HASTINGS
Technology Metals Limited

APPENDIX 2-1

Terrestrial Fauna Report

YANGIBANA PROJECT BIOLOGICAL ASSESSMENT: TERRESTRIAL FAUNA

Hastings Technology Metals Limited

ecoscape

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Rev.	Author	Approved	Date
Final rev 0	A Heidrich J Scanlon	D. Cancilla	30/11/2016
Final rev 1	D. Cancilla	D. Cancilla	22/01/2018

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ACKNOWLEDGEMENTS

Ecoscape wishes to acknowledge the following for their contributions:

- Andrew Border (Hastings Technology Metals Limited)
- Kieren Whittock (Hastings Technology Metals Limited)
- Jim Millar from Cobra Station for meals and accommodation during the field surveys
- Arthur Taylor from Gifford Creek Station for assistance during the field surveys.

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS	
BAM Act	Western Australian *Biosecurity and Agriculture Management Act 2007*
BoM	Bureau of Meteorology
C1, C2, C3	Declared Pest categories under the *BAM Act 2007*
CALM	Department of Conservation and Land Management (prior to becoming DEC)
DEC	Department of Environment and Conservation (now, in part, DPaW)
DPaW	Western Australian Department of Parks and Wildlife
DEE	Commonwealth Department of the Environment and Energy (formerly DoE, DSEWPaC)
DoE	Commonwealth Department of the Environment (now DEE)
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now DEE)
Ecoscape	Ecoscape (Australia) Pty Ltd
EP Act	Western Australian *Environmental Protection Act 1986*
EPA	Western Australian Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GDA 94	Geographic Datum of Australia 1994
GoA	Government of Australia
GWA	Government of Western Australia
IBRA	Interim Biogeographic Regionalisation for Australia
MGA	Map Grid of Australia
OEPA	Office of the Environmental Protection Authority
PEC	Priority Ecological Community
PF	Priority-listed Flora, Priority Flora
P1, P2, P3, P4, P5	Priority Flora species rankings
SRE	Short Range Endemic
sp.	Species (generally referring to an unidentified taxon or when a phrase name has been applied)
subsp.	Subspecies (infrataxon)
TEC	Threatened Ecological Community
TF	Threatened Flora (formerly termed Declared Rare Flora, DRF, in Western Australia)
WC Act	Western Australian *Wildlife Conservation Act 1950*
WAM	Western Australian Museum
*	Introduced species

SUMMARY

Hastings Technology Metals Limited (Hastings) is a rare earths resources development company that is currently looking to develop two projects; the Brockman Project in the East Kimberley Region and the Yangibana Project in the northern Gascoyne Region. The Yangibana project is currently progressing through feasibility studies with the goal of developing sections of its Yangibana Project tenement area into a rare metals mining project. The Yangibana project study area (Figure 1) is located on the Gifford Creek, Edmund and Wanna Stations in the northern Gascoyne; approximately 270 km north east of Carnarvon and 170 km south west of Paraburdoo. Hastings has established a significant tenement package covering approximately 550 km^2.

Ecoscape (Australia) Pty Ltd, (Ecoscape) was commissioned by Hastings to conduct the biological assessments of the Yangibana project, including flora and vegetation, vertebrate fauna, Short Range Endemic (SRE) invertebrate fauna and subterranean fauna (stygofauna and troglofauna). This report details the results of the Terrestrial Fauna (Vertebrate and Short Range Endemic) assessment of the Yangibana project.

The Terrestrial Fauna assessment comprised of a two phase Level 2 trapping survey which was conducted in autumn (11-24 May 2015) and spring (22 Sep – 2 Oct 2015). The trapping for SRE fauna was conducted in autumn (19 May – 22 July 2015), four weeks following significant rainfall events.

A total of eight systematic vertebrate fauna trap sites were established across five land systems and two vegetation units. These trap sites were also utilised as dry pitfall sites for SRE invertebrate fauna. Invertebrate fauna was also targeted with wet pitfall trap site which were set-up across five land systems and two vegetation units. A total of ten sites comprising of 40 wet pitfalls were placed across the study area covering a variety of habitats. In addition to trapping, hand searching and foraging was undertaken at 15 locations, bat recorders were set-up at 15 locations, motion cameras were installed at 10 locations, leaf litter was collected from 14 sites and additional bird surveys were undertaken at 10 opportunistic sites.

No fauna assessments are known to have been completed in the region surrounding the study area. A total of four surveys have been completed in the Midwest region within 350 km of the study area over the past six years, reporting on terrestrial vertebrate fauna assemblages and habitats, providing an overview of fauna recorded from the wider region. Due to the geographical location and context, surveys conducted within 150 km in the Pilbara region were not considered during the desktop review. Habitats, fauna assemblages and landforms of the project area are not closely associated to those found in the Pilbara region. In addition to fauna survey reports, a number of database searches were conducted to prepare a list of potential fauna present within the study area.

The desktop assessment has identified a total of 425 species as potentially occurring within the study area: 56 mammal species, 189 birds, 141 reptiles, nine fish and 14 amphibians. Of these, 35 species are of conservation significance (eight mammals, 13 birds, two reptiles, two fish). Of these, 13 species are listed under the EPBC Act (five mammals, seven birds, one reptiles).

A total of 134 species were recorded from the study area over the two phases of assessment which consisted of 20 species of mammal (12 species of non-volant mammals, eight species of bat), 85 species of bird, 25 species of reptile and four species of amphibian.

A total of three species of conservation significance were recorded from within the study area: Rainbow Bee-eater (*Merops ornatus*; WC Act Schedule 5), Eastern Great Egret (*Ardea modesta*; WC Act Schedule 5), Long-tailed Dunnart (*Sminthopsis longicaudata*; DPaW P4). In addition, the Grey Falcon (*Falco hypoleuca*; WC Act Schedule 3) was recorded from 3.5 km south of the study area. Historic mounds of the Western

Pebble-mound Mouse (*Pseudomys chapmani*; DPaW P4) were recorded throughout the study area; however based on the guide for the indication of presence and activity of Western Pebble-mound Mice, all mounds were older than 50 years, indicating no recent or current occupation of this species within the study area.

In total, 27 taxa were recorded from groups that support SRE species. Of these, 13 taxa are potential SRE species. The recorded number of SRE species is largely due to the fact that SREs are dominated by invertebrate species which are historically understudied and in many cases, lack formal descriptions. A reliable taxonomic evaluation of these species has begun only recently and thus the availability of literature relevant to SREs is relatively scarce. Based on the habitat types the species were recorded from, it is expected that the majority of potential SRE species, if not all, occur outside the study area.

Five habitat types were identified as occurring in the Yangibana study area: rocky plain (includes undulating hills and lower hillslopes), sandy plain, granite outcrop, major river and minor creekline. Of these, the rocky plain is the most widespread habitat type, followed by sandy plain. The remaining three habitats, granite outcrops, major river and minor creekline were recorded from isolated areas of smaller extent. All habitat types were also recorded from the wider region and are not thought to be unique to the study area.

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

Hastings Technology Metals Limited (Hastings) is a rare earths resources exploration company and is looking to develop the Yangibana Rare Earths Project (the Project) in the Upper Gascoyne region of Western Australia. The Project is currently progressing through detailed feasibility study. The deposits contain rare earth elements, predominantly of neodymium, praseodymium, dysprosium and europium that are used in the growing permanent magnets and phosphors markets.

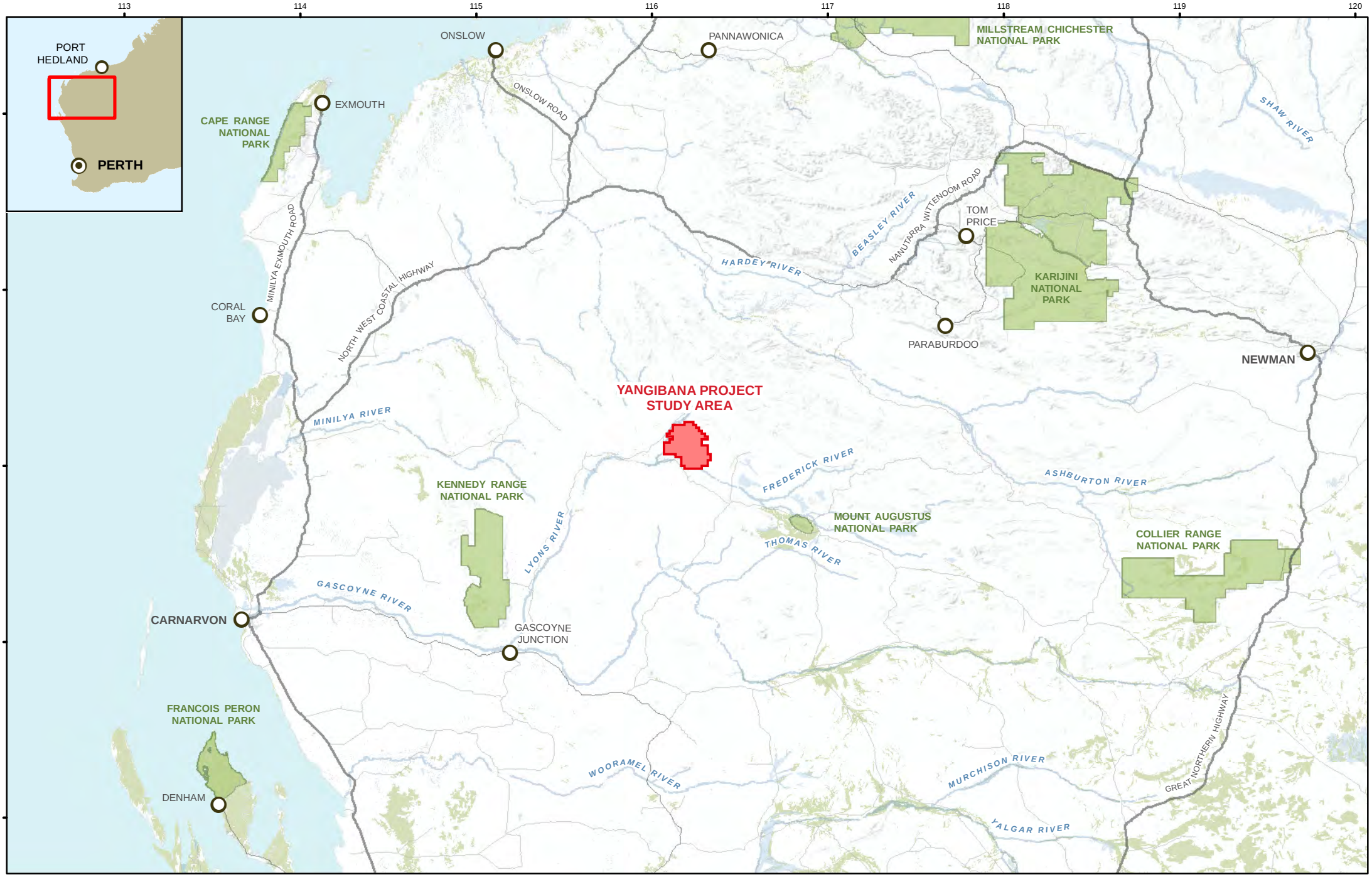
1.1.1 Study Area Location

The Project study area (Figure 1) is located on the Gifford Creek, Edmund and Wanna Stations in the northern Gascoyne; approximately 270 km north east of Carnarvon and 170 km south west of Paraburdoo. Hastings has established a significant tenement package covering approximately 650 km^2. The Yangibana project consists of four major deposits (Yangibana West, Yangibana North, Bald Hill and Fraser's) and several minor deposits.

1.2 PROJECT OBJECTIVES

Ecoscape (Australia) Pty Ltd (Ecoscape) was commissioned by Hastings to conduct the biological assessments of the Yangibana project, including flora and vegetation, vertebrate fauna, Short Range Endemic (SRE) invertebrate fauna and subterranean fauna (stygofauna and troglofauna). This report details the results of the Terrestrial Fauna (Vertebrate and Short Range Endemic) assessment of the Project. The terrestrial fauna assessment, incorporating targeted conservation significant fauna searches consisted of:

- Desktop assessment identifying the physical and biological attributes of the study area;
- Two phase Level 2 fauna field survey, resulting in an understanding of vertebrate and SRE invertebrate fauna species, the habitat types present and their representation over a broader area; and
- Targeted searches for significant fauna species and their habitats, including fauna listed as Threatened, Migratory or otherwise specially protected under Commonwealth and/or Western Australian legislation, Priority-listed fauna and fauna of local conservation significance.



Coordinate System: GCS GDA 1994
Datum: GDA 1994

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LEGEND

- Populated Places
- Survey Area
- Principal Road
- Secondary Road
- Minor Road
- Rivers
- National Parks

Scale 1:3,000,000 @ A4

0 50 100 150 km

REGIONAL LOCATION

FIGURE 1

1.3 LEGISLATION AND POLICIES

This assessment was conducted in accordance with the following Commonwealth and State legislation:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (CoA 1999);
- Western Australian *Environmental Protection Act 1986* (GWA 1986); and
- Western Australian *Wildlife Conservation Act 1950* (GWA 1950).

In addition to the legislation listed above, the assessment complied with the Office of the Environmental Protection Authority (OEPA) requirements for environmental surveys and reporting in Western Australia, as outlined in the following guidelines:

- EPA (2002) *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection;*
- EPA (2004) *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*;
- EPA (2009) Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia;
- EPA & DEC (2010) *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment;* and
- Department of Environment Water Heritage and the Arts (2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*.

2.0 EXISTING ENVIRONMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 Climate

According to the Köppen-Geiger climate classification, the study area is located in the 'BWh' climate zone (Peel *et al*. 2007), considered to be a dry (arid and semiarid) climate, desert with an average annual temperature above 18°C. The study site is within an area impacted by a number of different climate influences including the west coast trough, northwest cloudbanks, tropical cyclones, frontal systems and subtropical ridge (Bureau of Meteorology [BoM] 2010).

The west coast trough is a semi-permanent feature that is the dominant influence on weather conditions during the warmer months in the southwest of Western Australia. It is a zone of low pressure that develops at the boundary of between the warm continental easterly winds driven by the sub-tropical ridge to the south and cooler maritime air from the Indian Ocean. The development of the trough depends on the prevailing conditions, however in general areas to the east of the trough experience hot days in excess of 40°C, possibly with thunderstorms that at times have heavy rainfall, with areas to the west of the trough experiencing milder conditions (*ibid*.). The northwest cloudbanks are also active during the warmer months and are formed when warm, moist tropical air originating over the Indian Ocean moves south-eastward, and is forced to rise over the colder mid-latitude air. Widespread heavy rain is sometimes associated with the northwest cloudbanks (*ibid*.).

The study area is located in an area that can also be affected by tropical cyclones. The cyclone season is officially from November to April although there tend to be fewer cyclones early in the season. Destructive winds and high rainfall can be associated with tropical cyclones (*ibid*.). Frontal systems can also impact on the study area. Cold fronts, most frequently in winter, can also bring rainfall, at times for extended periods of up to a week. The subtropical ridge suppresses frontal activity during the warmer months when it is located to the south of the continent; in the winter the ridge moves over central Australia, permitting cold fronts to extend further northwards (*ibid*.).

Given the number of climate influences that may be active and affecting the study area, it is unsurprising that the rainfall is erratic and bimodal (i.e. occurring in both winter and summer) (Desmond *et al*. 2001; Kendrick 2002). BoM rainfall zone mapping places the study area in the Arid low rainfall (less than 350 mm) zone and Warm humid summer climate zone based on temperature and humidity (BoM 2012).

Rainfall and temperature data for the nearest BoM station with long-term rainfall data (Mt Phillip site 7058, active from 1902 (BoM 2015), approximately 70 km south of the study area; data accessed on 4 March 2015) is shown in **Figure 2**. **Figure 2** shows the bimodal nature of the rainfall, with two periods of higher rainfall; January to March and May-July, the latter corresponding with the southern (frontal) influences.

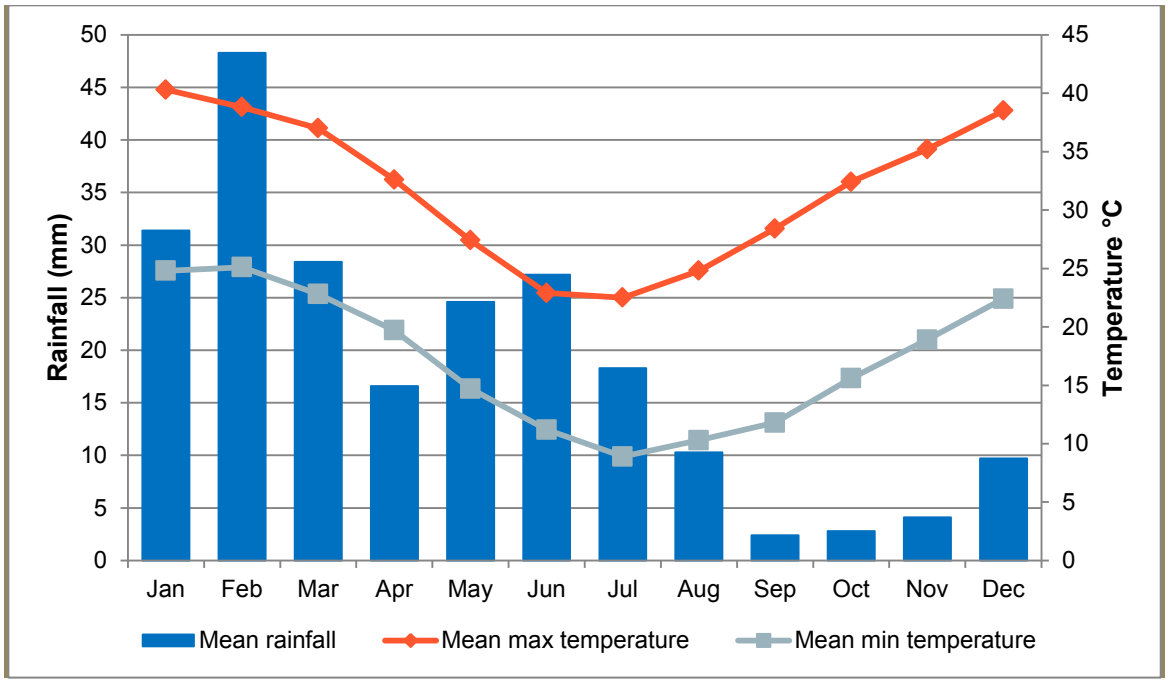

Figure 2: Monthly rainfall and daily maxima and minima for Mt Phillip (BoM 2015)

2.1.2 Geology

Map 1 shows the distribution of 61 geological units mapped within the study area (Department of Mines and Petroleum 2002; 2007). The most widespread geological units, in order of area, are PLgpi (granite), A3ti (sand and gravel), A1 (silt, sand and gravel in drainage channels), PLgynx (biotite-muscovite) and PLgpix (biotite-muscovite granodiorite to syenogranite).

2.1.3 Land Systems

The Pastoral Board of Western Australia commissioned the first joint Department of Land Administration-Agriculture Western Australia rangeland survey of the Gascoyne River catchment in 1969. The rangeland resource surveys, comprehensively described and mapped the biophysical resources of the Gascoyne River catchment, together with an evaluation of the condition of the soils and vegetation (from an agricultural perspective) (Wilcox & McKinnon 1972).

As part of this process an inventory of land systems and land units with particular use capabilities were established to assist in land use planning. According to this mapping, 10 land systems (grouped according to land type on the basis of a combination of landform, soil, vegetation, and drainage characteristics) intersect with the study area (Wilcox & McKinnon 1972).

The land systems are described in **Table 1** and their extents within the study area and Gascoyne bioregion is shown in **Table 2** and on **Map 2**.

Table 1: Land system descriptions (Wilcox & McKinnon 1972)

LAND SYSTEM	DESCRIPTION
Agamemnon System	Rocky hills, with peaks and ridges above extensive stony slopes, supporting scattered tall shrublands of mulga and other acacias
Augustus System	Rugged ranges, hills, ridges and plateaux with skeletal soils supporting mulga and other acacia shrublands in southern parts or hard spinifex grasslands in northern parts
Collier System	Undulating stony uplands, low hills, ridges, stony plains and drainage floors supporting mulga shrublands and some spinifex
Gascoyne System	River channels and associated narrow alluvial plains and inclusions, supporting river redgum fringing woodlands, also mulga and other acacias, *Senna* spp. and buffel grass
Glenburgh System	Rugged granite hills, stony uplands and lower plains supporting scattered tall shrublands of mulga and other acacias
James System	Low hills, ridges and tors of granite and quartz, with stony lower plains, rises and drainage floors, supporting scattered tall shrublands of mulga and other acacias
Jamindie System	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey
Nadarra System	Plains and calcrete rises with chenopod shrublands and hard spinifex grasslands
Phillips System	Low hills and undulating uplands on gneiss and quartz supporting mulga and other acacia tall shrublands
Yinnietharra System	Scattered granite tors and domes above stony slopes, broad sandy plains with groved vegetation and wide drainage tracts; supporting tall shrublands of mulga and other acacias

Table 2: Extent of land systems within the study area and regionally (Wilcox & McKinnon 1972)

LAND SYSTEM	EXTENT WITHIN STUDY AREA (KM^2)	PROPORTION OF STUDY AREA (%)	GASCOYNE EXTENT (KM^2)	PROPORTION OF STUDY AREA (%)
Agamemnon System	31.23	5.8	4,304.58	0.73
Augustus System	6.77	1.3	19,190.25	0.04
Collier System	0.39	0.1	4,822.86	0.01
Gascoyne System	17.84	3.3	2,152.81	0.83
Glenburgh System	50.93	9.5	702.05	7.25
James System	167.32	31.2	2,029.33	8.24
Jamindie System	33.88	6.3	9,952.62	0.34
Nadarra System	95.04	17.7	1,156.70	8.22
Phillips System	115.92	21.7	8,082.93	1.43
Yinnietharra System	16.12	3.0	1,413.37	1.14
TOTAL	**535.43**	**100.0**	**53,807.50**	

2.1.4 Drainage

The study area is located in the northern part of the Gascoyne River catchment, draining the southwestern slopes of the Barlee Range. A tributary of the Gascoyne River, the Lyons River is associated with the southern portion of the study area, and flows in a general north-westerly direction. The Edmund River, considered to represent a tributary of the Lyons River, is associated with the western edge of the study area and flows in a general southerly direction. Both rivers are considered ephemeral, and only flow after rainfall, although permanent or semi-permanent waterholes are likely to occur along their length and along tributaries.

Several tributaries of these rivers traverse the study area; Yangibana and Fraser Creeks are tributaries of the Lyons River, occupy the southern portion of the study area and flow in a generally southern direction, whilst Rock Hole and Dingo Creeks are tributaries of the Edmund River, flow in a general western direction

and occur in the northern portion of the study area. There are also several unnamed tributaries within the study area.

2.2 LAND USE

The Gascoyne region has mainly been used for grazing, with a shift over time from merino sheep to cattle, meat sheep and rangeland goats (DoE 2008). The Gascoyne catchment is considered to have been in poor condition since at least the 1960s and possibly since the 1930s, with large contiguous areas of vegetation cover declining due to the combined effects of continuous stocking through successive dry years, and flood events from occasional tropical storms (Waddell *et al*. 2012).

2.3 BIOLOGICAL ENVIRONMENT

2.3.1 Biogeographical Region

Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna and are defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (Department of the Environment [DoE] 2014).

The study area is located within the Gascoyne IBRA region which consists of three major subregions; Ashburton, Augustus and Carnegie (Thackway & Cresswell 1995). The majority of the study area is included in the Augustus (GAS3) subregion, described in the 2002 Biodiversity Audit of Western Australia's 53 Biogeographical Subregions (Desmond *et al*. 2001) as:

> *Rugged low Proterozoic sedimentary and granite ranges divided by broad flat valleys. Also includes the Narryera Complex and Bryah Basin of the Proterozoic Capricorn Orogen (on northern margin of the Yilgarn Craton), as well as the Archaean Marymia and Sylvania Inliers. Although the Gascoyne River System provides the main drainage of this subregion, it is also the headwaters of the Ashburton and Fortescue Rivers. There are extensive areas of alluvial valley-fill deposits. Mulga woodland with* Triodia *occur on shallow stony loams on rises, while the shallow earthy loams over hardpan on the plains are covered by Mulga parkland. A desert climate with bimodal rainfall. The subregional area for GAS3 is 10,687,739 ha.*

There is a small section near the northern edge of the study area located within the Ashburton (GAS1) subregion, described by Kendrick (2002) as:

> *Mountainous range country divided by broad flat valleys, associated with Ashburton River Catchment of the Ashburton Basin (shales, sandstones and conglomerates), and the north-western part of Bangemall Basin (sandstone, shale, carbonates). Mulga/snakewood low woodlands occur on shallow earthy loams over hardpan on the plains, with mulga scrub and* Eremophila *shrublands on the shallow stony loams of the ranges. Low mixed shrublands on hills with other areas supporting large areas of* Triodia*. Arid (desert) climate with bimodal (winter and summer) rainfall, with tropical monsoon influences. The subregional area of GAS1 is 4,039, 387 ha.*

2.3.2 Vegetation Association Mapping

The pre-European vegetation associations identified from the study area (DAFWA 2012) and their pre-European and current extents within the Gascoyne bioregion is shown in **Table 3** (Government of Western Australia 2013). The pre-European vegetation mapping is utilised in identifying and delineating habitat types.

Table 3: Vegetation associations (Government of Western Australia 2013)

VEGETATION ASSOCIATION	GASCOYNE BIOREGION			EXTENT WITHIN STUDY AREA	
	PRE-EUROPEAN EXTENT (HA)	CURRENT EXTENT (HA)	% REMAINING	EXTENT (HA)	PROPORTION OF BIOREGION (%)
18 Low woodland; mulga (*Acacia aneura*)	3,273,579.71	3,271,339.12	99.93	21,555.74	0.66%
165 Low woodland; mulga and snakewood (*Acacia eremaea*)	697,447.83	697,445.48	100.00	30,841.06	4.42%
166 Low woodland; mulga & *Acacia victoriae*	309,650.29	309,645.58	100.00	286.69	0.09%
181 Shrublands; mulga & snakewood scrub	1,632,078.44	1,631,913.77	99.99	860.02	0.05%

2.3.3 Regional Fauna Data

A reconnaissance survey of the study area was conducted in November 2014 by *ecologia* Environment (*ecologia* 2014), however no other vertebrate fauna or SRE invertebrate field surveys are known to have been conducted in the vicinity of the study area. Due to the geographical location and regional context of the study area (the landform, habitats and climate of the study area appears to be more closely associated with the Midwest and Gascoyne regions, than the Pilbara), surveys conducted within the Pilbara region were not included. A total of four surveys have been completed within 350 km of the study area over the past six years, reporting on terrestrial vertebrate fauna assemblages and habitats providing an extended overview of fauna recorded from the wider region. In addition to fauna survey reports, a number of database searches were conducted to prepare a list of potential fauna present within the study area. This also includes species of conservation significance. Only SRE invertebrate records from the WAM database search were used in the regional assessment, as the relevance of records from over 300 km away is questionable.

The details of each publication are listed in **Table 4**, database search criteria are listed in **Table 5**.

Database searches were undertaken prior to surveying between November 2014 and February 2015 (**Table 5**) to determine the fauna species that could potentially occur within the study area, with particular emphasis placed on species of conservation significance. Updates on the status of listed species were released in November 2015 and incorporated into the below database search results to reflect current listings.

Table 4: Previous biological survey reports

SURVEY NAME AND AUTHOR	LEVEL OF ASSESSMENT	DISTANCE FROM STUDY AREA (KM)
Pindabarn Paleochannel (Ecoscape 2012)	Targeted flora pre-clearance survey	275
Jack Hills (ecologia 2009a)	Level 2 vertebrate and SRE fauna assessment	290
Weld Range (ecologia 2009b)	Level 2 vertebrate and SRE fauna assessment	350
Robinson Range (ecologia 2009)	Level 2 vertebrate fauna assessment	307

Table 5: Details of Databases and literature searched

FIELD	DATABASE / TITLE	CUSTODIAN / AUTHOR	SEARCH DETAILS
Literature			
Vertebrate (bird) fauna	Birds of the Gascoyne Region, Western Australia	Storr (1985)	-
Vertebrate fauna	Biodiversity of the southern Carnarvon Basin, Western Australia	Burbidge *et al* (2000)	-
Database searches			
Vertebrate fauna / Conservation significant fauna	Commonwealth Protected Matters Search (PMST)	Department of Environment and Energy (DEE)	Date: 23 Feb 2015 Buffer: 30 km
Vertebrate fauna / Conservation significant fauna	DPaW Threatened and Priority Fauna Search (TPFS)	Department of Parks and Wildlife (DPaW)	Date: 28 Apr 2015 Buffer: 40 km
Vertebrate fauna / SRE Invertebrate fauna	NatureMap	DPaW / WAM	Date: 23 Feb 2015 Several search areas with 40 km buffer: Centre points: Barlee Range: 115°52'38"E, 23°12'54"S Kennedy Range: 115°03'48"E, 24°31'24"S Mt Augustus: 116°50'08"E, 24°19'32"S
Vertebrate fauna	Atlas of Living Australia Area Search	Atlas of Living Australia (ALA)	Date: 23 Feb 2015 Buffer: 30 km
Vertebrate fauna (Birds)	Birdata	Birdlife Australia	Date: 23 Feb 2015 Records within 1 degree square around Centre point: Longitude 116.14631 Latitude -23.9638
SRE Invertebrate fauna	WA Museum Arachnid Database	WAM	Search area: Latitude (South): -23.06 Longitude (East): 115.36 North-west: corner, Latitude (South): -24.97 Longitude (East): 117.55 Date: 14/11/14
SRE Invertebrate fauna	WA Museum Crustacea Database	WAM	Search area: Latitude (South): -23.06 Longitude (East): 115.36 North-west: corner, Latitude (South): -24.97 Longitude (East): 117.55 Date: 14/11/14

FIELD	DATABASE / TITLE	CUSTODIAN / AUTHOR	SEARCH DETAILS
SRE Invertebrate fauna	WA Museum Molluscs Database	WAM	Search area: Latitude (South): -23.06 Longitude (East): 115.36 North-west: corner, Latitude (South): -24.97 Longitude (East): 117.55 Date: 14/11/14

2.3.3.1 Commonwealth Protected Matters Search

A Commonwealth DEE online database search *(Protected Matters Search Tool*, Australian Government & DoE 2015) was conducted and Commonwealth *Species Profile and Threats Database* (DoE & Australian Government 2015a) lists were reviewed to identify EPBC listed threatened or specially protected fauna previously recorded nearby.

The PMST search conducted February 2015 identified one Threatened fauna species (Northern Quoll, *Dasyurus hallucatus* - EPBC Act Endangered) or its habitat as being likely to occur within the study area. The following listed Migratory species also resulted from the search:

- Fork-tailed Swift (*Apus pacificus)*
- Oriental Plover (*Charadrius veredus)*

The PMST search also indicated the likely presence or habitat of the following invasive exotic vertebrates (one bird and eight mammals):

- Domestic Pigeon (*Columba livia)*
- House Mouse (*Mus musculus)*
- Rabbit (*Oryctolagus cuniculus)*
- Camel (*Camelus dromedaries)*
- Goat (*Capra hircus)*
- Donkey (*Equus asinus)*
- Domestic Dog (*Canis lupus familiaris)*
- Fox (*Vulpes vulpes)*
- Cat (*Felis catus).*

2.3.3.2 DPaW Threatened and Priority Fauna Database Search

The search of the Department of Parks and Wildlife's (DPaWs) Threatened and Priority Fauna database resulted in a total of 11 species recorded from within 40 km of the study area: four mammal species, six species of bird and one species of reptile. The results of the rare fauna database search (DPaW) have been incorporated in the results in **Appendix Four** and are summarised as follows:

- Ghost Bat (*Macroderma gigas*) – Schedule 3 Vulnerable
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) – Schedule 3 Vulnerable
- Grey Falcon (*Falco hypoleucos*) – Schedule 3 Vulnerable
- Yinnietharra Dragon (*Ctenophorus yinnietharra* – Schedule 3 Vulnerable
- Common Greenshank (*Tringa nebularia*) – Schedule 5 Migratory
- Eastern Great Egret (*Ardea modesta*) – Schedule 5 Migratory
- Fork-tailed Swift (*Apus pacificus*) – Schedule 5 Migratory
- Rainbow Bee-eater (*Merops ornatus*) – Schedule 5 Migratory
- Peregrine Falcon (*Falco peregrinus*) – Schedule 7

- Long-tailed Dunnart (*Sminthopsis longicaudata*) – Priority 4
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – Priority 4.

2.3.3.3 NatureMap Search

NatureMap (DPaW 2007-2015) was reviewed to identify fauna species that have been recorded from within and near the study area. Due to relatively sparse sampling in the region and unavailability of relevant survey reports, multiple searches were conducted using areas centered on Barlee Range Nature Reserve, Kennedy Range National Park, former *Wanna* Station and Mount Augustus. The *NatureMap* search identified seven conservation significant fauna species, all of which were also identified by the DPaW database search (**Section 2.3.3.2** above). The *NatureMap* search results are incorporated in **Appendix Four**.

2.3.3.4 Atlas of Living Australia

An *Atlas of Living Australia Area* (Atlas of Living Australia [ALA] 2015b) search identified six species of mammals (including two bat species), 124 species of bird, 17 species of reptile, one species of amphibian and one species of fish (**Appendix Four**) previously recorded in the area.

2.3.3.5 Birdata

The Birdata database search is administered by Birdlife Australia and resulted in a total of 99 bird species previously recorded in the area. Of these, five species of conservation significance were recorded: four migratory species (Rainbow Bee-eater, Fork-tailed Swift, Eastern Great Egret and Common Greenshank) and the Grey Falcon (*Falco hypoleucos*; EPBC Act VU) (**Appendix Four**).

2.3.3.6 Western Australian Museum Database Search

Database searches from the Western Australian Museum (WAM) were requested for terrestrial invertebrate fauna species. A total of 25 taxa were reported including 16 arachnid taxa (spiders) from 14 families, three Diplopoda (millipedes) taxa from one family, one scorpion taxon, two amphipod taxa from two families, one copepod taxon and two diplostraca (worm) taxon (**Table 6**).

Table 6: SRE invertebrate species identified by WAM database search

ORDER/FAMILY	SPECIES	LOCATION
ARANEAE		
Araneidae	*Dolophones* sp. (VWF773)	Barlee Range NR, Harts Range
Barychelidae	*Synothele* 'Barlee Range sp.1'	Barlee Range NR
Idiopidae	*Eucyrtops* 'MYF131 group (028)'	Barlee Range NR
Lamponidae	*Asadipus baranar*	Barlee Range NR
Miturgidae	*Miturgopelma* 'barlee'	Barlee Range NR, Mt Narryer Station
Nemesiidae	*Aname* 'sp.indet'	Barlee Range NR
Oonopidae	*Grymeus barlee*	Barlee Range NR
Oxyopidae	*Oxyopes* 'Barlee Range sp. 1'	Barlee Range NR
Pholcidae	*Trichocyclus warianga*	Barlee Range NR
	Trichocyclus 'sp.2'	Barlee Range NR, Kennedy Range NP
Prodidomidae	*Nomindra barlee*	Barlee Range NR
	Wesmaldra bromilowi	Barlee Range NR
Salticidae	Neon 'PBS sp.2'	Barlee Range NR
Thomisidae	*Stephanopis* 'Barlee Range sp.1'	Barlee Range NR
Trochanteriidae	*Fissarena barlee*	Barlee Range NR

ORDER/FAMILY	SPECIES	LOCATION
Zodariidae	*Spinasteron* 'leeuwni'	Barlee Range NR, Little Sandy Desert, Mt Whaleback
POLYDESMIDA		
Paradoxosomatidae	*Antichiropus* 'DIP009'	Barlee Range NR, Mt Minnie
	Antichiropus 'DIP010'	Barlee Range NR
	Antichiropus 'DIP019'	Barlee Range NR, Mt Stuart Station
SCORPIONES		
Urodacidae	*Urodacus waldburg*	Waldburg station
AMPHIPODA		
indet.	indet.	Paraburdoo
Talitridae	*Austroides* sp.	Gleneagle
COPEPODA		
Cyclopoidae	*Diacyclops humphreysi*	Ratty Springs Bore (Pilbara)
DIPLOSTRACA		
Limnadiidae	*Limnadopsis pilbarensis*	Pirraburda Creek (near Paraburdoo)
	Bennelongia bidgelangensis	Bidgelang Pool, Callytharra Springs Station

3.0 METHODS

Prior to the development of field survey methods, a review was undertaken of factors likely to influence survey design and intensity (**Table 7**). Based on this review, it was deemed necessary for a Level 2 vertebrate fauna assessment to be conducted within the study area.

Table 7: Factors likely to influence survey design

FACTOR	RELEVANCE
Bioregion – level of existing survey/knowledge of the region and associated ability to predict accurately.	The Gascoyne region has not been surveyed extensively in recent years due in part to the small number of mining projects or other development in this region. The region is thought to combine elements of the Pilbara and Murchison bioregions, both of which have been surveyed in far greater detail. Preliminary results from the reconnaissance survey indicated that the study area was more similar to the Murchison bioregion based on fauna habitats, landforms and opportunistic fauna observations.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The landforms associated with the study area consist of an elevated floodplain bordered by the Barlee Range to the north and the Kennedy Range to the west. The landforms are consistent with floodplains found in the Murchison region to the south. Granite domes are common in the region and whilst not rare, they are known to support rare reptile taxa such as *Ctenophorus yinnietharra* and further to the south, *Egernia stokesii badia*.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present.	The survey area is associated with an arid climate. Fauna populations generally peak after significant rainfall, with activity linked to warmer humid conditions.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	No previous terrestrial vertebrate fauna surveys are known to have been carried out within 100 km of the study area. In addition, no known surveys have been carried out targeting terrestrial SRE invertebrate fauna in the region. Thus regional and local knowledge for the study area is not available. Previous surveys conducted up to 300 km from the study area have been included in the current desktop assessment
Number of different habitats or degree of similarity between habitats within a study area.	Five fauna habitat types have been initially identified based on recent reconnaissance, aerial photography, land systems and vegetation units.
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods).	The northern Gascoyne region experiences hot summers with occasional cyclonic rain events, followed by warm winters with little rain. Rainfall is highly unpredictable and the region has recently experienced heavy falls
Sensitivity of the environment to the proposed activities.	The study area contains habitat types which are well represented in the surrounding region. Highest impacts are associated with the restricted areas of mining.
Size, shape and location of the proposed activities.	The study area is 53,500 ha and of compact shape (polygon), and is located in the northern Gascoyne region, south of the Barlee Range and northeast of Mt Augustus

FACTOR	RELEVANCE
Scale and impact of the proposal.	The proposed impact areas are focused on several deposits that occur across the tenement. The ore is located relatively close to the surface however the waste material is expected to consist of 96% of the mined rock. Location and scale of the infrastructure is currently not confirmed

3.1 FAUNA ASSEMBLAGE

3.1.1 Systematic Vertebrate Fauna Survey Methods

Ecoscape utilised a standardised survey methodology which is in accordance with the *Technical Guide for Terrestrial Vertebrate Fauna Assessments* (Environmental Protection Authority [EPA] & Department of Environment and Conservation [DEC] 2010) and which allows direct comparison of survey results with previous surveys conducted in the region. The proposed Level 2 survey methodology included a detailed examination of the local fauna using a suite of trapping techniques. The traps used during the current Level 2 survey included (**Figure 3** and **Figure 4**):

- **20 L bucket and 60 cm PVC pipe traps:** these are dug into the ground and act as pitfall traps. A 10 m long, 30cm high fence was passed across the top of the pit to direct fauna into it. A trapping grid comprised of 10 such traps.
- **Fraser-type funnel traps:** similar to yabbie traps, these were placed at the ends of each fence to capture fauna that do not readily fall into pit traps (20 per trapping grid). All funnel traps were covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- **Elliott traps:** Medium size aluminium box traps were baited with 'universal bait' to attract and capture smaller mammals (10 per trapping grid) and re-baited daily. All Elliott traps were covered by industrial insulation shades to reduce the likelihood of animals suffering from overheating.
- **Cage traps:** larger Sheffield wire-frame box traps, also baited with 'universal bait', to capture medium-sized mammals (two per trapping grid). All cage traps were covered by hessian shades to reduce the likelihood of animals suffering from overheating.

Trapping grids were established across all major fauna habitats within the study area, with each trapping grid surveyed twice (spring and autumn) each over a seven-night period.

3.1.2 Systematic SRE Invertebrate Fauna Survey Methods

- **Dry Pitfall Trapping:** The pitfall and funnel traps used in the vertebrate fauna trapping grids are typically highly effective at collecting SRE invertebrate fauna. Each trap was open over two survey phases, each for seven nights and resulted in 420 trap nights per site.
- **Wet Pitfall Trapping:** Specifically used to target SRE invertebrates, wet pitfall traps consisted of a 1000 ml jar containing 500 ml of pitfall trapping solution (active ingredient propylene glycol) which was dug into the ground so that the surface was flush with the surface. A cover was then fitted 3 cm above the ground to exclude medium sized vertebrate fauna species and rain, and to deter the attention of larger vertebrate fauna species. Four wet pitfall traps were installed at each targeted SRE invertebrate site and left in the ground for six weeks before being removed and sent to Perth for further sorting and preliminary identification.
- **Leaf Litter Collection:** At each site, three quadrats ($3m^2$) of leaf litter were collected and separately placed into a leaf-litter reducer. The contents from each collection was then placed into a paper bag inside a zip-lock bag and kept separate. Samples were then transported back to Perth in a cool, dark container where they were placed on Tullgren funnels to extract any specimens.

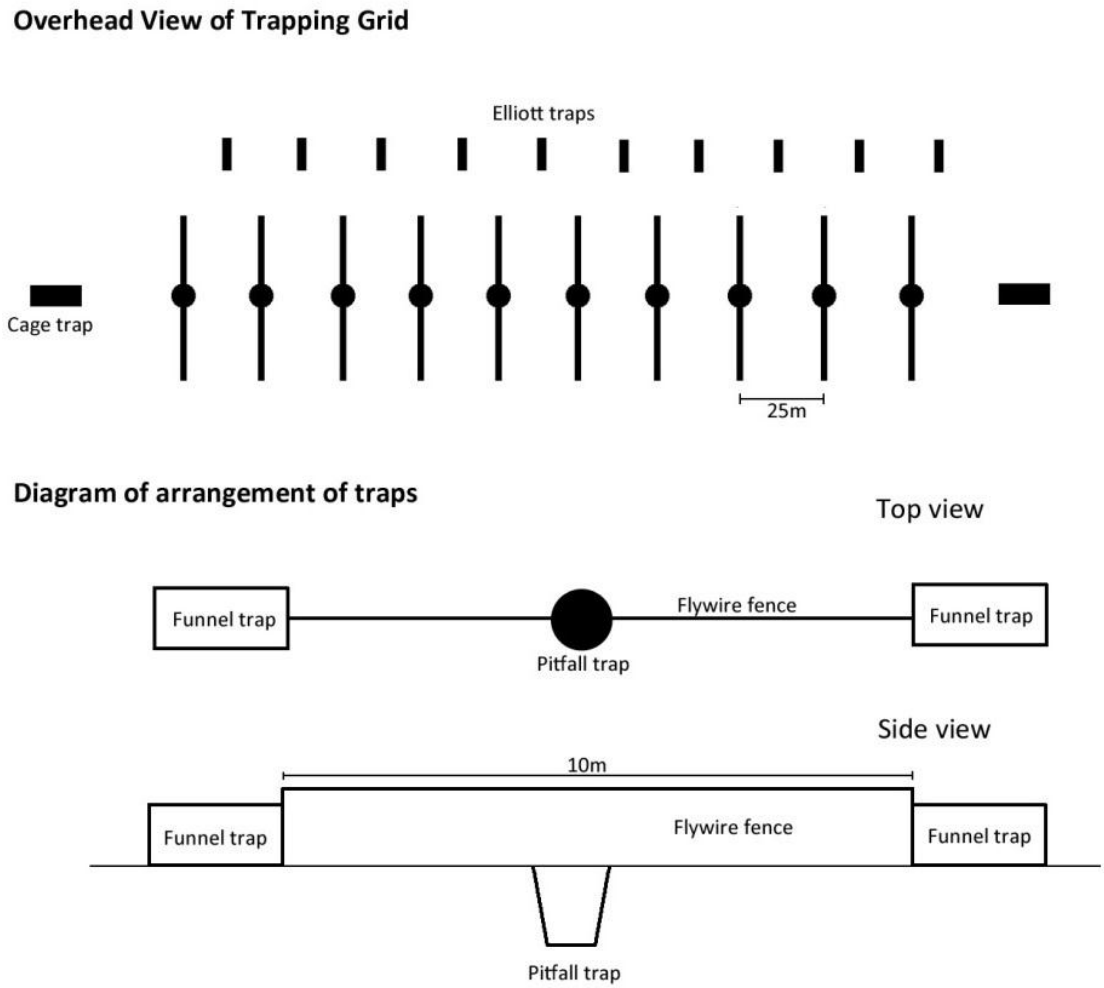

Figure 3: Systematic trap site set-up

Figure 4: Single trap line

3.1.3 Active Searches

Trapping surveys typically only target small to medium terrestrial species. Ecoscape compliments the systematic surveys with a suite of non-systematic sampling that targets specific species and habitats not normally covered by standard trapping. These active survey techniques are listed below:

- **Reptiles, Amphibians and SRE invertebrates:** Minimum 30 minute surveys of 1 ha areas within the survey area by an experienced zoologist. Microhabitats favoured by reptiles, amphibians and SRE invertebrates were searched. Survey techniques included raking of leaf litter and soil under shrubs, searching in rock piles and searching under and inside fallen timber. Nocturnal species searches were also performed (where safe access was available) using spotlights and recording frog calls.
- **Birds:** four 30 minute surveys were conducted at each trapping site during each phase of surveying within the survey area by an experienced ornithologist during optimal periods of the day (early morning and late afternoon) as per Birdlife Australia standard methodology. All bird species opportunistically observed inside the study area were also recorded.
- **Mammals:** Mammals observed during the above surveys and opportunistically were recorded. Tracks, scats and other traces of mammals were recorded and identified where possible.
- **Bat recorders:** Bats were recorded using SM2BAT ultrasonic recorder and identified by call analysis software (Songscope). SM2BAT recorders were set-up at all systematic trapping sites and at opportunistic sites such as creeklines and rivers.
- **Motion Cameras:** Motion sensitive cameras (Reconyx HC500) capable of recording both normal (day) and infra-red (night) images were set-up in areas of interest, such as near permanent water, to record cryptic species not normally seen during surveys.
- **Targeted Fauna Searches:** Rare or otherwise significant fauna species potentially occurring in the area (based on database searches) were opportunistically targeted during the survey. Targeted searches for conservation significant fauna species were conducted in suitable habitat across the study area. The targeted searches conducted during the Level 2 assessment were focussed on determining the presence of species of conservation significance and are not at the level of intensity required for the species' specific targeted conservation significant fauna surveys, in accordance with individual guidelines for each species.

3.1.4 Specimen sorting and identification

All vertebrate fauna specimens were identified in the field and released at the location of capture. Invertebrate samples collected in wet pitfall traps were drained and sorted in collaboration with Bennelongia Environmental Consultants (Bennelongia) and separated into taxonomic groups. All samples were identified by Bennelongia taxonomists (**Appendix Nine**).

3.1.5 Site selection

Sites were established on the basis of the desktop assessment including the review of existing information such as land systems, vegetation communities, landforms, literature collected from the desktop review and the fauna habitats identified within the study area. This information was ground truthed during the field survey. Sites were set-up so that the number of trap sites was proportional to the extent of fauna habitats within the study area. Habitat types with a larger extent were sampled by a larger number of sample sites than habitats that occupy smaller areas within the study area. Habitat types not adequately sampled by systematic trapping sites were targeted using opportunistic sampling techniques.

A total of eight systematic vertebrate fauna trap sites were established across five land systems and two vegetation units. These trap sites were also utilised as dry pitfall sites for SRE invertebrate fauna. Invertebrate fauna was also targeted with wet pitfall trap sites which were set-up across the five land systems and two vegetation units. A total of ten sites comprising of 40 wet pitfalls were placed across the study area covering a variety of microhabitats suitable for SRE invertebrates. In addition to trapping, hand

searching and foraging was undertaken at 15 locations, bat recorders were set at 15 locations, motion cameras were installed at 10 locations, leaf litter was collected from 14 sites and additional bird surveys were undertaken at 10 sites. Details and locations of each site location are presented in **Appendix Two** and **Appendix Three** and shown in **Map 5**.

3.1.6 Field Survey Timing

The recommended timing for fauna surveys in the Eremaean province is generally after significant (summer) rainfall, which applies to mammals, birds and amphibians, whilst the reptile fauna assemblage is best surveyed in hotter conditions spanning between September and April (EPA 2004b; EPA and DEC 2010). The first phase of the field survey was conducted in the autumn season approximately four weeks following significant delayed summer rainfall from 12 to 23 May 2015 with the SRE retrieval survey undertaken between 20 and 24 July 2015. The second phase of surveying was completed in the spring season with additional SRE sampling and a terrestrial fauna trapping program from 22 September to 2 October 2015.

3.1.7 Taxonomy and Nomenclature

Nomenclature for all terrestrial vertebrate fauna follows the *Western Australian Museum Checklist of the Vertebrates of Western Australia* as well as Christidis and Boles (Christidis & Boles 2008). Literature used for the identification of fauna (including electronic versions) is listed in **Table 8**.

Table 8: Literature used for identification of vertebrate fauna species

FAUNA GROUP	REFERENCE
Mammals	Menkhorst & Knight (2011), Van Dyck & Strahan (2008)
Bats	Churchill (1998), Menkhorst & Knight (2011)
Birds	Simpson and Day (2004), Morcombe (2012)
Reptiles	Cogger (2000), Storr *et al*. (1983; 1990; 1999; 2002), Wilson & Swan (2010), Macdonald (2013), recent publications
Amphibians	Tyler & Doughty (2009), Cogger (2000)

3.2 SIGNIFICANT FAUNA

3.2.1 Conservation Significant Fauna Occurrence

The likelihood that fauna listed under the current legislative frameworks occurs within the study area was identified by utilising the results of the literature review, database searches and survey results. Three lists of conservation significant fauna relevant to the project area have been developed at national (EPBC Act) and State levels (WC Act and DPaW Threatened and Priority fauna list).

The following criteria were used to determine the likelihood of occurrence for each conservation significant fauna species:

- suitability of habitats present within the study area
- distance between previous record of conservation significant species and the study area
- frequency and number of records in the region
- date of record of conservation significant species (recent or historical).

Each conservation significant species that potentially occurs within the study area was assigned a likelihood of occurrence based on the below category (**Table 9**). One or more criteria may determine a species to be allocated a certain category, with the precautionary principle (section 4A of the EP Act (Government of Western Australia 1986)) determining that the highest likelihood be assigned if criteria from more than one

category apply. The sufficiency of information and behavioural and ecological characteristics, such as cryptic behaviours were also taken into consideration to improve the accuracy of occurrence likelihood assigned to each species.

Table 9: Criteria for likelihood of occurrence

CRITERIA	LIKELIHOOD
Species recorded within the study area within a reasonable timeframe (0-5 years).	RECORDED
Species recorded in close proximity to the study area within 20 years; suitable habitat occurs within the study area.	HIGH
Species historically recorded in close proximity to the study area (more than 20 years ago); suitable habitat may exist within the study area.	MEDIUM
Species not recorded in the proximity of the study area or rarely recorded within 50 km of the study area; suitable habitat unlikely to occur within the study area.	LOW
Species not recorded by multiple surveys within 50 km of the survey area, suitable habitat does not occur within the survey area, or considered to be locally extinct.	VERY LOW

3.2.2 SRE Species Status

The SRE status of taxa collected is based on categories which were developed by the Western Australian Museum (WAM) (**Table 10)**. These categories are used by taxonomists and consultants in order to describe the SRE status of taxa collected from the study area. The classifications are based on the knowledge about the taxa (species or genus), their distribution (if known) and the representation of records in collections. Information gaps lead to classing taxa as potential SREs which is a requirement under the precautionary principle.

Table 10: Western Australian Museum SRE categories (2013)

DISTRIBUTION	TAXONOMIC CERTAINTY	TAXONOMIC UNCERTAINTY
Distribution < 10 000km^2	• Known distribution of <10 00km^2 • Taxonomy is well known • Group is well represented in collections and/ or via comprehensive sampling **Confirmed SRE**	• Patchy sampling has resulted in incomplete knowledge of the geographic distribution of the group • There is incomplete taxonomic knowledge • The group is not well represented in collections *This category is most applicable to situations where there are gaps in knowledge of the taxon* **Potential SRE**
Distribution > 10 000km^2	• Known distribution of >10 000km^2 • Taxonomy is well known • Group is well represented in collections and/ or via comprehensive sampling **Widespread (not an SRE)**	

3.3 FAUNA HABITAT ASSESSMENT AND MAPPING

The fauna habitats present within the study area were identified and mapped during the survey. Fauna habitats were described as an area which is distinguishable from its surrounding area by its land form, vegetation and fauna assemblage occupying the area. In addition, the likelihood to harbour specialised fauna species which are not found in adjacent areas was taken into consideration.

For the identification and mapping of all existing fauna habitats within the study area following information was utilised:

- Land systems (Wilcox & McKinnon 1972)
- Vegetation type and condition mapping (Ecoscape 2015, Government of Western Australia 2013), other previous surveys)
- Aerial imagery
- Landforms
- Soil characteristic
- Fauna assemblage.

The composition and characteristics of each fauna habitat were recorded and their extent mapped using ArcGIS v10.3.

3.4 DATA ANALYSIS

3.4.1 Habitat Analysis

Interpretation of the fauna groups into recognisable and mappable on-ground units is a tool used to identify habitat types. As presence-absence data is usually used in the analysis and there is no weighting given to dominant species, the habitat types may not correlate to on-ground observations of habitat types. Fauna habitats are therefore determined as a combination of fauna data analysis and on-ground interpretation using the methodologies discussed in **Section 3.2.2**.

To assess patterns in overall species composition among trapping sites, and to evaluate these patterns in relation to habitat type, two analyses were performed using R (R Development Core Team 2015): hierarchical cluster analysis and non-metric multidimensional scaling.

Hierarchical Cluster Analysis

For these analyses, bird species and terrestrial trappable fauna (non-volant mammals, reptiles and amphibians) were assessed separately. For the purposes of this analysis, species were treated as either present or absent within each site. A distance matrix was calculated from the site by species matrix using the Jaccard similarity coefficient. This coefficient is equivalent to the Bray-Curtis similarity coefficient for binary data, which is widely used for estimating ecological distances. A dendrogram was constructed from the distance matrix using UPGMA (Unweighted Pair Group Method with Arithmetic Mean), where sites with more similar species composition cluster more closely together.

Non-Metric Multidimensional Scaling

Non-Metric Multidimensional Scaling (NMDS) is performed on the same distance matrix and Hierarchical Cluster Analysis, using the metaMDS function within the vegan package. Site and species points were plotted along with associated habitat type centroids, which were calculated using the envfit function within the vegan package. The stress value for the NMDS was low (0.045), indicating that the multidimensional data are well represented in two dimensions.

3.4.2 Adequacy of Sampling

In order to determine adequacy of sampling, a species accumulation curve (SAC) was generated by the computer programme *Species Diversity and Richness* (Pisces Conservation Ltd 2007). Five random selections of sample order data from systematic trapping sites were utilised. For geographical illustration, a diagram was created which accumulates the occurrence of each species each time a new individual is recorded. The asymptotic plateau of this illustration was reached at the level at where no new species were

recorded. In addition, a number of species richness estimators were provided in order to estimate a realistic maximum number of species potentially recorded within the study area. These estimators were then compared with the number of species trapped and observed during the survey. This indicates the survey adequacy of each of the utilised methodologies.

3.4.3 Animal ethics

Ecoscape's surveying methodology conforms with the *Australian code of practice for the care and use of animals for scientific purposes* (National Health and Medical Research Council 2013). All survey staff were experienced with conducting fauna surveys using the described methods, or supervised by experienced staff. In all cases, vertebrate fauna individuals were identified in the field and released at the point of capture.

Invertebrate fauna were kept cool after collection, and then euthanised and stored in chilled 100% Ethanol.

3.4.4 Survey team and fauna licence

The terrestrial fauna assessment was undertaken by the personnel shown in **Table 11**.

Table 11: Survey staff

SURVEY MEMBER	EXPERTISE	EXPERIENCE
Damien Cancilla	Mammalogy/Ornithology	10 years
Jared Nelson	Ecologist	7 years
John Scanlon	Herpetology/Ornithology	5 years (WA); 30 years (Australia wide)
Astrid Heidrich	Herpetology/Ornithology	8 years
Chris Parker	Ecologist	4 years
Jesse Forbes-Harper	Zoologist	4 years

The survey was undertaken under the Regulation 17 license number SF010283 issued by the Department of Parks and Wildlife, specifically for this project.

4.0 RESULTS

4.1 VERTEBRATE FAUNA ASSESSMENT

4.1.1 Fauna Inventory

The desktop assessment has identified a total of 425 species as potentially occurring within the study area: 56 mammal species, 189 birds, 141 reptiles, nine fish and 14 amphibians. Of these, 35 species are of conservation significance (eight mammals, 13 birds, two reptiles, two fish). Of these, 13 species are listed under the EPBC Act (five mammals, seven birds, one reptiles).

A total of 134 species were recorded from the study area, which consist of 20 species of mammal (12 species of non-volant mammals, eight species of bat), 85 species of bird, 25 species of reptile and four species of amphibian.

The 12 non-volant mammal species which consist of three species of dasyurid, two macropods, two species of native mice and five introduced species. All species recorded are relatively common and expected to occur with the exception of the Long-tailed Dunnart (*Sminthopsis longicaudata*, DPaW P4) which typically occurs in rocky areas such mesas and breakaways. The specimen recorded was located in the rocky plain habitat, with no obvious rocky outcrops present, however this is not unexpected, as little is known about the habitat preference of this species.

A total of 85 species of bird were recorded from the study area. Of these, 24 species were exclusively recorded during phase 1 whereas seven species were only recorded during phase 2. Phase 1 was undertaken in autumn after heavy and extensive rainfall events which created suitable breeding conditions for a number of bird species. In particular, species such as the Pallid Cuckoo, Horsefield's Bush-lark, Brown Songlark and Black-eared Cuckoo were recorded during phase 1 only. Bird species recorded during phase 2 only included Common Bronzewing, Australian Owlet Nightjar, Australasian Darter, Nankeen Night-heron, Straw-necked Ibis, Sacred Kingfisher and Tree Martin (**Appendix Four**). This is largely due to additional opportunistic bird sites which were established within areas not sampled during phase 1 of the survey.

The total of 25 species of reptile consists of one turtle, six species of gecko (from two families), 10 species of skink, four species of varanid, one blind snake and three species of snake. In particular, the number of snakes recorded is relatively low in comparison to the expected number of species potentially occurring (13 species) (**Appendix Four**). Similarly a total of 67 skink species were determine to potentially occur in the study area and surrounding and of these, only 10 species were recorded during the survey. No pygopods (legless lizards) were recorded during surveying of which 10 species could potentially occur in the area. The relatively low number of reptile species recorded may be the result of the sparse understory vegetation present across the relatively uniform habitat types present within the Yangibana project.

Four species of amphibian were recorded during the survey of which all were captured during phase 1 of surveying. Weather conditions were favourable with recent heavy rainfall events and some light rainfall experienced during the survey. Conditions were drier during phase 2 of surveying with no rainfall experienced, however water pools were still present along creeklines and rivers.

One fish species was identified via remains; the large introduced cichlid, Blue Tilapia (*Oreochromis mossambicus*). Adults of this species with nests (hollow circular mounds of sand in shallow water) and juveniles were also observed in a pool of the Lyons River during phase 2.

4.1.2 Survey Effort

The survey effort completed was as follows:

- A total of eight trap sites were installed for seven consecutive nights resulting 4,144 trap nights over two phases of surveying
- A total of 18 avian sites (including eight systematic trapping sites) were surveyed for bird species totalling 49 hours of birding
- A total of 15 sites were searched for vertebrate and invertebrate fauna resulting in 15 hours of search time
- Motion cameras were installed at 10 sites for approximately eight weeks resulting in 511 days of recording
- SM2 Bat recorders were set-up at a total of 15 sites (including eight systematic trapping sites) for a total of 276 hours of recording
- Wet pitfall sites targeting invertebrate fauna were set-up at 10 locations comprising of four wet pitfalls each which resulted in 40 wet pitfalls left open for eight weeks
- Vertebrate fauna trap sites were also utilised as invertebrate fauna dry pitfalls resulting in 1,120 trap nights of dry pitfall trapping
- Leaf litter was collected from 14 locations resulting in 42 samples of leaf litter.

Details of the survey effort is shown in **Table 12**.

Table 12: Survey effort summary

TRAP SITE	PITFALLS (NIGHTS)		FUNNELS (NIGHTS)		CAGES (NIGHTS)		ELLIOTS (NIGHTS)		BIRDING (MIN)		FORAGING (MIN)		MOTION CAMERA (DAYS)		BAT ANALYSIS (HRS)		WET PITFALL (NO.)		INVERTEB-RATE DRY PITFALL S (NIGHTS)		LEAF LITTER COLLECTIONS (NO.)	
	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2	PH 1	PH 2
HYS1	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYS2	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYS3	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYS4	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYS5	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYS6	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYS7	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYS8	70	70	140	140	14	14	70	70	120	120	-	-	-	-	12	12	-	-	70	70	-	-
HYSRE1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
HYSRE10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-			-	-
Opp.	-	-	-	-	-	-	-	-	480	540	660	240	-	511	24	60	-	-			18	24
Total	**560**	**560**	**1120**	**1120**	**112**	**112**	**560**	**560**	**1440**	**1500**	**660**	**240**	**-**	**511**	**120**	**156**	**40**	**-**	**560**	**560**	**18**	**24**

4.1.3 Conservation Significant Fauna

A total of three species of conservation significance were recorded from within the study area: Rainbow Bee-eater (*Merops ornatus*; WC Act Schedule 5), Eastern Great Egret (*Ardea modesta*; WC Act Schedule 5) and Long-tailed Dunnart (*Sminthopsis longicaudata*; DPaW P4). In addition, the Grey Falcon (*Falco hypoleuca*; WC Act Schedule 3) was recorded from 3.5 km south of the study area. Historic mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*; DPaW P4) were recorded throughout the study area; however based on the guide for the indication of presence and activity of Western Pebble-mound Mice, all mounds were determined to be older than 50 years (Anstee *et al*. 1997) indicating no recent or current occupation of this species within the study area. This is consistent with the current theory that this species is locally extinct across the Murchison and Gascoyne regions.

Details of all records of conservation significant fauna are presented in **Table 13** and displayed in **Map 7**.

Table 13: Conservation Significant fauna recorded during the survey

SPECIES	CONSERVATION STATUS			COORDINATES		SITE	COUNT
	EPBC ACT	WC ACT	DPAW	EASTING	NORTHING		
Rainbow Bee-eater *Merops ornatus*		S5	-	411336	7350331	Outside study area (700 m)	1 individual
				421972	7345695	HYSA 2	1 individual
				422168	7345632	Opportunistic	1 individual
				422188	7345658	Opportunistic	1 individual
Eastern Great Egret *Ardea modesta*		S5	-	422086	7345703	Opportunistic	1 individual
				422016	7345606	Opportunistic	1 individual
				422168	7345636	Opportunistic	1 individual
Grey Falcon *Falco hypoleuca*	-	S3	-	420570	7340277	Outside study area (3.5 km)	1 individual
Long-tailed Dunnart *Sminthopsis longicaudata*	-	-	P4	414799	7362461	HYS5	1 individual

4.1.4 Motion Camera results

Ten motion-activated cameras (Reconyx HC500) were used the phase 2 survey, operating between late September and late November 2015. Cameras were set overlooking natural pools in watercourses (HYMC01, HYMC02), dry sections of watercourses at sites that had been pools in May 2015 and could be expected to fill if sufficient rainfall occurred (HYMC03, HYMC04, HYMC06, HYMC09, HYMC10), seeps below wells provided for cattle (HYMC05, HYMC08), and inside a large hollow log adjacent to a dry creekline (HYMC07).

Table 14 presents the details of motion camera use and results, where 'days' refers to 24 hour periods (00:00 – 23:59 hrs) during which each camera was operational (in HYMC08, less than the interval between set-up and retrieval because the memory card was filled); 'images' the number of images recorded excluding any during set-up and retrieval; and 'species' the number of identifiable vertebrate taxa recorded in images.

There was little if any rainfall during the camera monitoring period so that initially dry sites remained dry for the duration, but pools or seeps persisted at the other sites.

Table 14: Details of motion cameras

SITE ID	CAMERA ID	COORDINATES		DATE SET	DATE COLL.	DAYS	IMAGES	SPECIES
		EASTING	NORTHING					
HYMC01	MC031	414497	7364334	26/09/15	24/11/15	60	885	18
HYMC02	MC032	414294	7364314	26/09/15	24/11/15	60	675	20
HYMC03	MC037	405594	7358728	30/09/15	25/11/15	57	96	4
HYMC04	MC039	415500	7360639	30/09/15	24/11/15	56	873	1
HYMC05	MC038	414922	7357913	30/09/15	24/11/15	56	3108	16
HYMC06	MC036	419075	7355493	30/09/15	24/11/15	56	45	3
HYMC07	MC033	423869	7350250	27/09/15	24/11/15	59	4214	2
HYMC08	MC034	424930	7351551	28/09/15	24/11/15	45	18326	35
HYMC09	MC040	421952	7345652	28/09/15	24/11/15	58	146	10
HYMC10	MC035	421888	7345704	28/09/15	24/11/15	58	190	7

Due to the large number of fauna images on some cameras, results are scored in **Table 26** (**Appendix Six**) as the number of days on which each species was recorded, rather than attempting to count individuals or detection events.

Diversity and abundance of fauna was generally much higher at sites with surface water, and there was also variation depending on the field of view of each camera (in one case, with camera HYMC08, the orientation of the view was repeatedly altered due to disturbance by cattle, which resulted in different detection areas, number of individuals, and apparently different species being detected at different stages of the recording period). Red Kangaroo and Euro are not distinguishable from each other in the results, as most images are monochrome and many do not show distinguishing features of these species, both of which are known to occur in the study area. With the exception of a single Emu recorded at HYMC05 and a Barn Owl at HYMC08, all species recorded on cameras were also identified by other methods during the survey. No conservation significant species were recorded on the motion cameras.

4.2 INVERTEBRATE SRE FAUNA ASSESSMENT

The results of the SRE invertebrate survey within the study area are listed in **Table 15** and summarised as follows:

- three taxa of four genera from three families of spiders (all potential SREs)
- three taxa of one genus of scorpions (including two potential SREs)
- six taxa of pseudoscorpion from two genera from one family (including three potential SREs)
- six taxa of isopod (including four potential SREs) of three genera from one family
- two taxa of snail of one genus;
- three taxa of pincushion millipedes from two families;
- one taxon of tropical centipede (including one potential SRE)

- one taxon of soil centipede
- one taxon of stone centipede.

All invertebrate fauna recorded from the study area are summarised in **Table 15** with a site by species matrix shown in **Appendix Five.** The location of all potential, likely and confirmed SRE species are displayed in **Map 8**.

Table 15: Results of the invertebrate SRE sampling

HIGHER TAXON	SPECIES	SRE STATUS	COMMENT	SITE	COMMENTS
Araneae (Spiders)					
Barychelidae	*Synothele* sp. B14	Potential SRE	2 adult males	HYS5, HYSOP 5	-
Idiopidae	*Aganippe* sp. 21	Potential SRE	2 adult males	HYSOP 4, HYS 4	requires DNA barcoding
Nemesiidae	*Aname* sp. B19	Potential SRE	2 juveniles	HYSRE 5, HYSRE 6	-
Scorpiones (Scorpions)					
Buthidae	*Lychas* 'harveyi'	Not considered SRE	8 individuals	HYS1, HYS5, HYS7, HYS8, HYSOP7, HYSOP8	
	Lychas 'hairy tail' group	Potential SRE	1 individual	HYS6	
	Lychas 'multipunctatus' group	Potential SRE	1 individual	HYS8	
Pseudoscorpiones (pseudoscorpions)					
Olpiidae	*Beierolpium* 8/2	Potential SRE	2 individuals	HYSL6, HYSRE9	
	Beierolpium 8/3	Potential SRE	3 individual	HYSRE1 and HYSRE7, HYSL1	
	Beierolpium 8/4	Not SRE	3 individuals	HYSL11, HYSL12, HYSL14	Widespread
	Indolpium sp. B20	Not SRE	2 females	HYSL4, HYSL6	Species 1 from this project
	Indolpium sp. B21	Not SRE	1 male and 1 female	HYSL6	Species 2 from this project
	Linnaeolpium sp. *B04*	Potential SRE	Male adult	HYSL5	
Isopoda (slaters)					
Armadillidae	*Acanthodillo* sp. B16	Potential SRE	1 individual	HYSRE4	Recorded from sandy plain
	Buddelundia sp. B58	Not considered SRE	579 individuals	HYS1, HYS3-6, HYSRE1-4, HYSRE6-10, HYSOP2, 4-5	Recorded from variety of habitats
	Buddelundia sp. B59	Potential SRE	2 individuals	HYSRE8,	

HIGHER TAXON	SPECIES	SRE STATUS	COMMENT	SITE	COMMENTS
				HYSOP1	
	Buddelundia sp. B60	Potential SRE	4 individuals	HYSRE4	
	Buddelundia sp.	Not considered SRE	61 individuals	HYSRE3, HYSRE9	
	Cubaris sp. B07	Potential SRE	2 male individuals	HYSRE1	
Molluscs (snails)					
Pupilidae	*Pupoides contrarius*	Not considered SRE	130 individual	HYSL2-L4, HYSL6, HYSL11	
	Pupoides beltianus	Not considered SRE	25 individual	HYSL1-4, HYSL9	
Polyxenida (pincushion millipedes)					
Polyxenidae	Polyxenidae sp. B14	Not considered SRE	3 individuals	HYSRE5, HYSRE6, HYSRE9	
	Polyxenidae sp.	Not considered SRE	3 juveniles	HYSL1	Likely belongs to above species
	Synxenidae sp. B08	Not considered SRE	103 individuals	HYSRE3-5, HYSRE9, HYSL1	
Scolopendromorpha (tropical centipedes)					
Cryptopidae	*Cryptops* sp.	Potential SRE	1 individual	HYSOP1	Specimen in poor condition
Geophilomorph (soil centipedes)					
Oryidae	*Orphnaeus* nr	Not considered SRE	1 individual	HYSRE4	
Lithobiomorpha (stone centipedes)					
Henicopidae	*Lamyctes* nr *africanus*	Not considered SRE	1 individual	HYSRE 9	

4.2.1 SRE Specimen descriptions

The below specimen summaries are taken from the identification report provided by Bennelongia Environmental Consultants and repeated below with images of important specimens provided. The complete report is provided in **Appendix Nine**.

Overall, 935 specimens belonging to 24 species in seven SRE groups were collected. Pseudoscorpions and terrestrial slaters were most diverse with six and five species, respectively. Spiders, scorpions and centipedes were represented by three species each, and centipedes and snails were present with two species.

Spiders

The spider groups assessed under the current SRE framework are the trapdoor spiders and allies (infraorder Mygalomorphae). This group contains a high proportion of range-restricted species, often with ranges below the 10,000 km^2 threshold for SRE invertebrates. Taxonomic resolution in the Mygalomorphae is poor and most species remain undescribed although there are some taxonomic revisions (Raven 1994) and recent molecular analyses (Castalanelli *et al*. 2014; Harms & Framenau 2013).

Three species of mygalomorph spiders were collected in the current survey and they belong to three families: brush-footed trapdoor spiders (Barychelidae: *Synothele*), wishbone spiders (Nemesiidae: *Aname*) and true trapdoor spiders (Idiopidae: *Aganippe*).

***Synothele* sp. B14**

Two males were collected in a pitfall trap and by hand foraging at sites HYS5 and HYSOP5 (**Map 8**). This genus is very diverse at a species level. It was revised by Raven (1994) but many more species have since been collected and diversity in arid Australia is very high, with many more putative species indicated by a recent molecular analysis (Castalanelli *et al*. 2014). Most *Synothele* species remain undescribed and many have known ranges below the 10,000km^2 threshold. Given the regional endemism in this fauna, sp. B14 (**Figure 5**) is classified here as a potential SRE based on previous research and expertise. Its exact range is unknown.

Figure 5: *Syothele* sp. B14

***Aganippe* sp. 21**

This genus is highly diverse at a species level and currently undergoing taxonomic revision by staff at the Queensland Museum. Two males of a currently undescribed *Aganippe* species were collected at sites HYS4 and HYSOP4 (**Map 8**). Many *Aganippe* species have short ranges whereas others are clearly more widespread and have ranges > 10,000 km^2 (Castalanelli *et al*. 2014). Using a precautionary approach *Aganippe* sp. 21 (**Figure 6**) is classified here as a potential SRE based on research and expertise.

Figure 6: *Aganippe* sp. 21

***Aname* sp. B19**

This genus is highly diverse at a species level and occurs throughout all regions of the state. A recent revision of the Pilbara fauna identified four species (Harvey *et al*. 2011) but this has been overcome by a recent molecular analysis that has revealed many more species (Castalanelli *et al*. 2014) and high regional endemism. Species identification using morphology is difficult and molecular analyses could be undertaken to support the current recognition of the two females from sites HYSRE5 and HYSRE6 (**Map 8**) as a new species: *Aname* sp. B19 (**Figure 7**). Based on previous research, this is a potential SRE but the total range remains unknown.

Figure 7: *Aname* B19

Scorpions

Scorpions are a common element of SRE communities in arid Australia but taxonomic resolution is poor and the only revision available is clearly outdated (Koch 1977) whilst more recent papers have focussed on the description of single species only (Volschenk *et al*. 2000; Volschenk *et al*. 2012). The common families in arid habitats of WA are the Urodacidae with the single genus Urodacus, and the Buthidae with the genera Isometroides and Lychas (Volschenk *et al*. 2010).

Three scorpion species were collected in the current survey and they belong to the genus *Lychas* (family Buthidae). Most species in this genus are widespread but at least some potential SRE species have also been recorded.

***Lychas* 'hairy tail' group**

A single specimen was collected by hand at HYS6. Recent molecular research conducted by the WA Museum has shown that the former morphospecies *Lychas* 'hairy tail' is in fact a complex of morphologically cryptic but genetically distinct species. Some species in this complex may be SREs but little is known about species ranges and species delimitation is difficult. Based on the precautionary principle the species present at Hastings is classified as a potential SRE with deficient data (**Figure 8**).

Figure 8: *Lychas* 'hairy tail' group

Lychas 'harveyi'

This distinct morphospecies is widespread in arid Australia and there are records from the Pilbara, Gascocyne, the Goldfields and Barrow Island. It is one of the most commonly collected scorpion species in WA and not of conservation concern. Five specimens were collected in the current survey from four sites (**Map 8, Figure 9**).

Figure 9: *Lychas harveyi*

***Lychas* 'multipunctatus'-group**

A single specimen in this species complex was collected from a dry pitfall trap at site HYS8 (**Map 8**). *Lychas* 'multipunctatus' was assessed as widespread in many previous environmental reports but recent molecular research at the WAM has indicated that this is a complex of cryptic species. Some species in this complex may have short ranges although no further data are presently available. According to the precautionary principle, the species present at Hastings is a potential SRE with deficient data (**Figure 10**).

Figure 10: *Lychas 'multipunctatus'* group

Pseudoscorpions

Pseudoscorpions include a wide range of life characteristics and include groups that are arid-adapted and common in many habitats in WA (i.e. the Olpiidae), those that are dispersal-prone (e.g. the Chernetidae), habitat specialists that are often range-restricted (e.g. Synsphyronus in the Garypidae), and those that require high moisture levels and are considered Gondwanan 'relict' fauna (e.g. the Chthoniidae). The taxonomy of pseudoscorpions in WA is comparably well-resolved and there are revisions for some groups (e.g. Synsphyronus, (Harvey 1987); Tyrannochthonius and Lagynochthonius; (Edward & Harvey 2008)) but others remain unrevised and taxonomically poorly resolved (i.e. the Olpiidae). Six species of pseudoscorpion were collected in the current survey and they all belong to the widespread and arid-adapted family Olpiidae.

***Beierolpium* 8/2**

Two specimens of this morphotype that has two trichobothria on the movable chela finger were collected from wet traps and leaf litter at sites HYSL6 and HYSRE9 (**Figure 11, Map 8**). These pseudoscorpions are often found in ephemeral habitats such as under tree bark and are probably dispersal-prone (Bennelongia 2016). Information on the taxonomic status of this species is unknown and information is contradicting. Bennelongia assessed the species as not SRE (**Appendix Nine**), however communication with taxonomists from the WA Museum indicated that the systematics of members of this genus has not been established adequately and it is not possible to confirm its identity until a complete systematic revision of the genus *Beierolpium* in Western Australian has been undertaken (K. M. Abrams, WA Museum, 2015 pers. comm.). Under the precautionary principle requires that the species is considered a potential SRE due to the lack of data.

Figure 11: ***Beierolpium 8/2***

Beierolpium 8/3

This type of *Beierolpium* has three trichobothria on the movable chela finger (**Figure 12, Map 8**). Three specimens were collected from leaf litter and wet traps at sites HYSL1, HYSRE1 and HYSRE7. *Beierolpium* is a common genus in arid WA and includes arid-adapted species that are currently understood to be widespread (Bennelongia 2016). The specific biology of the species present at Hastings is unknown. Bennelongia assessed the species as not SRE (**Appendix Nine**), however communication with taxonomists from the WA Museum indicated that the systematics of members of this genus has not been established adequately and it is not possible to confirm its identity until a complete systematic revision of the genus *Beierolpium* in Western Australian has been undertaken (K. M. Abrams, WA Museum, 2015 pers. comm.). Under the precautionary principle requires that the species is considered a potential SRE due to the lack of data.

Figure 12: ***Beierolpium 8/3***

Beierolpium 8/4

Beierolpium is a genus in the pseudoscorpion family Olpiidae and defined by a specific arrangement of the trichobothria on the chela fingers (**Figure 13**). There is no taxonomic framework for these pseudoscorpions in Australia but adult specimens in the 8/4 group have four trichobothria on the movable pedipalp finger. Three nymphs that may belong to this group were collected from leaf litter at sites JSLL05, JSLL06 and JSLL08 (**Map 8**). These juveniles cannot be identified further but *Beierolpium* includes generally arid adapted pseudoscorpions that are widespread. This species is unlikely to be of conservation concern (Bennelongia 2016).

Figure 13: *Beierolpium 8/4*

***Indolpium* sp. B20**

Two specimens were collected from leaf litter at sites JSLL08 and HYSL4 (**Figure 14**). This is the most common pseudoscorpion genus in north-western WA and specimens are frequently collected during environmental surveys (Bennelongia 2016). The genus appears diverse at a species level but there is no taxonomic framework and species identification is difficult. However, these pseudoscorpions are arid-adapted and often collected from ephemeral microhabitats such as dry leaf litter and under tree bark. Dispersal abilities are estimated to be high and most species are currently understood to be widespread. *Indolpium* sp. B20 is unlikely to be restricted to the survey area and not of conservation concern (Bennelongia 2016).

***Indolpium* sp. B21**

Three specimens of a second *Indolpium* species were collected from leaf litter at site HYSL6 (**Figure 14**). This species differs from *Indolpium* sp. B20 in having a brown carapace and pedipalps (yellow carapace and dark-brown chela in *Indolpium* sp. B20), chela ratios and body measurements. *Indolpium* species are currently not considered SREs and *Indolpium* sp. B21 is unlikely to be of conservation concern (Bennelongia 2016).

Figure 14: *Indolpium* sp. B20

***Linnaeolpium* sp. B04**

A single male specimen was collected from leaf litter at site HYSL5 (**Figure 15, Map 8**). The only described species in this genus is *Linnaeolpium linneae* from subterranean habitats in the Robe Valley (Harvey & Leng 2008). This species is a confirmed SRE and the surface relative *Linnaeolpium* sp. B04 is classified here as a potential SRE based on research and expertise.

Figure 15: *Linnaeolpium* sp. B04

Isopods

Isopods are very common in environmental surveys in arid Australia and include many species with ranges that are much smaller than 10,000 km2 (Judd & Perina 2013). Taxonomic resolution in this fauna is extremely poor and there are no revisions although there is a key to the species from Barrow Island (Judd & Perina 2013) and some information on taxonomic diversity in general (Judd & Horwitz 2003). The most common genus in WA is *Buddelundia*; in the family Armadillidae; an unrevised genus that may include more than 100 species. Other groups, such as the Philosciidae, also include a high proportion of SRE species but are far less common.

Five isopod species were recorded in the current survey which belong to the genera *Acanthodillo* (one species), *Buddelundia* (three species) and *Cubaris* (one species). All species belong to the family Armadillidae: isopods that roll up when disturbed.

Acanthodillo sp. B16

A single male specimen was collected from a wet trap at site HYSRE4 (**Map 8, Figure 16**). Nothing is known about the specific biology of this species but many other *Acanthodillo* species in WA have been classified as potential SREs in previous fauna reports. Slaters generally have small ranges and dispersal abilities are often limited. *Acanthodillo* sp. B16 is classified here as a potential SRE with deficient data (Bennelongia 2016).

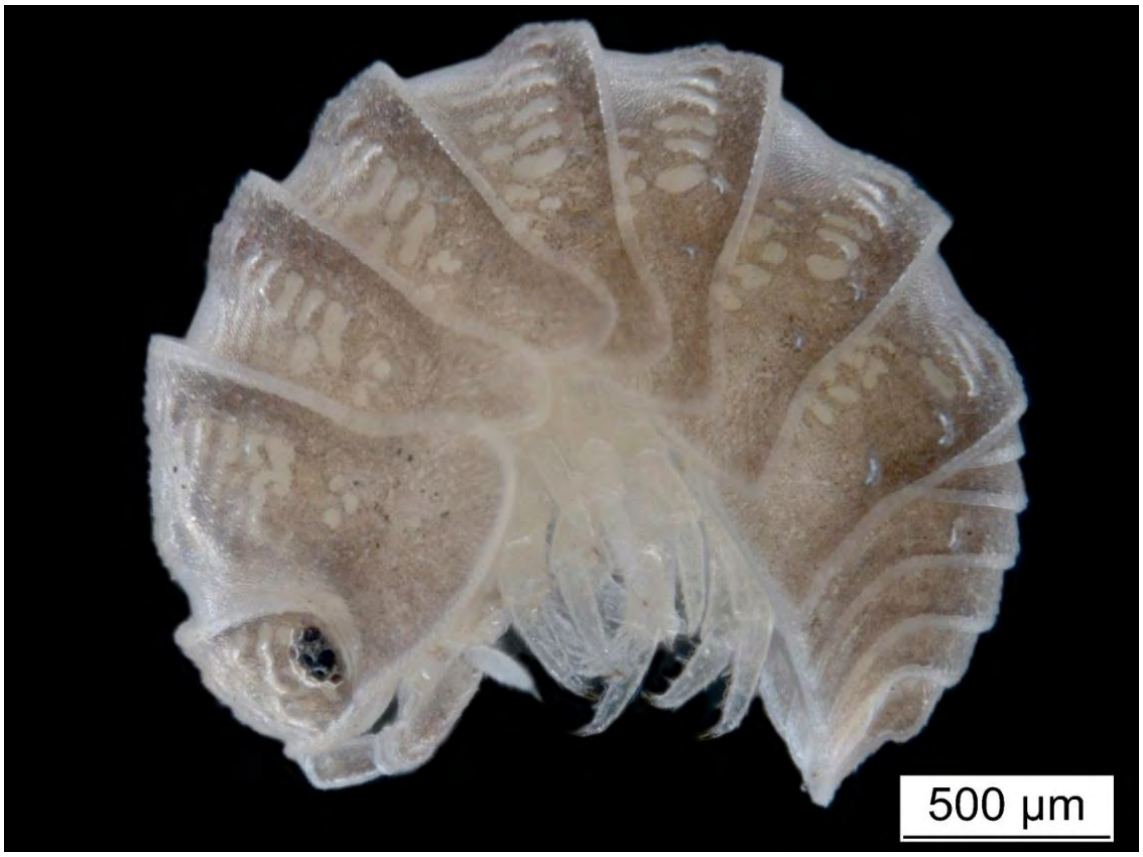

Figure 16: *Acanthodillo* sp. B16

***Buddelundia* sp. B58**

This was the most common terrestrial slater in the survey area and 632 specimens belonging to this species were collected from leaf litter and pitfall traps and multiple sites (**Figure 17**). This species is widespread and common in the survey area, is likely to occur outside the tenements and unlikely to be a SRE. This common slater is unlikely to be of conservation concern (Bennelongia 2016).

Figure 17: *Buddelundia* sp. B58

***Buddelundia* sp. B59**

Two specimens of this morphospecies were collected from sites HYSOP1 and HYSRE8 (**Map 8, Figure 18**). Nothing is known about the ecology of this species but many other *Buddelundia* species have short ranges and are restricted to refugial habitats of high moisture retention, vegetation cover and shade (Judd & Perina 2013). This is a potential SRE species with deficient data (Bennelongia 2016).

Figure 18: *Buddelundia* sp B59

***Buddelundia* sp. B60**

Four specimens of a third species in this genus were collected from a wet trap at site HYSRE4 (**Map 8, Figure 19**). Nothing is known about the ecology of this species but given the short-range endemism in the terrestrial slater fauna of WA this species is classified here as a potential SRE with deficient data (Bennelongia 2016).

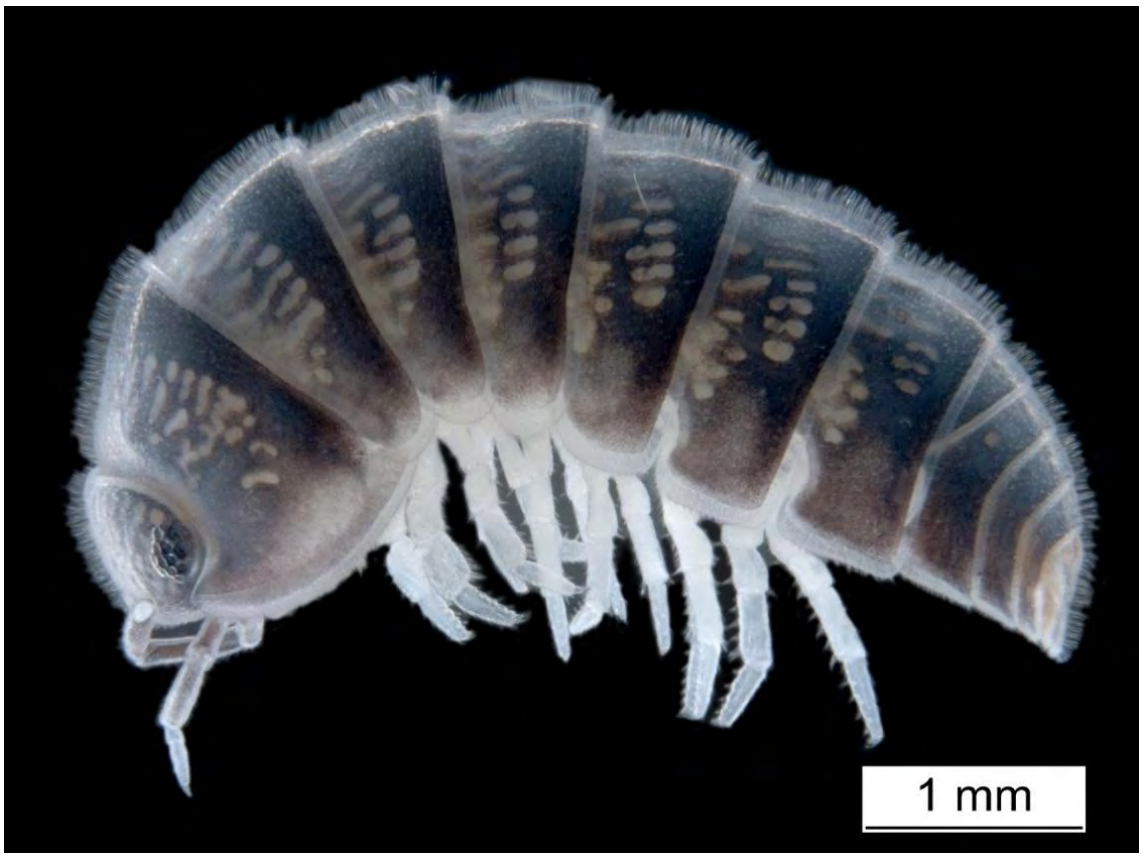

Figure 19: *Buddelundia* sp. B60

***Cubaris* sp. B07**

Two male specimens were collected from wet traps at site HYSRE1 (**Map 8, Figure 20**). Not much is known about the ecology and biology of these slaters but they generally have limited dispersal capacities and probably short ranges. *Cubaris* sp. B07 is classified as a potential SRE with deficient data (Bennelongia 2016).

Figure 20: *Cubaris* sp. B07

Centipedes

Almost nothing is known about centipedes in WA and there are no taxonomic revisions but some families, such as the Cryptopidae, contain some potential SRE species (Phoenix Environmental Sciences 2014). Centipedes are not as commonly collected in SRE surveys as other invertebrate groups but this may reflect sampling bias rather than rarity. Three species (and families) of centipede were collected in the current survey. They belong to the families Cryptopidae, Oryidae and Henicopidae.

***Cryptops* sp. B46**

A single specimen in the family Cryptopidae was collected in leaf litter at site HYSOP1 (**Map 8, Figure 21**). There is no taxonomic framework for this family in WA but these centipedes are probably diverse at a species level and often collected from moist leaf litter habitats. Nothing is known about the ecology and distribution of the singleton species *Cryptops* sp. B46 but at least some species in this genus have been assessed as potential SREs in previous fauna surveys. Using a precautionary approach, *Cryptops* sp. B46 is classified here as a potential SRE with deficient data (Bennelongia 2016).

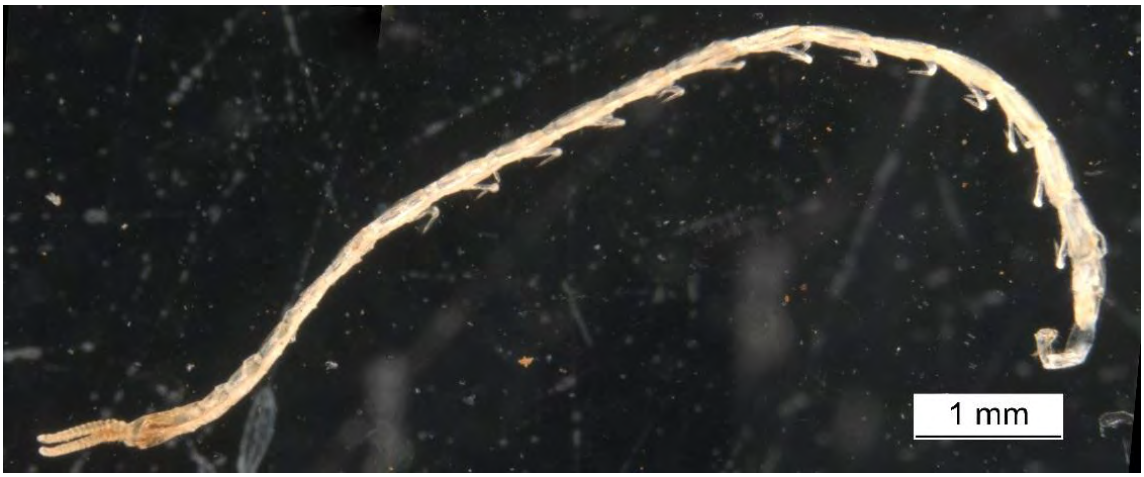

Figure 21: *Cryptops* sp. B46

Orphnaeus* nr *brevilabiatus

A single specimen was collected from a wet pitfall trap at site HYSRE4. It morphologically resembles *Orphnaeus brevilabiatus* in the family Geophilida which is a widespread species with multiple occurrences n WA and the Northern Territory (Atlas of Living Australia 2015a; Colloff *et al*. 2005). This species is unlikely to be of conservation concern.

Lamyctes* nr *africanus

A single specimen in the family Lithobiomorpha was collected in a wet pitfall trap at site HYSRE9. It morphologically resembles *Lamyctes africanus* which is a widespread species (Colloff *et al*. 2005). This species is unlikely to be of conservation concern.

Millipedes

Millipedes are diverse in WA at a species level. The family Paradoxosomatidae includes the genera *Antichiropus* and *Boreohesperus* that consist almost exclusively of SRE species (Car & Harvey 2013; Car & Harvey 2014). Other groups such as the pincushion-millipedes (Polyxenida) and fire millipedes (Pachybolidae) comprise widespread species (Car *et al*. 2013; Harvey *et al*. 2011).

At least two morphospecies of pincushion millipede (Polyxenida) were collected in the current survey. No other millipedes were collected.

Polyxenidae sp. B14

Three specimens of this species were collected from three sites. There is no taxonomic framework for Polyxenidae in WA and not even the genera are established. However, polyxenids are commonly collected from dry leaf litter and debris in Western Australia and can be extremely common locally; even in habitats that are disturbed or very dry. The available data indicate that most species are very widespread (Car and Harvey 2013) and Polyxenidae sp. B14 should also occur more widely. This species is not of conservation concern.

Synxenidae sp. B08

This is the second species of Polyxenidae in the survey area and 103 specimens were collected from five sites. Based on the perceived habitat preferences of polyxenids this species is unlikely to be an SRE and probably widespread. It is not of conservation concern.

Polyxenidae sp. indet.

Three juveniles were collected at site HYSL1 that cannot be identified further. They may belong to one of the two species mentioned above and almost certainly belong to a widespread taxon.

Snails

Terrestrial snails in arid WA include groups with predominantly widespread species (e.g. the family Puplillidae with the genera *Gastrocopta* and *Pupoides*) but also those that include many potential SRE species (e.g. the Camaenidae with the genera *Quistrachia* and *Rhagada*). There are some taxonomic revisions (Whisson & Köhler 2013), molecular phylogenies (O'Neill *et al*. 2014), catalogues (Breure & Whisson 2012) and faunistic papers (Köhler *et al*. 2012) that aid the identification of species.

Only two terrestrial snail species were collected in the current survey and they both belong to the genus *Pupoides* (family Pupillidae) that consists of widespread species.

Pupoides* cf. *beltianus

A total of 25 dead-taken shells consistent with *Pupoides beltianus* were collected from five sites. This species is clearly distinct from *Pupoides contrarius*, the second species of *Pupoides* in the survey area, because the shell coiling is sinistral in *P. contrarius* but dextral in *P. beltianus*. This terrestrial mollusc is widespread and commonly collected in WA but also occurs in central Australia (ALA 2015).

Pupoides* cf. *contrarius

This was the most common snail species in this survey and 130 specimens were collected from five sites. This is a widespread species and there are numerous records from north-western WA but also the Northern Territory and Queensland. *Pupoides* cf. *contrarius* is not of conservation concern.

4.3 FAUNA HABITAT TYPES

The following five broad fauna habitat types were identified in the Yangibana study area:

- Rocky plain
- Sandy plain
- Granite outcrop
- Major river
- Minor creekline.

The extent of each habitat type is presented in **Table 16** and their spatial extent is displayed in **Map 6.**

None of the habitats are exclusive to the study area, with all recorded from the surrounding region. The rocky plain habitat was recorded with the largest extent, followed by sandy plain habitat. Granite outcrops, major rivers and minor creeklines are minor habitat types which occupy smaller areas within then study area (**Table 16**).

Table 16: Extent of each habitat type

HABITAT TYPE	EXTENT (HA)	PERCENT OF STUDY AREA
Rocky plain	40,265.0	75.2
Sandy plain	5,812.4	10.8
Granite outcrop	2,609.1	4.9
Major River	1,890.1	3.5
Minor creekline	2,973.0	5.6

4.3.1 Rocky Plain

This habitat is characterised by gravelly/stony undulating hills of fine, red clay/loam soil with >70% cover of ironstone gravel or >40% of quartz stones with occasional granite rocks. The vegetation is sparse and consists of scattered *Acacia xiphophylla* and *Exocarpos latifolius* tall shrubs, over low *Eremophila fraseri, Ptilotus obovatus* and *Senna* spp shrubland (**Plate 1**). Some patches of *Dysphania rhadinostachya* open herbland and *Eriachne pulchella* subsp. *dominii* and *Aristida contorta* open tussock grassland can be found. It also comprises some undulating hills and smaller hillslopes in particular in the south of the study area as well as plains which were recorded throughout the study area. The rocky plain habitat types comprised 40,265 ha which represents 75.2 % of the study area.

Plate 1: Rocky plain habitat recorded from the study area

4.3.2 Sandy Plain

The sandy plain habitat type occupies 5,812.4 ha of the study area which represents 10.8 % of the total area. It is dominated by an open layer of *Acacia xiphophylla* tall shrubs over scattered *Senna ferraria* mid shrubs over occasional *Maireana* spp. low, isolated chenopod shrubs. This habitat types is also characterised by sandy fine, orange clay/loam soil with occasional calcrete and quartz pebbles (**Plate 2**). Rocks were rarely encountered. Leaf litter and wood litter is rare but was sometimes observed accumulated underneath shrubs.

Plate 2: Sandy plain habitat recorded from the study area

4.3.3 Granite Outcrop

The granite outcrop habitat is the most elevated of the habitat types. It is restricted to the east and north of the study area with some small patches of lower granites in the centre. It covers approximately 2,609.1 ha (4.9 %) and is dominated by patches of moderate vegetation structures with *Acacia cyperophylla* tall woodland over *a* mixed shrub layer dominated *by Eremophila species over* mixed tussock grass and herbland (**Plate 3**). The domes, ridges and boulder fields of weathered granite-type rock are interspersed with any of the other three substrate types (rocky, sandplain, or creekline). This habitat type can provide shelter for a number of fauna species, in particular larger species such as macropods in the form of caves and rock overhangs.

Plate 3: Granite outcrop habitat recorded from the study area

4.3.4 Major River

This habitat type consists of *Eucalyptus camaldulensis* trees over mid shrubland of *Acacia citrinoviridis* and *Acacia coriacea* over lower shrubs and *Cenchrus ciliaris* and *Eragrostis tenellula* closed tussock grassland. The substrate consists of coarse sand with occasional quartz/granite pebbles. Leaf and wood litter is usually accumulated against tree trunks, or in some cases entirely absent. After heavy rainfall events, semipermanent water pools may be present to support a large number of fauna species (**Plate 4**). This habitat type covers 1,890.1 ha (3.5 % of the study area) and was found in particular in the south of the study area.

Plate 4: Major river habitat recorded from the study area

4.3.5 Minor Creekline

Minor creeklines are dominated by tall *Acacia cyperophylla* shrubs of which a large proportion of deceased/burnt shrubs. The mid shrublayer comprises of *Acacia cuthbertsoniii* and *Eremophila fraseri* mid sparse shrubland over *Cyperus* spp. sparse sedgeland and *Nicotiana occidentalis* and *Cleome viscosa* sparse herbland (**Plate 5**). Wood litter and leaf litter is often accumulated against trunks of shrubs. The substrate is dominated by coarse sand with occasional quartz rocks. Some small temporary water pools can be present for a limited time after rainfall events. This habitat type covers 2,973.0 ha which represents 5.6 % of the study area.

Plate 5: Minor creekline habitat recorded from the study area

4.4 DATA ANALYSIS

4.4.1 Habitat Analysis

A hierarchical cluster and a non-metric Multidimensional Scaling (NMDS) of the systematic trapping sites within the different habitat types was completed for data collected for trapped terrestrial vertebrate fauna, avifauna recorded from eight systematic trapping sites (HYS1-8) and for invertebrate SRE species recorded from eight dry pitfall and ten wet pitfall trapping sites (HYS1-8, HYSRE1-10).

Figure 22 and **Figure 23** show the results from the analysis of terrestrial data (mammals, reptiles and frogs) in the form of a hierarchic cluster and a non-metric Multidimensional Scaling (NMDS). When comparing trapped terrestrial fauna data against the different habitat types, the minor drainage line (site HYS01) and major river habitats (site HYS03) were grouped together, indicating that fauna inhabiting these two habitats are similar. The trapping site established within granite outcrops (HYS02) captured a distinct fauna assemblage which makes this habitat relatively unique within the study area. The remaining sites established in rocky and sandy habitats had relatively similar results with the two rocky plain sites HYS05 and HYS07 being the most distinguished from this group (**Figure 22** and **Figure 23**). The most distinguished habitat types based on trappable fauna were the major river/minor drainage line and granite outcrops.

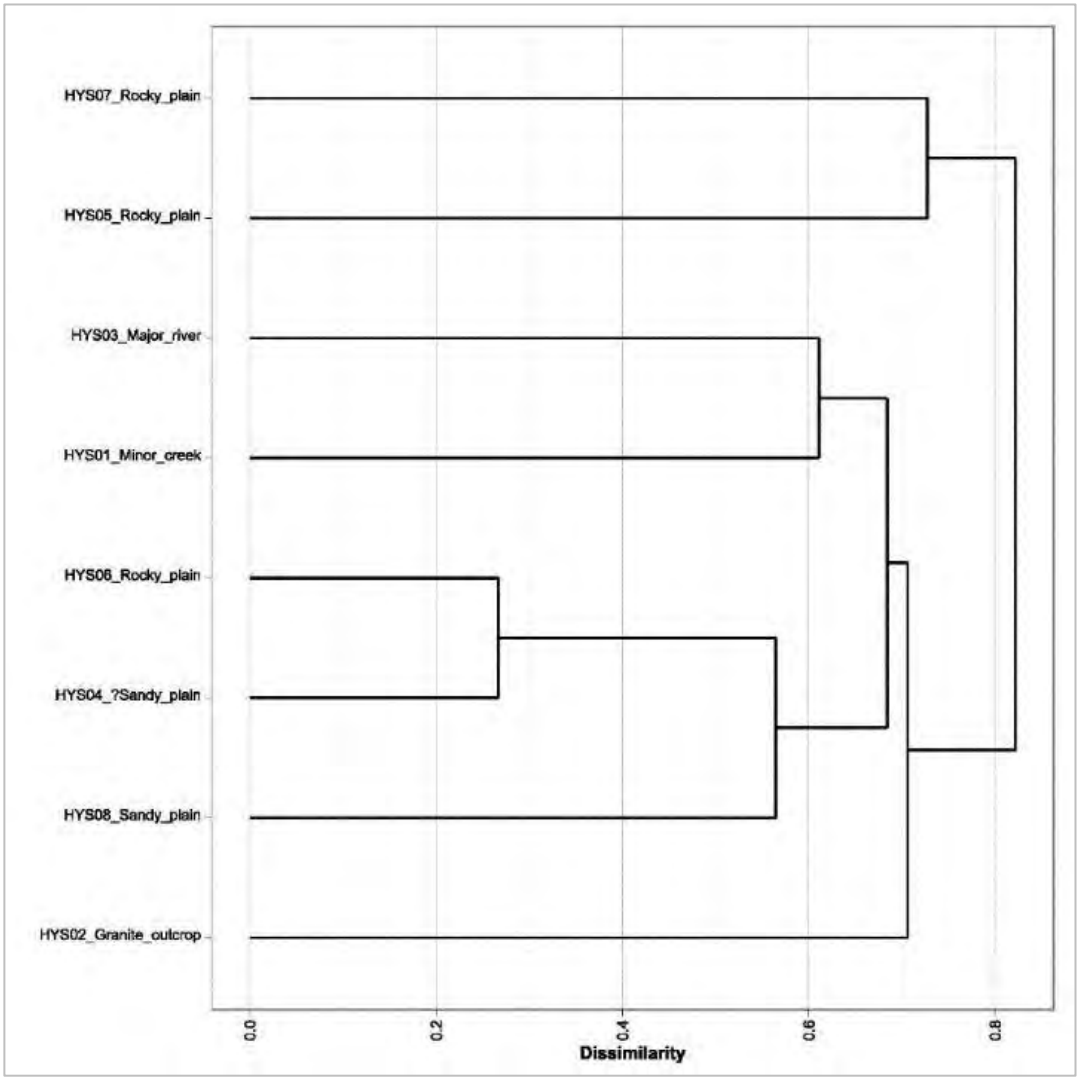

Figure 22: Cluster trappable fauna

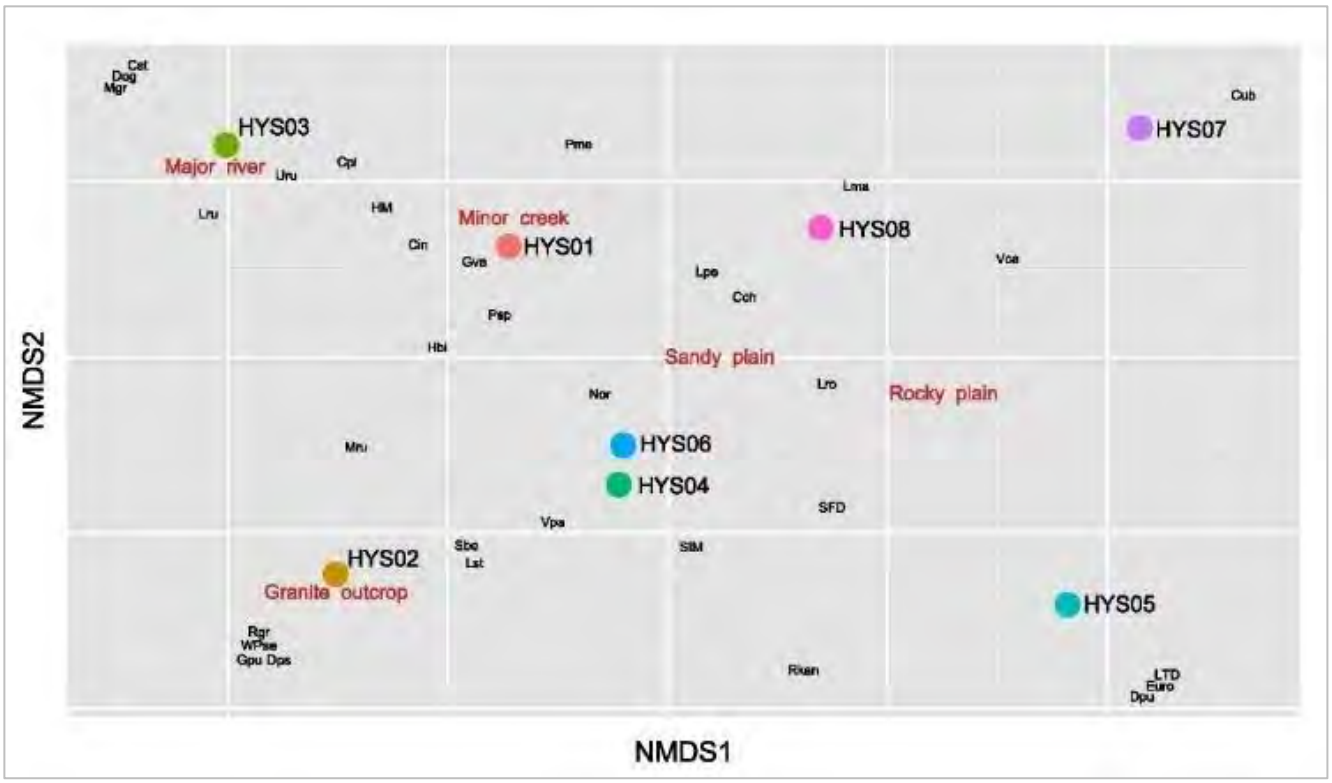

Figure 23: NMDS trappable fauna

A habitat analysis was also undertaken for all data recorded from all eight systematic trapping sites (HYS1-8). **Figure 24** and **Figure 25** shows the cluster and NMDS for bird data. Statistical analysis of avifauna recorded shows that the major river and minor creekline habitats are grouped together, meaning that similar bird species were recorded from these two sites. Granite outcrops were grouped with the rocky plain habitat which is based on data collected from one systematic site (HYS02). However, the two sites established in sandy plain habitat showed similarities and were separated from all sites established in the rocky plain. The most distinct habitats based on collected bird data were the major river/drainage line habitats. The sandy plain and rocky plains showed some distinguishable differences, however these appear to be minor.

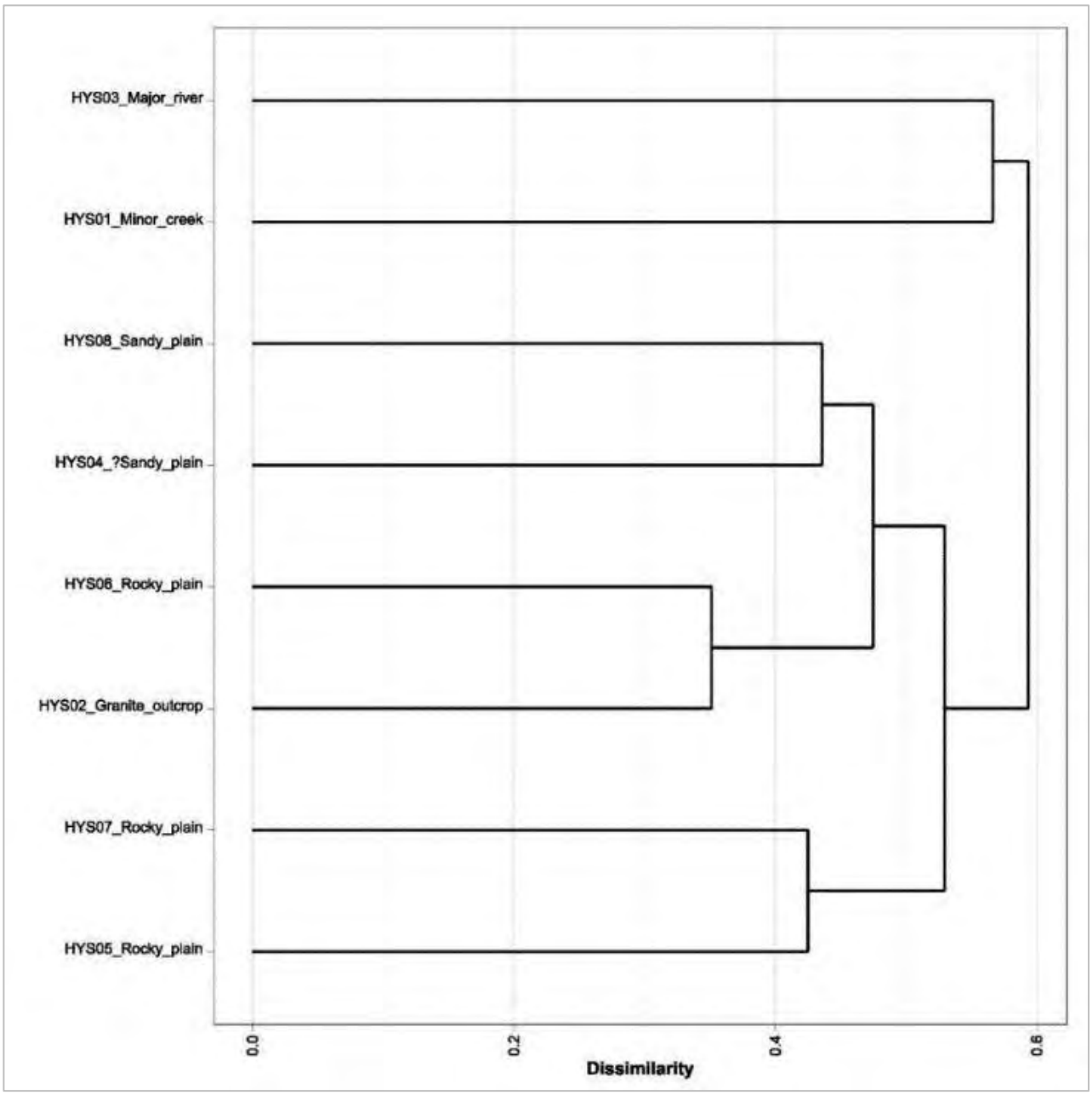

Figure 24: Cluster bird assemblage

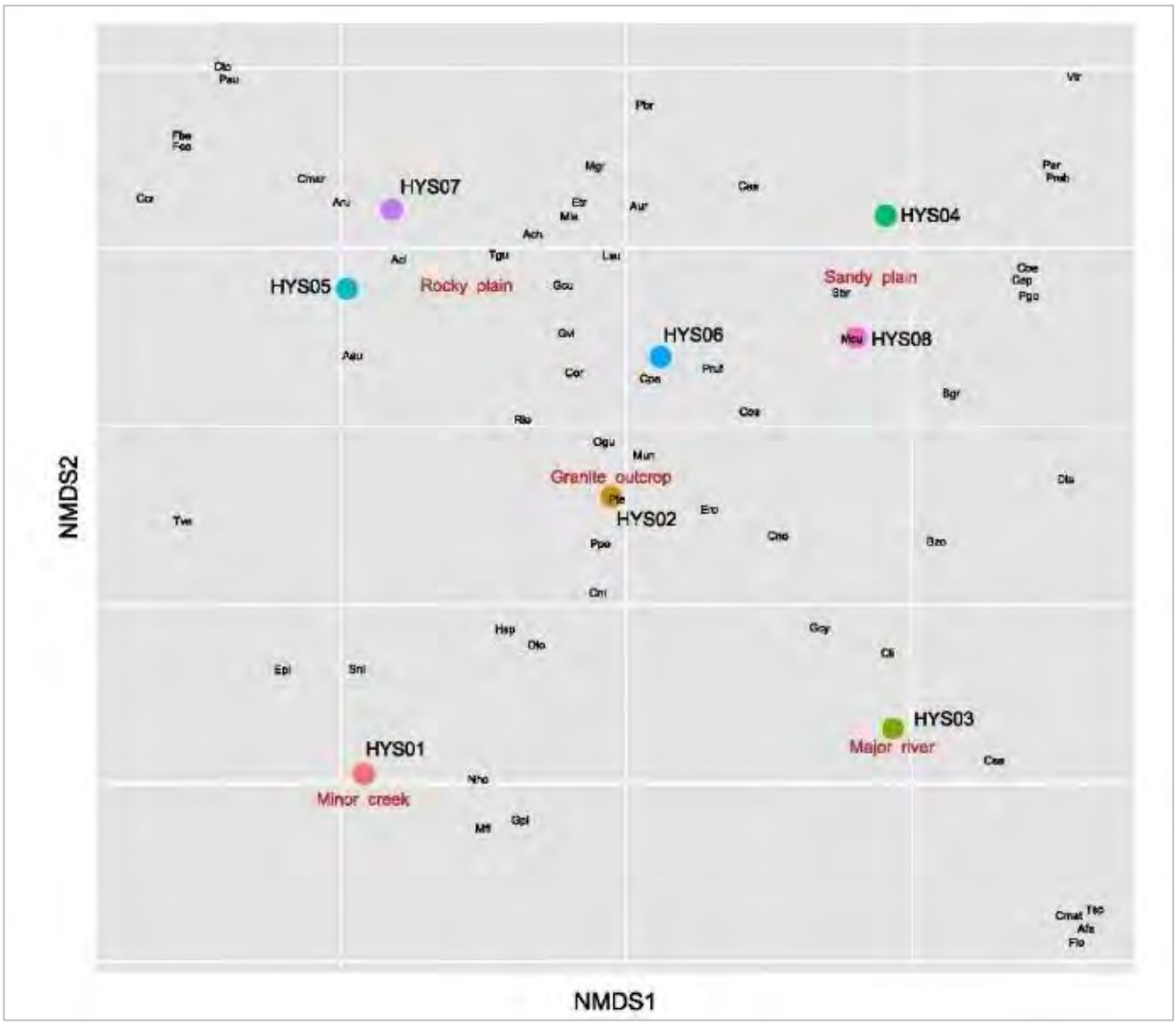

Figure 25: NMDS Birds

A habitat analysis was also undertaken for SRE invertebrate fauna using all data recorded from all eight systematic dry pitfall sites (HYS1-8) and from wet pitfall trapping sites (HYSRE1-10). **Figure 26** and **Figure 27** show the cluster and NMDS for SRE invertebrate fauna. Statistical analysis of SRE invertebrate fauna shows that most rocky plain sites are grouped together, meaning that similar invertebrate species were recorded from these habitat sites. However, SRE species recorded from minor creekline and the major river habitat sites were also similar to those captured at sites set-up within rocky plains. This may be due to the fact that drainage lines (major rivers and minor creeklines) are narrow and linear in shape and they border with rocky and sandy plain habitats. Invertebrate fauna species may be travelling across those habitats, impacting on the analysis by being trapped in different habitat. No invertebrate fauna species were recorded from site HYS2, which was within the granite outcrop habitat.

A group of sites were grouped together: HYSRE6 and HYSRE9 (minor creek), HYSRE3 and HYSRE5 (rocky plain) and HYSRE4 (sandy plain). HYSRE5 and HYSRE4 are within 180 m and 290 m, respectively, of a minor creekline.

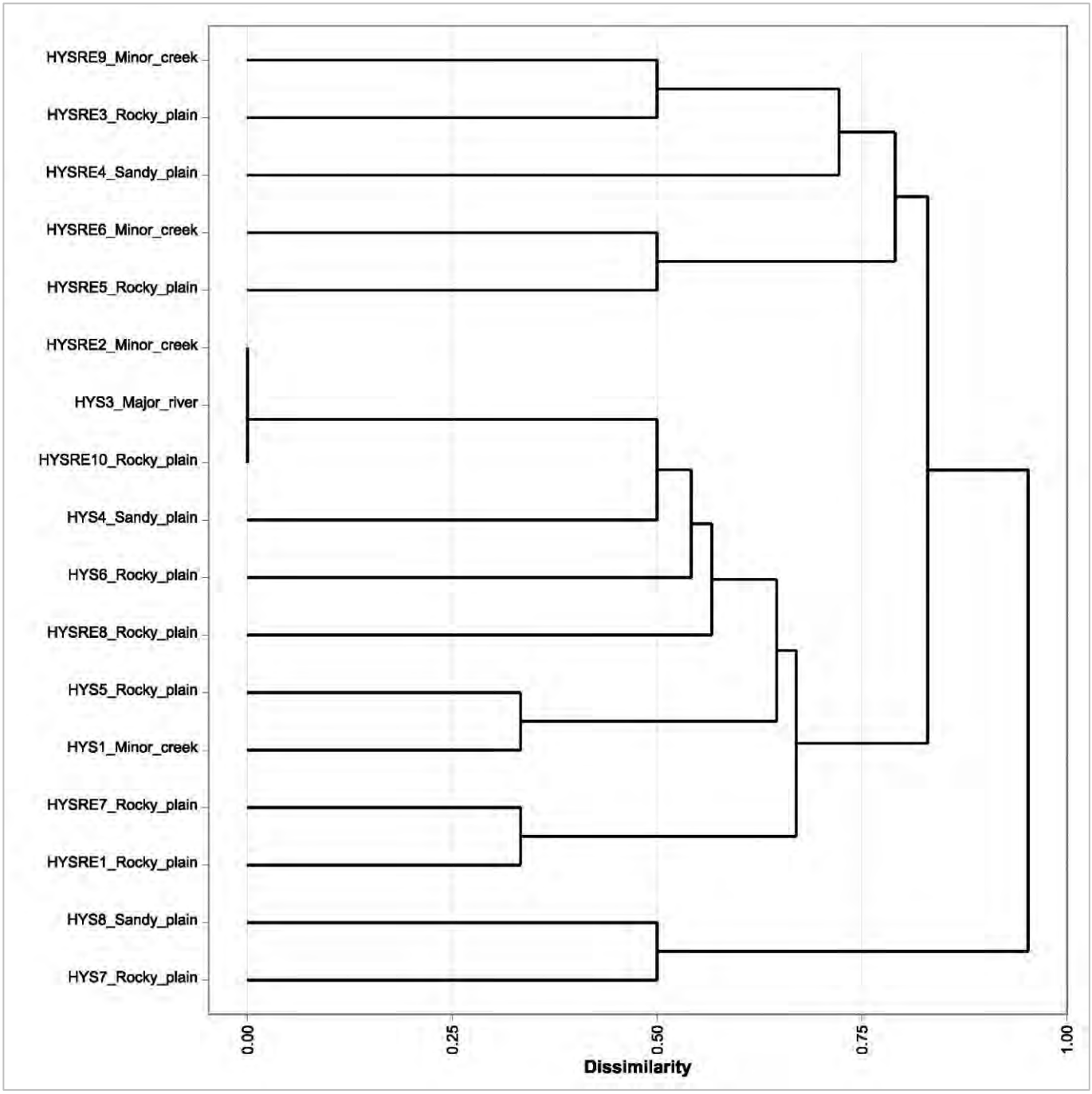

Figure 26: Cluster SRE invertebrate fauna

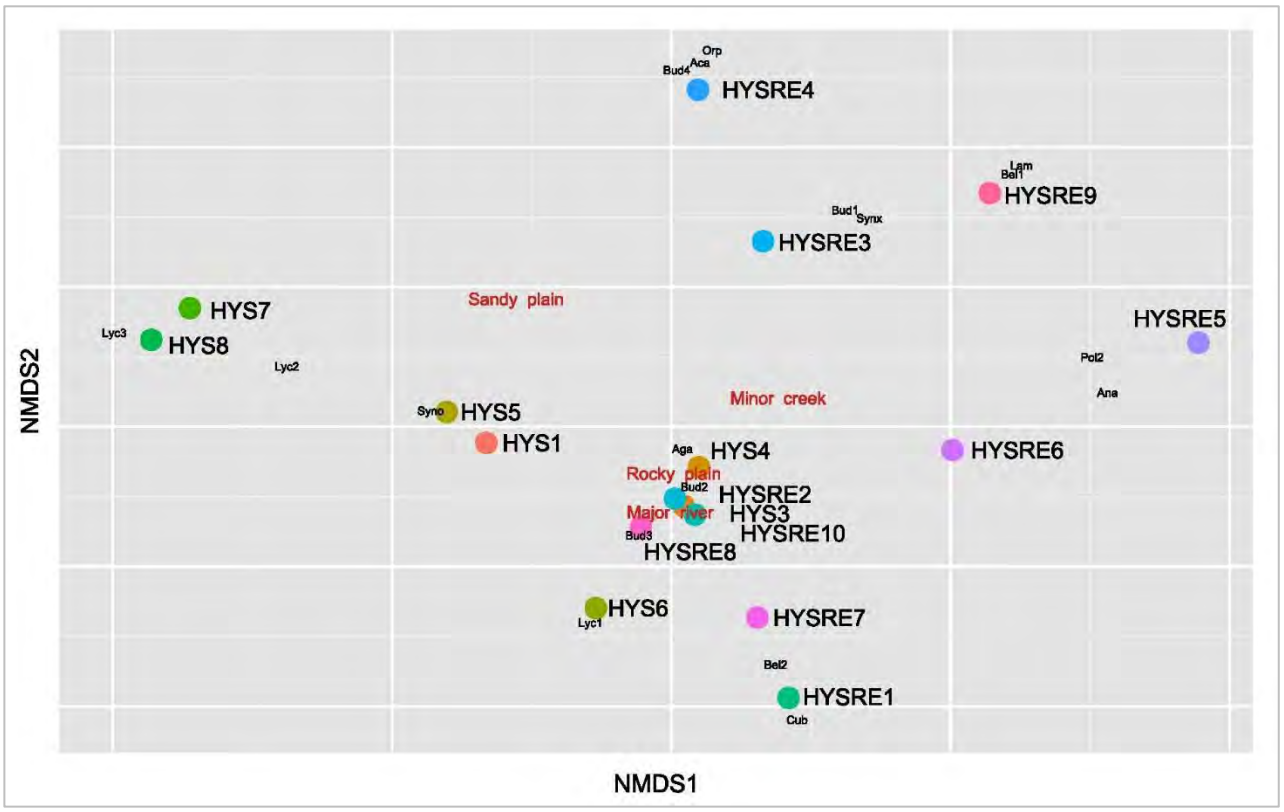

Figure 27: NMDS SRE Invertebrate fauna

4.4.2 Adequacy of Sampling

4.4.2.1 Vertebrate Fauna

To determine survey adequacy for terrestrial vertebrate fauna, all systematic (trapping) data was combined and opportunistic sightings excluded. **Table 17** lists the theoretical maximum number of species that occur at the study area. Two estimators were selected: Chao 1 and ACE Mean (estimators for abundance data). The average of the two estimators was then compared to the actual number of species trapped/recorded using systematic survey techniques (trap nights and repeated bird surveys). The overall number of recorded species was also compared to the estimated number which included all opportunistic sampling techniques and sightings.

Trappable fauna includes all captured species recorded from the systematic trapping sites over seven consecutive nights over two phases of surveying. The actual number of species trapped is n=34. The estimators (average) suggest that 36 species of trappable terrestrial fauna may occur in the study area. Overall, when combining the systematic survey techniques and opportunistic searches, a total of 40 species were recorded which also includes non-volant fauna such as the dog, feral cat, macropods (Red Kangaroo and Euro) and cattle which are not typically trappable. This indicates that the survey was adequate, however further trapping effort may have recorded additional species.

Table 17: Estimators for survey adequacy (Vertebrates)

ESTIMATES		TRAPPABLE FAUNA	BIRDS
S (est)		34	57
Estimators	Chao 1 Mean	36.14	64.19
	ACE Mean	39.51	63.95
	Average ACE, Chao, MMRuns	36.17	64.07
Actual Recorded at sites		34	57
Actual Recorded overall[#]		40	85

[#] Includes all sites and opportunistic sightings

For visualisation purposes, a diagram was created showing the analysis of the trapping results and the associated estimators as listed in **Table 17**. **Figure 28** shows a near asymptote of the species accumulation curve (SAC) which indicates that the majority of trappable mammal, reptile and amphibian species were recorded. The SAC for bird species is presented in **Figure 29**. It shows that a large proportion of potentially occurring bird species was recorded. The SAC is nearing an asymptote, however **Table 17** shows that the average of estimators suggest that an additional seven species may have been recorded if further sampling took place. When all sampling efforts are combined (systematic and opportunistic), a total of 85 species were recorded. This included sampling in habitats not sampled by systematic sites such as major rivers with water pools which usually attract a large number of bird species not occurring within other habitats.

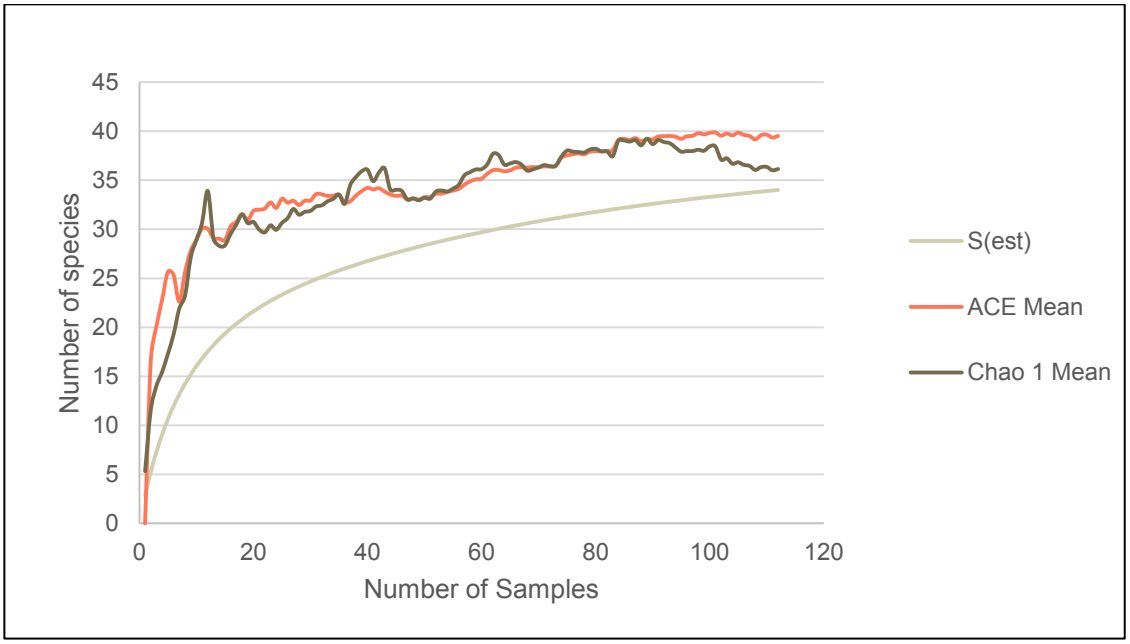

Figure 28: Species Accumulation Curve for Trappable Fauna

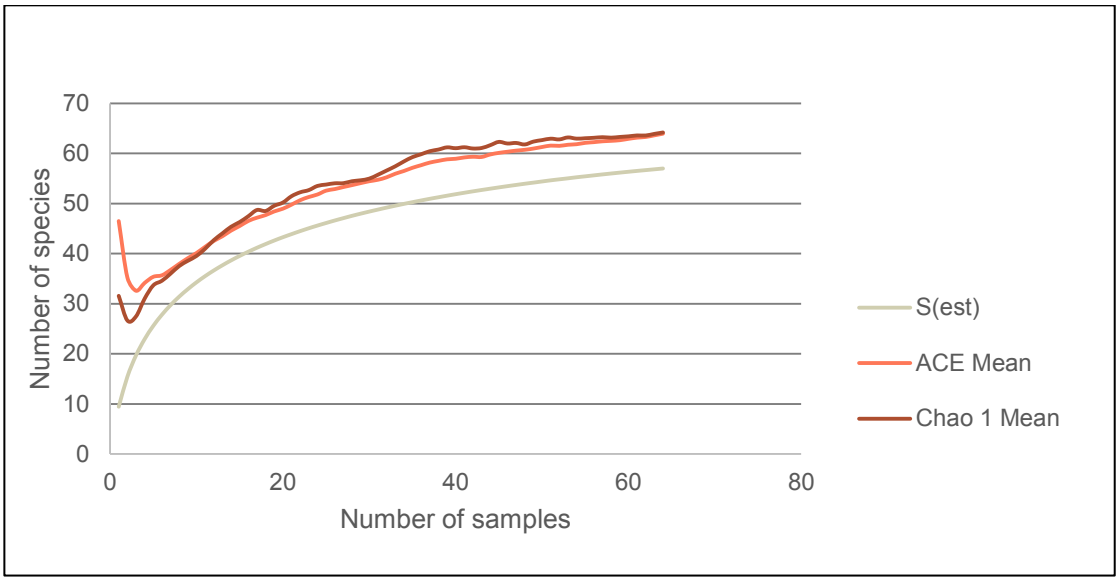

Figure 29: Species Accumulation Curve for Birds

4.4.2.2 Invertebrate Fauna

To determine survey adequacy for terrestrial invertebrate fauna, all systematic data was combined and opportunistic sightings excluded. Systematic data included samples retrieved from systematic vertebrate fauna dry pitfall traps (HYS1-8) over two phases, SRE wet pitfall trap sites and leaf litter collection sites.

The estimators ACE Mean and Chao Mean suggest that an additional 10 species could have been recorded with further sampling. The estimator ACE Mean suggests an additional 38 species that potentially occur, however the average of the two estimators indicate a total of 50 species may have been recorded if more sampling occurred (**Table 18**). Even when considering all sampling effort (including opportunistic sites), a total of 29 species of SRE invertebrate were recorded, which represents 57.5 % of the number of species (average of estimators) that are estimated to occur. However, only groups that are known to support SRE taxa were included in this analysis (e.g. millipedes, isopods) whereas groups not known to support SRE taxa (e.g. ants, mites) were excluded. A reliable taxonomic evaluation of these groups of SREs has begun only recently and thus the taxonomic knowledge relevant is relatively scarce.

Table 18: Estimators for survey adequacy (Invertebrates)

ESTIMATES		INVERTEBRATES
S (est)		26
Estimators	Chao 1 Mean	36.99
	ACE Mean	63.95
	Average Chao 1 and ACE Mean	50.47
Actual Recorded at sites		26
Actual Recorded overall[#]		29

[#] Includes all sites and opportunistic sightings

Figure 30 shows that the asymptote was not reached and additional species would have been collected with further sampling effort. Due to three species being recorded with a large number of specimens (*Buddelundia* sp. B58 n=557, *Buddelundia* sp. n=61, *Pupoides contrarius* n=130, Synxenidae sp. B08 n=100) the analysis resulted in a relatively flat curve and may have caused the high peaks of the MMRuns Mean curve (**Figure 30**).

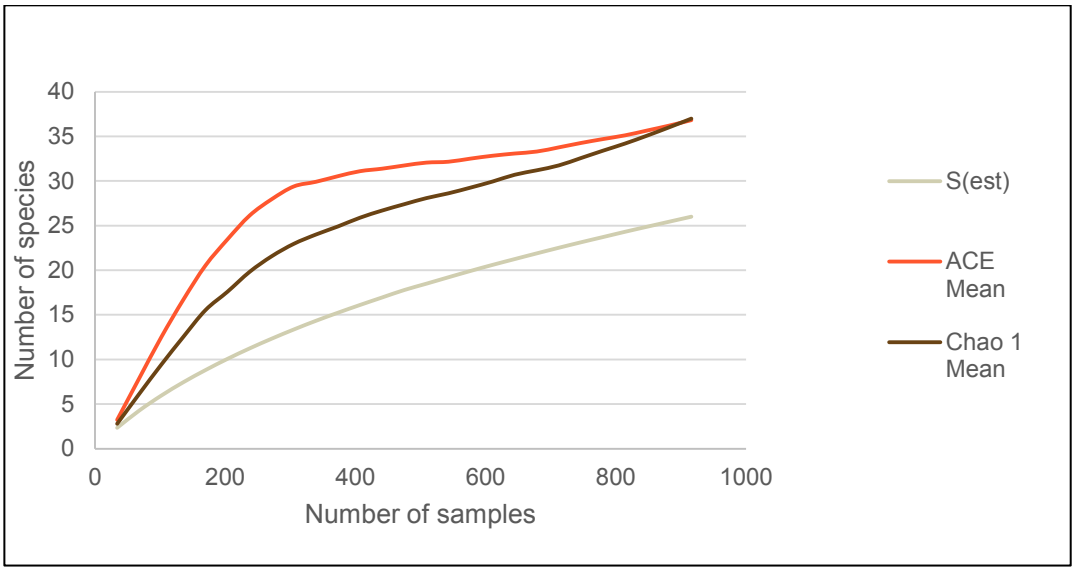

Figure 30: Species Accumulation Curve for Invertebrates

5.0 DISCUSSION

5.1 SIGNIFICANT VERTEBRATE FAUNA

No fauna species recorded in the study area is listed as Threatened under the *EPBC Act 1999*. Two species listed as EPBC Migratory were recorded during the survey: Eastern Great Egret (*Alba modesta*) and Rainbow Bee-eater (*Merops ornatus*). The WC Act listed Grey Falcon (*Falco hypoleucos*) was recorded from outside the study area. One species listed as Priority Fauna by DPaW was recorded during the second phase of surveying: Long-tailed Dunnart (*Sminthopsis longicaudata*, DPaW P4).

In addition to the species recorded, the likelihood of each species of conservation significant fauna to occur within the study area was assessed and summarised in **Appendix Seven**. A total of five species; three EPBC listed species, one species listed under the WC Act and one species listed by DPaW have a moderate to high likelihood to occur within the study area. These species are as follows:

- *EPBC Act 1999*:
    - Fork-tailed Swift (*Apus pacificus,* EPBC Migratory)
    - Eastern Great Egret (*Ardea modesta*, EPBC Migratory)
    - Yinnietharra Rock Dragon (*Ctenophorus yinnietharra*, EPBC Vulnerable)
- *WC Act 1950:*
    - Peregrine Falcon *(Falco peregrinus*, WC Act S7)
- DPaW:
    - Golden Gudgeon (*Hypseleotris aurea*, DPaW P2).

A further 11 species (eight EPBC listed, four DPaW listed species) have a low likelihood of occurrence. These species are described in further detail in **Appendix Eight.** These comprise:

- *EPBC Act 1999*:
    - Greater Bilby (*Macrotis lagotis,* EPBC Vulnerable)
    - Northern Quoll (*Dasyurus hallucatus,* EPBC Endangered)
    - Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia,* EPBC Vulnerable)
    - Ghost Bat (*Macroderma gigas*, EPBC Vulnerable)
    - Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*, EPBC Vulnerable)
    - Night Parrot (*Pezoporus occidentalis*, EPBC Endangered)
    - Common Greenshank (*Tringa nebularia*, EPBC Migratory)
    - Glossy Ibis (*Plegadis falcinellus*, EPBC Migratory)
- DPaW:
    - Brush-tailed Mulgara (*Dasycercus blythi,* DPaW P4)
    - Western Pebble-mound Mouse (*Pseudomys chapmani*, DPaW P4)
    - Blue-billed Duck *(Oxyura australis,* DPaW P4)

The species of moderate to high likelihood of occurrence as well as species recorded from the study area are discussed in the below sections. Species of low likelihood of occurrence are not discussed in further detail, however their description and ecological background data are listed in **Appendix Eight**.

5.1.1 Environment Protection and Biodiversity Conservation Act

Grey Falcon (*Falco hypoleucos*)

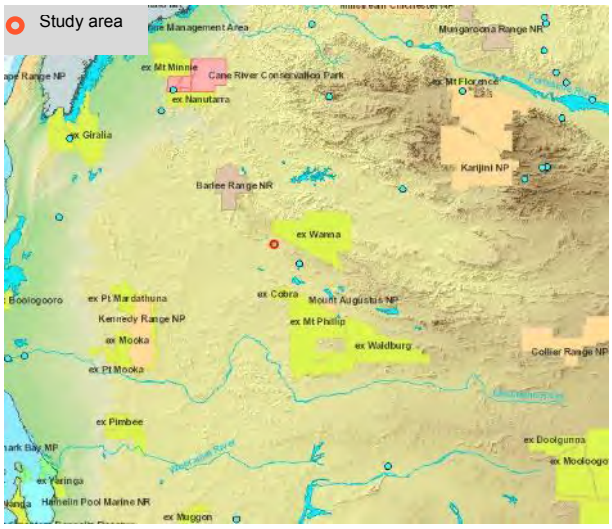

Figure 31: Regional records of the Grey Falcon (DPaW 2015a)

Conservation Status

WC Act Schedule 3, DPaW Vulnerable.

Distribution and Preferred Habitat

Grey Falcons are a rare, nomadic species sparsely distributed across much of arid and semi-arid Australia; the global population may be less than 1000 individuals (Debus 2012; Schoenjahn 2013), and sightings are very uncommon.

The species occurs in a wide variety of arid habitats including open woodlands and open acacia shrubland, hummock and tussock grasslands, low shrublands and may also be seen around swamps and waterholes that attract prey (Ehmann & Watson 2008). Grey Falcons once occurred across much of Western Australia, with sightings as far south as York and New Norcia during colonial times. The current distribution is now thought to be restricted to north of 26°S (Johnstone & Storr 1998), i.e. the latitude of Shark Bay and the SA-NT border. The distribution of the Grey Falcon is centred on inland drainage systems, and breeding locations lie within hot desert and grassland areas that are persistently dry or with winter drought, nearly always with annual rainfall <500 mm (Schoenjahn 2013).

Ecology

Grey Falcons feed on a wide variety of birds, but most often on ground-feeding parrots and pigeons; rodents are taken rarely, and records of other prey types (snakes, lizards, and large insects, e.g. Debus 2012). The Grey Falcon tolerates presence of other raptors, including all other Australian *Falco* species, at the same roosts and nesting in close proximity (Schoenjahn 2013). They use the nests of crows, kites or eagles, most often placed in upper branches of emergent eucalypts, often on a tree-lined watercourse, but also artificial structures such as microwave repeaters and powerline pylons; eggs are laid between July and October (Ehmann & Watson 2008; Olsen & Olsen 1986; Schoenjahn 2013). The decline in southern Australia may be partly due to effects of DDT on eggshell thickness reducing breeding success, and also replacement by the Peregrine Falcon which is favoured by increased abundance of Galahs and Feral Pigeons (Debus 2012).

Likelihood of Occurrence and Potential Impact

There are two records from 25- 33 km east of study area from 2003 and 2005 (DPaW 2015a; DPaW 2015b) (**Figure 31**) and additional records within 200 km from 2006 and 2010. The tree-lined major river but also open shrubland such as the rocky plain and sandy plain within the study area would provide suitable habitat for this species in which it may occur. Individuals were observed outside the study area on two occasions during the May 2015 phase (first phase), on Gifford Creek and Cobra Stations. Disturbance to large trees and cliff faces should be avoided or kept to a minimum as these may represent potential breeding sites.

Fork-tailed Swift *(Apus pacificus*)

Conservation Status

EPBC Act Migratory, WC Act Schedule 5.

Distribution and Preferred Habitat

In Australia they mostly occur over dry and open inland plains, but also over a wide variety of land and marine habitats. In Western Australia, the Fork-tailed Swift is considered uncommon to moderately common near the north-west, west and south-east coasts, common in the Kimberley and rare or scarce elsewhere (Johnstone & Storr 1998).

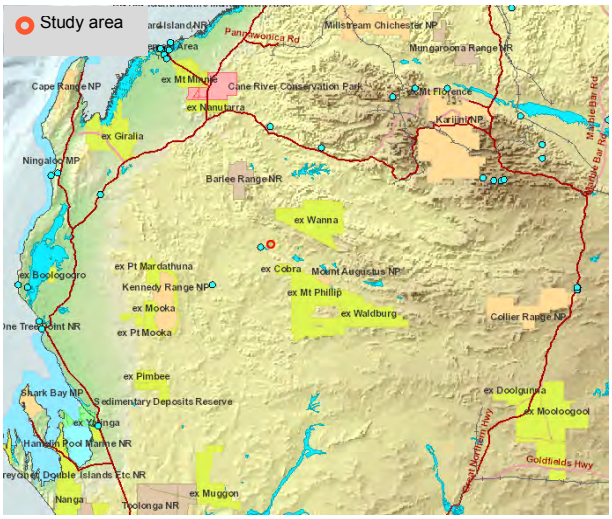

Figure 32: Regional records of the Fork-tailed Swift (DPaW 2015a)

Some birds have been sighted in Western Australia arriving from Indonesia between October toNovember. Flocks have been recorded near Broome on southward passage across the continent. In north and north-west Western Australia, most birds have departed by the end of April.

Ecology

A non-breeding visitor to all states and territories of Australia, this swift (Apodidae) feeds on flying insects and is almost exclusively aerial in habits, flying from less than 1 m to at least 300 m above ground and probably much higher (Simpson & Day 2004). Fork-tailed Swifts are nomadic and typically respond to broad-scale weather pattern changes. They are attracted to thunderstorms and cyclonic disturbances where they can be seen in flocks hawking insects from the storm fronts with numbers ranging from a few individuals to flocks of up to 2,000 birds.

Likelihood of Occurrence and Potential Impact

There are scattered records in the region with one record from 2009 from 13 km south-west of the study area (**Figure 32**). The species is therefore likely to occur intermittently in the study area as a seasonal visitor to forage, but is not expected to land or utilise the habitats within the study area. There are no significant threats to the Fork-tailed Swift in Australia (DSEWPaC 2012). No impact on this species is anticipated due to its highly nomadic and aerial lifestyle.

Eastern Great Egret (*Ardea modesta)*

Conservation Status

WC Act Schedule 5.

Distribution and Preferred Habitat

Eastern Great Egrets (Ardeidae) are widespread in Australia, occurring in a wide range of wetland habitats and breeding (November to April, depending on rainfall) in colonies in wooded and shrubby swamps (Johnstone & Storr 1998).

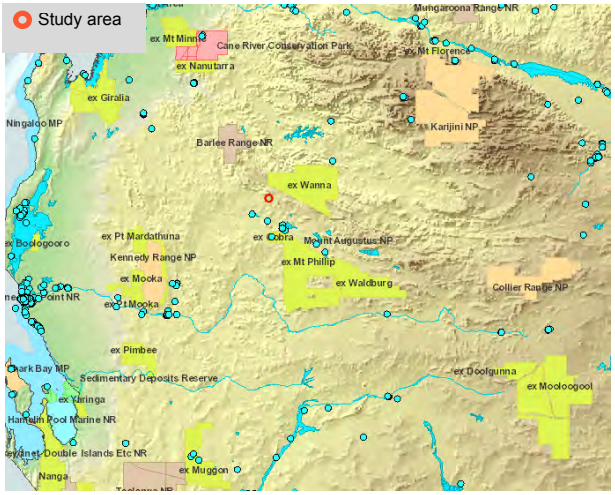

Figure 33: Regional records of the Eastern Great Egret (DPaW 2015a)

Ecology

Eastern Great Egrets feed on a wide range of invertebrates and small vertebrates including birds, reptiles and small mammals. The species undertakes some regular seasonal movements, mostly to and from breeding colonies, and towards the coast in the dry season. Regional differences in reporting rates suggest that individuals migrate north to winter in tropical northern Australia, consistent with changes in the availability of suitable wetland habitat. Regular migration to locations outside of Australia is suspected but not confirmed. Threats include loss and/or degradation of foraging and especially breeding habitat through alteration of water flows, drainage and/or clearing of wetlands for development, frequent burning of wetland vegetation used as nest sites, salinisation, and invasion by exotic plants or fishes (DSEWPaC 2012).

Likelihood of Occurrence and Potential Impact

The Eastern Great Egret was recorded from within the study area (Lyons River) during the survey. There are also numerous records from the Lyons River to the south of the study area (DPaW 2015b) and within 30 km of the study area as shown on NatureMap (DPaW 2015a) (**Figure 33**), and the species is considered likely to occur when surface water is present after sufficient rainfall. Minor impact on this species may occur through reduction of wet-season foraging area, but this is unlikely to be significant at the population level because of the large area of similar habitats available in the region.

Yinnietharra Rock Dragon
(Ctenophorus yinnietharra)

Conservation Status

EPBC Act Vulnerable, WC Act Schedule 3, DPaW Vulnerable.

Distribution and Preferred Habitat

The species was known from only two localities when first described. Currently the known distribution is still very limited, consisting of various sites separated by less than 30 km on both sides of the Gascoyne River on Yinnietharra Station, and another locality about 90 km to the northwest on Lyons River/Minnie Creek (Figure 34).

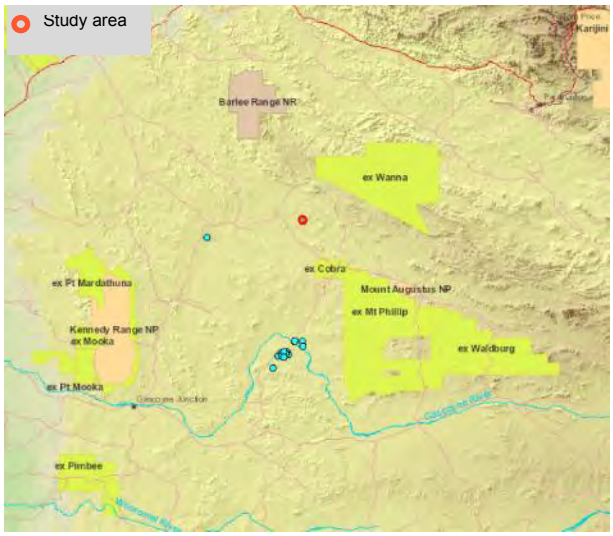

Figure 34: Regional records of the Yinnietharra Dragon (DPaW 2015a)

The Yinnietharra Dragon generally occurs in tall open shrubland inhabiting granite outcrops which can be separated by stony flats with sparse *Acacia* shrubs. The species also appears to be restricted to rocks of one origin: Archean gneissic biotite granites and granodiorite. Nearby outcrops of Early Proterozoic migmatite have been observed to be inhabited by a the much more common and widespread Ring-tailed Dragon *Ctenophorus caudicinctus* (Cogger *et al*. 1993). The Yinnietharra Dragon has been seen basking on low rocks and *Acacia* limbs (Wilson & Knowles 1988)." (DoE 2015b).

Ecology

The species has been observed running across gibber flats between granite outcrops and climbing stunted acacias. Individuals have also been recorded from beneath exfoliating granite and from burrows under granite boulders (Storr 1981).

Likelihood of Occurrence and Potential Impact

The Yangibana Project is about 45 km east along Lyons River from the Minnie Creek locality (50J, 360548mE, 7343648mN, *NatureMap* record), and about 70 km north of the nearest of the Gascoyne River localities (**Figure 34**). The study area includes outcropping rock units described as gneiss, biotite and granodiorite, which are mapped as Paleoproterozoic rather than Archaean, but as the association with Archaean granites was inferred from a small sample of localities, it may not be a valid generalisation. In addition, the level of knowledge and previous surveys in the region is very low and it is therefore considered reasonably likely that *C. yinnietharra* occurs in the study area; however, targeted searches within suitable habitat within the study area failed to record this species, whereas *C. caudicinctus* was frequently encountered. The lack of *C. yinnietharra* in the survey area might be due to the different geological age of the granites making them unsuitable as habitat for the species. If present, the level of impact on suitable habitats (granite outcrops) should be kept to a minimum or avoided. Granite outcrops were also recorded outside the proposed impact areas, in particular in the east of the study area, and therefore the impact is not expected to be significant on a regional scale.

The Level 2 survey effort to date is regarded as sufficient. A targeted survey would only be warranted if the development envelope was to change creating a larger impact on the relevant granites.

5.1.1.1 Wildlife Conservation Act 1950

Rainbow Bee-eater *(Merops ornatus)*

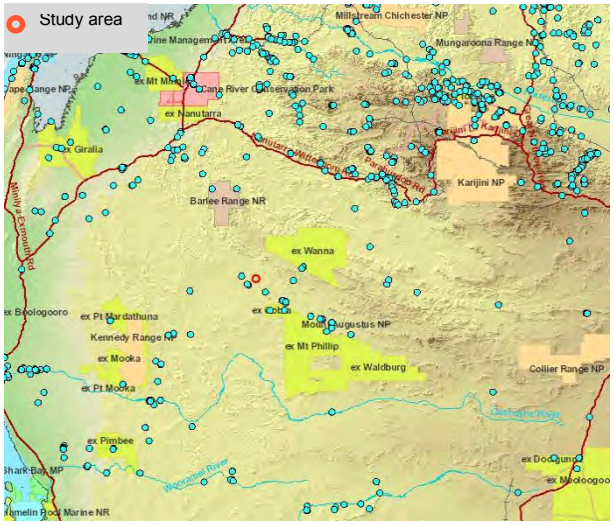

Figure 35: Regional records of the Rainbow Bee-eater (DPaW 2015a)

Conservation Status

WC Act Schedule 5.

Distribution and Preferred Habitat

The Rainbow Bee-eater is widespread throughout most of Australia with several records in the vicinity of the study area (Figure 35), and does not depend on any particular habitat or vegetation type for feeding or breeding. They are scarce to common throughout much of Western Australia except for the arid interior, preferring lightly wooded, sandy country near water (DSEWPaC 2012).

Ecology

Bee-eaters feed mainly on insects taken in flight (hawking), but also take prey from the ground and foliage (gleaning). Populations in southern Australia are migratory, wintering in Indonesia and New Guinea, moving south over summer and breeding in Australia, but the species is resident and present year-round in parts of northern Australia including the Pilbara (DSEWPaC 2012). Nesting occurs in burrows dug in flat or slightly sloping ground, sandy banks or cuttings, and often at the margins of roads or tracks; breeding is often colonial and cooperative (Boland 2004).

Likelihood of Occurrence and Potential Impact

Rainbow Bee-eaters were recorded during the survey from within the study area. Suitable foraging and breeding habitat is present in the form of major river systems and creeklines, in particular after rainfall events. The Rainbow Bee-eater is common throughout the region (**Figure 35**), with previous records from within the study area in 1978 and 2001 (DPaW 2015b) and the species is likely to utilise the major drainage lines as breeding and foraging habitat. The impact on the species by the proposed project is anticipated to be low due to its ability to utilise a variety of habitats and to move away from areas of disturbance.

Peregrine Falcon (*Falco peregrinus*)

Conservation Status

WC Act Schedule 7.

Distribution and Preferred Habitat

This species (Falconidae) is uncommon but wide-ranging throughout Australia, preferring areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land. Ledges, cliff faces, large tree hollows and spouts, electricity pylons and similar structures, or abandoned nests of other raptors are used for nesting (Debus 2012).

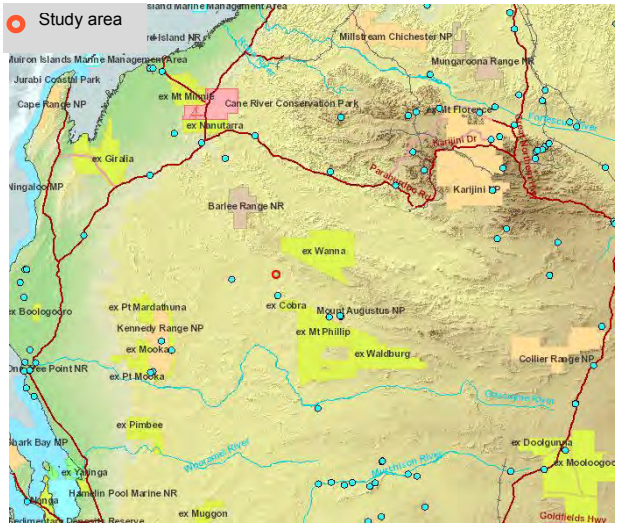

Figure 36: Regional records of the Peregrine Falcon (DPaW 2015a)

Ecology

The Peregrine Falcon feeds almost exclusively on birds (including pigeons, parrots and passerines) which are captured in flight, but rarely takes mammals (e.g. possums, rabbits), reptiles, fish or carrion (Debus 2012; Olsen *et al*. 2008). Eggshell thickness has returned to normal after the discontinuation of DDT use, but localised threats persist due to illegal persecution by pigeon-fanciers and taking of eggs and nestlings (Debus 2012).

Likelihood of Occurrence and Potential Impact

Individual Peregrine Falcons are occasionally sighted throughout the region (DEC 2012) and would certainly use the study area at least for foraging or may use the general area as part of a larger foraging range. Two individuals were sighted in 2000 and 2009 from 9 km south and 23 km west of the study area along major creeklines (DPaW 2015b) (**Figure 36**). Large trees along watercourses that may contain hollows, stick-nests of other raptor species (e.g. Nankeen Kestrel, Wedge-tailed Eagle), and ledges on steep faces of granite outcrops could provide suitable nesting sites. Impacts on adult individuals or foraging habitat are not likely to be significant, but destruction of tree hollows or existing nests of other birds could affect value of the habitat for breeding, especially if any are in use by this species. Impact is likely to be minor due to low density of population and ability to relocate to unaffected areas.

5.1.1.2 DPaW Priority Fauna

Long-tailed Dunnart *(Sminthopsis longicaudata)*

Conservation Status

DPaW Priority 4

Distribution and Preferred Habitat

This species of Dasyuridae is rare and patchily distributed in rocky areas of central Western Australia (Pilbara, Murchison, north-eastern Goldfields, Ashburton, and Gibson Desert regions) and a few sites in central southern Northern Territory, but at times it can be locally common. It is found in rocky scree and plateau areas, generally with little vegetation or of spinifex hummock grassland, shrubs, and open woodland (Burbidge et al. 2008)

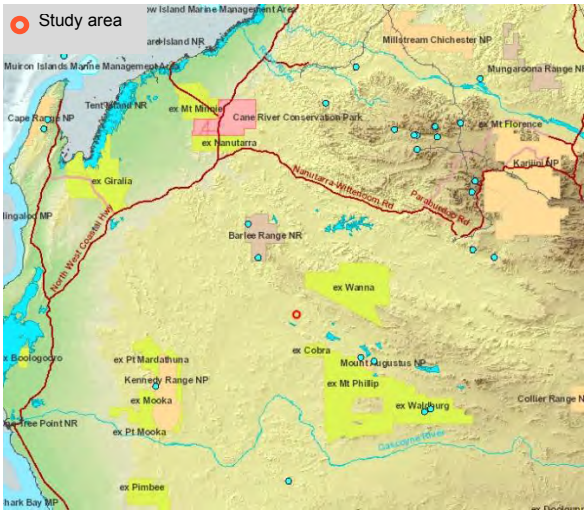

Figure 37: Regional records of the Long-tailed Dunnart (DPaW 2015a)

Ecology

This species is nocturnal, and its diet includes a variety of invertebrates. Females in captivity give birth to up to five young between the months of October and December (Pavey 2006b).

Likelihood of Occurrence and Potential Impact

The Long-tailed Dunnart was recorded from the study area. There are also records of this species in the vicinity with the closest record from 56 km south-east (in 1992) and from 66 km north-west (in 1994) of the study area (DPaW 2015a; DPaW 2015b) (**Figure 37**). The local population is expected to somewhat be impacted by the development of the project due to the loss of habitat, however the impact is relatively local and is not expected to not affect the species on a regional level. Due to the low detectability of the species and the low level of surveying (in particular for small sized mammals) in surrounding areas, additional populations are likely to exist outside the study area. This assumption is supported by the continuity of habitat in the region.

Golden Gudgeon *(Hypseleotris aurea*)

Conservation Status

DPaW Priority 2

Distribution and Preferred Habitat

The Golden Gudgeon (Eleotridae) was previously thought to be endemic to the Murchison River in Western Australia (Hoese & Allen 1983) but has subsequently been recorded from the Gascoyne (including Lyons), Wooramel, and Irwin River systems (Morgan & Gill 2004; NatureMap). Habitat is recorded as small, quiet pools with moderately turbid water and a boulder substratum with dead branches (Hoese & Allen 1983).

Figure 38: Regional records of the Golden Gudgeon (DPaW 2015a)

Ecology

Very little is known about the ecology of the Golden Gudgeon. The species is presumably tolerant to increased salinity and water temperature which typically occurs during the dry months (Allen *et al*. 2002).

Likelihood of Occurrence and Potential Impact

Potentially occurs in permanent pools of the Lyons River and larger tributaries (e.g. Edmund River), but the nearest known record is over 100 km downstream and the study area lies outside the currently known distribution (**Figure 38**). Other populations are only recently discovered, so further range extensions would not be surprising. Impacts are not expected to result from the proposed project, unless dewatering is anticipated which may impact on groundwater fed river pools. However, no significant impacts are expected.

5.2 SHORT RANGE ENDEMIC SPECIES

A total of 13 potential SRE species were recorded from the study area (three spiders, two scorpions, three pseudoscorpions, four isopods and one tropical centipede). Evaluation of the taxa and their SRE status is based on **Section 3.2.2** and is described below. The taxonomic report summarising the SRE results is shown in **Appendix Nine**.

Spiders (Araneae)

***Synothele* sp. B14**

Two adult males of the genus *Synothele* were recorded from two different sites (HYS5, HYSOP5). Taxonomic identification was not possible to species level as the genus is generally very diverse (Bennelongia 2016). The genus includes a number of species that remain undescribed and many are known to be SRE species with a range below 10,000km^2 (Ecologia 2014a; ecologia 2010a). This species is therefore considered a potential SRE. Its exact range is unknown.

***Aganippe* sp. 21**

Two adult male *Aganippe* sp. individuals were collected from two sites (HYSOP4, HYS4) which were located within a minor drainage line adjacent to sandy plain and rocky plain habitat. This species is known to be highly diverse at species level and occurs throughout WA. A recent molecular analysis identified many species with high regional endemism (Bennelongia 2016). Taxonomists who undertook the identification suggested DNA barcoding for this species to recognise the two females from the study area as a new species (Bennelongia 2016). Until further taxonomic work is completed, the species is therefore considered a potential SRE.

***Aname* sp. B19**

Aname sp. B19 was recorded from two locations. Due to the specimens being juveniles, identification to species level was not possible. The individuals were recorded from the minor drainage line and rocky plain habitat, both of which are widespread in the area and not unique to the study area. The species may be widespread, however due to lack of taxonomic information, the precautionary principle requires that this species (represented by only collected juveniles) is considered a potential SRE (Bennelongia 2016).

Scorpions (Scorpiones)

***Lychas* 'hairy tail group' and *Lychas* 'multipunctatus group'**

Each taxa of Scorpion was recorded from only one location during the survey (*Lychas* 'hairy tail group' site HYS6; *Lychas* 'multipunctatus group' site HYS8). Site HYS6 was set-up within the rocky plain habitat whereas site HYS8 was installed in the sandy habitat. The two habitats are considered common and widespread in the region. However, due to a lack of taxonomic information, it is thought that at least some taxa of this species complex have a short range and therefore the taxa are considered potential SRE. An additional three specimens of Scorpion were collected which could not be attributed to either group, however it is likely that the specimens belong to one of the groups of the *Lychas* taxa recorded, and would not represent a separate morph-species (Bennelongia 2016). The precautionary principle requires that the specimens are also considered to be potential SRE species.

Pseudoscorpions (Pseudoscorpiones)

***Beierolpium* 8/2**

A single specimen of the species *Beierolpium* 8/2 was recorded from two locations, sites HYSL6 and HYSRE9, which was within the sandy plain and minor drainage line habitat. The species has been reported from several surveys throughout Western Australia and the understanding is that it is not considered an SRE (Biologic 2015; Phoenix 2010), however the systematics of members of this genus has not been established adequately and it is not possible to confirm its identity until a complete systematic revision of the genus *Beierolpium* in Western Australian has been undertaken (ecologia 2010a, K. M. Abrams, WA Museum, 2015 pers. comm.). The species is considered a potential SRE until a taxonomic revision has been completed.

***Beierolpium* 8/3**

Beierolpium 8/3 has been reported to occur throughout Western Australia, however as mentioned above, the taxonomy of the genus requires revision to identify the status of each species appropriately (ecologia 2014b, K. M. Abrams, WA Museum, 2015 pers. comm.). Due to the uncertain identification the specimen collected, *Beierolpium* 8/3 is considered a potential SRE until molecular work has been completed.

***Linnaeolpium* sp. B04**

One adult male was recorded from a leaf litter site (HYSL5). The only described species in this genus was recorded from subterranean habitats in the Pilbara region and is known to be a confirmed SRE species (Bennelongia 2016). The specimen recorded from the study area is considered a potential SRE based on current knowledge.

Slater (Isopoda)

***Acanthodillo* sp. B16**

A single individual of *Acanthodillo* sp. B16 was recorded from site HYSRE4. The genus *Acanthodillo* has been reported to be of no conservation concern (ecologia 2010b; ecologia 2011) as well as having the potential to include SRE species (Bennelongia Environmental Consultants 2012). The current record from the study area was made from a site within the sandy plain habitat which is relatively common in the area and not thought to be restricted. Slater are known to have generally short ranges and limited dispersal abilities (Bennelongia 2016). Due to the lack of knowledge about the taxon's distribution and biology, the precautionary principle requires therefore that this taxon is considered a potential SRE.

***Buddelundia* sp. B59 and *Buddelundia* sp. B60**

Two specimens were recorded as *Buddelundia* sp. B59 from two different sites: one wet pitfall site (HYSRE8) and one opportunistic site (HYSOP1) which were established on the rocky plain and in granite outcrop habitats, respectively. An additional four specimens were identified as *Buddelundia* sp. B60 which were all collected from one wet pitfall site (HYSRE4) which was established in the sandy plain habitat. None of these habitats are particularly restricted and are thought to occur throughout the region. Granite outcrops may be limited to isolated patches, however the species *Buddelundia* sp. B59 was also recorded from other habitats. The genus *Buddelundia* has been recorded frequently from across Western Australia (Bennelongia 2012; Biologic 2015; ecologia 2007), however some species of this genus are regarded as widespread whereas others are considered confirmed SRE species (Ecologia 2014c). At this stage, the information available is not sufficient to determine the status of this taxa (Bennelongia 2016). For this reason *Buddelundia* sp. B59 and *Buddelundia* sp. 60 are considered a potential SRE species.

***Cubaris* sp. B07**

Two male individuals of *Cubaris* sp. B07 were recorded from one wet pitfall site (HYSRE1) from the rocky plain habitat which is widespread in the region. Taxa of the genus *Cubaris* are often found in low numbers (Bennelongia 2012) with species known to have limited dispersal capacities. A review of the Australian family Armadillidae is needed to resolve taxonomy and status (Ecologia 2014d). Due to the lack of information on the species, *Cubaris* sp. B07 is considered a potential SRE (Bennelongia 2016).

Tropical Centipede (Scolopendromorpha)

***Cryptops* sp. B46**

A single specimen was collected at an opportunistic site (HYSOP1). There is no taxonomic framework for this family in Western Australia and knowledge is very limited (Bennelongia 2016). The family is most likely widespread with a wide distribution, however at least some taxa of the genus *Cryptops* are thought to be potential SRE species. Following the precautionary principle, *Cryptops* sp. B46 is considered a potential SRE (Bennelongia 2016).

5.1 SIGNIFICANT FAUNA HABITATS

None of the fauna habitat types recorded from the study area were exclusive to the area. They all occur in the wider region. Two of the five recorded habitats are considered somewhat more vulnerable to impacts from the proposed project, due to the reasons described below.

The major river habitat type harbours a variety of fauna species after the occurrence of rainfall events and has the potential to support a number of conservation significant species such as breeding sites for Grey Falcons (EPBC Act Vu) but also foraging habitat for Migratory bird species (EPBC Act listed) such as the Eastern Great Egret and Rainbow Bee-eater. It is potentially the most susceptible habitat type to impacts from clearing and mining activities, but is also vulnerable to the effects of fire due to the long growing and recovery time associated with the large trees present therein (Hankins 2013; Radford *et al*. 2008).

Minor creeklines and major rivers are the most suitable habitats for invertebrate SRE fauna due to the increased moisture and shade provided by a relatively dense shrub layer and associated leaf and wood litter. Scorpions from the families Urodacidae and Buthidae often construct their burrows in softer substrates found along river beds and creeklines (Koch 1978, 1981). Snails, isopods, pseudoscorpions and millipedes often burrow into the soil and litter around the base of shrubs and trees found in this habitat type to escape desiccation (Black 1997; Harvey 1996; Lewis 1998; Slack-Smith 2006)

5.2 SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in **Table 19**. Given the few limitations encountered, it can be confirmed, an adequate level of survey has been undertaken.

Table 19: Survey limitations

POSSIBLE LIMITATIONS	CONSTRAINTS (YES/NO); SIGNIFICANT, MODERATE OR NEGLIGIBLE	COMMENTS
Competency/experience of the consultant carrying out the survey	No constraints	All survey staff have relevant recent experience surveying in a number of bioregions including Murchison, Gascoyne, Pilbara and the Wheatbelt regions.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions)	No constraints	Sampling techniques were deemed adequate and sufficient. The majority of faunal groups were sampled and no constrains were experienced.
Proportion of fauna identified, recorded and/or collected	No constraints	All vertebrate fauna individuals were identified in the field. Where further identification was necessary, the individuals were taken back to camp, identified and released within 24 hours of capture. All fauna was released at the point of capture. Invertebrate fauna was collected, kept cool and euthanised in ethanol and submitted to external taxonomists for identification. Species accumulation curves revealed that the majority of vertebrate fauna and invertebrate fauna was sampled during the current survey, however further sampling would have recorded additional species.

POSSIBLE LIMITATIONS	CONSTRAINTS (YES/NO); SIGNIFICANT, MODERATE OR NEGLIGIBLE	COMMENTS
Sources of information (historic/recent or new data)	Moderate	A very limited number of surveys have been undertaken previously in the region (within 200 km of the study area) which results in a limited knowledge of the faunal assemblage of the area. Database search results were consulted in the most thorough manner possible (multiple centre-point searches) and assisted in the assessment of fauna values on a regional level.
Proportion of the task achieved and further work that may need to be undertaken	No constraints	The level of surveying required was assessed to be a Level 2 fauna survey. All components of a Level 2 survey were completed with a total of eight systematic trapping sites, 15 opportunistic foraging sites for vertebrate and SRE fauna, 18 birding sites, 15 SM2 bat recorder sites, ten SRE wet pitfall sites and 14 leaf litter collection sites and ten additional avian sites.
Timing/weather/season/cycle	Negligible	The first phase of surveying was delayed due to ongoing heavy rainfall events. The survey was conducted during autumn, with relatively low night time temperatures and therefore reptile activity and consequently detection rates were low. However, across both phases, the survey was conducted during optimal seasonal conditions for all fauna groups.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention)	Negligible	See above. Rainfall events in early autumn resulted in the delay of phase one of surveying, however sampling was sufficient and phase two of surveying was completed during optimal survey timing.
Intensity of survey	No constraints	Level 2 surveys are the most intensive survey type in accordance with EPA, OEPA and DPaW guidance. A two phase Level 2 assessment was carried out and was appropriate for the project.
Completeness (e.g. was relevant area fully surveyed)	No constraints	All representative habitat types were sampled adequately. Some access restriction existed, however this is not expected to have impacted the completeness of sampling as all habitats in accessible areas were surveyed in detail.
Resources (e.g. degree of expertise available for species identification)	Negligible	All vertebrate fauna was identified in the field. Invertebrate SRE fauna was submitted to external taxonomists who experienced some issues in the liaison with WA Museum staff and collection. However, these issues had a negligible impact on the final results.
Remoteness and/or access problems	No constraints	Access restrictions were only partly experienced and all representative habitat types were sampled adequately. Remoteness and access problems are not expected to have impacted the completeness of sampling.

POSSIBLE LIMITATIONS	CONSTRAINTS (YES/NO); SIGNIFICANT, MODERATE OR NEGLIGIBLE	COMMENTS
Availability of contextual (e.g. bioregional) information for the study area	Negligible	Although slightly less than for other more well-surveyed regions, the level of biogeographic information available is considered adequate.

6.0 SUMMARY AND CONCLUSIONS

The key results and conclusions of the two phase Level 2 terrestrial vertebrate fauna and SRE invertebrate fauna survey of the Yangibana project area are as follows:

- The study area lies within a region that has not been studied in great detail in regards to vertebrate and invertebrate fauna. A total of three previous survey reports have been consulted from studies conducted within 350 km of the Yangibana site. In addition, the thorough desktop study included eight database searches with different centre-points which were conducted to increase the knowledge of the potential fauna assemblage and its values.
- Eight systematic trapping sites were set-up over seven consecutive nights (resulting in 4,144 trap nights) and 10 SRE wet pitfall sites were installed. In addition, 15 foraging sites, 10 motion camera sites and 14 leaf litter collection sites (42 samples) were established. In addition to birding and bat recording at the systematic trapping sites, 10 further bird survey sites and seven bat recorder sites were established.
- The desktop assessment has identified a total of 425 species as potentially occurring within the study area: 56 mammal species, 189 birds, 141 reptiles, nine fish and 14 amphibians. Of these, 35 species are of conservation significance (eight mammals, 13 birds, two reptiles, two fish). Of these, 13 species are listed under the EPBC Act (five mammals, seven birds, one reptiles).
- A total of 134 species were recorded from the study area which consist of 20 species of mammal (12 species of non-volant mammals, eight species of bat), 85 species of bird, 25 species of reptile and four species of amphibian.
- Four species of conservation significance were recorded during the survey (Rainbow Bee-eater (*Merops ornatus*, WC Act Schedule 5), Eastern Great Egret (*Ardea modesta*, WC Act Schedule 5), Grey Falcon (*Falco hypoleuca*, WC Act Schedule 3) and Long-tailed Dunnart (*Sminthopsis longicaudata*, DPaW P4) of which one species (Grey Falcon) was recorded outside the study area. It is not considered that any of these species will be impacted on a local or regional level by the project.
- A total of 27 species of terrestrial invertebrate fauna were recorded from groups that potentially support SRE species. Of these, 13 species are considered potential SREs. The recorded number of SRE species is largely due to the fact that SREs are dominated by invertebrate species which are historically understudied and in many cases, lack formal descriptions. A reliable taxonomic evaluation of these species has begun only recently and thus the availability of literature relevant to SREs is relatively scarce. The precautionary principle therefore requires that where there are information gaps, species are considered potential SREs.
- None of the conservation significant terrestrial vertebrate fauna species or SRE invertebrate species are anticipated to be impacted on a regional scale by the project. It is expected that some individuals will be impacted, however significant impacts are not expected.
- *Ctenophorus yinnietharra* was not recorded in the study area. We are unable to unequivocally state that the species does not occur in the study area because the current knowledge of the species is limited and a precautionary principle is recommended. However, the Level 2 survey effort to date is regarded as sufficient to detect the presence of this species. A targeted survey would only be warranted if the development envelope is modified creating a larger impact on the granites with which the species is associated.
- During the survey, five broad habitat types were identified and mapped within the Yangibana study area. All habitats occur in the regional area and are not unique to the study area. The most restricted habitat types identified are the granite outcrops (4.7 % of the study area) and the major rivers (3.5 % of the study area). The major river and minor creeklines are the most susceptible

habitat types to impacts from clearing and mining activities, but are also vulnerable to the effects of fire due to the long growing and recovery time associated with the large trees present therein.

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MAPS

405000 410000 415000 420000 425000 430000 435000

7370000 7365000 7360000 7355000 7350000 7345000

EDMUND

EDMUND RIVER

ULLAWARRA ROAD

LYONS RIVER

COBRA GIFFORD CREEK ROAD

Edmund

Mount Phillips

A1 A3ti W/A3 C1/PLgpi PLgpi Rk W A A3ti C1/PLgpi PLgpi PLgdi Rg A3ti A3/PLgpi Rg/PLgpi A1/Rk A3ti/Rk W/Rk PLgynx PLgpix PLls PLgyn W/A3ti A2 A3 C1tss _R-k _C1-t-ss

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

- Homesteads
- Roads
- Rivers
- Geological Survey of WA (GSWA) 1:100,000 Geological Map Sheet Boundaries
- Survey Area

GSWA 1:100,000 Geological Map*

Edmund Sheet

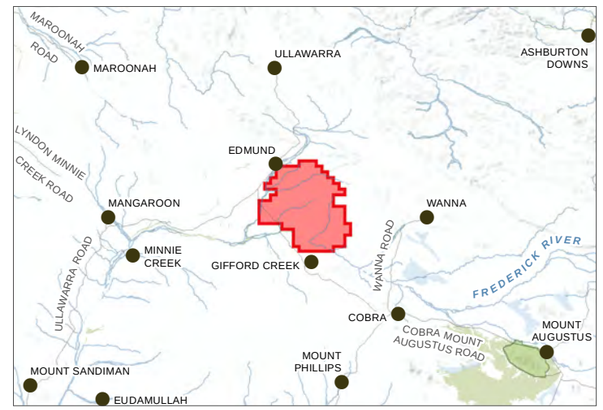
- C
- C1
- A1f
- PLgpit
- C1tss
- PLMEi
- PLgpi
- W/A3
- A
- Rk/PLgpi
- PLMEy
- A1c
- W/PLgpi
- C1q
- Rg/PLgpi
- PLge
- PLgyn
- A3ti/PLgpi
- PLMEd
- PLgdi
- A3ti
- A3ti/Rk
- L
- A3/PLgpi
- Rk
- PLgynx
- A3ti/PLgyn
- C1/Rk
- A3ti/Rg
- Rg
- W/A3ti
- A1/Rk
- A3
- Rf
- PLd12
- PLgpix
- PLls
- PLngo
- W
- W/Rk
- A2
- A2/Rk
- PLu
- C1/PLgpi
- C1f
- A1
- A3/Rk
- PLMEk
- PLgto

Mount Phillips Sheet

- P_-DUyn-gmi
- P_-MEk-sf
- P_-MOgo-mgn
- P_-PO-mtsf
- _A1
- _A1-cb
- _A1c
- _A2
- _Ad
- _C1-t-ss
- _R-k
- _W

* Data and symbology downloaded from Department of Mines and Petroleum http://geodownloads.dmp.wa.gov.au/datacentre/datacentreDb.asp

OVERVIEW



ecoscape

AUTHOR: CP/JN REVIEWED: SB
DATE: MAR-15 PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

GEOLOGY

MAP 1

SCALE 1:115,000 @ A3

0 1 2 3 4 5 km

405000 410000 415000 420000 425000 430000 435000

7370000 7365000 7360000 7355000 7350000 7345000

EDMUND

EDMUND RIVER

ULLAWARRA ROAD

COBRA GIFFORD CREEK ROAD

LYONS RIVER

Ph Na Du Na Ja Yi Jm Jm Na Ja Au Na Co Ph Jm Au Ag Ag Ph Gb Na Gb Au Na Au Na Au Na Ga Ph Ph Na Na Du Ph Na Au

LEGEND

- Homesteads
- Roads
- Rivers
- Creeks
- Survey Area

Project Tenements

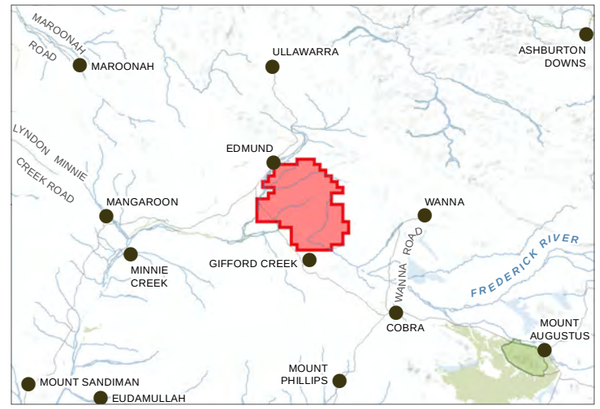
Type

- General Purpose Lease
- Mining Lease
- Miscellaneous Lease
- Proposed Infrastructure

Land Systems (DAFWA, 2012)

- Agamemnon System (Ag): Rocky hills, with peaks and ridges above extensive stony slopes, supporting scattered tall shrublands of mulga and other acacias.
- Augustus System (Au): Rugged ranges, hills, ridges and plateaux with skeletal soils supporting mulga and other acacia shrublands in southern parts or hard spinifex grasslands in northern parts.
- Collier System (Co): Undulating stony uplands, low hills, ridges, stony plains and drainage floors supporting mulga shrublands and some spinifex.
- Durlacher System (Du): Stony plains, lower tributary drainage plains and low stony rises, supporting scattered tall shrublands of mulga, other acacias and chenopod low shrubs.
- Gascoyne System (Ga): River channels and associated narrow alluvial plains and inclusions, supporting river redgum fringing woodlands, also mulga and other acacias, Senna spp. and buffel grass.
- Glenburgh System (Gb): Rugged granite hills, stony uplands and lower plains supporting scattered tall shrublands of mulga and other acacias.
- James System (Jm): Low hills, ridges and tors of granite and quartz, with stony lower plains, rises and drainage floors, supporting scattered tall shrublands of mulga and other acacias.
- Jamindie System (Ja): Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey.
- Nadarra System (Na): Plains and calcrete rises with chenopod shrublands and hard spinifex grasslands.
- Phillips System (Ph): Low hills and undulating uplands on gneiss and quartz supporting mulga and other acacia tall shrublands.
- Yinnietharra System (Yi): Scattered granite tors and domes above stony slopes, broad sandy plains with groved vegetation and wide drainage tracts; supporting tall shrublands of mulga and other acacias.

OVERVIEW



ecoscape

AUTHOR: CP/JN REVIEWED: SB
DATE: NOV-16 PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

LAND SYSTEMS

MAP 2

SCALE 1:110,000 @ A3

0 1 2 3 4 5 km

GDA 1994 MGA Zone 50

405000 410000 415000 420000 425000 430000 435000

7370000 7365000 7360000 7355000 7350000 7345000

EDMUND

EDMUND RIVER

ULLAWARRA ROAD

COBRA GIFFORD CREEK ROAD

LYONS RIVER

Ashburton

Augustus

18 181 165 166 29

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

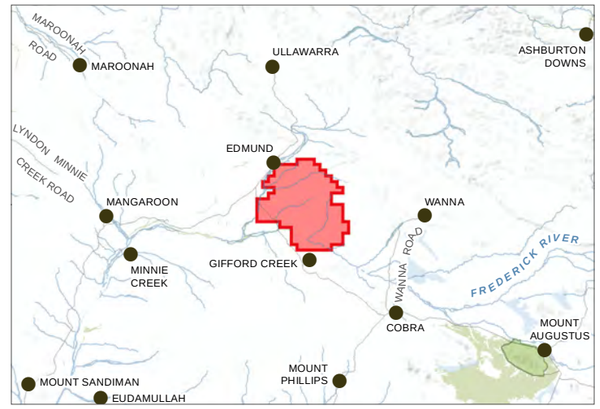
- Homesteads
- Roads
- Rivers
- Creeks
- Survey Area
- IBRA 7 Subregions

Beard Pre-European Vegetation (DAFWA 2012)

Vegetation Association

- 18: Low woodland; mulga (*Acacia aneura*)
- 29: Sparse low woodland; mulga, discontinuous in scattered groups
- 165: Low woodland; mulga and snakewood (*Acacia eremaea*)
- 166: Low woodland; mulga and *Acacia victoriae*
- 181: Shrublands; mulga and snakewood scrub

OVERVIEW



ecoscape

AUTHOR: CP/JN REVIEWED: SB
DATE: MAR-15 PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

PRE EUROPEAN VEGETATION

MAP 3

SCALE 1:110,000 @ A3

0 1 2 3 4 5 km

350000
400000
450000
7400000
7350000
7300000

MAROONAH ROAD
MAROONAH
YANNARIE RIVER
HENRY RIVER
GUM CREEK
WILE-COOEBING
ULLAWARRA
MOKKOBOGGANOONA
MINTHANNA
ASHBURTON RIVER
IRREGULLY CREEK
MUNTHARRA TABLETOP
MINNIERRA RANGE
WHITE CLIFFS
BARLEE RANGE
EDMUND RIVER
HIGH RANGE
COOLINGBAH OUTCAMP
ALMA OUTCAMP
EDMUND
LYNDON MINNIE CREEK ROAD
BLACK RANGE
MANGAROON
OAKEY ROCK
LYONS RIVER
WANNA
WANNA ROAD
KOORABOOKA CREEK
MINNIE CREEK
MINNIE CREEK BIG MINNIE CREEK
SEVENTEEN MILE OUTCAMP
GIFFORD CREEK
COBRA GIFFORD CREEK ROAD
PILBARA
FREDERICK RIVER
PEEDAWARRA FLAT
COBRA
BANGEMALL
COBRA MOUNT AUGUSTUS ROAD
MOUNT AUGUSTUS
MOUNT AUGUSTUS NATIONAL PARK
ULLAWARRA ROAD
CALBRAJACKA CREEK
EUDAMULLAH ROAD
MOUNT SANDIMAN
EUDAMULLAH
ONSLOW CREEK
THIRTY ONE RIVER
MORRISSEY CREEK
HOUSE CREEK
MOUNT PHILLIPS
THOMAS RIVER
MOUNT AUGUSTUS ROAD
LANDOR
LOCKIER RANGE
CAIRN MINING CENTRE
MORRISSEY HILL MINING CENTRE
THIRTY THREE RIVER

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA

GDA 1994 MGA Zone 50

LEGEND

- Homesteads
- Place Names
- Minor Road
- Track
- Rivers
- Flats/Indundation areas
- DPaW databases search area
- Survey Area

DPaW Communities Database

Priority 1 Ecological Community

- Gifford Creek calcrete groundwater assemblage type on Lyons palaeodrainage
- National Parks

DPaW Fauna Database Search

Threatened (EPBC Act, WC Act)

- Ghost Bat (VU, S3)
- Pilbara Leafnosed-bat (VU, S3)
- Yinnietharra Rock Dragon (VU, S3)

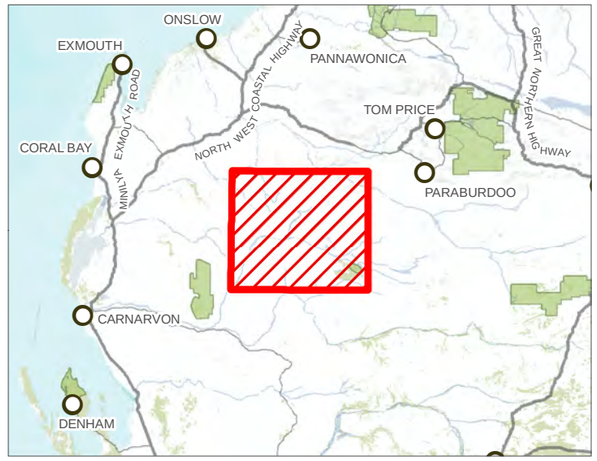
Birds and Migratory Birds (EPBC Act, WC Act)

- Grey Falcon (S3)
- Common Greenshank (M, S5)
- Eastern Great Egret (S5)
- Fork-tailed Swift (M, S5)
- Rainbow Bee-eater (S5)
- Peregrine Falcon (S7)

DPaW Priority 4

- Long-tailed Dunnart
- Western Pebble-mound Mouse, Ngadji

OVERVIEW



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AUTHOR: CP
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

DATABASE SEARCH RESULTS

MAP 4

SCALE 1:550,000 @ A3

0 10 20 30 km

405000 410000 415000 420000 425000 430000 435000

7370000 7365000 7360000 7355000 7350000 7345000 7340000

EDMUND
EDMUND RIVER
ULLAWARRA ROAD
LYONS RIVER
COBRA GIFFORD CREEK ROAD
GIFFORD CREEK

HYSOP 9
HYMC02 HYMC01 HYSA 9 HYSL 2
HYSOP 3
HYSA 10 HYSRE 1
HYS 1
HYSOP 6
HYSRE 6
HYSL 12 HYS 5
HYSOP 1
HYSRE 2
HYMC04
HYSA 1
HYSB 11
HYSRE 7
HYSOP 4
HYSL 7
HYS 2
HYSRE 5
HYMC05
HYSA 5 HYSA 8
HYSA 7
HYS 6 HYSL14
HYSOP 10
HYSOP 11
HYS 7
HYSL 13
HYMC06
HYSRE 9
HYSOP 7
HYSL 11
HYSL 10
HYSOP 8
HYMC03
HYSRE 8
HYSOP 2
HYSB 13
HYSRE 3
HYSL 4
HYSOP 12
HYS 3
HYSB 9 HYSL 3
HYSOP 5 HYSA 6
HYSRE 4
HYS 8 HYSL 1
HYS 4
HYSL 5
HYMC08
HYSRE 10
HYSOP 15
HYSL 6
HYSA 4
HYSA 3 HYMC07
HYSB 14
HYSOP 13
HYSB 12
HYSL 8
HYMC10 HYSA 2
HYSOP 14 HYMC09
HYSB 15 HYSB 10
HYSL 9

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA ZONE 50

LEGEND

- Homesteads
- Roads
- Rivers
- Creeks
- Survey Tracks
- Survey Area

Project Tenements

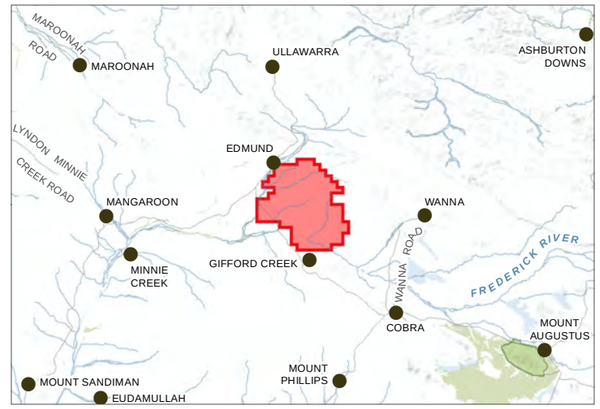
Type

- General Purpose Lease
- Mining Lease
- Miscellaneous Lease
- Proposed Infrastructure

Fauna Site Locations

- Leaf Litter Collection
- Motion Camera
- Opportunistic Collection / Search
- Ornithological Survey
- Sound Recorded (Anabat / SM2)
- Systematic Vertebrate and Dry Pitfall Site
- Wet Pitfall Trap Site

OVERVIEW



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AUTHOR: CP/JN REVIEWED: SB
DATE: NOV-2016 PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

SURVEY EFFORT

MAP 5

SCALE 1:120,000 @ A3

0 1 2 3 4 5 km

400000 402000 404000 406000 408000 410000

7372000 7370000 7368000 7366000 7364000

EDMUND RIVER

EDMUND

ULLAWARRA ROAD

COBRA GIFFORD CREEK ROAD

Major River

Rocky Plains and Hills

Sandy Plains

Minor Creekline

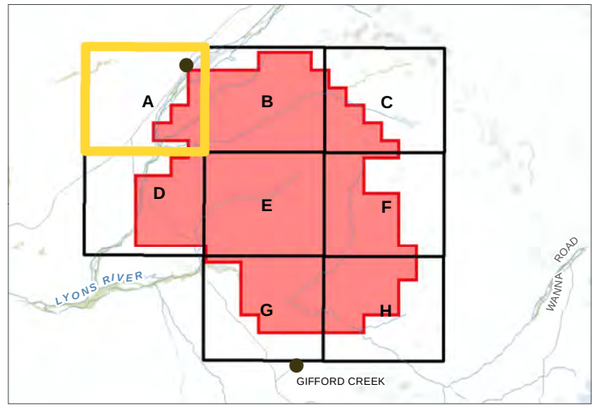
LEGEND

- Survey Area
- Rivers
- Creeks

Fauna Habitat Type

- Major River
- Minor Creekline
- Rocky Plains and Hills
- Sandy Plains
- Homesteads
- Roads

OVERVIEW



ecoscape

AUTHOR: CP
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - A

SCALE 1:40,000 @ A3

0 1 2 3 km

GDA 1994 MGA Zone 50

412000 414000 416000 418000 420000 422000

7372000 7370000 7368000 7366000 7364000

EDMUND RIVER

Major River

HYSOP 9

Sandy Plains

Rocky Plains and Hills

Granite Outcrop

HYMC02 HYMC01 HYSL 2 HYSA 9 HYSOP 3

Minor Creekline

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

- Survey Area
- Proposed Infrastructure Footprint
- Rivers
- Creeks

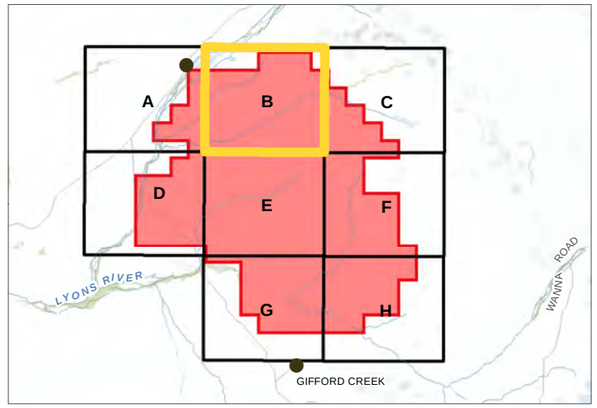
Fauna Site Locations

- Leaf Litter Collection
- Motion Camera
- Opportunistic Collection / Search
- Ornithological Survey
- Wet Pitfall Trap Site

Fauna Habitat Type

- Granite Outcrop
- Major River
- Minor Creekline
- Rocky Plains and Hills
- Sandy Plains

OVERVIEW



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AUTHOR: CP
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - B

SCALE 1:40,000 @ A3

0 1 2 3 km

424000 426000 428000 430000 432000 434000

7372000
7370000
7368000
7366000
7364000

Sandy Plains

Minor Creekline

Granite Outcrop

Rocky Plains and Hills

HYSOP 3

HYSA 10

HYSRE 1

HYS 1

HYSOP 6

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

Survey Area

Creeks

Fauna Site Locations

Opportunistic Collection / Search

Ornithological Survey

Systematic Vertebrate and Dry Pitfall Site

Wet Pitfall Trap Site

Fauna Habitat Type

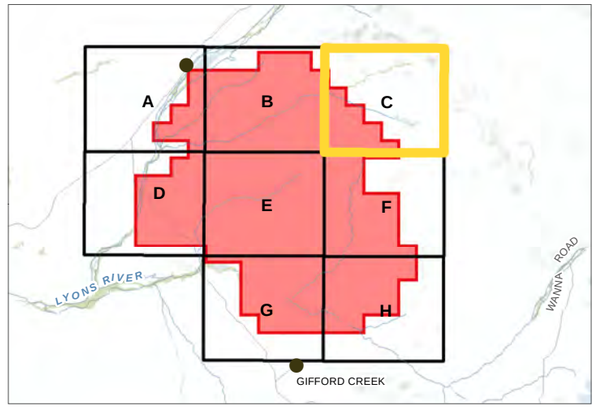
Granite Outcrop

Minor Creekline

Rocky Plains and Hills

Sandy Plains

OVERVIEW



ecoscape

AUTHOR: CP
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - C

SCALE 1:40,000 @ A3

0 1 2 3 km

400000 402000 404000 406000 408000 410000

7362000 7360000 7358000 7356000 7354000 7352000

ULLAWARRA ROAD

EDMUND RIVER

Major River

HYSA 5

HYSA 8

HYSA 7

HYSOP 10

Sandy Plains

Rocky Plains and Hills

HYSL 11

COBRA GIFFORD CREEK ROAD

Minor Creekline

LEGEND

- Survey Area
- Proposed Infrastructure Footprint
- Rivers
- Creeks

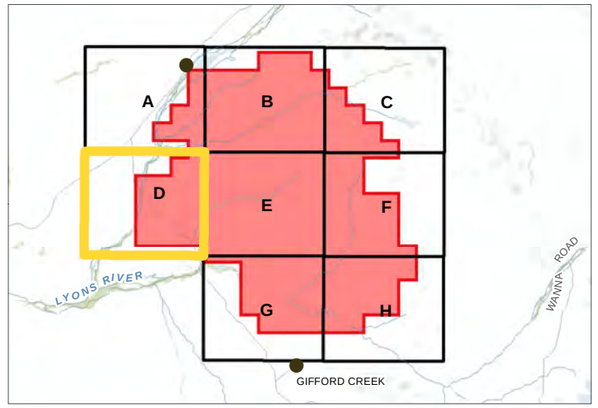
Fauna Site Locations

- Leaf Litter Collection
- Opportunistic Collection / Search
- Ornithological Survey

Fauna Habitat Type

- Major River
- Minor Creekline
- Rocky Plains and Hills
- Sandy Plains
- Roads

OVERVIEW



ecoscape

AUTHOR: CP
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - D

SCALE 1:40,000 @ A3

0 1 2 3 km

GDA 1994 MGA Zone 50

412000 414000 416000 418000 420000 422000

7362000 7360000 7358000 7356000 7354000 7352000

HYSRE 6
Minor Creekline
HYS 5
HYSL 12
HYMC04
HYSB 11
HYSA 1
HYSRE 7
HYSRE 5
HYMC05
Sandy Plains
Granite Outcrop
HYS 6
HYSL14
HYS 7
HYSOP 11
HYSL 13
HYMC06
HYSRE 9
HYSOP 7
Rocky Plains and Hills
HYSOP 8
HYMC03
HYSL 10
HYSRE 8
HYSL 3
HYSOP 5
HYSB 9
HYSA 6
HYSRE 4
HYS 8
HYSL 1

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

- Survey Area
- Proposed Infrastructure Footprint
- Creeks

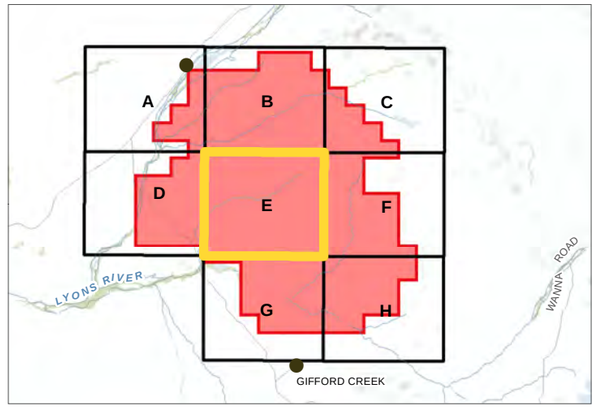
Fauna Site Locations

- Leaf Litter Collection
- Motion Camera
- Opportunistic Collection / Search
- Ornithological Survey
- Sound Recorded (Anabat / SM2)
- Systematic Vertebrate and Dry Pitfall Site
- Wet Pitfall Trap Site

Fauna Habitat Type

- Granite Outcrop
- Minor Creekline
- Rocky Plains and Hills
- Sandy Plains

OVERVIEW



ecoscape

AUTHOR: CP
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - E

SCALE 1:40,000 @ A3

0 1 2 3 km

424000 426000 428000 430000 432000 434000

7362000 7360000 7358000 7356000 7354000 7352000

HYSOP 6
HYSOP 1
HYSRE 2
HYSOP 4
HYSL 7
HYS 2
HYSOP 2
HYSB 13
HYSRE 3
HYSOP 12
HYSL 4
HYS 3
HYS 4
HYSRE 10
HYSL 5

Granite Outcrop
Minor Creekline
Rocky Plains and Hills
Sandy Plains
Major River

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

- Survey Area
- Proposed Infrastructure Footprint
- Creeks

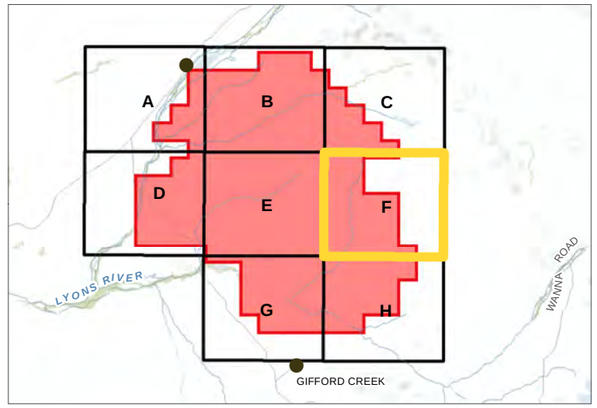
Fauna Site Locations

- Leaf Litter Collection
- Opportunistic Collection / Search
- Sound Recorded (Anabat / SM2)
- Systematic Vertebrate and Dry Pitfall Site
- Wet Pitfall Trap Site

Fauna Habitat Type

- Granite Outcrop
- Major River
- Minor Creekline
- Rocky Plains and Hills
- Sandy Plains

OVERVIEW



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AUTHOR: CP
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - F

SCALE 1:40,000 @ A3

0 1 2 3 km

412000 414000 416000 418000 420000 422000

7350000 7348000 7346000 7344000 7342000

Granite Outcrop

Minor Creekline

LYONS RIVER

Major River

Sandy Plains

Rocky Plains and Hills

COBRA GIFFORD CREEK ROAD

HYSL 8

HYMC10

HYSA 2

HYMC09

HYSB 15

HYSB 10

HYSOP 14

HYSL 9

LEGEND

- Survey Area
- Proposed Infrastructure Footprint
- Rivers
- Creeks

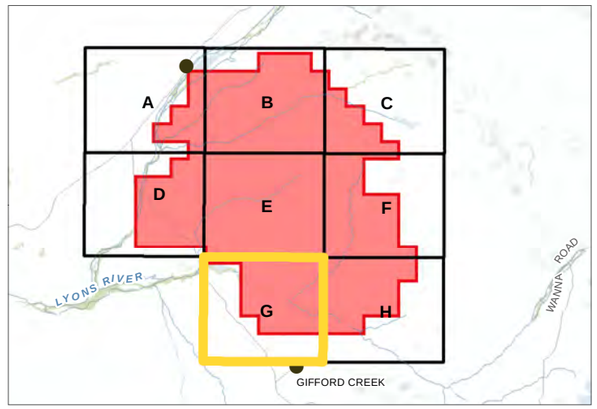
Fauna Site Locations

- Leaf Litter Collection
- Motion Camera
- Opportunistic Collection / Search
- Ornithological Survey
- Sound Recorded (Anabat / SM2)

Fauna Habitat Type

- Granite Outcrop
- Major River
- Minor Creekline
- Rocky Plains and Hills
- Sandy Plains
- Roads

OVERVIEW



ecoscape

AUTHOR: CP REVIEWED: SB

DATE: NOV-16 PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - G

SCALE 1:40,000 @ A3

0 1 2 3 km

GDA 1994 MGA Zone 50

424000 426000 428000 430000 432000 434000

7350000 7348000 7346000 7344000 7342000

HYMC08
Sandy Plains
HYSL 6
HYSA 3
HYSA 4
HYMC07
HYSB 14
HYSOP 13
HYSOP 15
Rocky Plains and Hills
Minor Creekline
Granite Outcrop
HYSA 2
Major River
LYONS RIVER

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA Zone 50

LEGEND

- Survey Area
- Proposed Infrastructure Footprint
- Rivers
- Creeks

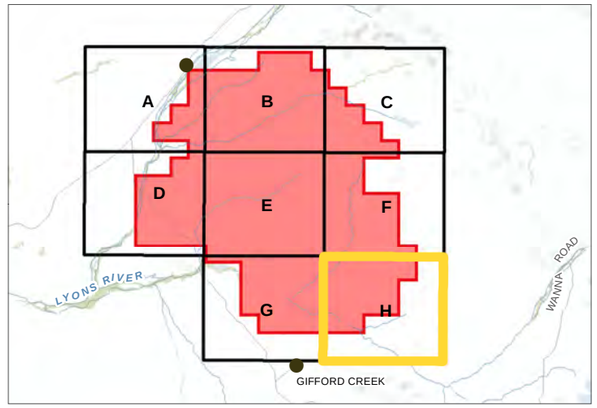
Fauna Site Locations

- Leaf Litter Collection
- Motion Camera
- Opportunistic Collection / Search
- Ornithological Survey
- Sound Recorded (Anabat / SM2)

Fauna Habitat Type

- Granite Outcrop
- Major River
- Minor Creekline
- Rocky Plains and Hills
- Sandy Plains

OVERVIEW



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AUTHOR: CP
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PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

FAUNA HABITAT TYPES

MAP 6 - H

SCALE 1:40,000 @ A3

0 1 2 3 km

400000
410000
420000
430000
7370000
7360000
7350000
7340000
EDMUND
EDMUND RIVER
ULLAWARRA ROAD
LYONS RIVER
GIFFORD CREEK
WANNA ROAD
COBRA GIFFORD CREEK ROAD

LEGEND

- Homesteads
- Roads
- Rivers
- Creeks
- Survey Tracks
- Survey Area

Project Tenements

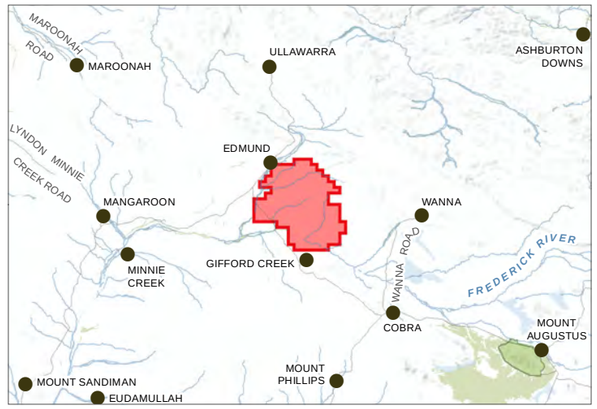
Type

- General Purpose Lease
- Mining Lease
- Miscellaneous Lease
- Proposed Infrastructure Footprint

Conservation Significant Fauna

- Grey Falcon (WC Act S3)
- Eastern Great Egret (WC Act S5)
- Rainbow Bee-eater (WC Act S5)
- Long-tailed Dunnart (Priority 4, DPAW)

OVERVIEW



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AUTHOR: CP/JN
DATE: NOV-16
REVIEWED: SB
PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

CONSERVATION SIGNIFICANT FAUNA

MAP 7

SCALE 1:140,000 @ A3

0 2 4 6 8 10 km

SERVICE LAYER CREDITS: SOURCES: ESRI, USGS, NOAA; SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

GDA 1994 MGA ZONE 50

400000 410000 420000 430000

7370000 7360000 7350000 7340000

EDMUND

EDMUND RIVER

ULLAWARRA ROAD

1

LYONS RIVER

COBRA GIFFORD CREEK ROAD

GIFFORD CREEK

WANNA ROAD

LEGEND

- Homesteads
- Roads
- Rivers
- Creeks
- Survey Area
- Disturbance Envelope
- Proposed Infrastructure Footprint

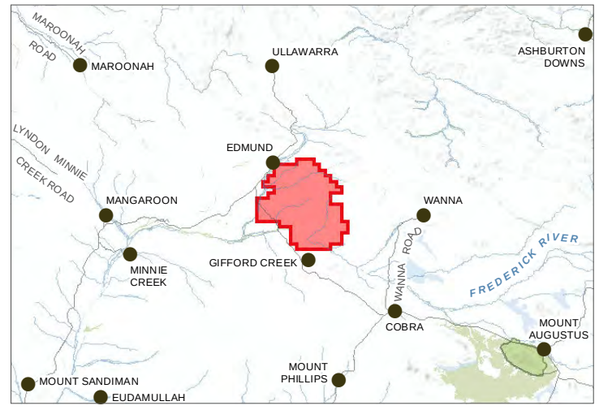
Project Tenements

- General Purpose Lease
- Mining Lease
- Miscellaneous Lease

Potential SRE Species

- Acanthodillo sp. B16
- Aganippe sp. B21
- Aname sp. B19
- Beierolpium 8/2 sp.
- Beierolpium 8/3 sp.
- Buddelundia sp. B59
- Buddelundia sp. B60
- Cryptops sp.
- Cubaris sp. B07
- Linnaeolpium sp. B04
- Lychas `hairy tail group`
- Lychas `multipunctatus group`
- Synothele sp. B14

OVERVIEW



ecoscape

AUTHOR: CP/JN REVIEWED: SB
DATE: NOV-16 PROJECT NO: 3397-15

YANGIBANA BIOLOGICAL ASSESSMENT

CLIENT: HASTINGS

POTENTIAL SHORT RANGE ENDEMICS

MAP 8

SCALE 1:140,000 @ A3

0 2 4 6 8 10 km

SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY; SOURCES: ESRI, USGS, NOAA

GDA 1994 MGA ZONE 50

APPENDIX ONE: DEFINITIONS AND CRITERIA

Table 20: *EPBC Act 1999* categories for flora and fauna (Commonwealth of Australia 1999)

EPBC ACT CATEGORY	DEFINITION
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (EN)	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 21: Conservation codes for Western Australian flora and fauna (DPaW 2014a)

CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA AND FAUNA	
T	**Threatened species** – Listed as Specially Protected under the *Wildlife Conservation Act 1950*, published under Schedules 1-3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora). • Fauna that is rare or likely to become extinct are declared to be fauna that is need of special protection • Flora that are extant and considered likely to become extinct, or rare and therefore in need of special protection, are declared to be rare flora: species* which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such. Threatened Fauna and Flora are ranked according to their level of threat using IUCN Red List categories and criteria. The number of Schedules published under the Wildlife Conservation Act has recently changed, with older Schedule 1 (all Threatened categories) replaced by Schedules 1-3. A list of the current rankings can be downloaded from the Parks and Wildlife Threatened Species and Communities webpage at http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities
CR	**Critically Endangered** (Schedule 1) • Threatened fauna considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice as 'Fauna that is rare or is likely to become extinct as critically endangered fauna'. • Threatened flora taxa that are extant and considered likely to become extinct or rare, as critically endangered flora, and therefore in need of special protection
EN	**Endangered** (Schedule 2) – • Threatened fauna considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice as 'Fauna that is rare or is likely to become extinct as endangered fauna' • Threatened flora taxa that are extant and considered likely to become extinct or rare, as endangered flora, and therefore in need of special protection
VU	**Vulnerable** (Schedule 3) – • Threatened fauna considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice as 'Fauna that is rare or is likely to become extinct as vulnerable fauna' • Threatened flora taxa that are extant and considered likely to become extinct or rare, as vulnerable flora, and therefore in need of special protection
EX	**Presumed extinct** (Schedule 4) – • Fauna which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice as 'Fauna presumed to be extinct' • Flora species which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such. Listed as Specially Protected under the Wildlife Conservation Act 1950, published under Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora (which may also be referred to as Declared Rare Flora).
IA	**Migratory birds protected under an international agreement** – (Schedule 5) Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice
CD	**Conservation Dependent** – (Schedule 6) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice

CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA AND FAUNA	
OS	**Other specially protected fauna** – (Schedule 7) Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice
P Priority species Species that may be threatened or near threatened but are data deficient, have not yet been adequately surveyed to be listed under the Schedules of the Wildlife Conservation (Specially Protected Fauna) Notice or the Wildlife Conservation (Rare Flora) Notice are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.	
P1	**Priority One: Poorly-known species (on threatened lands)** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road or rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further study.
P2	**Priority Two: Poorly-known species (some on conservation lands)** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further study.
P3	**Priority Three: Poorly-known species (some on conservation lands)** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further study.
P4	**Priority Four: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
*Species includes all taxa (plural of taxon-a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies, variety or forma).	

Table 22: IUCN Red List Categories and Criteria (IUCN 2012)

Additional detail is available in the quoted reference.

IUCN CATEGORY	DEFINITION
Extinct (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form
Extinct in the Wild (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CR)	A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see below), and it is therefore considered to be facing an extremely high risk of extinction in the wild. If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future. A: Reduction in population size based on a defined criteria (including a reduction of ≥90% or ≥80% over the last 10 years, depending on other defined factors) B: Geographic range in the form of either B1 (extent of occurrence <100 km^2 and fragmented, continuing to decline or fluctuating) or B2 (area of occupancy <10 km^2 and fragmented, continuing to decline or fluctuating) or both C: Population size estimated to number fewer than 250 mature individuals and shows continuing decline or extreme fluctuations D: Population size estimated to number fewer than 50 mature individuals E: Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years)
Endangered (EN)	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see below), and it is therefore considered to be facing a very high risk of extinction in the wild. A: Reduction in population size based on a defined criteria (including a reduction of ≥70% or ≥50% over the last 10 years, depending on other defined factors) B: Geographic range in the form of either B1 (extent of occurrence <5,000 km^2 and fragmented, continuing to decline or fluctuating) or B2 (area of occupancy <500 km^2 and fragmented, continuing to decline or fluctuating) or both C: Population size estimated to number fewer than 2,500 mature individuals and shows continuing decline or extreme fluctuations D: Population size estimated to number fewer than 250 mature individuals E: Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years)

IUCN CATEGORY	DEFINITION
Vulnerable (VU)	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see below), and it is therefore considered to be facing a high risk of extinction in the wild. A: Reduction in population size based on a defined criteria (including a reduction of ≥50% or ≥30% over the last 10 years, depending on other defined factors) B: Geographic range in the form of either B1 (extent of occurrence <20,000 km^2 and fragmented, continuing to decline or fluctuating) or B2 (area of occupancy <2,000 km^2 and fragmented, continuing to decline or fluctuating) or both C: Population size estimated to number fewer than 10,000 mature individuals and shows continuing decline or extreme fluctuations D: Population size very small or restricted and estimated to number fewer than 1,000 mature individuals or occupy typically < 20 km2 or five or less locations E: Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years
Near Threatened (NT)	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future
Least Concern (LC)	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

Table 23: DPaW definitions and criteria for TECs and PECs (DEC 2010)

CRITERIA	DEFINITION
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A. The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

CRITERIA	DEFINITION
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A. The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii. modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii. there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii. there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. C. The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A. The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B. The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C. The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

APPENDIX TWO: DETAILS OF SAMPLE SITES

Table 24: Details of Sample Sites

SITE	COORDINATES		PHASE	DETAILS	LANDSYSTEM	VEGETATION
	EASTING	NORTHING				
Vertebrate trap sites and SRE Dry pitfall						
HYS 1	426740	7363084	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	Glenburgh System	165
HYS 2	425826	7358530	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	James System	165
HYS 3	425888	7354825	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	James System	165
HYS 4	424641	7352640	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	Nadarra System	165
HYS 5	414860	7362446	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	Phillips System	165
HYS 6	414768	7357443	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	Nadarra System	18
HYS 7	417159	7356685	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	Agamemnon System	165
HYS 8	412098	7352196	Phase 1 & 2	Vert. trap site and invertebrate dry pitfall	Nadarra System	165
SRE wet pitfall						
HYSRE 1	425249	7364471	Phase 1	Invertebrate wet pitfall site	James System	165
HYSRE 2	426561	7361899	Phase 1	Invertebrate wet pitfall site	James System	165
HYSRE 3	428170	7356328	Phase 1	Invertebrate wet pitfall site	Glenburgh System	165
HYSRE 4	412264	7353025	Phase 1	Invertebrate wet pitfall site	Nadarra System	165
HYSRE 5	415369	7358897	Phase 1	Invertebrate wet pitfall site	Phillips System	18
HYSRE 6	417026	7362671	Phase 1	Invertebrate wet pitfall site	Phillips System	165
HYSRE 7	421439	7360274	Phase 1	Invertebrate wet pitfall site	James System	165
HYSRE 8	422618	7355199	Phase 1	Invertebrate wet pitfall site	Agamemnon System	165
HYSRE 9	418916	7355645	Phase 1	Invertebrate wet pitfall site	Glenburgh System	165
HYSRE 10	427251	7352066	Phase 1	Invertebrate wet pitfall site	James System	165
Bat recorder						
HYSB 1	426514	7362733	Phase 1 & 2	Bat recording at systematic trapping site	James System	165
HYSB 2	425826	7358530	Phase 1 & 2	Bat recording at systematic trapping site	James System	165

SITE	COORDINATES		PHASE	DETAILS	LANDSYSTEM	VEGETATION
	EASTING	NORTHING				
HYSB 3	425888	7354825	Phase 1 & 2	Bat recording at systematic trapping site	James System	165
HYSB 4	424641	7352640	Phase 1 & 2	Bat recording at systematic trapping site	Nadarra System	165
HYSB 5	414860	7362446	Phase 1 & 2	Bat recording at systematic trapping site	Phillips System	165
HYSB 6	414768	7357443	Phase 1 & 2	Bat recording at systematic trapping site	Nadarra System	18
HYSB 7	417159	7356685	Phase 1 & 2	Bat recording at systematic trapping site	Agamemnon System	165
HYSB 8	412098	7352196	Phase 1 & 2	Bat recording at systematic trapping site	Nadarra System	165
HYSB 9	413078	7353672	Phase 1	Bat recorder site	James System	165
HYSB 10	422187	7345648	Phase 1	Bat recorder site	Nadarra System	18
HYSB 11	415530	7360599	Phase 2	Bat recorder site	Phillips System	165
HYSB 12	411201	7350221	Phase 2	Bat recorder site	Augustus System	181
HYSB 13	425987	7356509	Phase 2	Bat recorder site	James System	165
HYSB 14	423686.	7350193	Phase 2	Bat recorder site	Phillips System	18
HYSB 15	421981	7345603	Phase 2	Bat recorder site	Gascoyne System	18
Motion Camera						
HYMC01	414497	7364334	Phase 2	Motion Camera site	Phillips System	18
HYMC02	414294	7364314	Phase 2	Motion Camera site	Phillips System	18
HYMC03	405594	7358728	Phase 2	Motion Camera site	James System	165
HYMC04	415500	7360639	Phase 2	Motion Camera site	Phillips System	165
HYMC05	414922	7357913	Phase 2	Motion Camera site	Nadarra System	18
HYMC06	419075	7355493	Phase 2	Motion Camera site	Glenburgh System	165
HYMC07	423869	7350250	Phase 2	Motion Camera site	Phillips System	18
HYMC08	424930	7351551	Phase 2	Motion Camera site	Nadarra System	165
HYMC09	421952	7345652	Phase 2	Motion Camera site	Gascoyne System	18
HYMC10	421888	7345704	Phase 2	Motion Camera site	Gascoyne System	18
Foraging (opportunistic)						

SITE	COORDINATES		PHASE	DETAILS	LANDSYSTEM	VEGETATION
	EASTING	NORTHING				
HYSOP1	428987	7362468	Phase 1	Foraging for vertebrate and invertebrate fauna	Glenburgh System	165
HYSOP2	429093	7356945	Phase 1	Foraging for vertebrate and invertebrate fauna	Augustus System	165
HYSOP3	423223	7364563	Phase 1	Foraging for vertebrate and invertebrate fauna	James System	165
HYSOP4	425596	7359790	Phase 1	Foraging for vertebrate and invertebrate fauna	James System	165
HYSOP5	413053	7353697	Phase 1	Foraging for vertebrate and invertebrate fauna	James System	165
HYSOP6	426795	7362992	Phase 1	Foraging for vertebrate and invertebrate fauna	Glenburgh System	165
HYSOP7	419045	7355467	Phase 1	Foraging for vertebrate and invertebrate fauna	Glenburgh System	165
HYSOP8	421896	7355183	Phase 1	Foraging for vertebrate and invertebrate fauna	James System	165
HYSOP9	418105	7369427	Phase 1	Foraging for vertebrate and invertebrate fauna	Yinnietharra System	18
HYSOP10	406660	7357137	Phase 1	Foraging for vertebrate and invertebrate fauna	Nadarra System	18
HYSOP11	414077	7356454	Phase 1	Foraging for vertebrate and invertebrate fauna	Agamemnon System	165
HYSOP12	428540	7356130	Phase 2	Foraging for vertebrate and invertebrate fauna	Glenburgh System	165
HYSOP13	423693	7350194	Phase 2	Foraging for vertebrate and invertebrate fauna	Phillips System	18
HYSOP14	421950	7345651	Phase 2	Foraging for vertebrate and invertebrate fauna	Gascoyne System	18
HYSOP15	430053	7351315	Phase 2	Foraging for vertebrate and invertebrate fauna	Glenburgh System	165
Leaflitter collection						
HYSL1	411875	7352018	Phase 1	Leaf litter collection site	Nadarra System	18
HYSL2	415852	7364500	Phase 1	Leaf litter collection site	Phillips System	18
HYSL3	413056	7353705	Phase 1	Leaf litter collection site	James System	165
HYSL4	425969	7355915	Phase 1	Leaf litter collection site	James System	165
HYSL5	427543	7352082	Phase 1	Leaf litter collection site	James System	165
HYSL6	424091	7351199	Phase 1	Leaf litter collection site	Nadarra System	165
HYSL7	425729	7358773	Phase 2	Leaf litter collection site	Agamemnon System	165
HYSL8	422937	7348893	Phase 2	Leaf litter collection site	Nadarra System	165

SITE	COORDINATES		PHASE	DETAILS	LANDSYSTEM	VEGETATION
	EASTING	NORTHING				
HYSL9	422192	7345102	Phase 2	Leaf litter collection site	James System	165
HYSL10	421904	7355102	Phase 2	Leaf litter collection site	James System	165
HYSL11	407639	7356260	Phase 2	Leaf litter collection site	Phillips System	18
HYSL12	414212	7362056	Phase 2	Leaf litter collection site	Phillips System	165
HYSL13	417689	7356126.	Phase 2	Leaf litter collection site	Agamemnon System	165
HYSL14	414721	7357341	Phase 2	Leaf litter collection site	Nadarra System	18
Additional Avian observations						
HYSA1	421688	7360771	Phase 1	Additional Avian site	James System	165
HYSA2	421973	7345695	Phase 1	Additional Avian site	Gascoyne System	18
HYSA3	423707	7350501	Phase 1	Additional Avian site	Nadarra System	165
HYSA4	425339	7364360	Phase 1	Additional Avian site	James System	165
HYSA5	405545	7358704	Phase 1	Additional Avian site	Gascoyne System	166
HYSA6	413119	7353677	Phase 2	Additional Avian site	James System	165
HYSA7	406336	7357532	Phase 2	Additional Avian site	Nadarra System	18
HYSA8	405569	7358718	Phase 2	Additional Avian site	Gascoyne System	166
HYSA9	414456	7364279	Phase 2	Additional Avian site	Phillips System	18
HYSA10	425323	7364481	Phase 2	Additional Avian site	James System	165

APPENDIX THREE: TRAPPING SITE DESCRIPTION

SITE	DESCRIPTION	SITE PHOTO
VERTEBRATE TRAP SITES AND SRE DRY PITFALL		
HYS 1	*Acacia cyperophylla* tall woodland over *A. cuthbertsoniii* and *Eremophila fraseri* mid sparse shrubland over *Cyperus* spp. sparse sedgeland and *Nicotiana occidentalis* and *Cleome viscosa* sparse herbland. Site dominated by river bed of coarse sand with occasional quartz rocks. *Acacia cyperophylla* observed are deceased with evidence of fire <2 years ago. Small temporary water pools litter the site. Habitat type: Minor creekline	
HYS 2	*Acacia cyperophylla* tall woodland over *Eremophila fraseri*, *E. phyllopodai* and *Senna artemisioides* subsp. *helmsii* mid shrubland over Indigofera colutea low, sparse shrubland over mixed tussock grass and herbland. Site consists of large granite ourcrops dissected by river bed. Sand is coarse with occasional quartz rocks and granite rocks/bulders. No evidence of fire recorded. Large temporary water pools located between outcrops. Many weed species present. Habitat type: Granite outcrops	

SITE	DESCRIPTION	SITE PHOTO
HYS 3	*Eucalyptus camaldulensis* tall, open woodland over *Acacia citrinoviridis* and *Acacia coriacea* subsp. *pendens* tall shrubland over *Cenchrus ciliaris* and *Eragrostis tenellula* closed tussock grassland. Major river bed of coarse sand with occasional quartz/granite pebbles. River bank consists of brown, loamy clay/sand. The area has not been recently burnt (>5 years ago). Large semipermanent water pools present in riverbed. Many weed species present. Habitat type: Major River	
HYS 4	*Senna artemisioides* subsp. *oligophylla* and *Senna artemisioides* subsp. *helmsii* mid, sparse shrubland, over *Eremophila cuneifolia*, *Acacia synchronicia*, *maireana melancoma* and *salsola australis* low, sparse shrubland over *Aristida contorta* sparse tussock grassland. Undulating sandy plain of fine, orange clay/loam soil with occasional calcrete and quartz pebbles. The area has not been recently burnt (>5 years ago). Large semipermanent water pools present in riverbed. Many weed species present. Habitat type: Sandy plain	

SITE	DESCRIPTION	SITE PHOTO
HYS 5	*Acacia xiphophylla* and *Exocarpos latifolius* tall, sparse shrubland over *Eremophila fraseri, Ptilotus obovatus* and *Senna glutinosa* subsp. ×*luersseni* mid, sparse shrubland over *Dysphania rhadinostachya* open herbland and *Eriachne pulchella* subsp. *dominii* and *Aristida contorta* open tussock grassland. Undulating gravelly/stony undulating hills of fine, red clay/loam soil with >70% of ironstone gravel, with occasional quartz. The area has not been recently burnt (>5 years ago). Leaf litter (2%) present under shrubs. No weed species or impacts from grazing were observed. Habitat type: Rocky plain	
HYS 6	*Acacia macraneura* and *A. synchronicia* tall, sparse shrubland over *Eremophila cuneifolia* and *Senna artemisioides* subsp. *oligophylla* mid, sparse shrubland over *Dysphania rhadinostachya* open herbland. Undulating stony hills of fine, orange clay/loam soil with 50% cover of calcrete and quartz stones. The area has not been recently burnt (>5 years ago). No weed species or impacts from grazing were observed. Habitat type: Rocky plain	

SITE	DESCRIPTION	SITE PHOTO
HYS 7	*Eremophila phyllopodia* and *Senna glutinosa* subsp. ×*luersseni* mid, sparse shrubland over *Aristida contorta* and *Eriachne pulchella* subsp. *dominii* closed tussock grassland. Undulating stony hills of fine, orange clay/loam soil with >80% cover of ironstone and quartz stones. The area has not been recently burnt (>5 years ago). No weed species or impacts from grazing were observed. Habitat type: Rocky plain	
HYS 8	*Acacia xiphophylla* tall, open shrubland over *Senna ferraria* mid, sparse shrubland over occasional *Maireana* spp. low, isolated chenopod shrubs Undulating sandy plain of fine, orange clay/loam soil with occasional calcrete and quartz pebbles. The area has not been recently burnt (>5 years ago). Leaf litter (2%) present under shrubs. Evidence of cattle grazing was observed. Habitat type: Sandy plain	
SRE WET PITFALL		

SITE	DESCRIPTION	SITE PHOTO
HYSRE 1	*Eremophila phyllopodia* and *E. exilifolia* mid, sparse shrubland over *Aristida contorta* and *Eriachne pulchella* subsp. *dominii* closed tussock grassland. Undulating stony hills of fine, orange clay/loam soil with >80% cover of ironstone and quartz stones. The area has not been recently burnt (>5 years ago). No weed species or impacts from grazing were observed. Habitat type: Rocky plain	
HYSRE 2	*Acacia cyperophylla* tall woodland over *A. cuthbertsoniii* and Eremophila fraseri mid sparse shrubland over *Cyperus* spp. sparse sedgeland and *Nicotiana occidentalis* and *Cleome viscosa* sparse herbland. Site dominated by river bed of coarse sand with occasional quartz rocks. *Acacia cyperophylla* observed are deceased with evidence of fire <2 years ago. Small temporary water pools litter the site. Habitat type: Minor creek	

SITE	DESCRIPTION	SITE PHOTO
HYSRE 3	*Acacia xiphophylla* tall, sparse shrubland, over *Acacia synchronicia, Salsola australis* and *Senna glutinosa* subsp. x *luerssenii* mid, sparse shrubland over *Aristida contorta* sparse tussock grassland. Undulating stony hills of fine, orange clay/loam soil with >60% cover of granite rocks (20 cm diameter) and quartz stones. The area has not been recently burnt (>5 years ago). No weed species or impacts from grazing were observed. Leaf litter is concentrated under *Acacia xiphophylla* with small amounts scattered throughout. Habitat type: Rocky plain	
HYSRE 4	*Acacia xiphophylla* tall, open shrubland over *Senna ferraria* mid, sparse shrubland over *Dysphania rhadinostachya* open herbland and occasional *Maireana* spp. low, isolated chenopod shrubs Undulating sandy plain of fine, orange clay/loam soil with occasional calcrete and quartz pebbles. The area has not been recently burnt (>5 years ago). Leaf litter (2%) present under shrubs. Evidence of cattle grazing was observed. Habitat type: Sandy plain	

SITE	DESCRIPTION	SITE PHOTO
HYSRE 5	*Acacia xiphophylla* tall, sparse shrubland over *Eremophila phyllopodia* and *E. exilifolia* mid, sparse shrubland over *Aristida contorta* and *Eriachne pulchella* subsp. *dominii* closed tussock grassland and *Dysphania rhadinostachya* open. Undulating gravelly/stony undulating hills of fine, red clay/loam soil with >70% of with quartz and granite stones and ironstone gravel. The area has not been recently burnt (>5 years ago). Leaf litter (2%) present under shrubs. No weed species or impacts from grazing were observed. Habitat type: Rocky hills	
HYSRE 6	*Acacia cyperophylla* tall woodland over *A. cuthbertsoniii* and *Eremophila fraseri* mid sparse shrubland over *Cyperus* spp. sparse sedgeland and *Nicotiana occidentalis* and *Cleome viscosa* sparse herbland. Site dominated by river bed of coarse sand with >20% quartz and granite rocks. No evidence of fire with leaf litter present under *Acacia cyperophylla*. Habitat type: Minor creekline	

SITE	DESCRIPTION	SITE PHOTO
HYSRE 7	*Eremophila phyllopodia* and *Senna glutinosa* subsp. ×*luersseni* mid, sparse shrubland over *Aristida contorta* and *Eriachne pulchella* subsp. *dominii* closed tussock grassland. Undulating stony hills of fine, orange clay/loam soil with >80% cover of ironstone and quartz stones, and some granite outcropping. The area has not been recently burnt (>5 years ago). No weed species or impacts from grazing were observed. Habitat type: Rocky plain	
HYSRE 8	*Eremophila phyllopodia* mid, sparse shrubland over *Aristida contorta* and *Eriachne pulchella* subsp. *dominii* closed tussock grassland. Undulating stony hills of fine, orange clay/loam soil with >40% cover of quartz stones, occasional granite rocks, and ironstone gravel. The area has not been recently burnt (>5 years ago). No weed species or impacts from grazing were observed. Habitat type: Rocky plain	

SITE	DESCRIPTION	SITE PHOTO
HYSRE 9	*Acacia cyperophylla* tall woodland over *A. cuthbertsoniii* and Eremophila fraseri mid sparse shrubland over *Cyperus* spp. sparse sedgeland and *Nicotiana occidentalis* and *Cleome viscosa* sparse herbland. Site dominated by river bed of coarse sand with >20% quartz and granite rocks. No evidence of fire with leaf litter present under *Acacia cyperophylla*. Habitat type: Minor creekline	
HYSRE 10	*Eremophila phyllopodia*, *Senna artemisioides* subsp. *oligophylla* and *solanum lasiophyllum* mid, sparse shrubland over *Aristida contorta* closed tussock grassland. Undulating stony hills of fine, orange clay/loam soil with >40% cover of quartz stones, occasional granite rocks, and ironstone gravel. The area has not been recently burnt (>5 years ago). No weed species or impacts from grazing were observed. Habitat type: Rocky plain	

APPENDIX FOUR: DESKTOP ASSESSMENT RESULTS

ORDER	FAMILY	COMMON NAME	SCIENTIFIC NAME	EPBC Act	WC Act s	DPAW	NatureMap (Barlee Range)	NatureMap (Kennedy Range)	NatureMap (Mt Augustus)	Ecoscape 2012 Pindabarn	ecologia 2009 Jack Hills	ecologia 2009 Weld Range	Burbidge et al. 2000 (% quadrats)	Storr 1985 Gascoyne Region	PMST	ALA (number of records)	Birdata	Yangibana
MAMMALS																		
Monotremata	Tachyglossidae	Echidna, Short-beaked Echi	*Tachyglossus aculeatus*							e	p	p	30					e
Dasyuromorphia	Dasyuridae	Kultarr	*Antechinomys laniger*							p	e	p	4.8					(?e)
		Northern Quoll	*Dasyurus hallcuatus*	EN	S2										L			
		Brush-tailed Mulgara	*Dasycercus blythi*			P4		p		e		e	1.5					e
		Little Red Kaluta	*Dasykaluta rosamondae*					p					4.8					e
		Wongai Ningaui	*Ningaui ridei*									e						
		Pilbara Ningaui	*Ningaui timealeyi*				p											e
		Woolley's Pseudantechinus	*Pseudantechinus woolley*				p			e	p	p				1		e
		Fat-tailed Dunnart	*Sminthopsis crassicaudata*							e			11					
		Little Long-tailed Dunnart	*Sminthopsis dolichura*							e		p	35					
		White-tailed Dunnart	*Sminthopsis granulipes*										3.2					
		Hairy-footed Dunnart	*Sminthopsis hirtipes*							e			16					
		Long-tailed Dunnart	*Sminthopsis longicaudata*			P4	p	p	p	p	p	p	3.2					e
		Stripe-faced Dunnart	*Sminthopsis macroura*				p	p	p	p	p	p	19			1		e
		Ooldea Dunnart	*Sminthopsis ooldea*															(?e)
		Lesser Hairy-footed Dunnar	*Sminthopsis youngsoni*					p					16					e
Peramelomorphia	Thylacomyidae	Greater Bilby	*Macrotis lagotis*	VU	S3				p	p		e						(?e)
	Macropodidae	Euro	*Macropus robustus*				p	p		p	p	p	17					e
		Red Kangaroo, Marlu	*Macropus rufus*				p				p	p	32					e
		Black-flanked Rock-wallaby	*Petrogale lateralis lateralis*	VU	S3					e		e						(?e)
		Rothschild's Rock-wallaby	*Petrogale rothschildi*				p									1		e
Chiroptera	Pteropodidae	Black Flying-Fox	*Pteropus alecto*				p						p					e
		Little Red Flying Fox	*Pteropus scapulatus*										p					(?e)
	Megadermatidae	Ghost Bat	*Macroderma gigas*	VU	S3		p			e		e	(Barlee Ra)					e
	Hipposideridae	Pilbara Leaf-nosed Bat	*Rhinonicteris aurantia*	VU	S3		p											(?e)
	Emballonuridae	Yellow-bellied Sheathtail-ba	*Saccolaimus flaviventris*					p				e	54					e
		Common Sheathtail-bat	*Taphozous georgianus*				p	p	p	e		e	7.7			6		e
		Hill's Sheathtail-bat	*Taphozous hilli*							p	p	p	(Greenough)					e
	Molossidae	Northern Freetail-bat	*Chaerephon jobensis*				p	p	p				46					e
		Beccari's Freetail-bat	*Mormopterus beccarii*				p	p					46					e
		White-striped Freetail-bat	*Tadarida australis*				p	p		p	p	p	92					e
	Vespertilionidae	Gould's Wattled Bat	*Chalinolobus gouldii*				p	p		p	p	p	92					e
		North-western Long-eared E	*Nyctophilus daedalus*				p											e
		Lesser Long-eared Bat	*Nyctophilus geoffroyi*				p	p		p	p	p	100					e
		Inland Broad-nosed Bat	*Scotorepens balstoni*							p	p	p	7.7					(?e)
		Little Broad-nosed Bat	*Scotorepens greyii*				p	p			p	e	46					e
		Finlayson's Cave Bat	*Vespadelus finlaysoni*				p	p	p	p	p	p	38			10		e
		Spinifex Hopping-mouse	*Notomys alexis*				p	p	p	p	p	p	71					e
		Ash-grey Mouse	*Pseudomys albocinereus*									e	13					
		Western Pebble-mound Mou	*Pseudomys chapmani*			P4	p	p	p	e		e						(ex)
		Delicate Mouse	*Pseudomys delicatulus*				p											(?e)
		Desert Mouse	*Pseudomys desertor*															(?e)
		Sandy Inland Mouse	*Pseudomys hermannsburgensis*				p	p	p	p	p	p	75					e
		Common Rock-rat	*Zyzomys argurus*				p						3.2					e
		House Mouse	**Mus musculus*				p		p	p	p	p	22		L			e
Lagomorpha	Leporidae	Rabbit	**Oryctolagus cuniculus*								p	p	51		L			e
Artiodactyla	Camelidae	Camel	**Camelus dromedaries*							p			3.2		L			e
	Bovidae	Domestic Cattle	**Bos taurus*									p	6.3					e
		Goat	**Capra hircus*								p	p	49		L			e
		Sheep	**Ovis aries*							e			54					e
Perissodactyla	Equidae	Donkey	**Equus asinus*				p			e					L			e
		Horse	**Equus caballus*				p			e		e	4.8					e
Carnivora	Canidae	Dingo	*Canis lupus dingo*						p		p	p				3		e
		Dog	**Canis lupus familiaris*							e		e			L			e
		Red Fox	**Vulpes vulpes*							e	p	p	68		L			(?e)
	Felidae	Domestic Cat	**Felis catus*							2	p	p	30		L			e
REPTILES																		
Testudines	Cheluidae	Flat-shelled Turtle	*Chelodina steindachneri*							p		p						(?e)
Squamata	Agamidae	Long-nosed Dragon	*Amphibolurus longirostris*				p	p			p	p	3.2					e
		Ringtailed Dragon	*Ctenophorus caudicinctus*				p	p	p	p	p	p	1.6			3		p
		Black-collared Dragon	*Ctenophorus clayi*					p					6.3					(?e)
		Long-tailed Sand Dragon	*Ctenophorus femoralis*					p					3.2					(?e)
		Military Dragon	*Ctenophorus isolepis*				p					e						e
		Spotted Military Dragon	*Ctenophorus maculatus*							e			35					(?e)
		Central Netted Dragon	*Ctenophorus nuchalis*					p			p	p	21					e
		Ornate Crevice Dragon	*Ctenophorus ornatus*							e		e						
		Western Netted Dragon	*Ctenophorus reticulatus*				p	p	p	p	p	p	33					e
		Red Dragon	*Ctenophorus rubens*					p					13					e
		Lozenge-marked Dragon	*Ctenophorus scutulatus*								p	p	24					e
		Yinnietharra Rock Dragon	*Ctenophorus yinnietharra*	VU	S3													e
		Carnarvon Dragon	*Diporiphora adductus*					p										e
		Mulga Dragon	*Diporiphora amphiboluroides (ex Caimanops)*							p	e	p				1		e
		Carnarvon Dragon	*Diporiphora adductus (ex winneckei)*										3.2					e
		Thorny Devil	*Moloch horridus*							e		p	21					(?e)
		Western Bearded Dragon	*Pogona minor*				p	p		p	p	p	65			1		e
		Pebble Dragon	*Tympanocryptis cephalus*						p	p	p	p						e
	Gekkonidae	Pilbara Dtella	*Gehyra pilbara*				p											(?e)
		Spotted Dtella	*Gehyra punctata*				p	p		p	p	p	1.6			1		e
		Common Dtella	*Gehyra variegata*				p	p	p	p	p	p	79			3		e
		Bynoe's Prickly Gecko	*Heteronotia binoei*				p	p	p	p	p	p	33			3		e
		Desert Cave Gecko	*Heteronotia spelea*				p	p										e
	Carphodactylidae	Smooth Knob-tailed Gecko	*Nephrurus levis*					p		e			63					e
		Midline Knob-tailed Gecko	*Nephrurus vertebralis*							p	e	p						

ORDER	FAMILY	COMMON NAME	SCIENTIFIC NAME	EPBC Act	WC Act s	DPAW	NatureMap (Barlee Range)	NatureMap (Kennedy Range)	NatureMap (Mt Augustus)	Ecoscape 2012 Pindabarn	ecologia 2009 Jack Hills	ecologia 2009 Weld Range	Burbidge et al. 2000 (% quadrats)	Storr 1985 Gascoyne Region	PMST	ALA (number of records)	Birdata	Yangibana
Squamata		Banded Knob-tailed Gecko	*Nephrurus wheeleri cinctus*							e		e						(?e)
	Diplodactylidae	Clawless Gecko	*Crenadactylus ocellatus (s.l.)*				p			e			11					e
		Fat-tailed Gecko	*Diplodactylus bilybara/conspicillatus (s.l.)*				p			p	p	e	14					e
		Western Stone Gecko	*Diplodactylus granariensis*									e						
		Kluge's Gecko	*Diplodactylus klugei*										9.5					e
		Ornate Stone Gecko	*Diplodactylus ornatus*										13					e
		Fine-faced Gecko	*Diplodactylus pulcher*					p		p	p	p	22					e
		Yellow-spotted Pilbara Geck	*Diplodactylus savagei*				p											e
		Spotted Ground Gecko	*Lucasium squarrosum*					p				p	43					e
		Sand-plain Gecko	*Lucasium stenodactylum*				p	p	p	p	p	e	9.5					e
		Pilbara Ground Gecko	*Lucasium wombeyi*				p											e
		Marbled Velvet Gecko	*Oedura marmorata*				p	p		p	p	p						e
		Western Beaked Gecko	*Rhynchoedura ornata*				p			p	p	e	24					e
		Northern Spiny-tail gecko	*Strophurus ciliaris*															e
		Jewelled Gecko	*Strophurus elderi*				p					e						e
		Southern Phasmid Gecko	*Strophurus jeanae*															e
		Robust Striped Gecko	*Strophurus michaelseni*										1.6					e
		Exmouth Spiny-tailed Geck	*Strophurus rankini*										3.2					e
		Soft Spiny-tailed Gecko	*Strophurus spinigerus*										9.5					e
		Western Spiny-tail Gecko	*Strophurus strophurus*					p	p	p	p	e	43					e
		Western Shield Spiny-tail G	*Strophurus wellingtonae*						p	e		p						e
		Mount Augustus Spiny-taile	*Strophurus wilsoni*															e
	Pygopodidae	Southern (Marble-faced) De	*Delma australis*							e		p	6.3					
		Unbanded Delma	*Delma butleri*							p	p	e	6.3					e
		Pilbara Delma	*Delma elegans*															e
		Fraser's Delma	*Delma fraseri*									e						
		Neck-barred Delma	*Delma haroldi*															e
		Sharp-snouted Delma	*Delma nasuta*				p					e	3.2					e
		Peace Delma	*Delma pax*															e
		Excitable Delma	*Delma tincta*				p			p	e	e						e
		Burton's Legless lizard	*Lialis burtonis*				p	p		e	e	e	14					e
		Western Hooded Scaly-foot	*Pygopus nigriceps*							e	p	p	6.3					e
	Scincidae	Shaded-litter Rainbow Skink	*Carlia munda*															e
		Desert Rainbow Skink	*Carlia triacantha*															e
		Buchanan's Snake-eyed Sk	*Cryptoblepharus buchananii*						p	e	p	p	3.2					e
		Péron's Snake-eyed Skink	*Cryptoblepharus plagiocephalus*							e		e	1.6					e
		Russet Snake-eyed Skink	*Cryptoblepharus ustulatus*				p											e
		Western Limestone Ctenotu	*Ctenotus australis*										3.2					e
		Blue-tailed Finesnout Cteno	*Ctenotus calurus*					p					7.9					e
		Pilbara Ctenotus	*Ctenotus duricola*				p											(?e)
		Grand Ctenotus	*Ctenotus grandis*				p											(?e)
		Nimble Ctenotus	*Ctenotus hanloni*				p	p					11					e
		Clay-soil Ctenotus	*Ctenotus helenae* (or aff.)				p			e	e	e						e
		North West Cape Ctenotus	*Ctenotus iapetus*					p					16					e
			Ctenotus inornatus															e
		Leonhard's Ctenotus	*Ctenotus leonhardii*							p	p	p						e
		Maryan's Ctenotus	*Ctenotus maryani*					p										e
		Checker-sided Ctenotus	*Ctenotus mimetes*							e	e	e	3.2					(?e)
		Leopard Ctenotus	*Ctenotus pantherinus*				p	p		e		e	11					e
		Coarse Sands Ctenotus	*Ctenotus piankai*										4.8					e
		Ruddy Ctenotus	*Ctenotus rubicundus*				p											(?e)
		Rufous Finesnout Ctenotus	*Ctenotus rufescens*					p										e
		Rusty-shouldered Ctenotus	*Ctenotus rutilans*				p		p									e
		Rock Ctenotus	*Ctenotus saxatilis*				p					e	3.2					e
		Barred Wedge-snout Ctenot	*Ctenotus schomburgkii*				p	p	p	p	p	p	33					e
		Stern Ctenotus	*Ctenotus severus*					p	p	p	p	p	4.8			3		e
		Spotted Ctenotus	*Ctenotus uber uber*					p			e	p	7.9			1		e
		Spinifex Slender Bluetongue	*Cyclodomorphus melanops*				p	p		p	p	e	1.6					e
		Southern Pygmy Spiny-taile	*Egernia depressa* (s.l.)							p	e	p	7.9					e
		Goldfields Crevice-skink	*Egernia formosa*				p											e
		Western Narrow-banded Sa	*Eremiascincus pallidus (ex fasciolatus)*					p					9.5					e
		Broad-banded Sandswimme	*Eremiascincus richardsonii*							p	p	p						e
		Northwestern Sandslider	*Lerista bipes* (& aff.)				p			e		e	1.6					e
		Sharp-blazed Three-toed Sl	*Lerista clara*					p					p					e
		Blinking Broad-blazed Slide	*Lerista connivens*					p		e			25					e
		Elegant Slider	*Lerista elegans*					p					35					e
		Good-legged Slider	*Lerista eupoda*			P1				e	e	p						
		Pilbara Flame-tailed Slider	*Lerista flammicauda*				p											(?e)
		Gascoyne Broad-blazed Sli	*Lerista gascoynensis*					p					11					e
		Kennedy Range Broad-blaz	*Lerista kennedyensis*					p					1.6					e
		Unpatterned Robust Slider	*Lerista macropisthopus*				p	p	p	e	p	e	60			2		e
		Micro Slider	*Lerista micra*					p										(?e)
		Wood-mulch Slider	*Lerista muelleri*				p			e								(?e)
		Inland Broad-blazed Slider	*Lerista nichollsi*							p	e	p						
		Hidden Slider	*Lerista occulta*					p										(?e)
		Pale Broad-blazed Slider	*Lerista petersoni (=L. talpina)*				p	p	p				1.6					e
		Keeled Slider	*Lerista planiventralis*					p					14					
		Blunt-tailed West-coast Slid	*Lerista praepedita*							e			p					
		Rolfe's Slider	*Lerista rolfei*				p	p	p							14		e
		Spotted Broad-blazed Slide	*Lerista sticopleura*						p									
		Timid Slider	*Lerista timida* (='*rhodonoides*')							e	p	p						e
		Slender Broad-blazed Slide	*Lerista uniduo*					p				e	54					(?e)
		Common Dwarf Skink	*Menetia greyii*				p	p	p	p	p	p	24			1		e
		Western Dwarf Skink	*Menetia surda*				p	p		e		e	17					e

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		Woodland Morethia Skink	*Morethia butleri*							e		e	1.6					
		Shrubland Morethia Skink	*Morethia obscura*							e	e	e	1.6					
		Fire-tailed Skink	*Morethia ruficauda exquisita*				p	p					1.6			2		e
		Ornate Soil-crevice Skink	*Notoscincus ornatus*				p	p	p				3.2			1		e
		Central Bluetongue	*Tiliqua multifasciata*										1.6					e
		Western Bluetongue	*Tiliqua occipitalis*							e	e	e	3.2					e
	Varanidae	Ridge-tailed Monitor	*Varanus acanthurus*				p									2		e
		Short-tailed Pygmy Monitor	*Varanus brevicauda*				p	p			e	e	6.3					e
		Stripe-tailed Monitor	*Varanus caudolineatus*				p	p	p	p	p	p	11					e
		Pygmy Desert Monitor	*Varanus eremius*				p	p		e	e		40					e
		Perentie	*Varanus giganteus*					p		p	p	p						e
		Gould's Sand Monitor	*Varanus gouldii*							p	p	e	14					e
		Yellow-spotted Monitor	*Varanus panoptes*				p				p	p				1		e
		Black-tailed Monitor	*Varanus tristis*				p				p	p				1		e
	Typhlopidae	Long-beaked Blindsnake	*Anilios grypus*							p	e	e	16					
		Pale-headed Blindsnake	*Anilios hamatus*							e	p	p	13					(?e)
		Beaked Blindsnake	*Anilios waitii*							e		e						(?e)
	Pythonidae	Pygmy Python	*Antaresia perthensis*						p	e	p	p	1.6			1		e
		Stimson's Python	*Antaresia stimsoni*							e	e	e						e
	Elapidae	Desert Death Adder	*Acanthophis pyrrhus*					p		e	e	e	1.6					e
		Pilbara Shovel-nosed Snake	*Brachyurophis approximans*							p	p	p						e
		Yellow-faced Whipsnake (N	*Demansia psammophis cupreiceps*							e	p	e	1.6					e
		Moon Snake	*Furina ornata*				p			e	e	p	3.2					e
		Monk Snake	*Parasuta monachus*							e	e	p						(?e)
		Mulga Snake, King Brown	*Pseudechis australis*				p			e	e	e	1.6					e
		Spotted Mulga Snake	*Pseudechis butleri*							e	e	p						
		Gwardar, Western Brown Sı	*Pseudonaja mengdeni*					p			e	e	6.3					e
		Ringed Brown Snake	*Pseudonaja modesta*					p	p	p	e	p	7.9					e
		Jan's Banded Snake	*Simoselaps bertholdi*				p	p		p	e	p	33					e
		Rosen's Snake	*Suta fasciata*						p	e	e	p	1.6					e
		Spotted Snake	*Suta punctata*															(?e)
BIRDS																		
Casuariiformes	Casuariidae	Emu	*Dromaius novaehollandiae*				p	p	p	3	p	p	97	p		19	p	e
	Phasianidae	Stubble Quail	*Coturnix pectoralis*							e			1.6	v		1		e
		Brown Quail	*Coturnix ypsiliophora*				p			e							p	e
Anseriformes	Anseranatidae	Magpie Goose	*Anseranas semipalmata*											(v)				
	Anatidae	Plumed Whistling Duck	*Dendrocygna eytoni*							p		e		p				e
		Wandering Whistling Duck	*Dendrocygna arcuata*					p										e
		Freckled Duck	*Stictonetta naevosa*							e		e		(v)				
		Black Swan	*Cygnus atratus*					p	p	p		e	14	v		8	p	e
		Australian Shelduck	*Tadorna tadornoides*							e		e	7.1	v				e
		Australian Wood Duck	*Chenonetta jubata*						p	p		e	20	v		5	p	e
		Pink-eared Duck	*Malacorhynchus membranaceus*							e		e	11	v		1		e
		Australian Shoveler	*Anas rhynchotis*							p				v				
		Grey Teal	*Anas gracilis*				p	p	p	p		e	32	p		13	p	e
		Pacific Black Duck	*Anas superciliosus*				p	p	p	p		e	16	v		13	p	e
		Hardhead	*Aythya australis*							p				v		2		e
		Blue-billed Duck	*Oxyura australis*			P4				e		e		(v)				
Podicipiformes	Podicipedidae	Australasian Grebe	*Tachybaptus novaehollandiae*				p		p	p		e	8.9	v		8	p	e
		Hoary-headed Grebe	*Poliocephalus poliocephalus*						p	p		e	18	v		5		e
Columbiformes	Columbidae	Rock Dove, Feral Pigeon	**Columba livia*						p	e			1.6		L			e
		Laughing Dove	**Streptopelia senegalensis*							e			3.2	(?p)				
		Common Bronzewing	*Phaps chalcoptera*				p	p	p	p	p	p	52	p		9	p	e
		Crested Pigeon	*Ocyphaps lophotes*				p	p	p	2	p	p	70	p		22	p	e
		Spinifex Pigeon	*Geophaps plumifera*				p	p	p	p		e	1.6	p		34	p	e
		Diamond Dove	*Geopelia cuneata*				p	p	p	20	p	p	30	p		29	p	e
		Peaceful Dove, Zebra Dove	*Geopelia striata*				p	p	p	p	e	e		p		30	p	e
Caprimulgiformes	Podargidae	Tawny Frogmouth	*Podargus strigoides*				p	p		p	p	p	14	p		2		e
	Eurostopodidae	Spotted Nightjar	*Eurostopodus argus*							p	p	p	11	p		2	p	e
	Aegothelidae	Australian Owlet Nightjar	*Aegotheles cristatus*				p	p	p	p	p	p	22	p		6	p	e
Apodiformes	Apodidae	Fork-tailed Swift	*Apus pacificus*	M	S5					e		e	0	v	L	1	p	e
Suliformes	Anhingidae	Australasian Darter	*Anhinga novaehollandiae*							p		e	11	p		7	p	e
	Phalacrocoracidae	Little Pied Cormorant	*Microcarbo melanoleucos*							p		e	11	p		17	p	e
		Great Cormorant	*Phalacrocorax carbo*						p	e				(v)				e
		Little Black Cormorant	*Phalacrocorax sulcirosreis*					p	p	p		e	11	p		17	p	e
		Pied Cormorant	*Phalacrocorax varius*							e			5.4	p				e
Pelecaniformes	Pelecanidae	Australian Pelican	*Pelecanus conspicillatus*					p	p	p		e	8.9	v		8	p	e
		White-necked Heron	*Ardea pacifica*				p	p	p	p		e	25	p		7	p	e
		Eastern Great Egret	*Ardea modesta*		S5			p	p	p		e	7.1	p	K	16	p	e
		Cattle Egret	*Ardea ibis*		S5					e		e						(?e)
		White-faced Heron	*Egretta novaehollandiae*				p			p		e	34	p		25	p	e
		Little Egret	*Egretta garzetta*										5.4	p				
		Nankeen Night-heron	*Nycticorax caledonicus*						p	p		e		p		1		e
	Threskiornithidae	Glossy Ibis	*Plegadis falcinellus*	M	S5					e				p				(?e)
		Straw-necked Ibis	*Threskiornis spinicollis*					p	p	p		e	5.4	p		6	p	e
		Yellow-billed Spoonbill	*Platalea flavipes*					p		p		p	5.4	v		7	p	e
	Accipitridae	Black-shouldered Kite	*Elanus axillaris*							1	p	e	9.5	p				e
		Square-tailed Kite	*Lophoictinia isura*							p		e	1.6			1		e
		Black-breasted Buzzard	*Hamirostra melanosternon*					p	p	1	p	p	6.3	p	5		p	e
		White-bellied Sea-eagle	*Haliaeetus leucogaster*										1.6	p				e
		Whistling Kite	*Haliastur sphenurus*				p	p	p	4	p	p	13	p		32	p	e
		Black Kite	*Milvus migrans*						p	p		e		v				e
		Brown Goshawk	*Accipiter fasciatus*				p	p	p	p	p	p	3.2	p		2	p	e
		Collared Sparrowhawk	*Accipiter cirrocephalus*				p		p	p	p	p	9.5	p		5	p	e

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Accipitriformes		Spotted Harrier	*Circus assimilis*					p	p	1	p	e	16	p		5		e
		Swamp Harrier	*Circus approximans*				p	p		e				(v)			p	e
		Wedge-tailed Eagle	*Aquila audax*				p	p	p	3	p	p	35	p		14	p	e
		Little Eagle	*Hieraeetus morphnoides*							p		e	7.9	p			p	e
	Falconidae	Nankeen Kestrel	*Falco cenchroides*				p	p	p	1	p	p	68	p		19	p	e
		Brown Falcon	*Falco berigora*				p	p	p	1	p	p	38	p		8	p	e
		Australian Hobby	*Falco longipennis*				p	p	p	p	p	p	7.9	p		8	p	e
		Grey Falcon	*Falco hypoleucos*		S3							e	1.6	(v)		1	p	e
		Peregrine Falcon	*Falco peregrinus*		S7			p	p	p	p	p		v		2		e
		Australian Spotted Crake	*Porzana fluminea*							e				p				
		Black-tailed Native-hen	*Tribonyx ventralis*							p		e	5.3	p		1		e
		Dusky Moorhen	*Gallinula tenebrosa*				p											e
		Eurasian Coot	*Fulica atra*						p	p		e	8.9	p		3		e
	Otididae	Australian Bustard	*Ardeotis australis*					p	p	2	e	e	27	p		5		e
Charadriiformes	Burhinidae	Bush Stone-curlew	*Burhinus grallarius*				p	p	p	p	p	p		p		1		e
	Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*							p		e	5.4	p				e
		Red-necked Avocet	*Recurvirostra novaehollandiae*							e		e	7.1	v				e
		Banded Stilt	*Cladorhynchus leucocephalus*							e		e	7.1	v				e
		Red-capped Plover	*Charadrius ruficapillus*							p		e	11	p				e
		Inland Dotterel	*Charadrius australis*				p			p		e		p				e
		Black-fronted Dotterel	*Elseyornis melanops*							p		e	18	p		30	p	e
		Red-kneed Dotterel	*Erythrogonys cinctus*							e		e	5.4	p				e
		Banded Lapwing	*Vanellus tricolor*				p	p		2	e	e	3.6	p				e
	Scolopacidae	Common Greenshank	*Tringa nebularia*	M	S5					e			7.1	v		1	p	e
	Turnicidae	Little Button-quail	*Turnix velox*				p	p	p	12	p	p	21	p				e
	Laridae	Gull-billed Tern	*Gelochelidon nilotica*							p		e	3.6	v				
		Whiskered Tern	*Chlidonias hybrida*							e		e		v				
		Crested Tern	*Thalasseus bergii*											p				
Psittaciformes	Cacatuidae	Red-tailed Black Cockatoo	*Calyptorhynchus banksii*					p		e	e	e	9.5	p				e
		Major Mitchell's Cockatoo	*Lophochroa leadbeateri*							p	e	e		(p)				
		Galah	*Eolophus roseicapillus*				p	p		3	p	p	51	p		42	p	e
		Little Corella (Pilbara-Murch	*Cacatua sanguinea westralensis*				p	p	p	p	e	e	4.8	p		38	p	e
		Cockatiel	*Nymphicus hollandicus*				p	p	p	2	p	p	13	p		16	p	e
	Psittaculidae	Regent Parrot	*Polytelis anthopeplus*							e				p				
		Australian Ringneck	*Barnardius zonarius*				p	p		2	p	p	44	p		30	p	e
		Mulga Parrot	*Psephotus varius*						p	1	p	p	25	p		1		e
		Budgerigar	*Melopsittacus undulatus*				p	p	p	18	p	p	40			17	p	e
		Bourke's Parrot	*Neopsephotus bourkii*							e	p	p	4.8	p		9		e
		Elegant Parrot	*Neophema elegans*							p		p		v				
		Night Parrot	*Pezoporus occidentalis*	EN	S1							e		(v)				
Cuculiformes	Cuculidae	Horsfield's Bronze-Cuckoo	*Chalcites basalis*							p	p	p	44	v		7	p	e
		Black-eared Cuckoo	*Chalcites osculans*					p		p	e	p	46	v		3	p	e
		Pallid Cuckoo	*Cacomantis pallidus*				p	p	p	p	p	p	6.3	v		1	p	e
Strigiformes	Strigidae	Barking Owl	*Ninox connivens*											(p)		3	p	e
		Southern Boobook	*Ninox novaeseelandiae*				p	p	p	p	e	p	4.8	p		10	p	e
		Eastern Barn Owl	*Tyto javanica (ex alba)*							p	p	e		(v)		1	p	e
Coraciiformes	Halcyonidae	Blue-winged Kookaburra	*Dacelo leachii*				p	p	p	e			1.6	p		16	p	e
		Red-backed Kingfisher	*Todiramphus pyrrhopygia*				p	p	p	2	p	e	4.8	p		10	p	e
		Sacred Kingfisher	*Todiramphus sanctus*				p	p	p	p	e	e	1.6	p		14	p	e
	Meropidae	Rainbow Bee-eater	*Merops ornatus*		S5		p	p	p	p	p	e	7.9	p	M	32	p	e
Passeriformes	Climacteridae	White-browed Treecreeper	*Climacteris affinis*							1		e		p				
		Black-tailed Treecreeper	*Climacteris melanura*											p		1		e
	Ptilonorhynchidae	Western Bowerbird	*Ptilonorhynchus guttatus*							p	p	e		p		3	p	e
	Maluridae	Splendid Fairy-wren	*Malurus splendens*					p	p	1	p	p	30	p		6	p	e
		White-winged Fairy-wren (m	*Malurus leucopterus leuconotus*				p	p	p	p	e	p	57	p		5		e
		Variegated Fairy-wren	*Malurus lamberti*				p		p	p	p	p	73	p		26	p	e
		Blue-breasted Fairy-wren	*Malurus pulcherrimus*							e			6.3	p				
		Rufous-crowned Emu-wren	*Stipiturus ruficeps*					p					3.2	p				e
		Thick-billed Grasswren (wes	*Amytornis t. textilis*			P4							7.9	p				
	Acanthizidae	White-browed Scrubwren	*Sericornis frontalis*							e			30	p				
		Rufous Fieldwren (other ma	*Calamanthus campestris*							e			33	(p)		1		e
		Redthroat	*Pyrrholaemus brunneus*				p	p	p	p	p	p	68	p		15	p	e
		Weebill	*Smicrornis brevirostris*				p	p	p	5	p	p	17	p		14	p	e
		Western Gerygone	*Gerygone fusca fusca*				p	p	p	p	p	p	14	v		18	p	e
		Desert Gerygone	*Gerygone fusca mungi*											v				
		Slaty-backed Thornbill	*Acanthiza robustirostris*				p	p	p	p	p	p	3.2	p		6	p	e
		Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*					p	p	p	p	p	3.2	p		7	p	e
		Chestnut-rumped Thornbill	*Acanthiza uropygialis*					p	p	p	p	p	56	p		23	p	e
		Slender-billed Thornbill (wes	*Acanthiza iredalei iredalei*							e		p	3.2	p				
		Broad-tailed (Inland) Thornb	*Acanthiza apicalis*						p	p	p	p	40	p		3		e
		Southern Whiteface	*Aphelocephala leucopsis*					p	p	p	p	p	35	p		9		e
		Banded Whiteface	*Aphelocephala nigricincta*							p	e	e		(p)		4		e
	Pardalotidae	Red-browed Pardalote	*Pardalotus rubricatus*							e	e	e	1.6	p		9	p	e
		Striated Pardalote	*Pardalotus striatus*				p	p	p	p	p	p	17	p		10	p	e
	Meliphagidae	Pied Honeyeater	*Certhionyx variegatus*					p	p	1	e	e	43	v		2	p	e
		Singing Honeyeater	*Gavicalis virescens (ex Lich.)*				p			10	p	p	89	p		31	p	e
		Grey-headed Honeyeater	*Ptilotula keartlandi (ex Lich.)*													1		e
		Grey-fronted Honeyeater	*Ptilotula plumulus (ex Lich.)*							e			6.3	p				
		White-plumed Honeyeater	*Ptilotula penicillatus (ex Lich.)*				p			1	p	p	1.6	p		47	p	e
		White-fronted Honeyeater	*Purnella albifrons*					p	p	p	p	e	35	v				e
		Yellow-throated Miner	*Manorina flavigula*				p	p	p	2	p	p	19	p		12	p	e
		Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*				p	p	p	3	p	p	71	p		22	p	e
		Red Wattlebird	*Anthochaera carunculata*							e			1.6	p				
		Grey Honeyeater	*Conopophila whitei*							e		p		p		7		e

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Passeriformes		Crimson Chat	*Epthianura tricolor*				p	p	p	10	p	p	29	p		8	p	e
		Orange Chat	*Epthianura aurifrons*							p		p	3.2	p				
		White-fronted Chat	*Epthianura albifrons*							e	e	e	4.8	p				
		Black Honeyeater	*Sugomel niger*					p		p	e	e	3.2	v				e
		Brown Honeyeater	*Lichmera indistincta*				p	p	p	p	p	e	9.5	p		11	p	e
		Brown-headed Honeyeater	*Melithreptus brevirostris*							e			13	p				
	Pomatostomidae	Grey-crowned Babbler	*Pomatostomus temporalis*				p	p	p	p	p	p	9.5	p		29	p	e
		White-browed Babbler	*Pomatostomus superciliosus*				p	p	p	4	p	p	76	p		1		e
	Cinclosomatidae	Chestnut Quail-thrush	*Cinclosoma castanotum*							e			11	p			p	
		Western Quail-thrush	*Cinclosoma marginatum*				p	p	p	p	p	p	4.8	p		6		e
	Psophodidae	Chiming Wedgebill	*Psophodes occidentalis*				p	p	p	2	p	e	65	p				e
	Neosittidae	Varied Sittella	*Daphoenositta chruysoptera*				p	p		1	p	e	8	p		1		e
	Campephagidae	Ground Cuckoo-shrike	*Coracina maxima*				p			p	p	p	1.6	p		1		e
		Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				p	p	p	p	p	p	19	p		36	p	e
		White-winged Triller	*Lalage sueurii*				p			6	p	p	33	v		12	p	e
	Pachycephalidae	Golden Whistler	*Pachycephala pectoralis*							e		e	6.3					
		Rufous Whistler	*Pachycephala rufiventris*				p	p	p	12	p	p	52	p		36	p	e
		Grey Shrike-thrush	*Colluricincla harmonica*				p	p	p	p	p	p	60	p		23	p	e
		Crested Bellbird	*Oreoica gutturalis (pallescens)*				p	p	p	e	p	p	84	p		28	p	e
	Artamidae	Masked Woodswallow	*Artamus personatus*				p	p	p	12	e	p	29	p		1		e
		Black-faced Woodswallow	*Artamus cinereus*				p	p	p	1	p	p	44	p		33	p	e
		Little Woodswallow	*Artamus minor*					p	p	p	p	p	3.2	p		1	p	e
	Cracticidae	Grey Butcherbird	*Cracticus torquatus*				p	p	p	1	p	p	56	p		5	p	e
		Pied Butcherbird	*Cracticus nigrogularis*				p	p	p	1	p	p	49	p		23	p	e
		Australian Magpie	*Cracticus tibicen*				p	p	p	p	p	p	3.2	p		7	p	e
		Grey Currawong	*Strepera versicolor*							e			1.6	(p)				
	Rhipiduridae	Grey Fantail	*Rhipidura albiscapa*				p	p		p	e	p	41	p		5	p	e
		Willie Wagtail	*Rhipidura leucophrys*				p	p	p	4	p	p	65	p		56	p	e
		Little Crow	*Corvus bennetti*				p	p	p	p	p	p	70	p		10	p	e
		Torresian Crow	*Corvus orru*				p	p	p	p	p	p	11	p		20	p	e
	Monarchidae	Magpie-Lark	*Grallina cyanoleuca*				p	p	p	1	p	p	1.6	p		48	p	e
	Petroicidae	Jacky Winter	*Microeca fascinans*							p	p	e		p				
		Red-capped Robin	*Petroica goodenovii*				p	p	p	p	p	p	49	p		18	p	e
		Hooded Robin	*Melanodryas cucullata*				p			1	p	p	21	p		7	p	e
		Western Yellow Robin	*Eopsaltria griseogularis*							e			4.8	p				
		Southern Scrub-robin	*Drymodes brunneopygia*							e			16	p				
	Alaudidae	Horsfield's (Singing) Bushla	*Mirafra javanica horsfieldii*					p						p		1		e
	Acrocephalidae	Australian Reed-warbler	*Acrocephalus australis*					p	p	e		e		p				e
	Megaluridae	Little Grassbird	*Megalurus gramineus*							e				p				
		Rufous Songlark	*Cincloramphus mathewsi*				p	p	p	p	p	p		p		11	p	e
		Brown Songlark	*Cincloramphus cruralis*				p	p	p	p	p	e	4.8	p		3	p	e
		Spinifexbird	*Eremiornis carteri*				p							p			p	e
	Timaliidae	Yellow White-eye	*Zosterops luteus*										6.3	p				
		Silvereye	*Zosterops lateralis*							e			16	p				
	Hirundinidae	White-backed Swallow	*Cheramoeca leucosterna*							p	p	p	11	p		2		e
		Welcome Swallow	*Hirundo neoxena*					p	p	p	p	p	17	p		1		e
		Fairy Martin	*Petrochelidon ariel*				p			p	e	p	1.6	p		2	p	e
		Tree Martin	*Petrochelidon nigricans*				p		p	p	p	e	52	p		38	p	e
	Nectariniidae	Mistletoebird	*Dicaeum hirundinaceum*				p	p	p	p	p	p	13	p		10	p	e
	Estrildidae	Zebra Finch	*Taeniopygia guttata*				p	p	p	19	p	p	70	p		46	p	e
		Star Finch (western)	*Neochmia ruficauda subclarescens*				p		p					(p)		5	p	e
		Painted Finch	*Emblema pictum*					p	p	e	p	e	1.6	p		2	p	e
	Motacillidae	Australasian Pipit	*Anthus novaeseelandiae*				p			p	p	p	32	p		15	p	e
FISH																		
Clupeiformes	Clupeidae	Bony Bream	*Nematalosa erebi*															e
Cypriniformes	Cyprinidae	Goldfish	**Carassius auratus*				p											
Siluriformes	Plotosidae	Eel-tailed Catfish, Tandan	*Neosilurus sp./"hyrtli"*				p											e
Gobiiformes	Eleotridae	Golden Gudgeon	*Hypseleotris aurea*			P2		p										e
Cichliformes	Cichlidae	Blue Tilapia	**Oreochromis mossambica*					p										e
Atheriniformes	Melanotaeniidae	Western Rainbowfish	*Melanotaenia australis*															e
formes (incl. Cirr	Terapontidae	Barred Grunter	*Amniataba percoides*				p											e
		Fortescue Grunter	*Leiopotherapon aheneus*			P4	p											e
		Spangled Perch	*Leiopotherapon unicolor*													1		e
AMPHIBIANS																		
Anura	Hylidae	Sheep Frog	*Cyclorana maini*				p			e	e	e	9.5					e
		Water-holding Frog	*Cyclorana platycephala*							p	e	e	1.6					e
		Little Red Tree Frog	*Litoria rubella*				p		p	p	e	p	3.2			12		e
	Limnodynastidae	Northern Burrowing Frog	*Neobatrachus aquilonius*				p						3.2					e
		Tawny Trilling Frog	*Neobatrachus fulvus*										4.8					e
		Shoemaker Ftrog	*Neobatrachus sutor*				p	p		e			4.8					e
		Plonking Frog	*Neobatrachus wilsmorei*							e		e	21					?
		Desert Spadefoot	*Notaden nichollsi*															e
		Desert Burrowing Frog	*Platyplectrum spenceri*					p	p	p	e	e	9.5					e
	Myobatrachidae	Gorge Toadlet	*Pseudophryne douglasi*				p		p									e
		Crawling Toadlet	*Pseudophryne guentheri*										3.2					(?e)
		Western Toadlet	*Pseudophryne occidentalis*							e								(?e)
		Northwest Toadlet	*Uperoleia russelli*						p				4.8					e
		Pilbara Toadlet	*Uperoleia saxatilis*															(?e)

p = present
v = vagrant
e = expected

(v) = vagrant along coast, uncommon inland
(x) = thought to be extinct
(p) = present along coast and Gascoyne region
(?e) = low expectancy
L = species or habitat likely to occur

APPENDIX FIVE: SPECIES RECORDED

Mammals

FAMILY	COMMON NAME	SCIENTIFIC NAME	EPBC Act	WC Act	DPaW	HYS 1	HYS 2	HYS 3	HYS 4	HYS 5	HYS 6	HYS 7	HYS 8	HYS Opp
Dasyuridae	Woolley's Pseudantechinus	*Pseudantechinus woolley*					1							
	Long-tailed Dunnart	*Sminthopsis longicaudata*			P4					1				
	Stripe-faced Dunnart	*Sminthopsis macroura*				1			1	4	3		1	
Macropodidae	Euro	*Macropus robustus*								1				
	Red Kangaroo	*Macropus rufus*					1			1				4
Emballanuridae	Hill's Sheathtail Bat	*Taphozous hilli*								P		P		P
Vespertilionidae	Gould's Wattled Bat	*Chalinolobus gouldii*				P	P	P	P	P	P	P	P	P
	Lesser Long-eared Bat	*Nyctophilus geoffroyi*				P				P	P	P	P	P
	Inland Broad-nosed Bat	*Scotorepens balstoni*												P
	Little Broad-nosed Bat	*Scotorepens greyii*												P
	Finlayson's Cave Bat	*Vespadelus finlaysoni*					P	P	P	P	P	P	P	P
Molossidae	Northern Freetail Bat	*Chaerophon jobensis*							P	P		P	P	P
	White-striped Freetail Bat	*Tadarida australis*									P			P
Muridae	Western Pebble-mound Mou	*Pseudomys chapmani*								S				S
	Sandy Inland Mouse	*Pseudomys hermannsburgensis*							7	2	1			
	House Mouse	**Mus musculus*				16	1	13	1		1			
Canidae	Dog/dingo	**Canis lupus*						1						3
Bovidae	Domestic Cattle	**Bos taurus*												numerous
Equidae	Horse	**Equus caballus*												2
Felidae	Cat	**Felis catus*												2

S=Secondary evidence (old mounds)

R= Remains

Birds

ORDER	FAMILY	COMMON NAME	SCIENTIFIC NAME	EPBC Act	WC Act	DPaW	HYS 1		HYS 2		HYS 3		HYS 4		HYS5		HYS6		HYS 7		HYS 8		Opp	
							ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2
Anseriformes	Anatidae	Black Swan	*Cygnus atratus*																				p	
		Australian Wood Duck	*Chenonetta jubata*																				p	
		Grey Teal	*Anas gracilis*																				p	p
		Pacific Black Duck	*Anas superciliosus*																				p	
Columbiformes	Columbidae	Common Bronzewing	*Phaps chalcoptera*																					p
		Crested Pigeon	*Ocyphaps lophotes*				p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p	p
		Spinifex Pigeon	*Geophaps plumifera*				p		p			p											p	p
		Diamond Dove	*Geopelia cuneata*				p			p		p	p	p	p	p	p	p	p	p	p	p	p	p
Caprimulgiforme	Eurostopodidae	Spotted Nightjar	*Eurostopodus argus*																				p	
	Aegothelidae	Australian Owlet Nightjar	*Aegotheles cristatus*																					p
Suliformes	Anhingidae	Australasian Darter	*Anhinga novaehollandiae*																					p
	Phalacrocoracidae	Little Pied Cormorant	*Microcarbo melanoleucos*																				p	
		Great Cormorant	*Phalacrocorax carbo*																				p	
		Little Black Cormorant	*Phalacrocorax sulcirosreis*																				p	
		White-necked Heron	*Ardea pacifica*																				p	p
		Eastern Great Egret	*Ardea modesta*		S5																		p	p
Pelecaniformes	Ardeidae	White-faced Heron	*Egretta novaehollandiae*																				p	p
		Little Egret	*Egretta garzetta*																				p	p
		Nankeen Night-heron	*Nycticorax caledonicus*																					p
	Threskiornithidae	Straw-necked Ibis	*Threskiornis spinicollis*								p												p	p
Accipitriformes	Accipitridae	Whistling Kite	*Haliastur sphenurus*				p		p		p						p						p	p
		Brown Goshawk	*Accipiter fasciatus*								p													
		Spotted Harrier	*Circus assimilis*										p				p		p		p		p	
		Swamp Harrier	*Circus approximans*																			p		
		Wedge-tailed Eagle	*Aquila audax*						p						p								p	
	Falconidae	Nankeen Kestrel	*Falco cenchroides*												p				p				p	
		Brown Falcon	*Falco berigora*													p			p				p	p
		Australian Hobby	Falco longipennis								p												p	
		Grey Falcon	Falco hypoleucos		S3																		p	
Gruiformes	Otididae	Australian Bustard	Ardeotis australis																				p	
Charadriiformes	Burhinidae	Bush Stone-curlew	Burhinus grallarius											p				p				p	p	
	Charadriidae	Black-fronted Dotterel	Elseyornis melanops																				p	p
		Banded Lapwing	Vanellus tricolor										p										p	
	Turnicidae	Little Button-quail	Turnix velox				p								p				p	p			p	p
Psittaciformes	Cacatuidae (ex Psittacidae)	Galah	Eolophus roseicapillus				p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	numerous	numerous
		Little Corella	Cacatua sanguinea						p		p	p									p	p	numerous	numerous
		Cockatiel	Nymphicus hollandicus				p	p	p		p	p				p		p		p	p		p	p
	Psittaculidae (ex Psittacidae)	Australian Ringneck	Barnardius zonarius						p	p	p	p	p	p			p				p	p	numerous	numerous
		Budgerigar	Melopsittacus undulatus				p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	numerous	numerous
Cuculiformes	Cuculidae	Black-eared Cuckoo	Chalcites osculans						p		p		p		p		p				p		p	
		Pallid Cuckoo	Cacomantis pallidus						p						p		p				p		p	p
Strigiformes	Strigidae	Southern Boobook	Ninox novaeseelandiae																				p	
Coraciiformes	Halcyonidae	Blue-winged Kookaburra	Dacelo leachii								p		p								p		p	
		Red-backed Kingfisher	Todiramphus pyrrhopygia																				p	
		Sacred Kingfisher	Todiramphus sanctus																					p
	Meropidae	Rainbow Bee-eater	Merops ornatus		S5																		p	p
	Maluridae	White-winged Fairy-wren (mainland)	Malurus leucopterus																				p	
		Variegated Fairy-wren	Malurus lamberti														p			p	p		p	p
	Acanthizidae	Redthroat	Pyrrholaemus brunneus										p	p	p				p				p	p
		Weebill	Smicrornis brevirostris							p				p			p				p		p	p
		Yellow-rumped Thornbill	Acanthiza chrysorrhoa												p						p		p	p
		Chestnut-rumped Thornbill	Acanthiza uropygialis						p				p	p	p		p	p	p	p	p	p	p	p

ORDER	FAMILY	COMMON NAME	SCIENTIFIC NAME	EPBC Act	WC Act	DPaW	HYS 1		HYS 2		HYS 3		HYS 4		HYS5		HYS6		HYS 7		HYS 8		Opp	
							ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2	ph 1	ph 2
Passeriformes	Pardalotidae	Red-browed Pardalote	Pardalotus rubricatus											p								p	p	p
	Meliphagidae	Singing Honeyeater	Gavicalis virescens				p		p		p		p	p	p	p	p	p	p	p	p	p	numerous	numerous
		White-plumed Honeyeater	Ptilotula penicillatus						p														p	p
		Yellow-throated Miner	Manorina flavigula				p	p	p	p	p	p	p						p		p		numerous	numerous
		Spiny-cheeked Honeyeater	Acanthagenys rufogularis												p		p	p	p	p			8	p
		Crimson Chat	Epthianura tricolor										p			p		p		p			p	p
		Black Honeyeater	Sugomel niger				p		p	p					p		p			p			p	
	Pomatostomidae	Grey-crowned Babbler	Pomatostomus temporalis				p	p	p	p	p	p	p	p	p			p	p		p	p	numerous	numerous
		White-browed Babbler	Pomatostomus superciliosus																p					
	Cinclosomatidae (ex Eupetidae)	Western Quail-thrush	Cinclosoma marginatum						p										p	p			p	p
	Campephagidae	Ground Cuckoo-shrike	Coracina maxima																				p	p
		Black-faced Cuckoo-shrike	Coracina novaehollandiae						p	p	p	p					p		p		p		p	p
		White-winged Triller	Lalage sueurii						p				p			p							p	
	Pachycephalidae	Rufous Whistler	Pachycephala rufiventris						p	p	p		p		p		p	p	p		p	p	numerous	numerous
		Crested Bellbird	Oreoica gutturalis				p	p	p		p		p	p	p		p	p	p	p	p	p	numerous	numerous
	Artamidae	Black-faced Woodswallow	Artamus cinereus						p							p	p	p	p				p	p
	Cracticidae	Grey Butcherbird	Cracticus torquatus																p				p	
		Pied Butcherbird	Cracticus nigrogularis				p	p	p	p	p	p	p	p	p		p		p		p	p	p	
		Australian Magpie	Cracticus tibicen								p	p			p				p		p	p	p	p
	Rhipiduridae	Willie Wagtail	Rhipidura leucophrys					p	p	p		p	p		p		p		p		p		numerous	numerous
	Corvidae	Little Crow	Corvus bennetti																				p	
		Torresian Crow	Corvus orru				p		p				p		p		p		p		p		numerous	numerous
	Monarchidae	Magpie-Lark	Grallina cyanoleuca						p	p	p	p					p		p			p	numerous	numerous
	Petroicidae	Red-capped Robin	Petroica goodenovii																		p	p	p	p
		Hooded Robin	Melanodryas cucullata						p									p			p	p		
	Alaudidae	Horsfield's (Singing) Bushlark	Mirafra javanica horsfieldii																				p	
	Megaluridae	Little Grassbird	Megalurus gramineus																p		p			
		Rufous Songlark	Cincloramphus mathewsi									p											p	p
		Brown Songlark	Cincloramphus cruralis												p								p	
	Hirundinidae	Fairy Martin	Petrochelidon ariel										p								p		p	p
		Tree Martin	Petrochelidon nigricans																					nesting
	Estrildidae	Zebra Finch	Taeniopygia guttata						p	p			p	p	p	p	p	p	p	p		p	numerous	numerous
		Painted Finch	Emblema pictum					p	p											p			p	p

p=present

Reptiles

Order	Family	Common Name	Scientific Name	HYS01	HYS02	HYS03	HYS04	HYS05	HYS06	HYS07	HYS08	Opp
Testudines	Cheluidae	Flat-shelled Turtle	*Chelodina steindachneri*			1						1
Squamata	Diplodactylidae	Fat-tailed Gecko	*Diplodactylus bilybara (ex conspicillatus)*									1
		Fine-faced Gecko	*Diplodactylus pulcher*					1				
		Sand-plain Gecko	*Lucasium stenodactylum*		6		3		2			
	Gekkonidae	Spotted Dtella	*Gehyra punctata*		7							1
		Common Dtella	*Gehyra variegata*	7	2	18	1	3	3		4	1
		Bynoe's Prickly Gecko	*Heteronotia binoei*			3	1		2			1
	Scincidae	Bar-shouldered Ctenotus	*Ctenotus inornatus*	45	10	9						1
		Barred Wedge-snout Ctenotus	*Ctenotus schomburgkii*		2				4		10	1
		Spotted Ctenotus	*Ctenotus uber*					6		21		
		Broad-banded Sandswimmer	*Eremiascincus richardsonii*									1
		Unpatterned Robust Slider	*Lerista macropisthopus*								1	
		Pale Broad-blazed Slider	*Lerista petersoni*	2			1		1		5	
		Rolfe's Slider	*Lerista rolfei*	2	6		5	8	9	2	11	2
		Common Dwarf Skink	*Menetia greyii*			2						
		Fire-tailed Skink	*Morethia ruficauda*	1	2							
		Ornate Soil-crevice Skink	*Notoscincus ornatus*			2	3		3		2	
	Varanidae	Ridge-tailed Monitor	*Varanus acanthurus*									1
		Stripe-tailed Monitor	*Varanus caudolineatus*	1				4	6	3	5	
		Perentie	*Varanus giganteus*									1
		Yellow-spotted Monitor	*Varanus panoptes*		1		1		2			1
	Typhlopidae	Long-beaked Blindsnake	*Anilios grypus*		2							
	Elapidae	Western Brown Snake	*Pseudonaja mengdeni*			1					1	
		Jan's Banded Snake	*Simoselaps bertholdi*		1				1			
		Yellow-faced Whipsnake	*Demansia psammophis*		1							

FAMILY	COMMON NAME	SCIENTIFIC NAME	HYS01	HYS02	HYS03	HYS04	HYS06	HYS07	HYS08	Opp
Amphibians										
Hylidae	Water-holding Frog	*Cyclorana platycephala*	1		1					
	Little Red Tree Frog	*Litoria rubella*	4	10	36		1			
Limnodynastidae	Desert Burrowing Frog	*Platyplectrum spenceri*	25	21	23	12	3	2	3	
Myobatrachidae	Northwest Toadlet	*Uperoleia russelli*	11	3	22					
Fish										
Cichliformes	Blue Tilapia	**Oreochromis mossambica*								numerous

Invertebrate SRE species

Taxon	Species	Systematic Sites																										Opportunistic Sites					
		HYS1	HYS3	HYS4	HYS5	HYS6	HYS7	HYS8	HYSRE1	HYSRE2	HYSRE3	HYSRE4	HYSRE5	HYSRE6	HYSRE7	HYSRE8	HYSRE9	HYSRE10	HYSL1	HYSL2	HYSL3	HYSL4	HYSL5	HYSL6	HYSL9	HYSL11	HYSL12	HYSL14	HYSOP1	HYSOP2	HYSOP4	HYSOP5	HYSOP7	HYSOP8
Araneae	Linyphiidae sp. B04																						1											
	Synothele sp. B14				1																											1		
	Aganippe sp. 21			1																											1			
	Aname sp. B19												1	1																				
Scorpiones	*Lychas* `hairy tail group`					1																												
	Lychas `harveyi` ms	1			1		1	2																										
	Lychas `multipunctatus group`							1																										
	Lychas sp.																																1	2
Pseudoscorpiones	*Beierolpium* 8/2 sp.																1																	
	Beierolpium 8/3 sp.								1						1				1															
	Beierolpium 8/4 sp.																									1	1	1						
	Indolpium sp.																											1						
	Indolpium sp. B20																					1		1										
	Indolpium sp. B21																							2										
	Linnaeolpium sp. *B04*																						1											
Isopoda	*Acanthodillo* sp. B16											1																						
	Buddelundia sp.										7						54																	
	Buddelundia sp. B58	4	1	1	7	1			1	361	11	6		16	11	5	128	4													1	11	2		
	Buddelundia sp. B59															1														1				
	Buddelundia sp. B60											4																						
	Cubaris sp. B07								2																									
Mollusc	*Pupoides beltianus*																			10	3	8		3		1								
	Pupoides contrarius																		28	71	20	10			1									
Polyxenida	Polyxenidae sp.																		3															
	Polyxenidae sp. B14												1	1			1																	
	Synxenidae sp. B08										12	1	1				86		3															
Scolopendromorpha	Cryptops sp.																														1			
Geophilomorph	Orphnaeus nr brevilabiatus											1																						
Lithobiomorpha	*Lamyctes* nr *africanus*																1																	

APPENDIX SIX: MOTION CAMERA RECORDINGS

Table 26: Species recorded on motion cameras (number of days per camera HYMCXX)

SPECIES	COMMON NAME	01	02	03	04	05	06	07	08	09	10	TOTAL
Macropus sp.	Red Kangaroo/Euro	1	11			30			25	1		**68**
**Bos taurus*	European Cattle		4	6					42		2	**54**
Canis lupus	Dingo/ Wild Dog	5	3			22			3			**33**
**Equus asinus*	Donkey	8										**8**
**Felis catus*	Cat		2			2			3	2	1	**10**
**Mus musculus*	House Mouse							38			1	**39**
Dromaius novaehollandiae	Emu					1						**1**
Anas gracilis	Grey Teal	2										**2**
Phaps chalcoptera	Common Bronzewing		1			4			35			**40**
Ocyphaps lophotes	Crested Pigeon		1	2					31	1		**35**
Geophaps plumifera	Spinifex Pigeon	1				21			23			**45**
Geopelia cuneata	Diamond Dove		1			31			42	1		**75**
Ardea pacifica	White-necked Heron	5	5						4			**14**
Egretta novaehollandiae	White-faced Heron	3	3						5			**11**
Accipiter sp.	Hawk	1										**1**
Circus assimilis	Spotted Harrier	4	2									**6**
Haliastur sphenurus	Whistling Kite	4							1			**5**
Aquila audax	Wedge-tailed Eagle	8	5	1		13						**27**
Falco berigora	Brown Falcon	1							1			**2**
Burhinus grallarius	Bush Stone-curlew						2		24			**26**
Elseyornis melanops	Black-fronted Dotterel								4			**4**
Cacatua sanguinea	Little Corella		3						9			**12**
Eolophus roseicapillus	Galah		3				2		27	1		**33**
Barnardius zonarius	Australian Ringneck	1	1						33			**35**
Melopsittacus undulatus	Budgerigah					1			9			**10**
Tyto javanica	Eastern Barn Owl								1			**1**
Ptilotula penicillata	White-plumed Honeyeater								3			**3**
Acanthagenys rufogularis	Spiny-cheeked Honeyeater								4			**4**
Epthianura tricolor	Crimson Chat	1							1			**2**
Pomatostomus temporalis	Grey-crowned Babbler								1		2	**3**
Coracina novaehollandiae	Black-faced Cuckoo-shrike								2			**2**

SPECIES	COMMON NAME	01	02	03	04	05	06	07	08	09	10	TOTAL
Cracticus nigrogularis	Pied Butcherbird		1			7	3		3			**14**
Cracticus tibicen	Australian Magpie								12			**12**
Rhipidura leucophrys	Willie Wagtail			1		1			1	2	2	**7**
Corvus orru	Torresian Crow	4	19			32			28	3		**86**
Grallina cyanoleuca	Magpie-lark	6	9	1		13			42	2	3	**76**
Petroica goodenovii	Red-capped Robin								1			**1**
Taeniopygia guttata	Zebra Finch	2				4			34			**40**
Emblema pictum	Painted Finch	1							3			**4**
Gowidon longirostris	Long-nosed Dragon									1		**1**
Varanus giganteus	Perentie								3			**3**
Varanus panoptes	Yellow-spotted Monitor		2		1	3		14	3	5	8	**36**
Total		**58**	**76**	**11**	**1**	**185**	**7**	**52**	**463**	**19**	**19**	**891**

Examples of Motion Camera recordings

Plate 6: Yellow spotted Monitor (*Varanus panoptes*)

Plate 7: Feral Cat (*Felis catus*)

Plate 8: Red Kangaroo (*Macropus rufus*)

Plate 9: Bush Stone-curlew (*Burhinus gallarius*)

Plate 10: Cattle (*Bos taurus*)

Plate 11: Galah (*Eolophus roseicapillus*)

APPENDIX SEVEN: LIKELIHOOD OF CONSERVATION SIGNIFICANT FAUNA TO OCCUR

Table 27: Conservation significant fauna recorded or potentially occurring within the study area

SPECIES NAME	CONSERVATION STATUS			HABITAT	PREVIOUS RECORDS	LIKELIHOOD OF OCCURRENCE
	EPBC Act	WC Act	DPaW			
EPBC Act						
Mammals						
Northern Quoll *Dasyurus hallucatus*	En	S2	En	Denning habitat: rocky escarpments, gorges and breakaways. Foraging and dispersal habitat: major drainage lines with fringing eucalypt trees (Oakwood 2008).	Based on PMST search potential habitat may occur within the study area. Study area outside the current distribution of the species (Oakwood 2008).	**Very Low** Some suitable habitat present. Species not expected to occur due to distance from known populations, but small possibility of presence as previous surveys and knowledge of fauna assemblage in the region limited.
Greater Bilby *Macrotis lagotis*	Vu	S3	Vu	Acacia shrublands, woodlands or grasslands on a mix of clay or soft soils (Menkhorst & Knight 2011).	Historical record from the wider region. Closest record 75 km to the south-east of the study area (1940). Also recorded 107 km to the west (1969) and 103 km to the south (1940) (DPaW 2015a). More recent record from 2011 from 209 km north of study area.	**Very Low** Not expected to occur, considered to be locally extinct.
Black flanked Rock-wallaby *Petrogale lateralis*	Vu	S3	Vu	Scattered populations. Lives amongst rocky outcrops, caves and crevices (Menkhorst & Knight 2011).	Historical records (1929) from 120 km south-east of study area, one record from 1985 from 90 km east of study area (DPaW 2015a).	**Very Low** Not expected to occur, considered to be locally extinct.
Pilbara Leaf-nosed bat *Rhinonicteris aurantia*	Vu	S3	Vu	Roosts in caves with high humidity and temperature. Forages along water bodies and may roost in fringing vegetation during summer months (Churchill 2009)	Record from 2006 from Barlee Range NP (41-48 km north-west of study area) and several records from 1995 from 98 km north of study area (DPaW 2015a).	**Low** Dry season roost habitat (potential breeding habitat) not present within study area and species was not recorded during the survey. Some potential foraging and wet season roost habitat present along major rivers.

SPECIES NAME	CONSERVATION STATUS			HABITAT	PREVIOUS RECORDS	LIKELIHOOD OF OCCURRENCE
	EPBC Act	WC Act	DPaW			
Ghost Bat *Macroderma gigas*	Vu	S3	Vu	Roosts occur in caves, mines, and rock clefts; forages in diverse habitats; breeds in Wet, disperses to small non-breeding colonies in Dry (Armstrong & Anstee 2000)	One record from 1991 from 110 km north-west (Barlee Range NP) of study area and one historical record from 1932 from 60 km north-west (DPaW 2015a). Study area lies south of species' known distribution.	**Low** Some potential roost habitat, but limited potential for dry season dispersal from Barlee Range; would be present sporadically if at all.
Birds						
Night Parrot *Pezoporus occidentalis*	En	S1	Cr	Associated with *Triodia* hummock grass and chenopod shrubs (samphire, saltbush etc), particularly where these occur together as a mosaic or along a boundary (ecotone) (Garnett et al. 1993).	Uncertain sighting record from 1967 to the north of the former Wanna Station lease (Department of Parks and Wildlife 2015a) so the study area is considered to be within the potential range of movements by this nomadic species	**Very Low** Suitability of habitat is questionable due to lack of *Triodia* and Chenopods**.** Detectability of the species is very low, however some residual likelihood is due to historical records and difficulties to detect the species.
Fork-tailed Swift *Apus pacificus*	M	S5	-	Over dry and open inland plains, but also over a wide variety of land and marine habitats. Highly nomadic aerial lifestyle (Johnstone & Storr 1998)	Record from 2009 from 13 km south-west of the study area. One record from 2001 from 86 km south-west of study area (DPaW 2015a).	**Medium** Some records in the surrounding region and species may occasionally overfly the study area but is not expected to land or utilise the study area.
Common Greenshank *Tringa nebularia*	M	S5	-	Mainly coastal but occasionally inland, foraging in shallow fresh water such as claypans, swamps and shallow pools (Simpson & Day 2004).	Species recorded in 1981 from 1.7 km outside the study area(DPaW 2015b) and one record close by (approx 10km) from 2000 (DPaW 2015a). All other records more than 180 km from study area (DPaW 2015a).	**Low** May occur infrequently as vagrant or during unusual seasonal conditions, no regular presence.

SPECIES NAME	CONSERVATION STATUS			HABITAT	PREVIOUS RECORDS	LIKELIHOOD OF OCCURRENCE
	EPBC Act	WC Act	DPaW			
Glossy Ibis *Plegadis falcinellus*	M	S5	-	Freshwater marshes, floodplains and artificial wetlands, but also uses coastal wetlands including saltmarsh and estuary habitats (DSEWPaC 2012).	Most records are coastal and there are only sparse, scattered inland records through most of WA	**Very Low** The species is not expected to occur within the study area, however potential habitat is present after heavy rainfalls. Potential occasional visitor.
Reptile						
Yinnietharra Rock Dragon *Ctenophorus yinnietharra*	Vu	S3	Vu	Inhabits granite outcrops separated by stony flats with sparse Acacia shrubs; associated with Archaean rather than Proterozoic rocks (Cogger *et al*. 1993)	Recorded in 2006 from 71 km south-west, all other records approximately 80 km south of the study area (DPaW 2015a).	**Medium** Abundant granite outcrop and Acacia shrubland are likely to be suitable habitat, further range extensions would not be surprising.
WC Act						
Birds						
Peregrine Falcon *Falco peregrinus*	-	S7		Sparse but widespread in most habitats, including those favoured by Grey Falcon (Debus 2012).	Two records within 30 km of study area from 2000 and 2009 (DPaW 2015a; DPaW 2015b).	**High** Habitat is suitable for foraging and possibly breeding, likely to occur at least occasionally
Grey Falcon *Falco hypoleuca*	-	S3		Sparse but widespread in arid northern Australia, usually in Acacia shrublands with tree-lined watercourses (Debus 2012).	Two records from 25- 33 km east of study area from 2003 and 2005 (DPaW 2015a; DPaW 2015b). Additional records within 200 km from 2006 & 2010.	**High** Recorded during the survey from close outside the study area. Habitat is suitable for foraging and possibly breeding.
Eastern Great Egret *Ardea modesta*		S5	-	Wide range of wetland habitats: Rivers and creeklines, lakes, wooded and shrubby swamps (DSEWPaC 2012).	Several records from 2001-2009 from within 15 km (DPaW 2015a)	**Recorded** Recorded on multiple occasions from Lyon River in the south of the study area. Suitable habitat present throughout the study area after rainfall events.

SPECIES NAME	CONSERVATION STATUS			HABITAT	PREVIOUS RECORDS	LIKELIHOOD OF OCCURRENCE
	EPBC Act	WC Act	DPaW			
Cattle Egret *Ardea ibis*		S5	-	Hallow, open and fresh wetlands including poorly drained pastures and swamps with tall grass, abundant aquatic flora and emergent vegetation (DSEWPaC 2012).	Few inland records between the southwest and the Kimberley. No records within 200 km of the study area.	**Very Low** The species is not expected to occur within the study area, however potential habitat is present after heavy rainfalls. Potential occasional visitor.
Rainbow Bee-eater *Merops ornatus*	-	S5	-	Variety of habitats such as woodlands, creeklines, rivers or shrublands (DSEWPaC 2012).	Recorded from inside the study area in 1978 and 2001 (DPaW 2015b). Several additional records closeby (within 20 km) from 1999, 2001 and 2007 (DPaW 2015a)	**Recorded**. Species recorded during the survey. Foraging and breeding habitat present within the study area
DPaW						
Mammals						
Long-tailed Dunnart *Sminthopsis longicaudata*			P4	Rocky areas, mesas and hills vegetated with hummock grassland and shrubs (Menkhorst & Knight 2011).	Closest records from 56 km south-east (1992) and 66 km north-west (1994) (DPaW 2015a; DPaW 2015b).	**Recorded** Species recorded during phase 2 of surveying. Suitable habitat occurs (except for spinifex).
Brush-tailed Mulgara *Dasycercus blythi*			P4	Spinifex grasslands on flats or dunes (Van Dyck & Strahan 2008)	Several records from 150 km north-west of study area (2007) and one record from Kennedy Range NP 147 km south-west of study area (1994) (DPaW 2015a).	**Low** Potentially suitable sandplain habitat occurs, but lack of records in vicinity (including distinctive traces) implies unlikely to occur
Western Pebble-mound Mouse *Pseudomys chapmani*			P4	Builds mounds of pebbles on shallow slopes or hilltops, usually with spinifex/Acacia vegetation; now restricted to Pilbara (Start 2008)	Records from 1994 from 22 km north-west and 44 km south of study area. More recent records from 2013 from within 62 km north of the study area (DPaW 2015a).	**Very Low** Considered to be locally extinct. Historic mounds (>50 years old) recorded within the study area.

SPECIES NAME	CONSERVATION STATUS			HABITAT	PREVIOUS RECORDS	LIKELIHOOD OF OCCURRENCE
	EPBC Act	WC Act	DPaW			
Birds						
Blue billed Duck *Oxyura australis*			P4	Almost entirely aquatic, mainly southern with occasional northern inland records (Horn 1983; Simpson & Day 2004)	Not recorded from Gascoyne, but occasional records in Murchison (2009) and Pilbara (2002)	**Low** Potentially occurs as occasional visitor or vagrant; pools on Lyons River are suitable habitat
Fish						
Golden Gudgeon *Hypseleotris aurea*			P2	Small, quiet pools with moderately turbid water and a boulder substratum littered with dead branches (Hoese & Allen 1983)	Recorded on Lyons River 130 km south-west of the study area (DPaW 2015a).	Medium Lyons and Edmund Rivers include potentially suitable habitat; some populations are only recently known, so further range extensions would not be surprising

APPENDIX EIGHT: SIGNIFICANT FAUNA PROFILES (LOW LIKELIHOOD OF OCCURRENCE)

EPBC Act listed fauna

Greater Bilby *(Macrotis lagotis*)

Conservation status

EPBC Act Vulnerable, WC Act Schedule3,
DPaW Vulnerable.

Distribution and Preferred habitat

Once very widespread, the only extant species of the Greater Bilby (*Macrotis lagotis*, Thylacomyidae) is now rare and scattered, confined to northern and mostly inland locations, particularly sandy deserts (patchily distributed through the Tanami Desert in the Northern Territory, west to Broome and south to Warburton in Western Australia). It occupies a variety of habitats, including cracking clays, desert sandplains, and dune fields with hummock grassland and Acacia shrubland (Van Dyck & Strahan 2008).

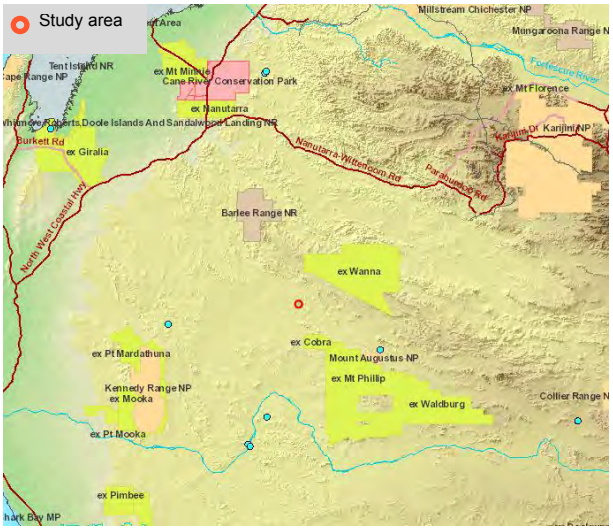
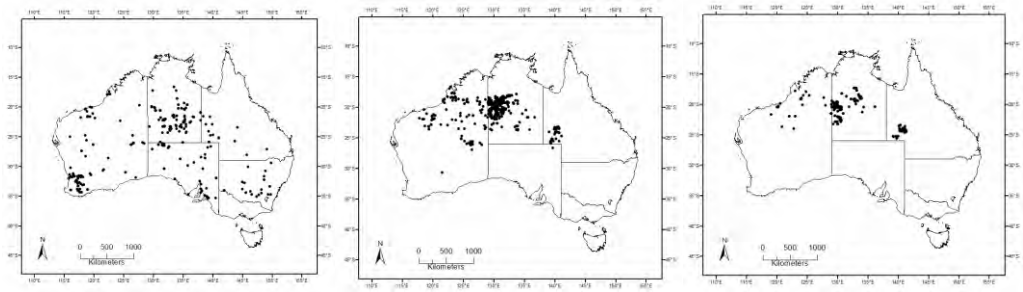


Figure 39: Regional records of the Greater Bilby (DPaW 2015a)



Records (left) up to and including 1970, (middle) 1971-1990, (right) 1991-2004 (Pavey 2006a)

Ecology

The Bilby is terrestrial, nocturnal and omnivorous, constructing an extensive burrow where it remains during the day, emerging at night to dig for insects, very small vertebrates, seeds, fruit and fungi. The burrow provides refuge from fires and many of its food plants are promoted by disturbance, so Bilbies are able to occupy recently burnt areas and have been considered 'dependent on fire' (Friend *et al*. 2011). Lavery & Kirkpatrick (1997) suggest that very small populations may leave traces that incorrectly suggest much larger numbers and healthier populations than is actually the case. Gait dimensions from trackways, and diameter of faecal pellets, can be used to estimate the size/age-class of individuals, and hence the minimum number of individuals present at a locality (Southgate 2005).

Likelihood of Occurrence

There is a 1940 record of the Bilby from Mt Augustus (75 km south-east of study area) and some unconfirmed sightings from pastoral leases in the western Gascoyne region from 1969 (*NatureMap*, DPaW 2007-2015), but it is considered to be locally extinct (DPaW 2015a). The most recent record (2011) is located 209 km north of the study area. The Greater Bilby is considered relatively easy to locate when present because of its distinctive tracks, burrows and foraging holes, so cryptic presence within the study area is very unlikely.

Northern Quoll *(Dasyurus hallucatus*)

Conservation status

EPBC Act Endangered, WC Act Schedule 2, DPaW Endangered.

Distribution and Preferred habitat

The Northern Quoll formerly occurred across northern Australia from the Pilbara region in Western Australia to south-eastern Queensland. A 75% reduction of available habitat occurred during the 20th century, so that the species is now restricted to the Pilbara and north Kimberley in Western Australia and a few discrete populations across the Northern Territory and eastern Queensland (Braithwaite & Griffiths 1994). Northern Quolls are most common on dissected rocky escarpments, but are also found in eucalypt forest and woodland (Oakwood 2008).

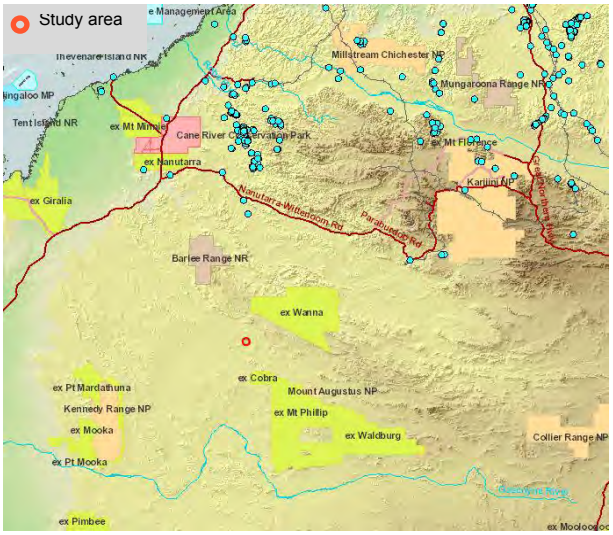


Figure 40: Regional records of the Northern Quoll (DPaW 2015a)

Potential denning / shelter habitat (considered critical for quoll survival) includes rocky gorges, gullies and escarpments associated with *Corymbia* woodland, boulder fields, termite mounds, and small caves. Rugged rocky areas are considered to be the core habitat and refuge for quolls because they provide a greater diversity of environments, many sites for shelter and protection from predators and weather, and both immediate refuge from fire and more likelihood of retaining patchiness post-fire (Woinarski et al. 2007). Foraging or dispersal habitat is considered to include any areas of predominantly native vegetation up to 2 km from denning habitat (DSEWPaC 2011).

Ecology

Northern Quolls are nocturnal and opportunistic omnivores feeding primarily on large insects, small vertebrates, nectar and soft fruits (e.g. figs). They are both arboreal and terrestrial and use a variety of den sites including rock crevices, tree hollows, logs, termite mounds, house roofs and goanna burrows (Oakwood 2008). Body mass is up to 0.69 kg in females and 1.12 kg in males; home ranges are estimated to be approximately 35 ha in adult females and 100 ha or more in breeding males. Body size, home range size and survival rate vary between rocky and savannah habitats, but Pilbara populations have not been well studied. The short generation span and large home ranges of this species, together with high variation in habitat condition between years, mean that population density and occupancy of habitat may fluctuate greatly, and sites that are occupied only occasionally may still be critical for long-term survival in the region.

Likelihood of Occurrence

Although the species or its habitat is predicted as 'likely to occur' in the PMST, there are no actual records of Northern Quoll occurring south of the Hamersley Range (which is itself sparsely occupied and mostly relatively marginal habitat), and it is here considered highly unlikely to occur.

Pilbara Leaf-nosed Bat *(Rhinonicteris aurantia*)

Figure 41: Regional records of the Pilbara Leaf-nosed Bat (DPaW 2015a)

Conservation status

EPBC Act Vulnerable, WC Act Schedule 3, DPaW Vulnerable.

Distribution and Preferred habitat

The Pilbara Leaf-nosed Bat is an isolated population of a species (Orange Leaf-nosed Bat or Orange Horseshoe Bat, Hipposideridae) that also occurs from the Kimberley to north-west Queensland. It appears to be divided into three discrete subpopulations (eastern Pilbara mines and granite, Hamersley Range, Upper Gascoyne), separated by relatively flat areas (Fortescue and Ashburton valleys) that impede gene flow. (Threatened Species Scientific Committee 2014). Because of its poor ability to thermoregulate and retain water, the Pilbara Leaf-nosed Bat is normally restricted to caves and mine adits (horizontal shafts) with stable, warm and humid microclimates (Van Dyck & Strahan 2008). Temporary roosts such as crevices and tree hollows could be used in warm and humid conditions, allowing greater dispersal during the Wet season. The roosting site is often at depth in mines; in small crevices within caves, usually those ascending between sedimentary rock layers; and with associated groundwater seeps, e.g. at Barlee Range (Armstrong 2001). Foraging has been observed in the following habitats: *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks; over small watercourses amongst granite boulder terrain and around nearby koppies; over pools and low shrubs in ironstone gorges; and above low shrubs and around pools in gravelly watercourses with *Melaleuca leucodendron*, such as in Barlee Range Nature Reserve (Armstrong 2001; Churchill *et al*. 1988).

Ecology

Typically, the Pilbara Leaf-nosed Bat flies low in the open spaces in watercourses and gorges, and over *Triodia* grassland, sometimes within centimetres of the ground, but up to 2–3 m in height. Feeding is mainly close to roost sites, the bat returning to the roost several times during the night between feeding flights. This species is very sensitive to even slight human disturbances, and frequent human interference may cause complete abandonment of a roost. It often shares roosts with the Ghost Bat, *Macroderma gigas*, Finlayson's Cave Bat, *Vespadelus finlaysoni*, Common Sheath-tailed Bat, *Taphzous georgianus* (Armstrong 2001; Churchill *et al*. 1988; DSEWPaC 2012). Foraging range is approximately 20 km from the day roost during the dry season, but up to 50 km during warm and humid conditions, when a wider range of temporary roost sites is available and energy requirements lower (R. Bullen, pers. comm. 2013).

Likelihood of Occurrence

Presence of the species or suitable habitat is not predicted by the PMST. There are *NatureMap* records (DPaW 2015a) from the Barlee Range northeast of the study area, but none further southwest. Some good quality foraging habitat is present within the study area after rainfall events and when conditions are favourable; however the species' range is generally considered to be contracting northward and therefore the Pilbara Leaf-nosed Bat is unlikely to occur within the study area.

Black-flanked Rock-wallaby
***(Petrogale lateralis lateralis*)**

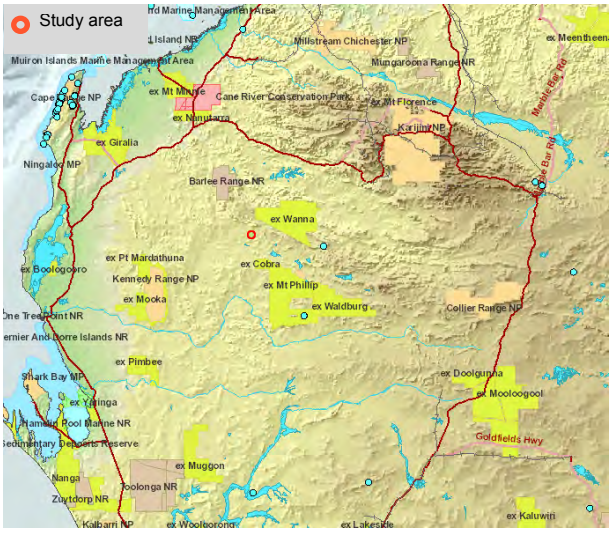


Figure 42: Regional records of the Black-flanked Rock-wallaby (DPaW 2015a)

Conservation status

EPBC Act Vulnerable, WC Act Schedule 2, DPaW Vulnerable.

Distribution and Preferred habitat

The Black-flanked (or Black-footed) Rock-wallaby (Macropodidae) has declined greatly due to foxes and other threats; by the 1990s, only scattered, small and insecure populations remained, mostly near the Pilbara coast (Barrow Island, Cape Range, Ningaloo Station, Fortescue River Roadhouse [near Roebourne]) but also far inland (Calvert Range) and further south in the Murchison and Wheatbelt (Pearson 2013; Pearson & Kinnear 1997).
Historical records exist from 1929 from 120 km south-east of the study area and one record was made in 1985 from 90 km east of the study area (DPaW 2015a). Suitability of habitat depends on availability of suitable refuge (cliff, rock-pile, talus or escarpment) close to sufficient vegetation to provide food.

Ecology

Diet is generalized, including forbs, browse, and minor amounts of grass, fruit, seeds, flowers and insect larvae (Van Dyck & Strahan 2008). Peak body condition and breeding occur several months after the season of peak rainfall, following similar cycles in both sexes (Willers *et al*. 2011).

Likelihood of Occurrence

There is an uncertain 1985 sighting from Wanna/Dooley Downs, about 90 km east of the study area (*NatureMap*, DPaW 2007-2015), but this species is considered to be locally extinct (Pearson 2013). Only *P. rothschildi* has been recorded from Barlee Range NP, and no rock-wallabies are known to occur in the Kennedy Range.

Night Parrot *(Pezoporus occidentalis)*

Conservation status

EPBC Endangered, WC Act Schedule 1, DPaW Critically Endangered.

Distribution and Preferred habitat

Night Parrots (Psittacidae) have been reported from all mainland states (Higgins 1999), but the few recent records come from southwestern Queensland and the eastern Pilbara. This species is most frequently associated with *Triodia* hummock grass and chenopod shrubs (samphire, saltbush etc), particularly where these occur together as a mosaic or along a boundary (ecotone). Suitability of habitat is thought to depend on particular stages of regeneration after fire, so that patch burning and low stocking rates may be important for persistence (Garnett *et al*. 1993).

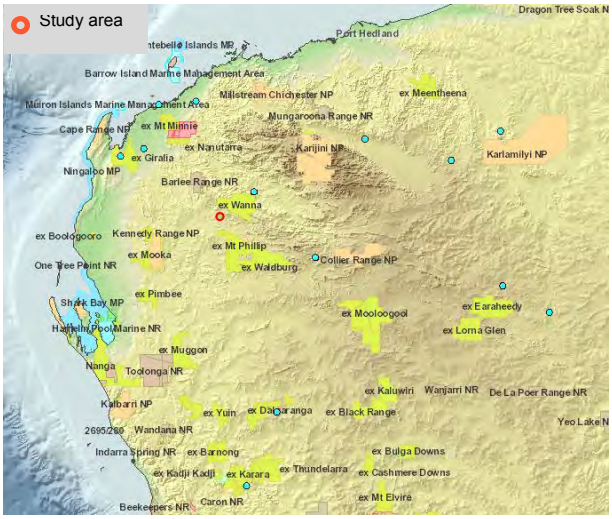


Figure 43: Regional records of the Night Parrot (DPaW 2015a)

Ecology

Nocturnal or crepuscular, reported drinking shortly after nightfall and then dispersing to forage. Sightings during the day are of birds flushed from cover by stock, dogs or fire; utilisation of diurnal retreats is not well documented but they may include caves, or burrows of other vertebrates, in addition to Spinifex clumps and dense samphire (Biota 2005; FMG 2005). Evidence suggests the species is either nomadic, or with very large individual home range (Boles *et al*. 1994), rather than 'migratory' (as incorrectly implied by EPBC listing). Like other seed-eating birds (e.g. most other parrots, pigeons and finches) it is likely to drink frequently, and thus be dependent on water sources which are often temporary. Threats are considered to include predation by foxes and feral cats, modification of vegetation by introduced herbivores (stock and feral), loss or degradation of watering points, and altered fire regimes (Blyth *et al*. 1997). The first sound recordings, photographs and video of a living Night Parrot were announced by wildlife cinematographer John Young in July 2013, recorded at an undisclosed location presumed to be in far western Queensland. The low-resolution versions of photos available on the web appear to show a living bird of this species (see above), while the video and audio have not been released. It is reported that the adult bird was responded to playback of a previously recorded call with aggressive territorial displays involving foot-stamping, 'puffing up' of body feathers, and 'screaming like a budgerigar' (e.g. Pickrell 2013). Young also reports scats containing a high proportion of insect remains, and estimates they comprise one third of the diet.

Likelihood of Occurrence

There is an uncertain sighting record from 1967 to the north of the former Wanna Station lease (*NatureMap*, DPaW 2007-2015), so the study area is considered to be within the potential range of movements by this nomadic species. There is no indication that the habitat is suitable for foraging, as neither *Triodia* nor chenopods were observed to characterise any of the vegetation types identified by Ecologia (2014), and due to recent rain the population is expected to be highly dispersed, so presence (or detection) at the time of survey is highly unlikely.

Ghost Bat *(Macroderma gigas)*

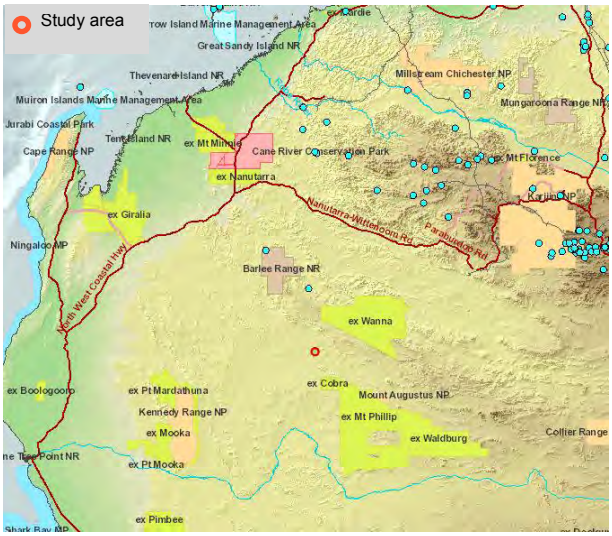


Figure 44: Regional records of the Ghost Bat (DPaW 2015a)

Conservation status

EPBC Vulnerable, WC Act Schedule 3, DPaW Vulnerable

Distribution and Preferred habitat

Regional populations of the Ghost Bat (Megadermatidae) are centred on maternity roosts that are genetically isolated from each other; up to 2001 only 10 such sites were known to exist in Australia, including one at Mt Brockman in the Pilbara (Armstrong 2001; Worthington-Wilmer *et al*. 1994). The persisting arid zone regional population in the Pilbara is also geographically isolated, being separated from extant northern Australian populations and the historical central Australian populations by extensive sandy deserts (Richards & Hand 1995). Roosts occur in caves, mines, and rock clefts, and most of the distribution is in the arid zone but the species also occurs in mesic environments including rainforest. Its range appears to have contracted into northern Australia in relatively recent times, especially in Central Australia (Churchill & Helman 1990)

Ecology

Australia's only carnivorous bat forages by gleaning (picking prey items from surfaces), eating large insects, frogs, lizards, small birds and mammals. Several distinct call types are known including a frequency-modulated search-mode echolocation call (duration 4-8 ms, frequency range 29-56 kHz, peak energy around 40.5 kHz) and longer calls thought to have social functions; the calls have low intensity and can only be detected by recording devices at very close range (McKenzie & Bullen 2009). Tidemann et al. (1985) reported Ghost Bats in the Northern Territory foraged, on average, 1.9km from their day roost, with a mean foraging area of 61 ha. This species detects prey using eyes and ears rather than using echolocation, and changes vantage points about every 15 minutes during foraging periods, with a mean distance of 360 m between them. Most males and subadult females disperse in the non-breeding (dry) season and form smaller temporary colonies sharing a daytime roost (Hoyle *et al*. 2001; Toop 1979; Toop 1985). Survival is critically dependent on finding natural roosts in caves, crevices, deep overhangs, and artificial roosts such as abandoned mine adits (Hall *et al*. 1997); the most suitable roosting locations in the Pilbara occur in the Marra Mamba Iron Formation (Armstrong & Anstee 2000). Threats include disturbance and loss of roosting sites due to mining, tourism, and internal dereliction of mines through aging of timber supports (Hall *et al*. 1997). In recent times population declines could be attributable to competition for prey with foxes, feral cats, and prey lost through habitat modification by fire and livestock (Environment Australia 1999).

Likelihood of Occurrence

There are *NatureMap* (DPaW 2007-2015) and literature records (Armstrong & Anstee 2000; Douglas 1956) from the Barlee Range north of the study area, but none further southwest. The study area is probably within dispersal range for the Barlee Range population and it may be expected to occur.

Common Greenshank (*Tringa nebularia*)

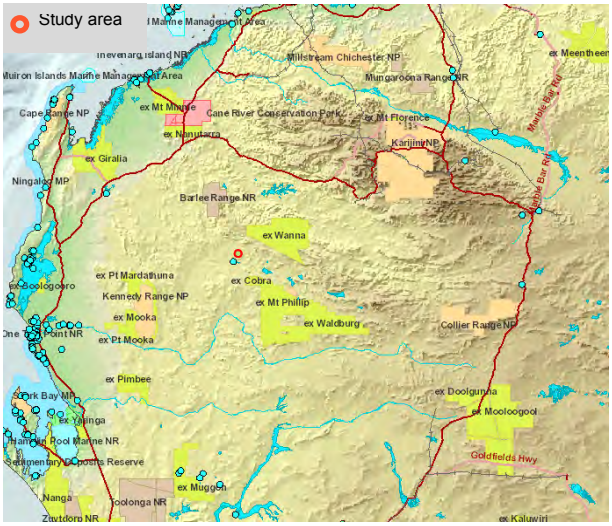


Figure 45: Regional records of the Common Greenshank (DPaW 2015a)

Conservation status

EPBC Act Migratory, WC Act Schedule 5

Distribution and Preferred habitat

The Common Greenshank is widespread throughout Western Australia with the majority of records made along the coastline and along major river systems through the inland (DSEWPaC 2012; Johnstone & Storr 1998). It is a non-breeding visitor to Australia and can be observed throughout the year. It occupies fresh shallow, fresh water such as claypans, swamps and shallow pools as well as estuaries and samphire flats (Simpson & Day 2004).

Ecology

The Common Greenshank is a wading species that feeds on invertebrates and fish (Johnstone and Storr 1998).

Likelihood of Occurrence

The species is usually recorded along the coast and major river systems which provide an abundance of suitable inland habitats. Records from the Midwest and Gascoyne region are rare with the exception of two records in 1981 and 2000 of which one record was less than 2 km south of the study area (DPaW 2015b). These records are extremely rare in the vicinity of the study area and therefore the species has a low likelihood to occur.

Glossy Ibis *(Plegadis falcinellus*)

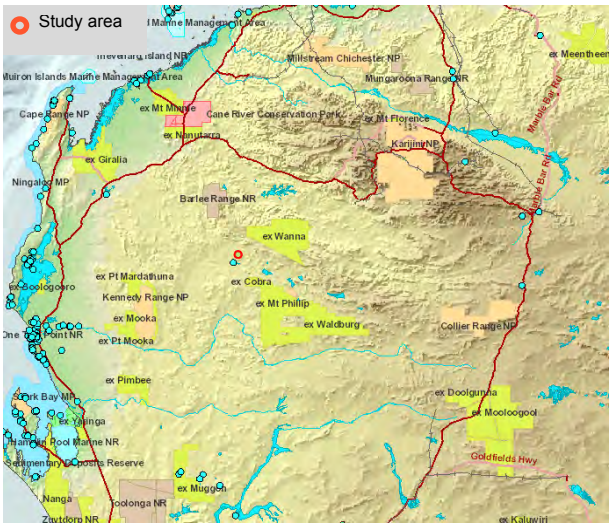


Figure 46: Regional records of the Cattle Egret (DPaW 2015a)

Conservation status

EPBC Act Migratory, WC Act Schedule 5

Distribution and Preferred habitat

This bird has a nearly global distribution, and in Australia mostly occurs in eastern and northeastern areas, but also patchily in most of Western Australia. It usually occurs in freshwater marshes, floodplains and artificial wetlands, but also uses coastal wetlands including saltmarsh and estuary habitats (DSEWPaC 2012).

Ecology

Migratory and nomadic, moving long distances to breed after good rainfall and to tropical areas in Autumn. Feeds on aquatic invertebrates and insects, small aquatic and terrestrial vertebrates, and aquatic plants (DSEWPaC 2012).

Likelihood of Occurrence

Most records are coastal and there are only sparse, scattered inland records through most of WA (*NatureMap*, DPaW 2007-2015), but this species may be an occasional visitor

DPaW Priority Fauna

Brush-tailed Mulgara (*Dasycercus blythi*)

Conservation status

DPaW Priority 4

Two species of Mulgara (Dasyuridae) have only recently been consistently distinguished by Woolley (2005), and the actual distribution and conservation status of each have been uncertain. Until recently, the listing of the Crest-tailed Mulgara under the EPBC Act as *Dasycercus hillieri* was based on the Action Plan for Australian Marsupials and Monotremes (Maxwell *et al*. 1996) and did not reflect current taxonomic understanding. The Brush-tailed Mulgara, now known as *Dasycercus blythi*, is listed at a lower level of conservation significance in Western Australia (Priority 4, Department of Parks and Wildlife), while the Crest-tailed Mulgara is now correctly named *Dasycercus*.

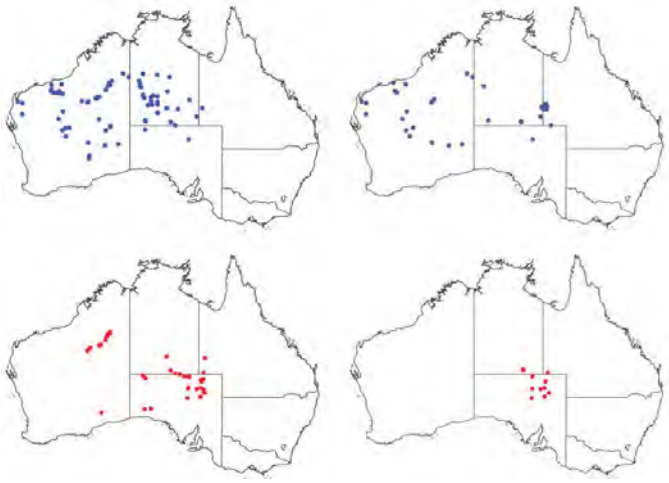


Figure 47: Historic and recent distribution of *Dasycercus*

Blue: *D. blythi* (DPAW P4), Red: *D. cristicauda* (EPBC Act Vulnerable). Left panels: specimens registered in Australian museums; right: specimens collected 1990–2012 (museum records and others) (Woolley *et al*. 2013)

cristicauda and listed as Vulnerable under the Commonwealth EPBC Act. Both species have been reported from the region (Department of Parks and Wildlife 2014b), though species identifications are questionable where voucher specimens or tissue samples are not available. Until recently the Commonwealth Department of Environment has taken the position (eg DSEWPaC 2010) that where specimens of *Dasycercus* have not been positively assigned to species based on diagnostic characters, as a precautionary measure they are assumed to represent *D. cristicauda* due to its higher level of statutory protection

Distribution and Preferred habitat

Both Mulgara species have (historically) a wide geographic range in the arid zone of Australia, and broadly overlapping distributions, typically occurring in mature spinifex grasslands on sandy substrates (including sandy loam). Within the Pilbara, there are many records of Mulgara in the Chichester IBRA subregion and eastern Fortescue valley, but very few in the Hamersley subregion, where rocky substrates predominate. There are no confirmed records of *D. cristicauda* in WA after 1931 (Woolley *et al*. 2013); a specimen trapped east of Newman was stated to be 'positively' identified as *D. cristicauda* by genetic testing (Phoenix 2011), but this has not been confirmed by other sources. A recent review of morphology and distribution in both species indicates that, since 1990, *D. cristicauda* is now confined to central Australia (northeastern SA and adjacent border regions of NT and Qld) (Woolley *et al*. 2013). Evidence from areas of sympatry in Central Australia indicates habitat differences between the two species, with *D. cristicauda* occurring on sandhills and sandridges (dunefields), *D. blythi* mostly on sandplains and gibber plains, but also in dune swales (Pavey *et al*. 2011; Woolley 2005; Woolley *et al*. 2013)

Ecology

Both Mulgara species are primarily nocturnal, carnivorous marsupials, feeding mainly on invertebrates, along with some reptiles and small mammals. The Crest-tailed Mulgara is somewhat larger: females up to 80 g and males up to 140 g, vs 60 and 75 g respectively in Brush-tailed Mulgara (Pavey *et al*. 2011). They construct and occupy burrow systems with two or more entrances, usually at the edge of spinifex hummocks (Thompson & Thompson 2007; Woolley 1990).

Likelihood of Occurrence

After the taxonomic revision of all museum specimens in Australia, there are no confirmed records of *D. cristicauda* west of the Canning stock route at any time (Woolley *et al*. 2013). There is a confirmed record of *D. blythi* collected from the Kennedy Range in 1994 (WAM M46148, habitat of interdune red sandplain with *Triodia* hummock grass and Mallee) (DPaW 2015a) and one more record from 2013 from 166 km south of the study area. The study area is located within the distribution of the species which is therefore considered to potentially occur in sandplain or slightly stony plain habitats of the study area. However, no evidence of the species was recorded during the survey.

Western Pebble-mound Mouse
(*Pseudomys chapmani*)

Conservation status

DPaW Priority 4

Distribution and Preferred habitat

This native rodent (Muridae) is restricted to non-coastal, central and eastern parts of the Pilbara, although it was formerly more widespread (IUCN 2007). Abandoned mounds found in the Gascoyne and Murchison districts indicate a recent decline in distribution, most likely due to fox and feral cat predation. The species does however appear secure in its remaining range (Start 2008). This species occurs across the central and southern Pilbara and into smaller ranges of the Little Sandy Desert. The preferred habitat is gentle slopes of rocky ranges sparsely vegetated by *Triodia* grasses, *Senna, Acacia* and *Ptilotus* species.

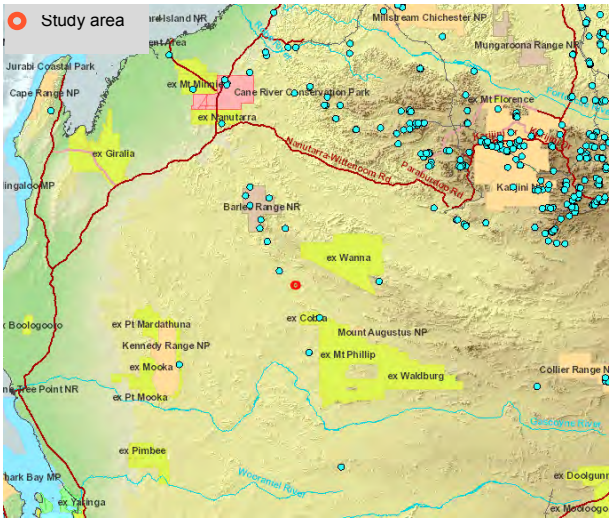


Figure 48: Regional records of the Western Pebble-mound Mouse (DPaW 2015a)

Ecology

Animals live in small family groups in U-shaped burrows below mounds of pebbles, the mounds up to 9 m^2 in area and composed of rocks 15-40 (typically 20-30) mm in diameter (Dunlop & Pound 1981). Each mouse utilises and maintains several mounds, and active mounds are identifiable by structural features and absence of vegetation, but remain recognisable for some time once abandoned (Anstee 1996). Females can produce several litters of four young annually. There appear to be no major threats to this species; the reasons for its elimination from the southern portion of its range are unclear, but may have been related to predation by feral cats and foxes. Mining may be a localized threat (Anstee *et al*. 1997), but this would not significantly affect the overall population size

(IUCN 2011). Diet has not been reported, but likely to be mainly seeds, with some leaves and invertebrates.

Likelihood of Occurrence

Old disused mounds have been recorded in the study area and surrounding Gascoyne and Murchison regions, but no extant populations are thought to occur and the presence of a population in the study area is unlikely. Mounds were recorded in the 1990's from Edmund Station, however the species is thought to be locally extinct (Start 2008).

Blue-billed Duck *(Oxyura australis*)

Conservation status

DPaW Priority 4

Distribution and Preferred habitat

This small species of stiff-tailed duck (Anatidae) is almost entirely aquatic and mainly restricted to southern Australia, with occasional records in the northern inland (including one in the Pilbara) and a subfossil record from New Zealand (Horn 1983; Simpson & Day 2004)

Figure 49: Regional records of the Blue-billed Duck (DPaW 2015a)

Ecology

Unlike many other ducks that are strongly nomadic, this species shows fairly regular seasonal movements between breeding sites on inland ephemeral wetlands (winter and spring), and permanent wetlands closer to the coast (summer and autumn) (Guay *et al*. 2010). However, occasional occurrences well beyond the regular range indicate a degree of opportunism..

Likelihood of Occurrence

Generally unlikely to occur in the region, but the strong recent rain will have created temporary wetland conditions in the study area that might be exploited for winter breeding; any wetlands remaining at the time of survey should be targeted for this species as well as migratory waders and herons

APPENDIX NINE: TAXONOMIC SRE REPORT

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Your reference
Our reference B_ECO_01

Damien Cancilla
Group Leader Environment
Ecoscape Australia
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Western Australia 6159

Dear Damien

Re: SRE Fauna Identifications for Hastings Rare Metals

As requested, this short report provides our identifications for invertebrate species in the SRE target groups and provides additional information on their SRE status according to the framework of the Western Australian Museum. It also includes the collecting localities for each species and some general information on the groups present at the Project.

1 Background

SRE invertebrates are species with distributions of less than 10,000 km^2 and their occurrence within their distribution is usually patchy because they are confined to discontinuous habitats. The small ranges of SRE invertebrates, combined with poor dispersal capacities, slow growth and low fecundity, make them particularly vulnerable to habitat loss or disturbance (Harvey 2002; Ponder and Colgan 2002). Guidance Statement 20 (EPA 2009) requires that impacts on SRE invertebrates are considered during environmental impact assessments. In practice, assessment of risk to SRE invertebrates in arid Western Australia is focused on seven taxonomic groups (the *SRE Groups*) that are known to contain high proportions of SRE species: centipedes (Chilopoda), snails (Gastropoda), millipedes (Diplopoda), pseudoscorpions (Pseudoscorpiones), slaters (Isopoda), scorpions (Scorpiones) and spiders (Araneae).

The Western Australian Museum uses a three-tier classification scheme for SRE species which we have applied to all species listed in this report. The categories are as follows:

Confirmed SREs are species with a known distribution range smaller than 10,000 km^2. The taxonomy is well known and the group well represented in collections and/or via comprehensive sampling.

Potential SREs are species that belong to a group where there are gaps in our knowledge of the taxon, either because the group is not well represented in collections, taxonomic knowledge is incomplete, or the distribution is imperfectly understood because sampling has been patchy.

Widespread (not SRE) species have a known distribution range larger than 10,000 km^2. The taxonomy is well known and the group well represented in collections and/or via comprehensive sampling.

The WAM further uses five sub-categories if a species is determined to be a "Potential SRE". These sub-categories are:

1. Data Deficient: There is insufficient data available to determine SRE status, either because there is a lack of geographic and taxonomic information, or because the individuals sampled prevent identification to species level;
2. Habitat Indicators: The status of a species can be elucidated through its association with a particular habitat and vice versa;
3. Morphological Indicators: The status of a species can be elucidated through its morphological characteristics;
4. Molecular Evidence: DNA sequence data reveal patterns congruent or incongruent with SRE status for a species; and
5. Research & Expertise: Available research data and/or WAM expertise elucidate the status.

2 Methods

Animals collected in the field were preserved directly in 100% ethanol and identified morphologically using dissecting and compound microscopes, as necessary, and the available taxonomic literature, unpublished keys, online resources such as the Atlas of Living Australia (ALA) and reference collections. Slaters, centipedes and millipedes were identified by Jane McRae, snails by Michael Curran and Danilo Harms, and all arachnids (pseudoscorpions, scorpions and spiders) by Danilo Harms.

3 Taxonomic results

Overall, 935 specimens belonging to 24 species in seven SRE groups were collected. Pseudoscorpions and terrestrial slaters were most diverse with six and five species, respectively. Spiders, scorpions and centipedes were represented by three species each, and centipedes and snails were present with two species.

3.1 Spiders

The spider groups assessed under the current SRE framework are the trapdoor spiders and allies (infraorder Mygalomorphae), wall-crab spiders (family Selenopidae) and goblin spiders (family Oonopidae). These groups contain a high proportion of range-restricted species, often with ranges below the 10,000 km^2 threshold for SRE invertebrates. The taxonomy of selenopid spiders in Australia is moderately well resolved (Crews and Harvey 2011, Crews 2013) but taxonomic resolution in the Mygalomorphae is poorer and most species remain undescribed although there are some taxonomic revisions (Raven 1994) and recent molecular analyses (Harms and Framenau 2013, Castalanelli *et al.* 2014)

Three species of mygalomorph spiders were collected in the current survey and they belong to three families: brush-footed trapdoor spiders (Barychelidae: genus *Synothele*), wishbone spiders (Nemesiidae: *Aname*) and true trapdoor spiders (Idiopidae: *Aganippe*).

Aganippe sp. 19

This genus is highly diverse at a species level and currently undergoing taxonomic revision by staff at the Queensland Museum. Two males of a currently undescribed *Aganippe* species were collected at sites HYS4 and HYSOP4. Many *Aganippe* species have short ranges whereas others are clearly more widespread and have ranges > 10,000 km^2 (Castalanelli *et al.* 2014). Using a precautionary approach *Aganippe* sp. 19 is classified here as a potential SRE based on research and expertise.

Aname sp. B19

This genus is highly diverse at a species level and occurs throughout all regions of the state. A recent revision of the Pilbara fauna identified four species (Harvey *et al.* 2012) but this has been overcome by a recent molecular analysis that has revealed many more species (Castalanelli *et al.* 2014) and high regional endemism. Species identification using morphology is difficult and molecular analyses could be undertaken to support the current recognition of the two females from sites HYSRE5 and HYSRE6 as a new species: *Aname* sp. B19. Based on previous research, this a potential SRE but the total range remains unknown.

Synothele sp. B14

Two males were collected in pitfall traps and by hand foraging at sites HYS5 and HYSOP5. This genus is very diverse at a species level. It was revised by Raven (1994) but many more species have since been collected and diversity in arid Australia is very high, with many more putative species indicated by a recent molecular analysis (Castalanelli *et al.* 2014). Most *Synothele* species remain undescribed and many have known ranges below the 10,000km^2 threshold. Given the regional endemism in this fauna, *Synothele* sp. B14 is classified here as a potential SRE based on previous research and expertise. Its exact range is unknown.

3.2 Scorpions

Scorpions are a common element of SRE communities in arid Australia but taxonomic resolution is poor and the only revision available is clearly outdated (Koch 1977) whilst more recent papers have focussed on the description of single species only (e.g. Volschenk 2000, 2012). The common families in arid habitats of WA are the Urodacidae with the single genus *Urodacus*, and the Buthidae with the genera *Isometroides* and *Lychas* (Volschenk *et al.* 2010).

Three scorpion species were collected in the current survey and they belong to the genus *Lychas* (family Buthidae). Most species in this genus are widespread but at least some potential SRE species have also been recorded.

Lychas 'hairy tail'-group

A single specimen was collected by hand at Site 6 B6. Recent molecular research conducted by the WA Museum has shown that the former morphospecies *Lychas* 'hairy tail' is in fact a complex of morphologically cryptic but genetically distinct species. Some species in this complex may be SREs but little is known about species ranges and species delimitation is difficult. Based on the precautionary principle the species present at Hastings is classified as a potential SRE with deficient data

Lychas 'harveyi'

This distinct morphospecies is widespread in arid Australia and there are records from the Pilbara, Gascocyne, the Goldfields and Barrow Island. It is one of the most commonly collected scorpion species in WA and not of conservation concern. Five specimens were collected in the current survey from four sites.

Lychas 'multipunctatus'-group

A single specimen in this species complex was collected from a dry pitfall trap at site HYS8. *Lychas* 'multipunctatus' was assessed as widespread in many previous environmental reports but recent molecular research at the WAM has indicated that this is a complex of cryptic species. Some species in this complex may have short ranges although no further data are presently available. According to the precautionary principle, the species present at Hastings is a potential SRE with deficient data.

3.3 Pseudoscorpions

Pseudoscorpions include a wide range of life characteristics and include groups that are arid-adapted and common in many habitats in WA (i.e. the Olpiidae), those that are dispersal-prone (e.g. the Chernetidae), habitat specialists that are often range-restricted (e.g. *Synsphyronus* in the Garypidae), and those that require high moisture levels and are considered Gondwanan 'relict' fauna (e.g. the Chthoniidae). The taxonomy of pseudoscorpions in WA is comparably well-resolved and there are revisions for some groups (e.g. *Synsphyronus*, Harvey 1987; *Tyrannochthonius* and *Lagynochthonius*; Edward and Harvey 2008) but others remain unrevised and taxonomically poorly resolved (i.e. the Olpiidae).

Six species of pseudoscorpion were collected in the current survey and they all belong to the widespread and arid-adapted family Olpiidae.

Beierolpium 8/4

Beierolpium is a genus in the pseudoscorpion family Olpiidae and defined by a specific arrangement of the trichobothria on the chela fingers. There is no taxonomic framework for these pseudoscorpions in Australia but adult specimens in the 8/4 group have four trichobothria on the movable pedipalp finger. Three nymphs that may belong to this group were collected from leaf litter at sites JSLL05, JSLL06 and JSLL08. These juveniles cannot be identified further but *Beierolpium* includes generally arid adapted pseudoscorpions that are widespread. This species is unlikely to be of conservation concern.

Beierolpium 8/3

This type of *Beierolpium* has three trichobothria on the movable chela finger. Three specimens were collected from leaf litter and wet traps at sites HYSL1, HYSRE1 and HYSRE7. *Beierolpium* is a common genus in arid WA and includes arid-adapted species that are currently understood to be widespread. The specific biology of the species present at Hastings is unknown but it is probably widespread and not of conservation concern.

Beierolpium 8/2

Two specimens of this morphotype that has two trichobothria on the movable chela finger were collected from wet traps and leaf litter at sites HYSL6 and HYSRE9. These pseudoscorpions are often found in ephemeral habitats such as under tree bark and are probably dispersal-prone. This type of pseudoscorpion is unlikely to be of conservation concern.

Indolpium sp. B20

Two specimens were collected from leaf litter at sites JSLL08 and HYSL4. This is the most common pseudoscorpion genus in north-western WA and specimens are frequently collected during environmental surveys. The genus appears diverse at a species level but there is no taxonomic framework and species identification is difficult. However, these pseudoscorpions are arid-adapted and often collected from ephemeral microhabitats such as dry leaf litter and under tree bark. Dispersal abilities are estimated to be high and most species are currently understood to be widespread. *Indolpium* sp. B20 is unlikely to be restricted to the survey area and not of conservation concern.

Indolpium sp. B21

Three specimens of a second *Indolpium* species were collected from leaf litter at site HYSL6. This species differs from *Indolpium* sp. B20 in having a brown carapace and pedipalps (yellow carapace and dark-brown chela in *Indolpium* sp. B20), chela ratios and body measurements. *Indolpium* species are currently not considered SREs and *Indolpium* sp. B21 is unlikely to be of conservation concern.

Linnaeolpium sp. B04

A single male specimen was collected from leaf litter at site HYSL5. The only described species in this genus is *Linnaeolpium linneae* from subterranean habitats in the Robe Valley (Harvey and Leng 2008). This species is a confirmed SRE and the surface relative *Linnaeolpium* sp. B04 is classified here as a potential SRE based on research and expertise.

3.4 Slaters

Slaters are very common in environmental surveys in arid Australia and include many species with ranges that are much smaller than 10,000 km^2 (Judd and Perina 2013). Taxonomic resolution in this fauna is extremely poor and there are no revisions although there is a key to the species from Barrow Island (Judd and Perina 2013) and some information on taxonomic diversity in general (Judd and Horwitz 2003). The most common genus in WA is *Buddelundia*; in the family Armadillidae; an unrevised genus that may include

more than 100 species. Other groups, such as the Philosciidae, also include a high proportion of SRE species but are far less common.

Five slater species were recorded in the current survey and they belong to the genera *Buddelundia* (three species), *Cubaris* (one species) and *Acanthodillo* (one species). All species belong to the family Armadillidae: slaters that roll up when disturbed.

Acanthodillo sp. B16

A single male specimen was collected from a wet trap at site HYSRE4. Nothing is known about the specific biology of this species but many other *Acanthodillo* species in WA have been classified as potential SREs in previous fauna reports. Slaters generally have small ranges and dispersal abilities are often limited. *Acanthodillo* sp. B16 is classified here as a potential SRE with deficient data.

Buddelundia sp. B58

This was the most common terrestrial slater in the survey area and 632 specimens belonging to this species were collected from leaf litter and pitfall traps and multiple sites. This species is widespread and common in the survey area, is likely to occur outside the tenements and unlikely to be a SRE. This common slater is unlikely to be of conservation concern.

Buddelundia sp. B59

Two specimens of this morphospecies were collected from sites HYSOP1 and HYSRE8. Nothing is known about the ecology of this species but many other *Buddelundia* species have short ranges and are restricted to refugial habitats of high moisture retention, vegetation cover and shade (Judd and Perina 2003). This is a potential SRE species with deficient data.

Buddelundia sp. B60

Four specimens of a third species in this genus were collected from a wet trap at site HYSRE4. Nothing is known about the ecology of this species but given the short-range endemism in the terrestrial slater fauna of WA this species is classified here as a potential SRE with deficient data.

Cubaris sp. B07

Two male specimens were collected from wet traps at site HYSRE1. Not much is known about the ecology and biology of these slaters but they generally have limited dispersal capacities and probably short ranges. *Cubaris* sp. B07 is classified as a potential SRE with deficient data.

3.5 Centipedes

Almost nothing is known about centipedes in WA and there are no taxonomic revisions but some families, such as the Cryptopidae, contain some potential SRE species (e.g. Phoenix 2014). Centipedes are not as commonly collected in SRE surveys as other invertebrate groups but this may reflect sampling bias rather than rarity.

Three species (and families) of centipede were collected in the current survey. They belong to the families Cryptopidae, Oryidae and Henicopidae.

Cryptops sp. B46

A single specimen in the family Cryptopidae was collected in leaf litter at site HYSOP1. There is no taxonomic framework for this family in WA but these centipedes are probably diverse at a species level and often collected from moist leaf litter habitats. Nothing is known about the ecology and distribution of the singleton species *Cryptops* sp. B46 but at least some species in this genus have been assessed as potential SREs in previous fauna surveys. Using a precautionary approach, *Cryptops* sp. B46 is classified here as a potential SRE with deficient data.

Orphnaeus nr *brevilabiatus*

A single specimen was collected from a wet pitfall trap at site HYSRE4. It morphologically resembles *Orphnaeus brevilabiatus* in the family Geophilida which is a widespread species with multiple occurrences n WA and the Northern Territory (Colloff *et al.* 2005; ALA 2015). This species is unlikely to be of conservation concern.

Lamyctes nr *africanus*

A single specimen in the family Lithobiomorpha was collected in a wet pitfall trap at site HYSRE9. It morphologically resembles *Lamyctes africanus* which is a widespread species (Colloff *et al.* 2005). This species is unlikely to be of conservation concern.

3.6 Millipedes

Millipedes are diverse in WA at a species level. The family Paradoxosomatidae includes the genera *Antichiropus* and *Boreohesperus* that consist almost exclusively of SRE species (Car and Harvey 2013, 2014). Other groups such as the pincushion-millipedes (Polyxenida) and fire millipedes (Pachybolidae) comprise widespread species (e.g. Car *et al.* 2013; Harvey *et al.* 2011).

At least two morphospecies of pincushion millipede (Polyxenida) were collected in the current survey. No other millipedes were collected.

Polyxenidae sp. B14

Three specimens of this species were collected from three sites. There is no taxonomic framework for Polyxenidae in WA and not even the genera are established. However, polyxenids are commonly collected from dry leaf litter and debris in Western Australia and can be extremely common locally; even in habitats that are disturbed or very dry. The available data indicate that most species are very widespread (Car and Harvey 2013) and Polyxenidae sp. B14 should also occur more widely. This species is not of conservation concern.

Synxenidae sp. B08

This is the second species of Polyxenidae in the survey area and 103 specimens were collected from five sites. Based on the perceived habitat preferences of polyxenids this species is unlikely to be an SRE and probably widespread. It is not of conservation concern.

Polyxenidae sp. indet.

Three juveniles were collected at site HYSL1 that cannot be identified further. They may belong to one of the two species mentioned above and almost certainly belong to a widespread taxon.

3.7 Snails

Terrestrial snails in arid WA include groups with predominantly widespread species (e.g. the family Puplillidae with the genera *Gastrocopta* and *Pupoides*) but also those that include many potential SRE species (e.g. the Camaenidae with the genera *Quistrachia* and *Rhagada*). There are some taxonomic revisions (e.g. Whisson and Köhler 2013), molecular phylogenies (e.g. O'Neill *et al.* 2014), catalogues (Breure and Whisson 2012) and faunistic papers (Köhler and Whisson 2013) that aid the identification of species.

Only two terrestrial snail species were collected in the current survey and they both belong to the genus *Pupoides* (family Pupillidae) that consists of widespread species.

Pupoides cf. *beltianus*

A total of 25 dead-taken shells consistent with *Pupoides beltianus* were collected from five sites. This species is clearly distinct from *Pupoides contrarius*, the second species of *Pupoides* in the survey area, because the shell coiling is sinistral in *P. contrarius* but dextral in *P. beltianus*. This terrestrial mollusc is widespread and commonly collected in WA but also occurs in central Australia (ALA 2015).

Pupoides cf. *contrarius*

This was the most common snail species in this survey and 130 specimens were collected from five sites. This is a widespread species and there are numerous records from north-western WA but also the Northern Territory and Queensland. *Pupoides* cf. *contrarius* is not of conservation concern.

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