# APPENDIX 4: LEVEL 2 FAUNA SURVEY OF THE GRUYERE GOLD PROJECT (RAPALLO 2015)

REPORT No. 16414

# Level Two Vertebrate Fauna Survey of the Gruyere Project Area

Prepared for: Gold Road Resources Limited
Date: July 2015

Rapallo Environmental is a Western Australian consultancy with a strong reputation for technical excellence, client-focus and innovation. We build long-term alliances through outstanding delivery on a range of services to the resource sector, government and associated industries.

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# Table of Contents

# Tables

# Figures



# Appendices

# EXECUTIVE SUMMARY

Gold Road Resources Limited (Gold Road) propose to develop the Gruyere Project (the project), comprising a gold mine and associated infrastructure within tenement MLA38/1267**.** The site infrastructure layout is unknown at this stage. The project area is located approximately 160 km northeast of Laverton in the Yamarna Greenstone Belt of Western Australia and is 6,845 ha in size. The project is located approximately 25 km northeast of Gold Road's Central Bore Project on the Yamarna Pastoral Station Lease.

Rapallo Environmental was commissioned by MBS Environmental on behalf of Gold Road to conduct a Level 2 fauna survey of the project area, comprising a desktop review and a single-season Level 2 field survey of the 6,845 ha project area.

***Survey Methods***

The field survey was completed in accordance with Position Statement No. 3 (EPA 2002), Guidance Statement No. 56 (EPA 2004a) and the Technical Guide for Terrestrial Vertebrate Fauna Surveys (EPA 2010). The survey occurred over an 11-day period in spring, from 31$^{st}$ October to the 10$^{th}$ November 2014 and focused on all vertebrate fauna groups as well as short-range endemic (SRE) invertebrates. The survey included deployment of five systematic trapping grids, foraging surveys, systematic bird surveys, bat surveys by means of acoustic recordings, and Motion Detecting Cameras (MDCs). Opportunistic records of all vertebrate fauna and putative SRE fauna were also recorded.

Seven broad fauna habitats were identified in the project area, using existing vegetation maps and ground truthing. The most extensive habitats were Sand Plains (62.0 %), Clay Loam Plains (12.4 %), and Quartz Rocky Plains (13.9%), which made up most of the project area. The other four habitats appeared in pockets throughout the project area, these were Sand Ridges (4.2 %), Rocky Hill Slopes (4.3%), Breakaways (0.5%) and Drainage Depressions (2.7%). In addition, the ecotone (transition zone) between the Sand Plain and Clay Loam Plain habitat was also investigated, as this combination of soil and vegetation types has potential to yield specialist fauna species that may not occur elsewhere.

Five systematic trap sites were established in the Sand Ridge, Sand Plain, Clay Loam Plain and Quartz Rocky Plain habitat, and in the Ecotone sub-habitat. Each trap site comprised 10 pitfall traps with drift fences, 20 funnel traps, 20 Elliot box traps, and two cage traps. An exception was site 5 located in the Quartz Rocky Plain habitat where the hard soil prevented using pitfall traps. At this site additional funnel traps were deployed. Traps were not deployed at the Rocky Slopes, Breakaways and Drainage Depression habitats but these were surveyed thoroughly using foraging, leaf litter collection, deployment of motion-detecting cameras (MDCs), and nocturnal spotlighting. A total of sixteen forage sites were surveyed, using various combinations of these techniques as appropriate based on the habitat at each site.

The pitfall traps were suitable for capturing vertebrate fauna as well as putative SRE fauna. In addition, leaf litter samples for small SRE were collected from all trap sites, and from six forage sites, with a total of approximately 220 litres of leaf litter collected. MDCs were positioned at all trap sites, and at four forage sites. A Songbird SM2BAT+ ultrasonic sound recorder was positioned at Ziggy's Bore (forage site FS12) and left *in situ* for five days.

***Vertebrate Fauna***

A total of 116 vertebrate fauna species were recorded, comprising 45 reptile species, 17 mammal species (including three bats), and 54 bird species. Calls of one additional bat species were detected on the acoustic recordings, but could not be identified to species level due to significant call overlap between closely related species. This bat is not included in total species counts.

One species of conservation significance was recorded during the survey, but not from within the project area. This was the Rainbow Bee-eater (*Merops ornatus*), which is listed under the WA *Wildlife Conservation Act 1950* (WC Act) as Schedule 3 – Migratory birds protected under an international agreement. A small flock of Rainbow Bee-eaters was recorded foraging in the vicinity of Yamarna Camp, 20 km south-west of the project area. Because it was recorded outside of the project area, this species is not included in the total species count for the survey. However, due to the close proximity to the project area, and the species being migratory, it is highly likely that the Rainbow Bee-eater would also occur in the project area. The project is unlikely to impact on this species because is a widespread species that would only use the project area as a hunting visitor.

During an earlier Level 1 survey of a subsection of the project area (Harewood 2014) the Australian Bustard (*Ardeotis australis*), listed Priority 4 by the Department of Parks and Wildlife (DPaW), was recorded within the project area. No evidence of this species was found during the Level 2 survey (this study).

The desktop review identified thirteen species of conservation significance with the potential to occur in the project area (including the Rainbow Bee-eater and Australian Bustard). Based on the known range and habitat requirements of these species, and previous records in the region, each species was assessed as having either a high, medium, or low likelihood to occur in the project area. The Great Victoria Desert is relatively under-surveyed, and some of these species are very difficult to detect. For these reasons, the survey efforts expended to detect a species, and the likelihood of detection (cryptic nature) were also taken into account when assessing likelihood of occurrence.

Two species were considered highly likely to occur in the project area, these were:

- Rainbow Bee-eater (*Merops ornatus*) – WC Act Schedule 3, *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Migratory.
- Australian Bustard (*Ardeotis australis*) – DPaW Priority 4.

Four species were considered possible to occur in the project area (medium likelihood). These were:

- Brush-tailed Mulgara (*Dasycercus blythi*) – DPaW Priority 4.
- Peregine Falcon (*Falco peregrinus*) – WC Act Schedule 4.
- Striated Grasswren (*Sandhill race*) (*Amytornis striatus striatus*) – DPaW Priority 4.
- Princess Parrot (*Polytelis alexandrae*) – DPaW Priority 4.

Seven species were considered unlikely (low likelihood) to occur in the project area. These were:

- Southern Marsupial Mole (*Notoryctes typhlops*) – WC Act Schedule 1, EPBC Act Endangered.
- Great Desert Skink (*Liopholis kintorei*) - WC Act Schedule 3, EPBC Act Vulnerable.
- Buff-snouted Blind Snake (*Ramphotyphlops margaretae*) – DPaW Priority 2.
- Sandhill Dunnart (*Sminthopsis psammophila*) – WC Act Schedule 1, EPBC Act Endangered.
- Malleefowl (*Leipoa ocellata*) – WC Act Schedule 1, EPBC Act Endangered and Migratory.
- Eastern Great Egret (*Ardea modesta*) – WC Act Schedule 3, EPBC Act Migratory and Marine.
- Oriental Plover (*Charadrius veredus*) – WC Act Schedule 3, EPBC Act Migratory and Marine.

The reptile, mammal, and bird assemblages recorded from the project area were representative of the Great Sandy and Gibson Deserts, with no unexpected species or range extensions. The survey results provided an indication of the fauna assemblages in the project area in spring. However, species

numbers as well as the number of individuals recorded appeared to be lower than anticipated for all vertebrate fauna groups, and no frogs were recorded. In addition, several common species that would normally occur in the area (some of which in abundance) were not recorded. This may have been due to impacting pressures such as:

- Dry conditions prior to the survey, resulting in reduced food resources thus impacting breeding and migration patterns of nomadic species.
- Grazing pressure on the Yamarna Pastoral Station Lease, contributing to low species diversity on the project area.

***Short-range Endemic Fauna***

On a regional scale, as with many regions of Western Australia, SRE invertebrate survey data from the Shield and Central subregions of the GVD is deficient. Previous collections of potential SRE have been made by Harewood (2014) and Keith Lindbeck and Associates (KLA) in 2012.

A total of 37 potential SRE specimens were collected during this survey. These comprised eight spiders, 25 scorpions, and two pseudoscorpions. No snails were found during the survey.

All spiders were found at sites 3 and 4 and scorpions were captured in pitfall traps at sites 1, 2, 3 and 4. The pseudoscorpions were extracted from leaf litter samples collected at the foraging sites FS03 (granite rocky rise) and FS15 (Hakea). None of the other nine leaf litter samples yielded invertebrates of potential SRE groups.

Taxonomic identifications revealed that the specimens contained six potential SRE species, comprising three species of Mygalomorph spider, and three species of scorpion. The pseudoscorpions were identified as not likely SRE. The potential SRE species are listed below:

| | | |
|---|---|---|
| • *Synothele* sp. indet | Mygalomorph spider | Trap site 3 |
| • *Aname* 'yamarna' | Mygalomorph spider | Trap site 3 |
| • *Kwonkan* 'yamarna' | Mygalomorph spider | Trap site 4 |
| • *Lychas* 'GVD' | Scorpion | Trap sites 2 and 4 |
| • *Lychas* 'multipunctatus complex' | Scorpion | Trap sites 1 and 2 |
| • *Urodacus* 'yaschenkoi complex' | Scorpion | Trap site 3 |

All four trap sites that allowed for pitfall trap deployment yielded potential SRE species, all of which are currently only known from the Gruyere project area.

# 1 INTRODUCTION

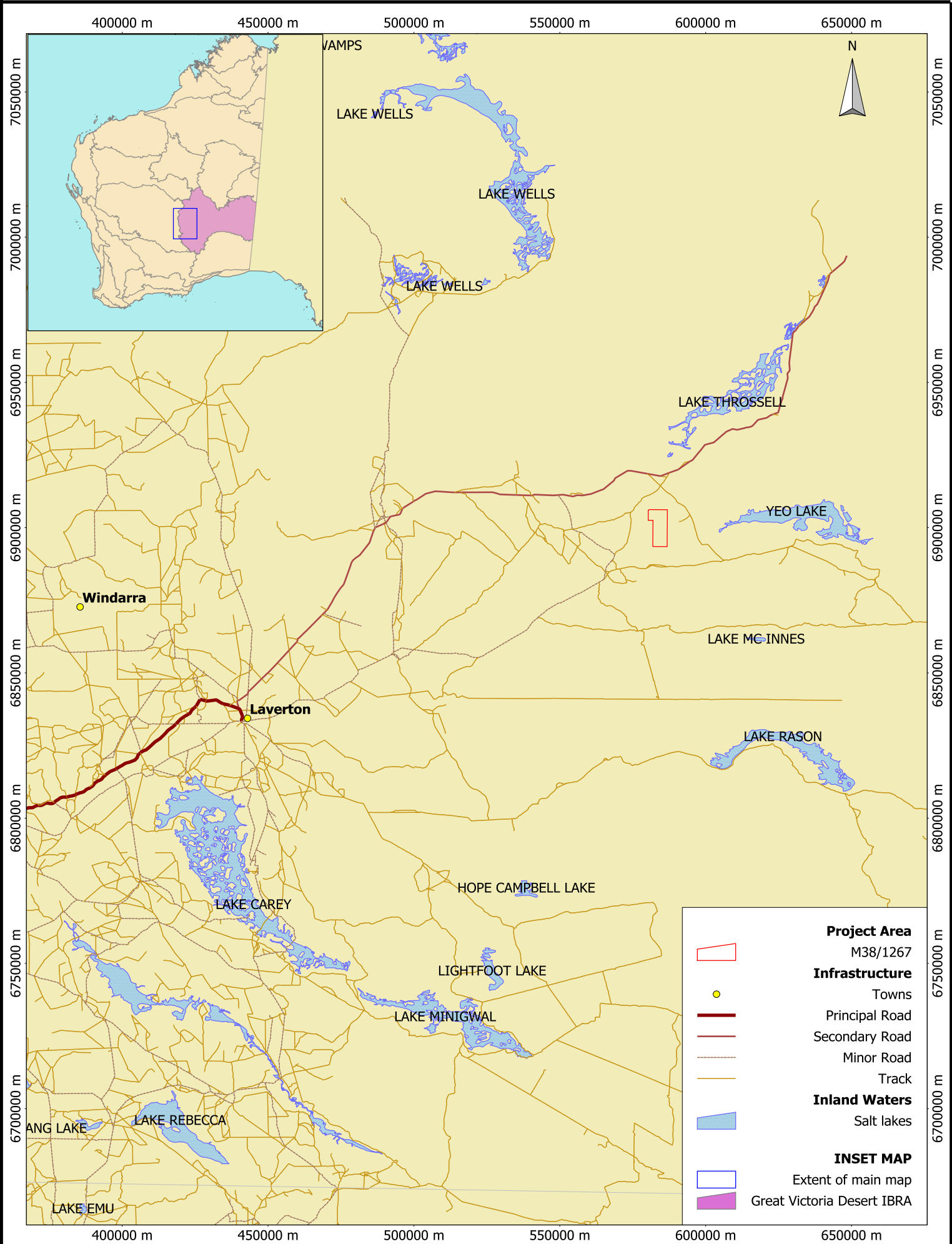
Gold Road Limited (Gold Road) proposes to develop the Gruyere Project (the project), comprising a gold mine and associated infrastructure. The site infrastructure layout is unknown at this stage. The project area is located approximately 160 km northeast of Laverton in the Yamarna Greenstone Belt of Western Australia. It comprises mining lease MLA38/1267 which is 6,845 hectares (ha) in size (Figure 1). The project is located approximately 25 km northeast of Gold Road's Central Bore Project located on the Yamarna Pastoral Station.

## 1.1 SCOPE AND OBJECTIVES

Rapallo Environmental was commissioned by MBS Environmental on behalf of Gold Road to conduct a single-season Level 2 fauna survey of the 6,845 ha mining lease, hereafter referred to as the survey area. The survey comprised a desktop review of regional data, and a single-season field survey. The field survey was completed over an 11-day period in spring, from 31st October to the 10th November 2014 by a team of three experienced ecologists (section 4.3). Detailed survey methods are outlined in section 4.

The objectives of the fauna survey were to:

- To provide an indication of the vertebrate fauna assemblage (reptiles, amphibians, small mammals and birds) on and in the vicinity of the project area, so that potential impacts on the fauna and fauna assemblage may be subsequently assessed.
- Identify the presence and/or potential occurrence of species of conservation significance that are present or likely to be present in the project area.
- Assess the habitat types and values associated with the Gruyere project area.
- Determine if any additional surveys are required to assess the potential impact on fauna assemblages in the Gruyere project area, in particular, impacts on species of conservation significance.
- Record opportunistic fauna observations.




Rapallo environmental

Gold Road Resources Ltd.
Gruyere Project

Scale: 1 : 1,500,000
Datum: MGA94 (51)

0 50 km

**Figure 1**

Location of the Project Area

# 2 LEGISLATION AND SURVEY GUIDANCE

Legislation relevant to the assessment of impacts on flora and fauna in Western Australia include the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the State *Environmental Protection Act 1986* (EP Act), and the State *Wildlife Conservation Act 1950* (WC Act).

In addition to species listed under these Acts, the Western Australian Department of Parks and Wildlife (DPaW) also lists fauna species under Priority rankings.

The Western Australian Environmental Protection Authority (EPA) has produced a series of guidance documents to aid in assessing the environmental impacts of developments in Western Australia.

## 2.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The EPBC Act, together with the *Environment Protection and Biodiversity Conservation Regulations 2000*, provides for the protection, identification and listing of nationally and internationally important flora, fauna, ecological communities and heritage, defined as Matters of National Environmental Significance.

The main authority under the EPBC Act is the Federal Department of the Environment (DoE). Actions likely to have a significant impact on Matters of National Environmental Significance need to be referred to the DoE for assessment and approval.

The conservation categories of species listed under the EPBC Act follow recommendations of the International Union for the Conservation of Nature (IUCN 2014). The following categories of threatened fauna are recognised: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), and Conservation Dependent (CD).

The EPBC Act also provides for protection of migratory species that are covered under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA).
- China-Australia Migratory Bird Agreement (CAMBA).
- Republic Of Korea – Australia Migratory Bird Agreement (ROKAMBA).
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Ecological communities are unique and naturally occurring groups of plants and animals. Their presence can be determined by factors such as plant assemblage, soil type, position in the landscape, climate and water availability. The following categories of Threatened Ecological Communities are recognised: Critically Endangered (CR), Endangered (EN), and Vulnerable (VU).

## 2.2 ENVIRONMENTAL PROTECTION ACT 1986

The EP Act provides for the protection of the environment from harm and pollution resulting from the development of land or natural resources. The main authority under the Act is the EPA which has statutory obligations under Part III and IV of the Act to undertake environmental impact assessment, protect the environment from harm and to provide advice to the Minister of Environment on matters of environmental importance.

The Act provides for the protection of Environmentally Sensitive Areas (ESAs) under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. ESAs are selected for their environmental values at State or national level, and are defined under the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*.

ESAs include:

- Declared World Heritage properties.
- Areas on the Register of the National Estate.
- Defined wetlands and riparian vegetation within 50 metres of the wetland.
- Area of vegetation within 50 metres of Declared Rare Flora.
- Areas covered by Threatened Ecological Communities.
- Bush Forever sites.

The main protection given to ESAs is that clearing permit exemptions that may exist under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* do not apply in ESAs.

## 2.3 WILDLIFE CONSERVATION ACT 1950

In Western Australia, all native fauna is protected under the WC Act and cannot be collected, kept or culled without the appropriate permits. The WC Act uses a set of Schedules to classify the level of protection given to fauna species.

Special protection is given to species that are formally recognised as under threat of extinction, rare, or generally in need of protection. Specially protected fauna are classified under a set of Schedules which outline the level of protection; these are:

- Schedule 1 – Threatened Fauna (T): Fauna that is rare or is likely to become extinct.
- Schedule 2 – Presumed Extinct Fauna (X).
- Schedule 3 – Birds protected under International Agreement (IA): Migratory birds subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and the Republic of Korea (ROKAMBA) relating to the protection of migratory birds.
- Schedule 4 – Other Specially Protected Fauna (S): Fauna that is in need of special protection, for reasons otherwise than for those mentioned under Schedules 1, 2 and 3.

Threatened Fauna (T) are further ranked by the DPaW according to their level of threat, using International Union for Conservation of Nature (IUCN) Red List Criteria. These sub-categories are: Critically Endangered (CR), Endangered (EN) and Vulnerable (VU).

The DPaW regularly reviews and revises the schedule of threatened fauna listings in Western Australia. The list of specially protected fauna is published in the *Western Australian Government Gazette* as Wildlife Conservation (Specially Protected Fauna) Notices, with the most recent dated 17 September 2013 (Government of Western Australia 2013).

## 2.4 DPAW PRIORITY FAUNA RANKINGS

The Western Australian DPaW (previously Department of Environment and Conservation, DEC) maintains a supplementary list of Priority fauna rankings. Priority fauna are species which are not

considered Threatened under the State and Federal Acts mentioned above, but for which the DPaW considers that there is cause for concern.

Priority fauna are recognised as having conservation significance and are given consideration when developments are proposed within their distribution and/or habitats. There are five levels of Priority ranking. Priority 1, 2 or 3 (not yet adequately surveyed), Priority 4 (rare, near threatened, or in need of monitoring), and Priority 5 (conservation dependent).

The list of Priority Fauna is published on the DPaW website, with the most current list dated 2nd December 2014 (DPaW 2014).

## 2.5 EPA GUIDANCE STATEMENTS

The EPA of Western Australia is responsible under the WC Act to protect the environment and to prevent environmental harm. Part of its role is to conduct environmental impact assessments (EIA) of major projects. Another part is to develop policy and guidance documents; these documents carry the force of law under both the WC Act and the EP Act.

### *2.5.1 EPA GUIDANCE FOR TERRESTRIAL FAUNA*

The guidance documents relevant to terrestrial vertebrate fauna are:

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

Guidance Statement 56 outlines the minimal expectations of the EPA in regards to terrestrial fauna considerations in EIA. It provides a number of general recommendations for consideration before an assessment is conducted, including the level of survey required, survey design and intensity, survey limitations, and reporting of data. For the Great Victoria Desert Bioregion, Guidance Statement 56 recommends that any proposed project with footprint greater than 50 ha requires a Level 2 survey to adequately assess potential impacts on terrestrial fauna (EPA 2004a).

### *2.5.2 EPA GUIDANCE FOR SHORT-RANGE ENDEMIC FAUNA*

Short-range Endemic (SRE) fauna are considered to be invertebrate species with a naturally small range (less than 10,000 square kilometres) (Harvey 2002). SRE species often possess a combination of ecological and life-history traits that make them vulnerable to extinction. These traits include poor powers of dispersal, confinement to isolated habitats, low levels of fecundity, and usually highly seasonal activity patterns (i.e. only active during cooler, wetter periods).

Based on these traits and after reviewing the literature in Australia, Harvey (2002) listed a series of invertebrate groups that either showed high levels of short range endemism or were likely to include SRE species. The list of groups includes Mygalomorph spiders, scorpions, pseudoscorpions, millipedes, and land snails. Taxa from these groups are of particular risk of being SRE, and survey methods should be designed to optimise the chances of recording these groups (EPA 2009).

The following guidance documents outline the minimum expectations of the EPA in regards to consideration of SRE fauna in an environmental impact assessment.

- *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002).
- *Guidance Statement No. 20: Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA 2009).

Guidance Statement No. 20 outlines the general standards required for SRE surveys, and presents a common framework by which they should be carried out. It also sets out the expectations in respect of the quality and quantity of data collected during SRE surveys, and how this data should be analysed and reported.

Guidance Statement No. 20 suggests that the optimum time to survey SRE is during seasonally wet conditions. Typically, SRE taxa are easier to collect during wet conditions as they become more active and venture from their hiding places. In addition, for many SREs adults (particularly adult males) are required for identification, and many taxa reach maturity timed to coincide with wet conditions. In the Goldfields and Midwest areas, high rainfall events are scattered and sporadic, with rainfall influenced by south-west fronts in the south, and by cyclone events in the north. This means that for the project area the optimum SRE survey time will be determined by the rainfall events of that particular year, rather than an annual time period (EPA 2009).

Important in the context of Environmental Impact Assessments, Guidance Statement No. 20 recognises and discusses limitations on current knowledge in respect to SRE fauna. In particular, the limitations encountered after recording rare and cryptic taxa, and the low probability of further survey success. If such rare or cryptic specimens are restricted to impact zones, a risk-based analysis using habitat as a surrogate for distribution can be considered (EPA 2009).

# 3 REGIONAL CONTEXT OF THE SURVEY AREA

## 3.1 CLIMATE

The Great Victoria Desert is characterised by an arid climate, with hot summers and cool winters. Summer maximum temperatures average about 35°C, while winter minimums are around 5°C. Rainfall is related both to dissipating tropical cyclones tracking southeast and to locally generated thunderstorms. Thunderstorm activity tends to be greatest between October and December when cool airflows from the south wedges beneath humid north-westerly winds. Cyclonic activity is greatest between January and May, reflecting the tropical wet season in the north of the state.

Average annual rainfall in the Great Victoria Desert is 190 mm (Barton and Cowan 2001). These two mechanisms of rainfall spanning autumn to winter can lead to a more evenly distributed annual rainfall distribution than other parts of Western Australia. While relatively evenly distributed, rainfall is very infrequent with only about 30 rain days per year. Rainfall is highest in the cyclone season (Figure 2). Most of the annual rainfall is often received in one or two significant events and many years have close to zero rainfall.

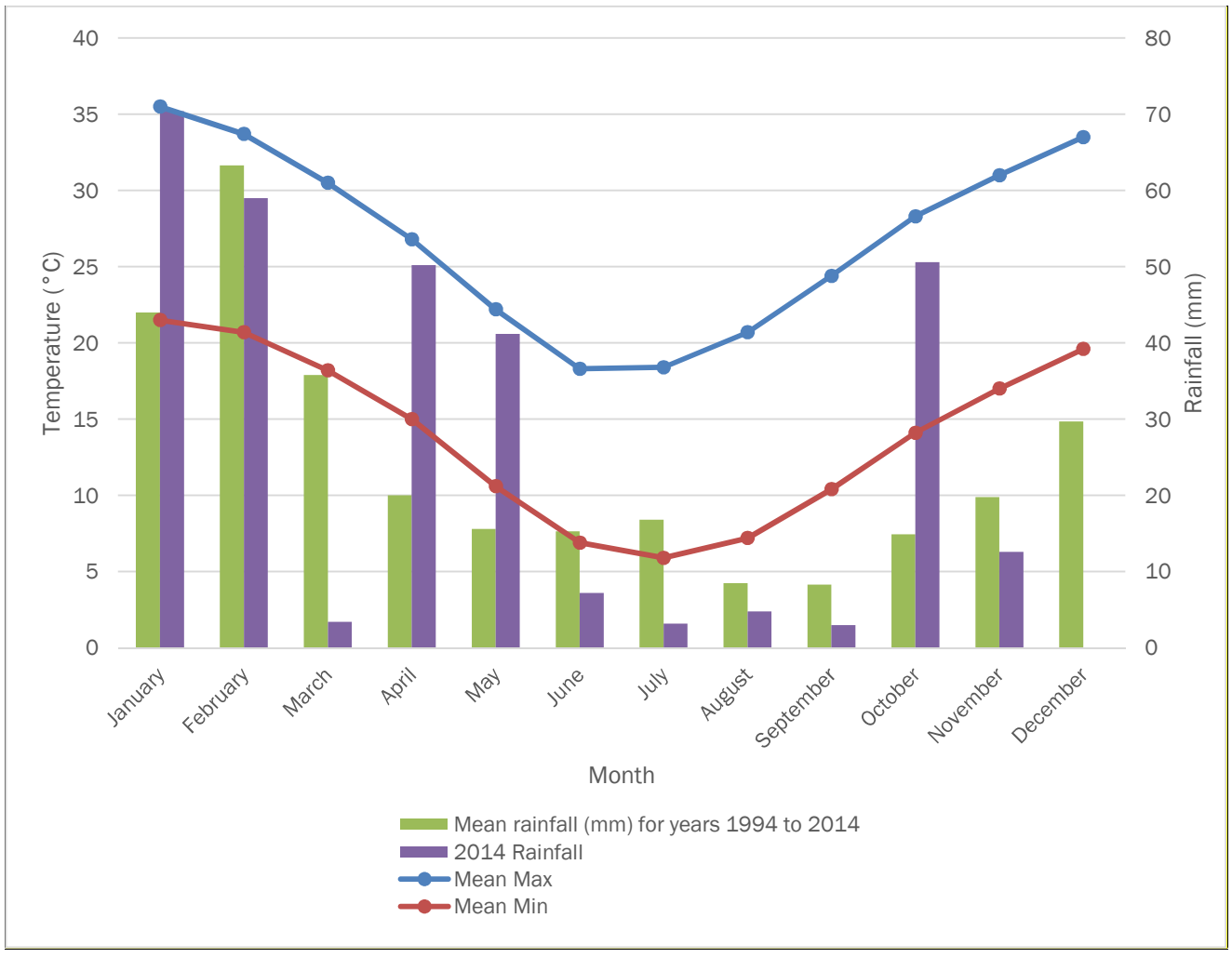



**Figure 2 Monthly mean maximum and minimum temperatures and rainfall recorded at Laverton Aerodrome weather station (012305)**

The total amount of rainfall recorded at the Laverton Aerodrome from January to November 2014 was 305 mm, with the majority falling in January (70.4 mm). Over the four months preceding the survey (July to October), Laverton Aerodrome received a total of 61.6 mm of rain, with the majority falling in October (50.6 mm). Rainfall received at the Yamarna Camp totalled 10.2mm for November. During the survey, from 31st October to the 10th November 2014, the Laverton Aerodrome weather station recorded 5.2 mm of rainfall. Rainfall was recorded on November 10th, after the survey had concluded (5.2 mm). Daytime temperatures during the survey were in the mid to high 30's, with November 6th (41.9°C) and November 5th (36.6°C) being the hottest days. Night time temperatures fluctuated between 12.8°C on the night of November 1st to 24°C on the night of November 6th 2014. Daily temperature and rainfall data from the Laverton Aerodrome Weather Station during the survey period are shown in Table 1.

**Table 1 Daily temperature and rainfall recorded at Laverton over the period of the survey**

| Survey day | Maximum temperature (°C) | Minimum temperature (°C) | Rainfall (mm) |
|---|---|---|---|
| October 31st, 2014 | 28.6 | 19.0 | 0.00 |
| November 1st, 2014 | 26.9 | 12.8 | 0.00 |
| November 2nd, 2014 | 34.4 | 14.4 | 0.00 |
| November 3rd, 2014 | 33.8 | 21.4 | 0.00 |
| November 4th, 2014 | 32.3 | 14.8 | 0.00 |
| November 5th, 2014 | 36.6 | 18.6 | 0.00 |
| November 6th, 2014 | 41.9 | 24.0 | 0.00 |
| November 7th, 2014 | 29.4 | 23.5 | 0.00 |
| November 8th, 2014 | 33.3 | 15.3 | 0.00 |
| November 9th, 2014 | 36.7 | 21.0 | 0.00 |
| November 10th, 2014 | 28.2 | 20.9 | 5.2 |

## 3.2 BIOGEOGRAPHY

The bioregions of Australia are described in the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway & Cresswell 1995). Bioregions are large, geographically distinct areas of land with common characteristics such as geology, landform patterns, climate, ecological features and plant and animal communities. The latest version, IBRA7, classifies Australia's landscapes into 89 large geographically distinct bioregions and 419 subregions (DoE 2013).

The survey area is located within the Great Victoria Desert IBRA Region. This is further divided into six subregions (Shield, Central, Maralinga, Kintore, Tallaringa and Yellabinna). The majority of the survey area is located within the Shield (GVD1) subregion with the remainder to the east located within the Central (GVD2) subregion (Barton and Cowan 2001).

The Shield subregion contains Ponton Creek (a major palaeochannel occasionally running from the northeast Goldfields to Lake Bonderoo) and the highest proportion of sand plains in the bioregion. It is bounded to the east by an arid active sand-ridge desert of deep Quarternary aeolian sands overlying Permian and Mesozoic strata of the Officer Basin (Barton and Cowan 2001).

The major landforms of the Shield subregion include:

- Salt lakes and major valley floors with lake derived dunes.

- Sand plains with patches of seif dunes running east west.
- Areas of moderate relief with out-cropping and silcrete-capped mesas and plateaus (breakaways).

## 3.3 HYDROLOGY

The survey area is characterised by sand ridges and sand plains bounded to the east by Dorothy Hills, the west by Virginia Range and draining toward Lake Throssell and the southern end of the Newland Range in the north. The Virginia Range forms the western border draining to Minnie Creek, which flows through the review area northeast to Lake Throssell. Dorothy Hills in the east directs much surface runoff toward Lake Yeo in the east. These landforms differ to those of the Central Bore project where sand ridges are less prevalent and the landforms are generally flatter in nature (MBS 2014).

## 3.4 SOILS

Beard (1974) describes the sandy areas of the desert as dune sands that are red in colour and incoherent with sand plains formed of the same material. The soil is unstructured and may be deep. In sand ridge areas, the soil between dunes may or may not be sandy and frequently seems to be developed on a truncated profile from which sand has been removed. For this reason, vegetation between sandhills is not uniform and may consist of a variety of communities (Beard, J.S. 1974).

On Precambrian rocks Beard (1974) describes the outcropping ranges as extremely rocky with little soil. On flatter ground there is typically a red loam on which mulga (*Acacia aneura*) grows. These soils are loose and friable with a few small ironstone and quartz pebbles and overlies a massive siliceous hardpan. The surface may frequently be strewn with small stones all with an iron oxide patina. A structurally similar soil but with a high pH occurs in the vicinity of basic rock outcrops. Close to salt lakes a whitish colour appears due to the accumulation of lime and gypsum. The beds of salt lakes are formed by extremely stiff red clay, frequently with a surface efflorescence of salt crystals in dry weather (Beard, J.S. 1974).

The project area occurs within the Gunbarrel Province of Western Australia and within the north-western Great Victoria Desert soil-landscape zone, an area of 94,450 $km^2$ consisting of northwest dunes and hills (Tille 2006). Soils and landscapes of the north-western Great Victoria Desert Zone as described by Tille are similar to Beard's descriptions. The area consists of sand plains and dunes (with some undulating plains and uplands) on sedimentary rocks of the Gunbarrel Basin. Soils are typically red sandy earths and red deep sands with some red loamy earths and red-brown hardpan shallow loams. Vegetation characteristic of the zone are mulga shrublands and spinifex grasslands with mallee.

## 3.5 REGIONAL VEGETATION

Vegetation of the Helms Botanical District comprises a mosaic of tree and shrub steppe between sandhills and on sand plains, consisting of marble gum, mallee and spinifex (*Eucalyptus gongylocarpa*, *E. youngiana*, *Triodia basedowii*). Beard (1990), states that dunes in the west, are thinner, few and weak. *E. gongylocarpa* is comparatively scarce with *E. youngiana* replaced by *E. kingsmillii* and *Acacia aneura* and *A. linophylla* becoming frequent on the sand plain.

The Shield subregion contains spinifex (*Triodia* spp) and mallee (*Eucalyptus kingsmillii*, *E. youngiana*) over hummock grassland dominated by *Triodia basedowii* on aeolian sand plain. Scattered marble gum (*E. gongylocarpa*) and native pine (*Callitris sp.*) occur on the deeper sands of the sand plains. Mulga and

Acacia woodland occur mainly on the colluvial and residual soils. Halophytes such as salt bush (*Atriplex*), bluebush (*Kochia*) and samphire (*Arthrocnemum*) occur on the margins of salt lakes and in saline drainage areas (Barton and Cowan, 2001).

The Central subregion vegetation is primarily a Tree steppe of *Eucalyptus gongylocarpa*, Mulga and *E. youngiana* over hummock grassland dominated by *Triodia basedowii* on the Aeolian sands. The Acacia dominates colluvial soils with *Eremophila* and *Santalum spp.*, halophytes are confined to edges of salt lakes and saline drainage systems (Barton and Cowan, 2001).

## 3.6 PROTECTED AREAS

### *3.6.1 ENVIRONMENTALLY SENSITIVE AREAS*

The project area does not overlay any ESAs as described by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* or Priority Ecological Communities (PECs) as defined by the Department of Environment Regulation (DER) Native Vegetation Map Viewer. There are no ESAs within five kilometers of the project area (DER 2014).

The survey area is not located within a Schedule 1 Area, as described in Regulation 6 and Schedule 1, clause 4 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

The survey area is not located within any DPaW managed land. However the Yeo Lake Nature Reserve, which is listed as a Class A Nature Reserve managed by the DPaW, is located approximately 15 km to the east of the survey area. The Yeo Lake Nature Reserve is listed as an ESA and a Schedule 1 Area.

The Yeo Lake Nature Reserve is significant as it is biologically important for the different assemblages of plants and animals present. It comprises of some permanent and semi-permanent water holes in an otherwise arid region (DoE 2014c). It is described as a system of salt lakes, the floor of which is vegetated with a rich variety of halophytes (some endemic). It includes gypsum ridges carrying *Casuarina cristata*/*Acacia colletioides* association that is unknown elsewhere in the desert. To the west, south-west and north are extensive sand plains and dunes interspersed with rocky hills and breakaways. The area is rich in reptiles (forty species lizards and three species of snake) and is the type locality for several species. The sand areas are dominated by spinifex, mallees, mulga and bara gum (DoE, 2014c). The project area is located 15 km west from Yeo Lake, and does not contain any of the habitats that makes this reserve significant, i.e. no salt lakes or gypsum ridges.

### *3.6.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES*

A Level 2 flora and vegetation survey of the project area (Botanica 2014) indicated that there are no TECs or PECs within the project area, as listed under Commonwealth legislation (DoE 2014a) or as defined by the DPaW (2013a).

# 4 METHODS

## 4.1 SCIENTIFIC LICENCE

This survey was licensed under the Western Australian *Wildlife Conservation Act 1950 Regulation 17* "Licence to Take Fauna for Scientific Purposes" licence number: SF-010094.

## 4.2 VOUCHERING

Following EPA (2010) recommendations, Rapallo will voucher specimens if:

- They are of a species or species group specifically requested by the WAM;
- They cannot be identified in the field (typically species such as blind snakes or potential SREs);
- They represent a species of taxonomic confusion/interest;
- They exhibit a significant range extension; or
- They are possibly an un-described species.

## 4.3 PERSONNEL

Table 2 outlines the personnel that were involved in the field survey and the preparation of this report.

**Table 2 Personnel involved in this survey**

| Name | Position | Trap Installation | Field Survey | Reporting |
|---|---|---|---|---|
| Kate George | Principal Scientist | ● | ● | ● |
| Chris Cooper | Ecologist | ● | ● | ● |
| Magnus Peterson | Field Ecologist | ● | ● | ● |
| Marieke Weerheim | Ecologist | | | ● |
| Harvey Murray (HM) | Yilka Traditional Owner | | ● | |
| Harvey Murray (HJ) | Yilka Traditional Owner | | ● | |
| Rowan Murray | Yilka Traditional Owner | | ● | |
| Sebastian Murray | Yilka Traditional Owner | | ● | |
| Hayley Westlake | Yilka Traditional Owner | | ● | |
| Kassey Murray | Yilka Traditional Owner | | ● | |

## 4.4 DESKTOP SEARCH

Prior to the field survey, a desktop search was completed. The aim of the desktop search was to identify whether species of conservation significance had either been recorded close to the survey area or had the potential to occur within habitats in the project area. It must be noted that the Great Victoria Desert, and the region in which the project area are located, are relatively under-surveyed. This places some limitations on the interpretation of the desktop data.

Most of the information included in the desktop was based on an earlier desktop by Harewood (2014). Harewood reviewed several databases as well as reports of previous surveys in the Great Victoria Desert. In this report, Harewood's database searches are not fully reproduced, and only those data sources that are most relevant to the project area were used. In addition, a search of DPaW fauna database was also completed, covering a circular area of 150 km radius centred on the project area. The complete list of databases and reports used in this Level 2 report is listed in Table 3.

Birdlife Australia's online Atlas database, Birdata, was used to verify species boundaries and identify recent sightings of conservation significant bird species. Van Dyck and Strahan (2008) Mammals of Australia, and Cogger (2014) Reptiles and Amphibians of Australia were used to verify species boundaries and habitat requirements for respectively mammals and reptiles.

Results of the desktop searches are listed in Table 3, and are summarised in Appendix I.

**Table 3 Databases and Reports reviewed for the Desktop Search**

| Name of Database or Survey Report | Relevance to Project Area |
|---|---|
| Department of Parks and Wildlife (DPaW) Threatened and Priority Fauna (TPF) Database search (2014). | 150 km buffer zone centred on the project area. |
| DPaW NatureMap Database (2014). | 20 km buffer zone centred on the project area. |
| Department of the Environment (DOE) Protected Matters Database. | 40 km buffer centred on the project area. |
| Harewood (2014). Fauna Assessment (Level 1) Gruyere Project. Unpublished report for Gold Road Resources Limited, August 2014. | Same area, but only subsection of the MLA. |
| Ecologia (2009). Tropicana Gold Project. Operational Area Vertebrate Fauna Assessment. Unpublished Report for Tropicana Joint Venture, February 2009. | 200 km south-east of the project area. |
| KLA (2012). Fauna Assessment (Level 2). Yamarna Project. Unpublished report for Gold Road Resources. October 2012. | Approximately 20 km from centre of the project area. |
| Terrestrial Ecosystems (2011) Level 2 fauna risk assessment for the Granny Deeps Project Area. Unpublished report. February 2011. | 160 km to the south-west. |
| Harewood (2011). Terrestrial Fauna Survey (Level 1) of Yamarna Gold Project (Central Bore), Atilla, Alaric, Haul Road and Khan North). Unpublished report for Gold Road Resources. September 2011. | Approximately 20 km from centre of project area. |
| Hall et al. (1994). The Biological Survey of the Eastern Goldfields of WA - Pt 10: Sandstore-Sire Samuel and Laverton-Leonora Survey Areas. Records of the WAM, Supplement 47: 1-166. | Very large area covering parts of the Great Victoria Desert. |

## 4.5 VERTEBRATE FAUNA SURVEY

A single-phase Level 2 fauna survey of the project area was completed in accordance with Position Statement No. 3 (EPA 2002), Guidance Statement No. 56 (EPA 2004a) and the Technical Guide for Terrestrial Vertebrate Fauna Surveys (EPA 2010). The survey period was from 31st October to the 10th November 2014 by a team of three Rapallo ecologists. Survey work included deployment of systematic trapping grids, hand foraging, leaf litter collection, bird surveys, bat surveys by means of acoustic recordings, spotlighting, deployment of Motion Detecting Cameras (MDCs), and opportunistic records.

A total of five trap sites were established, and sixteen forage sites were selected in areas of interest across the project area. These are summarised in Table 4 below.

Hand foraging was completed at all trap sites and twelve of the forage sites (n=17). MDCs were deployed at all trap sites and at four of the foraging sites (n=9). Leaf litter was collected from all trap sites and six of the forage sites (n=11). Bird surveys were completed at all trap sites and at Ziggy's Bore (n=6). A Songbird SM2BAT+ ultrasonic sound recorded was placed at Ziggy's bore over five consecutive nights (n=1). Nocturnal spotlight surveys were conducted at all trapping sites, and opportunistically across the project area while driving at night.

**Table 4 Summary of survey effort at all survey sites**

| Type | Name | Habitat | Trap site | Hand Forage | MDC | Leaf Litter | Bird Survey | Bat Survey | Easting | Northing |
|---|---|---|---|---|---|---|---|---|---|---|
| Trap site | Site 1 | Sand Ridge | x | x | x | x | x | | 582665 | 6905086 |
| Trap site | Site 2 | Sand Plain | x | x | x | x | x | | 582727 | 6897221 |
| Trap site | Site 3 | Ecotone | x | x | x | x | x | | 586396 | 6898343 |
| Trap site | Site 4 | Clay Loam Plain | x | x | x | x | x | | 586533 | 6898656 |
| Trap site | Site 5 | Quartz Rocky Plain | x | x | x | x | x | | 586413 | 6899876 |
| Forage site | FS01 | Breakaway | | x | x | x | | | 586277 | 6896013 |
| Forage site | FS02 | Minor Drainage | | x | | x | | | 585750 | 6895030 |
| Forage site | FS03 | Granite Rocky Rise | | x | x | x | | | 585977 | 6899949 |
| Forage site | FS04 | Sand Plain Unburnt | | x | | | | | 583795 | 6896766 |
| Forage site | FS05 | Sand Plain (burnt) | | x | | | | | 585722 | 6896228 |
| Forage site | FS06 | Sand Ridge | | x | | | | | 584507 | 6896318 |
| Forage site | FS07 | Small Sand Ridge | | x | | | | | 582932 | 6896406 |
| Forage site | FS08 | Small Rocky Hill | | x | | | | | 585020 | 6895143 |
| Forage site | FS09 | Small Outcrop | | x | | | | | 585589 | 6896289 |
| Forage site | FS10 | Quartz | | x | | | | | 586125 | 6895983 |
| Forage site | FS11 | Drainage Depression | | x | | | | | 586752 | 6897258 |
| Forage site | FS12 | Ziggy's Bore | | x | x | | x | x | 586648 | 6898574 |
| Forage site | FS13 | Callitris on Sand Ridge | | | | x | | | 582113 | 6906046 |
| Forage site | FS14 | Quartz Rocky Plain | | | | x | | | 585724 | 6905189 |
| Forage site | FS15 | Hakea | | | | x | | | 586394 | 6904699 |
| Forage site | FS16 | Sand Plain | | | x | | | | 582872 | 6903740 |
| **TOTAL sites: 21** | | | | | | | | | | |
| **Number of sites for each survey activity:** | | | **5** | **17** | **9** | **11** | **6** | **1** | | |

### 4.5.1 FAUNA HABITAT MAPPING

The project area was traversed using a combination of driving, walking, and riding quad bikes. The aim was to ensure that the majority of the survey area was examined including those parts where road access was limited, in order to ground-truth the extent of fauna habitat interpreted from aerial photography, and to collect additional fauna records by hand foraging (section 4.5.6) and opportunistic records (section 4.5.7).

Broad-scale fauna habitat mapping of the project area was completed using the following information:

- Vegetation maps by Botanica (2015).
- Habitat assessments of a portion of the MLA by Harewood (2014).
- Google Earth imagery.
- Selective ground-truthing of habitat types and boundaries during site selection and while traversing the survey area (see section 4.5.6).

Rapallo's habitat mapping focussed on broad habitat types as relevant from a terrestrial vertebrate fauna perspective. Using this method, seven broad fauna habitat types were identified in the project area. The most extensive of these were Sand Ridges, Sand Plains, Clay Loam Plains, and Quartz Rocky Plains, which made up most of the project area. The other three habitats appeared in pockets throughout the project area, and were Rocky Slopes, Breakaways and Drainage Depressions. In addition, the ecotone (transition zone) between the Sand Plain and Clay Loam Plain habitat was also considered significant, as this combination of soil and vegetation types has the potential to yield specialist fauna that may not occur elsewhere. This sub-habitat was labelled Ecotone.

### 4.5.2 SYSTEMATIC TRAPPING

Five systematic trap sites were deployed across the project area (Figure 3). Four trap sites were positioned within the most extensive habitat types in the project area: Sand Ridge, Sand Plain, Clay Loam Plain and Quartz Rocky Plain. One trap site was located within the Ecotone sub-type, as described in section 4.5.1. The Rocky Slopes, Breakaways and Drainage Depression habitats were not trapped but were surveyed thoroughly using foraging and nocturnal spotlighting.

The locations of the five systematic trap sites across the project area are shown in Figure 3. Table 5 shows the total number of trap nights by trap site and habitat type. Trap sites were selected within each of the five dominant habitat types present in the project area, as identified from maps and information provided prior to the survey. Fauna habitats are described in section 5.2.

**Table 5 Trap night summary and trap configuration per site**

| Site number and habitat | Pitfall Traps | Elliot Traps | Funnel Traps | Cage Traps | Nights |
|---|---|---|---|---|---|
| Site 1 – Sand Ridge | 90 | 180 | 180 | 36 | 9 |
| Site 2 – Sand Plain | 80 | 160 | 160 | 32 | 8 |
| Site 3 – Sand/Clay Loam Plain Ecotone | 70 | 140 | 140 | 28 | 7 |
| Site 4 – Clay Loam Plain | 70 | 140 | 140 | 28 | 7 |
| Site 5 – Quartz Rocky Plain | 0*) | 140 | 182*) | 28 | 7 |
| **Total** | **310** | **760** | **802** | **152** | **38** |

**) Hard rocky ground at this site made digging pitfalls unfeasible; extra funnel traps were deployed instead.*

Rapallo used a pitfall trap grid to survey the terrestrial fauna of the survey area. For trap sites 1 to 4 each systematic trap site consisted of:

- 20 Elliot traps.
- 20 funnel traps (two per bucket).
- 10 pitfall traps (alternating bucket/pipe design).
- 4 Sherman cage traps.
- 1 MDC.

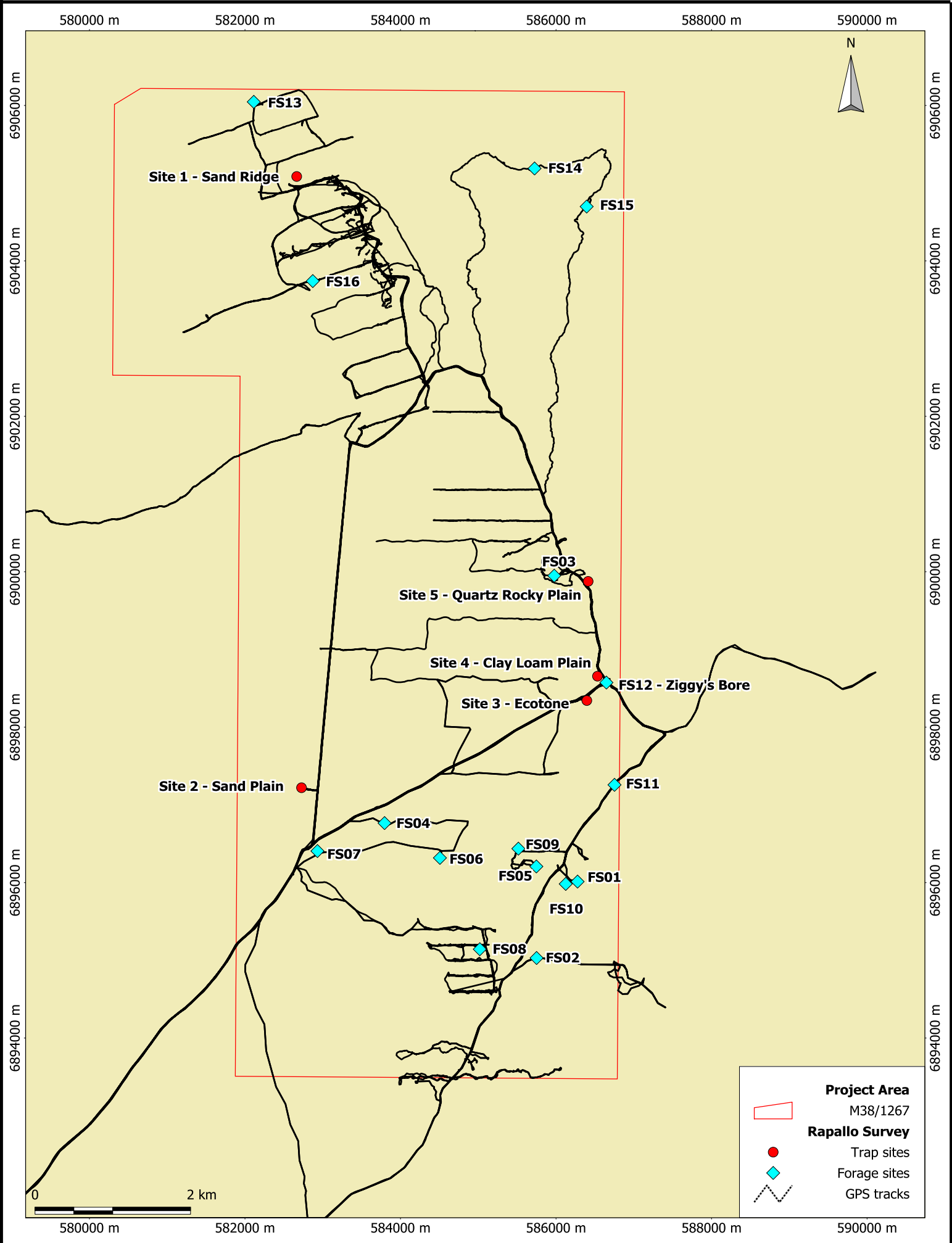
Trap site 5 was located on a quartz plain where the hard rocky ground made pitfall trap installation unfeasible. To compensate for this, 6 extra funnel traps were deployed at this site, i.e. 26 instead of 20. The number of Elliot box traps, cage traps, and MDCs for trap site 5 was similar to the other sites.

Each pitfall trap had a white polystyrene tray to provide shelter for any captured fauna, and had a drift fence either side to guide animals into the trap. Funnel traps and Elliot traps were covered with native vegetation and cage traps were covered with insulation sheeting, to provide shelter for captured fauna. Elliot and cage traps were baited with a mixture of oats, sardines, honey and peanut butter. Baits were replaced every three days.

Elliot traps and cage traps were closed after being checked each morning and reopened each afternoon to avoid the temperature extremes encountered during the day.

Vertebrate fauna were identified and released each morning as the trap lines were cleared. Specimens that could not be immediately identified were placed in a calico bag and kept in a cool location until identified at the field camp. After identification the specimens were released near the site of capture when conditions for release were suitable (i.e. early morning or late afternoon). The following data were recorded for each animal captured:

- Trap site and trap number.
- Species and (where possible) race and subspecies.
- Sex and reproductive condition (where possible).
- Age class, i.e. whether juvenile or adult (where possible).




Rapallo environmental

Gold Road Resources Ltd.
Gruyere Project

Scale: 1 : 60,000
Datum: MGA94 (51)

**Figure 3**

Locations of Trap Sites and Foraging Sites

### 4.5.3 BIRD SURVEYS

The bird assemblages of the project area were assessed through a combination of systematic surveys and opportunistic observations. Systematic surveys, comprising of twenty minute two-hectare bird surveys, as per Birdlife Australia (2013b) guidelines, were completed at all trap sites during peak bird activity (5 am to 9 am) when cryptic species were most detectable. In addition to the trap sites, one systematic survey was completed at a location of free-standing water known as Ziggy's Bore.

Systematic records were supplemented with opportunistic records. These records were collected at trap sites, during travel between trap sites and during day time forage surveys. Data recorded during opportunistic observations included location, date, and habitat where the species was recorded. Birds were identified by direct observation, tracks and scats, and call.

### 4.5.4 BAT SURVEYS

Bat surveys were conducted by deploying a Songbird SM2BAT+ ultrasonic sound recorder. The Songbird unit was positioned at Ziggy's Bore over five consecutive nights (Figure 3). This area was the only known location of free standing water on the project and was within close proximity of several stands of mature, hollow bearing *Eucalypt*, Mulga and *Casuarina* trees. The Songbird unit was programmed to record continuously between the hours of 6 pm and 6 am. Following the field survey, all recordings were sent to Dr Kyle Armstrong of Specialised Zoological for analysis. In addition to acoustic recordings, Rapallo also collected opportunistic records of all bats seen or heard during spotlight surveys.

### 4.5.5 SPOTLIGHTING

Spotlight surveys were completed in each of the fauna habitat types as described in section 4.5.1. In order to not interfere with the movements of nocturnal fauna near trap sites, spotlight surveys were conducted at a minimum distance of 200 metres from trapping grids. Spotlight surveys were run over 30 minutes and were completed by a team of two ecologists. All nocturnal fauna and potential SRE's found during spotlighting searches were recorded using a handheld Garmin GPS.

### 4.5.6 FORAGING SURVEYS

Foraging surveys were completed at all systematic trap sites (Figure 3), and sixteen forage sites (Table 4, Figure 3) identified as having high potential to harbour small vertebrate fauna and potential SRE (n=17). Fauna records collected during foraging surveys have been included in the overall species lists for the survey. Foraging activities included lifting bark and old tin, rolling old logs, and raking through sand and leaf litter. The following data was recorded for each foraging site:

- GPS location.
- Soil type and characteristics.
- Geology and landform.
- Leaf litter depth.
- Evidence of disturbance (i.e. fire, grazing).
- Broad vegetation description.
- Potential suitability for species of conservation significance including SREs.

### 4.5.7 OPPORTUNISTIC RECORDS

While traversing the survey area, opportunistic records were taken of all fauna and potential SRE invertebrates, as well as secondary evidence such as tracks and burrows. The following data was recorded each time a species of conservation significance, SRE, or secondary evidence was recorded:

- GPS location.
- Family or genus identification, and (where possible) species identification, sex and maturity.
- Habitat type.
- Photograph of species, or of secondary evidence (where possible).

Data recorded from opportunistic sightings has been included in the overall species lists for the survey.

### 4.5.8 MOTION DETECTING CAMERAS

MDCs of the model Scoutguard SG550 were deployed across the survey area in different habitats to record species that can be difficult to detect via direct observation. MDCs were deployed at all systematic trap sites and at four of the forage sites (n=9) labelled FS01, FS03, FS12 (Ziggy's Bore), and FS16.

Each camera was programmed to record 30 seconds of video, at one minute intervals with detection sensitivity set to high. Each camera was securely fastened on either a small tripod that was secured to the ground, or a suitable tree trunk. The camera was focused on a bait station, baited with tinned cat food with high sardine content or tinned sardines. Data recorded from the MDCs has been included in the overall species lists for the survey.

## 4.6 SRE SURVEY

Surveys for potential SRE specimens were conducted in conjunction with the vertebrate fauna surveys from October 31st to November 10th 2014. Pitfall traps for vertebrate fauna (as described in section 4.5.2) are also suitable for capturing wandering spiders and scorpions, while SRE were also captured during hand foraging and opportunistic records (sections 4.5.6 and 4.5.7). In addition to these methods, leaf litter samples were collected to specifically survey for SRE.

### 4.6.1 LEAF LITTER COLLECTION

A combined total of 220 litres of leaf litter was collected, sieved, and analysed for the presence of small SRE fauna. Leaf litter was collected from all systematic trap sites and from six forage sites (n=11) labelled FS01, FS02, FS03, FS13, FS14, and FS15 (Table 4, Figure 3). The sites from which leaf litter was collected were located in microhabitats deemed most suitable for SRE due to their ability to hold moisture for extended periods. The remaining ten forage sites did not yield sufficient leaf litter for sampling as the soil was virtually bare.

At each of the eleven sites, leaf litter was collected in a twenty litre bucket, and the species of tree or shrub yielding the leaf litter was recorded. Care was taken to collect the lowest possible layer of leaf litter which would hold the highest moisture levels. However, it was noted in the field that the leaf litter layer at all foraging sites appeared very dry throughout. Samples were sifted in the field using 1.5 millimetre sieves. The final mixture of organic matter was transported back to Perth, and run through Tullgren Funnels for a minimum of 48 hours to extract invertebrate specimens.

Specimens collected from the Tullgren Funnels were sorted under a microscope at the Rapallo laboratory. Potential SRE taxa were separated from the bulk samples and vouchered for taxonomic identification according to WAM (2013c) submission guidelines.

### 4.6.2 CATEGORIES OF SHORT-RANGE ENDEMISM

Currently, there is no accepted system to determine the likelihood that a species is an SRE. For the purpose of this report, Rapallo has adopted the three-tier likelihood system, wherein species are categorised based on the different probabilities of short-range endemism: 'confirmed', 'likely' or 'potential' SRE. These categories are dynamic and can change as knowledge of SRE status is updated (Phoenix 2012).

Although categorisation of SRE likelihood may help to set conservation priorities, SRE taxa of all categories should be assessed on their merit, in order to determine appropriate conservation measures that adhere to the Precautionary Principle within environmental impact assessments.

The Precautionary Principle, as included in the 2004 amendment of the EP Act, is defined as:

> *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, decisions should be guided by: (a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) an assessment of the risk-weighted consequences of various options* (EPA 2004b).

### 4.6.3 TAXONOMIC IDENTIFICATION

All potential SRE taxa were sent off to taxonomic experts for identification before being vouchered in the WAM collection. The following taxonomists were involved with specimen identification:

- Dr Volker Framenau (Phoenix) Millipedes, centipedes, pseudoscorpions, spiders
- Dr Erich Volschenk (Scorpion ID) Scorpions

## 4.7 SURVEY LIMITATIONS AND CONSTRAINTS

An assessment of the limitation of the survey has been displayed in Table 6 in accordance with Guidance Statement No. 56 (EPA 2004a).

**Table 6 Discussion of potential limitations and constraints experienced during the survey**

| Aspect | Constraint | Discussion |
|---|---|---|
| Experience of consultants. | No | All members of the survey team have experience in undertaking fauna surveys throughout Western Australia, including the Great Victoria Desert, an area where staff from Rapallo Environmental have conducted field work over the last 30 years. |
| Scope. | No | Scope and intensity of survey were suitable to achieve the survey aims as outlined in section 1.1 |
| Proportion of fauna identified, recorded and/or collected. | Yes | Fauna records from the survey including diversity and abundance were lower than anticipated among the most common taxonomic groups.<br>Low rainfall plus grazing pressure may have contributed to reduced species abundance and diversity due to reduced resources. Several common species of birds, reptiles and mammal were not recorded during the survey in areas where these species were expected. |
| Information sources e.g. previously available information (whether historic or recent) vs. new data. | No | Sufficient regional information is available; however there are few recent studies in the vicinity of the project area. |
| Proportion of task achieved and further work may be required. | No | All the major fauna habitats of the project area were surveyed through trapping and foraging. |
| Timing, weather, seasons, cycle. | Yes | Survey timing conformed with EPA (2010) recommendations, however temperatures were hot and dry and there were no major rainfall events immediately prior to the survey. The dry conditions may have contributed to lower than anticipated faunal abundance; however grazing pressure must also be taken into consideration. |
| Disturbances that affected the survey. | No | A lightning storm interrupted spotlight surveys on one evening as it started several fires within the region. |
| Survey intensity. | No | Survey intensity was appropriate to survey all the major fauna habitats of the project area. |
| Completeness of Survey. | No | All the major habitats of the project area were surveyed, and all areas within the project area were examined. The survey program was completed as planned. |
| Resources. | No | The survey was adequately resourced. |
| Access problems and remoteness. | No | There were no access problems. All areas within the project area and all fauna habitats could be reached using a 4WD vehicle, quad bikes, and on foot. |
| Availability of contextual information within the region. | No | Sufficient information was available to plan the survey, and discuss the fauna assemblages and fauna habitat of the project area in a regional context. |

## 4.8 SOURCES OF INFORMATION

The following literature sources have been used to determine nomenclature, taxonomy and fauna distribution patterns used in this report:

- Mammals: Van Dyck and Strahan (2008), Menkhorst and Knight (2011).
- Bats: Churchill (2008).
- Reptiles: Cogger (2014); Storr et al.(2002); Storr et al.(1999); Wilson and Swan (2013).
- Amphibians: Tyler et al. (2000), Tyler and Doughty (2009).
- Birds: Christidis and Boles (2008), Barrett (2003), Johnstone and Storr (1998 and 2004), Benshemesh (2000), Marchant and Higgins (1993), Higgins (1999).

Nomenclature for herpetofauna and mammals follows that of the Checklist of Terrestrial Vertebrate Fauna of Western Australia, published by the Western Australian Museum (2013d). Nomenclature and taxonomy of birds follows that of Birdlife Australia (Barrett 2003; Birdlife Australia 2013a).

# 5 RESULTS

## 5.1 SUMMARY OF RESULTS

During the survey a total of 116 vertebrate fauna species were recorded from the project area, comprising 45 reptile species, 17 mammal species (including three bats), and 54 bird species.

No species of conservation significance were recorded from within the project area. However, the conservation listed Rainbow Bee-eater was recorded at Yamarna camp, 20 km south-west of the project area. The Rainbow Bee-eater is listed under the WC Act on Schedule 3 – Migratory birds protected under an international agreement, and listed under the EPBC Act as Migratory. This species is not included in the bird counts for the survey, but has high potential to occur in the project area. Species of conservation significance are discussed in section 6.

Analysis of the acoustic recordings identified three bat species, while calls of a fourth species were detected that was distinct from the others but could not be positively identified to species.

A total of 37 potential SRE specimens were collected during the survey. These comprised eight spiders, 27 scorpions, and two pseudoscorpions. All spiders and scorpions were captured in pitfall traps at sites 1, 2, 3 and 4. The pseudoscorpions were extracted from leaf litter samples collected at the foraging sites FS03 (granite rocky rise) and FS15 (Hakea). None of the other nine leaf litter samples yielded invertebrates of potential SRE groups. No snails were found during the survey.

Taxonomic identifications revealed that the specimens contained six potential SRE species, comprising three species of Mygalomorph spider, and three species of scorpion. The pseudoscorpions were identified as not likely SRE. All four trap sites that allowed for pitfall trap deployment yielded potential SRE species, all of which are currently only know from the Gruyere project area.

Seven broad fauna habitat types were identified in the project area, using existing vegetation maps (Botanica 2015) and ground-truthing. The habitats were Sand Ridges, Sand Plains, Clay Loam Plains, and Quartz Rocky Plains, Rocky Slopes, Breakaways and Drainage Depressions (Figure 4). The ecotone between Sand Plain and Clay Loam Plain habitats was also considered significant as this combination of soil and vegetation types has potential to yield specialist fauna that may not occur elsewhere.

The desktop search identified an additional 59 reptile species, 20 mammal species and 42 bird species, as well as 9 frog species, recorded previously from the region. It must be noted that not all of these species would potentially occur in the project area due to habitat requirements and mobility. The desktop identified thirteen species of conservation significance which may occur in the project area, these are two reptiles, three mammals, and eight birds. Desktop results are presented in Appendix I.

Based on the range and habitat requirements of these thirteen conservation significant species, two species were assessed as having a high likelihood to occur in the project area, five were considered possible to occur (medium likelihood), and six were considered unlikely to occur (low likelihood). This is discussed in detail in section 6.

## 5.2 FAUNA HABITATS RECORDED IN THE PROJECT AREA

Seven broad fauna habitats and one sub-type (transition zone / ecotone) were identified on the project area (Table 7). Fauna habitats were defined and mapped based on ground truthing in the field of landform mapping and vegetation units mapped by Botanica Consulting (2014; 2015).

Trap sites (see section 4.5.1) were established in four of the broad habitat types, with a fifth site positioned in the Ecotone sub-type. Foraging occurred in all habitats.

**Table 7 Fauna habitats identified in the project area**

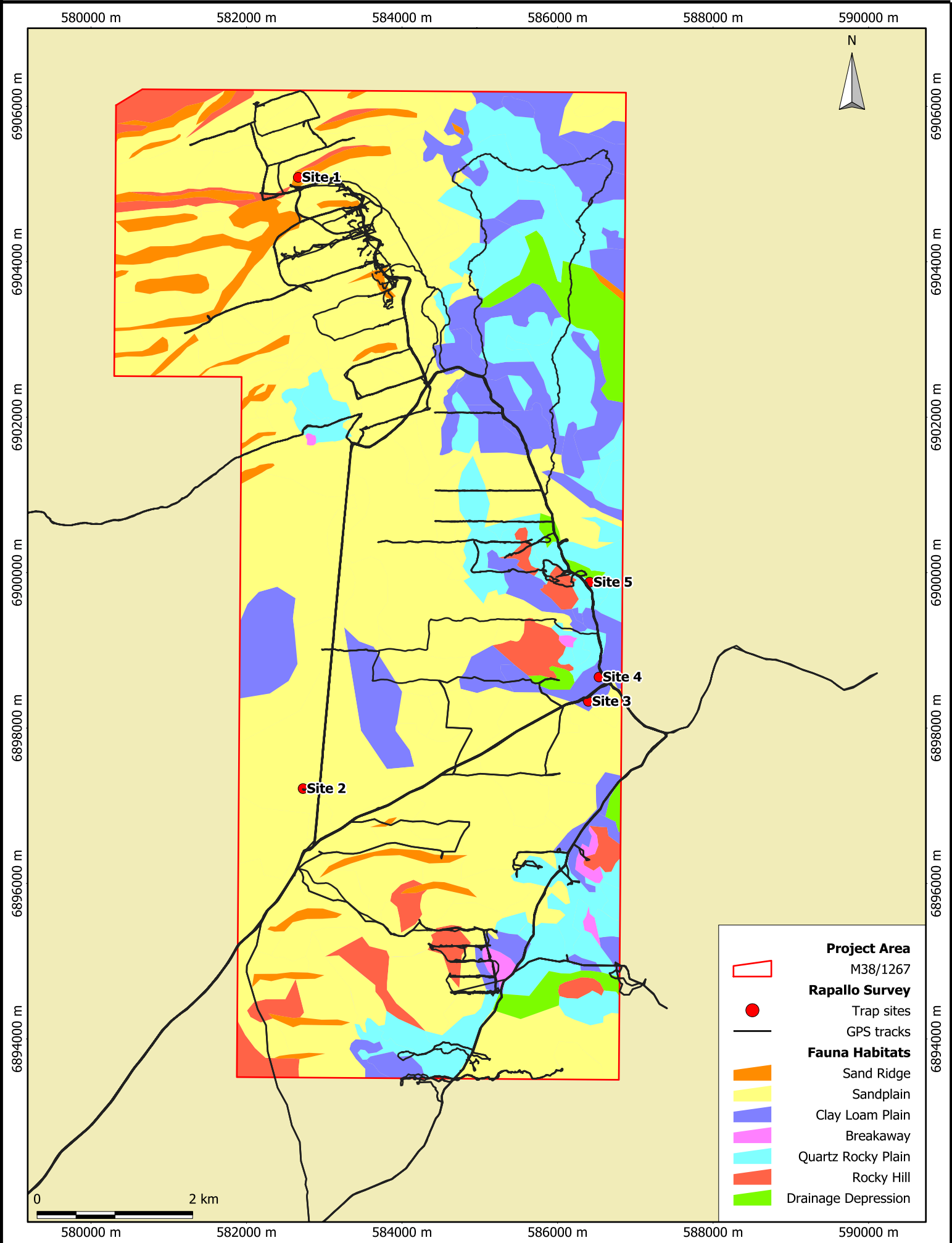
| Habitat Name | Habitat Description | Approximate extent in project area (ha, %) | Photo |
|---|---|---|---|
| **Sand Ridges**<br>(Trap Site 1) | **Vegetation**<br>Eucalypt Woodlands/Mallee.<br>Woodlands and Shrublands.<br>Lower story often *Triodia* dominated.<br><br>**Geology, Soil, Landform**<br>Red sands. | Approximate area:<br>**288.1 ha**<br><br>Percentage of total project area: **4.2 %** |  |
| **Sand Plains**[*)]<br>(Trap Site 2) | **Vegetation**<br>*Acacia* Forests and Woodlands; *Acacia* Shrublands; Eucalypt Woodlands; Eucalypt Woodlands/Mallee Woodlands and Shrublands; Mallee Woodlands and Shrublands; Regrowth (modified native vegetation).<br>Lower story *Triodia* dominated.<br>**Geology, Soil, Landform**<br>Red sands. | Approximate area:<br>**4242.0 ha**<br><br>Percentage of total project area: **62.0 %** |  |

| Habitat Name | Habitat Description | Approximate extent in project area (ha, %) | Photo |
|---|---|---|---|
| **Clay Loam Plains**[*)] (Trap Site 4) | **Vegetation**<br>*Acacia* Forests and Woodlands; *Acacia* Shrublands; Mallee Open Woodlands and Sparse Mallee Shrublands.<br>**Geology, Soil, Landform**<br>Clay Loam red soil plains in parts bisected by minor drainage. | Approximate area:<br>**849.8 ha**<br>Percentage of total project area: **12.4 %** |  |
| **Quartz Rocky Plains** (Trap Site 5) | **Vegetation**<br>*Acacia* Forests and Woodlands; *Acacia* open Woodlands; Casuarina Forests and Woodlands.<br>**Geology, Soil, Landform**<br>Quartz dominated plains and rises. Skeletal red soils. | Approximate area:<br>**949.8 ha**<br>Percentage of total project area: **13.9 %** |  |

| Habitat Name | Habitat Description | Approximate extent in project area (ha, %) | Photo |
|---|---|---|---|
| **Rocky Hill Slopes** (Foraged) | **Vegetation**<br>Acacia Forests and Woodlands.<br>**Geology, Soil, Landform**<br>Rocky skeletal red soils on hill slopes. | Approximate area: **295.3 ha**<br>Percentage of total project area: **4.3 %** |  |
| **Breakaways** (Foraged) | **Vegetation**<br>Acacia Shrublands.<br>**Geology, Soil, Landform**<br>Permian breakaway with gravel soils. | Approximate area: **32.4 ha**<br>Percentage of total project area: **0.5 %** |  |

| Habitat Name | Habitat Description | Approximate extent in project area (ha, %) | Photo |
|---|---|---|---|
| **Drainage Depression** (Foraged) | **Vegetation**<br>Acacia Open Woodlands; Mallee Open Woodlands and Sparse Mallee Shrublands.<br>Understory typically dominated by chenopods.<br>**Geology, Soil, Landform**<br>Light brown clays, bare patches due to water accumulation. | Approximate area: **185.7 ha**<br><br>Percentage of total project area: **2.7%** |  |

**) Note: Trap Site 3 (Ecotone) is a combination of Sand Plain and Clay Loam Plain habitat. It exists in the overlap zone where these two habitats meet, and therefore cannot be mapped or its extent measured.*




Rapallo environmental

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Gruyere Project

Scale: 1 : 60,000
Datum: MGA94 (51)

**Figure 4**

Fauna Habitats recorded in the Project Area

## 5.3 MAMMALS

### *5.3.1 NON-VOLANT MAMMALS RECORDED IN THE SURVEY*

Fourteen species of non-volant (non flying) mammals were recorded in the survey area, of which eight were native and six were introduced (feral) (Table 8). None of the native mammals recorded were of conservation significance.

The mammal assemblage recorded during the survey was low in both abundance and diversity. Of the eight native species recorded, only three were caught in traps, comprising four individuals in total. The other five species were recorded opportunistically from the survey area.

Small native mammals included the Dasyurids (carnivorous marsupials) Wongai Ningaui (*Ningaui ridei*) and Hairy-footed Dunnart (*Sminthopsis hirtipes*). The Wongai Ningaui was recorded twice in the Sand Plain habitat, while a single Hairy-footed Dunnart was recorded in the Sand Ridge habitat. Two native rodents were recorded, these were the Sandy Inland Mouse (*Pseudomys hermannsburgensis*) recorded in the Sand Ridge habitat, and tracks of the Spinifex Hopping-mouse (*Notomys alexis*). One Echidna (*Tachyglossus aculeatus*) was recorded opportunistically on the quartz plain.

Three macropods were recorded from the project area as opportunistic sightings and on MDC footage. These were the Red Kangaroo (*Macropus rufus*), the Common Wallaroo or Euro (*Macropus robustus*), and the Western Grey Kangaroo (*Macropus fuliginosus*). The Red Kangaroo and Euro were especially common across the survey area with sightings and signs being found at all five trap sites as well as opportunistic sightings throughout the survey area.

Six species of introduced mammal were recorded. The House Mouse (*Mus musculus*) was recorded twice during the trapping program from the Ecotone habitat. Dromedary Camels (*Camelus dromedaries*) were regularly encountered throughout the project area, with most records in the vicinity Ziggy's bore, which was the only source of free standing water in the project area. Evidence of cattle (*Bos taurus*) was also recorded. Feral cats (*Felis catus*) were opportunistically recorded twice during the survey, both records were of individuals sighted crossing roads at dusk in the south of the survey area.

Evidence of the European Rabbit was found in the vicinity of the trap site 5 in Quartz Rocky Plain habitat, where several old warrens were found. Live rabbits were also recorded within the survey area in close proximity to the Clay Loam Plain trap site near Ziggy's Bore.

Tracks of either Dingo or wild dog (*Canis* sp.) were found near Ziggys Bore. Since no live individuals were observed, positive identification was not possible. However, verbal accounts from Gold Road staff indicated that wild dogs had been observed several times within the survey area.

### *5.3.2 BATS RECORDED IN THE SURVEY*

Acoustic recordings of bat calls were made within the vicinity of Ziggy's Bore over five nights. Analyses of these recordings by Specialised Zoological identified four species of bat (Appendix II). Three species were positively identified to species based on calls. These were the Gould's Wattled Bat (*Chalinolobus gouldii*), Finlaysons Cave Bat (*Vespadelus finlaysoni*) and the Inland Broad-nosed Bat (*Scotorepens balstoni*). Due to the difficulty in separating certain species on call structure alone, the fourth species has been identified as either the Lesser Long-eared Bat (*Nyctophilus geoffroyi*) or the Central Long-eared Bat (*Nyctophilus major tor*). Positive identification will require the use of harp trapping to examine captured individuals.

**Table 8 Mammals recorded in the Gruyere Project Area**

| Species Name | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | Site 5 | Ziggy's Bore | Opportunistic Records | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T | O | T | O | T | O | O | O | O | O | |
| **Non-volant Native Mammals** | | | | | | | | | | | | |
| *Tachyglossus aculeatus* | Echidna | | | | | | | | 1 | | | 1 |
| *Ningaui ridei* | Wongai Ningaui | | | 2 | | | | | | | | 2 |
| *Sminthopsis hirtipes* | Hairy-footed Dunnart | 1 | | | | | | | | | | 1 |
| *Macropus fuliginosus* | Western Grey Kangaroo | | | | | | | | | 1 | | 1 |
| *Macropus robustus* | Euro | | | | | | | | 1 | 8 | | 9 |
| *Macropus rufus* | Red Kangaroo | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 7 |
| *Notomys alexis* | Spinifex Hopping-mouse | | | | | | | | | | 1 | 1 |
| *Pseudomys hermannsbergensis* | Sandy Inland Mouse | 1 | | | | | | | | | | 1 |
| **Native Bats** | | | | | | | | | | | | |
| *Chalinolobus gouldii* | Goulds Wattled Bat | | | | | | | | | 1 | | 1 |
| *Scotorepens balsoni* | Inland Broad-nosed Bat | | | | | | | | | 1 | | 1 |
| *Vespadelus finlaysoni* | Finlaysons Cave Bat | | | | | | | | | 1 | | 1 |
| *Nyctophilus geoffroyi/major tor* | Lesser/Central Long-eared Bat | | | | | | | | | 1 | | 1 |
| **Introduced (feral) Mammals** | | | | | | | | | | | | |
| *Mus musculus* | House Mouse | | | | | 2 | | | | | 1 | 3 |
| *Oryctolagus cuniculus* | Rabbit | | | | | | 1 | | 1 | | | 2 |
| *Felis catus* | Cat | | | | 2 | | | | | | | 2 |
| *Canis lupus dingo* | Dingo | | | | | | | 1 | | | | 1 |

| Species Name | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | Site 5 | Ziggy's Bore | Opportunistic Records | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T | O | T | O | T | O | O | O | O | O | |
| *Bos taurus* | European Cattle | | | | | | | | | | 1 | 1 |
| *Camelus Dromedarius* | Dromedary Camel | | | | | | 1 | 1 | 8 | 1 | | 11 |
| **Total Individuals** | | **3** | | **5** | | **5** | | **3** | **12** | **15** | **4** | **47** |
| **Total Species** | | **3** | | **3** | | **4** | | **3** | **5** | **8** | **4** | **30** |

*Footnotes with this table*:

T = Trapping data, O = Opportunistic sightings and species recorded during spotlight surveys or from MDC footage.

## 5.4 REPTILES AND AMPHIBIANS

A total of 45 species of reptile were recorded during the survey through a combination of systematic trapping, foraging and opportunistic sightings (Table 9). These comprised nine geckoes, three pygopods (legless lizards), 16 skinks, eight dragons, five varanids (monitors) and four snakes. Of these, 32 species were captured in traps while the remaining were recorded opportunistically or during spotlight surveys.

Although reptile diversity (number of different species) recorded in the survey was moderately high, the total abundance (number of individuals) was relatively low with many species represented by one or two individuals only. Several common species of reptile were also conspicuously absent from the trapping program. This is discussed further in section 7.1.

None of the reptiles recorded in the survey were conservation listed. Desktop searches identified two reptile species with the potential to occur in the project area. However, reviews of the known distribution and habitat requirements, as well as previous records in the area, indicate that both species are unlikely to occur in the project area. See section 6 for more details.

Reptile species richness was found to be generally consistent across the systematic survey sites however abundance and diversity were both found to be highest at the Sand Ridge habitat (Site 1) with 13 reptile species recorded from the systematic trapping program with an additional four species encountered opportunistically while foraging and spotlighting. Eleven of the 17 total species recorded from Site 1 were not encountered elsewhere in the survey area.

Reptile species richness and abundance were found to be lowest at the Quartz Plain habitat (Site 5) with only seven species recorded from the systematic trapping program with an additional species found opportunistically. These relatively low numbers are likely due to the inability to establish pitfall traps at this site, which is a very effective means of capturing small and medium sized species.

The most commonly encountered reptiles from the survey area were skinks of the genus *Ctenotus*. These small to medium sized skinks were recorded 54 times throughout the survey from the systematic trapping program with opportunistic records each accounting for one record despite multiple sightings of what was potentially the same individual.

One species of reptile was recorded in the vicinity of the Gold Road camp which was not encountered within the survey area, this was the Broad-banded Sand Swimmer (*Eremiascincus richardsoni*). This species was recorded within Mulga woodlands surrounding the camp and underneath camp infrastructure. The Broad-banded Sand-swimmer is a common and wide-ranging species, which is likely to occur within the survey area. Since this species was not recorded within the project area, it is not included in the total species count for the survey.

No amphibians were recorded during the survey. Regional records indicate that several species of amphibians are likely to occur within the survey area, however due to the low rainfall in the lead up to and during the survey, none of these were active on the surface. None of the frogs identified from the desktop are currently of conservation significance.

**Table 9 Reptiles recorded in the Gruyere Project Area (total individuals)**

| Scientific Name | Common Name | Sand Ridge | | Sand Plain | | Clay Loam Plain/Sand Plain Ecotone | | Clay Loam Plain | | Quartz Rocky Plain | | Opportunistic Sightings across project area | Total individuals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T[1)] | O[2)] | T | O | T | O | T | O | T | O | | |
| **Geckoes (Gekkonidae)** | | | | | | | | | | | | | |
| *Diplodactylus conspicillatus* | Fat-tailed Gecko | | | | | 8 | | 8 | | 1 | | | **17** |
| *Gehyra purpurascens* | Purplish Dtella | | | | | | | | | | | 1 | **1** |
| *Gehyra variegata* | Variegated Dtella | | | 1 | | | | | | 12 | | 1 | **14** |
| *Heteronotia binoei* | Binoe's Gecko | | | 2 | | | | | | 1 | | | **3** |
| *Lucasium damaeum* | Beaded Gecko | 3 | | | | | | | | | | 1 | **4** |
| *Nephrurus laevissimus* | Pale Knob-tailed Gecko | 3 | 2 | | | | | | | | | | **5** |
| *Rhynchoedura ornata* | Beaked Gecko | | 1 | | | | | | | | | | **1** |
| *Strophurus elderi* | Jewelled Gecko | 1 | | 4 | | | | | | | | 1 | **6** |
| *Strophurus strophurus* | Western Spiny-tailed Gecko | | | | | | | | | 1 | | | **1** |
| **Legless Lizards (Pygopodidae)** | | | | | | | | | | | | | |
| *Delma nasuta* | Long-nosed Delma | | | | | | | | | | | 1 | **1** |
| *Lialis burtonis* | Burton's Legless Lizard | | 1 | | | 1 | | | | | | 1 | **3** |
| *Pygopus nigriceps* | Western Hooded Scalyfoot | | | | | 1 | | | | 2 | | | **3** |
| **Skinks (Scincidae)** | | | | | | | | | | | | | |
| *Ctenotus brooksi* | Central Wedge-snout Ctenotus | | 1 | | | | | | | | | 1 | **2** |
| *Ctenotus calurus* | Blue-tailed Skink | | | | 1 | | | | | | | | **1** |
| *Ctenotus dux* | Narrow-lined Skink | 3 | | | | | | | | | | 1 | **4** |

| Scientific Name | Common Name | Sand Ridge | | Sand Plain | | Clay Loam Plain/Sand Plain Ecotone | | Clay Loam Plain | | Quartz Rocky Plain | | Opportunistic Sightings across project area | Total individuals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ctenotus helenae* | Dusky Ctenotus | | | 4 | | 3 | | | | | | | **7** |
| *Ctenotus leonhardii* | Leonardi's Skink | | | | | 2 | | 9 | | | | | **11** |
| *Ctenotus nasutus* | Nasute Finesnout Ctenotus | 3 | | | | | | | | | | | **3** |
| *Ctenotus pantherinus* | Leopard Skink | | | 2 | | 9 | | | | | | | **11** |
| *Ctenotus piankai* | Coarse Sand Ctenotus | | | 1 | | | | | | | | | **1** |
| *Ctenotus quattuordecimlineatus* | Fourteen-lined Skink | 7 | | 5 | | | | 1 | | | | | **13** |
| *Ctenotus schomburgkii* | Barred Wedgesnout Ctenotus | | | | | | | 2 | | | | | **2** |
| *Ctenotus uber* | Spotted Ctenotus | | | | | | | | | 1 | | 1 | **2** |
| *Eremiascincus pallidus* | Pale Sand-Swimmer | 3 | | | | | | | | | | | **3** |
| *Lerista bipes* | Western Two-toed Slider | 15 | | 6 | | | | | | | | | **21** |
| *Lerista desertorum* | Cental Desert Robust Slider | 2 | | | | 1 | | 1 | | 1 | | | **5** |
| *Lerista timida* | Timid Slider | | | 2 | | | | | | | | | **2** |
| *Liopholis striata* | Night Skink | | | | | | 1 | | | | | 1 | **2** |
| **Dragons (Agamidae)** | | | | | | | | | | | | | |
| *Caimanops amphiboluroides* | Mulga Dragon | | | | | | | 2 | | | | | **2** |
| *Ctenophorus isolepis* | Central Military Dragon | | 1 | | 1 | | | | 1 | | | | **3** |
| *Ctenophorus nuchalis* | Central Netted Dragon | | | | | | | | | | | 1 | **1** |
| *Ctenophorus reticulatus* | Western Netted Dragon | | | | | | | 2 | | | | 1 | **3** |
| *Ctenophorus scutulatus* | Lozenge-marked Bicycle Dragon | | | | | | | 1 | | | | | **1** |

| Scientific Name | Common Name | Sand Ridge | | Sand Plain | | Clay Loam Plain/Sand Plain Ecotone | | Clay Loam Plain | | Quartz Rocky Plain | | Opportunistic Sightings across project area | Total individuals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Diporiphora paraconvergens* | Grey-striped Western Desert Dragon | 1 | | | | | | | | | | | **1** |
| *Moloch horridus* | Thorny Devil | | | | | | | | | | | 1 | **1** |
| *Pogona minor* | Western Bearded Dragon | | | | | 2 | | | | | | 1 | **3** |
| **Monitors (Varanidae)** | | | | | | | | | | | | | |
| *Varanus brevicauda* | Short-tailed Pygmy Monitor | | | | | 1 | | 1 | | | | | **2** |
| *Varanus giganteus* | Perentie | | | | | | | | 2 | | 1 | 1 | **4** |
| *Varanus gouldii* | Goulds' Monitor | 1 | | | | | | | | | | 1 | **2** |
| *Varanus panoptes* | Yellow-spotted Monitor | | | | | | | | | | | 3 | **3** |
| *Varanus tristis* | Black-headed Monitor | | | | | | | | | | | 1 | **1** |
| **Snakes** | | | | | | | | | | | | | |
| *Brachyurophis approximans* | North-western Shovel-nosed Snake | | | | | | | 1 | | | | | **1** |
| *Pseudechis australis* | Mulga Snake | | | | | | | | | | | 3 | **3** |
| *Pseudonaja modesta* | Ringed Brown Snake | 1 | | | | | | | | | | | **1** |
| *Semoselaps anomalus* | Desert Banded Snake | 3 | | | | | | | | | | | **3** |
| **Total individuals recorded** | | **46** | **6** | **27** | **2** | **28** | **1** | **28** | **3** | **19** | **1** | **23** | **184** |
| **Total species per habitat** | | **17** | | **11** | | **10** | | **12** | | **8** | | **19** | **45** |

## 5.5 BIRDS

A total of 54 species of birds were recorded during the survey using a combination of systematic surveys, opportunistic and foraging sightings and spotlighting records (Table 10). Bird diversity and abundance was low in the project area. The most common species recorded during the survey were Zebra Finches (n=220) and Mulga Parrots (n=55). The majority of these records were in close proximity to Ziggy's Bore, an artificial watering point located in the project area.

Drier weather conditions prior to the survey may have suppressed bird species richness and abundance. The survey took place at the end of an extended dry period, which brought about reduced food availability. The most notable indication of this was the virtual absence of flowering, which resulted in low numbers of the common avian species that would have been expected to occur within the survey area. This is further discussed in section 7.2.

The habitats of the project area varied in avian species richness. Species richness was found to be highest in the Sand Plain/Clay Loam Plain Ecotone and within the vicinity of Ziggy's Bore with 13 species recorded at each location. Species richness was found to be lowest in the Quartz Rocky Plain habitat with only 8 species of bird recorded during the survey.

One species of conservation significant bird was recorded during the survey from an area outside the project area. The Rainbow Bee-eater listed WC Act Schedule 3, was observed foraging around Gold Road Camp at Yamarna, 20 km south-west of the project area. No records of other conservation significant birds were made within the survey area.

**Table 10 Birds Recorded in the Gruyere project area (frequency of occurrence data)**

| Family | Species | Common Name | Sand Ridge | Sand Plain | Clay Loam Plain/Sand Plain Ecotone | Clay Loam Plain | Quartz Rocky Plain | Ziggy's Bore | Opportunistic Sightings across project area | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Casuariidae** | *Dromaius novaehollandiae* | Emu | | | | | | 3 | 1 | **4** |
| **Columbidae** | *Phaps chalcoptera* | Common Bronzewing | | | | 1 | | 6 | 1 | **8** |
| **Columbidae** | *Ocyphaps lophotes* | Crested Pigeon | 1 | 4 | 9 | 2 | | | | **16** |
| **Eurostopodidae** | *Eurostopodus argus* | Spotted Nightjar | | | | | | | 1 | **1** |
| **Aegothelidae** | *Aegotheles cristatus* | Australian Owlet-nightjar | | | | | | | 1 | **1** |
| **Accipitridae** | *Haliastur sphenurus* | Whistling Kite | 1 | | | | | | | **1** |
| **Accipitridae** | *Accipiter fasciatus* | Brown Goshawk | | | | 3 | 1 | | 1 | **5** |
| **Accipitridae** | *Aquila audax* | Wedge-tailed Eagle | | | | | | | 3 | **3** |
| **Falconidae** | *Falco cenchroides* | Nankeen Kestrel | | | | | | | 1 | **1** |
| **Falconidae** | *Falco berigora* | Brown Falcon | | | | | | 1 | 1 | **2** |
| **Falconidae** | *Falco longipennis* | Australian Hobby | | 1 | | | | | | **1** |
| **Cacatuidae** | *Eolophus roseicapillus* | Galah | | | | 1 | | 1 | 1 | **3** |
| **Cacatuidae** | *Nymphicus hollandicus* | Cockatiel | | | | | | | 1 | **1** |
| **Psittacidae** | *Barnardius zonarius* | Australian Ringneck | 2 | | | | | | 1 | **3** |
| **Psittacidae** | *Psephotus varius* | Mulga Parrot | | | 2 | | 3 | | 1 | **6** |
| **Psittacidae** | *Neopsephotus bourkii* | Bourke's Parrot | | | | | | 4 | 1 | **5** |
| **Strigidae** | *Ninox novaeseelandiae* | Southern Boobook | | | | | | | 1 | **1** |
| **Halcyonidae** | *Todiramphus pyrrhopygius* | Red-backed Kingfisher | | 1 | | | | | | **1** |
| **Ptilonorhynchidae** | *Ptilonorhynchus guttatus* | Western Bowerbird | | | 1 | | | | 1 | **2** |
| **Maluridae** | *Malurus splendens* | Splendid Fairy-wren | | | | | | 1 | 1 | **2** |
| **Maluridae** | *Malurus lamberti* | Variegated fairy-wren | | | | | | | 2 | **2** |
| **Acanthizidae** | *Pyrrholaemus brunneus* | Redthroat | | | | | 1 | | 3 | **4** |
| **Acanthizidae** | *Smicrornis brevirostris* | Weebill | 2 | | 5 | | | | 2 | **9** |
| **Acanthizidae** | *Acanthiza robustirostris* | Slaty-backed Thornbill | | | 4 | | | | | **4** |

| Family | Species | Common Name | Sand Ridge | Sand Plain | Clay Loam Plain/Sand Plain Ecotone | Clay Loam Plain | Quartz Rocky Plain | Ziggy's Bore | Opportunistic Sightings across project area | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Acanthizidae** | *Acanthiza apicalis* | Inland Thornbill | | | 9 | 6 | 3 | | 2 | **20** |
| **Pardalotidae** | *Pardalotus rubricatus* | Red-browed Pardalote | 1 | | | | | | | **1** |
| **Meliphagidae** | *Lichenostomus virescens* | Singing Honeyeater | | | 1 | | 1 | | 1 | **3** |
| **Meliphagidae** | *Lichenostomus plumulus* | Grey-fronted Honeyeater | 3 | 11 | 1 | 3 | | | 1 | **19** |
| **Meliphagidae** | *Manorina flavigula* | Yellow-throated Miner | 5 | 3 | | | | | | **8** |
| **Meliphagidae** | *Acanthagenys rufogularis* | Spiny-cheeked Honeyeater | | 1 | 1 | 1 | | 1 | 1 | **5** |
| **Pomatostomidae** | *Pomatostomus superciliosus* | White-browed Babbler | | | | | | | 4 | **4** |
| **Psophodidae** | *Cinclosoma castaneothorax* | Chestnut-breasted Quail-thrush | | | | | 4 | | 1 | **5** |
| **Neosittidae** | *Daphoenositta chrysoptera* | Varied Sitella | | | | 5 | | | | **5** |
| **Campephagidae** | *Coracina maxima* | Ground Cuckoo-shrike | | | | | | | 1 | **1** |
| **Campephagidae** | *Coracina novaehollandiae* | Black-faced Cuckoo-shrike | | 1 | | 1 | | | 1 | **3** |
| **Pachycephalidae** | *Pachycephala rufiventris* | Rufous Whistler | | | 7 | 6 | 1 | | 3 | **17** |
| **Pachycephalidae** | *Colluricincla harmonica* | Grey Shrike-thrush | | | 2 | | 1 | 1 | 4 | **8** |
| **Pachycephalidae** | *Oreoica gutturalis* | Crested Bellbird | | 2 | 2 | | | | 2 | **6** |
| **Artamidae** | *Artamus personatus* | Masked Woodswallow | | | | | | | 1 | **1** |
| **Artamidae** | *Artamus cinereus* | Black-faced Woodswallow | | | | | | | 1 | **1** |
| **Artamidae** | *Artamus minor* | Little Woodswallow | | | | | | | 1 | **1** |
| **Artamidae** | *Cracticus nigrogularis* | Pied Butcherbird | 2 | 3 | | | | | 1 | **6** |
| **Artamidae** | *Cracticus tibicen* | Australian Magpie | | | | | | | 1 | **1** |
| **Rhipiduridae** | *Rhipidura leucophrys* | Willie Wagtail | | | | | | | 1 | **1** |
| **Corvidae** | *Corvus bennetti* | Little Crow | 1 | | | | | 1 | 1 | **3** |
| **Corvidae** | *Corvus orru* | Torresian Crow | | | | | 2 | | 1 | **3** |
| **Monarchidae** | *Grallina cyanoleuca* | Magpie-lark | | | | | | | 1 | **1** |

| Family | Species | Common Name | Sand Ridge | Sand Plain | Clay Loam Plain/Sand Plain Ecotone | Clay Loam Plain | Quartz Rocky Plain | Ziggy's Bore | Opportunistic Sightings across project area | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Petroicidae** | *Microeca fascinans* | Jacky Winter | | | | | | | 2 | **2** |
| **Petroicidae** | *Petroica goodenovii* | Red-capped Robin | | | 3 | 1 | | 2 | 2 | **8** |
| **Petroicidae** | *Melanodryas cucullata* | Hooded Robin | | 1 | 3 | 2 | | | 2 | **8** |
| **Megaluridae** | *Cincloramphus mathewsi* | Rufous Songlark | | | | | | | 1 | **1** |
| **Hirundinidae** | *Petrochelidon ariel* | Fairy Martin | | | | | | | 1 | **1** |
| **Hirundinidae** | *Petrochelidon nigricans* | Tree Martin | 1 | | | | | | 1 | **2** |
| **Estrildidae** | *Taeniopygia guttata* | Zebra Finch | | | | 8 | | 20 | 1 | **29** |
| **Total records (occurrences) of species per site** | | | **19** | **28** | **50** | **40** | **17** | **41** | **65** | **260** |
| **Total species per site** | | | **10** | **10** | **14** | **13** | **9** | **11** | **46** | **54** |

## 5.6 SHORT-RANGE ENDEMICS

A total of 37 potential SRE specimens were collected during the survey for taxonomic identification. These comprised eight spiders, 25 scorpions of the genus *Lychas*, two scorpions of the genus *Urodachus* (sand scorpions), and two pseudoscorpions. No snails were found during the survey.

All spiders were found at sites 3 and 4 and scorpions were captured in pitfall traps at sites 1, 2, 3 and 4 (Figure 5). The two pseudoscorpions were extracted from leaf litter collected at foraging sites FS03 (granite rocky rise) and FS15 (Hakea). None of the other nine leaf litter samples yielded invertebrates of potential SRE groups.

**Table 11 Summary of putative SRE specimens collected during the survey**

| Site | Coordinates (GDA94) | Spiders | *Lycas* scorpions | *Urodacus* scorpions | Pseudoscorpions | Totals |
|---|---|---|---|---|---|---|
| Site 1 | 582665 E, 6905086 S | | 18 | | | **18** |
| Site 2 | 582727 E, 6897221 S | | 5 | | | **5** |
| Site 3 | 586396 E, 6898343 S | 2 | 1 | 2 | | **4** |
| Site 4 | 586533 E, 6898656 S | 6 | 1 | | | **8** |
| FS03 | 585977 E, 6899949 S | | | | 1 | **1** |
| FS15 | 586394 E, 6904699 S | | | | 1 | **1** |
| **Total** | | **8** | **25** | **2** | **2** | **37** |

Taxonomic identifications determined that the specimens comprised four species of spider, three of which are potential SRE, and four species of scorpion, three of which are potential SRE. The two pseudoscorpions belonged to the same morpho-species which was assessed as unlikely to be SRE.

### *5.6.1 SPIDERS*

Eight spider specimens were submitted for identification. Taxonomic identifications revealed these to comprise four different species (Appendix III). Three of these species, *Synothele* sp. indet, *Aname* 'yamarna' and *Kwonkan* 'yamarna' were Mygalomorph spiders (Figure 5). All three were determined to be potential SRE because the species has not been recorded from elsewhere in Australia. The fourth species, *Miturga* 'BWI sp. 1' was an Araeneomorph spider which was assessed as not an SRE because it is a well-known and wide-ranging species.

The Mygalomorph spider species *Aname* 'yamarna' was collected from trap site 3, located in Clay Loam Plain/Sand Plain Ecotone habitat. Only one individual was captured, which was an adult male.

The Mygalomorph spider *Kwonkan* 'yamarna' was collected from trap site 4, located in Clay Loam Plain habitat. Five individuals were collected, all of which were adult males.

The Mygalomorph spider *Synothele* sp. indet. was collected from trap site 3. The genus *Synothele* is widespread throughout Australia, but individual species within this genus have very restricted ranges. The specimen captured was a juvenile, and could not be further identified.

**Table 12 Taxonomic identification of spiders collected from the project area**

| Potential SRE | Order | Family | Taxonomic ID | Male | Female | Juvenile | Site |
|---|---|---|---|---|---|---|---|
| **Yes** | Mygalomorphae | Barychelidae | *Synothele* sp. indet. | | | 1 | Site 3 |
| **Yes** | Mygalomorphae | Nemesiidae | *Aname* 'yamarna' | 1 | | | Site 3 |
| **Yes** | Mygalomorphae | Nemesiidae | *Kwonkan* 'yamarna' | 1 | | | Site 4 |
| **Yes** | Mygalomorphae | Nemesiidae | *Kwonkan* 'yamarna' | 1 | | | Site 4 |
| **Yes** | Mygalomorphae | Nemesiidae | *Kwonkan* 'yamarna' | 1 | | | Site 4 |
| No | Araeneomorphae | Miturgidae | *Miturga* 'BWI sp. 1' | 1 | | | Site 4 |
| **Yes** | Mygalomorphae | Nemesiidae | *Kwonkan* 'yamarna' | 1 | | | Site 4 |
| **Yes** | Mygalomorphae | Nemesiidae | *Kwonkan* 'yamarna' | 1 | | | Site 4 |

### *5.6.2 SCORPIONS*

Twenty-seven scorpion specimens were submitted for identification. Taxonomic identifications revealed these to comprise four different species (Appendix III). Three scorpion morpho-species are considered potential SRE's: *Lychas* 'GVD' (a new species), *Lychas* 'multipunctatus complex' and *Urodacus* 'yaschenkoi complex' (Figure 5).

The fourth species, the scorpion *Lychas* 'adonis' was widespread and not an SRE. This was the most commonly collected scorpion from the project area with 20 individuals collected from sites 1, 2, and 3.

*Lychas* 'GVD' was collected from sites 2 and 4, which are located approximately 4 km apart. Three individuals were captured, two males and one females. It represents a new species and is only known from the project area, and is considered a potential SRE. Further evidence of this is its close relationship with the *Lychas* 'annulatus' complex which is known for containing SRE species.

*Lychas* 'multipunctatus complex' was collected from sites 1 and 2, which are located approximately 8 km apart. Three individuals were captured, one female and two juveniles.

*Urodachus* 'yaschenkoi complex' was captured from site 3 only, represented by a single specimen. The specimen could not be clearly identified on the basis of its morphology as the specimen is a female. It is considered to be a potential SRE because there is a precedent for other representatives of the genus Urodacus to be SRE, including at least one morpho-species from the *Urodachus* 'yaschenkoi complex'

**Table 13 Taxonomic identification of scorpions collected from the project area**

| Potential SRE | Order | Genus | Taxonomic ID | Male | Female | Juvenile | Site |
|---|---|---|---|---|---|---|---|
| No | Scorpionidae | *Lychas* | *Lychas 'adonis'* | 15 | 2 | 1 | Site 1 |
| No | Scorpionidae | *Lychas* | *Lychas 'adonis'* | | | 1 | Site 2 |
| No | Scorpionidae | *Lychas* | *Lychas 'adonis'* | 1 | | | Site 3 |
| **Yes** | Scorpionidae | *Lychas* | *Lychas* 'GVD' | 2 | | | Site 2 |
| **Yes** | Scorpionidae | *Lychas* | *Lychas* 'GVD' | | 1 | | Site 4 |
| **Yes** | Scorpionidae | *Lychas* | *Lychas* 'multipunctatus complex' | | 1 | | Site 1 |
| **Yes** | Scorpionidae | *Lychas* | *Lychas* 'multipunctatus complex' | | | 2 | Site 2 |

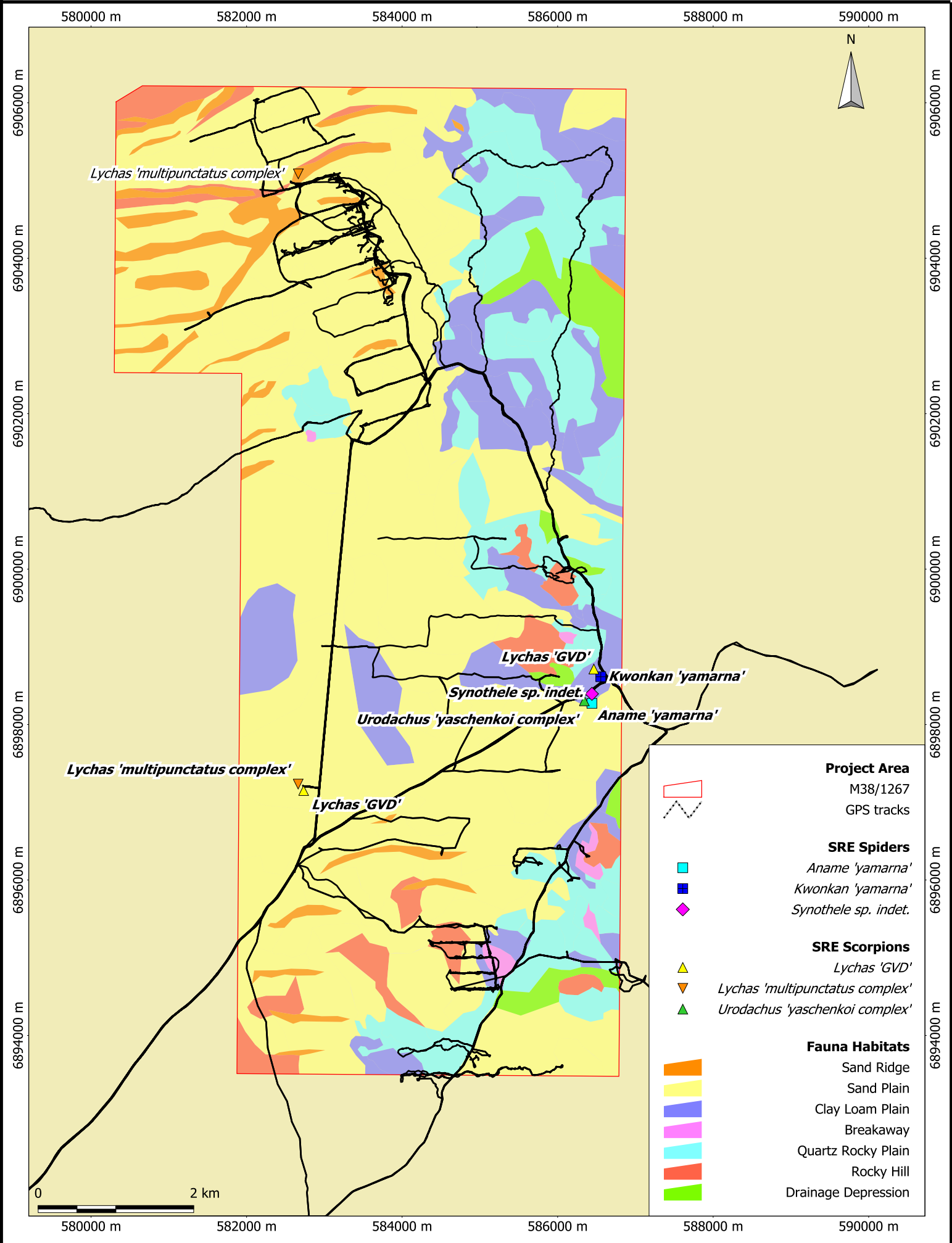
| Potential SRE | Order | Genus | Taxonomic ID | Male | Female | Juvenile | Site |
|---|---|---|---|---|---|---|---|
| **Yes** | Scorpionidae | *Urodachus* | *Urodachus* 'yaschenkoi complex' | | 1 | | Site 3 |

### *5.6.3 PSEUDOSCORPIONS*

Two pseudoscorpions were collected from foraging sites FS03 (previously labelled 'granite') and FS15 (previously labelled 'hakea') (Table 14). The specimens comprised one male, collected from FS03, and one female collected from site FS15. They were identified as belonging to the genus *Indolpium*. This genus is currently poorly known, but the main species described are widespread. For this reason the specimens collected from the project area were not considered to be potential SRE (Appendix III).

**Table 14 Taxonomic identification of pseudoscorpions collected from the project area**

| Potential SRE | Order | Genus | Taxonomic ID | M | F | J | Site |
|---|---|---|---|---|---|---|---|
| No | Pseudoscorpionidae | *Indolpium* | *Indolpium* sp. indet. | 1 | | | FS03 |
| No | Pseudoscorpionidae | *Indolpium* | *Indolpium* sp. indet. | | 1 | | FS15 |




Rapallo environmental

Gold Road Resources Ltd.
Gruyere Project

Scale: 1 : 60,000
Datum: MGA94 (51)

**Figure 5**

Locations of potential SRE

# 6 SPECIES OF CONSERVATION SIGNIFICANCE

Regional comparisons have identified 13 vertebrate fauna species of conservation significance that have been recorded from the greater region (Appendix I). Two of these species have been recorded in the project area: The Rainbow Bee-eater was recorded at Yamarna Camp, located outside but in close proximity to the project area. The Australian Bustard was recorded in an earlier survey (Harewood 2014). It must be noted that because the project lies within a region of the GVD that is not well surveyed the regional comparison has taken in a very large area (refer to Table 3). This means that habitats within the comparison are not particularly analogous to the project area and must be treated with a degree of caution.

The remaining eleven species were assessed as having either a high, medium, or low likelihood to occur in the project area. Likelihood ranking was based on the known ranges of these species, habitats available in the project area (section 5.2), and previous records from the greater region. Survey efforts expended in trying to detect a species, and likelihood of detection (cryptic nature) of species was also taken into account.

The results are summarised in Table 15 and explained in detail in sections 6.1 to 6.13. Four species are considered possible to occur in the project area (medium likelihood), and seven species are considered unlikely (low likelihood) to occur in the project area.

**Table 15 Summary of conservation significant fauna with potential to occur in the project area**

| Species | Common Name | Status | Likelihood to occur in project area | Comments |
|---|---|---|---|---|
| *Liopholis kintorei* | Great Desert Skink | S1 VU | Low (unlikely) | Species likely to be locally extinct (Harewood 2014). |
| *Ramphotyphlops margaretae* | Buff-snouted Blind Snake | P2 | Low (unlikely) | Project area outside of species' (highly restricted) range. |
| *Notoryctes typhlops* | Southern Marsupial Mole (Itjaritjari) | S1 EN | Low (unlikely) | Signs of the species not detected via targeted surveying (Harewood 2014; 2015) and lack of continuality of habitat that the species requires. |
| *Dasycercus blythi* | Brush-tailed Mulgara | P4 | Medium (possible) | Project area within species' range and suitable habitat present. |
| *Sminthopsis psammophila* | Sandhill Dunnart | S1 EN | Low (unlikely) | Project area outside of species' range and no yellow sand. |
| *Leipoa ocellata* | Malleefowl | S1 VU Mg | Low (unlikely) | Project area outside of species' range and habitat only marginally suitable. |
| *Falco peregrinus* | Peregrine Falcon | S4 | Medium (possible) | Project area within species' range and some suitable habitat present. |
| *Ardeotis australis* | Australian Bustard | P4 | High (likely) | Species recorded in project area and nearby. |
| *Amytornis striatus striatus* | Striated Grasswren (Sandhill) | P4 | Medium (possible) | Project area within species' range and suitable habitat present. Species cryptic and difficult to detect when present in low numbers. |

| Species | Common Name | Status | Likelihood to occur in project area | Comments |
|---|---|---|---|---|
| *Polytelis alexandrae* | Princess Parrot | P4 VU | Medium (possible) | Project area within species' range and suitable habitat present. Species would be sporadic visitor. |
| *Merops ornatus* | Rainbow Bee-eater | S3 Mg | High (likely) | Species recorded in project area and nearby. |
| *Ardea modesta* | Eastern Great Egret | S3 Mg Ma | Low (unlikely) | No suitable habitat. |
| *Charadrius veredus* | Oriental Plover | S3 Mg Ma | Low (unlikely) | No suitable habitat and project area well outside species' normal range in Australia. |

*Explanation of conservation status*:
S1 = *Wildlife Conservation Act 1950*, Schedule 1: Fauna that is rare or likely to become extinct.
S3 = *Wildlife Conservation Act 1950*, Schedule 3: Migratory birds protected under an international agreement.
S4 = *Wildlife Conservation Act 1950*, Schedule 4: Other specially protected fauna.
P2 = DPaW Priority 2: Taxa in urgent need of study, known from 5 or less locations some of which under threat.
P4 = DPaW Priority 4: Taxa in need of regular monitoring.
EN, VU = *EPBC Act 1999* Endangered and Vulnerable
Ma, Mg = *EPBC Act 1999* Marine and Migratory species.

## 6.1 GREAT DESERT SKINK (TJAKURA) – S1 VU

The Great Desert Skink (*Liopholis kintorei*) is a large lizard that can grow up to 44 cm long and weigh up to 350 g. The species is listed as Schedule 1 under the WC Act and as Vulnerable under the EPBC Act. It appears to be declining throughout its range with many previously known sites no longer supporting populations (McAlpin 1997). The current distribution of the Great Desert Skink consists of seven isolated populations and exceeds 5000 individuals (McAlpin 2001).

The Great Desert Skink lives in family groups within large and complex burrow systems in desert habitats on sandy, clay and loamy soils (Cogger 2014) vegetated with spinifex (Wilson and Swan 2013). In regions where it occurs, the species has a clumped distribution, with concentrations of burrows in areas of a few hectares separated by uninhabited, but seemingly suitable, habitat (McAlpin 1997).

Three populations occur in Western Australia at Patjarr (population estimated to be less than 2500 individuals), near the Kiwirrkura community, including the vicinity of Lake Mackay (less than 500 individuals), and in Rudall River National Park (unknown population size).

Sites in Western Australia are dominated by *Triodia basedowii* and *Triodia schinzii* with some *Eremophila leucophylla* shrubs (Pearson *et al.* 2001). Skinks appear to prefer a mosaic landscape of different aged vegetation, preferring habitat with at least 50% bare ground. They inhabit sites that have been burnt in the previous three to fifteen years (McAlpin 1998, 2001). A mosaic of regenerating vegetation may provide ample food while unburnt patches provide shelter (Pearson *et al*. 2001).

Harewood (2014) reported no evidence of burrows or scat latrines made by this species. Similarly, no live animals, burrows, tracks or scats were recorded by Rapallo. The only database that lists the species is the DPaW fauna database search, which has a 150 km radius. Harewood (2014) discusses that the closest records are from near Laverton located 150 km to the west, but this record dates back to 1967. More recent records are from the Gibson Desert Nature Reserve (370 km north, north east) in 1997 (DPaW 2014). Harewood concludes that although the project area falls within the historical range of the species, and contains suitable habitat, it is locally extinct and unlikely to occur in the project area.

## 6.2 BUFF-SNOUTED BLIND SNAKE – P2

The buff-snouted blind snake (*Ramphotyphlops margaretae*) is known only from Lake Throssell in Western Australia (Cogger 2014), approximately 80 km south-east of the project area. It is listed by the DPaW as Priority 2. It was flagged as a potential species in the desktop search, but only because of the 150 km search radius of the DPaW fauna database search. The restricted range of the species indicates that it is unlikely to occur in the project area and would not be affected by the project.

## 6.3 SOUTHERN MARSUPIAL MOLE (ITJARITJARI) – S1 EN

The Marsupial Mole is sparsely distributed across much of arid Australia (Menkhorst & Knight 2011). The Southern Marsupial Mole (*Notoryctes typhlops*) or Itjaritjari is listed as Endangered under the *EPBC* Act and S1 under the *WC Act*, however the conservation status of the Southern Marsupial Mole (*Notoryctes typhlops*) is currently under review (Harewood 2015). In the recently published Action Plan for Australian Mammals (Woinarski et al. 2014) it is rated as "least concern" and a recommendation made for its Endangered status to be "down listed to a lower category".

On the surface, Marsupial Moles are difficult to detect, being an extremely elusive species that rarely ventures to the surface and whose burrows collapse behind it as it "swims" through the sand (Van Dyck and Strahan 2008). Harewood (2014; 2015), utilised the trenching method for surveying Marsupial Moles (Benshemesh 2005) and examined four extensive sand ridge cuttings for mole holes.

Selected selections of each cutting face were either rubbed smooth by hand or 'shaved' via a spade to present a flat and smooth surface. No structures consistent with holes created by Marsupial Moles were observed in any of the cuttings and no surface tracks were recorded (Harwood 2015). Harwood (2014; 2015) concluded that it was unlikely that Marsupial Moles were present within the area surveyed at Gruyere due to absence of signs and also that the "dune field in the Gruyere project area appears to represent part of an isolated pod separate from other dune systems in surrounding areas". This is consistent with Benshemesh (2004) who notes that Marsupial Moles are not capable of travelling far across hard ground and continuity of suitable habitat (sand dunes, swales, sand plains) is likely to be very important for the occurrence of Marsupial Moles in an area. Based on a lack of signs and lack of habitat continuity the species is therefore unlikely to be affected by the project.

## 6.4 SANDHILL DUNNART – S1 EN

The Sandhill Dunnart (*Sminthopsis psammophila*) listed under the WC Act as Schedule 1, and listed Endangered under the EPBC Act. The species has been described as an enigma, with only sporadic records across arid southern Australia (van Dyck and Strahan 2008).

The Sandhill Dunnart is small carnivorous marsupial, with adults weighing about 25–55 g. It lives in a variety of sandy habitats with sand dunes with an overstorey of low open woodland of eucalypts and *Callitris* "pine", over an understorey of long unburnt spinifex (*Triodia* spp.) or complex low shrubland (Menkhorst and Knight 2011, Van Dyck and Strahan 2008).

In Western Australia, the Sandhill Dunnart occurs in a small area on the south-western fringe of the Great Victoria Desert where it inhabits yellow sand dune systems. The closest recent record to the project area is from Plumridge Nature Reserve, approximately 120 km to the south-west (2009).

The Sandhill Dunnart was not recorded during the Rapallo fauna survey. The likelihood of the Sandhill Dunnart occurring in the project area is low, because the project area lies outside of the species'

currently known range and does not contain yellow sand dune systems with long unburnt spinifex (cf. Harewood 2014). The species is therefore unlikely to be affected by the project.

## 6.5 BRUSH-TAILED MULGARA – P4

The Brush-tailed Mulgara (*Dasycercus blythi*) is listed by the DPaW as Priority 4. Until recently the species was clumped with the closely related Crest-tailed Mulgara (D*. cristicauda*), with more than four decades of records not distinguishing between the species. This means that there is ambiguity about the (historical) distribution of both species. The Brush-tailed Mulgara has the widest distribution, and is the only species that occurs in Western Australia, while the Crest-tailed Mulgara is confined to a small area on the border of the Northern Territory and South Australia (Van Dyck and Strahan 2008).

The Brush-tailed Mulgara has a widespread but patchy occurrence in sandy regions of arid central Australia (Menkhorst and Knight 2011). It occurs in a range of vegetation types including spinifex grassland on plains, sand ridges, and mulga shrubland on loamy sand. The principal habitat is mature hummock grasslands of spinifex, especially *Triodia basedowii* and *T. pungens* where it lives in burrows that it digs on the flats between low sand dunes (Van Dyck & Strahan 2008).

Rapallo found no evidence of the presence of Brush-tailed Mulgaras in the project area, and neither did Harewood (2014). The desktop search yielded very few records; Harewood (2014) states that the most recent nearby records are just south west of Yamarna, dating back to 1990 (DPaW 2014). However, the project area falls well within the known range of the species, and contains suitable habitat on the spinifex-covered sand plains and sand ridges. This indicates that it is possible that the species occurs in the project area, although in low numbers.

## 6.6 MALLEEFOWL – S1 VU

In Western Australia, the Malleefowl (*Leipoa ocellata*) is listed under the WC Act as Schedule 1: Fauna that is rare or likely to be extinct (Government of Western Australia 2013). Nationally, the species is listed under the EPBC Act as Vulnerable as well as Migratory (Department of the Environment 2013).

The Malleefowl belongs to an ancient family called Megapodiidae whose members build mounds for nesting (Marchant & Higgins 1993). Clearance for agriculture has eliminated and fragmented much of the Malleefowl habitat, resulting in localised extinctions and fragmented populations. The remaining isolated populations are now mostly in suboptimal habitat, since the mallee on the best soil has been cleared. This makes them vulnerable to catastrophic events, such as bushfires (Garnett *et al.* 2011).

The Malleefowl is found in semi-arid to arid shrublands and low woodlands, especially those dominated by mallee and/or Acacia species. A sandy substrate and abundance of leaf litter are required for mound construction and heat regulation (Johnstone & Storr 1998).

The species was picked up in the EPBC Protected Matters search, within a 20 km radius around the survey area. However this database does not provide dates or exact locations, and the species was not recorded in any of the other databases and previous surveys that were reviewed. The Birdlife Australia Atlas database, Birdata, indicates that the survey area falls outside the species' main range, with only one unrepeated sighting more than 300 km to the east of the project area. The species is therefore considered unlikely to occur in the project area.

## 6.7 PEREGRINE FALCON – S4

The Peregrine Falcon (*Falco peregrinus*) is listed under the WC Act as Schedule 4 - Other Specially Protected Fauna. The species experienced a large population decline as a result of herbicide and pesticide use in the 1950's to the 1970's, which caused major reductions in breeding success. However, since the banning of such chemicals the species population has stabilised and expanded. In Western Australia, populations are stable in areas with granite outcrops and cliffs (Johnstone & Storr 1998). This species is uncommon throughout its range, preferring areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land. In the absence of such habitats, the species is known to nest in trees using the nests of species from the family Corvidae, and occasionally hollows for nesting (Marchant & Higgins 1993).

The Peregrine Falcon was not recorded during the Rapallo survey of the project area. However, database searches indicate that it may occur in the area. It was picked up by the DPaW fauna database search, however this search covered a 150 km buffer area and the exact locality is not specified. Birdlife Australia's Birdata database shows repeated records of the species from a locality 50 km south of the project area. The project area provides suitable hunting habitat for the species, as well as potential breeding habitat in large hollow trees and abandoned large nests. Therefore the species could possibly occur in the project area.

## 6.8 AUSTRALIAN BUSTARD – P4

The Australian Bustard (*Ardeotis australis*) is listed by DPaW as Priority 4 – Taxa in Need of Monitoring The Australian Bustard is widely distributed, but has suffered massive historical population declines. It is particularly vulnerable to intensive agricultural practices and fox predation (Garnett & Crowley 2000). The species utilises a wide variety of grass habitats; including tussock, *Triodia* and grassy woodlands. They can also utilise chenopod flats and have been reported in lightly modified habitats such as golf courses. The species feeds on a variety of insects (such as stick insects and grasshoppers), as well as seeds and fruits (Johnstone & Storr 1998). The project area falls well within the known distribution of the species (Birdlife Australia 2015, Johnstone and Storr 1998).

Rapallo did not record evidence of the Australian Bustard within the project area. However, Harewood (2014) recorded tracks at several locations in the project area, and the species was recorded from the Yamarna project 20 km southwest from the Gruyere project area (lind ). The species was also reported in the DPaW 150 km database search, and during surveys of other locations in the Great Victoria Desert, including surveys by Ecologia (2009), and Hall *et al*. (1994). The absence of records during the survey was likely due to the dry conditions bringing about reduced food availability. The latter both in terms of reduced availability of seeds and fruits, but especially in terms of reduced numbers of invertebrates that depend on leafy plant material. The Australian Bustard is therefore likely to occur in the project area, but is unlikely to be impacted as it is a very mobile species with ample suitable habitat in surrounding areas.

## 6.9 STRIATED GRASSWREN (SANDHILL RACE) – P4

The Striated Grasswren (*Amytornis striatus*) is a small bird that spends most of its time on the ground hunting insects. It lives in small family groups in areas of mallee over spinifex (*Triodia* sp.) to which it is exceptionally well camouflaged; its presence is often detected only on calls. When it senses danger it can remain silent and motionless for a long time, making them easy to miss if startled. Striated Grasswrens have been shown to recolonise burnt areas after six or seven years, and the habitat

remains suitable up to around 40 years after fire (South Australian Department for Environment and Heritage 2006).

The Striated Grasswren occurs in several isolated populations across arid Australia. Four races are distinguished, two of which occur Western Australia. These are the Rufous Grasswren (*Amytornis striatus whitei*) which occurs in the Pilbara, and the Sandhill Grasswren (*A. s. striatus*) which occurs in the central arid zones including parts of the Great Sandy, Gibson, and Great Victoria Desert (Johnstone and Storr 2004).

Recent taxonomic revisions have reclassified the four races as separate species, with the Sandhill Grasswren proposed to be renamed as *Amytornis oweni*. However, this has not yet translated into legislative changes neither nationally nor at a state level. In Western Australia DPaW lists *A. s. striatus* as a protected Priority 4 species. In South Australia the Sandhill Grasswren (also as *A. s. striatus*) is listed as Vulnerable. Neither the species, nor any of its races are listed under the EPBC Act at this point in time, however this may change as taxonomic revisions make their way into law.

The project area falls within the distribution of the DPaW Priority 4 listed Sandhill Grasswren. The reason for listing is that the race has suffered loss and fragmentation of habitat as a result of clearing during the last century. This has resulted in reduced population size, and the population being scattered in isolated remnants, making them more vulnerable to extinction.

The Sandhill Grasswren was not recorded during the Rapallo survey, nor was it detected by Harewood (2014) during his visit to (part of) the project area. However, the DPaW TP fauna database search shows that recent records exist from the vicinity of the project area. Similarly, Birdata records show repeat observations of the species both north, south, east and west of the project area within 100 to 200 km. The project area contain suitable habitat in the form of mallee over spinifex on sand plains and sand ridges. Combined with the cryptic habits of the species, this suggest that it is possible that the Sandhill Grasswren occurs in the project area. However, it would only occur in low numbers and there is ample suitable habitat present in surrounding areas.

## 6.10 PRINCESS PARROT – P4 VU

The Princess Parrot (*Polytelis alexandrae*) is a slim, medium-sized parrot that grows to 40 to 45 cm in length (Higgins 1999). It is a colourful bird with a distinctive flight profile and flight movements, and a harsh far-ranging call (Johnstone and Storr 1994). The species is listed by DPaW as Priority 4 and listed as Vulnerable under the EPBC Act.

The Princess Parrot usually occurs singly, in pairs, or in small flocks of up to 30 birds. It occasionally congregates in large, loose flocks that may contain 100 or more birds; it breeds in small colonies of several pairs (Johnstone and Storr 1998). It occurs in lightly wooded country of, open mallee over spinifex, or open marble gum (*Eucalyptus gongylocarpa*) woodland (Johnstone and Storr 1998).

The Princess Parrot is confined to arid regions of Western Australia, the Northern Territory, and South Australia (Barrett et al. 2003, Johnstone and Storr 1998). In Western Australia it occurs in a broad band from the Great Sandy Desert in the north, across the Gibson and Tanami Desert to the Great Victoria Desert in the south (Johnstone and Storr 1998, Higgins 1999).

The species is rare and highly nomadic (Pizzey and Knight 2012), occurs over a very large area in remote or rarely visited regions, and its movements are largely unknown (Higgins 1999). These habits make it difficult to determine its exact range, or decide whether there has been a change in its population size and/or range. Historical records paint a picture of large range fluctuations over the decades, but they

do show a decline in the frequency of records from the periphery of its distribution since the 1950 which might indicate a decline in range (Garnett & Crowley 2000).

The Princess Parrot was not recorded during the Rapallo fauna survey, or by Harewood in 2014. The project area falls within the species' known range and contains suitable habitat in the form of mallee over spinifex and marble gum woodland. It is therefore possible that the Princess Parrot visits the project area occasionally, but due to its nomadic habits its presence would only be temporary. The most significant habitats in the project area would be areas with large mature marble gums which could offer hollows for breeding (cf. Harewood 2014).

## 6.11 RAINBOW BEE-EATER – S3 MG

The Rainbow Bee-eater (*Merops ornatus*) is listed under the WC Act as Schedule 3 – Migratory birds protected under an international agreement. It is protected under JAMBA. Under the EPBC Act the species is listed as Migratory.

The Rainbow Bee-eater prefers open or lightly timbered areas, often near water. This species has been recorded in dry open sclerophyll forest, open woodlands and shrublands, including mallee, spinifex tussock grassland with scattered trees, chenopod shrubland with scattered trees and riparian or littoral assemblages. It is often seen around disturbed areas such as quarries, road cuttings and mines where exposed bare soil provides suitable breeding sites (Marchant & Higgins 1993). The Rainbow Bee-eater is a migratory bird and will move north from the southern areas of Australia during winter (Johnstone & Storr 1998).

The species was recorded during the Rapallo survey of the project area, and was also picked up by the DPaW TP fauna database search, and the EPBC Protected Matters search. It was also recorded at Tropicana by Ecologia (2009), 200 km to the south-east of the project area. The Rainbow Bee-eater is therefore likely to occur in the project area as a visitor using the area for hunting. Because the species is migratory and is unlikely to breed in the project area, development is unlikely to impact on the Rainbow Bee-eater.

## 6.12 EASTERN GREAT EGRET – S3 MG MA

The Eastern Great Egret (*Ardea modesta*) is listed under the WC Act as Schedule 3 – Migratory birds protected under an international agreement. It is protected under CAMBA (as *Egretta alba*), and JAMBA (as *Egretta alba*). Under the EPBC Act it is listed as Marine and Migratory.

The Eastern Great Egret can be found throughout Australia, with the exception of the arid regions. It is listed under the EPBC Act as Migratory – Overfly Marine). The Great Egret inhabits terrestrial wetlands, estuarine, littoral habitats and grasslands. It prefers permanent water bodies on floodplains and the shallows of deep permanent lakes (Marchant & Higgins 1993), though it can be seen on any watered area including damp grasslands (Johnstone & Storr 1998).

The species was picked up in the EPBC Protected Matters search, but not in any of the other databases or survey reports reviewed in the desktop. The Birdata atlas shows no records of the species within 200 km of the project area. No suitable habitat in the form of lakes, rivers, or wetlands occurs in or near the project area. The species is therefore unlikely to occur in the project area, and unlikely to be affected by the development.

## 6.13 ORIENTAL PLOVER – S3 MG MA

The Oriental Plover (*Charadrius veredus*) is listed under the *WC Act* WC Act as Schedule 3 – Migratory birds protected under an international agreement, and under the EPBC Act as Marine and Migratory.

It is a large plover with distinctive colourations on the breast (in adults). It occurs in Australia only as a wintering (non-breeding) visitor to coastal and inland areas of northern Australia, north of the Tropic of Capricorn. It appears in Australia from late August to early April (Johnstone and Storr 1998) and it is estimated that the entire world population overwinters in Australia (Bishop 2006; Stewart et al. 2007). In its main wintering areas it often forms large flocks of up to 200, and sometimes more than 1000 birds. South of the Tropic, it is occasionally recorded as a vagrant (Johnstone and Storr 1998).

The project area falls well outside the common wintering range of the Oriental Plover. Any records picked up by the desktop search would have comprised vagrant birds. The species is discussed in this report because it appeared in the EPBC Protected Matters search with a 40 km radius around the project area. These records are likely to comprise vagrant birds, however, and it is highly unlikely that the Oriental Plover would visit the project area.

# 7 DISCUSSION

## 7.1 REPTILES

A total of 45 reptile species were recorded during the survey, comprising nine geckoes, three pygopods (legless lizards), 16 skinks, eight dragons, five monitors and four snakes. Of these, 32 species were captured in traps while the remaining were recorded opportunistically or during spotlight surveys.

None of the reptiles recorded in the survey were conservation listed. Desktop searches identified two conservation significant reptile species with potential to occur in the project area. However, reviews of the known distribution and habitat requirements, as well as previous records in the area, indicate that both species are unlikely to occur in the project area. See section 6 for more details.

Reptile diversity was moderately high, with the majority of species not unusual for the area. The reptile assemblage reflects the fact that the project area is located in the meeting zone of the temperate and tropical biogeographic regions, and contains a fine-scaled mosaic of different habitat types. Noteworthy records are the dragon lizard *Diporiphora paraconvergens* and the skink *Eremiascincus pallidus*, whose records in the project area are near the southern limits of their distribution. Of particular interest was the record of the shovel-nosed snake *Brachyurophis approximans* whose record represents the south-eastern limit of its distribution.

Reptile abundance during the survey was low, with more than half of all species recorded as singletons or doubletons, and only six species yielding records of ten or more captures. In addition, several common species which are usually abundant in the region were conspicuously absent from the trapping program. These include the dragons *Ctenophorus clayi* (normally abundant in the Great Victoria Desert), and *Ctenophorus fordi* (scarce but not uncommon), and the skinks *Liopholis inornatus* (reasonably common) and *Ctenotus grandis* (normally abundant), and *Ctenotus greeri* (scarce and localized). The absence of these species from the trapping program may be due to them being present in low numbers rather than actually absent. This is supported by the low abundance of trapped reptiles as a whole.

Like the birds, the low reptile abundance was likely due to the absence of significant rainfall events prior to and during the survey, and the associated reduced food availability and conditions unsuitable for breeding. Overall, reptile species records were moderately high, and can be considered representative for the actual reptile assemblage occurring in the project area.

## 7.2 BIRDS

A total of 54 bird species were recorded during the survey. The bird assemblage of the project area was representative for the region, and contained no surprises or range extensions. Of interest, however, was the great number of common species expected to be in the area, which were not recorded during the survey.

Bird activity at the time of the survey appeared suppressed, as judged by the absence of 25 bird species that were previously recorded from the Gruyere and nearby Yamarna project areas (Harewood 2011, 2014, KLA 2012). Among the absent species are common and very vocal species including Red Wattlebird, Yellow-rumped Thornbill, and Striated Pardalote. These species are readily detected if present, hence the absence of records most likely reflects actual absence.

Other absent species were irruptive migratory species that appear when flowering and insect activity are high, including White-winged Triller, Pied Honeyeater and White-fronted Honeyeater. The absence

of these species suggests that feeding conditions were not optimal during the survey which is supported by the virtual absence of blossoms.

Cuckoos were also not recorded. Three species of cuckoo are common in the region and would be expected in the project area. Cuckoos are easily detected when they are breeding, as their calls are loud and conspicuous, but cryptic when not breeding. The absence of cuckoo records suggests that the small songbirds and honeyeaters that these species parasitise were not breeding at the time of the survey.

Two conservation listed species were considered highly likely to occur in the project area. These were the Rainbow Bee-eater, recorded from the Yamarna camp during the survey, and the Australian Bustard recorded from the project area in 2014 by Harewood.

Bird assemblages of any area fluctuate over the seasons as species migrate in and out of the area, and increase and decrease in numbers as a result of breeding and mortality. Factors that influence how vocal and active species are also affect the number of species recorded, as this affects detectability. Overall the bird species recorded during the survey were representative of the bird assemblage typical for the Great Sandy Desert, *i.e.,* no unexpected species recorded. However, the absence of many common species and the low total number of species was of note. Surveys completed during more favourable seasonal conditions such as periods of flowering and high insect activity are likely to record further species.

## 7.3 MAMMALS

Fourteen non-volant mammals were recorded during the survey, of which eight native and six introduced. In addition three bat species were identified from acoustic recordings. Calls of a fourth species were also detected that could not be identified to species level due to significant call overlap between the two closely related 'candidate' species.

During the survey the activity of especially small mammal species was low, as judged from the small number of species recorded in traps (three) and the low number of individuals captured. A review of earlier surveys conducted at the project area (Harewood 2014) and at nearby Yamarna (Harewood 2011, KLA 2012) indicate three additional mammal species that are highly likely to occur in the project area, but which were not detected. These are the Stripe-faced and the Little Long-tailed Dunnart, and the Desert Mouse, all recorded at Yamarna. Absence of these species from the traps may indicate either actual local absence, or these species being present in low numbers during the survey, making them less likely to be captured over the ten-day survey period.

The desktop review flags one mammal species that have medium likelihood to occur in the project area, the Brush-tailed Mulgara. The project area falls within the known range of this species, and contains suitable habitat. The Brush-tailed Mulgara may indeed be locally absent from the project area, or be present in very low numbers. The reduced activity of other mammal species indicates that follow-up surveys may yet detect this species if it is present.

In summary, mammal records during the survey indicate reduced activity and/or reduced number of individuals during the survey compared to times of the year when resources are more abundant. The mammal species recorded during the survey were not unusual for the Great Sandy Desert. However, the low number of species and the absence of records for many common species was of note. Surveys completed during more favourable seasonal conditions may result in additional records.

## 7.4 SHORT RANGE ENDEMICS

Six species of potential SRE were collected during the survey, comprising three Mygalomorph spiders and two scorpions. All of these species are currently only known from the Gruyere project area. The SRE species were collected from all four trap sites that allowed for pitfall trap deployment (Table 16). The pseudoscorpions collected were assessed unlikely to be SRE. Collections of *Indolpium* sp. were made at Central Bore in 2012 (Burger et al 2012).

**Table 16 Summary of SRE species collected during the survey**

| Taxonomic Group | SRE species | Site 1 | Site 2 | Site 3 | Site 4 | Total |
|---|---|---|---|---|---|---|
| Mygalomorph spider | *Aname* 'yamarna' | | | 1 M | | 1 |
| | *Kwonkan* 'yamarna' | | | | 5 M | 5 |
| | *Synothele* sp. indet. | | | 1 J | | 1 |
| Scorpion | *Lychas* 'GVD' | | 2 M | | 1 M | 3 |
| | *Lychas* 'multipunctatus complex' | 1 F | 2 J | | | 3 |
| | *Urodachus* 'yaschenkoi complex' | | | 1 F | | 1 |
| **Number of specimens collected** | | **1** | **4** | **3** | **6** | **14** |
| **Number of different SRE species collected** | | **1** | **2** | **3** | **2** | **6** |

The scorpions *Lychas* 'GVD' and *Lychas* 'multipunctatus complex' were collected from two different trap sites, located respectively 4 km (sites 2 and 4) and 8 km (sites 1 and 2) apart. This indicates that these species have potential to occur in other areas within the project area.

Overall the total number of SRE captures was low, and indicative of the dry environmental conditions at the time of the survey. The project area had not experienced significant rainfall prior to and during the survey, which meant that environmental conditions were poor for trapping purposes, and unfavourable for leaf litter sampling. A strong indication of this was the very dry leaf litter, which yielded only two potential SRE specimens out of 220 litres of leaf litter collected from eleven different sites.

On a regional scale, as with many regions of Western Australia, SRE invertebrate survey data from the Shield and Central subregions of the GVD is deficient.

Potential SRE specimens were collected by Keith Lindbeck and Associates (KLA) in 2012 at Central Bore approximately 25 km to the southwest of Gruyere and 11 spider and 18 scorpion taxa were submitted for taxonomic identification (Burger et al 2012; Volschenk 2012). KLA (2012) as cited in Harewood (2014) reported that none of the specimens collected from the area were known to be SRE. Due to data deficiency, however, Burger et al (2012) did report the 'trapdoor spider' Aname 'MYG250' as a 'possible SRE', given little is known about its distribution. Aname 'MYG250' was collected at Atilla – an area associated with the Central Bore prospect (approximately 20 km to the south-west of the project area) from mulga woodland in creekline drainage (KLA 2012).

Volschenk (2012), reported that of the 18 scorpions collected from Central Bore in 2012, none were known to be SRE. However in an email to Nicole Garbin of MBS Environmental, Volschenk (pers com 5-5-2015) updated the status of the species *Lychas* 'annulatus' collected from Central Bore to 'potential SRE'.

The arachnid taxa collected by KLA from Central Bore in 2012 did not match any of the taxa collected from Gruyere in November 2014 by Rapallo.

Similarly, arachnid collections made from Gruyere in May 2014 during the level one fauna survey by Harewood (2014) did not match species collected from Gruyere in November 2014 (Rapallo). The specimens from May 2014 included a male "trapdoor spider" identified as the widespread Aganippe 'MYG159' (family Idiopidae) and an unidentified juvenile spider belong to the family Theraphosidae (Australian tarantulas). Neither specimen was deemed to be SRE or potential SRE given their known or likely large distributions (Phoenix 2014).

# 8 REFERENCES


Australian Government. (2013) Geoscience Australia. URL http://australia.gov.au/directories/australia/geoscience

Barrett, G. (2003) *The New Atlas of Australian Birds.* Royal Australasian Ornithologists Union, Hawthorn East, Vic. :

Beard, J.S. (1990) *Plant Life of Western Australia*. Kangaroo Press, Kenthurst, N.S.W.

Beard, J.S. (2005) Pre-European Vegetation - Western Australia (NVIS Complient version). Arc View Shape files.

Benshemesh, J. (2000) *National Recovery Plan for Malleefowl*. Department of Environment and Heritage, Adelaide.

Benshemesh, J. (2004) *Recovery Plan for Marsupial Moles* Notoryctes Typhlops *and* N. Caurinus. *Planning and Environment, Alice Springs Northern Territory.*

Benshemesh, J. (2005). Manual for Marsupial Mole survey and monitoring by trenches, version 1.0. Anangu-Pitjantjatjara Land Management and the Department of Environment and Heritage South Australia.

Birdlife Australia. (2013a) Birdata. URL http://www.birdata.com.au/homecontent.do

Birdlife Australia. (2013b) *Starter Kit: Atlas of Australian Birds. Everything You Need to Know to Get Started.*

Birdlife Australia. (2014) Birdlife Australia website. URL www.birdlife.org.au

Bureau of Meteorology. (2013) Bureau of Meteorology - Climate data online. URL http://www.bom.gov.au/

Burger, M., Castalanelli, M.A and Harvey M.S. (2012). Arachnids from Yamarna, 140 km East of Laverton, Western Australia. Report to Keith Lindbeck and Associates 8 May 2012. Western Australian Museum.

Christidis, L. & Boles, W. (2008) *Systematics and Taxonomy of Australian Birds*. CSIRO Publishing, Collingwood, Vic. :

Churchill, S. (2008) *Australian Bats*. Allen & Unwin, Crows Nest, N.S.W.

Cogger, H.G. (2000) *Reptiles and Amphibians of Australia*, Sixth Edition. Reed, Chatswood, NSW :

Cogger, H.G., Cameron, E.E., Sadlier, R.A. & Eggler, P. (1993) *The Action Plan for Australian Reptiles*. Australian Nature Conservation Agency, Canberra, A.C.T.

CSIRO Australia. (2013) Australian Soil Resource Information System (ASRIS). URL http://www.asris.csiro.au/index_other.html [accessed 20 June 2012]

Department of the Environment. (2013) The National Reserve System (NRS) - Australia's bioregions. URL http://www.environment.gov.au/topics/land/nrs/science-maps-and-data/ibra/australias-bioregion-framework [accessed 19 December 2013]

Department of Parks and Wildlife. (2013c) *Threatened Fauna Database*. Department of Parks and Wildlife.

Department of Parks and Wildlife. (2013d) NatureMap. URL http://naturemap.dec.wa.gov.au/ [accessed 14 June 2012]

Department of Parks and Wildlife. (2013e) *Priority Ecological Communities for Western Australia. Version 19. 20 September 2013.* Species and Communities Branch, Department of Parks and Wildlife.

Department of the Environment. (2013) *Leipoa ocellata* - Malleefowl. Species Profile and Threats Database (SPRAT). URL http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=934

Van Dyck, S. & Strahan, R. (2008) *The Mammals of Australia*. New Holland Publishers, Sydney.

Environmental Protection Authority. (2002) *EPA Position Statement No. 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection.* Environmental Protection Authority, Government of Western Australia.

Environmental Protection Authority. (2004a) *Guidance for the Assessment of Environmental Factors. No. 56. Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.* Environmental Protection Authority, Government of Western Australia.

Environmental Protection Authority. (2004b) *Position Statement No. 7. Principles of Environmental Protection.*

Environmental Protection Authority. (2009) *Guidance for the Assessment of Environmental Factors. No. 20. Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia.* Environmental Protection Authority, Government of Western Australia.

Environmental Protection Authority. (2010) *Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment.* Technical report of the Environmental Protection Authority and the Department of Environment and Conservation. September 2010.

Garnett, S. & Crowley, G.M. (2000) *The Action Plan for Australian Birds 2000*. Environment Australia, Canberra :

Garnett, S.T., Szabo, J.K. & Dutson, G. (2011) *The Action Plan for Australian Birds 2010.* CSIRO Publishing/Birds Australia, Melbourne.

Government of Western Australia. (2013) *Wildlife Conservation (Specially Protected Fauna) Notice 2013.* Western Australian Government Gazette No 170. 17 September 2013. State Law Publisher. URL http://www.slp.wa.gov.au/gazette/gazette.nsf/0/14AF61E1CA6F891348257BE8000CE219/$file/gg170.pdf

Harvey, M.S. (2002) Short-range endemism amongst the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics*, **16**, 555–570.

Harewood, G (2014). Fauna Assessment (Level 1) Gruyere Project (E38/1932, E38/2178, E38/2325, E38/2362 & E38/2446) Gold Road Resources Limited August 2014 Version 2

Harewood, G (2014). Southern Marsupial Mole (Notoryctes typhlops) – Additional Information on Presence/Absence - Gruyere Project Area. Correspondence to Gold Road Resources Limited June 2015.

Higgins, P.J. (ed). (1999) *Handbook of Australian, New Zealand and Antarctic Birds. Volume 4. Parrots to Dollarbird*. Oxford University Press, Melbourne :

Higgins, P.J. & Davies, S.J.J.F. (1996) *Handbook of Australian, New Zealand and Antarctic Birds, Volume 3. Snipe to Pigeons.*

International Union for Conservation of Nature. (2014) The IUCN Red List of Threatened Species. URL http://www.iucnredlist.org/ [accessed 21 June 2012]

Jacobson, G. & Lau, J.E. (1978) The Hydrologeology Map of Australia 1:5 000 000.

Johnstone, R.E. (Ronald E. & Storr, G.M. (Glen M. (1998) *Handbook of Western Australian Birds. Volume I: Non-Passerines (Emu to Dollarbird).* Western Australian Museum, Perth, W.A.

Johnstone, R.E. (Ronald E. & Storr, G.M. (Glen M. (2004) *Handbook of Western Australian Birds. Volume II: Passerines (Blue-Winged Pitta to Goldfinch)*. Western Australian Museum, Perth, W.A.

Keith Lindbeck and Associates (KLA) (2012). Fauna Assessment (Level 2) Yamarna Project. Unpublished report for Gold Road Resources. October 2012.

Marchant, S. & Higgins, P.J. (eds). (1993) *Handbook of Australian, New Zealand & Antarctic Birds. Volume 2. Raptors to Lapwings.* Oxford University Press, Melbourne :

Menkhorst, P. & Knight, F. (2011) *A Field Guide to the Mammals of Australia*, Third Edition. Oxford University Press.

Parnaby, H.E. (2009) A taxonomic review of Australian Greater Long-eared Bats previously known as *Nyctophilus timoriensis* (Chiropetera: Vespertilionidae) and some associated taxa. *Australian Zoologist*, **35**.

Parsons, B.D., Short, J.C. & Roberts, J.D. (2008) Contraction in range of Malleefowl (*Leipoa ocellata*) in Western Australia: a comparative assessment using presence-only and presence-absence datasets. *Emu*, **108**.

Phoenix Environmental Sciences. (2012) *Terrestrial Invertebrates from Lamb Creek, Western Australia*. Unpublished report prepared for Rapallo.

Schodde, R. & Mason, I. (1999) *Directory of Australian Birds - Passerines.*Melbounre, CSIRO.

Serena, M. & Soderquist, T.R. (1989) Serena, M. and Soderquist, T.R. (1989). population of the carnivorous marsupial *Dasyurus geoffroii. Journal of Zoology, London*, **219**, 373–383.

Short, J. & Parsons, B.D. (2008) *Malleefowl Conservation Informed and Integrated Community Action.*

Storr, G.M. (Glen M., Johnstone, R.E. (Ronald E. & Smith, L.A. (Lawrence A. (1999) *Lizards of Western Australia I. Skinks*, Second Edition. University of Western Australia Press with Western Australian Museum, Nedlands, W.A. :

Storr, G.M. (Glen M., Johnstone, R.E. (Ronald E. & Smith, L.A. (Lawrence A. (2002) *Snakes of Western Australia*. Western Australian Museum, Perth, W.A. :

Terrestrial Ecosystems. (2013) *Level 1 Vertebrate Fauna Risk Assessment for the Nova Project Area*.

Thackway, R. & Cresswell, I. (1995) *An Interim Biogeographic Regionalisation for Australia : A Framework for Setting Priorities in the National Reserves System Cooperative Program / Edited by R Thackway and I D Cresswell*. Australian Nature Conservation Agency, Reserve Systems Unit, Canberra :

Tille, P.J. (Peter J. (2006) *Soil-Landscapes of Western Australia's Rangelands and Arid Interior.* Resource Science and Land Management Branches of the Dept. of Agriculture, South Perth, W.A. :

Tyler, M.J. & Doughty, P. (2009) *Field Guide to Frogs of Western Australia*. Western Australian Museum, Welshpool, W.A. :

Tyler, M.J., Johnstone, R.E. (Ronald E. & Smith, L.A. (Lawrence A. (2000) *Frogs of Western Australia / by M.J. Tyler, L.A. Smith, R.E. Johnstone*. Western Australian Museum, Perth [W.A.] :

Volschenk (2012). Yamarna Scorpion Identification Report. Un published report by Scorpion ID for Keith Linbeck and Associates.

Western Australian Museum. (2013a) *Western Australian Museum Mollusc Database*. Western Australian Museum.

Western Australian Museum. (2013b) *Western Australian Museum Terrestrial Short Range Endemic Database*. Western Australian Museum.

Western Australian Museum. (2013c) *WAM Quarantine Services Submission Guidelines.* September 2013.

Western Australian Museum. (2013d) Checklist of the Terrestrial Vertebrate Fauna of Western Australia. URL http://museum.wa.gov.au/research/departments/terrestrial-zoology/checklist-terrestrial-vertebrate-fauna-western-australia

Wilson, S. & Swan, G. (2013) *A Complete Guide to Reptiles of Australia*, 4th ed. New Holland Publishers, Chatswood, N.S.W. :

Woinarski, J., Burbidge, A. and Harrison, P. (2014). The Action Plan for Australian Mammals 2012. CSIRO Publishing.

# Appendix I Regional Species Comparisons

## Appendix I – Regional Species Comparisons Table

*Key to abbreviations*:

Status: S1, S3, S4 = WC Act Schedules 1, 3 and 4; P2, P4 = DPaW Priority 2 and 4; EN = EPBC Act Endangered; VU = EPBC Act Vulnerable; Ma = EPBC Act Marine; Mg = EPBC Act Migratory.

Rap 2015 **This Survey**: Rapallo (2015) Fauna Survey of the Gruyere Project Area. Unpublished report prepared for Gold Road Resources Ltd.

HW 2014 Harewood (2014). Fauna Assessment (Level 1) Gruyere Project. Unpublished report for Gold Road Resources Limited, August 2014.

KLA 2012 KLA (2012). Fauna Assessment (Level 2). Yamarna Project. Unpublished report for Gold Road Resources. October 2012.

TE 2011 Terrestrial Ecosystems (2011) Level 2 fauna risk assessment for the Granny Deeps Project Area. Unpublished report. February 2011.

HW 2011 Terrestrial Fauna Survey (Level 1) of Yamarna Gold Project (Central Bore), Atilla, Alaric, Haul Road and Khan North). Unpublished report for Gold Road Resources. September 2011.

Eco 2009 Ecologia (2009). Tropicana Gold Project. Operational Area Vertebrate Fauna Assessment. Unpublished Report for Tropicana Joint Venture, February 2009.

Hall 1994 Hall *et al*. (1994). The Biological Survey of the Eastern Goldfields of WA - Pt 10: Sandstore-Sire Samuel and Laverton-Leonora Survey Areas. Records of the WAM, Supplement 47: 1-166.

DPaW Department of Parks and Wildlife Threatened and Priority Fauna Database and NatureMap database.

EPBC Department of the Environment EPBC Act Protected Matters database search.

*Footnotes with Rapallo 2015 (This Survey)*

SM2 Species identified from acoustic recordings of calls

x (tracks) Species recorded from tracks and/or diggings only

Yamarna Camp Species recorded outside the project area at Yamarna camp (20 km SW from project area), and not included in total species count for the survey.

| Class | Common Name | Status | Rap 2015* | HW 2014 | KLA 2012 | TE 2011 | HW 2011 | Eco 2009 | Hall 1994 | DPaW | EPBC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Family** | | | | | | | | | | | |
| *Species* | | | | | | | | | | | |
| **Amphibia** | | | | | | | | | | | |
| **Myobactrachidae** | | | | | | | | | | | |
| Ground or burrowing frogs | | | | | | | | | | | |
| *Neobatrachus aquilorius* | Northern burrowing frog | | | | | | | | | x | |
| *Neobatrachus kunapalari* | Kunapalari frog | | | | | x | | | x | x | |
| *Neobatrachus sutor* | Shoemaker frog | | | | x | x | | | | x | |
| *Neobatrachus wilsmorei* | Plonking Frog | | | | | | | | | | |
| *Opisthodon spenceri* | Centralian Burrowing Frog | | | | | | | | | | |
| *Pseudophryne occidentalis* | Western Toadlet | | | | | | | | | | |
| **Hylidae** | | | | | | | | | | | |
| Tree or Water-Holding Frogs | | | | | | | | | | | |
| *Cyclorana maini* | Sheep Frog | | | | | x | | | x | x | |

| Class | Common Name | Status | Rap 2015* | HW 2014 | KLA 2012 | TE 2011 | HW 2011 | Eco 2009 | Hall 1994 | DPaW | EPBC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cyclorana platycephala* | Water-holding Frog | | | | | x | | | x | | |
| **Reptilia** | | | | | | | | | | | |
| **Carphodactylidae** | | | | | | | | | | | |
| Knob-tailed Geckos | | | | | | | | | | | |
| *Nephrurus laevissimus* | Pale Knob-tail Gecko | | x | | | | | x | | x | |
| *Nephrurus levis* | Smooth Knob-tail Gecko | | | | | | | x | | | |
| *Nephrurus vertebralis* | Midline Knob-tailed Gecko | | | | | | | | | x | |
| **Diplodactylidae** | | | | | | | | | | | |
| Geckoes | | | | | | | | | | | |
| *Diplodactylus conspicillatus* | Fat-tailed Gecko | | x | | x | | | x | x | x | |
| *Diplodactylus grananensis* | Western Stone Gecko | | | | | x | | x | | | |
| *Diplodactylus pulcher* | Western Saddled Ground Gecko | | | | x | x | | | | x | |
| *Lucasium damaeum* | Beaded Gecko | | x | | | | | x | | x | |
| *Lucasium squarrosus* | Mottled Ground Gecko | | | | | | | | x | | |
| *Rhynchoedura ornata* | Beaked Gecko | | x | | | x | | x | x | x | |
| *Strophurus ciliaris* | Spiny-tailed Gecko | | | | | | | | | x | |
| *Strophurus elderi* | Jewelled Gecko | | x | | | | | x | x | x | |
| *Strophurus intermedius* | Southern Spirit-tailed Gecko | | | | x | | | | | x | |
| *Strophurus strophurus* | Western Spiny-tailed Gecko | | x | | | | | x | x | x | |
| *Strophurus wellingtonae* | Western-shield Spiny-tailed Gecko | | | | | x | | | x | | |
| **Gekkonidae** | | | | | | | | | | | |
| Geckoes | | | | | | | | | | | |
| *Gehyra purpurascens* | Purple Arid Dtella | | x | | | | | x | x | x | |
| *Gehyra variegata* | Variegated Dtella | | x | | x | x | x | x | x | x | |
| *Heteronotia binoei* | Binoe's Gecko | | x | | x | x | | x | x | x | |
| *Underwoodisaurus milli* | Barking Gecko | | | | | | | | x | | |
| **Pygopodidae** | | | | | | | | | | | |
| Legless Lizards | | | | | | | | | | | |
| *Delma butleri* | Unbanded Delma | | | x | | | | x | x | x | |
| *Delma nasuta* | Long-nosed Delma | | x | | | | | x | x | x | |
| *Delma petersoni* | Painted Delma | | | | | | | x | | | |
| *Lialis burtonis* | Burton's Legless Lizard | | x | x | | | | x | x | x | |
| *Pygopus nigriceps* | Western Hooded Scalyfoot | | x | | x | | | x | | x | |
| **Agmidae** | | | | | | | | | | | |
| Dragon Lizards | | | | | | | | | | | |
| *Caimanops amphiboluroides* | Mulga Dragon | | x | | x | x | | x | | | |
| *Ctenophorus caudicinctus infans* | Ring-tailed Dragon | | | | x | | | | | | |
| *Ctenophorus clayi* | Collared Dragon | | | | | | | x | | x | |
| *Ctenophorus cristatus* | Bicycle Dragon | | | | | | | x | | | |
| *Ctenophorus fordi* | Mallee Sand Dragon | | | | | | | x | x | x | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ctenophorus isolepis* | Military Dragon | | x | x | | | | x | x | x | |
| *Ctenophorus nuchalis* | Central Netted Dragon | | x | | | | | x | x | x | |
| *Ctenophorus pictus* | Painted Dragon | | | | x | | | | | x | |
| *Ctenophorus reticulatus* | Western Netted Dragon | | x | | x | | | x | x | x | |
| *Ctenophorus scutulatus* | Lozenge-marked Bicycle Dragon | | x | | x | | | | x | x | |
| *Diporiphora paraconvergens* | Grey-striped Western Desert Dragon | | x | | | | | | | | |
| *Diporiphora reginae* | Red-rumped Two-lined Dragon | | | | | | | x | | | |
| *Gowidon longirostris* | Long-nosed Dragon | | | | | | | x | | x | |
| *Moloch horridus* | Thorny Devil | | x | x | | | | x | x | x | |
| *Pogona minor* | Western Bearded Dragon | | x | | | | | x | x | x | |
| *Tympanocryptis cephala* | Pebble Dragon | | | | | X | | | | | |
| **Varanidae** | | | | | | | | | | | |
| Monitor's or Goanna"s | | | | | | | | | | | |
| *Varanus brevicauda* | Short-tailed Pygmy Monitor | | x | | | | | x | x | x | |
| *Varanus caudolineatus* | Stripe-tailed Pygmy Monitor | | | | x | x | | | x | x | |
| *Varanus eremius* | Pygmy Desert Monitor | | | | | | | x | | x | |
| *Varanus giganteus* | Perentie | | x | x | | | | x | | x | |
| *Varanus gilleni* | Pygmy Mulga Monitor | | | | | | | x | | x | |
| *Varanus gouldii* | Bungarra or Sand Monitor | | x | | x | | | x | x | x | |
| *Varanus panoptes* | Yellow-spotted Monitor | | x | | | x | | | | | |
| *Varanus tristis* | Black-headed Monitor | | x | | | | | x | | x | |
| **Scincidae** | | | | | | | | | | | |
| Skinks | | | | | | | | | | | |
| *Cryptoblepharus buchananii* | Fence Skink | | | | | | | | x | | |
| *Cryptoblepharus carnabyi* | Spiny-palmed Fence Skink | | | | | | | x | x | | |
| *Ctenotus ariadnae* | Ariadna's Ctenotus | | | | | | | x | | X | |
| *Ctenotus brooksi* | Central Wedge-snout Ctenotus | | x | | | | | x | | X | |
| *Ctenotus calurus* | Blue-tailed Skink | | x | | | | | x | | X | |
| *Ctenotus dux* | Narrow-lined Skink | | x | x | | | | x | | X | |
| *Ctenotus grandis* | Giant Desert Ctenotus | | | | | | | x | | x | |
| *Ctenotus greeri* | Spotted-necked Ctenotus | | | | | | | x | x | x | |
| *Ctenotus hanloni* | Nimble Ctenotus | | | | | | | | | x | |
| *Ctenotus helenae* | Dusky Ctenotus | | x | | x | | | x | x | x | |
| *Ctenotus leae* | Centralian Coppertail | | | | | | | | | x | |
| *Ctenotus leonhardii* | Leonhardi's Skink | | x | | x | x | | x | | x | |
| *Ctenotus nasutus* | Nasute Finesnout Ctenotus | | x | | | | | | | | |
| *Ctenotus pantherinus* | Leopard Ctenotus | | x | x | x | | | x | x | x | |
| *Ctenotus piankai* | Coarse Sands Ctenotus | | x | | | | | | | x | |
| *Ctenotus quattuordecimlineatus* | Fourteen-lined Ctenotus | | x | | | | | x | | x | |
| *Ctenotus schomburgkii* | Barred Wedge-snout Ctenotus | | x | x | | | | x | x | x | |
| *Ctenotus severus* | Stem Rock Ctenotus | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ctenotus uber* | Spotted Ctenotus | | x | | | | | | | | |
| *Cyclodomorphus melanops* | Eastern Slender Blue-tongue | | | | | | | x | | x | |
| *Egernia depressa* | Pygmy Spiny-tailed Skink | | | | | x | | | | | |
| *Eremiascincus pallidus* | Pale Sand Swimer | | x | | | | | | | | |
| *Eremiascincus richardsonii* | Broad-banded Sand Swimmer | | (Yamarna camp) | | x | x | | x | | x | |
| *Lerista bipes* | Western Two-toed Slider | | x | x | | | | x | | x | |
| *Lerista desertorum* | Great Desert Slider | | x | | x | x | | x | x | x | |
| *Lerista kingi* | Common Mulch Skink | | | | | | | | x | | |
| *Lerista taeniata* | Ribbon Slider | | | | | | | x | | | |
| *Lerista timida* | Timid Slider | | x | | | | | x | | | |
| *Liopholis inormata* | Desert Skink | | | | x | | | x | | | x |
| *Liopholis kintorei* | Great Desert Skink | **S1 VU** | | | | | | | | x | |
| *Liopholis striata* | Night Skink | | x | | | | | x | | x | |
| *Menetia greyii* | Dwarf Skink | | | | | x | | x | x | x | |
| *Morethia butleri* | Woodland Dark-flecked Morethia | | | | | x | | x | x | x | |
| *Proablepharus reginae* | Western Soil-Crevice Skink | | | | | | | x | | | |
| *Tiliqua multifasciata* | Central Blue-tongue | | | | x | x | | x | x | x | |
| *Tiliqua occipitalis* | Western Blue-tongue | | | | | | | x | x | x | |
| **Typhlopidae** | | | | | | | | | | | |
| Blind Snakes | | | | | | | | | | | |
| *Ramphotyphlops bicolor* | Dark- spinned Blind Snake | | | | | x | | | | x | |
| *Ramphotyphlops endoterus* | Interior Blind Snake | | | | | | | x | | x | |
| *Ramphotyphlops hamatus* | Northern Hook-snouted Blind Snake | | | | | | | | x | | |
| *Ramphotyphlops margaretae* | Buff-snouted Snake | **P2** | | | | | | | | x | |
| *Ramphotyphlops waitii* | Common Beaked Blind Snake | | | | | | | x | | | |
| **Boidae** | | | | | | | | | | | |
| Pythons, Boas | | | | | | | | | | | |
| *Antaresia stimsoni* | Stimson's Python | | | | | | | | | x | |
| **Elapidae** | | | | | | | | | | | |
| Elapid Snakes | | | | | | | | | | | |
| *Acanthophis pyrrhus* | Desert Death Adder | | | | | | | x | | | |
| *Brachyurophis approximans* | North-western Shovel-nosed Snake | | x | | | | | | | | |
| *Brachyurophis fasciolata* | Narrow-banded Shovel-nosed Snake | | | | | | | x | | | |
| *Brachyurophis semifasciata* | Southern Shovel-nosed Snake | | | | | | | x | | | |
| *Demansia psammophis* | Yellow-faced Whipsnake | | | | | | | x | | x | |
| *Furina ornata* | Moon Snake | | | | | | | | x | | |
| *Neelaps bimaculatus* | Black-naped Snake | | | | | | | x | | x | |
| *Parasuta monachus* | Monk Snake | | | | | x | | x | | x | |
| *Pseudechis australis* | Mulga Snake | | x | | | | x | x | x | x | |
| *Pseudonaja modesta* | Ringed Brown Snake | | x | | x | | | x | | x | |
| *Pseudonaja nuchalis* | Gwadar | | | | | | x | x | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Simoselaps anomalus* | Desert Banded Snake | | x | | | | | | | x | |
| *Simoselaps bertholdi* | Jan's Banded Snake | | | | | | | x | x | x | |
| *Suta fasciata* | Rosen's Snake | | | | | x | | | | x | |
| **Aves** | | | | | | | | | | | |
| **Casuariidae** | | | | | | | | | | | |
| Emus, Cassowarries | | | | | | | | | | | |
| *Dromaius novaehollandiae* | Emu | | x | x | x | x | x | x | x | x | |
| **Megapodiidae** | | | | | | | | | | | |
| Mound-builders | | | | | | | | | | | |
| *Leipoa ocellata* | Malleefowl | **S1 VU Mg** | | | | | | | | | x |
| **Ardeidae** | | | | | | | | | | | |
| Herons and Egrets | | | | | | | | | | | |
| *Ardea modesta* | Eastern Great Egret | **S3 Mg Ma** | | | | | | | | | x |
| **Accipitridae** | | | | | | | | | | | |
| Kites, Goshawks, Eagles,Harriers | | | | | | | | | | | |
| *Accipiter cirrocephalus* | Collared Sparrowhawk | | | | | | | x | | x | |
| *Accipiter fasciatus* | Brown Goshawk | | x | | | | x | | | x | |
| *Aquila audax* | Wedge-tailed Eagle | | x | x | x | x | x | x | x | x | |
| *Aquila morphnoides* | Little Eagle | | | | | | | x | x | | |
| *Circus assimilis* | Spotted Harrier | | | | | | | | x | | |
| *Elanus caeruleus* | Black-shoulders Kite | | | | x | | | | | | |
| *Haliastur sphenurus* | Whistling Kite | | x | | | | | | | | |
| **Falconidae** | | | | | | | | | | | |
| Falcons | | | | | | | | | | | |
| *Falcon berigora* | Brown Falcon | | x | x | x | x | x | x | x | x | |
| *Falcon cenchroides* | Nankeen Kestrel | | x | x | x | x | | x | x | x | |
| *Falcon longipennis* | Australian Hobby | | x | x | x | | x | x | x | x | |
| *Falco peregrinus* | Peregrine Falcon | **S4** | | | | | | x | | x | |
| **Otididae** | | | | | | | | | | | |
| Bustards | | | | | | | | | | | |
| *Ardeotis australis* | Australian Bustard | **P4 NT** | | x | x | | | x | x | x | |
| **Turnicidae** | | | | | | | | | | | |
| Button-quails | | | | | | | | | | | |
| *Tumix velox* | Little Button-quail | | | | x | | x | x | | x | |
| **Charadriidae** | | | | | | | | | | | |
| Lapwings, Plovers, Dotterels | | | | | | | | | | | |
| *Charadrius melanops* | Black-fronted Dotterel | | | | | x | | | x | | |
| *Charadrius veredus* | Oriental Plover | **S3 Mg Ma** | | | | | | | | | x |
| **Columbidae** | | | | | | | | | | | |
| Pigeons, Doves | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Geopelia cuneata* | Diamond Dove | | | | x | | x | x | x | x | |
| *Ocyphaps lophotes* | Crested Pigeon | | x | x | x | x | x | x | x | x | |
| *Phaps chalcoptera* | Common Bronzewing | | x | x | x | x | | x | x | x | |
| **Psittacidae** | | | | | | | | | | | |
| Parrots | | | | | | | | | | | |
| *Cacatua roseicapilla* | Galah | | x | | x | | | x | x | | |
| *Melopsittacus undulatus* | Budgerigar | | | | x | | x | x | x | x | |
| *Neophema bourkii* | Bourke's Parrot | | x | | x | | | | X | | |
| *Neophema splendida* | Scarlet-chested Parrot | | | | | | | x | | x | |
| *Nymphicus hollandicus* | Cockatiel | | x | | x | | | x | x | | |
| *Platycerus varius* | Mulga Parrot | | x | x | x | x | x | x | x | | |
| *Platycerus zonarius* | Australian Ringneck | | x | x | x | x | x | x | x | | |
| *Polytelis alexandrae* | Princess Parrot | **P4 VU** | | | | | | | | x | x |
| **Cuculidae** | | | | | | | | | | | |
| Parasitic Cuckoos | | | | | | | | | | | |
| *Chrysococcyx basalis* | Horsfield's Bronze Cuckoo | | | | | | x | x | x | | |
| *Chrysococcyx osculans* | Black-eared Cuckoo | | | | | | | x | | | |
| *Cuculus pallidus* | Pallid Cuckoo | | | x | | x | x | x | x | | |
| **Strigidae** | | | | | | | | | | | |
| Hawk Owis | | | | | | | | | | | |
| *Ninox novaeseelandiae* | Southern Boobook | | x | | x | | | | | x | |
| **Podargidae** | | | | | | | | | | | |
| Frogmouths | | | | | | | | | | | |
| *Podargus strigoides* | Tawny Frogmouth | | | | x | | | x | x | x | |
| **Caprimulgidae** | | | | | | | | | | | |
| Nightjars | | | | | | | | | | | |
| *Eurostopodus argus* | Spotted Nightjar | | x | x | x | | | x | | | |
| **Aegothelidae** | | | | | | | | | | | |
| Owlet-nightjars | | | | | | | | | | | |
| *Aegotheles cristatus* | Australian Owlet-nightjar | | x | | x | | | x | x | x | |
| **Halcyonidae** | | | | | | | | | | | |
| Tree Kingfishers | | | | | | | | | | | |
| *Todiramphus pyrrhopygia* | Red-backed Kingfisher | | x | x | x | x | | x | x | | |
| **Meropidae** | | | | | | | | | | | |
| Bee-eaters | | | | | | | | | | | |
| *Merops Ornatus* | Rainbow Bee-eater | **S3 Mg** | (Yamarna camp) | | | | | x | | x | x |
| **Climacteridae** | | | | | | | | | | | |
| Treecreepers | | | | | | | | | | | |
| *Climacteris affinis* | White-browed treecreeper | | | | | | | x | x | | |
| **Maluridae** | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Fairy Wrens, Grasswrens | | | | | | | | | | | |
| *Amytornis striatus striatus* | Striated Grasswren | **P4** | | | | | | | | x | |
| *Malurus lamberti* | Variegated Fairy-wren | | x | x | x | | x | | x | x | |
| *Malurus leucopterus* | White-winged Fairy-wren | | | | | x | x | | x | x | |
| *Malurus splendens* | Splendid Fairy-wren | | x | | | x | | x | | | |
| **Acanthizidae** | | | | | | | | | | | |
| Thornbills, Geryones Fieldwrens & Whtefaces | | | | | | | | | | | |
| *Acanthiza apicalis* | Inland Thornbill | | x | x | x | x | x | x | x | x | |
| *Acanthiza chrysorrhoa* | Yellow-rumped Thornbill | | | | x | x | | x | x | x | |
| *Acanthiza iredalei iredalei* | Slender-billed Thornbill (Western) | | | | | | | | | | x |
| *Acanthiza robustirostris* | Slaty-backed Thornbil | | x | x | x | x | | x | | x | |
| *Acanthiza uropygialis* | Chestnut-rumped Thornbill | | | x | x | | x | x | x | x | |
| *Aphelocephala leucopsis* | Southern Whiteface | | | x | x | x | x | x | x | x | |
| *Pyrrholaemus brunneus* | Redthroat | | x | x | x | | x | x | | x | |
| *Smicromis brevirostris* | Weebill | | x | x | x | | x | x | x | x | |
| **Pardalotidae** | | | | | | | | | | | |
| Pardalotes | | | | | | | | | | | |
| *Pardalotus rubricatus* | Red-browed Pardalote | | x | x | x | | | | | x | |
| *Pardalotus striatus* | Striated Pardalote | | | x | | x | | x | x | x | |
| **Meliphagidae** | | | | | | | | | | | |
| Honeyeaters, Chats | | | | | | | | | | | |
| *Acanthagenys rufogularis* | Spiny-cheeked Honeyeater | | x | x | x | x | x | x | x | x | |
| *Anthochaera carunculata* | Red Wattlebird | | | x | | | | x | | x | |
| *Certhionyx niger* | Black Honeyeater | | | | | | | | x | | |
| *Certhionyx variegatus* | Pied Honeyeater | | | | | x | x | | x | | |
| *Epthianura aurifrons* | Orange Chat | | | | | | | x | | | |
| *Epthianura tricolor* | Crimson Chat | | | x | x | x | x | x | x | x | |
| *Lichenostomus plumulus* | Grey-fronted Honeyeater | | x | x | | | | x | x | | |
| *Lichenostumus virecens* | Singing Honeyeater | | x | x | x | x | x | x | x | | |
| *Manorina flavigula* | Yellow-throated Miner | | x | x | x | x | x | x | x | x | |
| *Phylidonyris albifrons* | White-fronted Honeyeater | | | x | | | x | x | x | | |
| **Petroicidae** | | | | | | | | | | | |
| Australian Robins | | | | | | | | | | | |
| *Microeca fascinans* | Jacky Winter | | x | | | | | x | x | x | |
| *Petroica cucullata* | Hooded Robin | | x | x | x | x | x | x | x | | |
| *Petroica goodenovil* | Red-capped Robin | | x | x | x | x | x | x | x | x | |
| **Pomatostomidae** | | | | | | | | | | | |
| Babblers | | | | | | | | | | | |
| *Pomatostomus superciliosus superciliosus* | White-browed Babbler (central/northern) | | x | x | x | x | x | x | x | | |
| **Cinclosomatidae** | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Whipbirds, Wedgebills, Quail Thrushes | | | | | | | | | | | |
| *Cinclosoma castaneothorax* | Chestnut-breasted Quail-thrush | | x | x | x | | | | | x | |
| **Neosittidae** | | | | | | | | | | | |
| Sitellas | | | | | | | | | | | |
| *Daphoenositta chrysoptera* | Varied Sittella | | x | | | | | x | | | |
| **Pachycephalidae** | | | | | | | | | | | |
| Crested Shrike-tit, Crested Bellbird, Shrike Thrushes, Whistlers | | | | | | | | | | | |
| *Colluricincla harmonica* | Grey Shrike-thrush | | x | x | x | x | x | x | x | x | |
| *Oreoica gutturalis pallescens* | Crested Bellbird (central/northern) | | x | x | x | x | x | x | x | | |
| *Pachycephala refiventris* | Rufous Whistler | | x | x | x | x | x | x | x | x | |
| **Dicruridae** | | | | | | | | | | | |
| Monarchs, Magpie Lark, Flycatchers, Fantails, Drongo | | | | | | | | | | | |
| *Grallina cyanoleuca* | Magpie-lark | | x | x | x | x | x | x | x | x | |
| *Rhipidura leucophrys* | Willie Wagtail | | x | x | x | x | x | x | x | x | |
| **Campephagidae** | | | | | | | | | | | |
| Cuckoo-shrikes, Trillers | | | | | | | | | | | |
| *Coracina maxima* | Ground Cuckoo-shrike | | x | | x | x | x | x | x | x | |
| *Coracina novaehollandiae* | Black-faced Cuckoo-shrike | | x | x | | x | x | x | x | x | |
| *Lalage tricolor* | White-winged Triller | | | | x | x | x | | x | | |
| **Artamidae** | | | | | | | | | | | |
| Woodswallows, Butcherbirds, Currawongs | | | | | | | | | | | |
| *Artamus Cinereus* | Black-faced Woodswallow | | x | x | | x | x | x | x | x | |
| *Artamus minor* | Little Woodswallow | | x | | | x | | | | | |
| *Artamus personatus* | Masked Woodswallow | | x | | x | x | x | x | x | x | |
| **Cracticidae** | | | | | | | | | | | |
| Currawongs, Magpies & Butcherbirds | | | | | | | | | | | |
| *Cracticus nigrogularis* | Pied Butcherbird | | x | x | x | x | x | x | x | x | |
| *Cracticus tibicen* | Australian Magpie | | x | x | x | x | x | x | x | x | |
| *Cracticus torquatus* | Grey Butcherbird | | | x | x | x | x | x | x | x | |
| *Strepera versicolor* | Grey Currawong | | | x | x | | x | x | x | x | |
| **Corvidae** | | | | | | | | | | | |
| Ravens, Crows | | | | | | | | | | | |
| *Corvus bennetti* | Little Crow | | x | x | x | x | | x | x | x | |
| *Corvus orru* | Torresian Crow | | x | x | x | x | x | | | x | |
| **Ptilonorhynchidae** | | | | | | | | | | | |
| Bowerbirds | | | | | | | | | | | |
| *Ptilonorhynchus maculatus* | Western Bowerbird | | x | | | x | | | | | |
| **Motacillidae** | | | | | | | | | | | |
| Old World Pipits, Wagtails | | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| *Anthus autralis* | Australian Pipit | | | x | x | x | x | x | x | | |
| **Estrilidae** | | | | | | | | | | | |
| Grass finches and manikins | | | | | | | | | | | |
| *Taeniopygia guttata* | Zebra Finch | | x | x | x | x | x | x | x | x | |
| **Dicaeidae** | | | | | | | | | | | |
| Flowerpeckers | | | | | | | | | | | |
| *Dicaeum hirundinaceum* | Mistletoebird | | | | | x | x | x | x | | |
| **Hirundinidae** | | | | | | | | | | | |
| Swallows and martins | | | | | | | | | | | |
| *Cheramoeca leucosternus* | White-backed Swallow | | | x | | x | | x | x | | |
| *Hirundo ariel* | Fairy Martin | | x | | | | | | | | |
| *Hirundo neoxena* | Welcome Swallow | | | | | x | | | | | |
| *Hirundo nigricans* | Tree Martin | | x | | | x | | x | x | | |
| **Sylviidae** | | | | | | | | | | | |
| Old World Warblers | | | | | | | | | | | |
| *Cincloramphus cruralis* | Brown Songlark | | | x | x | | | | x | | |
| *Cincloramphus mathewsi* | Rufous Songlark | | x | | | | | | x | | |
| **Mammalia** | | | | | | | | | | | |
| **Tachyglossidae** | | | | | | | | | | | |
| Echidnas | | | | | | | | | | | |
| *Tachyglossus aculeatus* | Echidna | | x | | | | x | x | x | | |
| **Nororyctemorphia** | | | | | | | | | | | |
| *Marsupial moles* | | | | | | | | | | | |
| *Notoryctes typhlops* | Southern Marsupial Mole (Itjaritjari) | **S1 EN** | | | | | | | | x | x |
| **Dasyuridae** | | | | | | | | | | | |
| Carnivorous marsupials | | | | | | | | | | | |
| *Antechinomys laniger* | Kultarr | | | | | x | | | | | |
| *Dasycercus blythi* | Brush-tailed Mulgara | **P4** | | | | | | | | x | |
| *Ningaui ridei* | Wongai Ningaui | | x | | | | | | x | x | |
| *Ningaui yvonneae* | Southern Ningaui | | | | | | | x | | | |
| *Pseudantechinus macdonnellensis* | Fat-tailed Pseudantechinus | | | | | | | | | x | |
| *Sminthopsis crassicaudata* | Fat-tailed Dunnart | | | | | | | x | x | | |
| *Sminthopsis dolichura* | Little long-tailed Dunnart | | | | x | x | | x | | x | |
| *Sminthopsis hirtipes* | Hairy-footed Dunnart | | x | | | x | | x | x | x | |
| *Sminthopsis macroura* | Stripe-faced Dunnart | | | | x | x | | | x | x | |
| *Sminthopsis ooldea* | Ooldea Dunnart | | | | | | | x | x | x | |
| *Sminthopsis psammophila* | Sandhill Dunnart | **S1 EN** | | | | | | x | x | | x |
| **Burramyidae** | | | | | | | | | | | |
| Pygmy Possums | | | | | | | | | | | |

| Class | Common Name | Status | Rap 2015* | HW 2014 | KLA 2012 | TE 2011 | HW 2011 | Eco 2009 | Hall 1994 | DPaW | EPBC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cercartetus Concinnus* | Wester Pygmy-posum | | | | | | | | | x | |
| **Macropodidae** | | | | | | | | | | | |
| Kangaroos, Wallabies | | | | | | | | | | | |
| *Macropus fuliginosus* | Western Grey Kangaroo | | x | x | | | | x | | | |
| *Macropus robustus* | Euro | | x | x | | x | x | x | x | | |
| *Macropus rufus* | Red Kangaroo | | x | | x | | x | x | x | | |
| **Emballonuridae** | | | | | | | | | | | |
| Sheath-tailed bats | | | | | | | | | | | |
| *Taphozous hilli* | Hill's Sheathtail-bat | | | | | | | x | | | |
| **Molossidae** | | | | | | | | | | | |
| Freetail bats | | | | | | | | | | | |
| *Mormopterus planiceps* | Inland Freetail-bat | | | | x | x | | x | x | | |
| *Tadarida australis* | White-striped Freetail-bat | | | x | x | | x | x | x | | |
| **Vespertilionidae** | | | | | | | | | | | |
| Ordinary bats | | | | | | | | | | | |
| *Chalinolobus gouldii* | Gould's Wattled Bat | | x (SM2) | | x | x | | x | x | | |
| *Nyctophilus geoffroyi* | Lesser Long-eared Bat | | | | | | | x | x | | |
| *Scotorepens balstoni* | Inland Broad-nosed Bat | | x (SM2) | | x | x | | x | x | | |
| *Vespadelus baverstocki* | Inland Forest Bat | | | | | | x | | | | |
| *Vespadelus finlaysoni* | Finlayson's Cave Bat | | x (SM2) | | x | x | | x | | | |
| **Muridae** | | | | | | | | | | | |
| Rats and mice | | | | | | | | | | | |
| *Mus musculus* | House Mouse | Introduced | x | | x | x | | x | x | x | x |
| *Notomys alexis* | Spinifex Hopping-mouse | | x (tracks) | | x | x | | x | x | x | |
| *Pseudomys desertor* | Desert Mouse | | | | x | | | x | | x | |
| *Pseudomys hermannsburgensis* | Sandy Inland Mouse | | x | | x | x | | x | x | x | |
| **Canidae** | | | | | | | | | | | |
| Dogs and foxes | | | | | | | | | | | |
| *Canis lupus dingo* | Dingo | | x (tracks) | | | | x | x | | | |
| *Vulpes vulpes* | Red Fox | Introduced | | x | | | x | x | x | | x |
| **Felidae** | | | | | | | | | | | |
| Cats | | | | | | | | | | | |
| *Felis catus* | Cat | Introduced | x | x | x | x | | x | x | | x |
| **Equidae** | | | | | | | | | | | |
| Horses | | | | | | | | | | | |
| *Equus caballus* | Horse | Introduced | | | | | | | | x | |
| **Bovidae** | | | | | | | | | | | |
| Horned ruminants | | | | | | | | | | | |
| *Bos taurus* | European Cattle | Introduced | x | | x | | x | | | | |
| *Capra hircus* | Goat | Introduced | | x | | | | | | | |

| Class | Common Name | Status | Rap 2015* | HW 2014 | KLA 2012 | TE 2011 | HW 2011 | Eco 2009 | Hall 1994 | DPaW | EPBC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Camelidae** | | | | | | | | | | | |
| Camels | | | | | | | | | | | |
| *Camelus dromedarius* | Camel | **Introduced** | **x** | **x** | | | **x** | **x** | **x** | | **x** |
| **Leporidae** | | | | | | | | | | | |
| Rabbits and hares | | | | | | | | | | | |
| *Oryctolagus cuniculus* | Rabbit | **Introduced** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |

# Appendix II Bat Call Analysis Results

# Bat call identification

# from the Great Victoria Desert, WA

| | |
|---|---|
| Type: | Acoustic analysis |
| Prepared for: | Rapallo Pty Ltd |
| Date: | 18 December 2014 |
| Job No.: | SZ362 |
| Prepared by: | Kyle Armstrong and Yuki Konishi<br>Specialised Zoological<br>ABN 92 265 437 422<br>Tel 0404 423 264<br>kyle.n.armstrong@gmail.com<br>http://www.szool.com.au |

**SUMMARY**

Bat identifications from acoustic recordings are provided from the Great Victoria Desert, c. three hours north-east of Laverton, Western Australia. At least four species of bat were identified as being present (**Tables 1** and **2**). Representative echolocation calls are provided (**Figure 1**), as recommended by the Australasian Bat Society (ABS 2006). Further data are available should verification be required.

**COMMENTS ON IDENTIFICATIONS**

The identification of bat species from full spectrum WAV format recordings of their echolocation calls was based on measurements of characteristic frequency, pulse shape, and the pattern of harmonics.

The calls of long-eared bats *Nyctophilus* spp. are typically difficult to identify to species, and those recorded may be attributed to either the lesser long-eared bat *Nyctophilus geoffroyi,* or the central long-eared bat *Nyctophilus major tor*.

**METHODS**

Data recorded in full spectrum lossless WAC0 format with a Wildlife Acoustics SM2BAT bat detector (sampling rate 384 kHz, trigger 6 dB above background; 48 dB gain; set to turn on automatically at sunset and off at sunrise) was converted to high quality bitstream WAV format using Kaleidoscope 2.0.4 software.

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong and Aplin 2014) was then applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.7.6 (Binary Acoustic Technology), which also provides measurements (in "SonoBat™ compatible output") from each putative bat pulse. The output was then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language script that performed three tasks: 1. undertook a Discriminant Function Analysis on training data from representative calls from Western Australia; 2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over confidence regions for the defined call types; and 3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition CS6 version 5.0.2.

Species were identified based on information in Fullard et al. (1991) and Churchill (2008), and nomenclature follows Van Dyck et al. (2013).

## REFERENCES


ABS (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australasian Bat Society Newsletter* 27: 6–9. [ISSN 1448-5877]

Churchill, S.K. (2008). *Australian bats.* 2nd ed. Allen and Unwin, Crows Nest, NSW.

Fullard, J.H., Koehler, C., Surlykke, A. and McKenzie, N.L. (1991). Echolocation ecology and flight morphology of insectivorous bats (Chiroptera) in south-western Australia. *Australian Journal of Zoology* 39: 427–438.

Van Dyck, S., Gynther, I. and Baker, A. (eds.) (2013). *Field companion to the Mammals of Australia*. New Holland, London.


**TABLE 1.** Species identified in the present survey from all sites combined.

| | |
|---|---|
| **VESPERTILIONIDAE** | |
| Gould's wattled bat | *Chalinolobus gouldii* |
| Inland broad-nosed bat | *Scotorepens balstoni* |
| Finlayson's cave bat | *Vespadelus finlaysoni* |
| ***Ambiguous*** | |
| Lesser long-eared bat / ***and/or*** Central long-eared bat | *Nyctophilus geoffroyi* / *Nyctophilus major tor* |

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

| Date | *C. gouldii* | *Nyctophilus* sp. | *S. balstoni* | *V. finlaysoni* |
|---|---|---|---|---|
| 6/11/2014 | ◆ | NC | ◆ | ◆ |
| 7/11/2014 | ◆ | — | — | ◆ |
| 8/11/2014 | ◆ | NC | ◆ | ◆ |

**Definition of confidence level codes:**

— Not detected.

◆ Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.

**NC Needs Confirmation**. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

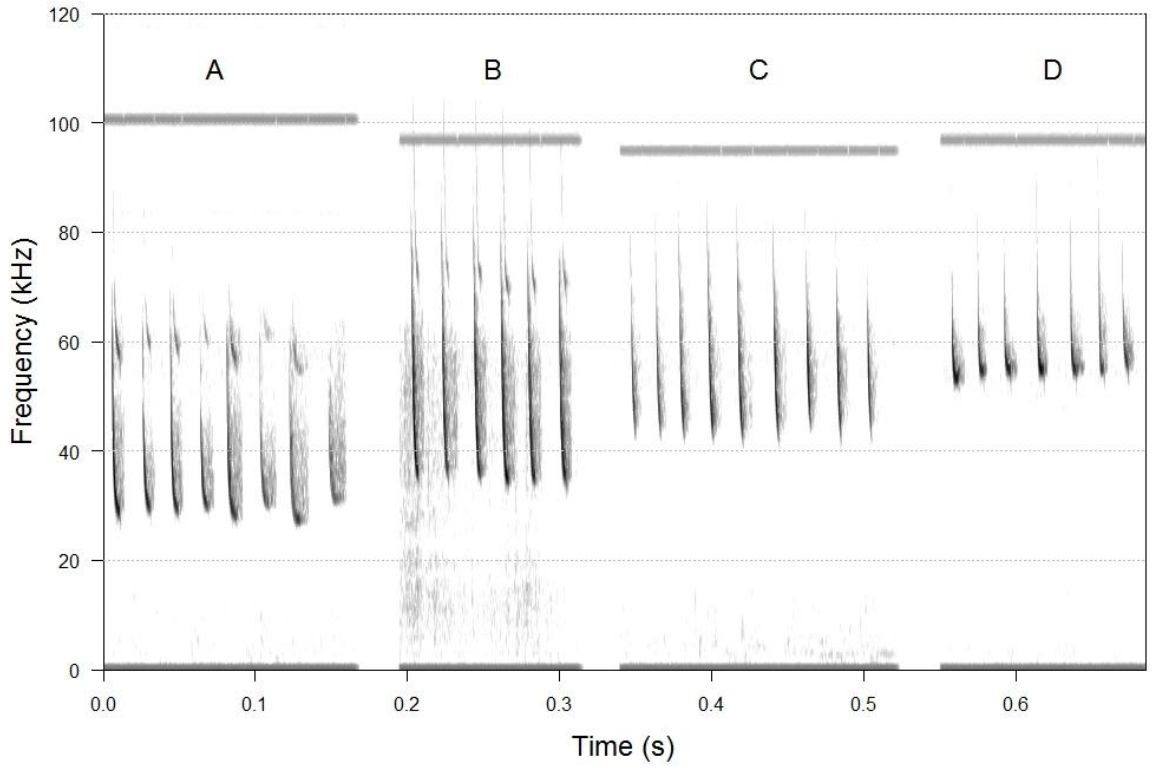


**FIGURE 1**. Representative call sequence portions of the species identified (time is compressed between pulses; **A**: *C. gouldii*; **B**: *S. balstoni*; **C**: *Nyctophilus* sp.; **D**: *V. finlaysoni*).

# Appendix III SRE Identification Reports

ScorpionID

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# TAXONOMIC REPORT FOR INVERTEBRATES SURVEYED FROM YAMARNA STATION

**Prepared for Rapallo**

The contents of 18 samples of invertebrates from Yamarna Station were identified to species and assessed for short-range endemism. Of these, 16 contained scorpions belonging to four species and two contained pseudoscorpions belonging to one species. Two species are widespread: the scorpion *Lychas* 'adonis' and an undescribed pseudoscorpion belonging to the genus *Indolpium*. Three scorpion morphospecies are considered potential SRE's: *Lychas* 'GVD' (a new species), *Lychas* 'multipunctatus complex' and *Urodacus* 'yaschenkoi complex'.

| | |
|---|---|
| Author: | Dr Erich S. Volschenk |
| Date: | 22 April 2015 |
| Submitted to | Kate George |
| Report ID: | 15-02 |
| Version | 2 |

## SCOPE OF WORK

In April, 2015, Rapallo submitted a collection of 18 samples (16 scorpion samples and two pseudoscorpion samples) from Yamarna Station in the Great Victoria Desert. The following services were requested:

- taxonomic identifications of samples;
- SRE assessment of these species; and
- Labelling and lodgement of these samples in the WAM (Western Australian Museum) Arachnology collection.

## BACKGROUND AND METHODS

The methods used to make species identifications and assess SRE categories closely follow those used by the WAM. A more detailed description of the methods and principals used to assess SRE categories are detailed in Appendix 1.

## RESULTS

The collection contained four scorpion species and one pseudoscorpion species. Two species were widespread and three species were potential SRE's (Table 1).

**Table 1. List of species present**

| Order | Family | Species | SRE category |
|---|---|---|---|
| Scorpiones | Buthidae | *Lychas* 'adonis' | widespread |
| | | *Lychas* 'GVD' | potential |
| | | *Lychas* 'multipunctatus complex' | potential |
| | Urodacidae | *Urodacus* 'yaschenkoi complex' | potential |
| Pseudoscorpiones | Olpiidae | *Indolpium* sp. indet. | widespread |

The complete record of the specimens identified is presented in Appendix 2

## DISCUSSION

Three potential SRE species and two widespread species were present in this collection. These species and the justification for these rankings is given below:

- ***Lychas* 'GVD'** represents a new species and is only known from the specimens in this collection. This species is considered to be a potential SRE owing to its close relationship to the *Lychas* 'annulatus complex' which is known to contain SRE species (unpublished data). The absence of this species from previous surveys of the Great Victoria Desert is further evidence that it is could be an SRE.
- ***Lychas* 'multipunctatus complex'** represents a widespread group of scorpions in WA; however, recent studies on this group indicate the presence of several cryptic species in the Pilbara some of which appear to be SRE's (unpublished data). The specimens recorded from this study represent its most southerly records for the group. This species is therefore considered to be a potential SRE.

- ***Urodacus* 'yaschenkoi complex'** cannot be clearly identified on the basis of its morphology as the specimen is a female. This specimen is here considered to be a potential SRE because there is a precedent for other representatives of the genus *Urodacus* to be SRE (*Urodacus mckenziei*, *Urodacus planimanus*, *Urodacus koolanensis*) and including at least one morphospecies from the *U*. 'yaschenkoi complex'.
- ***Indolpium* sp. indet.** represents an undescribed species of pseudoscorpion from the family Olpiidae. The taxonomy of this genus is very poorly resolved; however, all of the putative species from arid Western Australia appear to have widespread distributions and are not considered to be SRE's.

# APPENDIX 1. BACKGROUND AND METHODS

## SHORT-RANGE ENDEMISM

Short-range endemics are organisms with small geographic distributions (Harvey 2002; Ponder and Colgan 2002), nominally less than 10,000 km$^2$ (Harvey 2002). These organisms are typically characterised by one or more of the following characteristics:

- limited dispersal capabilities,
- seasonal activity (cooler or wetter periods),
- slow growth, and
- low levels of fecundity.

Isolating mechanisms are typically inhospitable habitat such as rivers, rocky ridges or plains that act to prevent dispersal (gene flow) between populations. Two types of short-range endemism have been recognised: Relictual Endemism and Habitat Specialist Endemism (Harvey 2002; Ponder and Colgan 2002).

**Relictual SREs** result when speciation occurs following the fragmentation of continuous habitat into two or more refugia. In Australia, the primary driver of this over the last 65 million years has been aridification, which acted to isolate formerly widespread species living in mesic forests to small patches of mesic refugia. Relictual SREs include scorpions in the genus *Aops* (Volschenk and Prendini 2008), pseudoscorpions in the genera *Tyrannochthonius* (Edward and Harvey 2008; Harvey 1991), *Indohya* (Harvey 1993b; Harvey and Volschenk 2007) and *Idioblothrus* (Harvey 1993a; Harvey and Leng 2008; Muchmore 1982) and millipedes in the genus *Antichiropus* (Car and Harvey 2014; Car *et al.* 2013). Troglobites are thought to be extreme examples of relictual SREs; most troglobites from the Pilbara have surface dwelling relatives living in the more mesic forests of northern Australia (Harvey 2002; Ponder and Colgan 2002).

**Habitat specialist SREs** are species that have adapted to very specific environment types, including those found in arid environments (e.g. rocky outcrops or isolated dune systems). Such habitats are often relatively young (<10 million years) and therefore are not refugial. Examples of habitat specialist SREs include spiders in the family Selenopidae and pseudoscorpions in the genera *Synsphyronus* (Harvey 2011, 2012) and *Feaella* (Harvey 1989; Harvey and Volschenk 2007).

### DEFINING SHORT-RANGE ENDEMISM

Assessment of short-range endemism can be challenging when data for evaluation are absent or limited. Limitations may include any of the following:

- **Poor survey coverage,** e.g. the fauna of an area has not been sampled extensively enough to enable assessment of species distributions. The absence of a species from survey records may not mean that it is absent from the area.
- **Poor taxonomic resolution,** e.g. a species has not been subject to systematic investigation, and/or the identity is either difficult or impossible to determine. Good taxonomic resolution does not necessarily need to be in the form of published revisions, as it can be facilitated by any of the following:
  - a researcher actively working on the group who can authorise identifications,
  - a publically accessible reference collection, and/or;
  - assessment of species boundaries using genomic methods such as DNA barcoding (Hebert *et al.* 2003a; Hebert *et al.* 2003b).
- **Identification issues**, e.g. surveys sampled life stages of potential SREs that are impossible to identify on the basis of morphological characters. Examples of relevant taxa include juvenile or female millipedes, mygalomorph spiders and *Urodacus* scorpions. Genomic methods have great potential to overcome this type of limitation.

There are no published systems for assessing the SRE potential for a species. Given this, ScorpionID employs the three categories used by the WA Museum to assess SRE-status of invertebrates (Western Australian Museum 2013):

- **Confirmed SRE:** This category applies when the identity of the taxon is unambiguous and its distribution is less than 10 000km$^2$ based on publically available vouchered records. Supporting data can be either genomic (from DNA sequences) or morphological, ideally both.
- **Potential SRE:** This category applies to situations where there are knowledge gaps for the taxon. The following sub-categories further elucidate this status:
  - **Data Deficiency:** This category covers taxa for which there is insufficient data available to determine SRE status. Factors that fall under this category include:
    - insufficient geographic information,
    - insufficient taxonomic information, and/or
    - inappropriate life stages prevent identification to species level.
  - **Habitat Indicators:** This category employs habitat characteristics to evaluate SRE status when particular habitats are known to support SRE taxa. For example, many species sampled from subterranean habitats are known to be range restricted; a new species discovered from such habitat therefore has greater potential to be range restricted (i.e. a SRE) than widespread.
  - **Morphological Evidence:** This category uses one or more morphological characters that are characteristic of SRE taxa inhabiting restricted environments, e.g. the specialised morphological features of animals adapted to subterranean habitats, including body markings that are absent or significantly paler than surface dwelling relatives, eyes that are absent or significantly reduced, and/or longer appendages (legs and antennae) than surface relatives.
  - **Unpublished Research & Expertise:** This category relies on unpublished research or expertise to develop SRE status.

  These categories of categories of potential SRE may be helpful in developing conservation priorities, however, each taxon should be assessed on its merit and in accordance with the *Precautionary Principle* (EPA 2002):

  > "*where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation*" (EPA 2002).

- **Widespread (not an SRE)**: This category applies when vouchered evidence demonstrates a distribution greater than 10,000 km$^2$.

## TAXONOMY

The taxonomic nomenclature of invertebrates follows the references detailed in Table 2. Morphospecies designations follow the parataxonomy of the scientist(s) working on the group; these informal names are written between single quotation marks rather than being italicised as they are not valid under the International Code of Zoological Nomenclature (1999).

**Table 2. Nomenclatural references, morphospecies designations and reference collections used to determine scorpion and pseudoscorpion species**

| Order | Taxonomic reference | Morphospecies and reference collection |
|---|---|---|
| Pseudoscorpiones | Harvey 1992; Harvey 2012, 2013; Murienne *et al.* 2008 | Reference collection and "PSE"-morphospecies codes of the WA Museum. |
| Scorpiones | Fet *et al.* 2000; Glauert 1925; Koch 1977; Kovařík 1997; Kovařík 2002; Volschenk 2008; Volschenk *et al.* 2010; Volschenk *et al.* 2012; Volschenk and Prendini 2008; Volschenk *et al.* 2000) | Reference collection at the WA Museum. Morphospecies designation by the author. |

Phylogenetic Species Concept (Cracraft 1983) is used for delineating morphospecies:

> "A species is the smallest diagnosable cluster of individual organisms within which there is a parental pattern of ancestry and descent."

## IDENTIFICATION

Unless otherwise stated, species identifications were carried out by the author. The references used for species determination are summarised in Table 2.

## SPECIMEN LODGEMENT

In accordance with EPA Guidance Statement 20 (2009), all specimens submitted to ScorpionID for taxonomic identification are lodged with the WA Museum.

# REFERENCES

References

Car, C.A. and Harvey, M.S. (2014). The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 2: species of the Great Western Woodlands region of Western Australia. *Records of the Western Australian Museum* **29**, 20–77.

Car, C.A., Wojcieszek, J.M. and Harvey, M.S. (2013). The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 1: redefinition of the genus and redescriptions of existing species. *Records of the Western Australian Museum* **28**, 83–118.

Cracraft, J. (1983). Species concepts and speciation analysis. In 'Current Ornithology'. (Johnston, R. F. *Ed*.). Vol. 1, 159-187. (Plennum Press: New York and London.)

Edward, K.L. and Harvey, M.S. (2008). Short-range endemism in hypogean environments: the pseudoscorpion genera *Tyrannochthonius* and *Lagynochthonius* (Pseudoscorpiones: Chthoniidae) in the semiarid zone of Western Australia. *Invertebrate Systematics* **22**, 259-293.

EPA (2002). Position Statement no. 3. Terrestrial biological surveys as an element of biodiversity protection. (Environmental Protection Authority: Perth, WA.).

EPA (2009). Guidance Statement No 20: Sampling of Short Range Endemic Invertebrate Fauna fpr Environmental Impact Assessment in Western Australia. (Environmental Protection Authority: Perth.) **20**, 1-31.

Fet, V., Sissom, W.D., Lowe, G. and Braunwalder, M.E., *Eds*. (2000). 'Catalogue of the scorpions of the world (1758–1998). New York Entomological Society: New York.

Glauert, L. (1925). Australian Scorpionidea. Part 1. *Journal of the Royal Society of Western Australia* **11**, 89-118.

Harvey, M. (2002). Short-range endemism among the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* **16**, 555-570.

Harvey, M., S. (1992). The phylogeny and classification of the pseudoscorpionida (Chelicerata: Arachnida). *Invertebrate Taxonomy* **6**(6), 1373-1435.

Harvey, M., S. (1993a). The systematics of the Hyidae (Pseudoscorpionida: Neobisioidea). *Invertebrate Taxonomy* **7**(1), 1-32.

Harvey, M.S. (1989). A new species of *Feaella* Ellingsen from north-western Australia (Pseudoscorpionida: Feaellidae). *Bulletin of the British Arachnological Society* **8**, 41-44.

Harvey, M.S. (1991). The cavernicolous pseudoscorpions (Chelicerata: Pseudoscorpionida) of Cape Range, Western Australia. *Records of the Western Australian Museum* **15**, 487-502.

Harvey, M.S. (1993b). The systematics of the Hyidae (Pseudoscorpionida: Neobisioidea). *Invertebrate Taxonomy* **7**(1), 1-32.

Harvey, M.S. (2011). Two new species of *Synsphyronus* (Pseudoscorpiones: Garypidae) from southern Western Australian granite landforms. *Records of the Western Australian Museum* **26**, 11–22.

Harvey, M.S. (2012). A new species of *Synsphyronus* (Pseudoscorpiones: Garypidae) from Western Australia. *Records of the Western Australian Museum* **27**, 55–61.

Harvey, M.S. (2013). Pseudoscorpions of the World, version 3.0. (Western Australian Museum: Perth, WA.).

Harvey, M.S. and Leng, M.C. (2008). Further observations on *Ideoblothrus* (Pseudoscorpiones: Syarinidae) from subterranean environments in Australia *Records of the Western Australian Museum* **24**, 381–386.

Harvey, M.S. and Volschenk, E.S. (2007). Systematics of the Gondwanan pseudoscorpion family Hyidae (Pseudoscorpiones: Neobisioidea); new data and a revised phylogenetic hypothesis. *Invertebrate Systematics* **21**, 365–406.

Hebert, P.D.N., A., C., Ball, S.L. and de Waard, J.R. (2003a). Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London (B)* **270**, 313-321.

Hebert, P.D.N., Ratnasingham, S. and de Waard, J.R. (2003b). Barcoding animal life: Cytochrome c oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society London B, Supplement* **270**, 96–99.

International Commission on Zoological Nomenclature (1999). 'International code of zoological nomenclature'. (International Trust for Zoological Nomenclature: London.)

Koch, L.E. (1977). The taxonomy, geographic distribution and evolutionary radiation of Australo-Papuan scorpions. *Records of the Western Australian Museum* **5**, 83-367.

Kovařík, F. (1997). Revision of the genera *Lychas* and *Hemilychas*, with descriptions of six new species (Scorpiones: Buthidae). *Acta Societatis Zoologicae Bohemoslovacae* **61**(4), 311-371.

Kovařík, F. (2002). The provenance of Lychas buchari (Scorpiones: Buthidae). *Acta Societatis Zoologicae Bohemicae* **66**(4), 291-292.

Muchmore, W.B. (1982). The Genera Ideobisium and Ideoblothrus with Remarks on the Family Syarinidae Pseudoscorpionida. *Journal of Arachnology* **10**(3), 193-222.

Murienne, J., Harvey, M.S. and Giribet, G. (2008). First molecular phylogeny of the major clades of Pseudoscorpiones (Arthropoda: Chelicerata). *Molecular Phylogenetics and Evolution* **49**, 170–184.

Ponder, W.F. and Colgan, D.J. (2002). What makes a narrow-range taxon? Insights from Australian freshwater snails. *Invertebrate Systematics* **16**, 571–582.

Volschenk, E.S., Burbidge, A.H., Durrant, B.J. and Harvey, M.S. (2010). Spatial distribution patterns of scorpions (Scorpiones) in the arid Pilbara region of Western Australia. *Records of the Western Australian Museum, Supplement* **78**, 271–284.

Volschenk, E.S., Harvey, M.S. and Prendini, L. (2012). A new species of *Urodacus* (Scorpiones: Urodacidae) from Western Australia. *American Museum Novitates* **3748**, 1–18.

Volschenk, E.S. and Prendini, L. (2008). *Aops oncodactylus*, gen. et sp. nov., the first troglobitic urodacid (Urodacidae: Scorpiones), with a re-assessment of cavernicolous, troglobitic and troglomorphic scorpions. *Invertebrate Systematics* **22**, 235–257.

Volschenk, E.S., Prendini, L. (2008). Aops oncodactylus, gen. et sp. nov., the first troglobitic urodacid (Urodacidae: Scorpiones), with a re-assessment of cavernicolous, troglobitic and troglomorphic scorpions. *Invertebrate Systematics* **22**, 235-257.

Volschenk, E.S., Smith, G.T. and Harvey, M.S. (2000). A new species of *Urodacus* from Western Australia, with additional descriptive notes for *Urodacus megamastigus* (Scorpiones). *Records of the Western Australian Museum* **20**(1), 57-67.

Western Australian Museum (2013). WAM short-range endemic categories. (Western Australian Museum: Welshpool, WA.).

# APPENDIX 2. LIST OF SPECIMENS IDENTIFIED FROM YAMARNA STATION

| Species | Site code | Latitude (South) | Longitude (East) | Habitat | Males | Females | Juveniles | Total |
|---|---|---|---|---|---|---|---|---|
| *Indolpium* sp. Indet. | Granite forage | 28°01'22.44 | 123°52'28.56 | litter on granite outcrop | 1 | | | **1** |
| *Indolpium* sp. Indet. | Hakea litter | 27°58'48 | 123°52'42.6 | Hakea litter | | 1 | | **1** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | 2 | | | **2** |
| *Lychas* 'adonis' | site 2 | 28°28'40.44 | 123°50'30.12 | Sand Plain (Red) | | | 1 | **1** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | | 1 | | **1** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | 7 | | | **7** |
| *Lychas* 'adonis' | site 3 | 28°02'13.56 | 123°50'43.68 | Clay-loam plain (Mulga)-Sandplain Ecotone | 1 | | | **1** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | | | 1 | **1** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | | 1 | | **1** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | 1 | | | **1** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | 4 | | | **4** |
| *Lychas* 'adonis' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | 1 | | | **1** |
| *Lychas* 'GVD' | site 2 | 28°28'40.44 | 123°50'30.12 | Sand Ridge (Red) | 1 | | | **1** |
| *Lychas* 'GVD' | site 4 | 28°02'04.2 | 123°52'48.36 | Clay Loam Plain (Mulga) | | 1 | | **1** |
| *Lychas* 'multipunctatus complex' | site 1 | 27°58'38.72 | 123°50'24 | Sand Ridge (Red) | 1 | | | **1** |
| *Lychas* 'multipunctatus complex' | site 2 | 28°28'40.44 | 123°50'30.12 | Sand Plain (Red) | | | 1 | **1** |
| *Lychas* 'multipunctatus complex' | site 2 | 28°28'40.44 | 123°50'30.12 | Sand Plain (Red) | | | 1 | **1** |
| *Urodacus* 'yaschenkoi complex' | site 3 | 28°02'13.56 | 123°50'43.68 | Clay-loam plain (Mulga)-Sandplain Ecotone | | 1 | | **1** |

PHOENIX
ENVIRONMENTAL SCIENCES

# Identification and assessment of short-range endemism of invertebrates from Yamarna Station, Western Australia

**Prepared for Rapallo Ltd**

**April 2015**

**Taxonomic Report**

# Identification and assessment of short-range endemism of invertebrates from Yamarna Station, Western Australia

Prepared for Rapallo Ltd

Taxonomic Report

Authors: Volker Framenau

Date: 16 April 2015

Submitted to: Kate George

| **Chain of authorship and review** | | | |
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| Name | Task | Version | Date |
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# 1 BACKGROUND

Short-range endemics (SREs) are organisms with a naturally narrow distribution range, in Western Australia environmental assessments nominally consider this to be less than 10,000 km$^2$ (EPA 2009; Harvey 2002). There are uncertainties in determining the range-restrictions of many invertebrates in Western Australia due to lack of surveys, lack of taxonomic resolutions within target taxa and problems in identifying certain life stages. The WA Museum has introduced a three-tier system to account for these uncertainties, confirmed and potential SREs in addition to widespread species (Western Australian Museum 2013).

# 2 SCOPE OF WORKS

In March 2015, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Rapallo Ltd to identify terrestrial invertebrates collected at Yamarna Station, Western Australia. A previous report on SREs from Yamarna Station (Phoenix 2014) was to be considered in the analysis.

# 3 METHODS

Specimens were identified by V.W. Framenau. Spider taxonomy followed the World Spider Catalog (2014). The WA Museum does currently not issue 'MYG'-numbers for species not present in their morphospecies collection (K. Abrams, email to V.W. Framenau, 27 March 2015). An interim morphological nomenclature based on the locality data is therefore used here.

# 4 RESULTS

The material submitted included three potential SREs and a widespread species (Table 4-1 and Table 4-2). None of the species is conspecific with those reported by Phoenix (2014).

**Table 4-1 Taxonomy and SRE categories of invertebrate species identified from Yamarna Station**

| Order | Family | Species | SRE Category (Western Australian Museum 2013) |
|---|---|---|---|
| Araneae (Mygalomorphae) | Barychelidae | *Synothele* sp. indet. | Potential |
| | Nemesiidae | *Aname* 'yamarna' | Potential |
| | | *Kwonkan* 'yamarna' | Potential |
| Araneae (Araneomorphae) | Miturgidae | *Miturga* 'BWI sp. 1' | Widespread |

Table 4-2 **Identification of SRE target invertebrates from Yamarna Station**

| Phoenix reg. no. | Client site no. | Family | Genus and species | ♂♂ | ♀♀ | Juv. | Total |
|---|---|---|---|---|---|---|---|
| 18356 | 4 | Nemesiidae | *Kwonkan* 'yamarna' | 1 | | | **1** |
| 18357 | 4 | Nemesiidae | *Kwonkan* 'yamarna' | 2 | | | **2** |
| 18358 | 4 | Miturgidae | *Miturga* 'BWI sp. 1' | 1 | | 1 | **1** |
| 18359 | 4 | Nemesiidae | *Kwonkan* 'yamarna' | 2 | | | **2** |
| 18360 | 3 | Barychelidae | *Synothele* sp. indet. | | | 1 | **1** |
| 18361 | 3 | Nemesiidae | *Aname* 'yamarna' | 1 | | | **1** |
| **Total:** | | | | **7** | | **1** | **8** |

## 4.1 *SYNOTHELE* SP. INDET. (FAMILY BARYCHELIDAE)

The genus *Synothele* can be identified by the low number of maxillary cuspules in combination with the lack of lyra (specialised clubbed setae) on the maxillae, and the often mottled abdomen (uniformly dark in the similar Aurecocrypta). The genus is widespread throughout Western (21 species) and South Australia (3 species) with most species known only from very limited ranges (Raven 1994). All unidentified specimens of *Synothele* should therefore be considered potential SREs.

The submitted specimen is a juvenile and species-level identification is not possible; it is here considered a potential SRE.

## 4.2 *ANAME* 'YAMARNA' (FAMILY NEMESIIDAE)

The genus *Aname* currently includes 37 named species (Framenau 2014) in Australia and is well represented by four named and numerous unnamed species from many different regions in Western Australia. *Aname* currently represent a highly diverse array of species of very small to large spiders. Males generally have a spur and spine on the first tibia of males opposing an often incrassate metatarsus. Members of the genus *Aname* are believed to be most common in sclerophyll forest, but are also known from rainforests and deserts (Raven 1981). *Aname* regularly belongs to the most diverse mygalomorph genera in biological spider surveys and with 12 species the Pilbara survey (Durrant *et al.* 2010) resulted in a similar number as found during the Carnarvon Basin survey (13 species) (Main *et al.* 2000). However, recent molecular studies suggest that the number of species in the Pilbara is much higher than previously anticipated (Castalanelli *et al.* 2014). Many *Aname* species appear to have restricted distributions as shown by two studies from northern Australia, including the Pilbara (Harvey *et al.* 2012; Raven 1985). Therefore, unidentifiable specimens are considered potential SREs.

A male *Aname* could not be matched to a species represented in the WA Museum reference collection. It is here given the provisionary designation 'yamarna' and based on distribution patterns in Aname considered a potential SRE.

## 4.3 *KWONKAN* 'YAMARNA' (FAMILY NEMESIIDAE)

Generic boundaries between *Yilgarnia* and *Kwonkan* remain uncertain as some species have the characteristics of both genera, i.e. cuspules on coxae III and IV (*Yilgarnia*) and tarsal spines (*Kwonkan*). This intermittent group was listed as "*Kwonkan*/*Yilgarnia*" in the WAM/DEC Carnarvon survey, where three species were recovered at a variety of sites (Main *et al.* 2000). The genus *Kwonkan* is restricted to Western Australia and currently includes six named species (Main 1977; Main 1983). All of these are currently known from their type specimens only. *Kwonkan eboracum* from the York region is listed on Schedule 1 of the WA Act (Western Australian Government 2014).

Five male *Kwonkan* could not be matched to a species represented in the WA Museum reference collection. The species is here given the provisionary designation 'yamarna' and based on distribution patterns in *Kwonkan* considered a potential SRE.

## 4.4 MITURGA 'BWI SP. 1' (FAMILY MITURGIDAE)

Members of the family Miturgidae, the false wolf spiders or prowling spiders, are generally widespread and not considered target groups for SRE survey. *Miturga* 'BWI sp. 1' is a widespread species in arid to semi-arid Western Australia (Phoenix unpublished data).

# 5 REFERENCES

Castalanelli, M. A., Teale, R., Rix, M. G., Kennington, J. & Harvey, M. S. 2014. Barcoding of mygalomorph spiders (Araneae: Mygalomorphae) in the Pilbara region of Western Australia *Invertebrate Systematics* **28**: 375–385.

Durrant, B. J., Harvey, M. S., Framenau, V. W., Ott, R. & Waldock, J. M. 2010. Patterns in the composition of ground-dwelling spider communities in the Pilbara bioregion, Western Australia. *Records of the Western Australian Museum, Supplement* **78**: 185–204.

EPA. 2009. *Guidance for the assessment of environmental factors (in accordance with the Environmental Protection Act 1986). Sampling of short range endemic invertebrate fauna for environmental impact assessment in Western Australia. No. 20*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/EPADocLib/2953_GS20SRE250509.pdf (accessed 7 September 2012).

Framenau, V. W. 2014. *Checklist of Australian spiders, version 1.30*. Australasian Arachnological Society. Available at: http://www.australasian-arachnology.org/download/checklist_australian_spiders.pdf (accessed 11 December 2014).

Harvey, F. S. B., Framenau, V. W., Wojcieszek, J. M., Rix, M. G. & Harvey, M. S. 2012. Molecular and morphological characterisation of new species in the trapdoor spider genus *Aname* (Araneae: Mygalomorphae: Nemesiidae) from the Pilbara bioregion of Western Australia. *Zootaxa* **3383**: 15–38.

Harvey, M. S. 2002. Short-range endemism among the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* **16**: 555–570.

Main, B. Y. 1977. Spiders. *In:* Kenneally, K. F. (ed.) *The natural history of the Wongan Hills. Handbook No.11.* West Australian Naturalist Club, Perth, WA, pp. 100–107.

Main, B. Y. 1983. Further studies on the systematics of Australian Diplurinae (Chelicerata: Mygalomorphae: Dipluridae): two new genera from southwestern Australia. *Journal of Natural History* **17**: 923–949.

Main, B. Y., Sampey, A. & West, P. L. J. 2000. Mygalomorph spiders of the southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum, Supplement* **61**: 281–293.

Phoenix. 2014. *Identification and assessment of short-range endemism of trapdoor spiders from Yamana [sic] Station, Western Australia*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for Botanica Consulting.

Raven, R. J. 1981. A review of the Australian genera of the mygalomorph spider subfamily Diplurinae (Dipluridae: Chelicerata). *Australian Journal of Zoology* **29**: 321–363.

Raven, R. J. 1985. A revision of the *Aname pallida* species-group in northern Australia (Anaminae: Nemesiidae: Araneae). *Australian Journal of Zoology* **33**: 377–409.

Raven, R. J. 1994. Mygalomorph spiders of the Barychelidae in Australia and the western Pacific. *Memoirs of the Queensland Museum* **35**: 291–706.

Western Australian Government. 2014. Wildlife Conservation Act 1950, Wildlife Conservation (Specially Protected Fauna) Notice 2014. *Western Australian Government Gazette* **188**: 4473–4481.

Western Australian Museum. 2013. *WAM short-range endemic categories*. Western Australian Museum, Welshpool, WA.

World Spider Catalog. 2014. *World Spider Catalog*. Natural History Museum Bern, Bern (Switzerland). Available at: http://wsc.nmbe.ch/ (accessed 26 August 2014).