



# **Southern Koolyanobbing Range Vertebrate Fauna Survey**





**Biota**  
Environmental  
Sciences



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# Southern Koolyanobbing Range Vertebrate Fauna Survey

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# 1.0 Summary

## 1.1 Background

Biota Environmental Sciences (Biota) was commissioned by Cliffs Asia Pacific Iron Ore Pty Ltd (Cliffs) to provide a Level 2 fauna assessment of the Southern Koolyanobbing Range Study Area (hereafter referred to as the "Study Area"). The 1,714 ha Study Area is located in the Yilgarn region of Western Australia, approximately 50 km north-northeast of Southern Cross.

The aims of the study were to:

- undertake a Level 2 fauna survey of the Study Area consistent with relevant government Guidance Statements and Technical Guides,
- document the vertebrate fauna assemblage of the Study Area using established sampling techniques,
- identify and record the locations of conservation significant fauna, being:
  - Threatened Species and Migratory Species listed under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999;
  - Specially Protected Fauna (Schedule species) listed under the Western Australian Wildlife Conservation Act 1950; and
  - Priority fauna classified by the Department of Parks and Wildlife (DPaW); and,
- identify and assess the local and regional conservation significance of the fauna assemblage and habitats present in the Study Area.

## 1.2 Methods

A list of species that may potentially occur in the locality was compiled from a desktop review. This included searches of various databases (the DPaW and WA Museum (WAM) NatureMap database, DPaW Threatened Fauna Database, Biota Internal Database and EPBC Act 1999 Protected Matters Database), along with a review of reports from previous surveys in the locality.

The two-phase fauna survey comprised an autumn survey from 8–15 April 2013 (Phase 1), followed by a spring survey from 22–30 October 2013 (Phase 2). The summer preceding Phase 1 was wetter than average. Lower than average winter rainfall was recorded between Phase 1 and Phase 2. Temperatures during both survey periods were appropriate for adequate sampling of reptiles, mammals and birds, with warm to hot maximum temperatures during both phases.

Systematic sampling of the terrestrial vertebrate fauna assemblage was carried out at 11 trapping sites with the aim of trapping as many species from the assemblage as possible. Trapping sites were distributed across the range of fauna landscapes present within the Study Area, while giving consideration to access to ensure that traps could be checked in a timely manner each morning.

Systematic sampling also included 73 bird censuses (typically 30 minutes duration) completed at the 11 trapping sites and one opportunistic site. Each systematic trapping site was censused twice during each phase as a minimum (i.e. for a minimum of 120 minutes over the course of the two-phase survey). The majority of censuses were conducted between 06:00 and 10:00 am. Over both survey phases, a total of 36.8 hours were dedicated to systematic bird censuses.

Bat echolocation calls were recorded at six locations in the Study Area using Song Meter (SM2BAT) bat detector units. Sampling equipment was placed in habitats where foraging, drinking and commuting activities were considered likely for a range of bat species. Bats were also sampled with a harp trap at one of the sites.

Further habitat assessment and searches for fauna were conducted on foot, particularly in areas inaccessible by vehicle and not practical for trap installation. A range of techniques were used when conducting fauna searches, including targeted searches for reptile, frog and mammal species that are not commonly trapped; and recording of opportunistic sightings of individuals

and secondary signs (e.g. tracks, scats and diggings). Malleefowl mounds were also specifically targeted, including checking the status of mounds recorded by other parties during botanical surveys in the area.

Nocturnal searching was conducted during each phase of surveying, generally for 2.5–3 hours immediately after sunset. Spotlighting from a moving vehicle was conducted, particularly when warm and humid conditions favoured fauna activity. Species that are not readily trapped were also targeted by searching on foot at trap sites, with the aim of achieving a more thorough inventory of the species assemblage at each trap site.

## 1.3 Results

The fauna survey yielded a total of 106 species of vertebrate fauna from 45 families. This comprised seven ground-dwelling mammal species (two of which were non-native), eight bat species, 57 bird species, 33 reptile species and one amphibian species.

The most frequently recorded ground-dwelling mammal species was the Western Pygmy-possum (*Cercartetus concinnus*). The most species-rich bird family was the Meliphagidae (honeyeaters), with eight species recorded. The Weebill (*Smicronis brevirostris*) was the most abundant bird species with 300 records, representing approximately 20% of the total avifauna individuals.

Of the nine reptile families represented in the assemblage, the most species rich was the Scincidae (skinks) with 11 species recorded. The most abundant species was the gecko *Gehyra variegata* with 30 individuals recorded, accounting for 12% of the total number of reptile individuals.

One frog species from the family Limnodynastidae was recorded during Phase 1 of the survey. No amphibians were recorded during Phase 2.

Species accumulation curves (SACs) indicated that the large majority of species likely to be recorded in the Study Area were recorded over the two phases of survey. SAC estimates indicate that 87% of the trappable ground fauna and 89% of the bird species likely to be present were recorded.

The following conservation significant fauna species were recorded in the Study Area:

- Malleefowl (*Leipoa ocellata*): listed as a Threatened Species and as a Migratory Species under the EPBC Act 1999, and as Specially Protected Fauna under the Wildlife Conservation Act 1950;
- Major Mitchell's Cockatoo (*Lophochroa leadbeateri*): listed as Specially Protected Fauna under the Wildlife Conservation Act 1950;
- Peregrine Falcon (*Falco peregrinus*): listed as Specially Protected Fauna under the Wildlife Conservation Act 1950;
- Rainbow Bee-eater (*Merops ornatus*): listed as a Migratory Species under the EPBC Act 1999 and Specially Protected Fauna under the Wildlife Conservation Act 1950;
- Little Woodswallow (*Artamus minor*): reliant on ironstone habitat regionally (DEC 2007); and
- Gilbert's Whistler (*Pachycephala inornata*): reliant on ironstone habitat regionally (DEC 2007).

In addition, the Slender Blue-tongue *Cyclodomorphus melanops* was recorded from the Study Area. This may represent the subspecies *Cyclodomorphus melanops elongatus*, which is reliant on ironstone regionally (DEC 2007), and is an isolated record at the southern extreme of the species' distribution.

The ironstone ridge crests and upper slopes were considered to be the landscape unit of highest faunal habitat value, both within the Study Area and the broader surrounding landscape. The ironstone ranges within the region are a habitat type that has a patchy distribution, with each ironstone range being spatially separate and representing a small proportion of the area of each bioregion in which they occur (DEC 2007, DSEWPac 2012).

## 2.0 Introduction

### 2.1 Project Background and Study Area

Cliffs' Yilgarn Operations include the mining of iron ore deposits at the Koolyanobbing Range, Mt Jackson Range and Windarling Range, processing of ore at Koolyanobbing, and road and rail transport between these operations and the Port of Esperance where the processed ore is exported to international customers.

Cliffs is investigating expansion of its Yilgarn Operations to include new mining operations at the southern Koolyanobbing Range. Biota was commissioned by Cliffs to provide a Level 2 fauna assessment of the Southern Koolyanobbing Study Area. The Study Area is 1,714 ha and is located adjacent to existing Cliffs' operations at Koolyanobbing, approximately 50 km north-northeast of Southern Cross in the Shire of Yilgarn (Figure 2.1).

### 2.2 Study Objectives and Scope

This report documents the methods, results and key findings of a two-phase Level 2 terrestrial fauna survey of the Study Area.

The aims of the study were to:

- undertake a Level 2 fauna survey of the Study Area consistent with relevant Environmental Protection Authority (EPA) Guidance Statements and other relevant government guidelines;
- document the vertebrate fauna assemblage within the Study Area using established sampling techniques;
- identify and record the locations of conservation significant fauna, being:
  - Threatened Species and Migratory Species of fauna listed under the Commonwealth EPBC Act 1999,
  - Specially Protected Fauna (Schedule species) listed under the WA Wildlife Conservation Act 1950, and
  - Priority fauna classified by DPaW; and
- identify and assess the local and regional conservation significance of the fauna assemblage and habitats present in the Study Area.

The survey was planned and implemented in accordance with the following guidance materials:

- 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); and,
- EPA and Department of Environment and Conservation<sup>1</sup> (DEC) Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010).

<sup>1</sup> Now operating as the Department of Parks and Wildlife (DPaW).



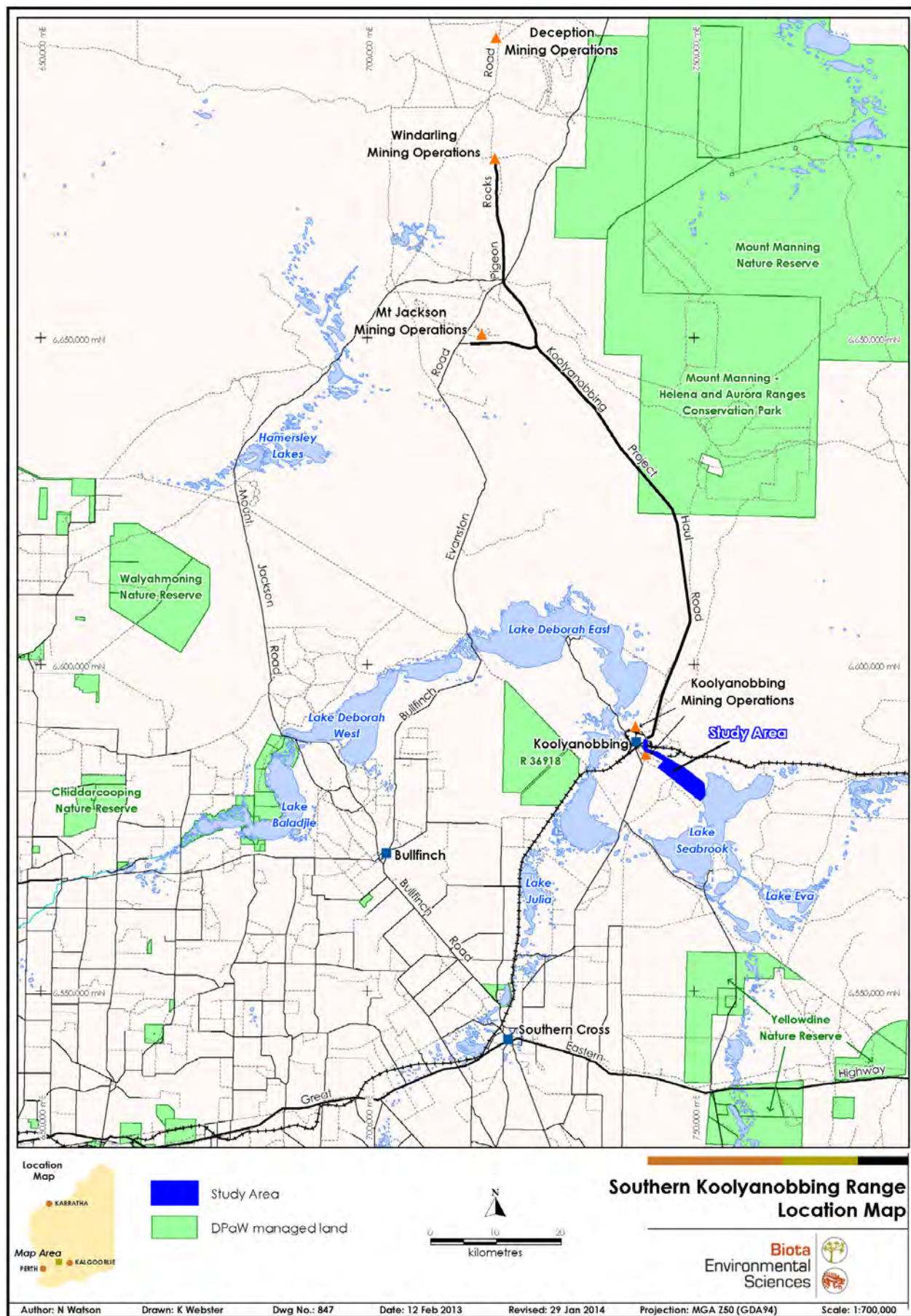


Figure 2.1: Regional location of the Study Area, including proximity to lands managed by DPaW for conservation purposes.

## 3.0 Regional Context

### 3.1 IBRA Bioregion and Subregions

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 89 bioregions and 419 subregions (DSEWPaC 2012). The Study Area is located in the Southern Cross subregion of the Coolgardie bioregion.

The Southern Cross subregion covers 7,041,232 ha and is described by Cowan et al. (2003) as:

*"The subregion has subdued relief, comprising gently undulating uplands dissected by broad valleys with bands of low greenstone hills. It lies on the 'Southern Cross Terrains' of the Yilgarn Craton. The granite strata of Yilgarn Craton are interrupted by parallel intrusions of Archaean Greenstone. Drainage is occluded. It has an arid to semi-arid Warm Mediterranean climate with 250-300 mm of mainly winter rainfall."*

### 3.2 Geology

The Study Area encompasses eight major geological units based on mapping by the Geological Survey of Western Australia (2002). The units are summarised in Table 3.1, while their distribution is shown in Figure 3.1. The majority of the Study Area is mapped as unit Qc, "Colluvium - silt, sand and gravel on slopes adjoining rock and laterite outcrop". These geological units formed the basis for the description of landforms and substrates that underlie the fauna landscapes within the Study Area.

Table 3.1: Geological units within the Study Area.

Unit	Description	Area (ha)	% Study Area
Qc	Colluvium - silt, sand and gravel on slopes adjoining rock and laterite outcrop	958	56
Tl	Laterite - limonite-cemented duricrust overlaying deeply weathered bedrock	454	26
Aiw	Banded iron-formation, quartz-grunerite-magnetite rock	105	6
Akb	Metamorphosed komatiitic basalt; tremolite-chlorite (-talc) schist	94	5
Aab	Metabasalt, fine and medium-grained amphibolite containing plagioclase, hornblende and/or actinolite	66	4
Aad	Metagabbro, medium and coarse-grained amphibolite containing plagioclase, hornblende and/or actinolite	24	1
Qa	Alluvium - silt, sand and gravel in stream channels	9	<1
Anl	Banded granitoid consisting of phases of gneissic adamellite, granodiorite and tonalite	4	<1
		1,714	100

### 3.3 Ironstone Formation Ranges of the Yilgarn Region

Koolyanobbing represents one of the ironstone formation ranges in the Yilgarn region. The ironstone ranges comprise a small proportion of the Yilgarn Craton, which is otherwise predominantly flat.

The ironstone ranges are ancient, isolated features which have different geology, soils, flora and fauna compared to the surrounding land. DEC (2007) notes records of vertebrate fauna species in the Midwest and Goldfields that tend to be locally restricted to ironstone range habitats and are not found in the surrounding woodlands and sandplains.



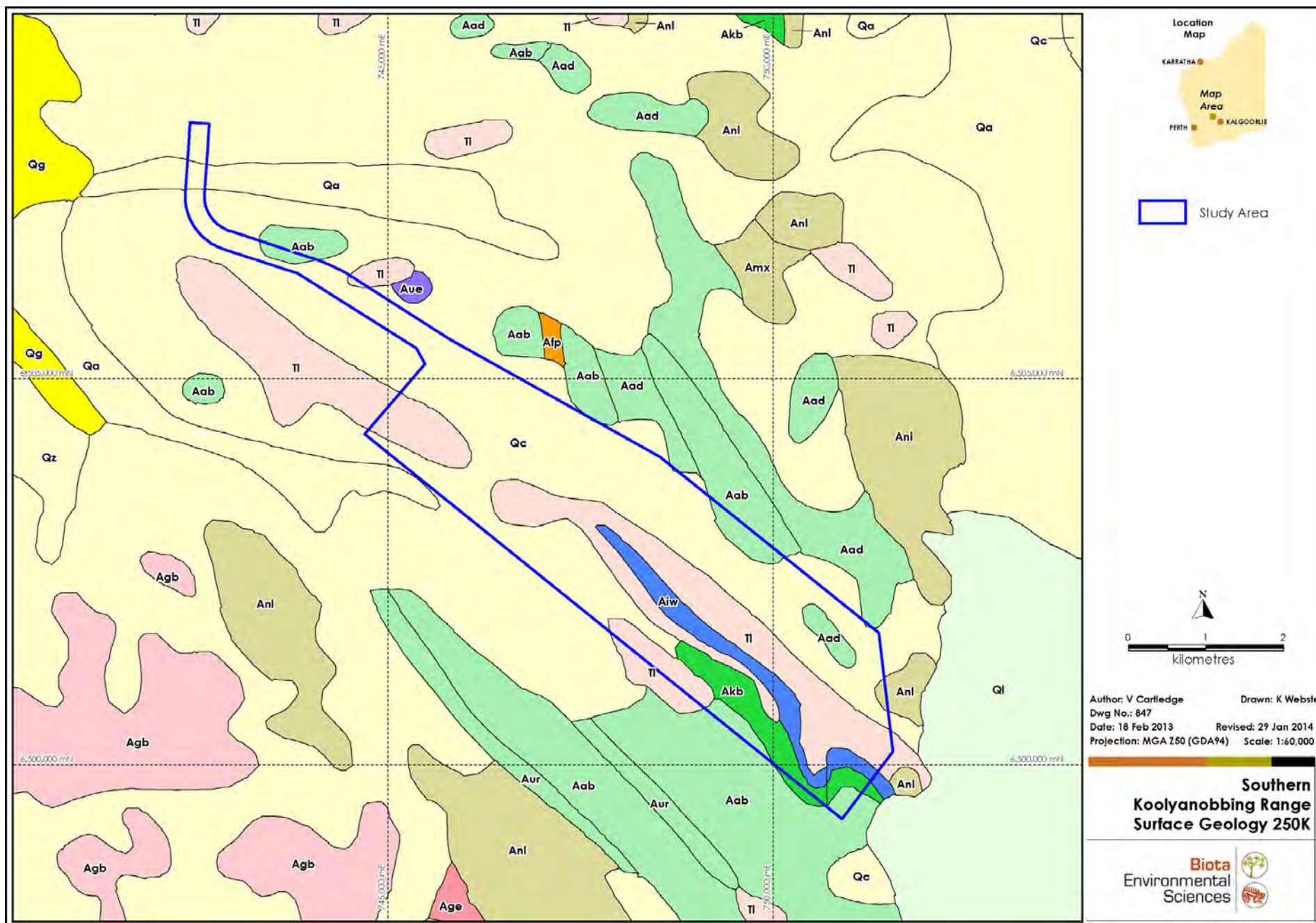
















Figure 3.1: Geological units of the Study Area.

## **Geology of Southern Koolyanobbing Range**

	<b>Aab</b>	Metabasalt, fine and medium-grained amphibolite containing plagioclase, hornblende and/or actinolite
	<b>Aad</b>	Metagabbro, medium and coarse-grained amphibolite containing plagioclase, hornblende and/or actinolite
	<b>Afp</b>	Dacitic feldspar porphyry
	<b>Agb</b>	Medium and coarse, even-grained biotite granite and adamellite; locally seriate
	<b>Age</b>	Fine and medium, even grained biotite granite and adamellite; locally seriate
	<b>Aiw</b>	Banded iron-formation, quartz-grunerite-magnetite rock
	<b>Akb</b>	Metamorphosed komatiitic basalt; tremolite-chlorite (-talc) schist
	<b>Amx</b>	Foliated heterogeneous granitoid containing abundant rafts of partly assimilated greenstone
	<b>Anl</b>	Banded granitoid consisting of phases of gneissic adamellite, granodiorite and tonalite
	<b>Aue</b>	Talc (-chlorite -carbonate) schist with minor talc-serpentine rock
	<b>Aur</b>	Coarse-grained tremolite (-chlorite -talc) schist, minor cummingtonite-cordierite-anthophyllite schist
	<b>Qa</b>	Alluvium - silt, sand and gravel in stream channels
	<b>Qc</b>	Colluvium - silt, sand and gravel on slopes adjoining rock and laterite outcrop
	<b>Qg</b>	Eolian and alluvial deposits - silt and sand in sheets and dunes; gypsiferous near playa lakes
	<b>Ql</b>	Lacustrine deposits - saline and gypsiferous clay and silt in playa lakes
	<b>Qz</b>	Sheet-wash deposits - silt and sand on gentle slopes marginal to Qa and Ql
	<b>Tl</b>	Remnant sandplain - yellow to white sand containing locally abundant limonitic pebbles

**Geological Unit Descriptions for the  
Southern Koolyanobbing Range Geology Map**

**Legend Sheet 1**



## 3.4 Conservation Reserves in the Locality

The closest conservation reserves to the Study Area (Figure 2.1) comprise:

- an unnamed Nature Reserve (R 36918) – 10 km west of the Study Area;
- Yellowdine Nature Reserve (R 41936) – 23 km south of the Study Area;
- Duladgin Nature Reserve (R 3112) – 29 km south of the Study Area;
- Mount Manning–Helena and Aurora Ranges Conservation Park (R 48470) – 35 km north of the Study Area;
- an unnamed Nature Reserve (R 25801) – 40 km southwest of the Study Area;
- Condarnin Rock Nature Reserve (R 29823) – 47 km south of the Study Area;
- an unnamed Nature Reserve (R 43219) – 47 km west-southwest of the Study Area; and
- Biljahnies Rock Nature Reserve (R 29920) – 50 km south-southeast of the Study Area.

## 3.5 Vegetation of the Locality

Vegetation in the locality was described and mapped as part of a broad scale (1:1,000,000) exercise by Beard (1980). The Study Area includes three of the vegetation units described by Beard (1980):

- Jackson 520: Shrublands; *Acacia quadrimarginea* thicket (51% of the Study Area);
- Jackson 141: Medium woodland; York Gum (*Eucalyptus loxophleba*), Salmon Gum (*Eucalyptus salmonophloia*) and Gimlet (*Eucalyptus salubris*) (47% of the Study Area); and
- Jackson 538: Shrublands; *Acacia brachystachya* scrub (2% of the Study Area).

Figure 3.2 illustrates the location of the vegetation units over the Study Area. The Jackson 520 unit occurs over much of the ironstone range within the Study Area, while the Jackson 141 unit dominates most of the lower-lying plains surrounding the range. A small area of the Jackson 538 unit is included along the northeastern boundary of the Study Area.



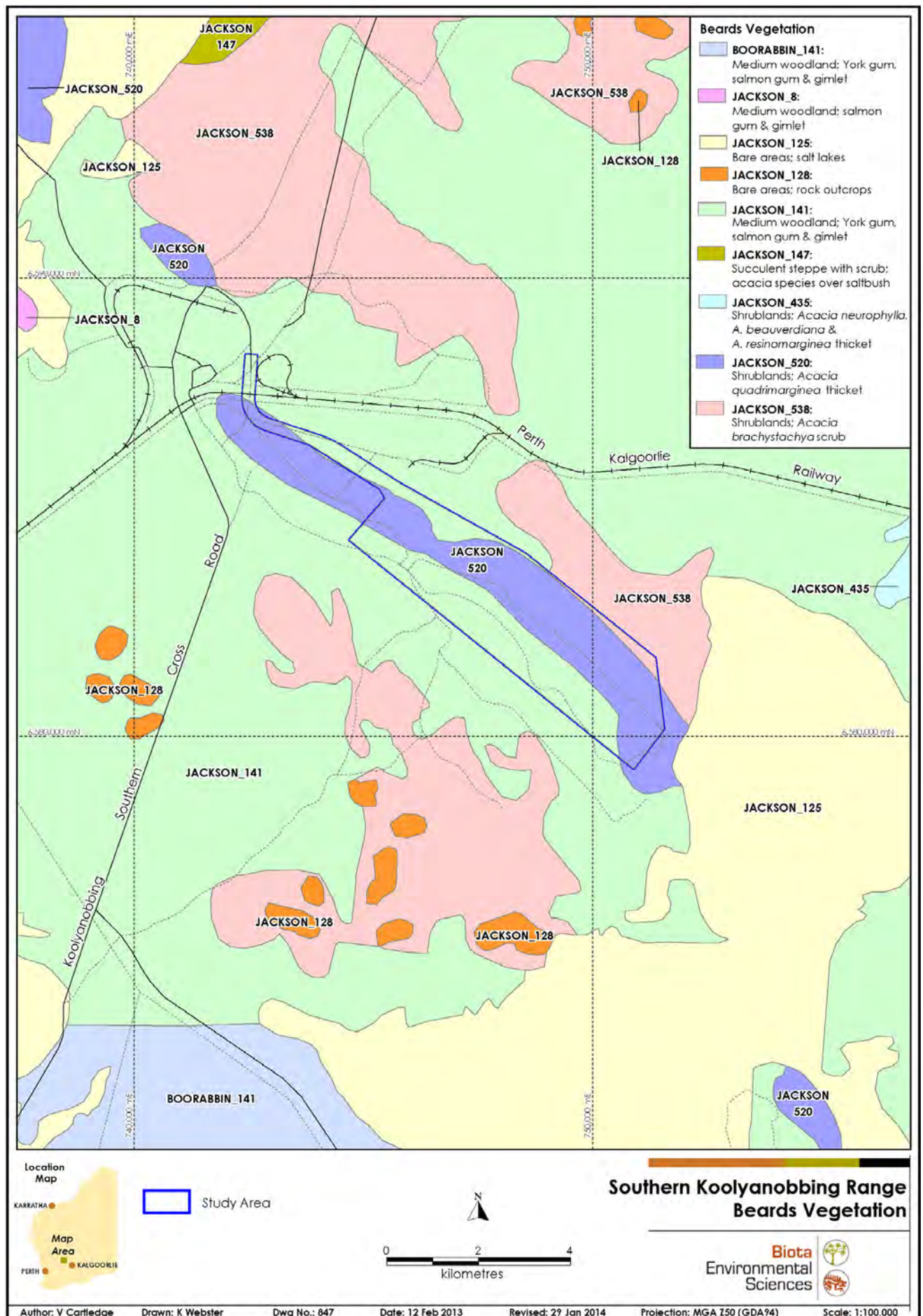


Figure 3.2: Vegetation units mapped by Beard (1980) in the Study Area.

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## 4.0 Survey Methodology

### 4.1 Desktop Review

#### 4.1.1 Literature Review

A number of vertebrate fauna surveys have been conducted within 50–100 km of the Study Area over the last 10 years. Table 4.1 provides a summary of the most relevant reports reviewed to provide context to the current survey. The species recorded during these previous studies were compiled and are presented in Appendix 2.

Table 4.1: Previous fauna studies conducted within 40 km of the Study Area.

Report/Survey	Dates of Survey	Description of Survey	Proximity to Study Area
Ecologia Environmental Consultants (Ecologia) (2001).	5–15 Dec 2000	Single phase, Level 2 fauna assessment of Mt Jackson/Windarling deposits and associated rail to Koolyanobbing.	Sites at the Koolyanobbing Range approximately 10 km north of the Study Area, and extending to Mt Jackson/Windarling, approximately 100 km north.
Ecologia (2003).	19–27 May 2003	Single phase, Level 2 fauna survey of haul road from Koolyanobbing to Mt Jackson/Windarling.	Sites at the Koolyanobbing Range approximately 10 km north of the Study Area, and extending to Mt Jackson/Windarling, approximately 100 km north.
Bamford Consulting Ecologists (BCE) (2007).	30 Jul–1 Aug 2007	Level 1 fauna assessment with site inspection and desktop review of the Koolyanobbing Range.	Survey coincides with the Study Area.
Ninox Wildlife Consulting (Ninox) (2009).	19–26 Jun 2008 and 26 Oct–1 Nov 2008	Level 2 fauna assessment east of the Helena and Aurora Ranges.	Approximately 40 km north.
Aprasia Wildlife (Aprasia) and Globe Environments (Globe) (2009).	18–19 May 2009	Preliminary fauna and habitat assessment, southeast of the Koolyanobbing town site in the Shire of Yilgarn.	Survey coincides with the Study Area.
BCE (2009).	9–15 Oct 2009	Level 2 fauna assessment of the southern Koolyanobbing Range.	Survey coincides with the Study Area.
BCE (2011).	March 2010	Extended Level 1 survey comprising a desktop review and reconnaissance survey of the Koolyanobbing Range.	Sites at the Koolyanobbing Range approximately 15 km northwest.

### 4.1.2 Database Searches

The following databases were searched to assist in the determination of the potential fauna assemblage of the Study Area:

1. NatureMap Database (<http://naturemap.dec.wa.gov.au>) (Appendix 3). This database is a joint project of DPaW and the WAM, and represents the most comprehensive source of information on the distribution of Western Australia's fauna and flora. It comprises records from the Fauna Survey Returns database and WA Threatened Fauna database (both maintained by DPaW), the WAM Specimen database, and BirdLife Australia's Birddata database. The search was performed in January 2013 and requested the return of records from a radius of 40 km around a central point within the Study Area (30°51'18" S 119°35'05" E).
2. The Commonwealth EPBC Act 1999 Protected Matters Database (Appendix 4). This database comprises matters of national environmental significance protected under the EPBC Act 1999, including Threatened Species of fauna and Migratory Species. The search was conducted in January 2013 and requested the return of records from a 40 km radius around the point listed above.
3. The Atlas of Living Australia (ALA) (<http://www.ala.org.au/>) (Appendix 5). The ALA is a joint project between academic collecting institutions, private individual collectors and community groups. It contains occurrence records, environmental data and images and lists the conservation status of species throughout Australia. This search was conducted in May 2013 and requested the return of records from a 10 km radius around the point listed above.
4. Biota's internal database of fauna records was also searched for records from studies completed in a 20 km radius around the point listed above.

No records were returned from the Biota database search. Records from the other database searches are included as appropriate in the list of species in Appendix 2.

## 4.2 Survey Timing and Weather

### 4.2.1 Timing

The fauna survey was completed over two phases. The Phase 1 survey was conducted over an eight-day period from 8–15 April 2013. The Phase 2 survey was conducted over a nine-day period from 22–30 October 2013.

### 4.2.2 Daily Weather Observations

Daily weather data for each survey phase were sourced from the Bureau of Meteorology (BOM). Rainfall data were taken from the Koolyanobbing weather station (number 12227), located approximately 1 km west of the Study Area. Daily temperatures were taken from the Southern Cross Airfield weather station (number 12320), located approximately 48 km south-southwest of the Study Area.

No rainfall was recorded during the Phase 1 survey. Maximum temperatures ranged from approximately 2°C to 37°C, while minimum temperatures ranged from approximately 14°C to 20°C (Table 4.2).

Table 4.2: Daily meteorological observations during the Phase 1 survey (8–15 April 2013).

Date	8/4	9/4	10/4	11/4	12/4	13/4	14/4	15/4	Total / Mean
Rainfall (mm)	0	0	0	0	0	0	0	0	Total = 0
Max Temp (°C)	35.9	36.3	36.4	37.0	32.0	29.1	30.7	31.4	Mean = 33.6
Min Temp (°C)	16.8	20.0	15.0	16.1	20.4	19.8	17.1	14.2	Mean = 17.4



No rainfall was recorded during the Phase 2 survey. Maximum temperatures ranged from approximately 23°C to 37°C, while minimum temperatures ranged from approximately 7°C to 19°C (Table 4.3).

Table 4.3: Daily meteorological observations during the Phase 2 survey (22–30 October 2013).

Date	22/10	23/10	24/10	25/10	26/10	27/10	28/10	29/10	30/10	Total / Mean
Rainfall (mm)	0	0	0	0	0	0	0	0	0	Total = 0
Max Temp (°C)	22.9	24.8	25.7	33.4	29.4	28.9	30.4	33.1	37.3	Mean = 29.5
Min Temp (°C)	6.7	9.2	13.8	12.8	13.5	12.8	12.8	15.9	18.9	Mean = 12.9

### 4.2.3 Climatological Data

The Study Area lies within the Yilgarn Shire in the Eastern Goldfields region of Western Australia. This region experiences a Mediterranean type climate with mild winters and warm to hot summers (Ohlsen and Murphy White 2005). Lower temperatures causing light frosts often occur during the summer months. While rainfall is typically higher during the winter months, the remnants of tropical cyclones moving from the north of the state can cause significant and irregular rainfall events during the summer (Ohlsen and Murphy White 2005).

Figure 4.1 charts the average monthly minimum and maximum temperatures and rainfall for the survey period and the year preceding each survey, with comparison also to the long-term averages from Koolyanobbing (BoM 2013). The Study Area received notably higher than average rainfall in the months leading up to Phase 1 of the survey.

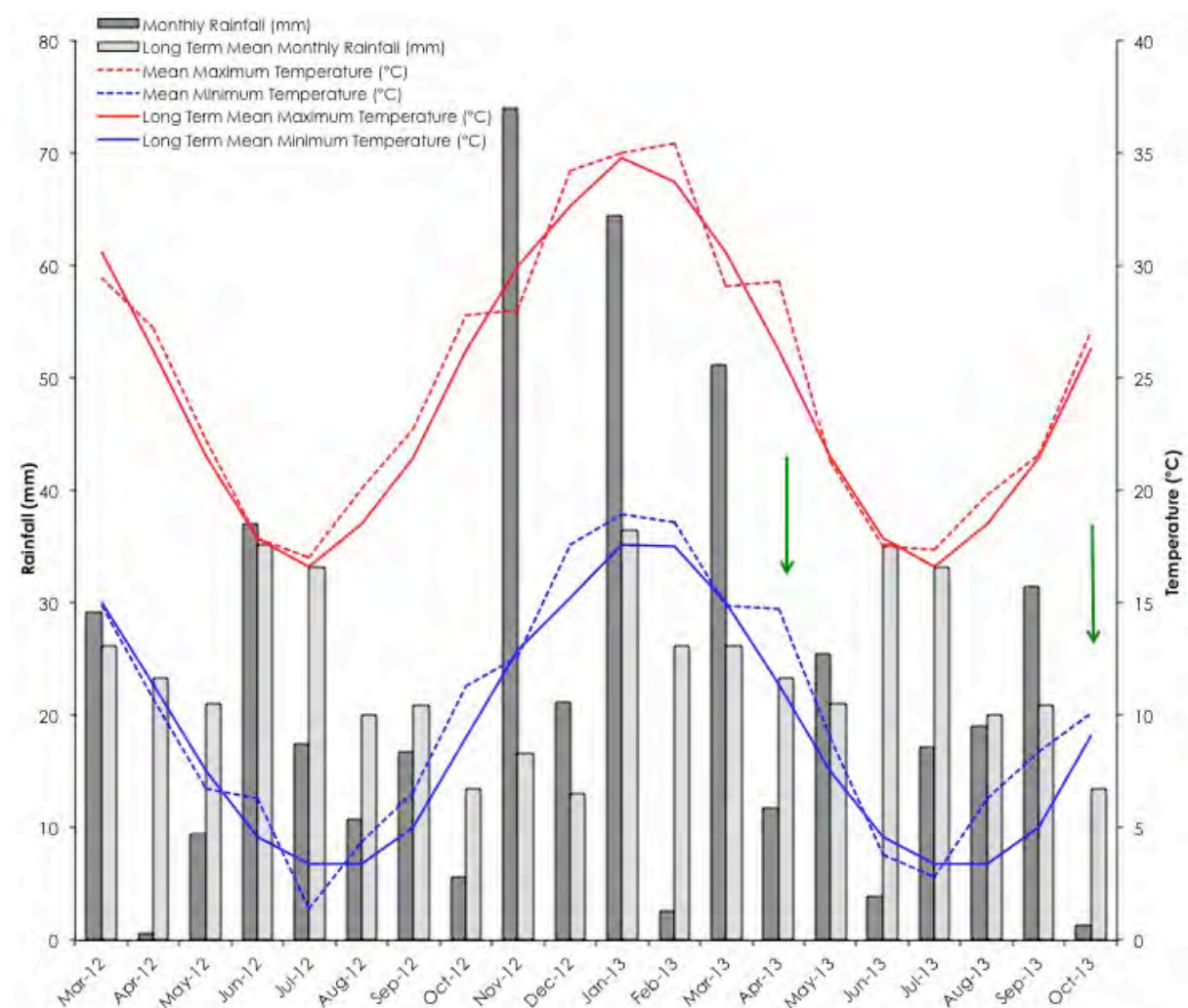


Figure 4.1: Monthly climate data for March 2012 to October 2013, together with long-term climate averages (temperature 1996–2013, rainfall 1967–2013) as recorded at Koolyanobbing. Arrows indicate timing of survey phases.

## 4.3 Fauna Survey and Reporting Team

The fauna survey was conducted under “Licence to Take Fauna for Scientific Purposes” No. SF009177 issued to Dr. Vickie Cartledge (Appendix 6).

The roles and experience of the members of the fauna survey and reporting team are detailed in Table 4.4.

Table 4.4: Role and experience of the members of the study team.

Team Member	Role in the Study	Position (Company)	Years Consulting
<b>Field Survey</b>			
Roy Teale	Field team leader (part Phase 1 and Phase 2)	Director/Principal Zoologist (Biota)	20+
Victoria Cartledge	Field team leader (part Phase 1)	Level 2 Zoologist (Biota)	5
Michael Greenham	Field team member (Phase 1)	Senior Zoologist (Biota)	11
David Keirle	Field team member (Phase 2)	Level 2 Zoologist (Biota)	5
Chris Cole	Field team member (part Phase 2)	Level 1 Zoologist (Biota)	3
<b>Data Management and Reporting</b>			
Jacinta King	Data entry, supplemental reporting	Graduate Zoologist (Biota)	2
Kylie Webster	Primary GIS analysis and mapping	Graduate Cartographer (Biota)	2
Ash Brown	Supplemental GIS analysis and mapping	Senior Cartographer (Biota)	15
Paul Sawers	Supplemental GIS analysis and mapping	GIS Manager (Biota)	20+
Victoria Cartledge	Primary reporting	Level 2 Zoologist (Biota)	5
David Keirle	Secondary reporting, peer review	Level 2 Zoologist (Biota)	5
Michi Maier	Final review	Director/Principal Botanist (Biota)	20+
Fiona Hedley	Format review	Office Administrator (Biota)	10
<b>Specialist Identifications and Advice</b>			
Bob Bullen	Specialist analysis of bat call recordings	Director (Bat Call WA)	15+
Ben Eckermann	Vegetation site descriptions	Senior Botanist (Biota)	8

## 4.4 Sampling of Vertebrate Fauna

### 4.4.1 Describing Fauna Landscapes and Selecting Sites

Fauna landscapes of the Study Area were mapped and used as the functional unit for this study. A fauna landscape is defined as a collection of similar landforms with definable functioning systems (Blandford 2012). Each fauna landscape can comprise numerous fauna habitats or niches. While each fauna landscape cannot be used to map the distribution of any single species, it is likely to offer a range of landforms and substrates comprising a suite of ecological niches that are distinct from other landscapes.

To ensure that survey effort encompassed the range of fauna landscapes present in the Study Area, preliminary fauna landscapes were mapped prior to the field survey based on analysis of:

- aerial imagery;
- a digital elevation model created from land contours;
- vegetation mapping by Beard (1980); and
- geological mapping by the Geological Survey of Western Australia (2002).

Indicative locations for fauna trapping and/or searching sites were then distributed across what appeared to be the likely fauna landscapes. These locations were subsequently ground-truthed in the field and a subset of the sites were chosen to be representative of the landforms present.

The resolution of the fauna landscape mapping is limited by the coarse nature of thematic layers available for the area.

Trapping sites were distributed amongst the two broad fauna landscapes of the Study Area and the landforms within them, which were broadly defined as:

#### Fauna Landscape 1: Southern Koolyanobbing Range

The landforms and sites established in this landscape comprised:

- Crest or upper slope: SKR01G, SKR05F, SKR07G, SKR10E;
- Midslope: SKR11E; and
- Footslope: SKR02G, SKR06G, SKR8G, SKRBat04.

Vegetation of the range was generally a tall shrubland dominated by *Banksia arborea*, *Acacia* sp. Mt Jackson (B. Ryan 176) and *Allocasuarina* sp. Soil types varied considerably between sites.

This landscape received the most trapping effort, as any potential mining development would likely focus on this landscape. Midslopes of the Study Area were generally not accessible by vehicle; hence only one site was established.

#### Fauna Landscape 2: Woodland Plains

The landforms and sites established in this landscape comprised:

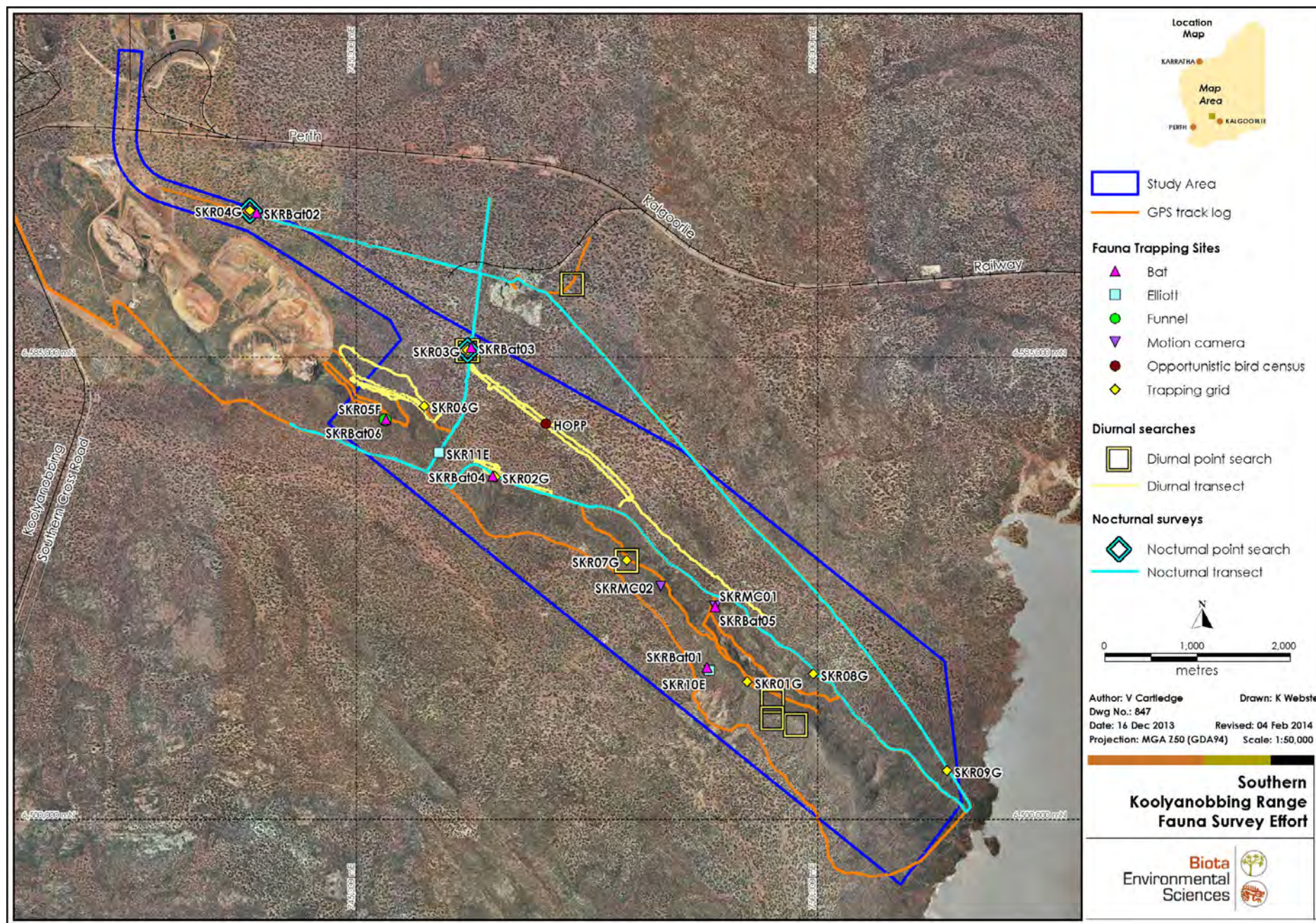
- Plain: SKR03G, SKRBat03; and
- Rolling plain: SKR04G, SKR09G, SKRBat02.

Vegetation of this landscape was a low open woodland of *Eucalyptus*.

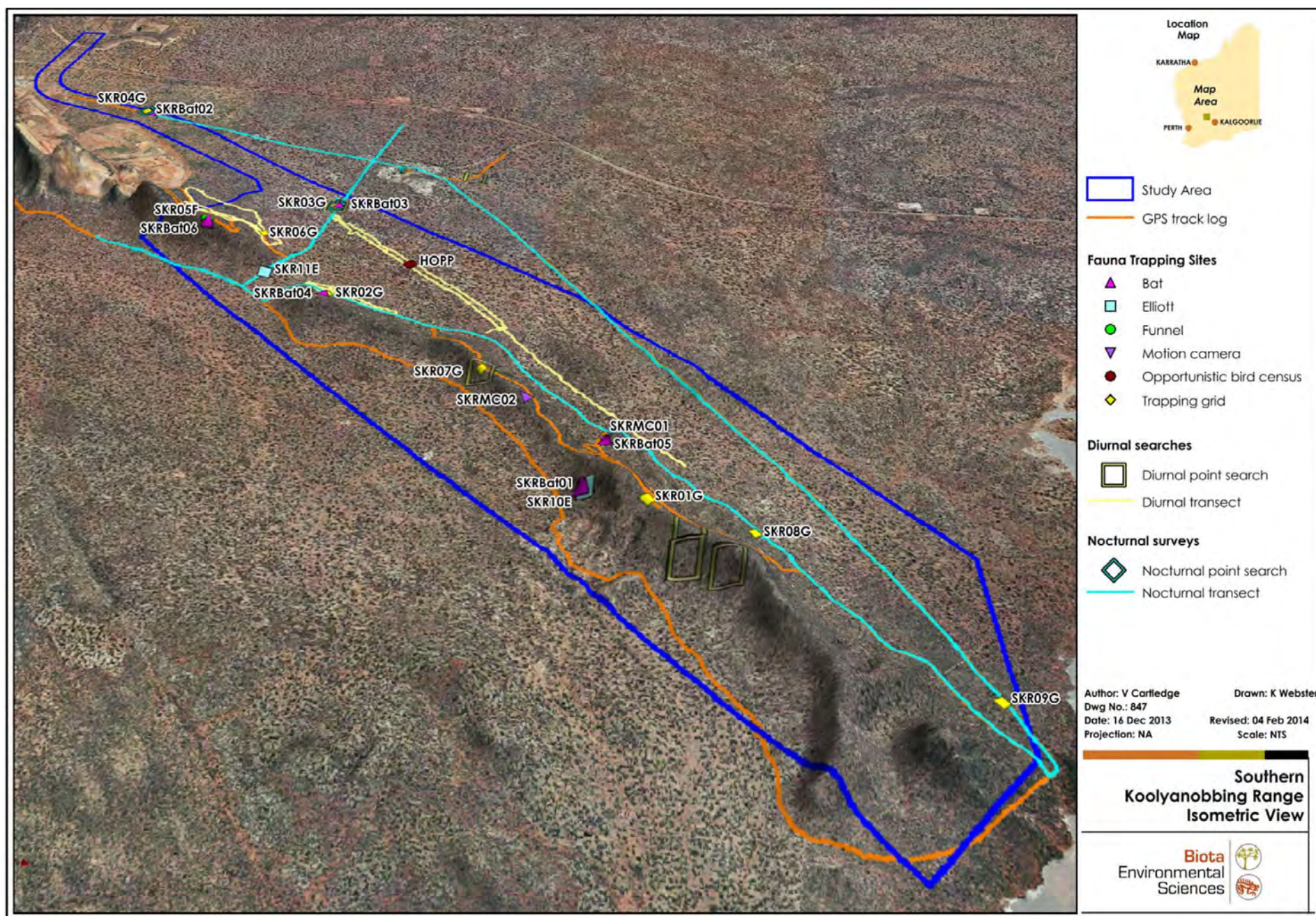
The location of trapping and search sites and transects in relation to the topography of the Study Area is illustrated in Figure 4.2.



(A)







(B)

Figure 4.2: Fauna survey sites in relation to the topography of the Study Area: A) digital elevation model, and B) isometric views.



#### 4.4.2 Systematic Trapping Effort and Method

Systematic sampling of vertebrate terrestrial fauna was carried out at 11 trapping locations with the aim of trapping as many species from the vertebrate fauna assemblage as possible. An integrated approach was employed using a variety of fauna sampling techniques and methodologies as described in EPA and DEC (2010) and summarised for the current study in Table 4.5.

Table 4.5: Sampling techniques and methodologies used in the current study.

Sampling Technique	Description	Faunal Group/s Targeted
Pit trap	Alternating plastic buckets and PVC pipes buried along a barrier drift fence, with the open top of the pit flush to the ground.	Small to medium-sized reptiles and mammals.
Funnel trap	A rectangular trap made from shade cloth covering a wire frame, with small funnel-shaped openings at each end. Laid parallel to barrier drift fence. Suited to rocky outcrops where installation of pit traps is problematic.	Snakes and some larger varanids that readily escape from pit traps. Small to medium-sized reptiles generally.
Elliott trap	Collapsible aluminium box trap. Baited.	Most rodent species and some larger marsupials.
Cage trap	Wire mesh cage available in a variety of sizes. Baited.	Larger mammal species including Chuditch ( <i>Dasyurus geoffroii</i> ).
Bat detector	Units that record ultrasonic and diagnostic bat calls. Analysed using appropriate computer software to distinguish species.	Echolocating bats.
Remote cameras	Remote digital cameras triggered by infrared movement sensors. Can be baited or passive. Can operate for extended periods of time.	Applications for most faunal groups. Particularly suited to shy or cryptic species (e.g. Malleefowl).
Observation	Various including active searching, spotlighting, bird observation, searching for traces (scats, tracks, nests).	Applications for most faunal groups. Particularly suited to species that are difficult to trap, nocturnal, or generally shy or cryptic.

Trapping sites were distributed across the range of fauna landscapes in the Study Area (Section 4.4.1), while giving consideration to access to ensure that traps could be checked in a timely manner each morning.

Each trapping site was one of the three types detailed below:

- Trapping grid (Figure 4.3): Eight individual sites comprised two pit-trap lines per site, with lines spaced 50–100 m apart. Within each trap line, six pit-fall traps of alternating 20 litre buckets and PVC tubes (150 mm diameter x 700 mm deep) were connected by a 60 m long, 30 cm high flywire drift fence. Parallel with each pit-trap line, a line of six Elliott box traps was set. Each Elliott trap line was comprised of a large Elliott trap at each end and four medium Elliott traps between, giving a total of 12 Elliott traps per site. Two Sheffield type cage traps were also set at opposite ends of each trapping grid. Two pairs of funnel traps were also set on each pit line between pitfall traps one and two, and five and six, giving a total of eight funnel traps per trapping grid. The trapping grid arrangement used was similar to that used by Biota elsewhere in the Murchison and Goldfields region, and is consistent with DPaW surveys carried out at Lorna Glen and Lake Mason (Mr Mark Cowan, DPaW, pers. comm. 2012).
- Elliott transect: One trapping transect in each phase consisted of a combination of 25 medium and 10 large Elliott box traps, which were spaced at 10–15 m intervals over a distance of approximately 500 m (Figure 4.4). These traps were baited with a universal bait mixture of peanut butter and oats.
- Funnel transect (Figure 4.5): One trapping transect consisted of funnel traps placed in pairs at approximately 9 m intervals adjacent to a 90 m length of 30 cm high fly wire fence. The funnel transect was installed on a rocky ridgetop (crest) where installation of a pit-line was not possible, and was run in both phases.

A summary of the trapping effort at each site is provided in Table 4.6, while a description of each site is provided in Table 4.7.

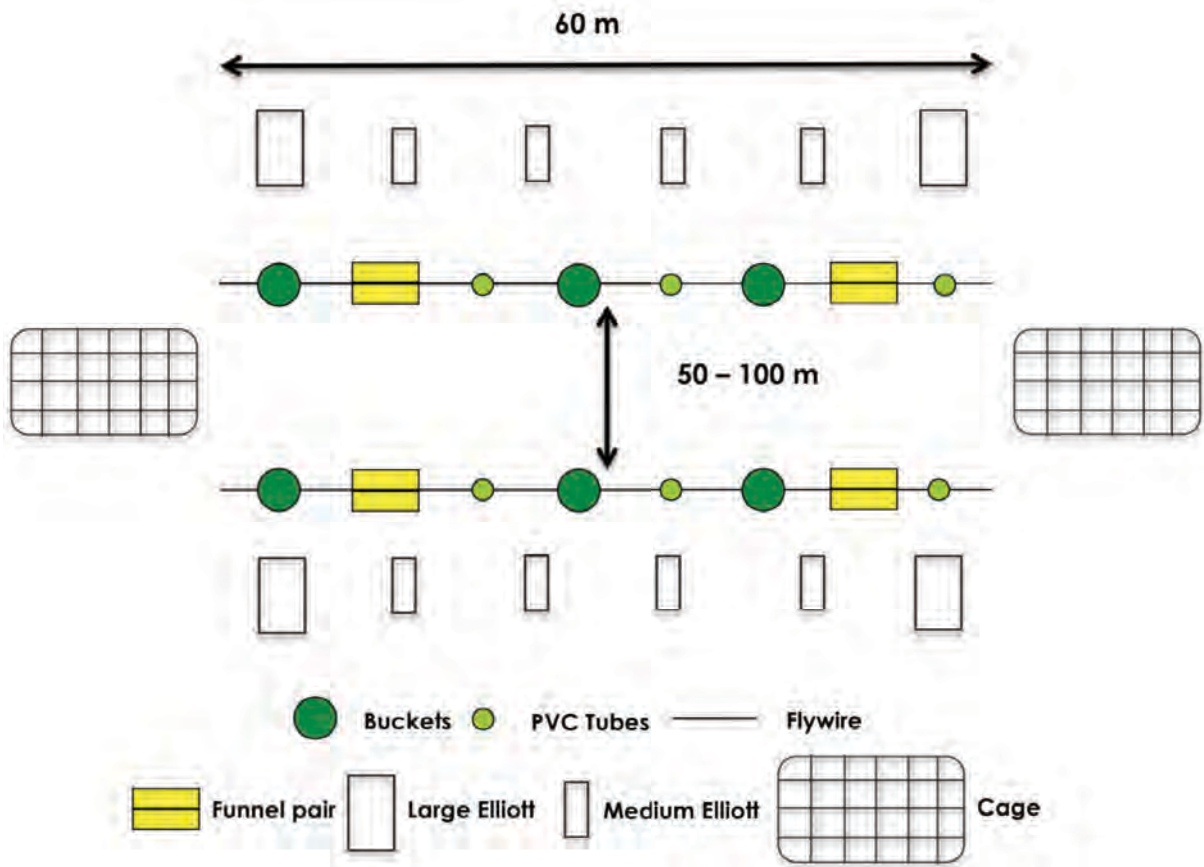


Figure 4.3: Layout of trapping grids.

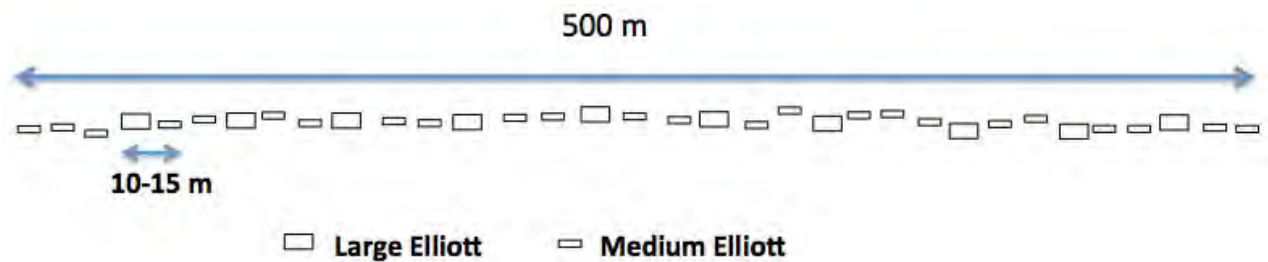


Figure 4.4: Layout of Elliott trapping transect.

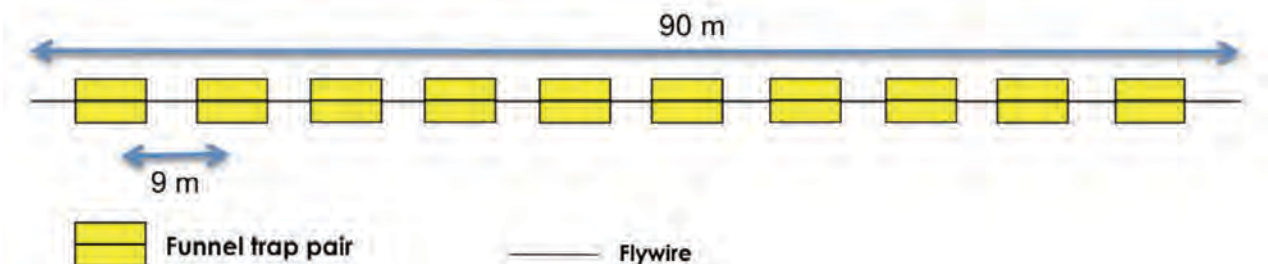


Figure 4.5: Layout of funnel trapping transect.

Table 4.6: Trapping site locations and effort applied within the Study Area.  
(All sites are in UTM Zone 50K, datum WGS84)

Site	Easting	Northing	Method	Phase 1					Phase 2				
				Start Date	End Date	Nights Open	No. of Traps	Trap Effort (trap-nights)	Start Date	End Date	Nights Open	No. of Traps	Trap Effort (trap-nights)
SKR01	749245	6581464	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	23/10/13	30/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14
SKR02G	746507	6583787	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	23/10/13	30/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14
SKR03G	746152	6585142	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	22/10/13	29/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14
SKR04G	743919	6586566	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	23/10/13	30/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14
SKR05F	745317	6584318	Funnel site	8/04/13	15/04/13	7	F: 20	F: 140	22/10/13	29/10/13	7	F: 20	F: 140
SKR06G	745744	6584494	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	22/10/13	29/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14
SKR07G	748073	6582727	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	23/10/13	30/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14
SKR08G	750016	6581674	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	23/10/13	30/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14

Site	Easting	Northing	Method	Phase 1					Phase 2				
				Start Date	End Date	Nights Open	No. of Traps	Trap Effort (trap-nights)	Start Date	End Date	Nights Open	No. of Traps	Trap Effort (trap-nights)
SKR09G	751391	6580533	Pitfall, Elliott, Funnel and Cage site	8/04/13	15/04/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14	23/10/13	30/10/13	7	P: 12 E: 12 F: 8 C: 2	P: 84 E: 84 F: 56 C: 14
SKR10E	748867	6581722	Elliott site	8/04/13	15/04/13	7	E: 35	E: 245	ns	ns	ns	ns	ns
SKR11E	745895	6583967	Elliott site	ns	ns	ns	ns	ns	23/10/13	29/10/13	6	E: 35	E: 210
SKRMC01	748890	6582303	Motion camera	ns	ns	ns	ns	ns	25/10/13	29/10/13	4	M: 1	M: 4
SKRMC02	748299	6582522	Motion camera	ns	ns	ns	ns	ns	25/10/13	29/10/13	4	M: 1	M: 4
P = Pit trap; E = Elliott trap; F = Funnel trap; C = Cage trap; M = Motion camera "ns" indicates not surveyed													Total Pit-trapping Effort (trap-nights).
													1,344
													Total Elliott-trapping Effort (trap-nights).
													1,799
													Total Funnel-trapping Effort (trap-nights).
													1,176
													Total Cage-trapping Effort (trap-nights).
													224
													Total Camera-trapping Effort (trap-nights).
													8

Table 4.7: Trapping site descriptions for the Study Area.

Site ID, Description & Site Photograph
<p>SKR01G</p> <p>Grid trapping site – pitfall, Elliott, cage and funnel traps.</p> <p>Landform: Ironstone ridge (upper slope).</p> <p>Vegetation: Scattered <i>Eucalyptus</i> sp. over Tall Shrubland (&gt;2 m) dominated by <i>Banksia arborea</i>, <i>Acacia</i> sp. Mt Jackson (B. Ryan 176) and <i>Allocasuarina acutivalvis</i> subsp. <i>acutivalvis</i> over Open Shrubland (1–2 m) dominated by <i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i>, <i>Philotheca brucei</i> subsp. <i>brucei</i> and <i>Eremophila</i> spp. over Low Open Shrubland (&lt;1 m) dominated by <i>Hibbertia lepidocalyx</i> subsp. <i>tuberculata</i> over Very Open Sedgeland dominated by <i>Lepidosperma ferricola</i>.</p> <p>Substrate: Ironstone gravel (2–30 mm diameter) forming discontinuous cover, with some outcropping ironstone and larger rocks (5–20 cm).</p> <p>Soil: Yellowish red (4/6, 5YR), sandy clay loam.</p> 
<p>SKR02G</p> <p>Grid trapping site - pitfall, Elliott, cage and funnel traps.</p> <p>Landform: Footslope.</p> <p>Vegetation: Tall Shrubland (&gt;2 m) dominated by <i>Acacia</i> sp. Mt Jackson (B. Ryan 176), <i>Acacia aneura</i> sens. lat. and some <i>Allocasuarina eriochlamys</i> subsp. <i>eriochlamys</i> over Open Shrubland (1–2 m) dominated by <i>Dodonaea inaequifolia</i>, <i>Eremophila granitica</i> and <i>Grevillea obliquistigma</i> subsp. <i>obliquistigma</i> over Scattered Bunch Grasses and Herbs.</p> <p>Substrate: Ironstone gravel (2–30 mm diameter) forming discontinuous cover.</p> <p>Soil: Red (4/6, 2.5YR), fine sandy loam.</p> 



## SKR03G

Grid trapping site - pitfall, Elliott, cage and funnel traps.

Landform: Plain.

Vegetation: Low Open Woodland dominated by *Eucalyptus ravida* over Low Open Shrubland dominated by *Eremophila scoparia*, *E. ionantha*, *Atriplex nummularia* subsp. *spathulata* and *Exocarpos aphyllus* over Low Shrubland dominated by *Atriplex bunburyana/vesicaria/stipitata*.

Substrate: Continuous fabric of subangular to subrounded quartz and ironstone gravels (2–15 mm diameter). Some areas of self-mulching clay.

Soil: Reddish brown (4/4, 5YR), medium clay.



## SKR04G

Grid trapping site - pit, Elliott, cage and funnel traps.

Landform: Rolling plain.

Vegetation: Low Open Woodland dominated by *Eucalyptus* spp. over Scattered Tall Shrubs dominated by *Acacia* spp. over Open Shrubland dominated by *Atriplex nummularia* subsp. *spathulata*, *Exocarpos aphyllus*, *Senna artemisioides* subsp. *filifolia* and *Eremophila ionantha* over Low Shrubland dominated by *Olearia muelleri*, *Acacia erinacea* and *Atriplex bunburyana/vesicaria/stipitata*.

Substrate: Matrix of weathered basalts, quartz and ironstone, generally subangular to subrounded (2–30 mm diameter). Larger stones are basalt.

Soil: Strong brown (4/6, 7.5YR), loam.



SKR05F

Funnel trapping line – pairs of funnel traps spaced along flywire drift fence.

Landform: Ironstone ridge (upper slope).

Vegetation: Scattered Trees of *Eucalyptus* sp. over Tall Shrubland (>2 m) dominated by *Banksia arborea*, *Acacia* sp. Mt Jackson (B. Ryan 176) and *Allocasuarina acutivalvis* subsp. *acutivalvis* over Open Shrubland (1–2 m) dominated by *Grevillea obliquistigma*, *Philotheca brucei* subsp. *brucei* and *Eremophila* spp. over Low Open Shrubland (<1 m) dominated by *Hibbertia lepidocalyx* subsp. *tuberculata* over Very Open Sedgeland dominated by *Lepidosperma ferricola*.

Substrate: Ironstone gravel (2–30 mm diameter) forming discontinuous cover, with some outcropping ironstone and larger rocks (5–20 cm).

Soil: Dark reddish brown (3/4, 2.5YR), fine sandy loam.



SKR06G

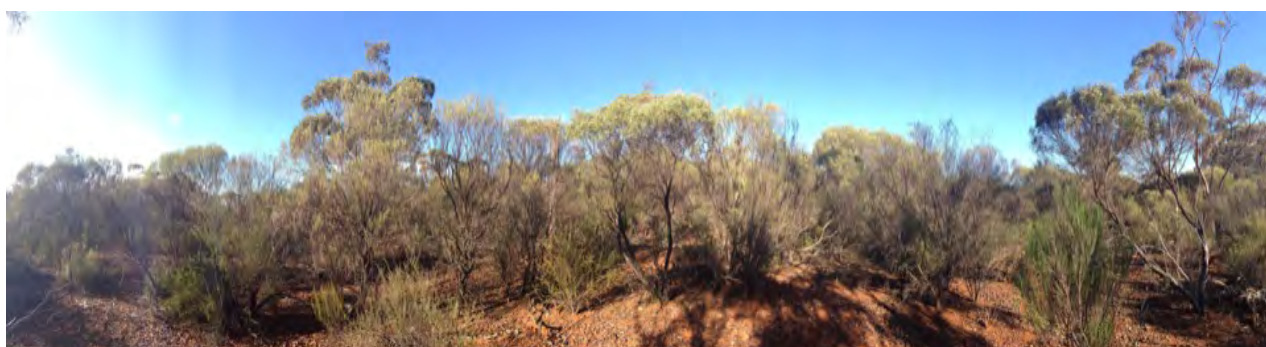
Grid trapping site - pitfall, Elliott, cage and funnel traps.

Landform: Lower slope, transitional slope.

Vegetation: Scattered Trees of *Eucalyptus loxophleba* subsp. *lissophloia* over Tall Shrubland dominated by *Acacia* sp. Mt Jackson (B. Ryan 176), *Acacia aneura* sens. lat. and *Eremophila oldfieldii* subsp. *angustifolia* over Open Shrubland dominated by *Scaevola spinescens* (narrow leaf spiny form), *Philotheca brucei* subsp. *brucei* and *Eremophila* spp.

Substrate: Discontinuous subangular to subrounded ironstone gravel (2–20 mm diameter).

Soil: Red (4/6 2.5YR), clay loam.





## SKR07G

Grid trapping site - pitfall, Elliott, cage and funnel traps.

Landform: Ironstone ridge crest.

Vegetation: Scattered Trees of *Eucalyptus* sp. over Tall Shrubland dominated by *Acacia* sp. Mt Jackson (B. Ryan 176) and *Allocasuarina actutivalvis* subsp. *acutivalvis* over Open Shrubland dominated by *Grevillea obliquistigma* subsp. *obliquistigma*, *Philotheca brucei* subsp. *brucei*, *Eremophila clarkei* and *E. latrobei* subsp. *latrobei*.

Substrate: Discontinuous matrix of ironstone gravel (2–20 mm diameter).

Soil: Dark red (3/6 2.5YR), fine sandy loam.



## SKR08G

Grid trapping site - pit, Elliott, cage and funnel traps.

Landform: Lower slope, transitional slope.

Vegetation: Scattered Trees of *Eucalyptus salubris* over Tall Shrubland dominated by *Acacia* sp. Mt Jackson (B. Ryan 176) and *Acacia tetragonophylla* over Shrubland dominated by *Grevillea obliquistigma* subsp. *obliquistigma*, *Philotheca brucei* subsp. *brucei*, *Scaevola spinescens* (narrow leaf spiny form) and *Dodonaea inaequifolia*.

Substrate: Discontinuous ironstone rock (10–50 mm diameter) matrix, some quartz gravel.

Soil: Dark red (3/6, 2.5YR), clay loam.



SKR09G

Grid trapping site - pitfall, Elliott, cage and funnel traps.

Landform: Lower slope to rolling plain.

Vegetation: Tall Shrubland dominated by *Allocasuarina eriochlamys* subsp. *eriochlamys* over Scattered Shrubs dominated by *Leucopogon* sp. Clyde Hill (M.A. Burgman 1207) and *Philotheca brucei* subsp. *brucei*.

Substrate: Continuous gravel matrix (2–20 mm diameter).

Soil: Yellowish red (5/6, 7.5YR), fine sandy clay loam.



SKR10E

Elliott trapping line – medium and large Elliott traps.

Landform: Rocky hill slope, upper slope. Elliotts placed amongst boulders and along rock face.

Vegetation: Scattered Trees of *Eucalyptus* sp. over Tall Open Shrubland dominated by *Banksia arborea* and *Acacia tetragonophylla* over Open Shrubland dominated by *Philotheca brucei* subsp. *brucei*, *Eremophila clarkei* and *Alyxia buxifolia* over Scattered Low Shrubs dominated by *Ptilotus obovatus* and *Chrysocephalum puteale*.

Substrate: Debris slope with ironstone boulders and rocks.

Soil: Dark red (3/6, 2.5YR), skeletal clay loam.



SKR11E

Elliott trapping line – medium and large Elliott traps.

Landform: Mid-slope, low rolling hills. Elliott transect located along mid-slope.

Vegetation: Low Open Woodland dominated by *Eucalyptus loxophleba* subsp. *lissophloia/supralaevis* over Tall Shrubland dominated by *Acacia* and *Eremophila* spp. over Low Open Shrubland dominated by *Olearia humilis*.

Substrate: Very slightly rocky, ironstone.

Soil: Dark reddish brown (3/4, 2.5 YR), fine sandy loam.



#### 4.4.3 Bird Censusing

Birds were sampled using a combination of techniques including:

- unbounded area searches (30-40 minutes duration) conducted at systematic trapping sites and an opportunistic location ("HOPP"; Figure 4.2) containing habitats likely to support previously unrecorded species;
- targeted searches for Malleefowl mounds (Section 4.4.6); and
- opportunistic observations of birds recorded during the survey (Section 4.4.6).

Individual censuses were confined to discrete landforms, which typically corresponded to vegetation type at each trapping site. Censuses were usually conducted between 6:00 am and 10:00 am (Table 4.8). Bird species were identified by sight or call.



Table 4.8: Date and time of avifauna surveys undertaken within the Study Area.

	Date	SKR01G	SKR02G	SKR03G	SKR04G	SKR05F	SKR06G	SKR07G	SKR08G	SKR09G	SKR10E	SKR11E	HOPP
Phase 1	9/04			08:30 - 09:00	09:17 - 09:47	06:52 - 07:22	07:39 - 08:09			10:18 - 10:48			
	10/04	07:07 - 07:37	08:37 - 09:07			09:16 - 09:46	09:51 - 10:21	07:50 - 08:20		06:10 - 06:40			
	11/04		10:10 - 10:40	06:41 - 07:11	06:03 - 06:33	09:30 - 10:00	07:15 - 07:45						
	12/04		09:25 - 09:55	06:55 - 07:25	06:11 - 06:41				10:03 - 10:33	07:50 - 08:20	08:37 - 09:07		14:40 - 15:20
	13/04	06:18 - 06:48	10:12 - 10:42	11:50 - 12:20	11:10 - 11:40			07:08 - 07:38	07:50 - 08:20	08:26 - 08:56	09:29 - 09:59		
	14/04			08:30 - 09:00	07:20 - 07:50	05:50 - 06:20	06:30 - 07:00		09:20 - 09:50	10:10 - 10:40	11:00 - 11:30		
	15/04	06:00 - 06:30						06:50 - 07:20	07:40 - 08:10		09:35 - 10:05		
Phase 2	25/10		09:25 - 09:55	06:47 - 07:17	06:04 - 06:34		08:50 - 09:20					08:12 - 08:50	
	26/10	06:31 - 07:01	08:55 - 09:25					08:01 - 08:31	07:19 - 07:49	05:45 - 06:15		09:28 - 09:58	
	27/10	09:50 - 10:20		06:51 - 07:21	07:31 - 08:01	06:11 - 06:41	05:34 - 06:04		09:08 - 09:38	08:25 - 08:55			
	28/10	08:25 - 08:55	07:09 - 07:39			05:45 - 06:15	06:24 - 06:54	07:46 - 08:16	09:04 - 09:34				
	29/10			05:45 - 06:15	06:39 - 07:09	08:45 - 09:15	07:54 - 08:24	09:34 - 10:04				07:20 - 07:50	
	30/10		05:05 - 05:35					05:56 - 09:26					
Total Minutes		180	240	240	240	210	240	210	210	210	120	98	40

#### 4.4.4 Bat Sampling

Bat sampling was undertaken at six locations within the Study Area. Bats were surveyed primarily using echolocation call recordings, supplemented by direct capture using a harp trap to aid in confirmation of identifications. The effort applied to sampling bats is detailed in Table 4.9.

Calls were sampled using Song Meter bat detector units (SM2BAT), which detect and record ultrasonic echolocation calls emitted by bats during flight. The selectable filters and triggers, jumper and audio settings used for the SM2BAT units followed the manufacturers recommendations for bat detection (Wildlife Acoustics 2010).


Sampling equipment was placed in locations considered likely to represent foraging, drinking and commuting activities of a range of species. Such habitats included open woodland; cave or rock shelter entrances overlooking valleys/gorges; and drainage lines. The sampling sites are described in Table 4.10.

Call details were analysed by Mr Bob Bullen (Bat Call WA) using the methods recommended by the Australasian Bat Society (2006) in conjunction with available reference data (Bullen and McKenzie 2002, McKenzie and Bullen 2003, 2009). Only sequences containing good quality search phase calls were considered for identification.




Table 4.9: Locations of bat sampling sites and sampling effort within the Study Area.

	Site	Easting (mE)	Northing (mN)	Method	Start	End	Nights Open
Phase 1	SKRBat01	748799	6581647	SM2	09/04/2013	11/04/2013	2
	SKRBat02 (SM2)	743919	6586566	SM2	11/04/2013	14/04/2013	3
	SKRBat02 (Harp)	743798	6586543	Harp	11/04/2013	11/04/2013	1
Phase 2	SKRBat03	746243	6585107	SM2	24/10/2013	27/10/2013	3
	SKRBat04	746477	6583715	SM2	27/10/2013	29/10/2013	2
	SKRBat05	748890	6582303	SM2	25/10/2013	27/10/2013	2
	SKRBat06	745321	6584327	SM2	27/10/2013	29/10/2013	2
Call Recording Total Nights							12
Harp Net Total Nights							1




Table 4.10: Descriptions of bat sampling sites.

Site ID and Description	Site Photograph
SKRBat01 (unit SM298-01)  Small cave entrance overlooking Eucalyptus closed woodland.	



Site ID and Description	Site Photograph
<p>SKRBat02 (Harp)</p> <p><i>Eucalyptus</i> open woodland over mixed <i>Acacia</i>, <i>Eremophila</i> and other shrubs.</p>	
<p>SKRBat02 (SM2) (unit SM298-02)</p> <p><i>Eucalyptus</i> open woodland over mixed <i>Acacia</i>, <i>Eremophila</i> and other shrubs.</p>	
<p>SKRBat03 (unit SM284-01)</p> <p>Isolated rock outcrop overlooking <i>Eucalyptus</i> open woodland.</p>	



Site ID and Description	Site Photograph
<p>SKRBat04 (unit SM284-02)</p> <p><i>Eucalyptus</i> open woodland over mixed <i>Acacia</i>, <i>Eremophila</i> and other shrubs.</p>	
<p>SKRBat05 (unit SM285-01)</p> <p>Small cave overlooking <i>Eucalyptus</i> open woodland over mixed <i>Acacia</i>, <i>Eremophila</i> and other shrubs.</p>	
<p>SKRBat06 (unit SM285-02)</p> <p>Top of rock outcrop overlooking open <i>Eucalyptus</i> woodland over mixed <i>Acacia</i>, <i>Eremophila</i> and other mixed shrubs.</p>	



#### 4.4.5 Remote Cameras

Two Bushnell Trophy Cam remote cameras were deployed in the Study Area (Table 4.11). One was a Cliffs' camera left on-site to monitor a potentially active Malleefowl mound (SKRMC02) over the summer, when breeding activity would be expected (if the mound was indeed active). The second camera (SKRMC01) was placed at a small cave where mammal scats were noted, potentially belonging to Woolley's Pseudantechinus.

Table 4.11: Descriptions of remote camera deployment sites.

Site ID and Description	Site Photograph
<p>SKRMC01</p> <p>Small cave overlooking Eucalyptus open woodland over mixed Acacia, Eremophila and other shrubs.</p>	
<p>SKRMC02</p> <p>Potentially active Malleefowl mound.</p> <p>Cliffs' remote camera site left at this mound for monitoring (25/10/2013 – ongoing).</p>	

#### 4.4.6 Fauna Search Sites

Transect searches and point searches were undertaken to more fully characterise the habitats of the Study Area and to supplement the species inventory obtained through trapping. These sites were selected while traversing the Study Area or, in the case of areas away from access tracks, were identified from aerial photography. The aim was to locate, search and describe habitats that may support fauna of conservation significance, habitat-specific species, SRE taxa, and species not likely to be trapped by other survey components.



A range of techniques were used for these additional searches including:

- searching of microhabitats for reptile, frog and mammal species that are not commonly recorded through trapping;
- nocturnal searches (night-spotting) for nocturnal birds such as owls, owlet-nightjars, frogmouths and nightjars, and also for species that are not easily trapped (e.g. some snakes and geckos); and
- identification and recording of opportunistic sightings of individuals, as well as secondary signs such as tracks, scats, mounds and diggings.

A number of Malleefowl mounds were identified by Biota staff while conducting habitat searches, and the activity status of these nest mounds was assessed. The description method for Malleefowl mounds employed by Biota was consistent with methods specified by the national manual for the Malleefowl Monitoring System (National Heritage Trust 2007).

Malleefowl mounds were also recorded by botanists from Woodman Environmental Consulting (Woodman) and Maia Environmental Consultancy (Maia) in 2013 in the process of conducting botanical surveys of the southern Koolyanobbing Range. Where possible, mounds recorded as potentially active were revisited by Biota zoologists to confirm their activity status. To ensure that the botanical teams had been generally correct in distinguishing inactive from active mounds, a subset of mounds recorded as active by the botanists were visited and described. For the remainder of the mounds, the status was checked using photos taken by the botanists.

## 4.5 Data Analysis

### 4.5.1 Species Richness

The total number of species recorded, or species richness, is the simplest representation of species diversity. This was compared to the potential species assemblage (as predicted from species distribution, previous records and the availability of habitat) with the aim of determining if the species richness recorded was equal or greater than expected.

### 4.5.2 Species Accumulation Curves

Species accumulation curves graph the incremental increase in the number of new species recorded as a function of the effort applied. When a survey has sampled a high proportion of the faunal community, the curve will plateau and approach an asymptote. In this way, the species accumulation curve can provide an indication of survey adequacy. Furthermore, asymptotic estimators can be used to estimate asymptotic richness; that is, the total number of species that may have been recorded with more effort and employing the same methodology.

EstimateS version 9.0.0 (Colwell 2013) was used to calculate smoothed species accumulation curves based on 1,000 random permutations of the species data. Three species richness estimators were used to extrapolate species richness within the Study Area: the Bootstrap, Chao 1 and Jack-knife richness estimators. The average of these three estimators was compared to the observed species richness.

Species recorded from targeted trapping methodologies (e.g. bat targeted trapping and targeted use of Elliott traps) were excluded from the analysis due to the limited scope of these methodologies to capture a diversity of species. Opportunistic fauna records were also removed from the data, given the unpredictable nature of such records that are not derived from equivalent sampling methods across sites. Excluding targeted trapping and opportunistic records meant that sampling data was consistent and the species accumulation curves could be validly extrapolated.

### 4.5.3 Assemblage Resemblance

A screened site-by-species matrix for each fauna group was imported into PRIMER v6 software and square-root transformed to reduce the influence of high abundance species on the similarity analyses (Clarke and Gorley 2006). A resemblance matrix was then constructed using the Bray-Curtis similarity index, which produces a similarity value for all pairs of sites based on species representation and transformed abundances. The resultant resemblance matrix was then run through PRIMER's CLUSTER routine, using group average linkage to construct a dendrogram. This grouped the survey sites into clusters based on the similarity of species composition. Sites were labeled according to the landscape unit they fell within to examine if assemblage similarity aligned with landform.

Records were screened to remove data with the potential to bias the results. For each vertebrate class, sites incorporating trapping methodologies that were unlikely to detect individuals of that vertebrate class were removed (e.g. funnel trap site results were not included in the mammal data set, and Elliott trap site results were not included in the reptile data set). The inclusion of results from such sites would introduce many null records into the data set, which would tend to mask any real similarities between sites.

## 4.6 Nomenclature

In accordance with the requirements of EPA and DEC (2010), species nomenclature for herpetofauna and mammals follows the standards of the WAM fauna taxonomic checklist, while avifauna nomenclature follows Christidis and Boles (2008).

## 4.7 Survey Limitations

Systematic fauna sampling was completed in all fauna landscapes and was considered to represent the range of landforms and land systems present in the Study Area. Whilst noting the above, it is not possible for any survey to ground-truth or systematically sample equally every part of the Study Area. Specifically for this survey, installation and regular checking of fauna traps was not possible in areas that were inaccessible by vehicle.

The EPA Guidance Statement 56 (EPA 2004) outlines a number of limitations that may arise during surveying. These survey limitations are addressed below in Table 4.12.

Table 4.12: Discussion of potential survey limitations.

Limitation	Comment
Level of survey.	Level 2 survey considered appropriate and supplements previous surveys of the Koolyanobbing Range and surrounds (see Table 4.1 for examples).
Competency/experience of the consultant(s) carrying out the survey.	The consultants have had extensive experience and were appropriately qualified to conduct the survey (see Table 4.4 for personnel).
Scope (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	Systematic and non-systematic sampling techniques were used (see Section 4.4). Targeted searches were conducted for key faunal groups and significant taxa.
Proportion of fauna identified, recorded and/or collected.	The species richness recorded from the current study is comparable or higher than other Level 2 studies that have been conducted in the local area (see Section 5.6).
Sources of information; e.g. previously available information (whether historic or recent) as distinct from new data.	Searches of various databases (the DPaW and WA Museum (WAM) NatureMap database, DPaW Threatened Fauna Database, Biota Internal Database and EPBC Act 1999 Protected Matters Database) were completed, along with a review of reports from previous surveys in the locality (Section 4.1).

Limitation	Comment
The proportion of the task achieved and further work which might be needed.	Level 2 survey completed.
Timing/weather/season/cycle.	Autumn survey completed in April 2013 (Phase 1), followed by a spring survey in October 2013 (Phase 2). Survey timing was appropriate for major faunal groups.
Disturbances (e.g. fire, flood, accidental human intervention etc.) that affected results of survey.	No disturbances affected the survey.
Intensity (In retrospect, was the intensity adequate?)	Survey intensity was adequate to record the fauna assemblage present, and to identify conservation significant fauna.
Completeness (e.g. was relevant area fully surveyed).	The Study Area was comprehensively surveyed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Adequate resources were employed. All vertebrate taxa were identified to species level.
Remoteness and/or access problems.	No significant access problems were experienced. Installation and regular checking of fauna traps was not possible in some areas due to inaccessibility by vehicle.
Availability of contextual (e.g. biogeographic) information on the region.	Considerable contextual information available from previous surveys and regional studies.

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## 5.0 Results

### 5.1 Vertebrate Fauna Overview

A total of 106 species of vertebrate fauna from 45 families (six mammal, 29 bird, nine reptile and one amphibian family) were recorded from the Study Area during the survey. Table 5.1 provides a summary of the number of species recorded from each major vertebrate group during each survey phase.

Table 5.1: Overview of vertebrate fauna recorded from the Study Area.

Fauna Group	Number of Species		Total Number of Species
	Phase 1	Phase 2	
Native ground-dwelling mammals	4	4	5
Introduced ground-dwelling mammals	2	1	2
Bats	8	8	8
Birds	50	47	57
Reptiles	22	29	33
Amphibians	1	0	1
Totals	87	89	106

While the total number of species recorded from each phase of surveying was similar, the second phase of surveying added 19 new species that were not recorded during the Phase 1 survey; 11 reptile species, seven bird and one mammal species.

### 5.2 Mammals

#### 5.2.1 Mammals of Conservation Significance

No mammals of conservation significance were recorded within the Study Area.

Scats potentially belonging to Woolley's *Pseudantechinus* were observed during the current survey but were not able to be confirmed. Whilst not classified as being of conservation significance, this species is noted by DEC (2007) as being regionally dependent on ironstone habitat. This species was previously recorded in the Study Area by Aprasia and Globe (2009) based on scats. The Study Area is at the southern extent of the range of this species.

#### 5.2.2 Ground-dwelling Mammals

Seven ground-dwelling mammal species were recorded in the Study Area, two of which are introduced (non-native) (Table 5.2).

Two species of ground-dwelling mammal that are now extinct from the broader region were recorded from secondary traces. These comprised:

- a mound that was previously a warren of the Burrowing Bettong or Boodie (*Bettongia lesueur*); and
- the remains of a stick-nest belonging to a Stick-nest Rat (*Leporillus* sp.).

These two species were not included in calculations of the number of species in the fauna assemblage, as individuals of these species were not recorded as being present.

Of the ground-dwelling mammal families recorded, the family Muridae was the most speciose, represented by five species. Ground-dwelling mammals accounted for 7% of the species recorded during the survey.

Introduced mammal taxa recorded in the Study Area included the European rabbit (*Oryctolagus cuniculus*), which was common, with individuals, diggings, small warrens and scats noted at numerous locations. The House Mouse (*Mus musculus*) was trapped at two sites during Phase 1 but was not recorded during Phase 2.

The record of two individuals of Mitchell's Hopping Mouse (*Notomys mitchellii*) was notable as these represent the only records for the local area (as indicated by the desktop review). This species has a preference for sandier substrates, which is in keeping with the sandy clay loam of the woodlands site at which it was recorded. This habitat type does not occur on the range and is generally limited within the Study Area and surrounds.

### **5.2.3        Bats**

A microbat assemblage of eight insectivorous species from two families was recorded within the Study Area on the basis of echolocation call recordings (Table 5.2). These included all of the bat species that were identified through the desktop review as potentially occurring in the Study Area.

Bat activity on the bat detector units was variable between sites, but was generally 'Low' (as defined in Appendix 7). The evening bats (*Vespertilionidae*) were the best represented of the two bat families, with six species recorded. Bats represented 8% of all vertebrate species recorded within the Study Area.

Table 5.2: Mammals recorded from the Study Area.

Family Species	Site / Phase	SKR01		SKR02		SKR03	SKR04	SKR06	SKR07		SKR08	SKR09		SKRBat01	SKRBat02 (SM2)	SKRBat02 (Harp)	SKRBat03	SKRBat04	SKRBat05	SKRBat06	Opp.		Total
	Common Name	P1	P2	P1	P2	P1	P2	P1	P1	P2	P2	P1	P2	P1	P1	P1	P2	P2	P2	P2	P1	P2	
Dasyuridae																							
<i>Sminthopsis dolichura</i>	Little long-tailed Dunnart								1		2												3
Potoroidae																							
<i>Bettongia lesueur</i> <sup>Ex</sup>	Burrowing Bettong, Boodie																				M		
Burramyidae																							
<i>Cercartetus concinnus</i>	Western Pygmy-possum		1		2		1			3	1	2	1										11
Vespertilionidae																							
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat													1	1		1	1	1	1			
<i>Chalinolobus morio</i>	Chocolate Wattled Bat													1			1		1				
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat													1	1		1	1	1				
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat													1	1			1					
<i>Vespadelus baverstocki</i>	Inland Forest Bat														1		1						
<i>Vespadelus regulus</i>	Southern Forest Bat														1		1		1	1			
Molossidae																							
<i>Mormopterus</i> sp. 3 <sup>**</sup>	-													1	1		1	1	1	1			
<i>Tadarida australis</i>	White-striped Freetail-bat													1	1		1	1	1	1			
Muridae																							
<i>Leporillus</i> sp. <sup>Ex</sup>	Stick-nest Rat																				T		
<i>Mus musculus</i> <sup>*</sup>	House Mouse	1							2														3
<i>Notomys mitchellii</i>	Mitchell's Hopping-mouse												2										2
<i>Pseudomys bolami</i>	Bolam's Mouse			1							1												2
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse			1				1	1			2											5
Leporidae																							
<i>Oryctolagus cuniculus</i> <sup>*</sup>	Rabbit					3	1																4

Total Individuals		1	1	2	2	3	2	1	4	3	4	4	3	6	7	0	7	5	6	4	0	0	30
Species per Site		1	1	2	1	1	2	1	3	1	3	2	2	6	7	0	7	5	6	4	1	1	7

Opp. denotes an opportunistic record; P1 = Phase 1, P2 = Phase 2.

Ex Extinct.

\* Introduced.

\*\* *Mormopterus* sp. 3 (form sp. 3 as recognised in Adams et al. (1988); species currently under revision).

M Mound (old).

T Trace (old nest).

## 5.3 Avifauna

### 5.3.1 Avifauna of Conservation Significance

Six conservation significant bird species were recorded from the Study Area:

- Malleefowl (*Leipoa ocellata*) (Threatened Species and Migratory Species under the EPBC Act 1999, Specially Protected Fauna under the Wildlife Conservation Act 1950): three recently active mounds (one including a dead chick) and five sets of fresh tracks were recorded, as well as 28 inactive mounds; no live individuals were recorded;
- Major Mitchell's Cockatoo (*Lophochroa leadbeateri*) (Specially Protected Fauna under the Wildlife Conservation Act 1950): this species was recorded during bird censuses at sites SKR09G, SKR08G and SKR07G, and was recorded opportunistically at another location;
- Peregrine Falcon (*Falco peregrinus*) (Specially Protected Fauna under the Wildlife Conservation Act 1950): this species was recorded opportunistically just south of the Study Area;
- Rainbow Bee-eater (*Merops ornatus*) (Migratory Species under the EPBC Act 1999 and Specially Protected Fauna under the Wildlife Conservation Act 1950): this species was observed at three sites (SKR02G, SKR04G and SKR06G);
- Little Woodswallow (*Artamus minor*) (reliant on ironstone regionally; DEC 2007): this species was recorded from three sites (SKR03G, SKR05G and SKR09G) during the systematic bird censuses; and
- Gilbert's Whistler (*Pachycephala inornata*) (reliant on ironstone regionally; DEC 2007): recorded from six sites (SKR01G, SKR02G, SKR04G, SKR06G, SKR07G and SKR08G) during the systematic bird censuses.

Further details for each of these species are provided in Section 6.0.

### 5.3.2 The Assemblage

Fifty-seven bird species were recorded from the Study Area. Twenty-nine families were represented, the most species-rich of which was the Meliphagidae (honeyeaters) with eight species recorded (Table 5.3). Avifauna represented 54% of the 103 vertebrate fauna species recorded within the Study Area.

The Weebill (*Smicrornis brevirostris*) was the most abundant species with 300 records, representing 20% of the individual birds recorded. Greater than 100 individuals were recorded for three other species; the Striated Pardalote with 117 individuals, the Spiny-cheeked Honeyeater with 113 and the Yellow-plumed Honeyeater with 112. Together these records accounted for a further approximately 23% of the total number of avifauna records (i.e. the four species together accounted for approximately 43% of all avifauna individuals recorded).

Seven bird species were represented by a single record. These comprised the Little Crow, White-winged Triller, Red-backed Kingfisher, Black-eared Cuckoo, Crested Pigeon, Whistling Kite and Goshawk (Table 5.3).



Table 5.3: Avifauna recorded from within the Study Area.

Family Species	Common Name	SKR01G		SKR02G		SKR03G		SKR04G		SKR05G		SKR06G		SKR07G		SKR08G		SKR09G		SKR10E	SKR11E	HOPP	Opp.		Total
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P1	P2	
Megapodiidae																									
<i>Leipoa ocellata</i> <sup>T, M, S</sup>	Malleefowl		1	1			1	1						1									1	8	14
Columbidae																									
<i>Phaps chalcoptera</i>	Common Bronzewing	1				2																		3	
<i>Ocyphaps lophotes</i>	Crested Pigeon					1																		1	
Podargidae																									
<i>Podargus strigoides</i>	Tawny Frogmouth					2												1						3	
Eurostopodidae																									
<i>Eurostopodus argus</i>	Spotted Nightjar																	1					1	2	
Aegothelidae																									
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar																		1					1	
Accipitridae																									
<i>Haliastur sphenurus</i>	Whistling Kite										1													1	
<i>Accipiter fasciatus</i>	Brown Goshawk																		1					1	
Falconidae																									
<i>Falco berigora</i>	Brown Falcon															1			1					2	
<i>Falco peregrinus</i> <sup>S</sup>	Peregrine Falcon																					1			
Cacatuidae																									
<i>Lophochroa leadbeateri</i> <sup>S</sup>	Major Mitchell's Cockatoo													1	5		5						5		16
Psittacidae																									
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet												12							2				14	
<i>Barnardius zonarius</i>	Australian Ringneck		2	2	6	3	4	7	4	2	2		3	3	2		3		1	2		1		47	
Cuculidae																									
<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo										1						1							2	
<i>Chalcites osculans</i>	Black-eared Cuckoo														1									1	
Strigidae																									
<i>Ninox novaeseelandiae</i>	Southern Boobook						1												1				1	3	
Halcyonidae																									
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher																1							1	
Meropidae																									
<i>Merops ornatus</i> <sup>M, S</sup>	Rainbow Bee-eater				1				6								3							10	
Climacteridae																									
<i>Climacteris rufa</i>	Rufous Treecreeper					2	11	11	9								3			1	1	3		41	
Maluridae																									
<i>Malurus lamberti</i>	Variegated Fairy-wren			7	3					4		4	10		1	2	4	2	1		1			39	
Acanthizidae																									
<i>Pyrrholaemus brunneus</i>	Redthroat	1		2						1	1	2				1				2				10	
<i>Smicrornis brevirostris</i>	Weebill	4	15	18	25	4	3	12	12	9	3	32	22	25	6	29	13	14	7	28	18	1		300	
<i>Gerygone fusca</i>	Western Gerygone			2													1							3	
<i>Acanthiza robustirostris</i>	Slaty-backed Thornbill							6									4							10	
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			2				1																3	
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill							6				5						3		3	7			24	
<i>Acanthiza apicalis</i>	Inland Thornbill		3	3	2	2		4		1		4	3			5				1	1			29	
Pardalotidae																									
<i>Pardalotus striatus</i>	Striated Pardalote		3	4	5	5	2	47	6		1	6	8	2		3	5	2		11	6	1		117	
Meliphagidae																									
<i>Lichenostomus virescens</i>	Singing Honeyeater	2	1	2	1	1		4		3		2	2	5	4	5	1	2	1					36	
<i>Lichenostomus leucotis</i>	White-eared Honeyeater	7		1	4	1						3	1	5	1	2		5	1	8	2			41	
<i>Lichenostomus ornatus</i>	Yellow-plumed Honeyeater			1	3	31	16	23	16				3	1			8		2		3	5		112	
<i>Purnella albifrons</i>	White-fronted honeyeater									1		2	1	1		29			1	10				45	

Family Species	Common Name	SKR01G		SKR02G		SKR03G		SKR04G		SKR05G		SKR06G		SKR07G		SKR08G		SKR09G		SKR10E	SKR11E	HOPP		Opp.		Total
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P1	P2		
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		6	17	2	11		5	2	1		8	1	3	2	4	7	3		37	2	2			113	
Anthochaera carunculata	Red Wattlebird			4	3	22		12	1			5		4		4		2	21		1			79		
Lichmera indistincta	Brown Honeyeater		25	2				5		3	12		1	1	6	2	1	1		1	2			62		
Melithreptus brevirostris	Brown-headed Honeyeater		1											2					4	3				10		
Pomatostomidae																										
Pomatostomus superciliosus	White-browed Babbler			6	5	1	2		3			4	5			1	2	1			1			31		
Eupetidae																										
Cinclosoma castanotum	Chestnut Quail-thrush							3								1		2			1			7		
Neosittidae																										
Daphoenositta chrysoptera	Varied Sittella																			4				4		
Campephagidae																										
Coracina novaehollandiae	Black-faced Cuckoo-shrike					6	1	3				1	4							3	4			22		
Lalage sueurii	White-winged Triller													1										1		
Pachycephalidae																										
Pachycephala inornata <sup>1</sup>	Gilbert's Whistler	2	1		1				2			4		1	2	3								16		
Pachycephala rufiventris	Rufous Whistler	3	3	1	3	1	2	1	1		4		3		2	2	3		2		1			32		
Colluricincla harmonica	Grey Shrike-thrush	4	2		1	1	3							4	1	1			1	4				22		
Oreoica gutturalis	Crested Bellbird	3		2	1	7	4	5	2			2	1		1	2	3	1	1		1	1		37		
Artamidae																										
Artamus cyanopterus	Dusky Woodswallow	2							3												5			10		
Artamus minor <sup>1</sup>	Little Woodswallow					1				2							3							6		
Cracticus torquatus	Grey Butcherbird			1		1		2		2									1		1			8		
Cracticus nigrogularis	Pied Butcherbird					4		3		1			1			3								12		
Cracticus tibicen	Australian Magpie					1		2						2										5		
Strepera versicolor	Grey Currawong			2	3	4		3			1	1	2	6	1	1			15	1				40		
Rhipiduridae																										
Rhipidura leucophrys	Willie Wagtail							3											2					5		
Corvidae																										
Corvus coronoides	Australian Raven			2		2		4	1	1		4				2								16		
Corvus bennetti	Little Crow							1																1		
Petroicidae																										
Microeca fascinans	Jacky Winter				1			3																4		
Petroica goodenovii	Red-capped Robin			2					1			3				5	5							16		
Hirundinidae																										
Petrochelidon nigricans	Tree Martin							8	8							1					6			23		

Total Individuals		29	63	84	70	116	50	185	77	30	27	87	72	80	32	110	74	42	27	151	60	32	6	10	1,514
Species per Site		10	12	22	18	24	12	27	16	13	9	16	18	16	16	21	22	12	14	21	18	13	3	9	56

Opp. denotes an opportunistic record; P1 = Phase 1, P2 = Phase 2.  
T Threatened Species under the EPBC Act 1999.  
M Migratory Species under the EPBC Act 1999.  
S Specially Protected Fauna under the Wildlife Conservation Act 1950.  
I Ironstone habitat dependent regionally (DEC 2007).

## 5.4 Reptiles

### 5.4.1 Reptiles of Conservation Significance

One reptile recorded from the Study Area is potentially of conservation significance:

- The Slender Blue-tongue (*Cyclodomorphus melanops*) (ironstone habitat restricted; DEC 2007): one individual was recorded, representing the southernmost record of this species, with the location being disparate from the more common range of the species. This record may represent the subspecies *Cyclodomorphus melanops elongatus*, which is thought to be an ironstone habitat specialist in the more southerly areas of its distribution (DEC 2007).

### 5.4.2 The Assemblage

Thirty-three reptile species were recorded from the Study Area. Of the nine families represented in the assemblage, the most species-rich was the Scincidae (skinks) with 11 species (Table 5.4). Reptiles represented 31% of all vertebrate species recorded in the Study Area.

The most abundant species was the gecko *Gehyra variegata* with 30 individuals recorded, accounting for 12% of the total number of reptile individuals. Other commonly recorded species included the gecko *Diplodactylus pulcher* with 28 individuals, and the skink *Ctenotus uber* with 27 individuals. These three species accounted for approximately 35% of all reptile individuals recorded within the Study Area.

Four reptile species were recorded from a single individual. These comprised the Slender Blue-tongue (*Cyclodomorphus melanops*), Western Blue-tongue (*Tiliqua occipitalis*), Perentie (*Varanus giganteus*) and *Lerista macropisthopus* (Table 5.4).

The second phase of the survey added 11 species to the reptile assemblage inventory, including two elapid snakes, two blind snakes, one monitor lizard, four skinks, one gecko and one dragon.

Table 5.4: Reptile species recorded from within the Study Area.

Family Species	Common Name	SKR01G		SKR02G		SKR03G		SKR04G		SKR05G		SKR06G		SKR07G		SKR08G		SKR09G		SKR10E	SKR11E	Opp.		Total
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	
Agamidae																								
<i>Ctenophorus cristatus</i>	Bicycle Dragon					1	1	2								2								6
<i>Ctenophorus scutulatus</i>					1		1																	2
<i>Pogona minor</i>										2						1								3
Diplodactylidae																								
<i>Crenadactylus ocellatus</i>	Clawless Gecko													1								1		2
<i>Diplodactylus granariensis</i>						19	2	4				1		1		2				1				19
<i>Diplodactylus pulcher</i>				2	1	3	1	2				2	1	5	5	2	1	2				1		28
<i>Lucasium maini</i>						4	1									1						3		6
<i>Hesperoedura reticulata</i>						10		4	1											19		1		6
Carphodactylidae																								
<i>Underwoodisaurus milii</i>	Southern Barking Gecko	1	3			3			2	1	4	1	1	4		1						1		22
Gekkonidae						3		3																
<i>Gehyra variegata</i>		3		7	2	2		1	1	1		1	1	2	2		4	1		1		1		30
<i>Heteronotia binoei</i>	Bynoe's Gecko	1							1	6	5			4	1					1				19
Pygopodidae																								
<i>Delma australis</i>			1					1																2
Scincidae																								
<i>Cryptoblepharus buchananii</i>						2			1															3
<i>Ctenotus uber</i>				2	1					6	2	1		7	2	3	1	3						27
<i>Cyclodomorphus melanops</i> <sup>1</sup>	Slender Blue-tongue		1																					1
<i>Egernia formosa</i>											4													4
<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer															2								2
<i>Lerista kingi</i>		3		1	1	1	1		3				1	1	4									16
<i>Lerista macropisthopus</i>									1															1
<i>Lerista timida</i>									2															2
<i>Menetia greyii</i>							1		1				1	1			1							5
<i>Morethia butleri</i>						1		1									1							3
<i>Tiliqua occipitalis</i>	Western Bluetongue																	1						1
Varanidae																								
<i>Varanus giganteus</i>	Perentie		1																					1
<i>Varanus tristis</i>	Racehorse Monitor			1			1							1	1	1					1			6
Typhlopidae																								
<i>Ramphotyphlops bituberculatus</i>													1									1		2
<i>Ramphotyphlops hamatus</i>			1		2		1										2							6
Elapidae																								
<i>Brachyurophis semifasciatus</i>					3										3		2							8
<i>Furina ornata</i>	Moon Snake	1					1				1													3
<i>Parasuta monachus</i>		1	1					1		1			1						1					6
<i>Pseudechis australis</i>	Mulga Snake				1																	1		2
<i>Simoselaps bertholdi</i>	Jan's Banded Snake		1						1															2

Total Individuals		10	9	13	12	49	11	21	12	17	16	6	7	26	19	12	15	6	2	22	1	4	6	246
Species per Site		6	7	5	8	11	10	10	9	6	5	5	7	9	8	7	9	3	2	4	1	2	6	32

Opp. denotes an opportunistic record; P1 = Phase 1, P2 = Phase 2.

I This was likely the subspecies *Cyclodomorphus melanops elongatus*, which is ironstone habitat dependent regionally (DEC 2007).



## **5.5        Amphibians**

### **5.5.1        Amphibians of Conservation Significance**

No amphibian species of conservation significance were recorded from the Study Area.

### **5.5.2        The Assemblage**

One frog species was recorded during the survey; two individuals of the Kunapalari Frog (*Neobatrachus kunapalari*) were pit-trapped during Phase 1.

Table 5.5: Amphibian species recorded from within the Study Area.

Family Species	Common Name	SKR01G		SKR02G		SKR03G		SKR04G		SKR05G		SKR06G		SKR07G		SKR08G		SKR09G		Opp.		Total
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	
Limnodynastidae																						
<i>Neobatrachus kunapalari</i>	Kunapalari Frog															2						
Total Individuals																2						2
Species per Site																1						1

Opp. denotes an opportunistic record; P1 = Phase 1, P2 = Phase 2.

## 5.6 Survey Adequacy

### 5.6.1 Comparison with Previous Surveys

The number of species recorded from each vertebrate class is compared with other studies conducted within 100 km and database records in Table 5.6. The effort applied in each study is detailed in Table 4.1. Even when compared to the records returned from the NatureMap database (119 species), which incorporates the results of a large number of studies, the species richness recorded from the current study is comparable or higher than other Level 2 studies that have been conducted in the local area (Table 5.6).

Table 5.6: Species richness recorded within the Study Area compared to previous surveys and database searches.

	NatureMap (<40 km)	Ecologia (2001)	Ecologia (2003)	BCE (2007)	Ninox (2009)	Aprasia and Globe (2009)	BCE (2009)	BCE (2011)	Biota (this survey)
Mammals	6	12	14	5	15	6	10	4	15
Birds	77	50	69	44	59	31	48	15	57
Reptiles	34	29	25	3	22	0	20	0	33
Amphibians	2	0	2	1	0	0	0	0	1
Total	119	91	110	53	96	37	78	19	106

### 5.6.2 Species Accumulation Curves

#### 5.6.2.1 Ground Fauna

The ground fauna species accumulation curve was plotted for all records of trapped ground-dwelling native fauna species (i.e. excluding bats and birds). The species accumulation curve plotted from these data indicated that relatively few new species would have been trapped with continued effort (Figure 5.1A). A total of 39 ground fauna species represented by 249 individuals were trapped during the survey, while the average accumulation curve estimate indicates that a total of 46 species may have potentially been recorded with continued trapping (i.e. 87% of the potentially trappable ground fauna species were recorded; Table 5.7). To approach the asymptote at 46 species, the species accumulation curve extrapolation predicted that 1,812 individuals would need to be trapped (Figure 5.1A) (i.e. seven times more survey effort may have been required to potentially record seven more species, if present).

#### 5.6.2.2 Birds

The species accumulation curve for avifauna indicated that the number of bird species recorded was approaching the asymptote representing the total number of species present in the Study Area at the time of the surveys (Figure 5.1B). A total of 56 species were recorded from 1,466 individuals during the quantitative site censuses, while 63 species was predicted by the species accumulation curve estimates as potentially occurring within the Study Area (i.e. 89% of the predicted bird species were recorded). The number of bird species recorded would therefore not have been significantly increased with increased survey effort. The extrapolated accumulation curve indicates that 5,864 individuals could have been recorded before reaching the asymptote (i.e. four times more survey effort may have been required to potentially record seven more species, if present).

Table 5.7: Observed and estimated species richness of ground fauna and birds for the Study Area.

	Observed	Jack-knife	Chao1	Bootstrap	Mean Estimate (difference from observed)
Ground Fauna	39	50	43	44	46 (+7)
Birds	56	66	65	61	63 (+7)



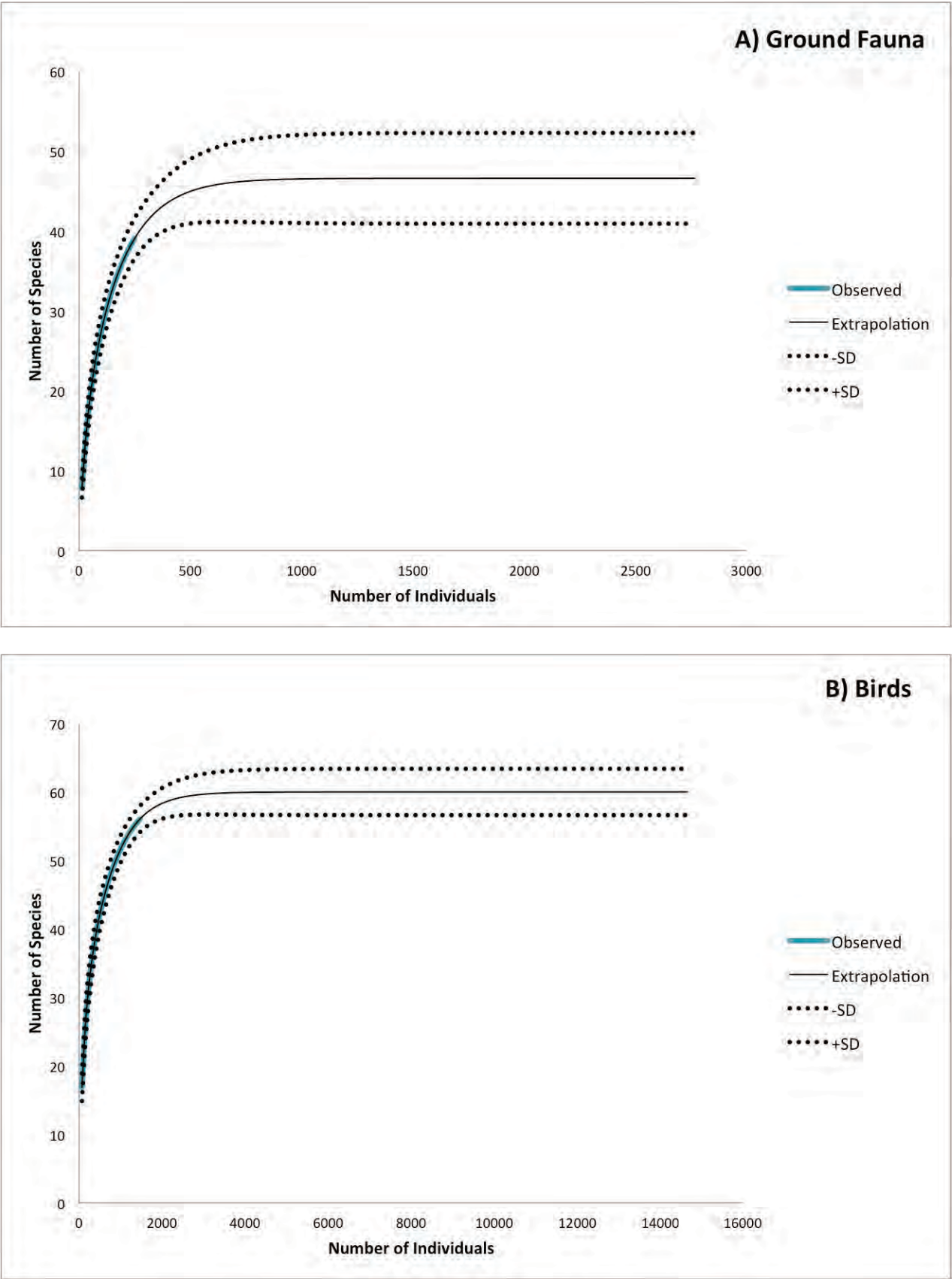


Figure 5.1: Species accumulation curves for species recorded quantitatively within the Study Area: A) trapped ground fauna, and B) avifauna recorded during timed bird censuses.

## 5.7 Fauna Assemblage Analysis

### 5.7.1 Ground fauna

Analysis of the ground fauna assemblage indicated that there was generally a 40–60% similarity in species between sample sites. The two sites that were most similar were the woodland sites SKR03G and SKR04G at approximately 60%. The low similarity in species assemblage between sites is likely a reflection of the high proportion of species represented at only one or two sites within the dataset. For example, 22 of the 40 ground fauna species that were trapped occurred at two or less sites.

Although sites were generally dissimilar, there was some pattern of relationship associated with landform; lower slopes and footslopes generally grouped in a cluster with plains sites, while crest sites (ridges) tended to group separately (with the exception of SKR07G) (Figure 5.2).

The ground fauna assemblage contained few habitat specialists. Exceptions included *Oedura reticulata*, which shows a preference for smooth-barked eucalypts and, as a result, was most commonly recorded from the woodland plains sites SKR03G and SKR04G. Similarly, *Cyclodomorphus melanops*, *Delma australis* and *Simoselaps bertholdi* all show a preference for sandier substrates, and these species were all recorded at SKR01G (a site with a sandy clay loam soil). While this was not the only site with sand in the soil matrix, it was sandier than most.

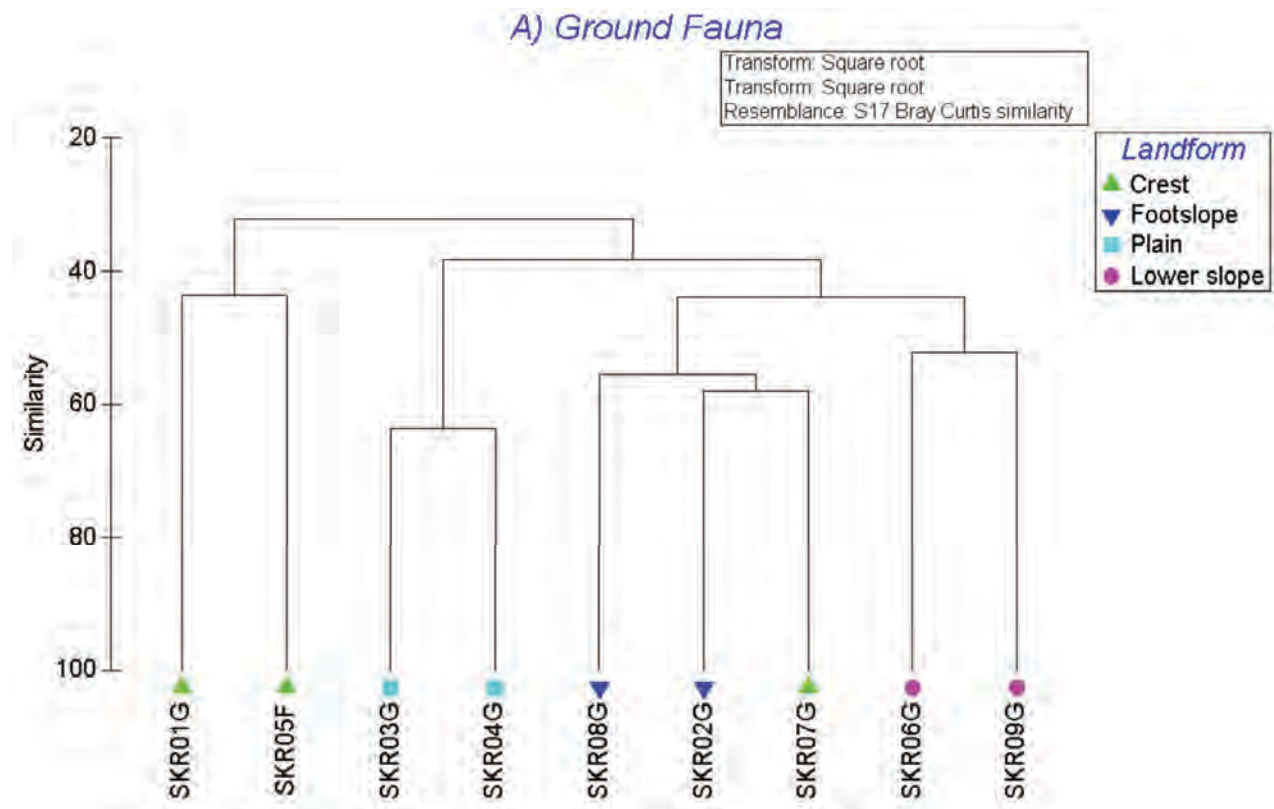


Figure 5.2: Bray-Curtis similarity of the abundance and assemblage at sites of ground fauna, with sites labelled according to their landform.

### 5.7.2 Birds

Bird assemblages generally showed more similarity between sites than the ground fauna assemblage (50–80%; Figure 5.3), which is consistent with the higher mobility and lower habitat specificity of birds compared to ground fauna. The overall bird assemblage comprised a high proportion of common species, with 26 of the 56 species recorded from five or more of the 11 sites that were systematically censused. Ten species were recorded from one site, and 13 were recorded from two sites.

Some pattern associated with landform was evident, with plains sites grouping together and being more similar to footslope and lower slope sites than crest sites. A small number of woodland specialists were present at the plains sites, such as the Rufous Tree-creeper and Black-faced Cuckoo-shrike, which probably contributing to the dissimilarity of these sites from the others.

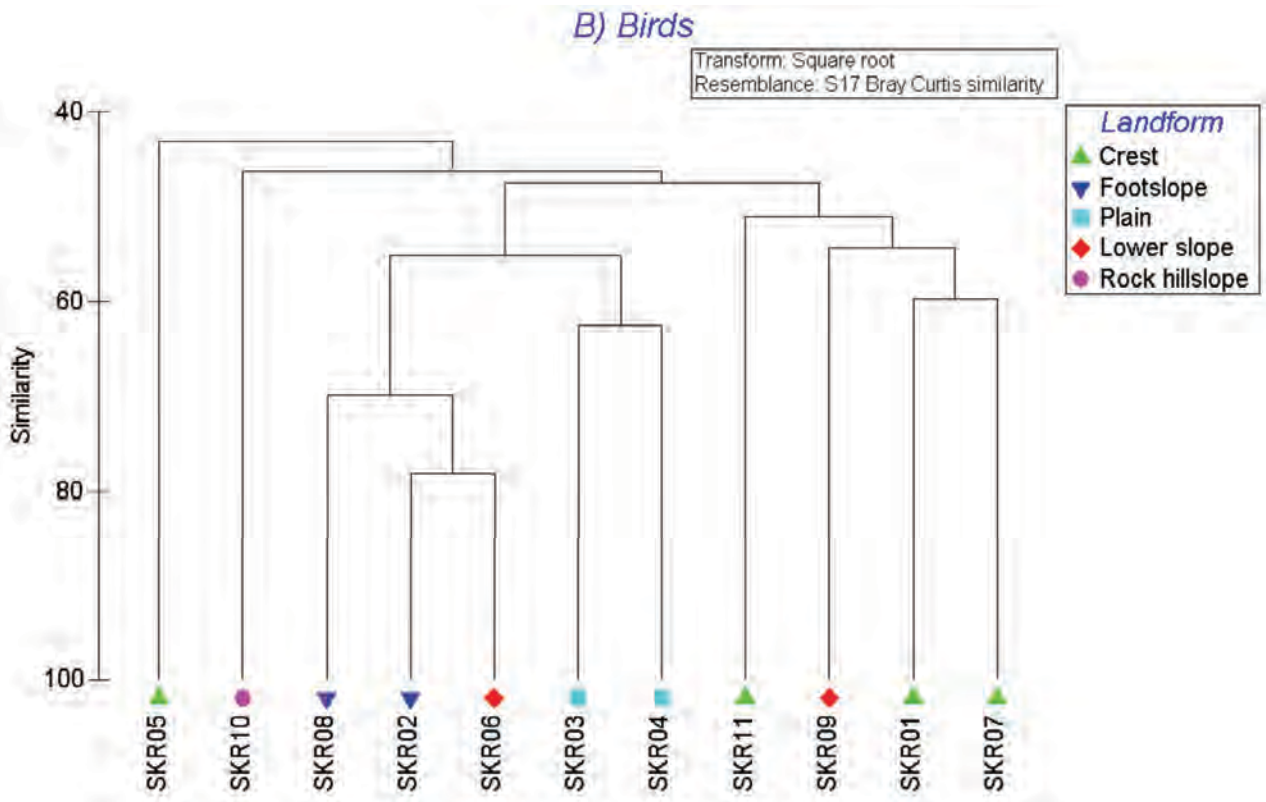


Figure 5.3: Bray-Curtis similarity of the abundance and assemblage at sites of birds, with sites labelled according to their landform.

## 6.0 Discussion of Conservation Significant Species

Species defined as conservation significant for the purposes of this report are:

- Threatened Species and Migratory Species listed under the EPBC Act 1999;
- Specially Protected Fauna (Schedule species) listed under the Wildlife Conservation Act 1950; and
- Priority fauna classified by DPaW.

The conservation significance rankings are provided in Appendix 1.

Whilst not of listed conservation significance, species have also been discussed herein if they are recognised as locally restricted; or, whilst they may be locally common, are reliant on restricted habitat that occurs in the locality (i.e. ridges). In particular, species listed as being restricted to ironstone ranges in DPaW's interim status report on the ironstone ranges of the Midwest and Goldfields (DEC 2007) have been considered for their likelihood to occur in the Study Area and their level of reliance on habitats therein.

### 6.1 Conservation Significant Species Recorded from the Study Area

The following species that are formally listed as being of conservation significance were recorded in the Study Area:

- Malleefowl (*Leipoa ocellata*): Threatened Species and a Migratory Species under the EPBC Act 1999, Specially Protected Fauna under the Wildlife Conservation Act 1950;
- Major Mitchell's Cockatoo (*Lophochroa leadbeateri*): Specially Protected Fauna under the Wildlife Conservation Act 1950;
- Peregrine Falcon (*Falco peregrinus*): Specially Protected Fauna under the Wildlife Conservation Act 1950; and
- Rainbow Bee-eater (*Merops ornatus*): Migratory Species under the EPBC Act 1999 and Specially Protected Fauna under the Wildlife Conservation Act 1950.

In addition, two species recorded are considered to be of potential conservation significance as they are reliant on ironstone habitat regionally (DEC 2007):

- Little Woodswallow (*Artamus minor*): and
- Gilbert's Whistler (*Pachycephala inornata*).

The Slender Blue-tongue *Cyclodomorphus melanops* was also recorded from the Study Area. This may represent the subspecies *Cyclodomorphus melanops elongatus*, which is considered reliant on ironstone habitat regionally (DEC 2007), and is an isolated record at the southern extreme of the species' distribution.

Secondary evidence of two species long extinct from the broader region was also recorded, comprising an old nest of a Stick-nest Rat (*Leporillus* sp.) and the remnants of the warren of a Burrowing Bettong or Boodie (*Bettongia lesueur*).

Figure 6.1 illustrates the location records of the formally listed conservation significant fauna within the Study Area and broader locality. Further information on each of the conservation significant species is provided in Section 6.1.1.



Table 6.1: Conservation significant fauna recorded from the Southern Koolyanobbing Range field survey.

Species Name	Common Name	Conservation Status		Occurrence and Likely Distribution in the Study Area
		State	Commonwealth	
Avifauna				
<i>Leipoa ocellata</i>	Malleefowl	Specially Protected Fauna (Schedule 1)	Threatened Species / Migratory Species	RECORDED – three recently active mounds and five sets of fresh tracks were recorded, along with numerous inactive mounds; typically recorded from the lower slopes of the range and surrounding plains.
<i>Falco peregrinus</i>	Peregrine Falcon	Specially Protected Fauna (Schedule 4)	-	RECORDED – species recorded during this study as a fly-over. May utilise the ironstone ridges in the Study Area for nesting, as observed previously by Aprasia and Globe (2009).
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo	Specially Protected Fauna (Schedule 4)	-	RECORDED – species may utilise woodlands in the Study Area for nesting. Unlikely to be reliant on ridge habitat.
<i>Merops ornatus</i>	Rainbow Bee-eater	Specially Protected Fauna (Schedule 3)	Migratory Species	RECORDED – observed at three sites during Phase 2 of the current study. This species is commonly recorded in woodland areas.
<i>Artamus minor</i> *	Little Woodswallow	-	-	RECORDED – utilises ironstone ridge habitat.
<i>Pachycephala inornata</i> *	Gilbert’s Whistler	-	-	RECORDED – numerous records within the Study Area across a variety of landforms. Utilises ironstone ridge habitat.
Reptiles				
<i>Cyclodomorphus melanops elongatus</i> *	Slender Blue-tongue	-	-	POSSIBLY RECORDED – one individual of the species was recorded from SKR01G, however it is not possible to identify this to subspecies level on the basis of morphology.

\* Identified by DEC (2007) as being of potential conservation significance due to restriction to ironstone range habitats.



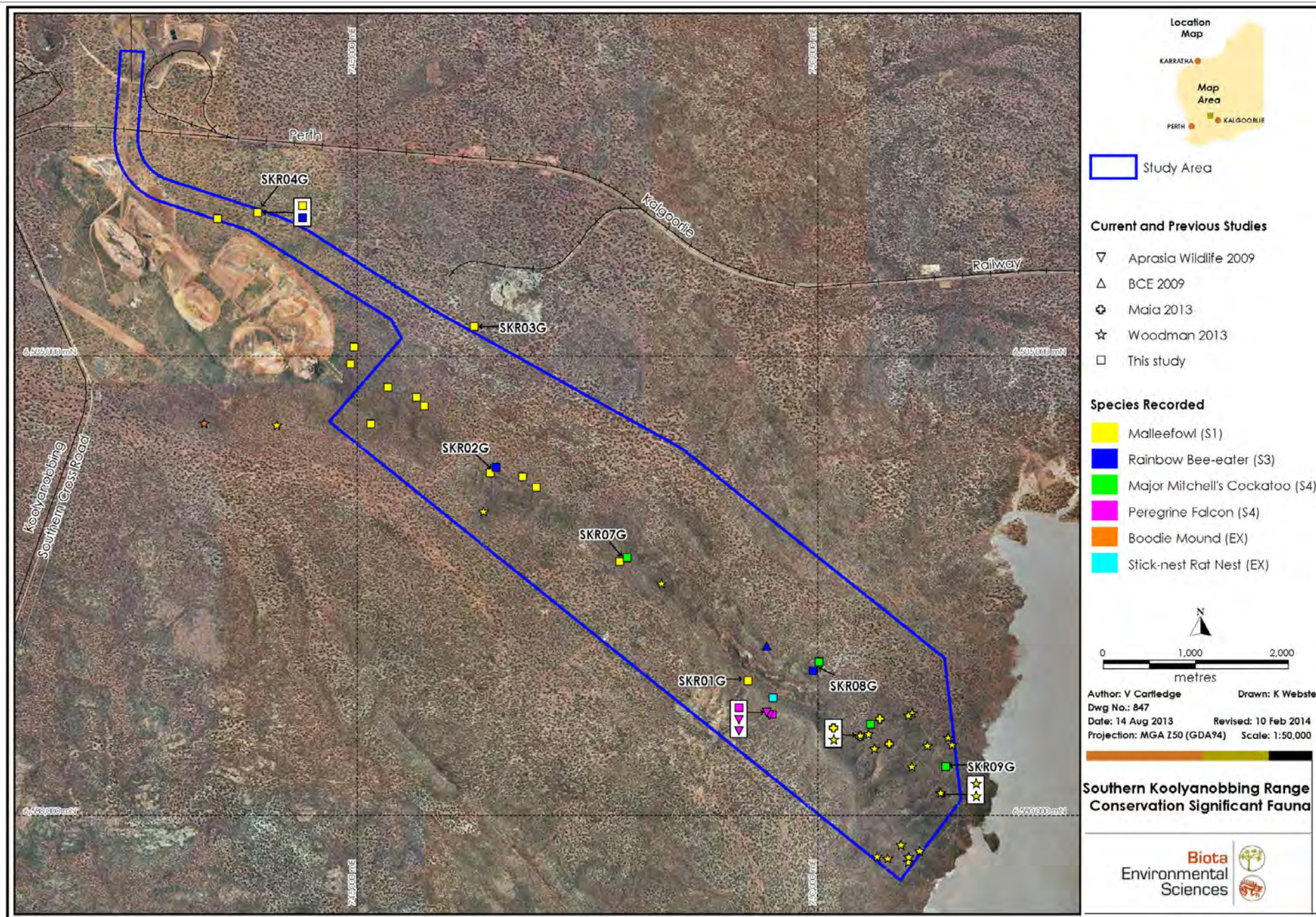


Figure 6.1: Conservation significant fauna records from the Study Area.



## 6.1.1 Descriptions of Species

### 6.1.1.1 Malleefowl (*Leipoa ocellata*)

Threatened Species and Migratory Species under the EPBC Act 1999; Specially Protected Fauna under the Wildlife Conservation Act 1950.

The Malleefowl was once broadly distributed across the southern half of the Australian continent, but has undergone significant range reduction over the past several decades. It is now restricted to the South-west of Western Australia, and to southern areas of South Australia and New South Wales (Burbidge 2004, Garnett et al. 2011). Populations are scattered throughout the southern portion of mainland Australia with the largest section of contiguous habitat occurring east of the Wheatbelt in WA. A large portion of suitable habitat in this region has been cleared for agriculture (Burbidge 2004). Malleefowl have been assessed as meeting the category of 'Vulnerable' using the criteria of the International Union for Conservation of Nature.

Malleefowl are mainly found in the semi-arid and arid zones of Australia in mallee dominated shrublands or low woodlands (Benshemesh 2007). They feed on the seeds, flowers and fruits of shrubs as well as tubers, fungi and invertebrates (Garnett et al. 2011). For breeding, they require a sandy substrate and abundant source of leaf litter to build a mound used to incubate their eggs (Benshemesh 2007). Malleefowl begin laying eggs at the start of September and continue to lay every 5–7 days until summer (Benshemesh 2007). Clutch size can be highly variable but on average, 15–20 eggs are laid (Garnett et al. 2011). This variation is thought to be related to food supply and the onset of hot weather conditions, which alters the length of the egg-laying season (Benshemesh 2007). Rainfall also influences the fecundity and survival of Malleefowl (Garnett et al. 2011). The chicks usually hatch between November and January and receive no parental care. They reach sexual maturity after 3–4 years and are able to breed for a period of 15 years (Benshemesh 2007).

The main threats to this species include clearing and habitat fragmentation, inappropriate fire regimes and predation by introduced species (Benshemesh 2007).

Likelihood of occurrence: Three recently active mounds, five sets of tracks, one record of old diggings, and 28 inactive mounds were located in the Study Area through the combined search effort of Biota zoologists, and botanists from Maia and Woodman (Table 6.2; Figure 6.2).

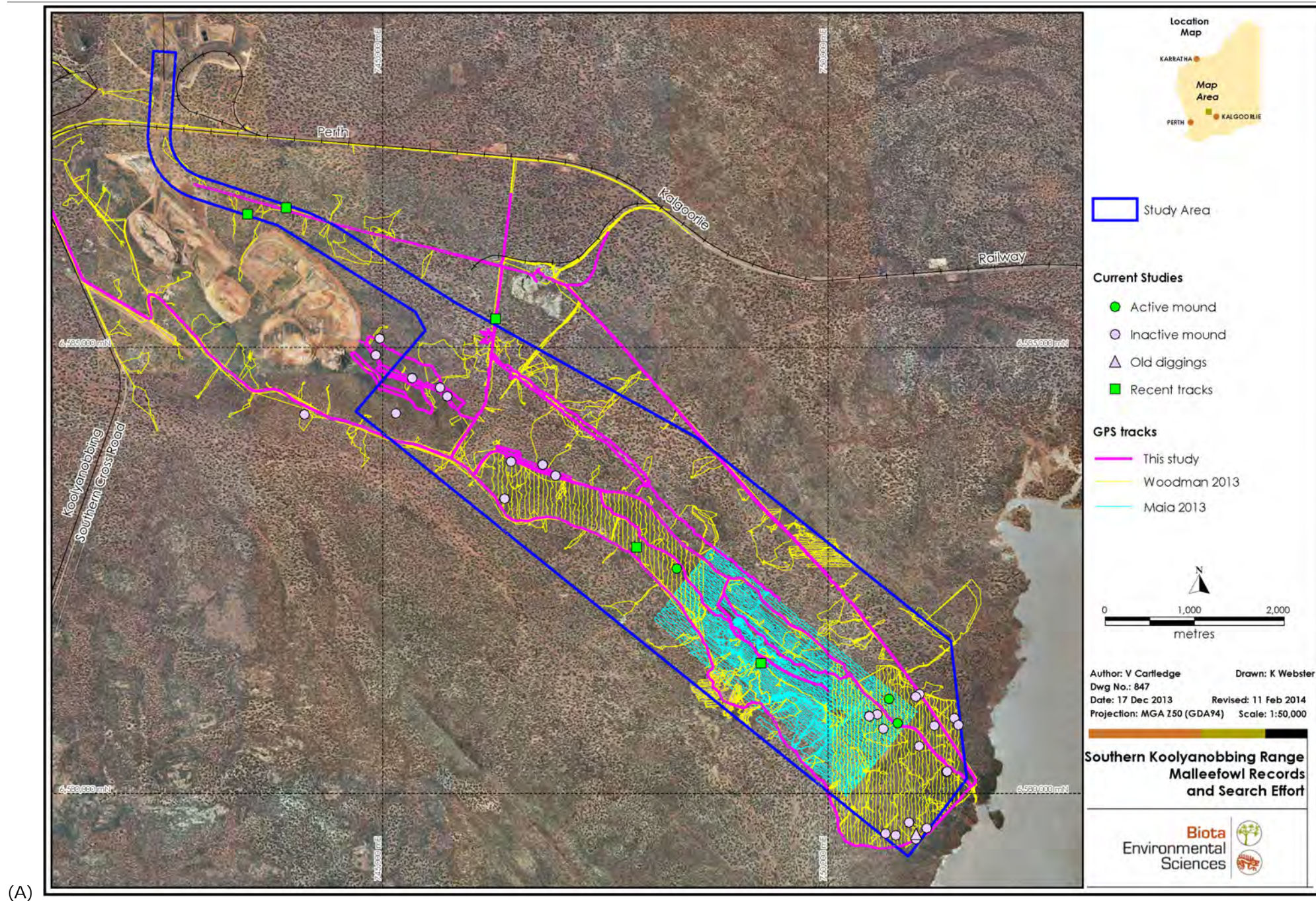
Representative photographs of the mounds are provided in Plate 6.1. No adult individuals were observed, however recent tracks were recorded during both phases of the current study, and a dead chick was noted at the recently active mound 23.

The area covered by foot traverses, equating to Malleefowl search effort, is shown in Figure 6.2A.

The highest density Malleefowl records were located through the southern half of the Study Area. Malleefowl records are plotted on topography in Figure 6.2B, which illustrates that Malleefowl mounds were typically recorded from the lower slopes of the range and surrounding plains.

Table 6.2 includes the details of the mounds, tracks and diggings that were located. All mounds assessed as potentially active by Maia and Woodman were revisited by Biota zoologists during the current study, with some of these mounds confirmed by Biota as now being inactive.







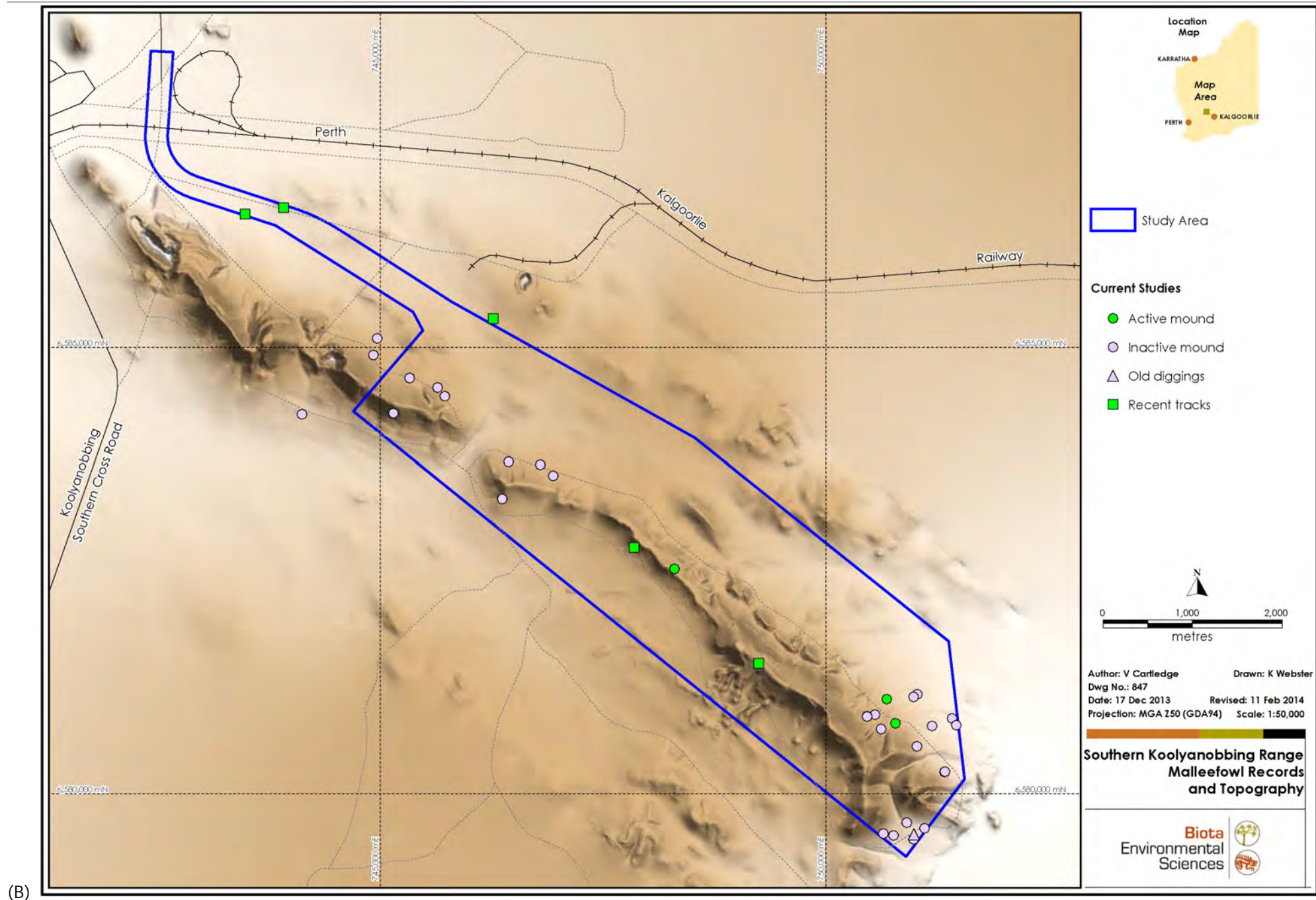


Figure 6.2: Malleefowl survey effort and records in the Study Area (A) and Malleefowl records in relation to topography (B).

Table 6.2: Evidence of Malleefowl recorded within the Study Area.

ID	Easting (mE)	Northing (mN)	Data Source	Biota Assessment Method	Biota Assessment/Description
1	743339	6584269	Woodman	Field Survey	Not Malleefowl mound; possibly old Bettong mound.
2	744126	6584249	Woodman	Field Survey	Inactive.
3	750646	6579551	Woodman	Field Survey	Inactive.
4	750905	6579677	Woodman	Photograph	Inactive.
5	746370	6583307	Woodman	Field Survey	Inactive.
6	751023	6580531	Woodman	Photograph	Inactive.
7	750553	6580885	Woodman	Photograph	Inactive.
8	751026	6581114	Woodman	Photograph	Inactive.
9	751108	6579610	Woodman	Photograph	Inactive.
10	751331	6580244	Woodman	Photograph	Inactive.
11	750617	6580727	Woodman	Photograph	Appears inactive.
12	748303	6582523	Woodman	Field Survey	Recently active mound. Mound mounded up (no crater), 3.4 m diameter, 0.8 m high. Motion camera set (25/10/13 – ongoing).
13	750760	6579530	Woodman	Field Survey	Inactive mound. Typical crater with raised rims, 2.8 m diameter, 0.06 m high, 0.4 m deep crater.
14	750984	6579490	Woodman	Field Survey	Inactive.
15	750989	6579546	Woodman	Field Survey	Probable old diggings.
16	750985	6581087	Woodman	Photograph	Inactive.
17	751460	6580767	Woodman	Photograph	Inactive.
18	751336	6580246	Woodman	Photograph	Inactive.
19	750464	6580869	Woodman	Not assessed (No photograph)	Not assessed (Woodman previously classed as inactive).
20	751192	6580759	Woodman	Field Survey	Inactive.
21	751417	6580845	Woodman	Field Survey	Inactive.
22	750681	6581060	Maia	Field Survey	Recently active mound. Mound fully dug out, 3.0 m diameter, 0.5 m high, 0.4 m crater depth.
23	750779	6580788	Maia	Field Survey	Recently active mound. Mound fully dug out, 3.0 m diameter, 0.5 m high, 0.4 m crater depth. Hatched eggs visible (previous season). Dead chick.
24	750462	6580866	Maia	Field Survey	Inactive.
25	746796	6583686	Biota	Field Survey	Inactive.
26	746943	6583566	Biota	Field Survey	Inactive.
27	745644	6584551	Biota	Field Survey	Inactive.
28	745331	6584658	Biota	Field Survey	Inactive.
29	744925	6584914	Biota	Field Survey	Inactive.
30	744966	6585101	Biota	Field Survey	Inactive.

ID	Easting (mE)	Northing (mN)	Data Source	Biota Assessment Method	Biota Assessment/Description
31	745728	6584455	Biota	Field Survey	Inactive.
32	745148	6584262	Biota	Field Survey	Inactive.
33	746442	6583721	Biota	Field Survey	Inactive.
34	749245	6581464	Biota	Field Survey	Recent tracks.
35	747850	6582765	Biota	Field Survey	Recent tracks.
36	746269	6585322	Biota	Field Survey	Recent tracks.
37	743483	6586496	Biota	Field Survey	Recent tracks.
38	743919	6586566	Biota	Field Survey	Recent tracks.





Mound 1



Mound 2



Mound 3



Mound 4



Mound 5



Mound 6



Mound 7



Mound 8





Mound 9



Mound 10



Mound 11



Mound 12



Mound 13



Mound 14



Mound 15



Mound 16





Mound 17



Mound 18



Mound 20



Mound 22



Mound 23

Plate 6.1: Representative photographs of Malleefowl mounds.  
Mound number refers to Table 6.2. No photographs were taken for some very old mounds.

#### 6.1.1.2 Major Mitchell's Cockatoo (*Lophochroa leadbeateri*)

Specially Protected Fauna under the Wildlife Conservation Act 1950.

Major Mitchell's Cockatoo has a widespread but disjunct distribution in the arid and semi-arid regions of inland Australia (Schodde and Tidemann 1990, Higgins 1999). Major Mitchell's Cockatoo may be found in a variety of habitats including sparsely timbered grasslands, scrublands, cypress pine along sand ridges, rocky outcrops with casuarina, mallee and trees close to reliable water sources or cereal crops (Schodde and Tidemann 1990). They feed on acacia and cypress pine seeds, along with various other seeds, nuts, fruits and roots. Breeding occurs between May and December with eggs (usually 2-4) laid in the hollows of trees (Schodde and Tidemann 1990).

Likelihood of occurrence: Major Mitchell's Cockatoo was recorded at three trapping sites during systematic bird censuses for this study, and was also recorded opportunistically in the Study Area (Figure 6.1). The species has been relatively commonly recorded from the local area, as indicated by records in the Birddata database (BirdLife Australia 2013). Woodlands of the Study Area (and beyond) represent suitable breeding habitat.

#### **6.1.1.3 Peregrine Falcon (*Falco peregrinus*)**

Specially Protected Fauna under the Wildlife Conservation Act 1950.

The Peregrine Falcon has an almost cosmopolitan distribution across Australia, but is absent from most deserts and the Nullarbor Plain (Johnstone and Storr 1998). This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country (Pizzey and Knight 2007). The Peregrine Falcon, like other birds of prey, is a relatively long-lived species, with low reproductive rates and low population density. These factors, combined with the fact that they are a top end predator and limited by their prey, make them particularly vulnerable to human impact.

Likelihood of occurrence: The Peregrine Falcon was recorded flying over the Study Area during the current study. Evidence of the Peregrine Falcon was also recorded by Aprasia and Globe (2009) by distinctive white faecal staining on ledges of the south-facing cliffs of the southern Koolyanobbing Range. The cliffs of the range represent suitable breeding habitat.

#### **6.1.1.4 Rainbow Bee-eater (*Merops ornatus*)**

Migratory Species under the EPBC Act 1999 and Specially Protected Fauna under the Wildlife Conservation Act 1950.

Some Rainbow Bee-eaters migrate northward during winter, either within Australia or as far as Indonesia (Johnstone and Storr 1998), however most birds residing in Western Australia do not migrate outside of Australia. This species forages aerially for insects and nests in burrows in the ground (Johnstone and Storr 1998). It occurs in a variety of habitats that are generally well watered and lightly wooded, with suitable (sandy) soil for nesting and a tall stratum of vegetation for perching.

Likelihood of occurrence: The Rainbow Bee-eater was observed at three trapping sites (SKR02G, SKR04G and SKR06G) during the current study. This species is commonly recorded in the local woodland area and surrounds (Birddata 2013).

#### **6.1.1.5 Little Woodswallow (*Artamus minor*)**

Whilst not formally listed as conservation significant, DEC (2007) identifies the Little Woodswallow as potentially regionally significant due to its occurrence being restricted to ironstone ranges. This species utilises vertical rock faces for refuges, breeding and roosting sites (Johnstone and Storr 2004, DEC 2007).

Likelihood of occurrence: The Little Woodswallow was recorded from three sites (SKR03G, SKR05G and SKR09G) during systematic bird censuses. The sites ranged in landform from ironstone ridge crest and lower slope to the woodland plains. As noted by DEC (2007), this species is expected to predominantly utilise the range as core habitat. The species was recorded daily from the ridgetop in the Study Area by BCE (2009), and has also been recorded from Windarling and Mt Jackson during previous surveys (BCE 2007). The Study Area is close to the southern extent of the species' distribution in Western Australia.



### 6.1.1.6 **Gilbert's Whistler (*Pachycephala inornata*)**

Whilst not formally listed as conservation significant, DEC (2007) identifies Gilbert's Whistler as potentially regionally significant due to its occurrence being restricted to ironstone ranges.

Gilbert's Whistler was included by DEC (2007) as a species dependent on ironstone ranges, citing an example at Mungada Ridge (Mid-west Region) where the species was recorded from the lower slopes but not in the surrounding plains. This species, however, is more regularly recorded from woodland and mallee habitat (Johnstone and Storr 2004). Clearing of this habitat throughout the Wheatbelt has led to a decline in the abundance and range of Gilbert's Whistler (Saunders and Ingram 1995), with the species now scarce and localised in distribution in Western Australia between the Wheatbelt and mulga-eucalypt line (Johnstone and Storr 2004).

Likelihood of occurrence: Gilbert's Whistler was recorded from six of the 11 sites receiving systematic bird censuses during the current study. These sites encompassed a range of landform types from ridge crest, to lower slope and the woodland plains. The species' usual habitat preference is the denser vegetation of the lower slopes of the range and scrub and woodland of the surrounding plains. The species has been well documented in the Koolyanobbing area including previous records within the Study Area (BCE 2007, Aprasia and Globe 2009, BirdLife Australia 2013).

### 6.1.1.7 **Slender Blue-tongue (*Cyclodomorphus melanops elongatus*)**

Whilst not formally listed as conservation significant, DEC (2007) identifies the Slender Blue-tongue as potentially regionally significant due to its occurrence being restricted to ironstone ranges.

The Slender Blue-tongue has a disjunct distribution with populations in the Pilbara, southern interior of Western Australia (as the subspecies *Cyclodomorphus melanops elongatus*), the Kimberley, central deserts, South Australia and Queensland (Wilson and Swan 2010). The species has been recorded from ironstone ranges at Jack Hills and the Helena and Aurora Ranges (DEC 2007), however the species' distribution is otherwise concentrated in the Pilbara.

Likelihood of occurrence: A single individual of this species was recorded from site SKR01G in the Study Area on the upper slopes of the southern Koolyanobbing Range. This record represents one of the most southerly from Western Australia (the specimen was collected and vouchered with the WAM; specimen number R173347). Genetic testing would be necessary to determine whether it may be the subspecies *Cyclodomorphus melanops elongatus*.

## 6.2 **Conservation Significant Fauna Potentially Occurring in the Study Area but Not Recorded**

### 6.2.1 **Overview**

In addition to the species of conservation significance that were recorded during the current study (Section 6.1), Table 6.3 presents a summary of the conservation significant species that were not recorded but were identified from database searches and reports in the desktop review as potentially occurring within the Study Area. The likelihood of these species occurring within the Study Area was assessed based on habitat preference and the proximity of known records, as detailed in Table 6.3.

Those species identified by DEC (2007) as conservation significant on the grounds that they appear to be confined to ironstone range habitat in the Midwest and Goldfields have also been assessed for their likelihood of occurrence. However, the distribution of a number of these species does not approach the vicinity of Koolyanobbing, and on this basis those particular species have not been considered further here.

Two DPaW-classified Priority 4 bird subspecies returned from the literature review (the Crested Bellbird (southern) and White-browed Babbler (western Wheatbelt)) are difficult to identify to subspecies in the field due to the subtle morphological differences separating them from the nominate species. For these species, the Directory of Australian Birds was consulted as to the



distribution of each subspecies (Schodde and Mason 1999) to determine the likelihood that the listed subspecies would occur in the Study Area.

The following species, although not recorded during the current study, are considered likely to occur within the Study Area:

- Western Yellow Robin (ironstone range dependent; DEC 2007); and,
- Woolley's Pseudantechinus (ironstone range dependent; DEC 2007).

Table 6.3: Conservation significant fauna identified through the desktop review as potentially occurring in the Study Area, but not recorded by the field survey.

Species Name	Common Name	Conservation Status		Likelihood of Occurrence in the Study Area
		State	Commonwealth	
Mammals				
<i>Dasyurus geoffroii</i>	Chuditch, Western Quoll	Specially Protected Fauna (Schedule 1)	Threatened Species	LOW – sporadic historical records in the region. Not recorded from previous surveys of the southern Koolyanobbing Range or any of the fauna surveys of the nearby ranges (e.g. Windarling, Mt Jackson, Helena and Aurora Ranges). The Study Area is at the extreme north of the species' potential range.
<i>Sminthopsis longicaudata</i>	Long-tailed Dunnart	DPaW-classified Priority 4		LOW – no previous records in the local area; Study Area appears to be beyond the southern limits of the species' distribution based on NatureMap records.
<i>Pseudantechinus woolleyae</i> *	Woolley's Pseudantechinus	-	-	HIGH (previously recorded) – scats potentially belonging to this species were found during the current study and by Aprasia and Globe (2009). The Study Area is at the southern limits of the species' known distribution.
Avifauna				
<i>Ardea modesta</i> **	Eastern Great Egret**	Specially Protected Fauna (Schedule 3)	Migratory Species	LOW – returned from EPBC search only; no records in the vicinity. Dependent on the presence of significant water bodies, which do not occur within the Study Area.
<i>Ardea ibis</i>	Cattle Egret	Specially Protected Fauna (Schedule 3)	Migratory Species	LOW – returned from EPBC search only; no records in the vicinity. Dependent on the presence of significant water bodies, which do not occur within the Study Area.
<i>Apus pacificus</i>	Fork-tailed Swift	Specially Protected Fauna (Schedule 3)	Migratory Species	LOW – returned from EPBC search only; no records in the vicinity.
<i>Ardeotis australis</i>	Australian Bustard	DPaW-classified Priority 4	-	MODERATE – closest records are from Mt Jackson and east of the Helena and Aurora Ranges. Suitable plains habitat occurs within the Study Area.
<i>Oreoica gutturalis gutturalis</i>	Crested Bellbird (southern)	DPaW-classified Priority 4	-	LOW/MODERATE – while 37 Crested Bellbirds were recorded from the Study Area, this area falls within the zone of intergradation between <i>Oreoica gutturalis gutturalis</i> and the more widely occurring subspecies <i>Oreoica gutturalis pallescens</i> (Schodde and Mason 1999); records from the Study Area most likely represent the latter subspecies.

Species Name	Common Name	Conservation Status		Likelihood of Occurrence in the Study Area
		State	Commonwealth	
<i>Pomatostomus superciliosus ashbyi</i>	White-browed Babbler (Wheatbelt)	DPaW-classified Priority 4	-	LOW – while 31 White-browed Babblers were recorded from the Study Area, the Study Area does not occur within the range of subspecies <i>ashbyi</i> but rather within the range of subspecies <i>superciliosus</i> (Schodde and Mason 1999); records from the Study Area most likely represent the latter subspecies.
<i>Hylacola cauta whitlocki</i>	Shy Heathwren (western)	DPaW-classified Priority 4	-	MODERATE – not previously recorded from Koolyanobbing, but recorded in the vicinity of Southern Cross (BirdLife Australia 2013) and Windarling and Mt Jackson (Ecologia 2003, Bamford and Metcalf 2005); suitable habitat occurs within the Study Area.
<i>Eopsaltria griseogularis</i> *	Western Yellow Robin	-	-	HIGH – commonly recorded in the local area (Ecologia 2001, BCE 2009, BirdLife Australia 2013).
<i>Pachycephala pectoralis</i> *	Golden Whistler	-	-	MODERATE – the Birddata atlas (Birddata 2013) indicates records from the local area; however this species was not recorded during any of the previous studies at Koolyanobbing included in the desktop review.
Reptiles				
<i>Morelia spilota imbricata</i>	Carpet Python (south-western)	Specially Protected Fauna (Schedule 4)	-	LOW/MODERATE – this species has been recorded once opportunistically from the Windarling Range, located approximately 100 km north of the Study Area (BCE 2010). Suitable rocky habitat occurs within the Study Area, and is within the species known distribution.
<i>Delma butleri</i> *	Unbanded Delma	-	-	LOW – nearby records but preferred <i>Triodia</i> habitat (Wilson and Swan 2010) is absent from the Study Area.

\* Identified by DEC (2007) as potentially conservation significant due to being confined to ironstone range habitats.

\*\* Listed as a subspecies of *Ardea alba* (Great Egret / White Egret) under the EPBC Act 1999 however *Ardea modesta* (Eastern Great Egret) was recently elevated to full species status (Christidis and Boles 2008).



## 6.2.2 Descriptions of Species – Vertebrate Fauna

### 6.2.2.1 Chuditch, Western Quoll (*Dasyurus geoffroii*)

Threatened Species and and Migratory under the EPBC Act 1999; Specially Protected Fauna under the Wildlife Conservation Act 1950.

The previous distribution of the Chuditch extended throughout a large area of southern semi-arid Australia from the South-west of Western Australia to the west of New South Wales and Queensland (Menkhorst and Knight 2011). However, its range has significantly reduced in recent times to only a small area in the south-west of Western Australia (Menkhorst and Knight 2011). The areas of Western Australia where the Chuditch remains are characterised by wet and dry sclerophyll and mallee (Menkhorst and Knight 2011).

Likelihood of occurrence: The Chuditch is more commonly recorded in Western Australia's Jarrah forest, and less commonly recorded from the Goldfields. The Study Area is approaching the northeastern extremities of the species' most common distribution. There are occasional sightings of this species in the Wheatbelt and Goldfield areas where habitat is much more fragmented (DEC 2012). The species was targeted using cage traps set in woodland habitat in the Study Area, however it was not recorded, nor has it been recorded by any previous surveys of the Study Area. Given the sporadic nature of historic records from the locality and the lack of recent records, the Chuditch is considered to have a low likelihood of occurrence in the Study Area.

#### 6.2.2.2 Long-tailed Dunnart (*Sminthopsis longicaudata*)

DPaW-classified Priority 4.

The Long-tailed Dunnart inhabits rocky, rugged habitat from the Pilbara and adjacent upper Gascoyne region east to the central Northern Territory and South Australia.

Records have come from plateaus near breakaways and scree, and rugged boulder strewn scree, often in areas with little vegetation. This species has been recorded from the Goldfields region from most stony substrates, particularly fractured/weathered mudstone/siltstone but also from breakaways (Mark Cowan, DPaW, pers. comm. 2004). Biota has recorded the Long-tailed Dunnart from the Pilbara adjacent to a rugged scree, from calcareous soil on a low hill near Mt Brockman, from spinifex hummock grassland on a low stony hill slope (Biota 2005), and from the Albion Downs Borefield (Biota 2010). Survey effort has shown that it is relatively common and widespread, occurring over much of inland Western Australia but restricted to a rocky habitats (Burbidge 2004).

Likelihood of occurrence: The likelihood of this species occurring in the Study Area is considered to be low. While suitable habitat does exist within the Study Area, it has not been recorded as far south as Koolyanobbing despite intensive surveys in the local area.

#### 6.2.2.3 Woolley's Pseudantechinus (*Pseudantechinus woolleyae*)

Whilst not formally listed as conservation significant, DEC (2007) identifies Woolley's Pseudantechinus as potentially regionally significant due to its occurrence being restricted to ironstone ranges.

Woolley's Pseudantechinus has a strong preference for rocky habitats, making it potentially vulnerable to population isolation and fragmentation in association with ironstone ranges of the Midwest and Goldfields (DEC 2007). As a result of the habitat restriction and potential for isolation and fragmentation, this taxon may potentially be of conservation significance at a regional level.

Likelihood of occurrence: Live individuals of the species were not recorded during the current study, however scats that appeared to belong to *Pseudantechinus woolleyae* were recorded by Aprasia and Globe (2009) within the Study Area. Scats were also recorded at SKRMC01 during the current survey. These records represent the southernmost record of the species, although the species has been recorded from Mt Jackson, Bungabbin (Ecologia 2001) and the Helena and Aurora Ranges. The species is considered to have a high likelihood of occurrence in the Study Area, which may represent the southern extent of the species distribution.

#### **6.2.2.4 Eastern Great Egret (*Ardea modesta*) and Cattle Egret (*Ardea ibis*)**

Migratory Species under the EPBC Act 1999 and Specially Protected Fauna under the Wildlife Conservation Act 1950.

The Eastern Great Egret (formerly Great Egret / White Egret) and Cattle Egret are largely dependent on the presence of significant water bodies, such as Lake Seabrook located immediately to the east of the Study Area and Lake Deborah located approximately 10 km west of the Study Area.

Likelihood of occurrence: These species were returned from the EPBC Act 1999 Protected Matters Search only, with no other records identified during the desktop review. Suitable habitat is unavailable in the Study Area. The likelihood of the Eastern Great Egret or Cattle Egret occurring within the Study Area is considered to be low.

#### **6.2.2.5 Fork-tailed Swift (*Apus pacificus*)**

Migratory Species under the EPBC Act 1999 and Specially Protected Fauna under the Wildlife Conservation Act 1950.

The Fork-tailed Swift is most often observed following storms and cyclonic weather patterns and the associated emergence of invertebrate fauna, which are a food source for this species. Fork-tailed Swifts are thought to be exclusively aerial in Australia as they breed in the northern hemisphere, migrating south to the Australasian region from October to April. Consequently, Fork-tailed Swifts do not rely on terrestrial habitats, but are likely to overfly the Study Area on occasion.

Likelihood of occurrence: This species was returned by the EPBC Act 1999 Protected Matters Search only, with no other records identified during literature review. Although it may fly over the Study Area at times, this species would be unlikely to be recorded within the Study Area. The likelihood of the Fork-tailed Swift occurring within the Study Area is considered to be low.

#### **6.2.2.6 Australian Bustard (*Ardeotis australis*)**

DPaW-classified Priority 4.

The Australian Bustard occurs over much of Western Australia, with the exception of the more heavily wooded southern portions of the state (Johnstone and Storr 1998). It is mostly extinct from the residential and cleared agricultural areas, but is common in more remote (less settled) parts of Western Australia (Pizzey and Knight 2007). Its wider distribution includes eastern Australia and New Guinea. This species was classified as Near Threatened by Garnett and Crowley (2000), however it was not listed in the most recent Action Plan for Australian Birds due to the criteria for Near Threatened status being revised (Garnett et al. 2011).

This species is typically nomadic and occupies large home ranges (Marchant and Higgins 1994) in open or lightly wooded grassland including spinifex (*Triodia* spp.) sandplains (Johnstone and Storr 1998). It is considered scarce to common depending on season and habitat. It has an omnivorous diet and occurs in a relatively broad range of habitats, but is often recorded from recently burnt areas (Marchant and Higgins 1994). The Australian Bustard breeds from March to September and the eggs are laid on bare, preferably stony ground (Johnstone and Storr 1998), which makes the eggs and young vulnerable to predation by foxes and cats.

Likelihood of occurrence: The Australian Bustard has previously been recorded to the north of the Study Area from Mt Jackson (Ecologia 2001) and east of the Helena and Aurora Range (Ninox 2009). None of the previous studies at Koolyanobbing have recorded this species. The Australian Bustard is considered to have a moderate likelihood of occurrence in the Study Area and would utilise the plains habitat.

**6.2.2.7 Crested Bellbird (southern) (*Oreoica gutturalis gutturalis*)**

DPaW-classified Priority 4.

This sedentary and solitary species inhabits the drier mallee woodlands and heaths of the southern parts of Western Australia and is widespread in the arid zone. This species was classified as Near Threatened by Garnett and Crowley (2000), however it was not listed in the most recent Action Plan for Australian Birds due to the criteria for Near Threatened status being revised (Garnett et al. 2011).

Subspecies *gutturalis* inhabits woodland, mallee and Acacia shrublands. It is moderately common in the arid zone, but scarce and patchily distributed in wetter country (Johnstone and Storr 1998). This is a mainly insectivorous species.

Likelihood of occurrence: The Study Area falls within the zone of intergradation between the Priority subspecies *Oreoica gutturalis gutturalis* and the more widely occurring subspecies *Oreoica gutturalis pallescens* (Schodde and Mason 1999), which occurs throughout central and northern Australia. The likelihood of the Crested Bellbird (southern subspecies) occurring within the Study Area is considered to be low to moderate.

**6.2.2.8 White-browed Babbler (Wheatbelt) (*Pomatostomus superciliosus ashbyi*)**

DPaW-classified Priority 4.

This species occurs mainly in the arid and semiarid zones south of the Tropic of Capricorn. This species was classified as Near Threatened by Garnett and Crowley (2000), however it was not listed in the most recent Action Plan for Australian Birds due to the criteria for Near Threatened status being revised (Garnett et al. 2011).

This species inhabits eucalypt forests and woodlands, preferring the edge of most types of thicket and scrub. It is mainly insectivorous and forages on or near the ground for insects and seeds.

Likelihood of occurrence: The Study Area does not occur within the range of the Priority 4 subspecies *Pomatostomus superciliosus ashbyi* but rather within the range of *Pomatostomus superciliosus superciliosus* (Schodde and Mason 1999), which occurs throughout the majority of the species distribution. The likelihood of the White-browed Babbler (Wheatbelt) occurring within the Study Area is considered to be low.

**6.2.2.9 Shy Heathwren (western) (*Hylacola cauta whitlocki*)**

DPaW-classified Priority 4.

The Shy Heathwren is distributed in Western Australia from the Wheatbelt and Lake Moore across to Coolgardie and Southern Cross, down towards Lake Dundas and Ravensthorpe to a small section of the coast (Johnstone and Storr 2004). There have also been recorded sightings north of Eyre and in south-eastern Australia (Johnstone and Storr 2004). The Shy Heathwren is found in habitat characterised by dense mallee eucalypt woodlands and sometimes post fire regeneration areas (Garnett and Crowley 2000).

Clearing of vegetation for agricultural purposes in the Wheatbelt of Western Australia has greatly reduced the habitat available to this species (Garnett and Crowley 2000). It is thought that the Shy Heathwren now exists in isolated subpopulations occupying remaining fragments of habitat (Garnett and Crowley 2000). This species was classified as Near Threatened by Garnett and Crowley (2000), however it was not listed in the most recent Action Plan for Australian Birds due to the criteria for Near Threatened status being revised (Garnett et al. 2011).

Likelihood of occurrence: The Shy Heathwren has not been recorded during previous studies at Koolyanobbing, however it has been recorded in the vicinity of Southern Cross (BirdLife Australia 2013) and at Windarling and Mt Jackson (Ecologia 2003, Bamford and Metcalf 2005). Suitable habitat occurs within the Study Area and this species is considered to have a moderate likelihood of occurrence. The Study Area occurs at the northeastern extent of the subspecies' range.



**6.2.2.10 Western Yellow Robin (*Eopsaltria griseogularis*)**

Whilst not formally listed as conservation significant, DEC (2007) identifies the Western Yellow Robin as potentially regionally significant due to its occurrence being restricted to ironstone ranges.

Habitat preferences of the Western Yellow Robin include thicket, scrub and tall shrubland including the understorey of eucalypt forest and woodland. The species is widespread from the southern Murchison to the Goldfields and parts of the lower southwest, however it has disappeared from much of the Wheatbelt due to habitat removal (Saunders and Ingram 1995). The species has been documented from a number of ironstone ranges including Koolanooka Hills, Blue Hills and the Helena and Aurora Range (DEC 2007). The species appears to be restricted to the lower slopes of ironstone ranges, particularly the vegetation along gullies and drainage lines (DEC 2007).

Likelihood of occurrence: The Western Yellow Robin was not recorded during the current study, however this species has been recorded by a number of surveys in the locality (Ecologia 2001, BCE 2009, BirdLife Australia 2013). The likelihood that this species would occur in the Study Area is considered to be high.

**6.2.2.11 Golden Whistler (*Pachycephala pectoralis*)**

Whilst not formally listed as conservation significant, DEC (2007) identifies the Golden Whistler as potentially regionally significant due to its occurrence being restricted to ironstone ranges.

The Golden Whistler is more common in the temperate southwest of Western Australia, with the Study Area nearing the northeastern extent of its distribution. The species prefers mainly thickets and scrubs (Johnstone and Storr 2004).

The species was found to occur in thick shrubland on the lower slopes of the Blue Hills, approximately 300 km northwest of the Study Area, where it appeared to be regionally restricted to the rocky ironstone hills and adjacent rock slopes; it was not recorded from surrounding flat areas (DEC 2007).

Likelihood of occurrence: The Golden Whistler was not recorded during the current study. The Birddata atlas (Birddata 2013) does indicate records from the local area (one record 12 km north, and records from 50 km north and from 50 km south), however the species was not recorded during any of the previous studies at Koolyanobbing that were included in the desktop review. As such, it is considered to have a moderate likelihood of occurrence in the Study Area.

**6.2.2.12 Carpet Python (south-western) (*Morelia spilota imbricata*)**

Specially Protected Fauna under the Wildlife Conservation Act 1950.

Distribution: This subspecies of the Carpet Python is distributed across the South-west of Western Australia from Northampton to Albany and east to Kalgoorlie (DEC 2006). It also occurs in suitable bushland in the Darling Ranges, some parts of Perth and Yanchep National Park (DEC 2006). In addition, there are populations on Garden Island in Western Australia and Francis Island in South Australia (DEC 2006). The Carpet Python population is thought to have declined due to habitat clearing and degradation (Pearson et al. 2005).

Habitat preferences of the subspecies include eucalypt woodlands, Banksia woodlands and grassland habitats in both semi-arid coastal and inland areas of Western Australia (DEC 2006). Carpet pythons are nocturnal animals, sheltering in a wide range of places including tree hollows and rock crevices (Bush et al. 2010).

Likelihood of occurrence: The Study Area occurs within the distribution of this species, however there is only a single record of this species based on all of the surveys completed in the locality (an opportunistic record from the Windarling area between 2000 and 2004 (pers. comm. B. Metcalf in BCE 2010). The Carpet Python is generally rarely recorded but could occur within the Study Area, particularly in the rocky habitats of the southern Koolyanobbing Range. The species is considered to have a low to moderate likelihood of occurrence.

### 6.2.2.13 Unbanded Delma (*Delma butleri*)

Whilst not formally listed as conservation significant, DEC (2007) identifies the Unbanded Delma as potentially regionally significant due to its occurrence being restricted to ironstone ranges.

This species shelters in spinifex in semi-arid to arid areas (Wilson and Swan 2010). The Unbanded Delma was found to occur on the Jack Hills and Helena and Aurora Range ironstone ranges and was not found on the surrounding flat plains (DEC 2007), indicating a local reliance on the ironstone range habitat.

Likelihood of occurrence: While the NatureMap database (DPaW and WAM 2013) includes records of this species from approximately 60 km north of the Study Area (Ecologia 2001), the Delma's preferred *Triodia* habitat does not occur within the Study Area. The likelihood of the Unbanded Delma occurring within the Study Area is therefore considered to be low.

## 6.2.3 Descriptions of Species – Invertebrate Fauna

### 6.2.3.1 Arid Bronze Azure Butterfly (*Ogyris subterrestris petrina*)

Specially Protected Fauna under the Wildlife Conservation Act 1950.

While the current study was specifically for vertebrate fauna species, at the request of DPaW, an effort was made to determine if the invertebrate fauna species Arid Bronze Azure Butterfly occurred in the Study Area.

The Arid Bronze Azure Butterfly has disappeared from much of its previously known range and is now only known from a few disjunct localities across Western Australia, South Australia, New South Wales and Victoria. Subspecies *petrina* was thought to be possibly extinct until it was rediscovered in 2006, but it has since been found only in the northeastern Wheatbelt of Western Australia (Gamblin et al. 2009), located approximately 140 km west of the Study Area. The butterfly has an obligate association with the pale form of the ant *Camponotus terebrans*, with the butterfly larvae protected by the ants within their nests.

Likelihood of occurrence: The paucity of records of the Arid Bronze Azure Butterfly in Western Australia makes it difficult to judge the likelihood of its occurrence within the Study Area. Some research has indicated a preference by the associated *Camponotus terebrans* to nest at the base of Gimlet (*Eucalyptus salubris*), a tree species common on the plains of the Study Area. The distinctive nests of *Camponotus terebrans* were not found during the current survey, nor were any individuals recorded by the current survey. Given the low number of records of the Arid Bronze Azure Butterfly in Western Australia, its likelihood of occurrence in the Study Area is considered to be low.

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## 7.0 Faunal Value of Landscapes Identified within the Study Area

When assessing the faunal value of the landscape units identified within the Study Area (see Section 4.4.1), the following factors were considered:

- whether the landscape is uncommon in the region;
- whether the landscape supports fauna of conservation significance; or
- whether the landscape supports unique faunal assemblages.

### 7.1.1 Southern Koolyanobbing Range

Ironstone ranges are widespread through the Midwest and Goldfields regions, however they represent only a small proportion of the area of each bioregion in which they occur. In addition, each range is spatially separated (DEC 2007, Department of Environment 2013).

The northern half of the southern Koolyanobbing Range has been subject to mining since the 1960s, resulting in fragmentation of the fauna habitats. By contrast, the northern Koolyanobbing Range and the southern half of the southern Koolyanobbing Range have been subject to only limited mining (exploration only). The woodland plains landscape (see Section 7.1.2) within the Study Area is both widespread and abundant in the region.

Some vertebrate fauna species tend to be locally restricted to ironstone range habitats and are not found on the surrounding woodlands and sandplains (DEC 2007). The ridge crests and upper slopes of the southern Koolyanobbing Range comprise rock outcropping that would provide shelter for saxicolous (rock-dwelling) species. These landforms include small caves that may be utilised by bats, owls and numerous other species. Conservation significant species likely to utilise the ridge crests and upper slopes would include Woolley's Pseudantechinus (potentially recorded from scats); the Slender Blue-tongue (*Cyclodomorphus melanops*) (recorded); and the southwestern Carpet Python (not recorded).

The Koolyanobbing Range lies at the interzone between the Wheatbelt and Goldfields regions, which also corresponds to an area of transition in climate from the temperate southwest to the arid interior. As such, many species occurring in the area are at the extremes of their distribution. This includes a number of species that previously had extensive distributions in the now largely cleared Wheatbelt. These species tend to utilise the areas of denser vegetation of the ridges and slopes. Examples include the Western Yellow Robin (not recorded), Shy Heathwren (not recorded), Golden Whistler (not recorded) and the southwest Carpet Python (not recorded).

### 7.1.2 Woodland Plains

The faunal landscape type of the woodland plains within the Study Area is both common and widespread within the Southern Cross subregion and the greater Coolgardie bioregion (Cowan et al. 2003). As such, it is unlikely that the limited component within the Study Area would be considered regionally significant.

This landscape type does, however, support some fauna of conservation significance. In particular, the majority of the Malleefowl (*Leipoa ocellata*) nest mounds recorded during the current study were from this habitat. This is a reflection of the preference of this species for a sandy substrate and an abundant source of leaf litter for mound construction, which is typically found amongst mallee dominated shrublands or low woodlands on plains (Benshemesh 2007). This core habitat type is well represented outside of the Study Area, and the Malleefowl is well documented from the broader locality (see Section 6.1.1.1). It could be reasonably expected that the distribution of Malleefowl would continue in the area beyond the Study Area boundary within the woodland plains habitat type.

Other fauna of conservation significance and unique fauna assemblages occurring within this landscape type are similarly unlikely to be restricted to the limited areas occurring within the Study Area.

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## 9.0 Glossary and Acronyms

Biota	Biota Environmental Sciences.
Cliffs	Cliffs Asia Pacific Iron Ore Pty Ltd.
DPaW	Department of Parks and Wildlife, Western Australia (formerly the Department of Environment and Conservation).
Elliott trap	A collapsible aluminium box trap.
EPA	Environmental Protection Authority, Western Australia.
EPBC Act 1999	Federal Environment Protection and Biodiversity Conservation Act 1999.
Fauna landscape	A collection of similar landforms with definable functioning systems. A fauna landscape will support multiple fauna habitats.
IBRA	Interim Biogeographic Regionalisation for Australia.
Opportunistic record	Recorded by non-systematic sampling methods.
SAC	Species Accumulation Curve.
sens. lat.	Abbreviation of sensu lato (L.), "in the broad sense"; used where a taxon comprises a known species complex.
SM2	A model of Song Meter by Wildlife Acoustics.
sp.	Abbreviation of species (singular).
spp.	Abbreviation of species (plural).
Study Area	The area in which the fauna study was conducted. This includes the Southern Koolyanobbing Range Study Area, in combination with areas outside the project boundary studies to provide context to the project.
Systematic sampling	Sampling using trapping (including pitfall traps, Elliott traps and/or funnel traps) and/or timed avifauna censuses in a defined habitat.
>	Greater than.
<	Less than.





# Appendix 1

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## Classifications for Conservation Significant Fauna in Western Australia





## Threatened Fauna Statutory Framework

Native fauna species that are rare, threatened with extinction, or have high conservation value, are specially protected by law under the WA *Wildlife Conservation Act 1950*. In addition, some of these species are listed for their protection under the Commonwealth *EPBC Act 1999*.

### Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Fauna species of national environmental significance are listed under the *EPBC Act 1999*, and have been classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent'.

Migratory species are also protected under the *EPBC Act 1999*. The national List of Migratory Species consists of those species listed under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA);
- Republic of Korea-Australia Flyway Partnership (ROKAMBA);
- The East Asian- Australasian Flyway Partnership; and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

### Western Australian *Wildlife Conservation Act 1950*

Under the *Wildlife Conservation Act 1950* classification of rare and endangered fauna are defined by the *Wildlife Conservation (Specially Protected Fauna) Notice 2013*, which recognises four distinct schedules of taxa:

- Schedule 1 taxa that are rare or likely to become extinct and are declared to be fauna in need of special protection;
- Schedule 2 taxa that are presumed to be extinct and are declared to be fauna in need of special protection;
- Schedule 3 birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, which are declared to be fauna in need of special protection; and
- Schedule 4 taxa that are in need of special protection, otherwise than for the reasons mentioned in paragraphs (1), (2) and (3).

### DPaW Priority Species

In addition, DPaW maintains a list of Priority species that have not been assigned statutory protection under the *Wildlife Conservation Act 1950*. Species on this list are considered to be of conservation priority because there is insufficient information to make an assessment of their conservation status or they are considered to be rare but not threatened and are in need of monitoring.

Species are classified according to five Priority codes:

- Priority One Taxa with few, poorly known populations on threatened lands.  
Taxa that are known from a few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
- Priority Two Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands.  
Taxa that 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. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.



- Priority Three    Taxa with several, poorly known populations, some on conservation lands.
- Taxa that 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 Four    Taxa in need of monitoring.
- Taxa that are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Taxa that are declining significantly but are not yet threatened.
- Priority Five    Taxa in need of monitoring.
- Taxa that 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 2

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### Desktop Review





## Amphibians

Family/Species Name	Common Name	Conservation status	Naturemap +40km	EPBC +40km	ALA	Ecologia (2001)	Ecologia (2003)	BCE (2007)	Ninox Wildlife (2009)	Aprasia and Globe (2009)	BCE (2009)	BCE (2011)	This Survey	This Study
<b>Limnodynastidae</b>														
<i>Neobatrachus albipes</i>	White-footed Trilling Frog		•											
<i>Neobatrachus kunapalari</i>	Kunapalari Frog		•		•		•	•					•	•
<i>Neobatrachus pelobatoides</i>	Humming Frog													
<i>Neobatrachus sutor</i>	Shoemaker Frog													
<b>Myobatrachidae</b>														
<i>Pseudophryne occidentalis</i>	Western Toadlet						•							



# Birds

Family/Species Name	Common Name	Conservation Status	ALA	Naturemap within 40km	EPBC within 40km	Ecologia (2001)	Ecologia (2003)	BCE (2007)	Ninox Wildlife (2009)	Aprasia and Globe (2009)	BCE (2009)	BCE (2011)	This Survey	This survey Phase 1	This survey Phase 2
<b>Casuariidae</b>															
<i>Dromaius novaehollandiae</i>	Emu		•	•		•	•		•						
<b>Megapodiidae</b>															
<i>Leipoa ocellata</i>	Malleefowl	S1, Vulnerable	•	•	•	•	•						•	•	•
<b>Phasianidae</b>															
<i>Coturnix pectoralis</i>	Stubble Quail														
<b>Anatidae</b>															
<i>Tadorna tadornoides</i>	Australian Shelduck			•											
<i>Anas gracilis</i>	Grey Teal		•	•											
<i>Anas superciliosa</i>	Pacific Black Duck		•	•											
<b>Podicipedidae</b>															
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe		•	•											
<b>Columbidae</b>															
<i>Streptopelia senegalensis</i>	Laughing Dove			•											
<i>Phaps chalcoptera</i>	Common Bronzewing		•	•			•	•	•	•	•		•	•	
<i>Ocyphaps lophotes</i>	Crested Pigeon		•				•	•		•	•		•	•	
<b>Podargidae</b>															
<i>Podargus strigoides</i>	Tawny Frogmouth						•				•		•	•	•
<b>Eurostopodidae</b>															
<i>Eurostopodus argus</i>	Spotted Nightjar					•	•			•	•		•		•
<b>Aegothelidae</b>															
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar			•			•	•			•		•	•	
<b>Apodidae</b>															
<i>Apus pacificus</i>	Fork-tailed Swift	S3, Migratory		•											
<b>Ardeidae</b>															
<i>Ardea modesta</i>	Eastern Great Egret	S3, Migratory			•										
<i>Ardea ibis</i>	Cattle Egret	S3, Migratory			•										
<b>Accipitridae</b>															
<i>Elanus axillaris</i>	Black-shouldered Kite														
<i>Lophoictinia isura</i>	Square-tailed Kite							•							
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard														
<i>Haliastur sphenurus</i>	Whistling Kite												•		•
<i>Milvus migrans</i>	Black Kite														
<i>Accipiter fasciatus</i>	Brown Goshawk		•				•	•	•		•		•	•	
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk														
<i>Circus assimilis</i>	Spotted Harrier														
<i>Aquila audax</i>	Wedge-tailed Eagle			•		•	•	•	•						
<i>Hieraetus morphnoides</i>	Little Eagle		•				•								
<b>Falconidae</b>															
<i>Falco cenchroides</i>	Nankeen Kestrel			•		•									
<i>Falco berigora</i>	Brown Falcon		•	•			•		•	•	•		•	•	•
<i>Falco longipennis</i>	Australian Hobby		•				•	•							
<i>Falco subniger</i>	Black Falcon														
<i>Falco peregrinus</i>	Peregrine Falcon	S4					•			•			•	•	
<b>Otididae</b>															
<i>Ardeotis australis</i>	Australian Bustard	P4							•						
<b>Recurvirostridae</b>															
<i>Himantopus himantopus</i>	Black-winged Stilt		•	•											
<b>Charadriidae</b>															
<i>Elseyornis melanops</i>	Black-fronted Dotterel		•												
<b>Cacatuidae</b>															
<i>Calyptrorhynchus banksii</i>	Red-tailed Black-Cockatoo			•											
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo	S4	•	•			•	•	•		•		•	•	•
<i>Eolophus roseicapillus</i>	Galah		•				•	•	•	•	•				
<b>Psittacidae</b>															
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet		•	•		•	•	•	•	•	•		•	•	•
<i>Polytelis anthopeplus</i>	Regent Parrot			•			•	•	•						
<i>Barnardius zonarius</i>	Australian Ringneck		•	•		•	•	•	•	•	•	•	•	•	•
<i>Psephotus varius</i>	Mulga Parrot		•							•					
<i>Melopsittacus undulatus</i>	Budgerigar			•											
<b>Cuculidae</b>															
<i>Chalcites basalus</i>	Horsfield's Bronze-Cuckoo			•					•		•	•	•	•	•
<i>Chalcites osculans</i>	Black-eared Cuckoo						•						•		•
<i>Cacomantis pallidus</i>	Pallid Cuckoo						•		•						
<i>Ninox novaeseelandiae</i>	Southern Boobook			•		•	•						•	•	•
<b>Tytonidae</b>															
<i>Tyto javanica</i>	Eastern Barn Owl						•								
<b>Halcyonidae</b>															
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher		•			•	•		•				•		•

Family/Species Name	Common Name	Conservation Status	ALA	Naturemap within 40km	EPBC within 40km	Ecologia (2001)	Ecologia (2003)	BCE (2007)	Ninox Wildlife (2009)	Aprasia and Globe (2009)	BCE (2009)	BCE (2011)	This Survey	This survey Phase 1	This survey Phase 2
<b>Meropidae</b>															
<i>Merops ornatus</i>	Rainbow Bee-eater	S3, Migratory		•	•	•	•		•		•		•		•
<b>Climacteridae</b>															
<i>Climacteris rufa</i>	Rufous Treecreeper		•	•		•	•		•		•		•	•	•
<b>Maluridae</b>															
<i>Malurus splendens</i>	Splendid Fairy-wren			•			•	•	•			•			
<i>Malurus leucopterus</i>	White-winged Fairy-wren		•	•											
<i>Malurus lamberti</i>	Variegated Fairy-wren			•					•		•		•	•	•
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren					•									
<b>Acanthizidae</b>															
<i>Sericornis frontalis</i>	White-browed Scrubwren			•											
<i>Hylacola cauta whitlocki</i>	Shy Heathwren	P4		•			•								
<i>Pyrrholaemus brunneus</i>	Redthroat			•		•	•	•	•		•		•	•	•
<i>Smicrornis brevirostris</i>	Weebill		•	•		•	•	•	•	•	•	•	•	•	•
<i>Gerygone fusca</i>	Western Gerygone		•	•			•	•		•			•	•	•
<i>Acanthiza robustirostris</i>	Slaty-backed Thornbill			•			•						•	•	•
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill		•	•		•	•	•	•		•		•	•	•
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill		•	•		•	•	•	•		•	•	•	•	•
<i>Acanthiza iredalei</i>	Slender-billed Thornbill				•										
<i>Acanthiza apicalis</i>	Inland Thornbill			•		•	•	•	•			•	•	•	•
<i>Aphelocephala leucopsis</i>	Southern Whiteface			•			•		•						
<b>Pardalotidae</b>															
<i>Pardalotus punctatus</i>	Spotted Pardalote							•							
<i>Pardalotus striatus</i>	Striated Pardalote		•	•		•	•		•	•	•	•	•	•	•
<b>Meliphagidae</b>															
<i>Certhionyx variegatus</i>	Pied Honeyeater			•											
<i>Lichenostomus virescens</i>	Singing Honeyeater		•	•		•	•	•	•	•	•	•	•	•	•
<i>Lichenostomus leucotis</i>	White-eared Honeyeater		•	•		•	•	•	•	•	•	•	•	•	•
<i>Lichenostomus ornatus</i>	Yellow-plumed Honeyeater		•	•		•	•	•	•		•		•	•	•
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater							•							
<i>Purnella albifrons</i>	White-fronted Honeyeater			•			•		•	•	•	•	•	•	•
<i>Manorina flavigula</i>	Yellow-throated Miner		•	•		•	•	•	•	•	•				
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater		•	•		•	•	•	•	•	•	•	•	•	•
<i>Anthochaera carunculata</i>	Red Wattlebird		•	•		•	•	•	•	•	•		•	•	•
<i>Epthianura albifrons</i>	White-fronted Chat			•											
<i>Lichmera indistincta</i>	Brown Honeyeater		•	•		•	•	•	•		•		•	•	•
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater			•		•		•	•		•		•	•	•
<b>Pomatostomidae</b>															
<i>Pomatostomus superciliosus</i>	White-browed Babbler		•	•			•	•	•	•	•		•	•	•
<b>Eupetidae</b>															
<i>Cinclosoma castanotum</i>	Chestnut Quail-thrush		•			•	•						•	•	•
<i>Cinclosoma castaneothorax</i>	Chestnut-breasted Quail-thrush								•						
<b>Neosittidae</b>															
<i>Daphoenositta chrysoptera</i>	Varied Sittella			•		•	•	•			•		•		•
<b>Campephagidae</b>															
<i>Coracina maxima</i>	Ground Cuckoo-shrike					•			•						
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		•	•		•	•		•	•	•		•	•	•
<i>Lalage sueurii</i>	White-winged Triller		•						•				•		•
<b>Pachycephalidae</b>															
<i>Pachycephala inornata</i>	Gilbert's Whistler			•				•	•	•	•		•	•	•
<i>Pachycephala pectoralis</i>	Golden Whistler			•											
<i>Pachycephala rufiventris</i>	Rufous Whistler		•	•		•	•	•	•		•		•	•	•
<i>Colluricincla harmonica</i>	Grey Shrike-thrush		•	•		•	•	•	•	•	•		•	•	•
<i>Oreica gutturalis</i>	Crested Bellbird		•	•		•	•	•	•		•		•	•	•
<b>Artamidae</b>															
<i>Artamus personatus</i>	Masked Woodswallow								•						
<i>Artamus cinereus</i>	Black-faced Woodswallow		•	•			•								
<i>Artamus cyanopterus</i>	Dusky Woodswallow			•		•			•		•		•	•	•
<i>Artamus minor</i>	Little Woodswallow			•		•		•	•				•	•	•
<i>Cracticus torquatus</i>	Grey Butcherbird		•	•		•	•	•	•		•		•	•	•
<i>Cracticus nigrogularis</i>	Pied Butcherbird		•	•		•	•	•	•	•	•		•	•	•
<i>Cracticus tibicen</i>	Australian Magpie		•	•		•	•	•	•	•	•		•	•	•
<i>Strepera versicolor</i>	Grey Currawong			•		•	•	•	•	•	•		•	•	•
<b>Rhipiduridae</b>															
<i>Rhipidura fuliginosa</i>	Grey Fantail		•						•						
<i>Rhipidura leucophrys</i>	Willie Wagtail		•	•		•	•	•	•	•	•		•	•	
<b>Corvidae</b>															
<i>Corvus coronoides</i>	Australian Raven		•	•		•	•	•	•		•		•	•	•
<i>Corvus bennetti</i>	Little Crow			•		•	•						•	•	
<i>Corvus orru</i>	Torresian Crow								•	•					

Family/Species Name	Common Name	Conservation Status	ALA	Naturemap within 40km	EPBC within 40km	Ecologia (2001)	Ecologia (2003)	BCE (2007)	Ninox Wildlife (2009)	Aprasia and Globe (2009)	BCE (2009)	BCE (2011)	This Survey	This survey Phase 1	This survey Phase 2
<b>Monarchidae</b>															
<i>Grallina cyanoleuca</i>	Magpie-lark		•	•			•	•		•	•				
<b>Petroicidae</b>															
<i>Microeca fascians</i>	Jacky Winter		•	•		•	•	•	•				•	•	•
<i>Petroica goodenovii</i>	Red-capped Robin		•	•		•	•		•	•			•	•	•
<i>Melanodryas cucullata</i>	Hooded Robin					•	•								
<i>Eopsaltria griseogularis</i>	Western Yellow Robin			•		•					•				
<i>Drymodes brunneopygia</i>	Southern Scrub-robin					•									
<b>Megaluridae</b>															
<i>Cincloramphus cruralis</i>	Brown Songlark			•											
<b>Timaliidae</b>															
<i>Zosterops lateralis</i>	Silvereye			•											
<b>Hirundinidae</b>															
<i>Cheramoeca leucosterna</i>	White-backed Swallow		•				•								
<i>Hirundo neoxena</i>	Welcome Swallow			•		•	•								
<i>Petrochelidon nigricans</i>	Tree Martin		•			•	•		•		•		•	•	•
<b>Nectariniidae</b>															
<i>Dicaeum hirundinaceum</i>	Mistletoebird			•		•	•								
<b>Estrildidae</b>															
<i>Taeniopygia guttata</i>	Zebra Finch		•	•			•		•						
<b>Motacillidae</b>															
<i>Anthus novaeseelandiae</i>	Australasian Pipit						•	•			•				





## Reptiles

Family / Species Name	Common Name	Conservation Status	Naturemap within 40km	EPBC within 40km	ALA	Ecologia (2001)	Ecologia (2003)	BCE (2007)	Ninox Wildlife (2009)	Aprasia and Globe (2009)	BCE (2009)	BCE (2011)	This Survey	This Survey Phase 1	This Survey Phase 2
<b>Agamidae</b>															
<i>Ctenophorus cristatus</i>	Bicycle Dragon		•	•			•		•		•		•	•	•
<i>Ctenophorus maculatus</i>	Spotted Military Dragon														
<i>Ctenophorus reticulatus</i>	Western Netted Dragon		•	•	•		•								
<i>Ctenophorus salinarum</i>	Salt Pan Dragon		•												
<i>Ctenophorus scutulatus</i>						•							•		•
<i>Moloch horridus</i>	Thorny Devil								•						
<i>Pogona minor</i>			•	•	•		•		•		•		•	•	
<i>Tympanocryptis cephalus</i>	Pebble Dragon					•									
<b>Diplodactylidae</b>															
<i>Crenadactylus ocellatus</i>	Clawless Gecko		•			•							•		•
<i>Diplodactylus granariensis</i>			•			•			•		•		•	•	•
<i>Lucasium maini</i>							•						•	•	•
<i>Diplodactylus pulcher</i>			•			•	•		•		•		•	•	•
<i>Lucasium maini</i>			•						•				•	•	
<i>Lucasium stenodactylum</i>															
<i>Hesperoedura reticulata</i>			•	•	•		•		•		•		•	•	•
<i>Rhynchoedura ornata</i>	Western Beaked Gecko					•	•								
<i>Strophurus assimilis</i>	Goldfields Spiny-tailed Gecko					•									
<b>Carphodactylidae</b>															
<i>Underwoodisaurus milii</i>	Southern Barking Gecko					•	•		•		•		•	•	•
<i>Nephurus vertebralis</i>															
<b>Gekkonidae</b>															
<i>Gehyra purpurascens</i>															
<i>Gehyra variegata</i>			•	•		•	•	•	•		•		•	•	•
<i>Heteronotia binoei</i>	Bynoe's Gecko		•	•		•	•	•			•		•	•	•
<b>Pygopodidae</b>															
<i>Delma australis</i>							•		•				•	•	•
<i>Delma butleri</i>			•			•									
<i>Delma fraseri</i>															
<i>Lialis burtonis</i>	Burton's Legless-Lizard		•	•			•								
<i>Pygopus lepidopodus</i>	Common Scaly Foot					•		•							
<b>Scincidae</b>															
<i>Cryptoblepharus buchananii</i>			•										•	•	•
<i>Cryptoblepharus plagioccephalus</i>						•					•				
<i>Ctenotus atlas</i>			•				•								
<i>Ctenotus impar</i>			•												
<i>Ctenotus leonhardii</i>															
<i>Ctenotus mimetes</i>															
<i>Ctenotus pantherinus</i>	Leopard Ctenotus														
<i>Ctenotus schomburgkii</i>															
<i>Ctenotus severus</i>															
<i>Ctenotus uber</i>			•			•	•				•		•	•	•
<i>Cyclodomorphus melanops</i>	Slender Blue-tongue		•			•	•		•				•		•
<i>Egernia depressa</i>	Southern Pygmy Spiny-tailed Skink														
<i>Egernia formosa</i>									•				•		•
<i>Liopholis inornata</i>	Unadorned Desert-skink						•								
<i>Liopholis striata</i>	Night Skink														
<i>Eremiascincus richardsonii</i>	Broad-banded Sand Swimmer		•			•							•	•	
<i>Hemiergis initialis</i>			•			•					•				
<i>Lerista gerrardii</i>							•								
<i>Lerista kingi</i>			•								•		•	•	•
<i>Lerista macropisthopus</i>													•		•
<i>Lerista muelleri</i>						•	•								
<i>Lerista timida</i>									•				•	•	
<i>Liopholis inornata</i>			•												
<i>Menetia greyii</i>			•			•	•		•		•		•	•	•
<i>Morethia butleri</i>						•			•		•		•	•	•
<i>Morethia obscura</i>															
<i>Tiliqua occipitalis</i>	Western Bluetongue												•		•
<i>Tiliqua rugosa</i>							•								
<b>Varanidae</b>															
<i>Varanus caudolineatus</i>															
<i>Varanus giganteus</i>	Perentie		•			•					•		•		•
<i>Varanus gouldii</i>	Bungarra or Sand Monitor		•				•								
<i>Varanus panoptes</i>	Yellow-spotted Monitor														
<i>Varanus tristis</i>	Racehorse Monitor		•			•			•		•		•	•	•

Family / Species Name	Common Name	Conservation Status	Naturemap within 40km	EPBC within 40km	ALA	Ecologia (2001)	Ecologia (2003)	BCE (2007)	Ninox Wildlife (2009)	Aprasia and Globe (2009)	BCE (2009)	BCE (2011)	This Survey	This Survey Phase 1	This Survey Phase 2
<b>Typhlopidae</b>															
<i>Ramphotyphlops australis</i>			•			•	•		•		•				
<i>Ramphotyphlops bicolor</i>			•						•						
<i>Ramphotyphlops bituberculatus</i>						•							•		•
<i>Ramphotyphlops hamatus</i>			•								•		•		•
<i>Ramphotyphlops waitii</i>															
<b>Boidae</b>															
<i>Antaresia stimsoni</i>	Stimson's Python														
<i>Morelia spilota imbricata</i>	Carpet Python	S4													
<b>Elapidae</b>															
<i>Acanthophis pyrrhus</i>	Desert Death Adder														
<i>Brachyuropsis fasciolatus</i>															
<i>Brachyuropsis semifasciatus</i>									•				•		•
<i>Demansia psammophis</i>	Yellow-faced Whipsnake														
<i>Furina ornata</i>	Moon Snake					•							•	•	•
<i>Neelaps bimaculatus</i>	Black-naped Snake								•						
<i>Parasuta gouldii</i>									•						
<i>Parasuta monachus</i>			•				•		•		•		•	•	•
<i>Pseudechis australis</i>	Mulga Snake		•				•				•		•	•	•
<i>Pseudonaja modesta</i>	Ringed Brown Snake		•	•											
<i>Pseudonaja nuchalis</i>	Gwardar; Northern Brown Snake														
<i>Simoselaps bertholdi</i>	Jan's Banded Snake					•							•		•
<i>Suta fasciata</i>	Rosen's Snake		•	•			•								



## Appendix 3

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### NatureMap Search Results







# NatureMap Species Report

Created By Guest user on 02/01/2013

**Kingdom** Animalia  
**Current Names Only** Yes  
**Core Datasets Only** Yes  
**Species Group** All Animals  
**Method** 'By Circle'  
**Centre** 119°35' 05" E, 30°51' 18" S  
**Buffer** 40km  
**Group By** Species Group

Species Group	Species	Records
Amphibian	2	2
Bird	78	500
Invertebrate	10	206
Mammal	6	8
Reptile	34	63
<b>TOTAL</b>	<b>130</b>	<b>779</b>

	Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
<b>Amphibian</b>					
1.	25421	<i>Neobatrachus albipes</i> (White-footed Trilling Frog)			
2.	25425	<i>Neobatrachus kunapalari</i> (Kunapalari Frog)			
<b>Bird</b>					
3.	24559	<i>Acanthagenys rufogularis</i> (Spiny-cheeked Honeyeater)			
4.	24260	<i>Acanthiza apicalis</i> (Broad-tailed Thornbill)			
5.	24261	<i>Acanthiza chrysorrhoa</i> (Yellow-rumped Thornbill)			
6.	24264	<i>Acanthiza robustirostris</i> (Slaty-backed Thornbill)			
7.	24265	<i>Acanthiza uropygialis</i> (Chestnut-rumped Thornbill)			
8.	25536	<i>Accipiter fasciatus</i> (Brown Goshawk)			
9.	25544	<i>Aegotheles cristatus</i> (Australian Owlet-nightjar)			
10.	24312	<i>Anas gracilis</i> (Grey Teal)			
11.	24316	<i>Anas superciliosa</i> (Pacific Black Duck)			
12.	24561	<i>Anthochaera carunculata</i> (Red Wattlebird)			
13.	25528	<i>Aphelocephala leucopsis</i> (Southern Whiteface)			
14.	24285	<i>Aquila audax</i> (Wedge-tailed Eagle)			
15.	25566	<i>Artamus cinereus</i> (Black-faced Woodswallow)			
16.	24353	<i>Artamus cyanopterus</i> (Dusky Woodswallow)			
17.	24355	<i>Artamus minor</i> (Little Woodswallow)			
18.	24722	<i>Cacatua leadbeateri</i> (Major Mitchell's Cockatoo)		S	
19.	25717	<i>Calyptorhynchus banksii</i> (Red-tailed Black-Cockatoo)			
20.	24564	<i>Certhionyx variegatus</i> (Pied Honeyeater)			
21.	24431	<i>Chrysococcyx basalis</i> (Horsfield's Bronze Cuckoo)			
22.	24833	<i>Cincloramphus cruralis</i> (Brown Songlark)			
23.	24396	<i>Climacteris rufa</i> (Rufous Treecreeper)			
24.	25675	<i>Colluricincla harmonica</i> (Grey Shrike-thrush)			
25.	25568	<i>Coracina novaehollandiae</i> (Black-faced Cuckoo-shrike)			
26.	24416	<i>Corvus bennetti</i> (Little Crow)			
27.	25592	<i>Corvus coronoides</i> (Australian Raven)			
28.	24420	<i>Cracticus nigrogularis</i> (Pied Butcherbird)			
29.	25595	<i>Cracticus tibicen</i> (Australian Magpie)			
30.	25596	<i>Cracticus torquatus</i> (Grey Butcherbird)			
31.	25673	<i>Daphoenositta chrysoptera</i> (Varied Sittella)			
32.	25607	<i>Dicaeum hirundinaceum</i> (Mistletoebird)			
33.	24470	<i>Dromaius novaehollandiae</i> (Emu)			
34.	24651	<i>Eopsaltria australis</i> subsp. <i>griseogularis</i> (Western Yellow Robin)			
35.	24567	<i>Epthianura albifrons</i> (White-fronted Chat)			
36.	25621	<i>Falco berigora</i> (Brown Falcon)			
37.	25622	<i>Falco cenchroides</i> (Australian Kestrel)			
38.	25623	<i>Falco longipennis</i> (Australian Hobby)			

	Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
39.	25530	<i>Gerygone fusca</i> (Western Gerygone)			
40.	24735	<i>Glossopsitta porphyrocephala</i> (Purple-crowned Lorikeet)			
41.	24443	<i>Grallina cyanoleuca</i> (Magpie-lark)			
42.	25734	<i>Himantopus himantopus</i> (Black-winged Stilt)			
43.	24491	<i>Hirundo neoxena</i> (Welcome Swallow)			
44.	34001	<i>Hylacola cauta</i> subsp. <i>whitlocki</i> (Shy Heathwren (western))		P4	
45.	24557	<i>Leipoa ocellata</i> (Malleefowl)		T	
46.	25659	<i>Lichenostomus leucotis</i> (White-eared Honeyeater)			
47.	24577	<i>Lichenostomus ornatus</i> (Yellow-plumed Honeyeater)			
48.	24581	<i>Lichenostomus virescens</i> (Singing Honeyeater)			
49.	25661	<i>Lichmera indistincta</i> (Brown Honeyeater)			
50.	25651	<i>Malurus lamberti</i> (Variegated Fairy-wren)			
51.	25652	<i>Malurus leucopterus</i> (White-winged Fairy-wren)			
52.	25654	<i>Malurus splendens</i> (Splendid Fairy-wren)			
53.	24583	<i>Manorina flavigula</i> (Yellow-throated Miner)			
54.	25663	<i>Melithreptus brevirostris</i> (Brown-headed Honeyeater)			
55.	24736	<i>Melopsittacus undulatus</i> (Budgerigar)			
56.	24598	<i>Merops ornatus</i> (Rainbow Bee-eater)		IA	
57.	25693	<i>Microeca fascians</i> (Jacky Winter)			
58.	25748	<i>Ninox novaeseelandiae</i> (Boobook Owl)			
59.	24407	<i>Ocyphaps lophotes</i> (Crested Pigeon)			
60.	24618	<i>Oreoca gutturalis</i> (Crested Bellbird)			
61.	24619	<i>Pachycephala inornata</i> (Gilbert's Whistler)			
62.	25679	<i>Pachycephala pectoralis</i> (Golden Whistler)			
63.	25680	<i>Pachycephala rufiventris</i> (Rufous Whistler)			
64.	25682	<i>Pardalotus striatus</i> (Striated Pardalote)			
65.	24659	<i>Petroica goodenovii</i> (Red-capped Robin)			
66.	24409	<i>Phaps chalcoptera</i> (Common Bronzewing)			
67.	24593	<i>Phylidonyris albifrons</i> (White-fronted Honeyeater)			
68.	24750	<i>Platycercus zonarius</i> subsp. <i>semitorquatus</i> (Twenty-eight Parrot)			
69.	25722	<i>Polytelis anthopeplus</i> (Regent Parrot)			
70.	24683	<i>Pomatostomus superciliosus</i> (White-browed Babbler)			
71.	24278	<i>Pyrrholaemus brunneus</i> (Redthroat)			
72.	25614	<i>Rhipidura leucophrys</i> (Willie Wagtail)			
73.	25534	<i>Sericornis frontalis</i> (White-browed Scrubwren)			
74.	30948	<i>Smicromis brevirostris</i> (Weebill)			
75.	25597	<i>Strepera versicolor</i> (Grey Currawong)			
76.	25590	<i>Streptopelia senegalensis</i> (Laughing Turtle-Dove)	Y		
77.	25705	<i>Tachybaptus novaehollandiae</i> (Australasian Grebe)			
78.	24331	<i>Tadorna tadornoides</i> (Australian Shelduck)			
79.	30870	<i>Taeniopygia guttata</i> (Zebra Finch)			
80.	25765	<i>Zosterops lateralis</i> (Grey-breasted White-eye)			

#### Invertebrate

81.	33902	<i>Aganippe castellum</i> (Tree-stem Trapdoor Spider)		P4	
82.	-13456	<i>Atelomastix bamfordi</i>			
83.	-14766	<i>Cercophonius sulcatus</i>			
84.	-14148	<i>Cethegus fugax</i>			
85.	-14540	<i>Hoggicosa storri</i>			
86.	-13337	<i>Isometroides vescus</i>			
87.	-13904	<i>Scolopendra laeta</i>			
88.	-13999	<i>Scolopendra morsitans</i>			
89.	-13837	<i>Urodacus hoplurus</i>			
90.	-13545	<i>Wesmaldra talgomine</i>			

#### Mammal

91.	24086	<i>Cercartetus concinnus</i> (Western Pygmy-possum)			
92.	24186	<i>Chalinolobus gouldii</i> (Gould's Wattled Bat)			
93.	24184	<i>Mormopterus planiceps</i> (Southern Freetail-bat)			
94.	24096	<i>Ningauai yvonneae</i> (Southern Ningauai)			
95.	24237	<i>Pseudomys hermannsburgensis</i> (Sandy Inland Mouse)			
96.	24109	<i>Sminthopsis dolichura</i> (Little long-tailed Dunnart)			

#### Reptile

97.	24918	<i>Crenadactylus ocellatus</i> subsp. <i>ocellatus</i>			
98.	30893	<i>Cryptoblepharus buchananii</i>			
99.	24871	<i>Ctenophorus cristatus</i> (Bicycle Dragon)			
100.	24886	<i>Ctenophorus reticulatus</i> (Western Netted Dragon)			
101.	24888	<i>Ctenophorus salinarum</i> (Salt Pan Dragon)			
102.	25026	<i>Ctenotus atlas</i>			
103.	25047	<i>Ctenotus impar</i>			
104.	25465	<i>Ctenotus uber</i>			

	Name ID	Species Name	Naturalised	Conservation Code	<sup>1</sup> Endemic To Query Area
105.	25080	<i>Ctenotus uber subsp. uber</i>			
106.	25089	<i>Cyclodomorphus melanops subsp. elongatus</i>			
107.	24997	<i>Delma butleri</i>			
108.	25469	<i>Diplodactylus granariensis</i>			
109.	24940	<i>Diplodactylus pulcher</i>			
110.	25109	<i>Eremiascincus richardsonii</i> (Broad-banded Sand Swimmer)			
111.	24959	<i>Gehyra variegata</i>			
112.	25474	<i>Hemiergis initialis</i>			
113.	24961	<i>Heteronotia binoei</i> (Bynoe's Gecko)			
114.	30927	<i>Lerista kingi</i>			
115.	-19555	<i>Lerista kingi</i>			
116.	25005	<i>Lialis burtonis</i>			
117.	41411	<i>Liopholis inornata</i> (Desert Skink)			
118.	30935	<i>Lucasium maini</i>			
119.	25184	<i>Menetia greyii</i>			
120.	25190	<i>Morethia butleri</i>			
121.	24978	<i>Oedura reticulata</i>			
122.	25254	<i>Parasuta monachus</i>			
123.	25510	<i>Pogona minor</i>			
124.	24907	<i>Pogona minor subsp. minor</i>			
125.	25263	<i>Pseudonaja modesta</i> (Ringed Brown Snake)			
126.	25271	<i>Ramphotyphlops australis</i>			
127.	30824	<i>Ramphotyphlops bicolor</i>			
128.	25269	<i>Suta fasciata</i> (Rosen's Snake)			
129.	25218	<i>Varanus gouldii</i> (Bungarra or Sand Monitor)			
130.	25526	<i>Varanus tristis</i> (Racehorse Monitor)			

#### 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

<sup>1</sup> For NatureMap's purposes, species flagged as endemic are those whose records are wholly 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.





## Appendix 4

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### EPBC Act 1999 Protected Matters Search Results







# 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 is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 17/01/14 15:08:49

[Summary](#)

[Details](#)

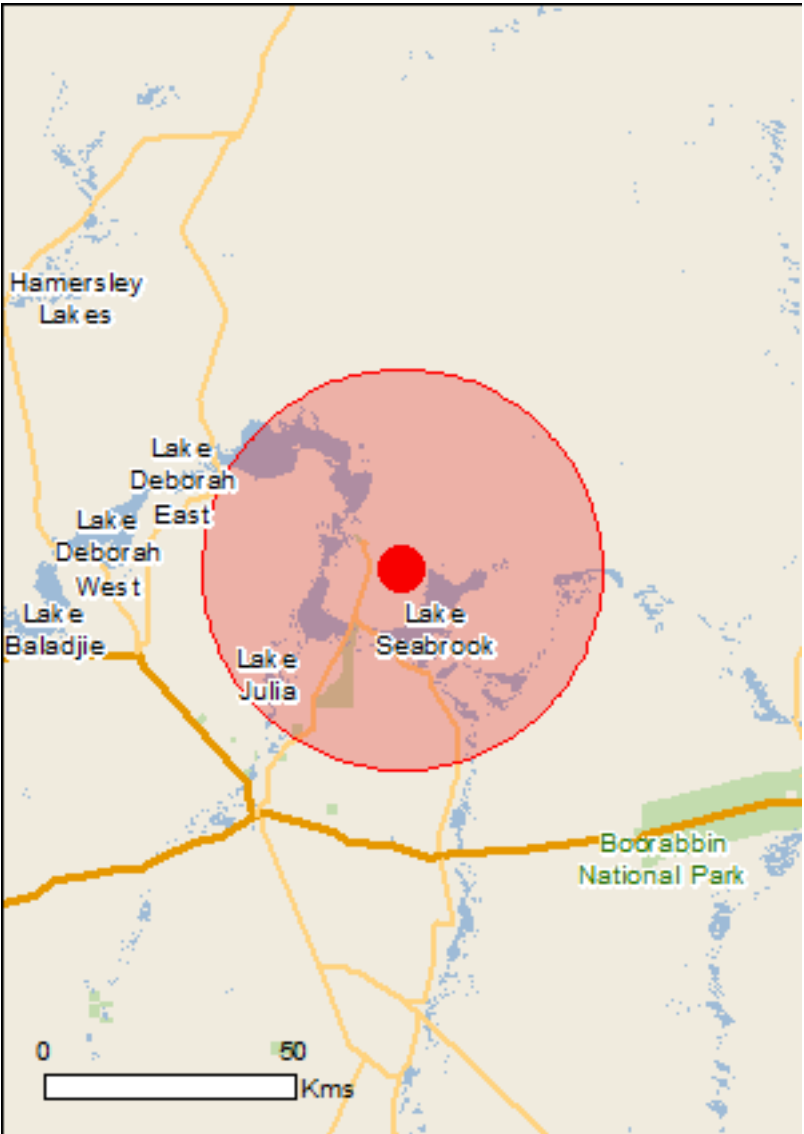
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)



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[Coordinates](#)

Buffer: 40.0Km





# Summary

## Matters of National Environmental 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](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Areas:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	None
<a href="#">Listed Threatened Species:</a>	10
<a href="#">Listed Migratory Species:</a>	5

## 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.

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.

<a href="#">Commonwealth Land:</a>	1
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	4
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Commonwealth Reserves Marine</a>	None

## Extra Information

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

<a href="#">Place on the RNE:</a>	1
<a href="#">State and Territory Reserves:</a>	4
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	11
<a href="#">Nationally Important Wetlands:</a>	None
<a href="#">Key Ecological Features (Marine)</a>	None

## Details

### Matters of National Environmental Significance

Listed Threatened Species		[ Resource Information ]
Name	Status	Type of Presence
Birds		
<a href="#">Acanthiza iredalei iredalei</a> Slender-billed Thornbill (western) [25967]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Plants		
<a href="#">Acacia lobulata</a> Chiddarcooping Wattle [55567]	Endangered	Species or species habitat may occur within area
<a href="#">Eremophila virens</a> Campion Eremophila, Green-flowered Emu bush [21433]	Endangered	Species or species habitat may occur within area
<a href="#">Eremophila viscida</a> Varnish Bush [2394]	Endangered	Species or species habitat likely to occur within area
<a href="#">Frankenia parvula</a> Short-leaved Frankenia [20872]	Endangered	Species or species habitat known to occur within area
<a href="#">Leucopogon spectabilis</a> Ironstone Beard-heath [83012]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Ricinocarpos brevis</a> [82879]	Endangered	Species or species habitat known to occur within area
<a href="#">Roycea pycnophylloides</a> Saltmat [21161]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
<a href="#">Tetratheca paynterae</a> Paynter's Tetratheca [66451]	Endangered	Species or species habitat may occur within area

Listed Migratory Species	<a href="#">[ Resource Information ]</a>
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.	

Name	Threatened	Type of Presence
Migratory Marine Birds		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Migratory Terrestrial Species		
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area

Migratory Wetlands Species		
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area

### Other Matters Protected by the EPBC Act

Commonwealth Land	<a href="#">[ Resource Information ]</a>
<p>The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.</p>	

Name
Commonwealth Land -

Listed Marine Species	<a href="#">[ Resource Information ]</a>
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.	

Name	Threatened	Type of Presence
Birds		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat may occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Places on the RNE

[ Resource Information ]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
<a href="#">Yellowdine Proposed Reserve</a>	WA	Registered

State and Territory Reserves

[ Resource Information ]

Name	State
Duladgin	WA
Mount Manning Range	WA
Unnamed WA36918	WA
Yellowdine	WA

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, 2001.

Name	Status	Type of Presence
Birds		
<a href="#">Columba livia</a>		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
<a href="#">Streptopelia senegalensis</a>		
Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Mammals		
<a href="#">Canis lupus familiaris</a>		
Domestic Dog [82654]		Species or species habitat likely to occur within area
<a href="#">Capra hircus</a>		
Goat [2]		Species or species habitat likely to occur within area
<a href="#">Equus asinus</a>		
Donkey, Ass [4]		Species or species habitat likely to occur within area
<a href="#">Equus caballus</a>		
Horse [5]		Species or species habitat likely to occur within area
<a href="#">Felis catus</a>		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area



Name	Status	Type of Presence
<a href="#">Mus musculus</a> House Mouse [120]		Species or species habitat likely to occur within area
<a href="#">Oryctolagus cuniculus</a> Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
<a href="#">Vulpes vulpes</a> Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
<a href="#">Carrichtera annua</a> Ward's Weed [9511]		Species or species habitat likely to occur within area

# Coordinates

-30.85531 119.58888

## 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 resolutions.

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 information sources.

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](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- 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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[Department of Sustainability, Environment, Water, Population and Communities](#)

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## Appendix 5

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### Atlas of Living Australia Search Results







## Avifauna

Acanthagenys rufogularis	Spiny-cheeked Honeyeater
Acanthiza (Geobasileus) chrysorrhoa	Yellow-rumped Thornbill
Acanthiza (Geobasileus) uropygialis	Chestnut-rumped Thornbill
Anas (Anas) superciliosa	Pacific Black Duck
Anas (Nettion) gracilis	Grey Teal
Anthochaera (Anthochaera) carunculata	Red Wattlebird
Artamus (Angroyan) cinereus	Black-faced Woodswallow
Barnardius zonarius	Australian Ringneck
Cheramoeca leucosterna	White-backed Swallow
Cinclosoma (Malleoavis) castanotum	Chestnut Quail-thrush
Climacteris (Climacteris) rufa	Rufous Treecreeper
Colluricincla (Colluricincla) harmonica	Grey Shrike-thrush
Coracina (Coracina) novaehollandiae	Black-faced Cuckoo-shrike
Corvus coronoides	Australian Raven
Cracticus nigrogularis	Pied Butcherbird
Cracticus tibicen	Australian Magpie
Cracticus torquatus	Grey Butcherbird
Dromaius novaehollandiae	Emu
Elseyaornis melanops	Black-fronted Dotterel
Eolophus roseicapillus	Galah
Falco (Falco) longipennis	Australian Hobby
Falco (Ieracidea) berigora	Brown Falcon
Gerygone fusca	Western Gerygone
Glossopsitta porphyrocephala	Purple-crowned Lorikeet
Grallina cyanoleuca	Magpie-lark
Hieraaetus (Hieraaetus) morphnoides	Little Eagle
Himantopus himantopus	Black-winged Stilt
Lalage (Lalage) sueurii	White-winged Triller
Leipoa ocellata	Malleefowl
Lichenostomus (Gavicalis) virescens	Singing Honeyeater
Lichenostomus (Nesoptilotis) leucotis	White-eared Honeyeater
Lichenostomus (Ptilotula) ornatus	Yellow-plumed Honeyeater
Lichmera (Lichmera) indistincta	Brown Honeyeater
Lophochroa leadbeateri	Major Mitchell's Cockatoo
Malurus (Musciparus) leucopterus	White-winged Fairy-wren
Manorina (Myzantha) flavigula	Yellow-throated Miner
Microeca (Microeca) fascinans	Jacky Winter
Oreoica gutturalis	Crested Bellbird
Pachycephala (Alisterornis) rufiventris	Rufous Whistler
Pardalotus (Pardalotinus) striatus	Striated Pardalote
Petrochelidon (Hylochelidon) nigricans	Tree Martin
Petroica (Petroica) goodenovii	Red-capped Robin
Phaps (Phaps) chalcoptera	Common Bronzewing
Pomatostomus (Morganornis) superciliosus	White-browed Babbler

Psephotus (Psephotus) varius	Mulga Parrot
Rhipidura (Rhipidura) albiscapa	Grey Fantail
Rhipidura (Sauloprocta) leucophrys	Willie Wagtail
Smicronis brevirostris	Weebill
Tachybaptus novaehollandiae	Australasian Grebe
Taeniopygia guttata	Zebra Finch
Todiramphus (Cyanalcyon) pyrrhopygius	Red-backed Kingfisher

### Mammals

Chalinolobus gouldii	Gould's Wattled Bat
Pseudomys hermannsburgensis	Sandy Inland Mouse

### Reptiles

Pogona minor	Western Bearded Dragon
Ctenophorus reticulatus	Western Netted Dragon
Ctenophorus cristatus	Bicycle Lizard
Pseudonaja modesta	Ringed Brown Snake
Suta fasciata	Rosen's Snake
Gehyra variegata	Tree Dtella
Heteronotia binoei	Bynoe's Gecko
Lialis burtonis	Burton's Snake-lizard

### Amphibians

Neobatrachus kunapalari	Kunapalari Frog
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## Appendix 6

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### DPaW Regulation 17 Licence







Department of  
Environment and  
Conservation

Our environment, our future

## DEPARTMENT OF ENVIRONMENT AND CONSERVATION

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PAGE 1  
NO. SF009177  
PERSON NO. 130206

RECEIPT NO. AMOUNT  
\$0.00

### WILDLIFE CONSERVATION ACT 1950 REGULATION 17

### LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

THE UNDERMENTIONED PERSON MAY TAKE FAUNA FOR RESEARCH OR OTHER SCIENTIFIC PURPOSES AND WHERE AUTHORISED, KEEP IT IN CAPTIVITY, SUBJECT TO THE FOLLOWING AND ATTACHED CONDITIONS, WHICH MAY BE ADDED TO, SUSPENDED OR OTHERWISE VARIED AS CONSIDERED FIT.

DIRECTOR GENERAL

#### CONDITIONS

- 1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.
- 2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.
- 3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.
- 4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.
- 5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR BE HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTOR GENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.
- 6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.
- 7 \*\*\*\*\*ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE DEPT OF SUSTAINABILITY, ENVIRONMENT, WATER, POPULATION & COMMUNITIES PH 02 6274 1111. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.\*\*\*\*\*
- 8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.
- 9 FURTHER CONDITIONS (NUMBERED 1 TO 9) ARE ATTACHED.

#### PURPOSE

LEVEL 2 VERTEBRATE AND SHORT RANGE ENDEMIC (SRE) INVERTEBRATE FAUNA SURVEY USING CAGE, ELLIOTT, FUNNEL AND DRY PIT TRAPS, HARP NETTING, BAT ECHOLOCATION RECORDERS, MOTION SENSOR CAMERAS, VISUAL CENSUS, FORAGING, TARGETED SEARCHES, SPIDER AND SCORPION BURROW EXCAVATION FOR REPRESENTATIVE SPECIMENS, RAKING, SOIL AND LEAF LITTER SIEVING, AT THE SOUTH KOOLYANOBING RANGE PROJECT AREA, 50KM NORTH OF SOUTHERN CROSS, FOR CLIFFS ASIA PACIFIC IRON ORE PTY LTD, YILGARN OPERATIONS.





Department of  
Environment and  
Conservation

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## DEPARTMENT OF ENVIRONMENT AND CONSERVATION

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MICHAEL GREENHAM  
ROY TEALE  
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CHRIS COLE  
JESS CAIRNES  
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JACINTA KING

DATE OF ISSUE 02/04/2013  
VALID FROM 02/04/2013  
DATE OF EXPIRY 31/10/2013



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(VICTORIA ANNE)

-----

# WILDLIFE CONSERVATION REGULATIONS 1970

## Regulation 17:- Licence to Take Fauna for Scientific Purposes

FURTHER CONDITIONS (OF LICENCE NUMBER SF009177)

1. The licensee shall take fauna only in the manner stated on the endorsed Regulation 17 licence application form and endorsed related correspondence.
2. Except in the case of approved lethal traps, the licensee shall ensure that measures are taken in the capture and handling of fauna to prevent injury or mortality resulting from that capture or handling. Where traps or other mechanical means or devices are used to capture fauna these shall be deployed so as to prevent exposure of trapped animals to ants and debilitating weather conditions and inspected at regular intervals throughout each day of their use. At the conclusion of research all markers etc and signs erected by the licensee and all traps shall be removed, all pitfalls shall be refilled or capped and the study area returned to the condition it was in prior to the research/capture program. During any break in research, cage traps should be removed and pitfalls either removed, capped or filled with sand.
3. No collecting is to be undertaken in areas where it would impinge on pre-existing scientific research programs.
4. Any form of colour marking of birds or bats shall only be undertaken in accordance with the requirements of the Australian Bird and Bat Banding Scheme.
5. Any inadvertently captured specimen of fauna which is declared as likely to become extinct, rare or otherwise in need of special protection is to be released immediately at the point of capture. Where such a specimen is injured or deceased, the licensee shall contact Department of Environment and Conservation licensing staff at Kensington (08 9423 2434) for advice on disposal. Records are to be kept of any fauna so captured and details included in the report required under further condition 6 below.
6. Within one month of the expiration of this licence, the holder shall submit an electronic return detailing the locality, site, geocode, date and number of each species captured, sighted or vouchered during the currency of the licence, into the Department of Environment and Conservation Fauna Survey Database (DECFSDB). A copy of any paper, report or thesis resulting from the research shall on completion be lodged with the Director General. If a renewal of this licence is required, the licensee shall submit a written progress report for activities undertaken during this licence period prior to the expiry of this licence.
7. Not more than ten specimens of any one protected species shall be taken and removed from any location less than 20km apart. Where exceptional circumstances make it necessary to take large series in order to obtain adequate statistical data the collector will proceed with circumspection and justify their actions to the Director General in advance.
8. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence shall be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected which represents a significant extension of geographic range shall be donated on request to the Western Australian Museum.
9. To prevent any unnecessary collecting in this State, all specimens and material collected under the authority of this license shall, on request, be loaned to the Western Australian Museum. Also, the unused portion or portions of any specimen collected under the authority of this license shall be offered for donation to the Western Australian Museum or made available to other scientific workers if so required.



## Appendix 7

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### Bat Echolocation Analysis







**South Koolyanobbing, WA,  
Fauna Survey Phases 1 and 2,  
April and October 2013**

**Echolocation Survey of Bat Activity.**

Prepared for Biota Environmental Sciences

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Issue B  
16 November 2013

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## **Document Revision History**

Date	Issue	Revision History
24 April 2013	Issue A	Initial draft prepared for Biota
16 November 2013	Issue B	Phase 2 data added and errata corrected.

## Summary

Microbat species presence, with an estimate of activity level, is presented for two survey phases at South Koolyanobbing, approximately 50 km northeast of Southern Cross, WA. Biota Environmental Sciences carried out an echolocation based survey during April and October 2013. Bat Call WA has reviewed the recordings made and provided species lists for the bats present.

Recordings were made at sites representative of the bat habitat in the study area covering rocky hills and plain sites. Eight species of insectivorous microbats were recorded.

## Habitats

Sites for the microbat survey were chosen by Biota. Details of the sites are presented in Table 1. Sites chosen cover the likely bat habitat present in the study area.

## Bat Fauna

A microbat assemblage of eight insectivorous species was confirmed as present at the study sites in April, (details of calls analysed are provided in Table 2 as recommended by Australasian Bat Society (ABS 2006)). No priority bat species were detected. The species activity levels varied between high and low which is typical for the time of year, see criteria below.

## Survey Timing, Moon Phase and Weather

Phase 1 was conducted between 9<sup>th</sup> and 13<sup>th</sup> April 2013. Sampling evenings were fine and warm with minimum overnight temperatures between 15 and 20 °C. The moon in this period was new. Phase 2 was conducted between 24<sup>th</sup> and 28<sup>th</sup> October 2013. Sampling evenings were fine and cool with minimum overnight temperatures between 10 and 15 °C. The moon in this period was last quarter. These conditions are optimum for recording bat echolocation activity for the season.

## Survey Team

A team of Biota ecologists conducted the bat sampling work. Bob Bullen of Bat Call WA completed analysis of echolocation recordings.

## Sampling

The survey consisted of completing overnight bat sound recordings, beginning at twilight, at locations within the survey area. The recordings were “continuous” (Hyder *et al.* 2010) made using SM2BAT SongMeter (Wildlife Acoustics Inc, USA) detectors. The jumper and audio settings used for the SM2BAT followed the manufacturer’s recommendations for bat detection contained in the user manual (Wildlife Acoustics 2010). Selectable filters and triggers were also set using the manufacturer’s recommendations.

For the SM2BAT recordings, once reformatted as .wav files, COOL EDIT 2000 (Now available as AUDITION from Adobe Systems Inc.) was used to display each “continuous call” sequence for identification. Calls were identified manually. Only good quality call

sequences were used. Details of calls analysed are provided in Table 2 as recommended by Australasian Bat Society (ABS 2006). Reference data for the species identified are available in Bullen and McKenzie 2002 and Bullen and Dunlop 2012.

Bat activity was then characterised as “Low”, “Medium” or “High” based on the rate of call sequences recorded.

- Low species activity is referred when a species is recorded with call spacing less often than ten minutes,
- Medium species activity refers to call recordings more often than 10 minutes but less often than two minutes apart for a significant time period followed by sporadic records for the remainder of the session.
- High species activity refers to call recording more often than two minutes apart for significant periods followed by reasonably regular records for the remainder of the session.

Further details of the calls analysed including graphical presentations are available from Bat Call WA on request.

### **Survey Limitations**

All sites surveyed were accessible on foot and the recorders were set at ground level with the omnidirectional microphone aligned horizontally. Bat sound recording was carried out overnight beginning at twilight. The survey method using SM2 detectors gives optimum recorder effectiveness.

Bat species density is impossible to estimate from echolocation records. Bat activity is therefore substituted as an approximate guide to the relative numbers of each species using the study area.

## References

- ABS (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australasian Bat Society Newsletter* 27: 6-9.
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**Table 1 Site Specific details.**

<b>Site</b>	<b>Date</b>	<b>Recording Time</b>	<b>Habitat</b>	<b>Easting Note 1</b>	<b>Northing Note 1</b>
<b>Phase 1</b>					
SKRBat 01	9-10 April	Two overnight recordings using Sm2 S/n 4698	Cave entrance overlooking Eucalyptus woodland	748795	6581658
SKRBat 02	11 -13 April	Three overnight recordings using Sm2 S/n 4698	Eucalyptus woodland over mixed shrubs.	743910	6586578
<b>Phase 2</b>					
SKRBat03	24-26 Oct	Three overnight recordings using Sm2 S/n 4684	Rock outcrop overlooking Eucalyptus woodland	746243	6585107
SKRBat04	27-28 Oct	Two overnight recordings using Sm2 S/n 4684	Eucalyptus woodland over mixed shrubs.	746477	6583715
SKRBat05	25-26 Oct	Two overnight recordings using Sm2 S/n 4685	Cave entrance overlooking Eucalyptus woodland	748890	6582303
SKRBat06	27-28 Oct	Two overnight recordings using Sm2 S/n 4685	Rock outcrop overlooking Eucalyptus woodland.	745321	6584327

Note 1: Coordinates are WGS84 Zone 50J

**Table 2: Summary of Echolocation call characteristics for microbat species present.**

Genus species Authority	Common name	Typical $F_{peakC}$ kHz	Ave. $Q$	Typical Duration msec	Typical Call Shape
<i>Chalinolobus gouldii</i> (Gray 1841)	Gould's wattled bat	32	10	7 - 11	FM
<i>Chalinolobus morio</i> (Grey 1841)	Chocolate wattled bat	50	10	7	FM
<i>Mormopterus species 3</i> (in Adams <i>et al.</i> 1988)	Inland free-tailed bat	25	10	7 - 14	Shallow FM
<i>Nyctophilus geoffroyi</i> Leach 1821	Lesser long-eared bat	47	2.5	5	Steep FM
<i>Scotorepens balstoni</i> (Thomas 1906)	Inland broad-nosed bat	34	10	7 - 13	FM
<i>Tadarida australis</i> (Grey 1838)	White-striped free-tailed bat	12	7	12 - 23	CF– shallow FM
<i>Vespadelus baverstocki</i> (Kitchener, Jones and Caputi 1987)	Inland forest bat	44	10	4 - 8	FM
<i>Vespadelus regulus</i> (Thomas 1906)	Southern forest bat	43	10	4 - 10	FM

Note:  $F_{peakC}$  and  $Q$  are defined in Bullen and McKenzie 2002, Bullen and Dunlop 2012.

**Table 3. Microbat lists obtained presented by site and night.**

Site	<i>Chalinolobus gouldii</i>	<i>Chalinolobus morio</i>	<i>Mormopterus</i> sp. 3	<i>Nyctophilus geoffroyi</i>	<i>Scotorepens balstoni</i>	<i>Tadarida australis</i>	<i>Vespadelus baverstocki</i>	<i>Vespadelus regulus</i>
<b>Phase 1</b>								
SKRBat 01	High	Low	Low	Med	Low	Low		
SKRBat 02	Low		Low	Low	Low	Low	Low	High
<b>Phase 2</b>								
SKRBat03	Med	Low	Low	Low		Low	Low	Low
SKRBat04	Low		Low	Low	Low	Low		
SKRBat05	Med	Low	Low	Low		Low		Low
SKRBat06	High		Low			High		Low