bodies (present/absent): absent

Caves / Subterranean roosts (present/absent): Absent

Nests or Roosts (present/absent): Present: birds in Spinifex

Disturbances (present/absent): Present: tracks, drill pads

Ecological processes important to habitat (present/absent): Present: Fire, seasonal rain.

FAUNA HABITAT SURVEY DATA SHEET 2

Location: Callawa **Site #**: Transect 1 (T1) **Date:** 25/05/2012

Observer: EL, KZ **GPS Location:** -20.6338 120.2822

Search time: 8:23am **Photo #:** 659 Camera 1

Broad Habitat: 2. Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble.

Vegetation association: Low open woodland of *Eucalyptus* spp. over open heath of *Acacia* spp. over closed hummock grassland of *Triodia* spp. on red clay loam on alluvial plains.

Vegetation Condition: Pristine

Vegetation (% cover)
Trees >30m: 0
Trees 5-30m: 1 (*Corymbia*)
Trees <5m: 2
Mallees: 0
Shrubs >2m: 20
Shrubs 1 -2m: 35
Shrubs 0.5 – 1m: 5
Shrubs <0.5m:2
Spinifex: 75
Soft Grasses: <1
Sedges: 0
Herbs: <1



Photo 2: OTHER Habitat Type 2 Site T1 Callawa ELA 25052012

Landform (Drain, footslope etc): Alluvial plain
Soil type, depth & colour: red clay loam with alluvial sand on surface
Rock type & size: nil
Rocky outcrops: nil

Leaf litter (% cover): 15
Twig litter (% cover):5
Fallen logs (% cover): 5
Dead stags (abundance): <1

Bare ground (% cover): 12
Average size: 10mm
Average size: 5 cm
Average Dimension:1m x 2cm DBH

Hollow-bearing trees (abundance) & average size: nil

Water bodies (present/absent): Absent

Caves / Subterranean roosts (present/absent): Absent

Nests or Roosts (present/absent): Potential nesting for small birds i.e. Honeyeaters

Disturbances (present/absent): Present- tracks, cattle grazing/ movement.

Ecological processes important to habitat (present/absent): Present: Fire, Seasonal rainfall, seasonal inundation.

FAUNA HABITAT SURVEY DATA SHEET 3

Location: Callawa **Site #**: S2 **Date:** 25/05/2012

Observer: EL / KZ **GPS Location:** -20.6432 120.2969

Search time: 1:00pm **Photo #:** 709 Camera 1

Broad Habitat: 4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping.

Vegetation association: Low woodland of ?*Terminalia canescens* over high shrubland of *Acacia* spp. over very open hummock grassland of *Triodia* spp on red stony loam on gullies.

Vegetation Condition: Pristine

Vegetation (% cover)
Trees >30m: 0
Trees 5-30m: 5
Trees <5m: 35
Mallees: 0
Shrubs >2m: 25
Shrubs 1 -2m: 5
Shrubs 0.5 – 1m: 3
Shrubs <0.5m: <1
Spinifex: 10
Soft grasses: 2
Sedges: <1

Herbs: <1



Photo 3: OTHER Habitat Type 4 Site S2 Callawa ELA 25052012

Landform (Drain, footslope etc): Gully
Soil type, depth & colour: red stony, rocky loam
Rocky outcrops: 10% cover

Leaf litter (% cover): 1
Twig litter (% cover): 1
Fallen logs (% cover): 10
Dead stags (abundance):1

Bare ground (% cover): 35
Average size: 10mm
Average size: 10 cm
Average Dimension:4m x 15cm DBH

Hollow-bearing trees (abundance) & average size: Several, 4m average height.

Water bodies (present/absent): Present – permanent water hole and 4 semi-permanent approximately 4m wide x 1m deep

Caves / Subterranean roosts (present/absent): Potentially in rock walls and crevices

Nests or Roosts (present/absent): Present in trees

Disturbances (present/absent): nil

Ecological processes important to habitat (present/absent): Seasonal flooding

FAUNA HABITAT SURVEY DATA SHEET 4

Location: Callawa **Site #**: T2 **Date:** 26/05/12

Observer: KZ, EL, RA, JT **GPS Location:** -20.6319 120.3013

Search time: 11:14am **Photo #:** 733 Camera 1

Broad Habitat: 1. Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays.

Vegetation association: Low woodland of *Eucalyptus* sp. over open scrub of *Acacia* spp. over closed hummock grassland of *Triodia* spp. on red alluvial sand on drainage lines.

Vegetation Condition: Pristine

Vegetation (% cover)

Trees >30m: 0
Trees 5-30m: 2
Trees <5m: 25
Mallees: 0
Shrubs >2m: 50
Shrubs 1 -2m: 20
Shrubs 0.5 – 1m: 2
Shrubs <0.5m: <1
Spinifex: 80
Soft grasses: 5
Sedges: 0
Herbs: 1



Photo 4: OTHER Habitat Type 1 Site T2 Callawa ELA 26052012

Landform (Drain, footslope etc): drainage line
Soil type, depth & colour: red alluvial sand to 20cm then clay loam
Rock type & size: some ironstone 1 – 5cm
Rocky outcrops: nil

Leaf litter (% cover): 20
Twig litter (% cover): 5
Fallen logs (% cover): 5
Dead stags (abundance):<1

Bare ground (% cover): 5
Average size: 20mm
Average size: 10cm
Average Dimension:5cm DBH

Hollow-bearing trees (abundance) & average size: 3 trees, 20 cm DBH, 8m tall

Water bodies (present/absent): Absent

Caves / Subterranean roosts (present/absent): Absent

Nests or Roosts (present/absent): Present in hollows, trees, shrubs and spinifex

Disturbances (present/absent): Present: Tracks, cattle damage

Ecological processes important to habitat (present/absent): seasonal inundation, flooding

FAUNA HABITAT SURVEY DATA SHEET 5

Location: Callawa **Site #**: T3 **Date:** 26/05/2012

Observer: KZ/EL/RA/JT **GPS Location:** -20.632 120.3039

Search time: 09:00am **Photo #:** 310-312 Camera 1

Broad Habitat: 2. Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble.

Vegetation association: Scattered trees of *Eucalyptus* sp. over high open shrubland of *Grevillea* and *Acacia* spp. over hummock grassland of *Triodia* spp. on red stony clay on plains and lower slopes.

Vegetation Condition: Pristine

Vegetation (% cover)

Trees >30m: 0
Trees 5-30m: 1
Trees <5m: 0
Mallees: 0
Shrubs >2m: 5
Shrubs 1 -2m: 2
Shrubs 0.5 – 1m: 2
Shrubs <0.5m: <1
Spinifex: 65
Soft grasses: <1
Sedges: 0
Herbs: <1



Photo 5: OTHER Habitat Type 3 Site T3 Callawa ELA 25052012

Landform (Drain, footslope etc): Lower slope
Soil type, depth & colour: deep red stony clay
Rock type & size: ironstone, quartz 1-10cm
Rocky outcrops: nil

Leaf litter (% cover): 1
Twig litter (% cover): <1
Fallen logs (% cover): 0
Dead stags (abundance):0

Bare ground (% cover): 30
Average size: 5mm
Average size:
Average Dimension:

Hollow-bearing trees (abundance) & average size: Absent

Water bodies (present/absent): Absent

Caves / Subterranean roosts (present/absent): Absent

Nests or Roosts (present/absent): Present: potentially nesting in spinifex and shrubs

Disturbances (present/absent): tracks, exploration, and minor cattle movement through area

Ecological processes important to habitat (present/absent): fire, seasonal rainfall

FAUNA HABITAT SURVEY DATA SHEET 6

Location: Callawa **Site #**: T4 **Date:** 26/05/2012

Observer: RA, KZ **GPS Location:** -20.6417 120.3115

Search time: 7:41am **Photo #:** 677 Camera 2

Broad Habitat: 3. Stony rises, low stony hills and scree slopes supporting scattered shrubs and *Triodia* hummock grasslands on shallow stony pebble clays.

Vegetation association: Open shrubland of *Acacia* spp. over low shrubland of *Acacia* spp. over hummock grassland of *Triodia* spp. on red rocky clay on lower slopes.

Vegetation Condition: Excellent - Pristine

Vegetation (% cover)
Trees >30m: 0
Trees 5-30m: 0
Trees <5m: 1
Mallees: 0
Shrubs >2m: 5
Shrubs 1 -2m: 5
Shrubs 0.5 – 1m: 15
Shrubs <0.5m: 5
Spinifex: 70
Soft grasses: 1
Sedges: 0
Herbs: <1



Photo 6: OTHER Habitat type 3 Transect 4 pic1 Callawa ELA 28052012

Landform (Drain, footslope etc):
Lower slope
Soil type, depth & colour: red rocky clay
Rock type & size: ironstone 2-20cm
Rocky outcrops: yes – 1%

Leaf litter (% cover): 15
Twig litter (% cover): 1
Fallen logs (% cover): 0
Dead stags (abundance):0

Bare ground (% cover): 20
Average size: 10 mm
Average size:
Average Dimension:

Hollow-bearing trees (abundance) & average size: Absent
Water bodies (present/absent): Absent
Caves / Subterranean roosts (present/absent): Absent
Nests or Roosts (present/absent): Potentially in shrubs and spinifex
Disturbances (present/absent): Tracks
Ecological processes important to habitat (present/absent): fire- long unburnt, seasonal rainfall

FAUNA HABITAT SURVEY DATA SHEET 7

Location: Callawa **Site #**: T5 **Date:** 26/05/2012

Observer: KZ, EL, RA, JT **GPS Location:** -20.6291 120.2977

Search time: 12:15pm **Photo #:** 735, 736 Camera 1; 669 Camera 2

Broad Habitat: 1. Minor creeks supporting low *Eucalyptus/Acacia* woodlands, mixed hummock and tussock grasslands on alluvial sandy clays.

Vegetation association: Scattered Trees of *Eucalyptus* sp. over open scrub of *Acacia* spp. over hummock grassland of *Triodia* spp. on red alluvial sand on drainage lines.

Vegetation Condition: Excellent

Vegetation (% cover)

Trees >30m: 0
Trees 5-30m: 2
Trees <5m: <1
Mallees: 0
Shrubs >2m: 35
Shrubs 1 -2m: 10
Shrubs 0.5 – 1m: 1
Shrubs <0.5m: 1
Spinifex: 40
Soft grasses: 5
Sedges: <1
Herbs: 1



Photo 7: OTHER Habitat type 1Transect 5 pic2 Callawa ELA 28052012

Landform (Drain, footslope etc): Drainage line
Soil type, depth & colour: red alluvial sand
Rock type & size: Ironstone, granite, quartz, 0.5-10cm
Rocky outcrops: nil

Leaf litter (% cover): 5 **Bare ground** (% cover): 65
Twig litter (% cover): 2 **Average size**: 5mm
Fallen logs (% cover): 1 **Average size**: 5 cm
Dead stags (abundance):1 **Average Dimension**:2m

Hollow-bearing trees (abundance) & average size: None visible

Water bodies (present/absent): Dry creek line (ephemeral)

Caves / Subterranean roosts (present/absent): Absent

Nests or Roosts (present/absent): Potentially nesting/roosting in trees, shrubs or spinifex

Disturbances (present/absent): tracks, cattle grazing, some weeds

Ecological processes important to habitat (present/absent): seasonal inundation

FAUNA HABITAT SURVEY DATA SHEET 8

Location: Callawa **Site #**: T6 **Date:** 25/05/2012

Observer: EL, KZ **GPS Location:** -20.6328 120.2865

Search time: 7:09am **Photo #:** 637, 638 Camera 1

Broad Habitat: 2. Plains of open *Acacia* shrubland and *Triodia* hummock grasslands on sandy clay loam with occasional areas of sparse surface gravel or pebble.

Vegetation association: Shrubland of *Acacia* spp. over low open shrubland of *Acacia* spp. over closed hummock grassland of *Triodia* spp. on red loamy clay on plains.

Vegetation Condition: Pristine

Vegetation (% cover)

Trees >30m: 0
Trees 5-30m: 0
Trees <5m: <1
Mallees: 0
Shrubs >2m: 2
Shrubs 1 -2m: 20
Shrubs 0.5 – 1m: 5
Shrubs <0.5m: 2
Spinifex: 85
Soft grasses: <1
Sedges: 0
Herbs: 1



Photo 8: OTHER Habitat Type 2 Site T6 Callawa ELA 28052012

Landform (Drain, footslope etc): Sandy plain
Soil type, depth & colour: deep red loamy clay
Rock type & size: pebbles of quartz and ironstone
Rocky outcrops: nil

Leaf litter (% cover): 3 **Bare ground** (% cover): 10
Twig litter (% cover): 2 **Average size**: 10-20mm
Fallen logs (% cover): 1 **Average size**: 5 cm
Dead stags (abundance):1 **Average Dimension**:2m x 10cm DBH

Hollow-bearing trees (abundance) & average size: Absent

Water bodies (present/absent): Absent

Caves / Subterranean roosts (present/absent): Absent

Nests or Roosts (present/absent): potential nesting for small birds i.e. finch

Disturbances (present/absent): tracks, low level movement and grazing by cattle

Ecological processes important to habitat (present/absent): fire, seasonal rainfall

FAUNA HABITAT SURVEY DATA SHEET 9

Location: Callawa **Site #**: T7 **Date:** 25/05/2012

Observer: EL, KZ **GPS Location:** -20.6465 120.2955

Search time: 9:52am **Photo #:** 673 Camera 1

Broad Habitat: 5. Rocky hills and ridges supporting *Grevillea/ Acacia* shrublands and *Triodia* hummock grasslands on ironstone and shallow clay.

Vegetation association: High open shrubland of *Grevillea* and *Acacia* spp. over shrubland of *Grevillea* and *Acacia* spp. over hummock grassland of *Triodia* spp. on red stony clay on upper slopes and ridges.

Vegetation Condition: Pristine

Vegetation (% cover)

Trees >30m: nil
Trees 5-30m: 2
Trees <5m: <1
Mallees: 0
Shrubs >2m: 5
Shrubs 1 -2m: 15
Shrubs 0.5 – 1m: 5
Shrubs <0.5m: 2
Spinifex: 40
Soft grasses:<1
Sedges: <1
Herbs: 1- *Apiaceae*



Photo 9: OTHER Habitat Type 3 Site T7 Callawa ELA 28052012

Landform (Drain, footslope etc): Upper slope/ ridge line.
Soil type, depth & colour: red stony clay
Rock type & size: ironstone 2-15cm, Average 10cm
Rocky outcrops: Yes, 20%

Leaf litter (% cover): <1
Twig litter (% cover): <1
Fallen logs (% cover): <1
Dead stags (abundance):<1

Bare ground (% cover): 55
Average size: 20mm
Average size: 8 cm
Average Dimension:3.5m x 3cm DBH

Hollow-bearing trees (abundance) & average size: Absent

Water bodies (present/absent): Absent

Caves / Subterranean roosts (present/absent): potentially some in rocky outcrops but none observed

Nests or Roosts (present/absent): Honeyeater nest in Grevillea

Disturbances (present/absent): tracks, exploration drilling

Ecological processes important to habitat (present/absent): fire

FAUNA HABITAT SURVEY DATA SHEET 10

Location: Callawa **Site #**: T8 **Date:** 25/05/2012

Observer: EL, KZ **GPS Location:** -20.6489 120.2921

Search time: 11:15am **Photo #:** 679 - 682 Camera 1

Broad Habitat: 4. Canyons, breakaways and steep rocky gullies supporting mixed woodlands, mixed hummock and tussock grasslands on stony clay loams, with rocky outcropping

Vegetation association: High shrubland of *Grevillea* and *Acacia* spp. over shrubland of *Grevillea* and *Acacia* spp. over hummock grassland of *Triodia* spp. on red stony clay on gullies.

Vegetation Condition: Pristine

Vegetation (% cover)

Trees >30m: 0
Trees 5-30m: <1
Trees <5m: <1
Mallees: <1
Shrubs >2m: 15
Shrubs 1 -2m: 20
Shrubs 0.5 – 1m: 5
Shrubs <0.5m: 2
Spinifex: 50
Soft grasses: <1
Sedges: <1
Herbs: <1



Photo 10: OTHER Habitat Type 4 Site T8 Callawa ELA 28052012

Landform (Drain, footslope etc): Gully
Soil type, depth & colour: Red clay with a stony surface
Rock type & size: Ironstone, pebbles to boulders
Rocky outcrops: Ironstone 50%

Leaf litter (% cover): 1
Twig litter (% cover): 1
Fallen logs (% cover): 1
Dead stags (abundance):1
Bare ground (% cover): 10
Average size: 10mm
Average size: 3 cm
Average Dimension: 3m x 5cm DBH

Hollow-bearing trees (abundance) & average size: Absent

Water bodies (present/absent): Absent

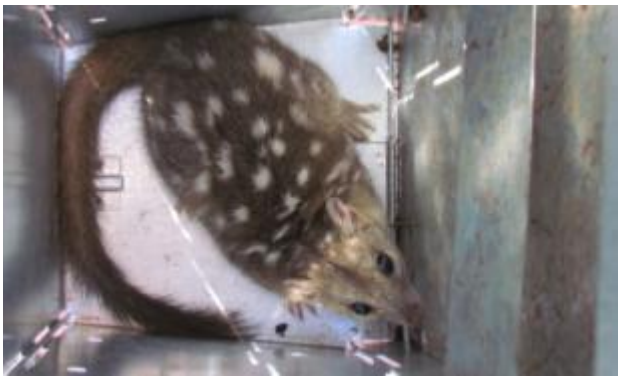
Caves / Subterranean roosts (present/absent): Present in outcropping, ledges, etc.

Nests or Roosts (present/absent): Potential nesting for small birds.

Disturbances (present/absent): tracks

Ecological processes important to habitat (present/absent): Seasonal inundation/ flooding, fire

Appendix J: Conservation significant specimen photos



Northern Quoll *Dasyurus hallucatus*



Rainbow Bee-eater *Merops ornatus*



Western Pebble-mound Mouse *Pseudomys chapmanii* (disused mound)



Australian Bustard *Ardeotis australis* (tracks)



Bush Stone-curlew *Burhinus grallarius* (tracks)



Northern Quoll *Dasyurus hallucatus* (scats)

Appendix K: Specimen photos



Kaluta *Dasykaluta rosamondae*



Sandy Inland mouse *Pseudomys hermannsburgensi*



Long tailed Planigale *Planigale ingrami*



Wild Dog *Canus lupus*



Stripe –faced Dunnart *Sminthopsis macroura*



Desert Mouse *Pseudomys desertor*



Pilbara Ningaui *Ningaui timealeyi*



Common Sheathtail Bat *Taphozous georgianus*



Rothschild's Rock-wallaby *Petrogale rothschildi*



Euro *Macropus robustus* subsp*. erubescens*



Dtella *Gehyra* sp*. (aff. pilbara)*



Dtella *Gehyra variegata*



Perentie *Varanus giganteus*



Fire-tail Skink *Morethia ruficauda*



Keeled Rainbow Skink *Carlia triacantha*



Leopard Ctenotus *Ctenotus pantherinus*



Central Military Dragon *Ctenophorus isolepis isolepis*



Legless Lizard *Delma pax*



Slender Blue-tongue *Cyclodomorphus melanops*. *melanops*



Sand-plains Gecko *Lucasium stenodactylum*



Spinifex Pigeon *Geophaps plumifera*



Painted Finch *Emblema pictum*

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