Lake Wells Potash Project:

Level 2 Vertebrate Fauna Survey 2018

(Fauna pictured above, Great Desert Skink and Brush-tailed Mulgara)

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Executive Summary

Introduction

Australian Potash Limited are proposing to mine sulphate of potash at their Lake Wells Potash Project (the 'Project'). As part of the feasibility process, a Level 2 vertebrate fauna survey was undertaken in spring 2016 and autumn 2017 (Harewood 2017). Several gaps were identified in the coverage of the fauna survey, as it had been undertaken prior to the refinement of the project boundary. To fill these gaps, Australian Potash Limited commissioned Western Wildlife to carry out an additional vertebrate fauna survey in spring 2018.

The key objectives of the fauna survey were to:

- Identify and describe the fauna habitats present.
- List the vertebrate fauna that were recorded in and/or have the potential to occur.
- Identify species of conservation significance, or habitats of particular importance for fauna.

This report includes the findings of the fauna survey conducted in November/December 2018 and also summarises records from the previous fauna survey undertaken in 2016/2017 by Harewood (2017).

Methods

The fauna survey was undertaken in accordance with the *Statement of environmental principles, factors and objectives* (Environmental Protection Authority (EPA) 2016a), *Environmental factor guideline – terrestrial fauna* (EPA 2016b), *Technical guidance – terrestrial fauna surveys* (EPA 2016c), the *Technical Guide: terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA and DEC 2010) and relevant State and Federal Guidelines on surveying conservation significant fauna.

The field survey was carried out by four zoologists between the 23 November - 4 December 2018, and included:

- Identification and ground-truthing of fauna habitats.
- Trapping at nine sites for seven nights, each with ten pitfall traps (five buckets and five PVC pipe), five funnel traps, 20 Elliott traps and two cage traps to give a total of 630 pitfall trap-nights, 630 funnel trap-nights, 1,260 Elliott trap-nights and 126 cage trap-nights.
- Bird surveys.
- Bat surveys with acoustic detectors at 16 sites.
- Night Parrot survey with passive acoustic detectors at 12 sites.
- Camera trap survey at 32 sites, targeting conservation significant fauna.
- Spot-lighting.

- Targeted transects and searches for evidence of conservation significant species, such as burrows, tracks and scats.
- Keeping opportunistic records of fauna.

Species of conservation significance were classified as: **Threatened** if listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or *Biodiversity Conservation Act 2016* (BC Act); **Migratory** if listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened; **Specially Protected** if listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act; **Priority** if listed as Priority by DBCA and **Locally Significant** if considered by the author to potentially be of local significance.

Results and Discussion

Nine fauna habitats were identified in the Study Area:

- Salt lake (includes both vegetated areas and open playa)
- Claypans and clay-loam dunes
- Sand dunes
- Sandplain
- Mulga woodland
- Drainages
- Rocky hills
- Stony Plains

All of the habitats present are widespread in the region, and habitats of importance within the Study Area are those that support threatened species.

The faunal assemblage of the Study Area is likely to be diverse, though many of the species that occur are widely distributed through arid Australia. The predicted faunal assemblage includes up to ten frogs, 116 reptiles, 145 birds, 33 native mammals and nine introduced mammals. The observed assemblage thus far includes five frogs, 71 reptiles, 92 birds, 25 native mammals and eight introduced mammals. Twenty-five conservation significant fauna have been recorded or potentially occur in the Study Area, though at least one of these is considered likely to be locally extinct. The species have been grouped into their conservation significance categories and discussed below.

Threatened species

Seven threatened species potentially occur in the Study Area, of which a single species (in bold) was recorded:

- **Great Desert Skink (*Liopholis kintorei*) - EPBC Act (Vulnerable), BC Act (Vulnerable)**
- Malleefowl (*Leipoa ocellata*) - EPBC Act (Vulnerable), BC Act (Vulnerable)
- Grey Falcon (*Falco hypoleucos*) - BC Act (Vulnerable)
- Princess Parrot (*Polytelis alexandrae*) - EPBC Act (Vulnerable), DBCA Priority 4
- Night Parrot (*Pezoporus occidentalis*) - EPBC Act (Endangered), BC Act (Critically Endangered)

- Sandhill Dunnart (*Sminthopsis psammophila*) - EPBC Act (Endangered), BC Act (Endangered)
- Bilby (*Macrotis lagotis*) - EPBC Act (Vulnerable), BC Act (Vulnerable)

The Great Desert Skink was recorded on spinifex sandplain in the south of the Study Area. It appeared to be restricted to this area of relatively treeless plain and further searching in sandplain with a greater cover of mallee eucalypts failed to locate it. The record of this species is important as it is only the second in this part of its range in more than 40 years. As this species is terrestrial and lives in small groups, even the loss of a few individuals could cause a large impact on a local level.

The Night Parrot was not recorded during the survey. However, so little is known about this species in Western Australia, that it is difficult to state with any certainty the likelihood of it occurring, other than to say that the species is very rare and thus has a low likelihood of occurrence at any site. The Study Area has habitats that may support the Night Parrot, however, most are heavily impacted by feral herbivores or are recently burnt. The Sandhill Dunnart has recently been recorded 85km to the southwest of the Study Area. This species may possibly occur, though the available habitat is very patchy and it is currently unknown whether its distribution extends as far north as the Study Area. The Bilby may be a scarce resident, may only occur in years of high productivity or may be locally extinct. The one nearby record of this species is based on secondary evidence and is thus unconfirmed, and the Study Area is to the south of its current known range of the species.

Study Area is unlikely to provide important habitat for the Malleefowl, Grey Falcon or Princess Parrot. The Grey Falcon and Princess Parrot are not likely to breed in the Study Area, though they may forage on occasion. The Malleefowl appears to be locally extinct, though the Study Area is within its historical range.

Migratory species

Ten Migratory species potentially occur in the Study Area, of which a single species (in bold) has been recorded:

- Oriental Plover (*Charadrius veredus*) – EPBC Act (Migratory), BC Act (Migratory)
- Sharp-tailed Sandpiper (*Calidris acuminata*) – EPBC Act (Migratory), BC Act (Migratory)
- Red-necked Stint (*Calidris ruficollis*) – EPBC Act (Migratory), BC Act (Migratory)
- Pectoral Sandpiper (*Calidris melanotos*) – EPBC Act (Migratory), BC Act (Migratory)
- Wood Sandpiper (*Tringa glareola*) – EPBC Act (Migratory), BC Act (Migratory)
- Common Sandpiper (*Tringa hypoleucos*) – EPBC Act (Migratory), BC Act (Migratory)
- **Common Greenshank (*Tringa nebularia*) – EPBC Act (Migratory), BC Act (Migratory)**
- Marsh Sandpiper (*Tringa stagnatilis)* – EPBC Act (Migratory), BC Act (Migratory)
- Gull-billed Tern (*Sterna nilotica*) – EPBC Act (Migratory), BC Act (Migratory)
- Fork-tailed Swift (*Apus pacificus*) – EPBC Act (Migratory), BC Act (Migratory)

It is unlikely but unknown whether the Study Area provides important habitat for migratory shorebirds. Surveys for shorebirds would need to be undertaken during the summer months, (when the birds are present in Australia), and after sufficient rainfall has occurred to fill the claypans and lake playas to provide foraging habitat. Inland salt lakes are generally under surveyed as they are remote and inhospitable in summer, so there is also a lack of regional data for comparison. The Fork-tailed Swift is a Migratory species that is thought to be almost entirely aerial when visiting Australia, so the Study Area is not likely to provide important habitat for this species.

Specially Protected species

A single Specially Protected species potentially occurs in the Study Area:

- Peregrine Falcon (*Falco peregrinus*) – BC Act (Other Specially Protected species)

The Peregrine Falcon is likely to occur as a foraging visitor. The Study Area is unlikely to be important for this species as its population is large and secure, and breeding habitat is absent.

Priority species

Six Priority species potentially occur in the Study Area, of which two species (in bold) have been recorded:

- Buff-snouted Blind Snake (*Anilios margaretae*) – Priority 2
- Striated Grasswren (*Amytornis striatus striatus*) – Priority 4
- **Brush-tailed Mulgara (*Dasycercus blythi*) – Priority 4**
- **Long-tailed Dunnart (*Sminthopsis longicaudata*) – Priority 4**
- Southern Marsupial Mole (*Notoryctes typhlops*) – Priority 4
- Central Long-eared Bat (*Nyctophilus major tor*) – Priority 3

The Buff-snouted Blind Snake is data deficient and known from only a few locations. This species may occur, but the Study Area is unlikely to provide important habitat as the Buff-snouted Blind Snake occurs across a large part of arid Australia and is not thought to be restricted to a particular habitat type. The Brush-tailed Mulgara was widely recorded throughout the Study Area, occurring mainly on sandplains. The Southern Marsupial Mole was not recorded but potentially occurs in sand dunes in the Study Area. The Long-tailed Dunnart was recorded and is likely to be restricted to the rocky hills and surrounding stony plains. It is only likely to range into other habitats when dispersing between isolated rocky hills. The Central Long-eared Bat and Striated Grasswren may occur in the Study Area, though the habitats that these species rely on are relatively widespread in the region. The presence of the Striated Grasswren is likely to be influenced by fire, as it prefers long-unburnt spinifex habitats. The Central Long-eared Bat, if present, roosts in tree hollows which are present mainly in the gypsum dune, mulga woodland and sandplain habitats.

Locally significant species

A single locally significant species is potentially occurs in the Study Area:

- Woma (*Aspidites ramsayi*)

If present, the Woma is likely to occur on the sandplain.

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Tables, Figures and Plates

1. Introduction

Australian Potash Limited are proposing to mine sulphate of potash at their Lake Wells Potash Project (the 'Project'). The Project is located 160km north-east of Laverton in the shire of Laverton, Western Australia. Bores will be used to extract the potash-bearing brine, which will be fed into a series of evaporation ponds on Lake Wells, and the resulting evaporite processed to extract the sulphate of potash.

As part of the feasibility process for the Project, a Level 2 vertebrate fauna survey was undertaken in spring 2016 and autumn 2017 (Harewood 2017). Several gaps were identified in the coverage of the fauna survey, as it had been undertaken prior to the refinement of the project boundary. To fill these gaps, Australian Potash Limited commissioned Western Wildlife to carry out an additional vertebrate fauna survey in spring 2018. The key objectives of the fauna survey were to:

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1.1 Regional Context

The Lake Wells Potash Project is located 160km north-east of Laverton in the Shire of Laverton, Western Australia (Figure 1). The Project overlaps Lake Wells, a large, inland salt lake of about 49,500ha, and adjacent terrestrial habitats. De La Poer Range Nature Reserve is located about 8km west of the Project and Yeo Lake Nature Reserve is located about 100km to the southeast.

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies Australia's landscapes into 89 Bioregions based on common climate, geology, landform, native vegetation and species information. These Bioregions are further subdivided into 419 subregions.

The Project is situated on the western edge of the Shield subregion (GVD1), one of four subregions in the Great Victoria Desert Bioregion in Western Australia (Figure 2). This subregion is underlain by the Yilgarn Craton in the west, grading to an active sand-ridge desert in the east (Barton and Cowan 2001). Salt lakes with lake-derived dunes occur in the valley floors, vegetated with chenopod and samphire shrublands. Sandplains with patches of dunes support mallee eucalypts over Spinifex hummock grasslands, with deeper sands supporting Marble Gum (*Eucalyptus gonglyocarpa*) and Native Pine (*Callitris spp*.). Mulga and *Acacia* woodlands occur where there are colluvial and residual soils and areas of low relief such as mesas, breakaways and plateaus (Barton and Cowan, 2001).

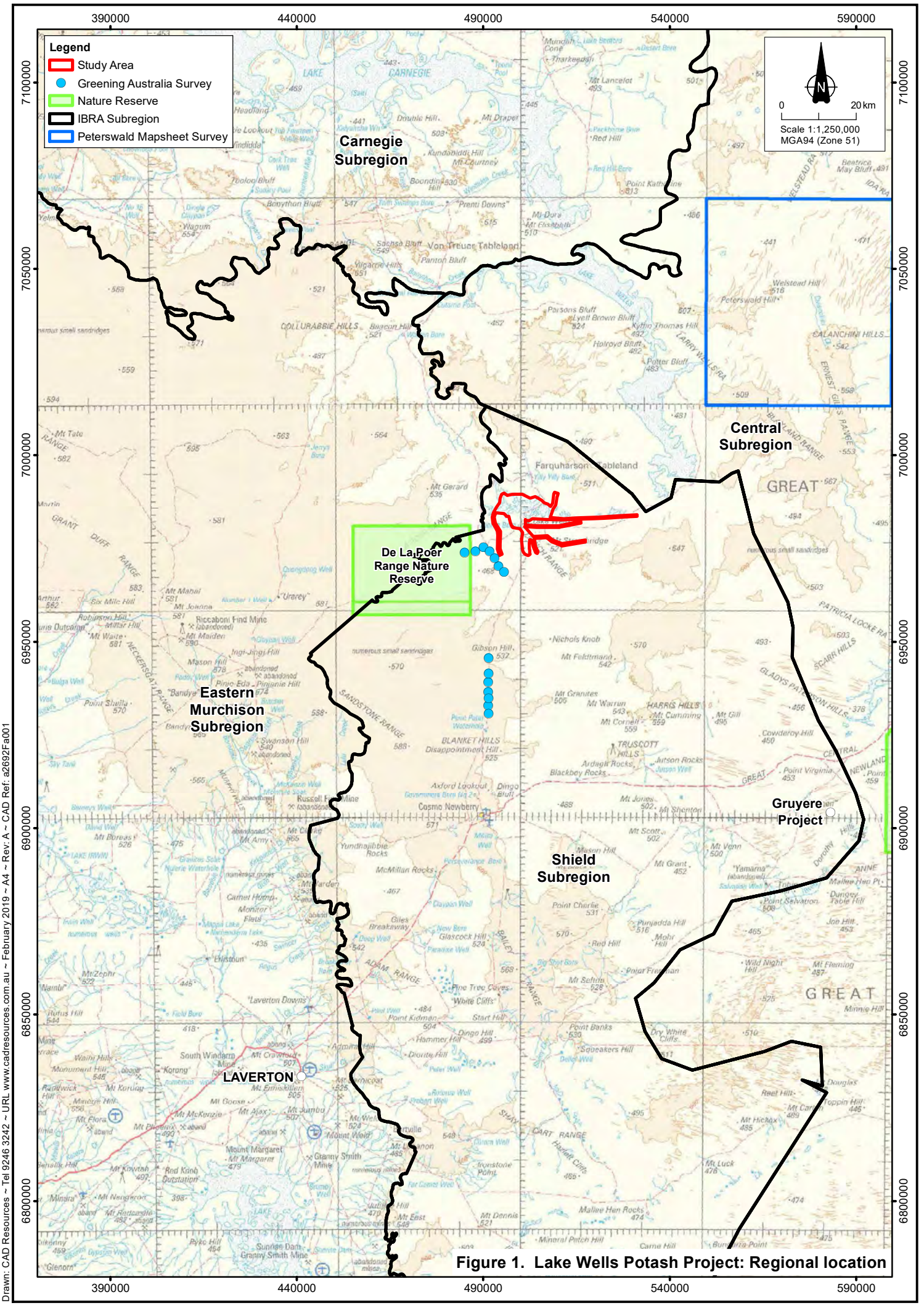

Figure 1. Lake Wells Potash Project: Regional location

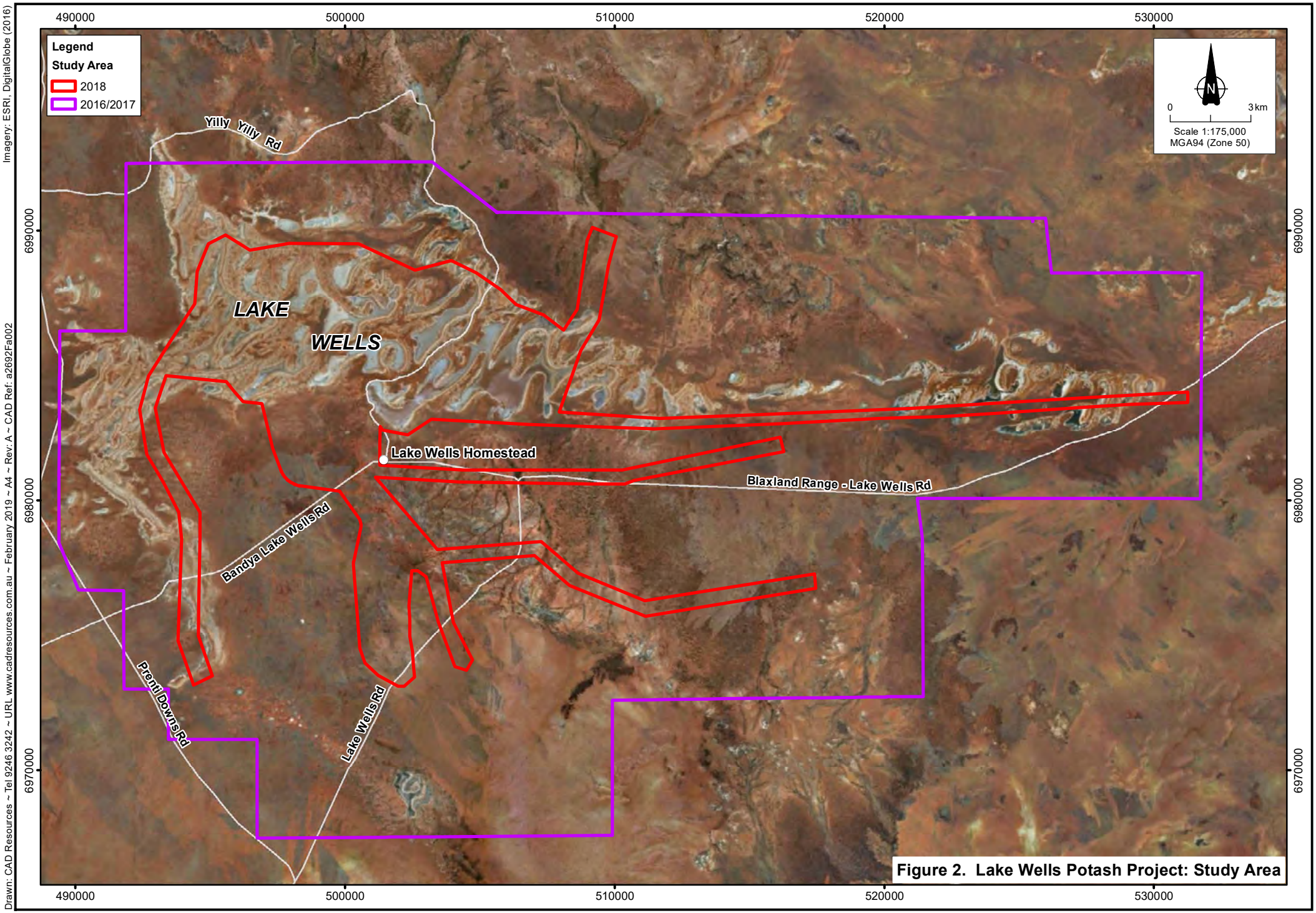

Figure 2. Lake Wells Potash Project: Study Area

Special features of the Shield subregion are the yellow sandplain communities that support diverse mammal and reptile assemblages, the assemblages of Queen Victoria Spring (about 350km south of the study area) and Mulga woodlands over Spinifex (*Triodia scariosa*) hummock grasslands, which are almost entirely confined to this subregion (Barton and Cowan 2001).

1.2 Study Area

For the previous fauna survey in 2016/2017, the extent of the Project was relatively undefined, resulting in a large area of 55,900ha for the initial survey (Harewood 2017). This area was subsequently refined, resulting in a 14,339.2ha Study Area prior to this survey in 2018 (Figure 2). The 2018 fauna survey was primarily focused on this 14,339.2ha Study Area, with some additional targeted surveys in similar habitats outside the Study Area.

1.3 Climate and Weather

The nearest weather station is Laverton Aero (site number 012305), about 150km southwest of the Study Area. The mean monthly maximum and minimum temperatures and rainfall for these weather stations are presented in Figure 3. The data indicate that the highest rainfall and temperatures occur in the summer months, though some rain falls throughout the year. The average annual rainfall for Laverton Aero is 299.5mm (Bureau of Meteorology 2018). After a below average year with 240.0mm in 2015, annual rainfall was higher than average in 2016 (338.6mm), 2017 (509.8mm) and 2018 (340.6mm). Weather during the 2016 and 2017 surveys was characterised by cold nights and warm days. Weather during the November/December 2018 field survey was characterised by warm, humid nights and hot days, with thunderstorms and rainfall in the latter part of the survey. The daily maximum and minimum temperatures at Laverton Aero are presented in Appendix 1.

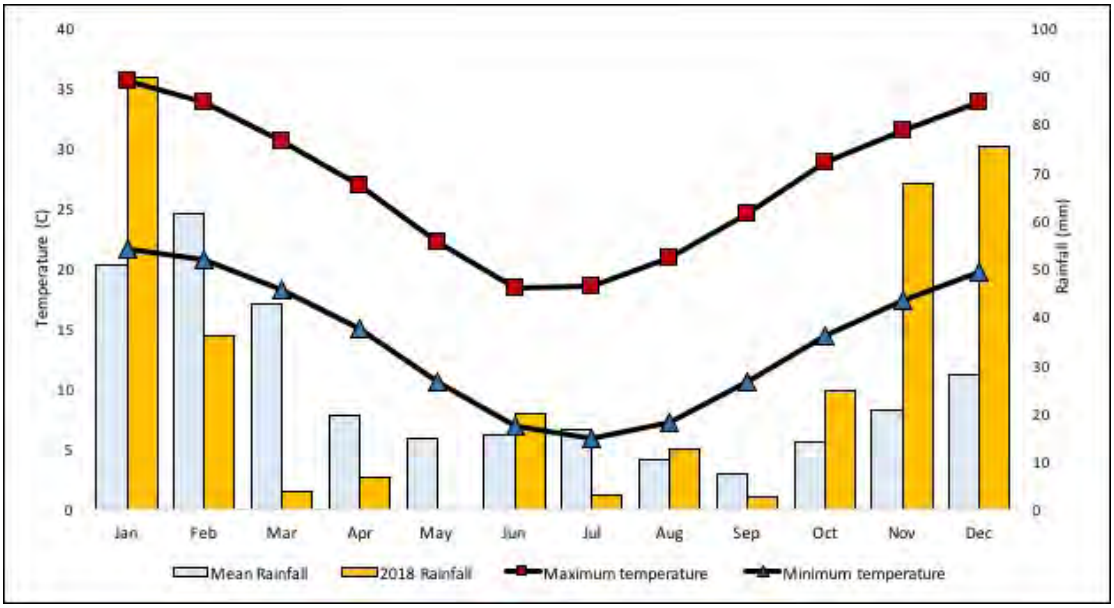

Figure 3. Monthly Climate Statistics for Laverton (Bureau of Meteorology 2018).

2. Methods

2.1 Overview

A single phase Level 2 vertebrate fauna survey was undertaken across the Study Area in November/December 2018, supplementing a previous two phase Level 2 fauna survey undertaken by Harewood (2017) in September 2016 and April 2017. Targeted searches were undertaken across the entire Study Area, where there was habitat that potentially supported conservation significant fauna. These methods are further described in the sections below.

2.2 Guidance Documents

The fauna survey was conducted with reference to the following documents:

- Environmental factor guideline: terrestrial fauna (EPA 2016b)
- Technical guidance: terrestrial fauna surveys (EPA 2016c)
- Technical guide: terrestrial vertebrate fauna surveys for environmental impact assessment (EPA and DEC 2010)
- Guidelines for surveys to detect the presence of bilbies, and assess the importance of habitat in Western Australia (DBCA 2017)
- Interim guideline for preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia (DPAW 2017)
- Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a)
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010)
- Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b)

2.3 Personnel

Four zoologists undertook the fieldwork in November/December 2018, with bat call analysis provided by Dr Kyle Armstrong of Specialised Zoological. Details of the survey team and their experience is shown in Table 2. This report was prepared by Ms Jenny Wilcox.

Table 1. Fauna Survey Personnel.

Name	Role	Qualification	Experience
Jenny Wilcox	Supervising Vertebrate Zoologist (plan and lead fieldwork, analyse data, prepare report)	BSc.Biol/Env.Sci., Hons.Biol.	18 years
Mike Brown	Vertebrate zoologist (fieldwork)	BSc.Biol/Env.Sci.,	12 years
Ray Lloyd	Vertebrate zoologist (fieldwork)	BSc.Env.Sci.	11 years
Brenden Metcalf	Vertebrate zoologist (fieldwork)	BSc.Env.Sci.	18 years
Kyle Armstrong	Bat call analysis	PhD. Zool.	21 years

2.4 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists, last updated September 2018. In the text, common names are used where appropriate, and all scientific names are given in species lists. Where a species lacks a common name, they are referred to by their scientific name.

2.5 Literature Review

Lists of fauna expected to occur in the Study Area were produced using information from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al*. 2000), reptiles (Wilson and Swan 2017, Storr *et al*. 1983, 1990, 1999 and 2002), birds (Barrett *et al*. 2003; Johnstone and Storr 1998 and 2004) and mammals (Churchill 2008, Menkhorst and Knight 2011; Van Dyck and Strahan 2008).

The databases listed in Table 2 were searched for fauna records in and around the Study Area. In all cases the extent of the database search was larger than the extent of the Study Area in order to pick up records of species in the wider area that may also occur in the Study Area. Note that the maximum radius of a database search on NatureMap (DBCA 2007-) is 40km.

Table 2. Databases used in the preparation of Appendices 4 - 7.

Database	Type of records held	Area searched
WA Museum Specimen Databases for reptiles frogs, birds and mammals (NatureMap: DBCA 2007-)	Records of specimens held in the Western Australian Museum. Includes historical records.	40km radius around a point in the center of the Survey Area (27º 17' 24"S, 123º 03' 36"E).
Fauna Survey Returns Database (NatureMap: DBCA 2007-)	Records collected from fauna surveys carried out in Western Australia. Includes observational and trapping data.	40km radius around a point in the center of the Survey Area (27º 17' 24"S, 123º 03' 36"E).
DBCA's Threatened and Priority Fauna Database (DBCA 2018)	Information and records on Threatened and Priority species in Western Australia.	100km radius around a point in the center of the Survey Area (27º 17' 24"S, 123º 03' 36"E).
Birds Australia Atlas Database (NatureMap: DBCA 2007-)	Records of bird observations in Australia, 1998-2009.	40km radius around a point in the center of the Survey Area (27º 17' 24"S, 123º 03' 36"E).
Birdata (NatureMap: DBCA 2007-)	Records of bird observations in Australia, 2010-2018.	40km radius around a point in the center of the Survey Area (27º 17' 24"S, 123º 03' 36"E).
EPBC Act Protected Matters Search Tool	Information and modelled distributions for matters protected under the EPBC Act, including threatened species and ecological communities, migratory species and marine species.	20km radius around a point in the center of the Survey Area (27º 17' 24"S, 123º 03' 36"E).

Some species may occur on database results that are not likely to be present in the Survey Area, usually due to a lack of suitable habitat or the Study Area being outside the known range of the species as presented in the literature (i.e. erroneous records). Some records may be historical, with the species known to be locally or regionally extinct. These species are generally not included in lists of expected fauna unless some discussion is thought to be necessary.

Few fauna studies have been undertaken in the region, and the Great Victoria Desert is generally recognised as lacking in surveys. A suite of surveys have been completed for the Tropicana Gold Mine in the southern Great Victoria Desert, but these are more than 100km south of the Study Area and have not been referred to here. The following four surveys have been completed within 100km of the Study Area:

- ***Fauna Survey (Level 2) Lake Wells Potash Project (Harewood 2017)***
  A previous Level 2 fauna survey of the Lake Wells Potash Project was undertaken in 2016/2017 by Harewood (2017), and the survey area is shown in Figure 2. This survey has been heavily referenced throughout this report as it provides important context for the current survey. The survey included trapping at six sites, each site consisting of 10 bucket pitfalls in a transect, each on a separate 7m drift-fence, with a funnel trap at both ends of the fence. An Elliott trap was placed near each pitfall, with cage traps at each end of the transect. Traps were open for seven nights in September 2016 and April 2017. The survey also included opportunistic searching, bird surveys and spotlighting. Harewood (2017) references additional fauna surveys that have been undertaken in the Bioregion, but are more than 100km from the Survey Area. Conservation significant fauna detected was the Marsh Sandpiper (*Tringa stagnatilis*).

- ***Peterswald Map Sheet Terrestrial Vertebrate Fauna Survey – Great Victoria Desert Western Australia (Cowan and Burbidge 2014)***
  This survey was undertaken in August – September 2014, in the area covered by the Peterswald Map Sheet, about 85km north-east of the study area (Figure 1). The survey included trapping at 15 sites, each site consisting of a 60m drift fence with six 20 litre bucket pitfall traps and six funnel traps, with 15 Elliott traps and two camera traps, all open for 6 nights. The habitats covered by this survey included Mulga, Mallee or Marble Gum over Spinifex grasslands on sandy sites, or *Acacia* shrublands over Eremophila and grasses on heavier loams and rocky sites. Opportunistic searches were undertaken at each trapping site and across the survey area, and spot-lighting occurred on several nights and trenches were dug to sample for the tunnels of marsupial moles. Bird surveys were also undertaken in 4ha areas around each trapping site. A total of 48 reptiles, 57 birds and 18 mammals were recorded. Conservation significant fauna detected were the Brush-tailed Mulgara (*Dasycercus blythi*) and Southern Marsupial Mole (*Notoryctes typhlops*).

- ***Fauna Survey of the Gruyere Project Area (Rapallo Environmental 2015)***
  This survey was undertaken in October/November 2014, in the Gruyere Project Area, about 100km southeast of the Study Area (Figure 1). The survey included trapping at five sites, each site consisting of 10 pitfalls in a transect, each on a separate 7m drift-fence, with a funnel trap at both ends of the fence and a transect of 20 Elliott traps and four cage traps. Foraging was undertaken at 16 additional sites, and other methods included bird surveys, spot-lighting, bat call detection and deployment of eight camera traps. The habitats covered by this survey were spinifex grasslands on sandplains, sand ridges, mulga woodland on clay-loam plains, drainages, rocky plains, rocky hills and breakaways. A total of 45 reptiles, 54 birds and 17 mammal species were recorded. No conservation significant fauna were detected.

- ***Great Victoria Desert Sandhill Dunnart Baseline Survey (Greening Australia 2018)***
  This survey was undertaken in September – December 2017, across three IBRA sub-regions (GVD1 – Shield, GVD2 – Central, GVD3 – Maralinga, WA portion only). The survey involved camera trapping at 31 sites, two of which were within 100km of the Study Area. These two sites each consisted of seven motion cameras set for 35 nights each, set in De La Poer Range Nature Reserve and on the Lake Wells Road (Figure 1). Conservation significant fauna detected on these two sites was the Brush-tailed Mulgara (*Dasycercus blythi*).

These sources of information were used to create lists of species that potentially occur in the Study Area. As far as possible, expected species are those that are likely to utilise the Study Area. The lists exclude species that have been recorded in the general region as vagrants, or for which suitable habitat is absent within the Study Area.

2.6 Field Survey

2.6.1 Licensing

All fauna works in November/December 2018 were carried out under Regulation 17 License 08-003115-1 issued by the Department of Biodiversity, Conservation and Attractions (DBCA).

2.6.2 Timing

Trapping in 2018 was undertaken in a single season survey in late spring, (23 November - 4 December). This is during the recommended September – April survey period for reptiles (EPA and DEC 2010).

2.6.3 Trapping for Terrestrial Fauna

Trapping for terrestrial fauna (frogs, reptiles and small mammals) was undertaken using a combination of pitfall traps, Elliott traps, funnel traps and cage traps.

Trapping was undertaken across six sites (TS 01 – TS 06) by Harewood (2017), in spring 2016 and autumn 2017. On these surveys the traplines consisted of 10 bucket pitfalls in a transect, each on a separate 7m drift-fence, with a funnel trap at both ends of the fence. An Elliott trap was placed near each pitfall, with cage traps at each end of the transect (Harewood 2017).

Rather than duplicate this work, the placement of trapping sites in the current survey aimed to increase the geographic spread of the survey, sample habitats that were not previously trapped and provide replicate sampling in the most common habitats. Nine trapping sites were installed in 2018 (LW Site 7 – LW Site 15), each trapping site consisting of ten pitfall traps (five buckets and five PVC pipes), ten funnel traps, 20 Elliott traps and two cage traps open for seven nights (Figure 4, Table 3). The number and types of traps were chosen to sample the likely faunal assemblage while allowing for timely checking of traps to preserve animal welfare.

The pitfall traps were placed in two transects of five, alternating buckets and pipes, each with a continuous 50m flywire driftfence. Each bucket pitfall trap was a 40cm deep, white 20L bucket and each PVC pipe was a 60cm deep, 150mm diameter pipe. A piece of egg carton was used as shelter for any fauna in the trap. Alternating with the pitfall traps, five funnel traps were set along each transect, with the fence bisecting the funnel entrances. Funnel traps were shaded with a shade-cloth cover, and on exposed sites, shaded with additional layers of hessian or shade-cloth (Plate 1).

Plate 1. Examples of trap line set-up at LW Site 10 (left) and LW Site 14 (right).

Table 3. Trapping site locations.

Survey	Site	Dates open	Location (WGS84)	Habitat
September 2016 and April 2017 (Harewood 2017)	TS 01	11/9/16 – 19/9/16, 24/4/17 – 1/5/17	51 J 497503 6978903	**Sandplain**.
	TS 02	11/9/16 – 19/9/16, 24/4/17 – 1/5/17	51 J 494754 6983988	**Clay-loam dune.**
	TS 03	12/9/16 – 19/9/16, 24/4/17 – 1/5/17	51 J 499651 6982106	**Mulga woodland.**
	TS 04	13/9/16 – 20/9/16, 24/4/17 – 1/5/17	51 J 501049 6989442	**Sand dune**.
	TS 05	13/9/16 – 20/9/16, 24/4/17 – 1/5/17	51 J 505084 6989599	**Mulga woodland.**
	TS 06	13/9/16 – 20/9/16, 24/4/17 – 1/5/17	51 J 498070 6988305	**Gypsum dune**.
November 2018 (this survey)	LW Site 07	23/11/18 – 30/11/18	51 J 500722 6985363	**Sand dune**. Spinifex hummock grassland with patches of mallee eucalypt on a red sand dune and slope.
	LW Site 08	23/11/18 – 30/11/18	51 J 504019 6985884	**Gypsum dune**. Sparse Sheoak woodland on a gypsum dune.
	LW Site 09	24/11/18 – 1/12/18	51 J 508094 6980816	**Mulga woodland**. Mulga woodland with scattered eucalypts over tussock grasses on a sandy-loam plain.
	LW Site 10	24/11/18 – 1/12/18	51 J 502199 6973729	**Sandplain**. Spinifex hummock grassland with occasional emergent shrubs and small trees on a red sandplain.
	LW Site 11	24/11/18 – 1/12/18	51 J 494765 6977241	**Salt lake**. Samphire and chenopod shrubland on the edge of a salt lake playa.
	LW Site 12	25/11/18 – 2/12/18	51 J 501438 6984796	**Salt lake**. Samphire shrubland on the edge of a salt lake playa.
	LW Site 13	25/11/18 – 2/12/18	51 J 492752 6982919	**Clay-loam dune.** Mulga woodland on a low clay-loam dune on the edge of a claypan.
	LW Site 14	26/11/18 – 3/12/18	51 J 493982 6984635	**Gypsum dune**. Sparse Sheoak and eucalypt woodland on a gypsum dune.
	LW Site 15	27/11/18 – 4/12/18	51 J 504669 6983263	**Sand dune**. Open mallee woodland over spinifex hummock grassland on a red sand dune and swale.

Elliott traps were placed in a separate transect with the cage traps at either end. All cage and Elliott traps were placed under vegetation to shade any captured animals and cage traps were covered with a hessian sack. All Elliott and cage traps were baited with a mixture of rolled oats, sardines, peanut butter and vanilla essence.

The number of trap-nights for each trap type are given in Table 4, for both the previous and current survey, and photographs of each site are given in Plates 2 - 10. All animals caught were identified and recorded, and generally released immediately at the site of capture.

Table 4. Survey effort at each trap site.

Survey	Site	Number of trap-nights				
		Bucket Pitfalls	PVC Pipe Pitfalls	Funnel traps	Elliott traps	Cage traps
September 2016 (Harewood 2017)	TS 01	80	-	80	80	16
	TS 02	80	-	80	80	16
	TS 03	70	-	70	70	14
	TS 04	70	-	70	70	14
	TS 05	70	-	70	70	14
	TS 06	70	-	70	70	14
	Subtotal:	**440**	**-**	**440**	**440**	**88**
April 2017 (Harewood 2017)	TS 01	70	-	70	70	14
	TS 02	70	-	70	70	14
	TS 03	70	-	70	70	14
	TS 04	70	-	70	70	14
	TS 05	70	-	70	70	14
	TS 06	70	-	70	70	14
	Subtotal:	**420**	**-**	**420**	**420**	**84**
November 2018 (this survey)	LW Site 07	35	35	70	140	14
	LW Site 08	35	35	70	140	14
	LW Site 09	35	35	70	140	14
	LW Site 10	35	35	70	140	14
	LW Site 11	35	35	70	140	14
	LW Site 12	35	35	70	140	14
	LW Site 13	35	35	70	140	14
	LW Site 14	35	35	70	140	14
	LW Site 15	35	35	70	140	14
	Subtotal:	**315**	**315**	**630**	**1260**	**126**
Total:		1,175	315	1,490	212	298

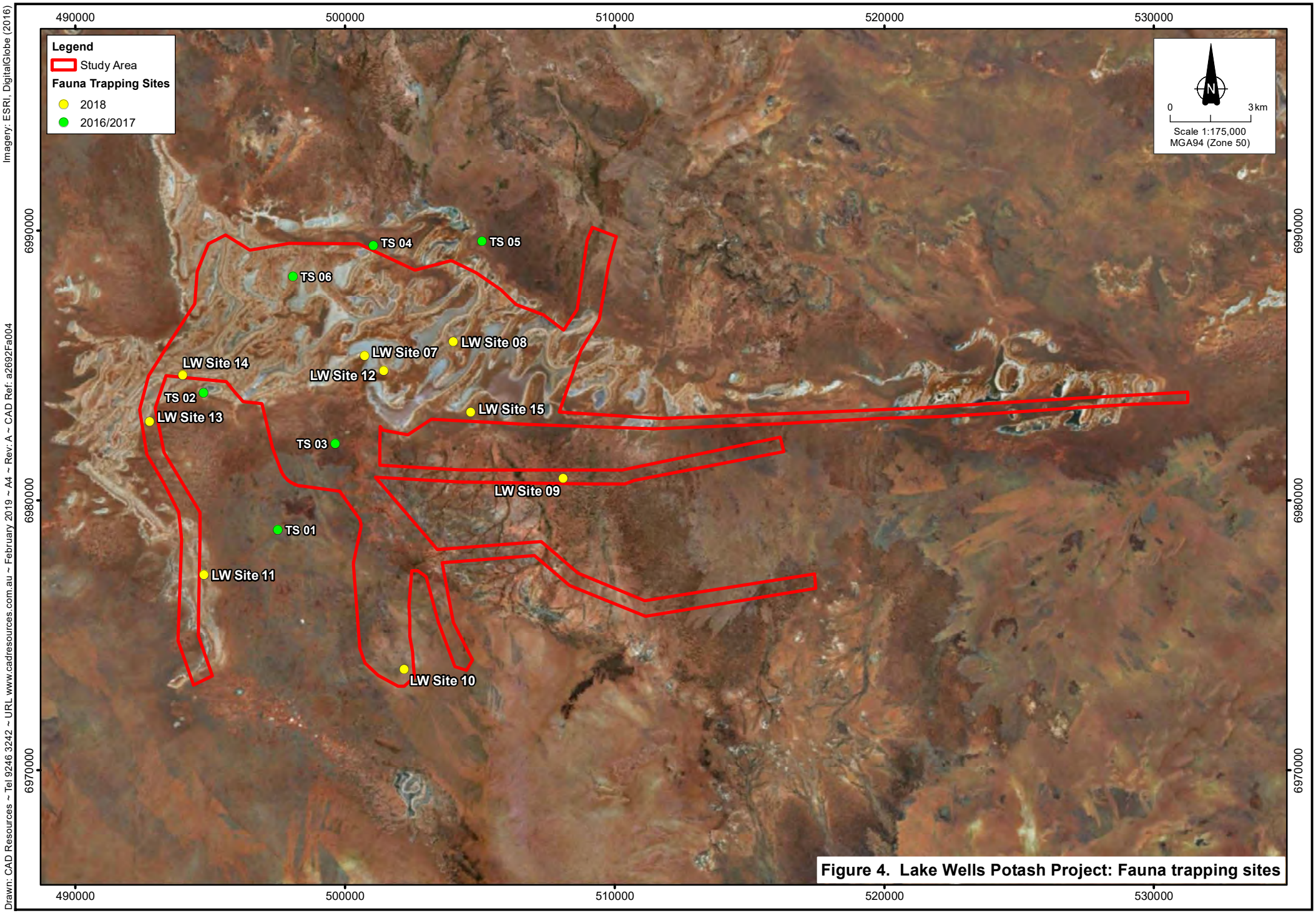

Figure 4. Lake Wells Potash Project: Fauna trapping sites

Plate 2. LW Site 07 – sand dune.

Plate 3. LW Site 08 – gypsum dune.

Plate 4. LW Site 09 - mulga woodland.

Plate 5. LW Site 10 – spinifex sandplain.

Plate 6. LW Site 11 – salt lake.

Plate 7. LW Site 12 – salt lake.


Plate 8. LW Site 13 – low clay-loam dune.


Plate 9. LW Site 14 – gypsum dune.


Plate 10. LW Site 15 – sand dune.

2.6.4 Trapping for Great Desert Skink

A single trapping site consisting of four Elliott traps set for a single night was used to target the Great Desert Skink at a burrow near LW Site 10 (Figure 4). The purpose of this was to confirm the identity of this species in the Study Area with a photograph, as recommended in the survey guidelines (DSEWPaC 2011b). Elliott traps were baited with tinned corn, and the traps were checked early, shut during the day and re-opened in the late afternoon.

2.6.5 Bird Surveys

Bird surveys were undertaken at each trapping site to give a total of six 20 minute surveys at each site, (18 hours in total across all sites). Surveys were unbounded, but within 300m of the trapping site. Surveys at trapping sites were undertaken concurrently with morning trap checks, between sunrise and approximately 10am. Birds were recorded if seen or heard. Birds were recorded as present only, and a frequency of occurrence calculated for each site.

Birds were also recorded opportunistically during targeted searches and transects, with some targeted searches aiming to survey habitats that may attract birds, such as dense stands of mulga. No survey were undertaken to target waterbirds, as the claypans and salt lake playas were dry at the time of survey.

This supplements the bird surveys undertaken by Harewood (2017). These surveys were undertaken at each of the trapping sites, while undertaking transects and at claypans and playas around Lake Wells. The survey effort and records of birds at each site were not available.

2.6.6 Bat Survey

In 2018, bat calls were recorded using two Anabat Swift call detectors set to record between dusk and dawn. Detectors were deployed overnight at each trap site and then at selected sites around the Survey Area, to give a total of 16 nights of recordings (Appendix 2, Figure 5). The calls were then analysed by Kyle Armstrong of Specialised Zoological, and the bat calls identified to species level where possible.

This supplements the nine nights of bat call recordings using SM2+ bat detectors undertaken by Harewood (2017), six nights in September 2016 and four nights in April 2017 (Figure 5).

2.6.7 Night Parrot Survey

Songmeter 4 (SM4) passive acoustic detectors were deployed in potentially suitable habitat across the target survey area (Appendix 2, Figure 5). Each SM4 was secured to a stake to hold it about 0.5m off the ground, and was set to record between dusk and dawn each night for five or six nights, giving a total of 66 recording nights across 12 sites.

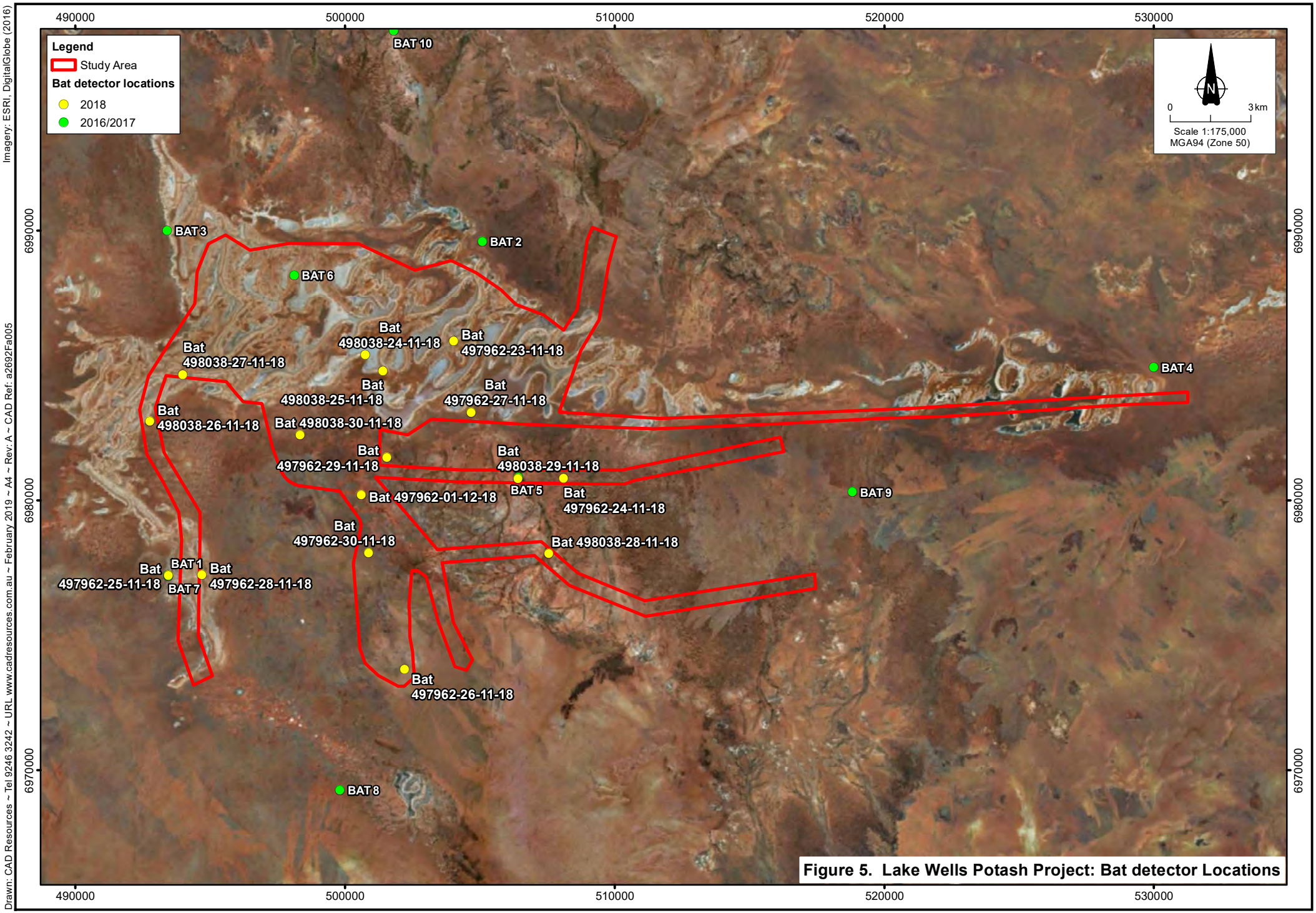

Figure 5. Lake Wells Potash Project: Bat detector Locations

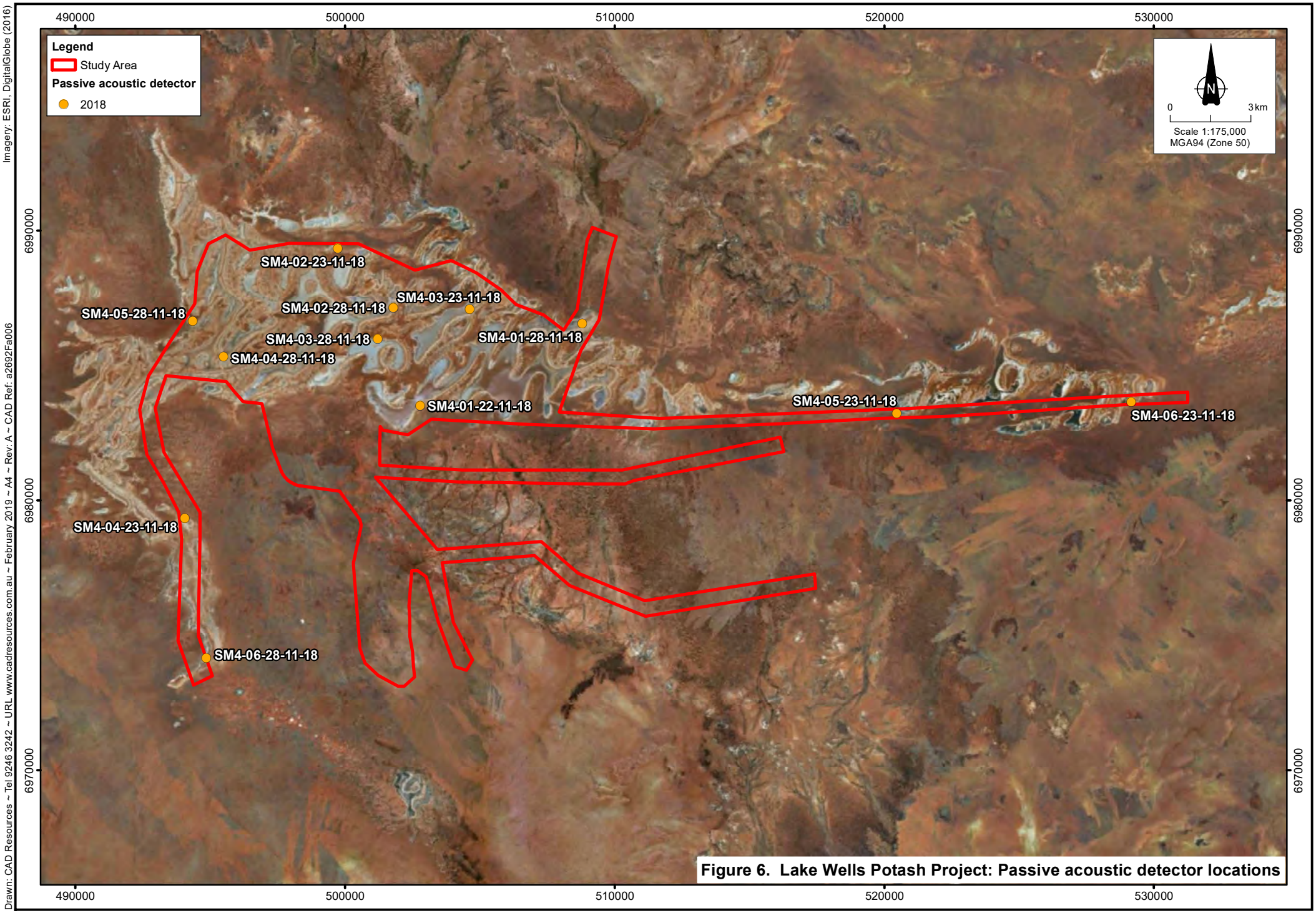

Figure 6. Lake Wells Potash Project: Passive acoustic detector locations

All of the SM4 recordings were analysed in Wildlife Acoustic's Bioacoustic Monitoring System Kaleidoscope Pro. Recordings were broken up into clusters with similar characteristics and the clusters inspected for consistency. Classifiers generated from known recordings of Night Parrots were used to analyse the data for Night Parrot calls. Random noise, vehicles, insects and other non-relevant recordings were removed and the remaining audio clusters containing bird calls further scrutinised via their sonogram and through audio playback. Night Parrot calls, if found, would be referred to the Night Parrot Recovery Team for confirmation.

2.6.8 Targeted Searches and Transects

Targeted transects and searches were undertaken throughout the Survey Area. The purpose of these was to search for species or evidence of species that are not readily trapped, and to search for signs of conservation significant fauna where potential habitat was found. A GPS location was recorded for small search areas, and a tracklog recorded when walking transects (Figure 7, Appendix 3).

A total of 223km of transect were walked on the 2018 survey (Appendix 3). Transects generally focused on sandplain habitats that potentially support conservation significant fauna. Secondary signs were searched for, and recorded with a GPS co-ordinate and representative photographs if found. Secondary signs included (but were not limited to):

- scat latrines and burrows of the Great Desert Skink (*Liopholis kintorei*)
- burrows, tracks, scats or diggings of the Brush-tailed Mulgara (*Dasycercus blythi*)
- burrows, tracks, scats or diggings of the Bilby (*Macrotis lagotis*)
- mounds, tracks or feathers of the Malleefowl (*Leipoa ocellata*)

Species such as the Princess Parrot (*Polytelis alexandrae*), Grey Falcon (*Falco hypoleucos*) and Peregrine Falcon (*Falco peregrinus*) were also targeted on both transects and search sites. As these species are distinctive diurnal birds, no specific methodology, other than vigilance, was required.

Reptiles were targeted by hand-searching in suitable habitat. Hand-searching involved raking through leaf litter, peeling bark from dead trees and raking through windrows of dead Spinifex. Hand-searching can be particularly effective in the cooler months. Any reptiles found were identified and released in situ. Birds were also targeted in transects and search sites. All other fauna and secondary signs of fauna encountered while undertaking targeted searches and transects were also recorded.

Transects were also walked as part of the 2016/2017 survey (Harewood 2017), but the location of these are unavailable.

2.6.9 Spotlighting

Spotlighting was carried out on the 29th and 30th November 2018, from 6:45pm – 9:30pm. Two teams of two personnel undertook either road-spotting using vehicle headlights, hand-searching using head-torches or a combination of the two. An additional night of spot-lighting with one team was undertaken from 7pm – 8pm on the 2nd December 2018, to search for frogs after late afternoon thunderstorms. The routes followed are shown in Figure 7.

Spotlighting was also undertaken along the main access tracks by Harewood (2017), comprising two transects in 2016 and two in 2017, with additional searching at some trapping sites.

2.6.10 Camera Trap Survey

Camera traps were deployed at 32 sites during the 2018 field survey, to give 199 trap-nights. (Appendix 4, Figure 8). Cameras were deployed to target habitat that conservation significant species such as the Bilby (*Macrotis lagotis*), Brush-tailed Mulgara (*Dasycercus blythi*) or Long-tailed Dunnart (*Sminthopsis longicaudata*) may use, as well as sampling the other habitats present. Two Great Desert Skink (*Liopholis kintorei*) burrows were also targeted, to determine occupancy. Most cameras were baited with a mixture of rolled oats, peanut butter and sardines, but cameras at Great Desert Skink burrows were left unbaited.

Camera trapping was also undertaken in 2016/2017 by Harewood (2017), with eight cameras deployed between the two surveys and four cameras re-deployed during the second survey. The long-term deployments varied in length due to camera battery life, and a total of 1,072 trap-nights was achieved overall.

2.6.11 Opportunistic Records

At all times, observations of fauna were noted when they contributed to the accumulation of information on the fauna of the site. These included casual observations of reptiles, mammals and birds seen while travelling between sites or while undertaking other activities, such as targeted searches. Opportunistic observations were recorded to a general location for common species, and conservation significant species were recorded with a GPS location.

2.7 Habitat Assessment and Mapping

Habitat mapping was undertaken using landform descriptions and vegetation mapping by Botanica Consulting (2017), observations made by fauna personnel in the field and interpretation of aerial photography. CAD Resources produced the maps from shapefiles and information provided by Botanica and Western Wildlife. Elements of each habitat likely to be important for fauna were identified. Habitat elements may include, but are not limited to, rocky crevices, caves, tree hollows, tree crevices, leaf litter or sands suitable for burrowing.

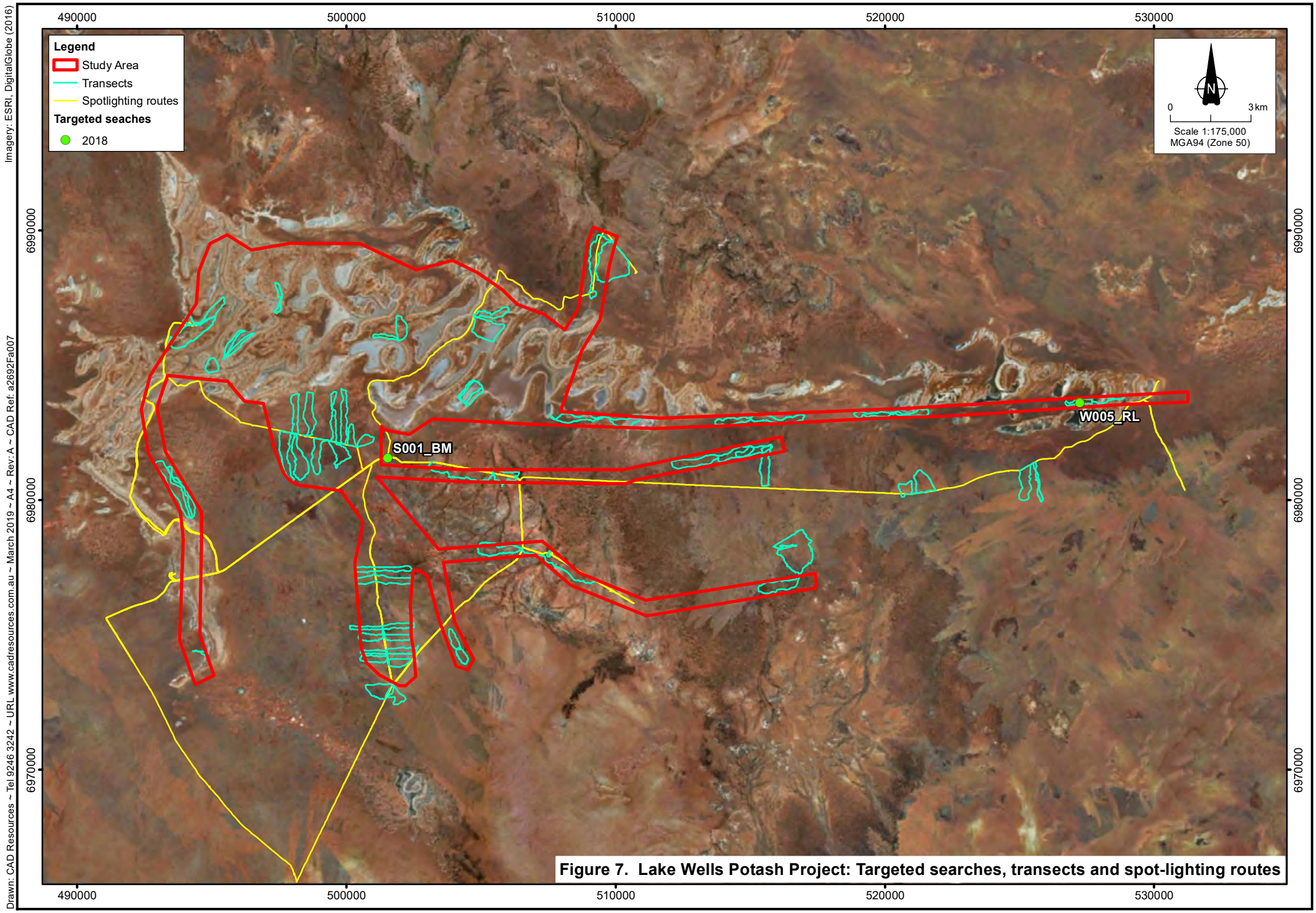

Figure 7. Lake Wells Potash Project: Targeted searches, transects and spot-lighting routes

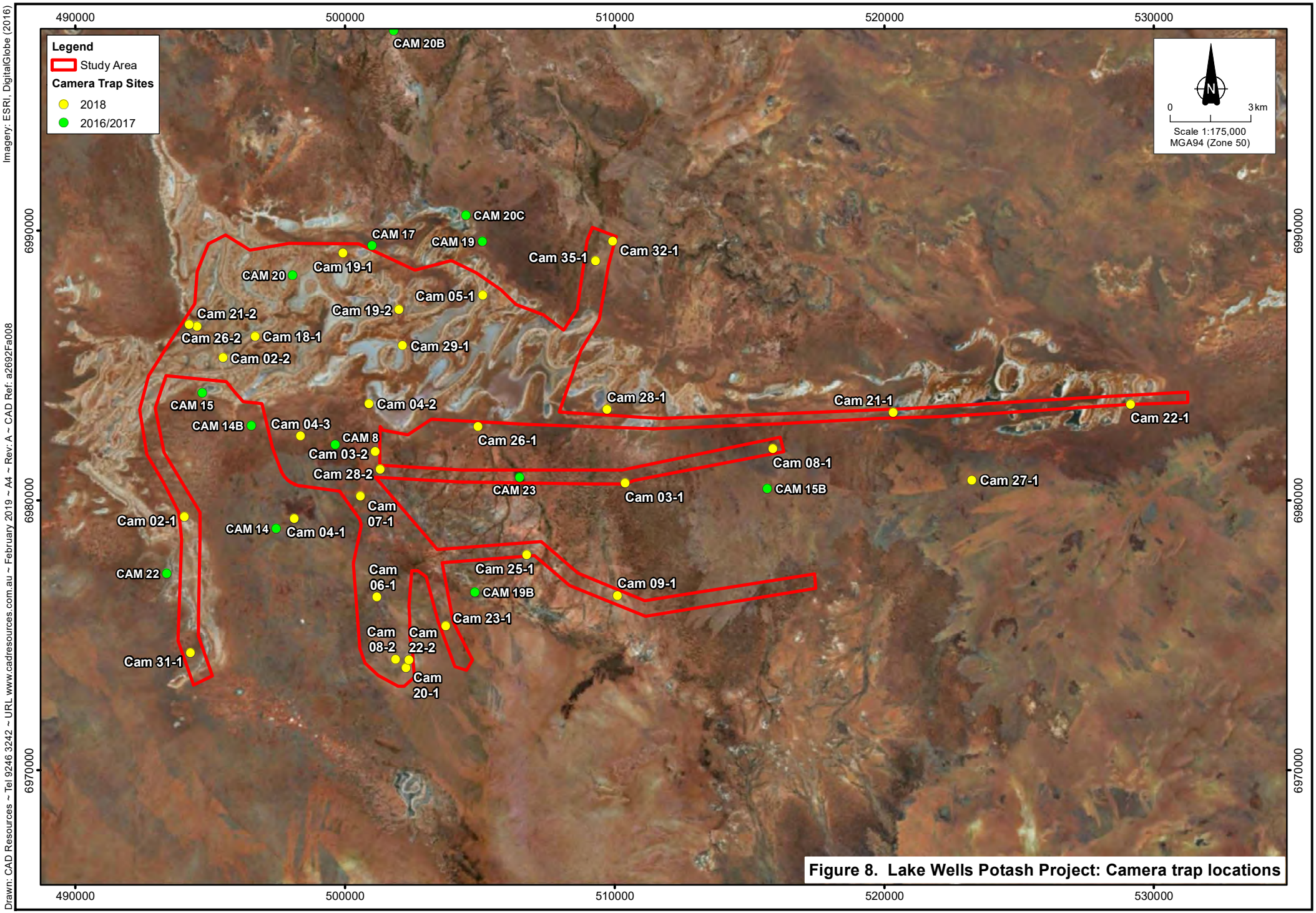

Figure 8. Lake Wells Potash Project: Camera trap locations

2.8 Assessment of Conservation Significance

2.8.1 Legislative Protection for Fauna

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the Commonwealth Government's primary piece of environmental legislation. Listed under Part 3 of the EPBC Act are 'Matters of National Environmental Significance' (MNES); these include threatened species, threatened ecological communities and migratory species. Threatened fauna species are assessed against categories based on International Union for Conservation of Nature (IUCN) criteria.

The migratory species listed under the EPBC Act are those recognised under international agreements. These agreements are the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), or species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) for which Australia is a range state.

Matters of National Environmental Significance (MNES) include the following categories:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.
- **Migratory (Mi):** Taxa listed under international agreements to which Australia is a party.

Reports on the conservation status of most vertebrate fauna species have been produced by the federal Department of Environment and Energy (DoEE) in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for amphibians (Tyler 1998), reptiles (Cogger *et al*. 1993), birds (Garnett *et al*. 2011) and mammals (Woinarski *et al*. 2014). These publications also use categories similar to those used by the EPBC Act. The information presented in some of the earlier Action Plans may be out of date due to changes since publication.

The *Biodiversity Conservation Act 2016* (BC Act) is State legislation that aims to conserve and protect biodiversity and biodiversity components in Western Australia, including threatened fauna. It is administered by the Department of Biodiversity, Conservation and Attractions (DBCA). In addition to threatened fauna, the BC Act has scope to protect threatened ecological communities and important habitats.

Fauna species are listed under the BC Act as threatened species using IUCN categories, or as specially protected species, as described below.

Threatened Species:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.

Specially Protected Species:

- **Migratory (Mi)**: A subset of the migratory fauna that are known to visit Western Australia that are protected under the international agreements or treaties, excluding species that are listed as Threatened species.
- **Conservation dependent fauna (CD):** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened
- **Other specially protected species (OS):** fauna in need of special protection to ensure their conservation.

The BC Act supersedes the *Western Australian Wildlife Conservation Act 1950* (WC Act).

Priority species are not listed under State or Commonwealth Acts. In Western Australia, DBCA maintains a list of Priority Fauna made up of species that are possibly Threatened but do not meet adequacy of survey requirements or are otherwise data deficient. There are four levels of Priority as defined by DBCA, as listed below.

- **Priority 1:** Poorly known species (on threatened lands)
- **Priority 2:** Poorly known species in few locations (some on conservation lands)
- **Priority 3:** Poorly known species in several locations (some on conservation lands)
- **Priority 4:** Rare, near threatened and other species in need of monitoring

2.8.2 Levels of Conservation Significance in this report

Five levels of conservation significance are used within this report to indicate the level of significance of fauna species, according to the following criteria:

- **Threatened (T):** Taxa listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the EPBC Act and/or BC Act. These species are grouped as they are all species considered to be at risk of extinction, are often rare and are likely to be subject to on-going threatening processes.

- **Migratory (Mi):** Taxa listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened. These species are grouped as they are not necessarily rare, but may be dependent on specific habitats for a portion of their life-cycle. For these species, loss of important foraging, breeding or stop-over sites may have a disproportionately large impact on populations.
- **Specially Protected (SP):** Taxa listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act. These species are not necessarily rare, but may be dependent on on-going conservation to ensure their protection.
- **Priority (P):** Taxa listed as Priority by DBCA. These species are grouped as they are either conservation dependent or data deficient and in need of further survey.
- **Locally Significant (LS):** Locally significant taxa are not listed under State or Commonwealth Acts or in publications on threatened fauna or as Priority species by DBCA, but are considered by the author to potentially be of local significance because they are at the limit of their distribution in the area, they have a very restricted range or they occur in breeding colonies (e.g. some waterbirds). This level of significance has no legislative recognition and is based on interpretation of information on the species patterns of distribution. For example, the Government of Western Australia (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Bush Forever. Recognition of such species is consistent with the aim of preserving regional biodiversity.

2.9 Species Accumulation Curves

A species accumulation curve at its most simple is a graph of the number of detected species against sampling effort. However, the curve is usually derived through sub-sampling the dataset to find a mean curve, otherwise known as a sample-based rarefaction curve.

Species accumulation curves were calculated for reptiles, mammals and birds in each habitat. For reptiles and mammals, an 'individuals' based approach was used, as sampling effort was not consistent between the two surveys. This means that the species richness was graphed against the number of individuals caught, rather than per each sample. The sampling unit for birds was all species observed in a 20 minute bird survey at a trapping site, and only data from 2018 was used as no systematic data were available from the previous survey.

The statistical package EstimateS (Colwell 2013) was used to find a non-parametric estimator of species richness; either Chao1 or Chao2. Chao1 uses abundance data to provide an estimation of the lower bound of species richness and is a good estimator of the actual species richness when the sample size is large or the rare species in the sample have similar detection probabilities (Chao and Chiu 2016). Chao2 is similar, but uses incidence (presence only, no abundance) data only.

EstimateS (Colwell 2013) uses a bias-corrected form of Chao1 and Chao2 as a default, though these become imprecise when the co-efficient of variation or incidence distribution >0.5. In these cases, the classic Chao1 and Chao2 were used, and the larger estimate of Chao1(classic) and ACE (Abundance-based Coverage Estimator) or Chao2(classic) and ICE (Incidence-based Coverage Estimator) is used as the estimate of species richness. For large sample sizes, if Chao 1 or Chao 2 are equal to the observed number of species, then the accumulation of species is assumed to have reached an asymptote (Colwell 2013).

Jackknife estimators of species richness are not used, as they typically underestimate the true species richness when the sample is small, (as is often the case in Level 2 surveys) and overestimate when the sample is large. Thus there is only a small window when the Jackknife estimators are close to the true species richness (Chao and Chiu 2016).

2.10 Likelihood of Occurrence

Fauna of conservation significance were assessed and ranked for their likelihood of occurrence in the study area, according to the following criteria:

- **Very Low:** The study area is outside the current known distribution of the species as presented in the literature; no suitable habitat was identified as being present during the field survey; for some species, individuals may occur occasionally as vagrants, especially if suitable habitat is located nearby, but the study area itself would not support the species; includes species generally accepted as being locally extinct.

- **Low:** The study area is within or just outside the current known distribution of the species, as presented in the literature; any habitat present is either limited in extent or of marginal quality at best; no recent or nearby records of the species on databases; the species is generally known to be less common in the vicinity of the study area (e.g. for inland sites, where the species usually occurs on the coast).

- **Moderate:** The study area is within the current known distribution of the species, as presented in the literature; habitat of reasonable quality was identified as being present during the field survey; some recent and/or nearby records of the species of databases;

- **High:** The study area is well within the current known distribution of the species, as presented in the literature; habitat of good quality was identified as being present during the field survey; many recent and nearby records of the species on databases.

- **Known to Occur:** The species was positively identified in the study area during this field survey, or recorded as occurring in the study area on previous recent field surveys. Note that for a species 'known to occur', the habitat may still be marginal and therefore the population may be small or the species may visit the site irregularly.

3. Survey Limitations

Various factors can limit the effectiveness of a fauna survey. Pursuant to EPA Technical Guidance (EPA 2016c), these factors have been identified and their potential to impact on the effectiveness of the surveys has been assessed in
Table 5 below. All fauna surveys have limitations, and not all fauna species present on the site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year.

Table 5. Fauna survey limitations.

Potential Limitation	Extent of limitation for the fauna survey	
Competency /experience of the team carrying out the survey	Not limiting	Supervising zoologist has 18 years' experience with fauna surveys in Western Australia. Field zoologists have more than 10 years' experience each. The field team included personnel experienced in desert environments and fauna.
Proportion of fauna identified, recorded and/or collected.	Minor limitation	A large proportion of the fauna expected to occur (based on literature review) were recorded during this survey or the 2016/2017 survey by Harewood (2017). The only vertebrate taxa undersurveyed are any migratory shorebirds that use the lake when inundated in summer, as no surveys were undertaken during the December - March period. Lake Wells is unlikely to flood and provide shorebird habitat on a regular basis, as rainfall in this region is unpredictable.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	Minor limitation	Few studies have been undertaken in the region, leading to a paucity of nearby recent records of fauna, making it difficult to place records in the Study Area into a regional context. This is somewhat ameliorated for many species as arid zone fauna typically have wide distributions. There is little data available on the importance of inland salt lakes for migratory shorebirds.
Timing/weather/season/cycle	Minor limitation for some species	As three field surveys have been undertaken in the study area, trapping has occurred under a range of weather conditions including thunderstorms and rain and post summer rain. Although overnight temperatures were cool on the 2016/2017 surveys, warm minimums during 2018 ensured captures and observations of nocturnal reptiles such as geckoes. Overnight rain and thunderstorms reduced the number of nights of clear weather for passive acoustic recording (Night Parrot survey).
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	Minor limitation	Access to the north-western part of the study area was restricted for the first week of survey, to avoid safety issues with feral horse shooters operating on the road between the Lake Wells Homestead and Warren Bore.

Table 5. (cont.)

Potential Limitation	Extent of limitation for the fauna survey	
Intensity (in retrospect, was the intensity adequate)	Not limiting	Sufficient time was allowed to survey all habitats.
Completeness (e.g. was relevant area fully surveyed)	Not limiting	A representative proportion of all habitats were able to be accessed and surveyed, using trapping and a range of supporting survey methods.
Resources (e.g. degree of expertise available in animal identification to taxon level)	Minor limitation for some species	Almost all vertebrate fauna could be identified to species. Minor exceptions include species of *Nyctophilus* and *Chalinolobus* bats that cannot always be reliably identified on call.
Remoteness and/or access problems	Minor limitation	Entire Study Area accessible by vehicle or on foot. Access to the north-western part of the study area was restricted for the first week of survey, to avoid safety issues with feral horse shooters operating on the road between the Lake Wells Homestead and Warren Bore.
Availability of contextual (e.g. biogeographic) information on the region	Minor limitation	There is little contextual information available for this region, however, much of the fauna that occur have widespread distributions across the arid zone.

4. Fauna Habitats of the Study Area

Nine fauna habitats were identified in the Study Area (Table 6, Figure 9). The habitat boundaries vary somewhat from those presented by Harewood (2017), as ground-truthing during the field survey resulted in changes to better match the observed habitat characteristics. The habitats around the salt lake occur as a complex mosaic, with the various dune habitats interleaving around a series of interconnected claypans and salt lake playas.

Table 6. Fauna habitats in the Study Area.

Habitat	Key Habitat Elements	Total Area (ha)
Salt lake (includes both vegetated areas and open playa)	• Water-holding depressions provide habitat for shorebirds and other waterbirds.	4,163.2
Claypans and clay-loam dunes	• Water-holding depressions provide habitat for shorebirds and waterbirds and breeding habitat for frogs.	756.6
Sand dunes	• Loose sands provide habitat for fossorial reptiles. • Mallee eucalypts (where present) provide nesting habitat for birds.	2,239.0
Gypsum dunes	• Large casuarina and eucalypts provide tree hollows and crevices for birds, bats and arboreal reptiles. • Dense leaf litter and fallen logs provide shelter for reptiles. • *Eremophila* and *Grevillea spp*. provide seasonal resource for nectar-feeding birds.	2,491.7
Sandplain	• Consolidated sands for burrowing mammals and reptiles. • Mallee eucalypts (where present) provide hollows and crevices for birds, bats and arboreal reptiles. • Eucalypt and *Hakea spp*. provide seasonal resource for nectar-feeding birds.	1,413.7
Mulga woodland	• Hollows and crevices in large mulga and eucalypts provide roosting and nesting habitat for birds, bats and arboreal reptiles. • Where present, dense leaf litter and fallen logs provide shelter for reptiles. • Mulga trees and taller shrubs provide nesting habitat for birds, particularly where the Mulga occurs in groves or dense stands.	2,342.3
Drainages	• Dense vegetation provides nesting habitat for birds.	214.8
Rocky hills	• Cracks and crevices in rocks provide shelter for reptiles and mammals.	264.5
Stony plains	• *Eremophila spp*. provide seasonal resource for nectar-feeding birds.	453.5
	Total:	**14,339.2**

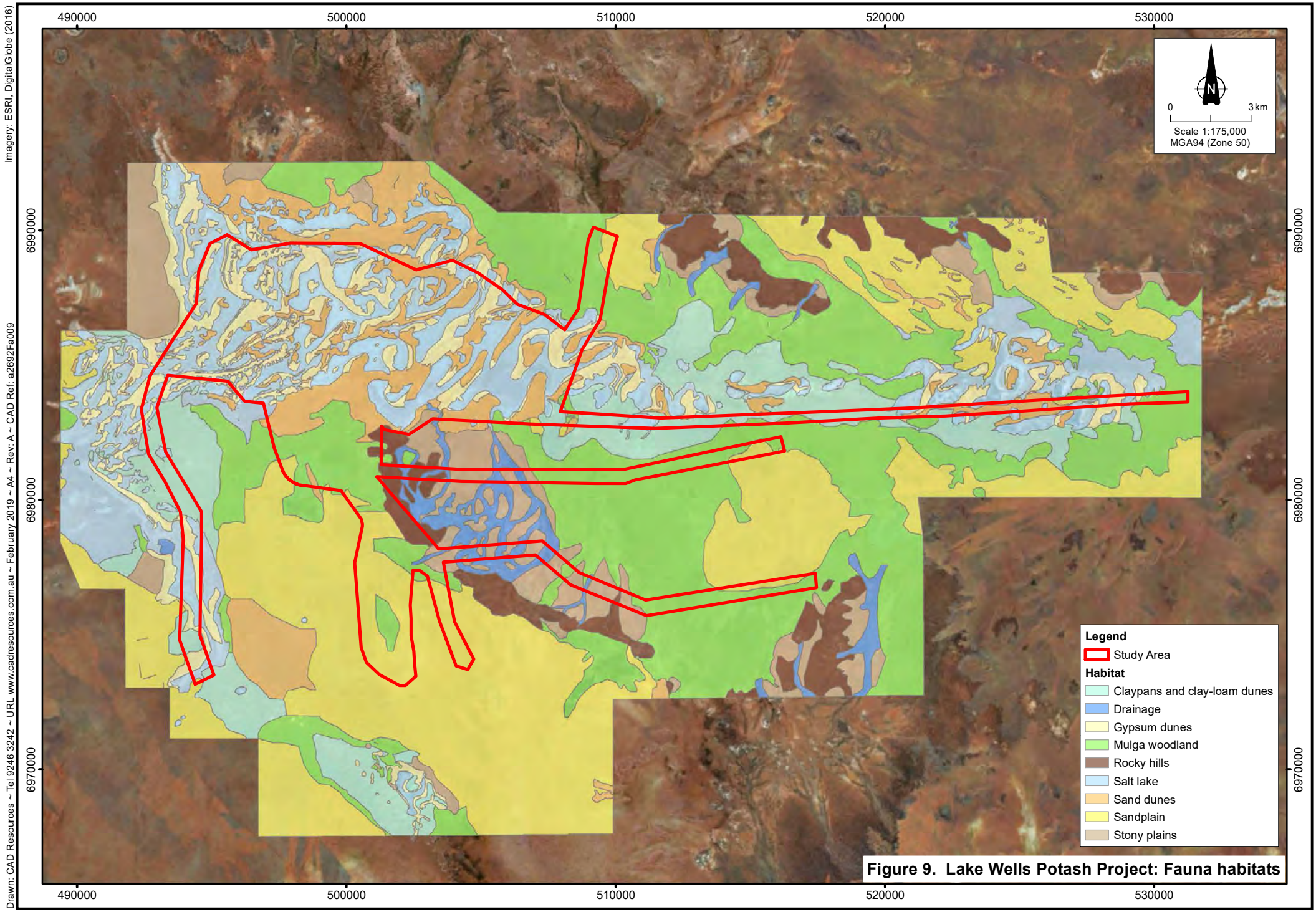

Figure 9. Lake Wells Potash Project: Fauna habitats

There was some disturbance to all habitats, mainly from livestock and feral herbivores such as Rabbits (*Oryctolagus cuniculus*) and Horses (*Equus caballus*). These pressures were particularly pronounced near water sources (tanks and bores) and areas of shade such as the dense vegetation along drainage lines or stands of mulga.

All of the habitats present in the Survey Area are widely represented in the Great Victoria Desert Bioregion. The habitats are described in the sections below, with vegetation descriptions summarised from Botanica Consulting (2017).

4.1 Salt Lake

Low shrublands of samphire (*Teticornia spp*.) and chenopods (*Atriplex spp., Maireana spp.* and *Sclerolaena spp.*) occur in association with the salt lake. The salt lake occurs as a series of closed depressions (playas) that range from almost totally vegetated in the west, to a narrow margin of vegetation around an open lake bed in the east. This habitat has been impacted by feral herbivores. Though few species are likely to be associated with this habitat overall, Migratory shorebirds and other waterbirds potentially occur after significant rain events that fill the lake.

Plate 11. Samphire and chenopod shrublands on the salt lake edges.

Plate 12. Bare salt lake bed (left) and grasses nibbled short by herbivores (right).

4.2 Claypans and Clay-loam Dunes

This habitat occurs as a complex, consisting of a series of closed depressions (claypans), each surrounded by low semi-circular clay-loam dunes (Plates 13 and 14). The claypans may be bare or sparsely vegetated with a chenopod shrubland (*Maireana pyramidata* and *Atriplex spp.*) over forbs (*Frankenia spp*.). The low dunes support a woodland of Western Blue Mulga (*Acacia caesaneura*) with *Eremophila spp*. over tussock grasses (*Eragrostris eriopoda*). Migratory shorebirds and other waterbirds potentially occur after significant rain events that fill the claypans.

Plate 13. Claypans.

Plate 14. Low clay-loam dunes occurring in association with claypans.

4.3 Sand Dunes

Aeolian sand dunes composed of a fine orange-red sand occur in association with the salt lake, often in a complex with gypsum dunes (Plates 15 and 16). The dunes support either an open mulga woodland (*Acacia caesaneura* and *Acacia incurvaneura*) over *Eremophila spp*. and spinifex (*Triodia basedowii*) and tussock grass (*Eragrostris eriopoda*) or Yellow-leaved Mallee (*Eucalyptus concinna*) over *Aluta maisonneuvei*, *Dodonaea viscosa* and spinifex (*Triodia desertorum*). Sand dunes potentially support the Priority 4 Southern Marsupial Mole (*Notoryctes typhlops*).

Plate 15. Sand dune crest and mulga woodland on sand dune.

Plate 16. Sand dune with mallee eucalypts.

4.4 Gypsum Dunes

Gypsum dunes, also known as kopi dunes, occur in association with the salt lake, often in a complex with sand dunes (Plates 17 and 18). The gypsum dunes are sparsely vegetated with an open woodland of *Casuarina pauper*, sometimes with Kopi Mallee (*Eucalyptus gypsophila*), over *Acacia burkittii, Grevillea sarrissa, Senna* and/or *Eremophila* shrubland and low chenopods (*Atriplex vesicaria*). Leaf litter forms large mounds under the *Casuarina pauper*, and the sparse vegetation may protect these mounds from fire, allowing them to persist for many years. The habitat potentially supports the Priority 2 Buff-snouted Blind Snake (*Anilios magaretae*), though its habitat preferences are poorly known.

Plate 17. Gypsum dunes.

Plate 18. Leaf litter under *Casuarina pauper* on gypsum dune (left) and Kopi Mallee (right).

4.5 Spinifex Sandplain

Spinifex sandplains occur mostly on the southern part of the Survey Area (Plates 19 and 20). Deep orange-red sands support a grassland of Spinifex (*Triodia desertorum* and/or *Triodia basedowii*). While some of this habitat is open grassland, most is relatively well vegetated with an open mallee woodland (*Eucalyptus spp*.) over *Acacia* shrubland. Small areas support a Marble Gum (*Eucalyptus gongylocarpa*) woodland over *Eremophila spp*., though Marble Gum woodlands are more common outside the Study Area. Spinifex sandplains are likely to support a diverse reptile assemblage. The deep sands provide habitat for burrowing fauna, including reptiles such as the Threatened Great Desert Skink (*Liopholis kintorei*) and mammals such as the Priority 4 Brush-tailed Mulgara (*Dasycercus blythi*).

Plate 19. Spinifex sandplain with few trees.

Plate 20. Spinifex sandplain with emergent shrubs and mallee.

4.6 Mulga Woodlands

Mulga woodlands occur on sandy-loam and clay-loam plains (Plates 21 and 22). The ground vegetation varies from spinifex (*Triodia basedowii*) to tussock grass (*Eragrostris eriopoda* and *Eriachne mucronata*), the spinifex occurring where the soils are sandier. The canopy is a woodland of Western Blue Mulga (*Acacia caesaneura*) or Narrow-leaved Mulga (*Acacia incurvaneura*) with Barlee Box (*Eucalyptus lucasii*) where the soils are sandier, over a shrubland of *Eremophila spp.* The Mulga woodlands are variable in structure, from the dense stands of mulga that occur in low-lying areas, to very open woodlands with little understory.

The Priority 3 Central Long-eared Bat (*Nyctophilus major tor*) potentially occurs in this habitat, though it has not been recorded in the Survey Area. The Priority 4 Brush-tailed Mulgara potentially occurs where the soils are sandier and there is a spinifex understory.

Plate 21. Mulga woodlands.

Plate 22. Mulga woodlands.

4.7 Drainages

Linear drainages are present where water formed channels, running off the rocky hills (Plate 23). The vegetation along the drainages is similar to that in the mulga woodlands, but denser than on the surrounding stony plains, and consists of Western Blue Mulga (*Acacia caesaneura*) over *Senna artemisiodes* over tussock grass (*Eragrostris eriopoda*). This habitat has been disturbed by livestock and feral herbivores. The Priority 3 Central Long-eared Bat (*Nyctophilus major tor*) potentially occurs in this habitat, though it has not been recorded in the Study Area.

Plate 23. Drainages.

4.8 Rocky Hills

Although stony and rocky hills in the region are likely to support a distinct faunal assemblage, the low stony hills and plains that extend into the Study Area are unlikely to support fauna that favour very rugged terrain. Except for a few very small outcrops, this habitat lacks crevices and exfoliating rock (Plate 24). Caves are absent thought they may occur in the surrounding hills. This habitat supports the Priority 4 Long-tailed Dunnart (*Sminthopsis longicaudata*).

Plate 24. Rocky hills.

4.9 Stony Plains

The stony plains occur downslope from the rocky hills, and the soil surface has a mulch of small stones, often including quartz (Plate 25). The vegetation is usually sparse, with a few dense stands, consisting of an open woodland of Western Blue Mulga (*Acacia caesaneura*) and Narrow-leaved Mulga (*Acacia incurvaneura*) over *Acacia burkitii* and *Eremophila spp*. over tussock grass (*Eragrostris eriopoda*). This habitat supports reptiles that favour a stony soil surface.

Plate 25. Stony plains.

5. Faunal Assemblage of the Study Area

The results of the literature review and field survey were combined to create a list of all the vertebrate fauna potentially occurring in the Study Area (Appendices 5 - 8). Indicated in the fauna lists are all the species observed during the fauna survey, those recorded previously in the Study Area by Harewood (2017) and those recorded in the region as part of the literature review (see Table 3 for search areas). As the Bioregion is undersurveyed, several species are not represented by records in the surrounding area, and their presence has been inferred from their patterns of distribution as presented in the literature.

The potentially occurring faunal assemblage is summarised in Table 7. The overall vertebrate faunal assemblage is likely to be largely intact, with the exception of species that are extinct or greatly reduced in their distribution in the Bioregion. The faunal assemblage and conservation significant species likely to occur are further discussed in the sections below.

Table 7. Summary of vertebrate fauna potentially occurring in the Study Area.

Taxon	Total species	Introduced species	Conservation significant species				
			Threatened (T)	Migratory (Mi)	Specially Protected (SP)	DBCA Priority (P)	Locally significant (LS)
Amphibians	10	0	-	-	-	-	-
Reptiles	116	1	1	-	-	1	1
Birds	145	0	4	10	1	1	-
Mammals	42	8	2	-	-	4	-
Totals:	**264**	**9**	**7**	**10**	**1**	**6**	**1**

The conservation significant fauna recorded within 100km of the Study Area on DBCA's Threatened and Priority Fauna Database are shown in Figure 10. The results of the EPBC Act Protected Matters search are given in Appendix 9. The significant fauna potentially occurring in the Study Area are discussed in the following sections and summarised in Table 15, with the individual records presented in Appendix 10. The analysis of the bat call data collected on the field survey is given in Appendix 11.

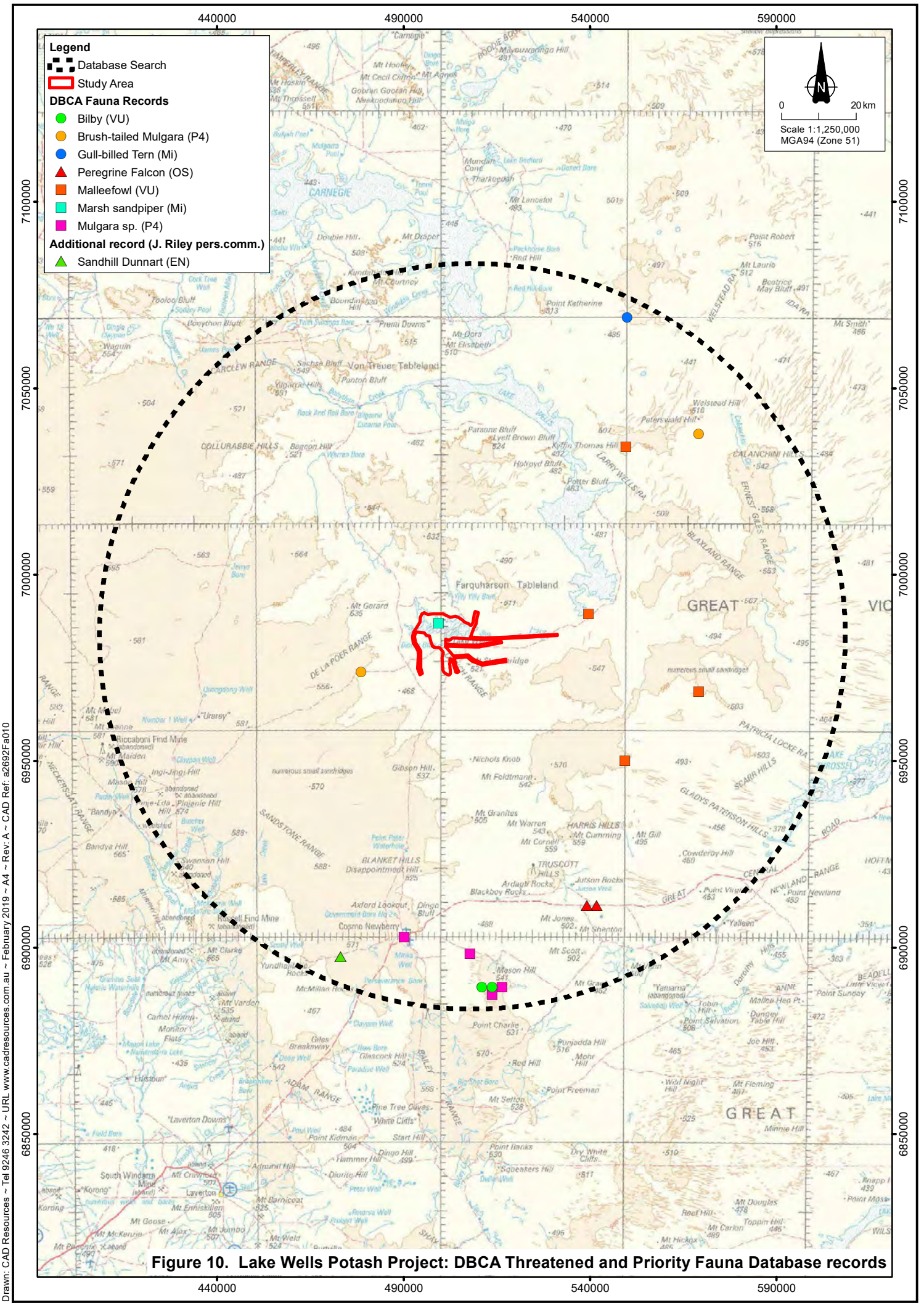

Figure 10. Lake Wells Potash Project: DBCA Threatened and Priority Fauna Database records

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5.1 Amphibians

There are ten species of frog potentially occur, of which five were recorded in the Study Area (Table 8, Appendix 5). Four frogs were recorded during the 2018 survey (Plate 26), although one species (*Neobatrachus sp.*) was unable to be identified to species level as juveniles are not readily distinguishable on morphology. Four species were recorded during the 2016/2017 survey (Harewood 2017). The frog species of the Study Area are common and widely distributed in the semi-arid zone.

Plate 26. *Cyclorana occidentalis* (left) and *Cyclorana maini* (right), recorded in 2018.

Table 8. Frogs recorded in the Study Area.

Species	Site															Opportunistic only
	2016/2017 (Harewood 2017)						2018 (this survey)									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Sandplain	Clay-loam dune	Mulga woodland	Sand dune	Mulga woodland	Gypsum dune	Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Water-holding Frogs																
Cyclorana maini	-/4															
Cyclorana occidentalis																+
Burrowing Frogs																
Neobatrachus aquilonius		-/3		-/1	-/2											
Neobatrachus sutor			-/1													
Neobatrachus sp.															2	
Notaden nichollsi				1/16											11	
Total species:	**1**	**1**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	

Note that numbers may represent the same individuals recorded over successive days. + = Opportunistic.

Burrowing species aestivate underground when conditions are dry, so are difficult to sample except immediately after rainfall events. The Desert Spadefoot (*Notaden nichollsi*) prefers to burrow in sand dunes (Tyler and Doughty 2009). These species breed opportunistically after rain and are likely to occur in claypans or in drainage lines associated with hills and ranges in the region, though they can also forage in terrestrial habitats when conditions are suitable.

Frogs may occur throughout the Study Area, potentially breeding anywhere that holds relatively fresh water after rainfall, including claypans and man-made depressions. Many species develop from tadpoles into frogs very quickly, and can make use of ephemeral pools.

5.1.1 Amphibians of Conservation Significance

No frogs of conservation significance are likely to be present in the Study Area.

5.2. Reptiles

There are 116 species of reptile that have the potential to occur, of which 71 were recorded in the Study Area, 70 native species and one introduced (Table 9, Appendix 6). A total of 54 species were recorded during this survey and 53 were recorded in 2016/2017 by Harewood (2017). The majority of species have a widespread distribution across arid central Australia. The reptile assemblage of the Study Area is likely to be informed by substrate (e.g. sandy, clayey or rocky surfaces) and it is also likely to change over time in response to fire. Some species favouring open post-fire habitats and others favouring dense stands of long-unburnt spinifex (Pianka and Goodyear 2012).

Distinct assemblages are likely to be present on the loose sands of sand dunes, consolidated sands of the sandplains and the clay-loam dunes, though there is likely to be some species overlap. For example, *Ctenotus brooksi* and *Ctenotus quattrodecimlineatus* occurred mainly on sand dunes, and *Ctenophorus isolepis* occurs mainly on sandplains, but *Lerista bipes* occurred in both habitats (Table 8). The sand dune, sandplain and clay-loam dune habitats were some of the most species rich in this survey (Table 9).

The low samphire that occurred on the playa edges supports few species, though the Salt Pan Dragon (*Ctenophorus salinarum*) tends to be restricted to samphire and claypan habitats. Other species may range into this habitat to forage, but are likely to rely on adjacent dune habitats for most of their needs.

Two gecko species, *Underwoodisaurus milli* and *Diplodactylus granariensis* were most commonly caught in the gypsum dune habitat (Table 9). The dense leaf litter under the *Casuarina pauper* trees is likely to provide shelter for reptiles in this otherwise open habitat. The rocky hills and stony plains are also likely to support a distinct assemblage of species that favour heavy soils, such as *Ctenophorus reticulatus* and *Diplodactylus pulcher*, or shelter in rock crevices, such as *Egernia formosa*. The heavier clay-loam soils associated with parts of the mulga woodlands also supports some of these species, including *Ctenophorus reticulatus* and the Lozenge-marked Dragon (*Ctenophorus scutulatus*).

Table 9. Reptiles recorded in the Study Area.

Species	Site and habitat															Opportunistic only
	2016/2017 (Harewood 2017)						2018 (this survey)									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Sandplain	Clay-loam dune	Mulga woodland	Sand dune	Mulga woodland	Gypsum dune	Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Geckoes																
Diplodactylus conspicillatus															1	
Diplodactylus granariensis						-/1		11	2					3		
Diplodactylus laevis																+
Diplodactylus pulcher																+
Gehyra purpurescens	1/-						1		3							
Gehyra variegata		1/-						3	1			1	2	8		
Hemidactylus frenatus **(Int.)**																+
Heteronotia binoei																+
Lucasium stenodactylum							1					1	3		1	
Nephrurus laevissimus				1/-			9	2							15	
Nephrurus vertebralis									7			1	5			
Rhynchoedura ornata																+
Strophurus ciliaris		2/-														
Strophurus strophurus													1			
Underwoodisaurus miii						-/1		3	1					6		
Legless lizards																
Aprasia inaurita						1/-										
Delma australis																+
Delma butleri			-/1				1									
Delma nasuta							1			2				1		
Lialis burtonis	1/-				-/1				1							
Pygopus nigriceps				1/-											2	
Dragons																
Ctenophorus caudicinctus			2/-													
Ctenophorus isolepis	1/-									4	1					
Ctenophorus nuchalis		1/-											1			
Ctenophorus reticulatus			6/2	1/-					2							
Ctenophorus salinarum											4	5				
Ctenophorus scutulatus			2/-						6							
Diporiphora amphiboluroides									1							
Moloch horridus																+
Pogona minor				9/1	2/-	-/1							1	1	1	

Table 9 (cont.)

Species	Site and habitat															Opportunistic only
	2016/2017 (Harewood 2017)						2018 (this survey)									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Sandplain	Clay-loam dune	Mulga woodland	Sand dune	Mulga woodland	Gypsum dune	Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Skink Lizards																
Cryptoblepharus buchananii																+
Ctenotus brooksi							4									
Ctenotus calurus																+
Ctenotus dux	5/1			1/3												
Ctenotus grandis	-/1									2						
Ctenotus greeri	2/-			1/-	6/2											
Ctenotus helenae	-/33	-/1	-/7		-/3		1			1			8			
Ctenotus leonhardii	6/23	5/6	17/9		4/8			1	15		7	1			1	
Ctenotus pantherinus	4/34		3/4				1			5						
Ctenotus quattuordecimlineatus	-/1			10/-	-/1		19			1					9	
Ctenotus schomburgkii					11/1				1							
Ctenotus uber	1/-															
Egernia formosa																+
Eremiascincus pallidus																+
Eremiascincus richardsonii								1								
Lerista bipes				-/1			14			10			2		10	
Lerista desertorum								4	1			2	7	10		
Lerista timida						1/		2								
Liopholis inornata			2/-										3			
Liopholis kintorei **(T)**																+
Liopholis striata									6	1		1				
Menetia greyii	3/1	1/1			1/-											
Morethia butleri	4/-	-/1	2/-		1/-											
Morethia ruficauda										1						
Tiliqua multifasciata	2/-															
Goannas																
Varanus eremius	-/1								1	4						
Varanus giganteus																+
Varanus gilleni					-/3											
Varanus gouldii							1		2	2					2	
Varanus tristis		-/1									1				1	
Pythons																
Antaresia stimpsoni																+

Table 9 (cont.)

Species	Site and habitat															Opportunistic only
	2016/2017 (Harewood 2017)						2018 (this survey)									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Sandplain	Clay-loam dune	Mulga woodland	Sand dune	Mulga woodland	Gypsum dune	Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Blind Snakes																
Anilios endoterus																+
Elapid Snakes																
Brachyurophis semifasciatus														1	1	
Furina ornata					-/1											
Demansia psammophis				2/-	-/1											
Parasuta monarchus		1/-														
Pseudonaja modesta				1/1	-/1	1/-										
Pseudonaja mengdeni					-/1		1									
Pseudechis australis	-/1		1/-		1/-											
Simoselaps anomalus		-/1													1	
Simoselaps bertholdi							1	1							1	
Total species:	**16**	**10**	**10**	**10**	**15**	**6**	**13**	**9**	**15**	**11**	**4**	**7**	**10**	**7**	**13**	

Note that numbers may represent the same individuals recorded over successive days. + = Opportunistic.

A suite of species is semi-arboreal and are likely to favour treed habitats across all substrates. This includes species such as the Mulga Dragon (*Diporiphora amphiboluroides*), *Varanus tristis* and *Cryptoblepharus buchananii*, that shelter in tree hollows and tree crevices (Plate 27).

Two records from the Study Area represent range extensions of more than 300km. Both *Delma australis* and the Red-tailed Worm-lizard (*Aprasia inaurita*) were recorded in 2016/2017. The nearest records of the Red-tailed Worm-lizard are to the southeast, from near Rawlinna Station and the Great Victoria Desert Nature Reserve. The nearest records for *Delma australis* are from Goongarrie Station to the southwest. These species are likely to be undersampled rather than rare and the presence of these range extensions highlights the generally undersurveyed nature of the Great Victoria Desert Bioregion.

Plate 27. Mulga Dragon observed in Study Area.

5.2.1 Reptiles of Conservation Significance

There are three reptiles of conservation significance that potentially occur in the Study Area, as listed and discussed below.

Threatened Species

Great Desert Skink *Liopholis kintorei*
This species is listed as Vulnerable under the EPBC Act and Vulnerable under the BC Act.

The **Great Desert Skink** is a large burrowing lizard that occurs patchily across the western deserts region of central Australia (McAplin 2001). Formerly widespread, it has disappeared from much of its range in Western Australia, including the Gibson Desert north of Warburton and the Great Victoria Desert (TSSC 2016a). Great Desert Skinks in the Ngaanyatjarra Indigenous Protected Area and in the Karlamilyi National Park (Gibson Desert) are recognised as key populations in Western Australia (TSSC 2016a).

The Great Desert Skink usually occurs on spinifex sandplains, but is also known to inhabit adjacent dune swales. In the Tanami and parts of the Great Sandy Desert it also occurs in the lateritic soils of paleodrainage lines (McAplin 2001). The Great Desert Skink lives in burrow systems that can be 1m deep and over 10m in diameter. The burrow systems can have multiple entrances and are characterised by the presence of a scat latrine. Up to three generations live in the burrow system. Burrows may remain active for several years, and males move between burrow systems, mating with females across several burrows. Great Desert Skinks hibernate in the cooler months, usually between May/June and September/October.

Threats to the Great Desert Skink include predation after loss of vegetation cover from fire and possibly habitat degradation from feral Camels and Rabbits (TSSC 2016a). With the cessation of traditional land management practices across much of the western deserts region, frequent patch-burning has been replaced by extensive hot fires (McAplin 2001). Fire management to protect the species should focus on prevention of frequent, widespread hot fires, though the needs of other fauna should also be considered (Cadenhead *et al*. 2016). Great Desert Skinks prefer a mosaic of fire ages, favouring areas that have been burnt in the past three to 15 years (McAplin 2001). Both Cats and Foxes are known to prey on the Great Desert Skink. The conservation objective identified in the conservation advice for the species is to "increase the extent of suitable habitat for the species and retain its evolutionary potential across its range" (TSSC 2016a). This is to be achieved through targeted feral predator control at key Great Desert Skink populations and by undertaking prescribed burning with the aim of maximizing ground cover within Great Desert Skink habitat, by reducing the frequency, intensity and size of fires (TSSC 2016a).

The Great Desert Skink was recorded in the Study Area (Front cover image, Plates 28 and 29, Figure 11, Appendix 10). Four burrows were recorded, with the identity of the species confirmed using camera traps and targeted Elliott trapping at burrows. This species potentially occurs anywhere on Spinifex sandplains, but it is likely to be patchily distributed. Despite further searching on sandplains both inside and adjacent to the Study Area, no further burrows could be located. The record of this species is important, as it represents the most southwestern record in recent times, more than 350km southwest of the population at Warburton and 185km south of a 2017 camera record obtained by Greening Australia (2018).

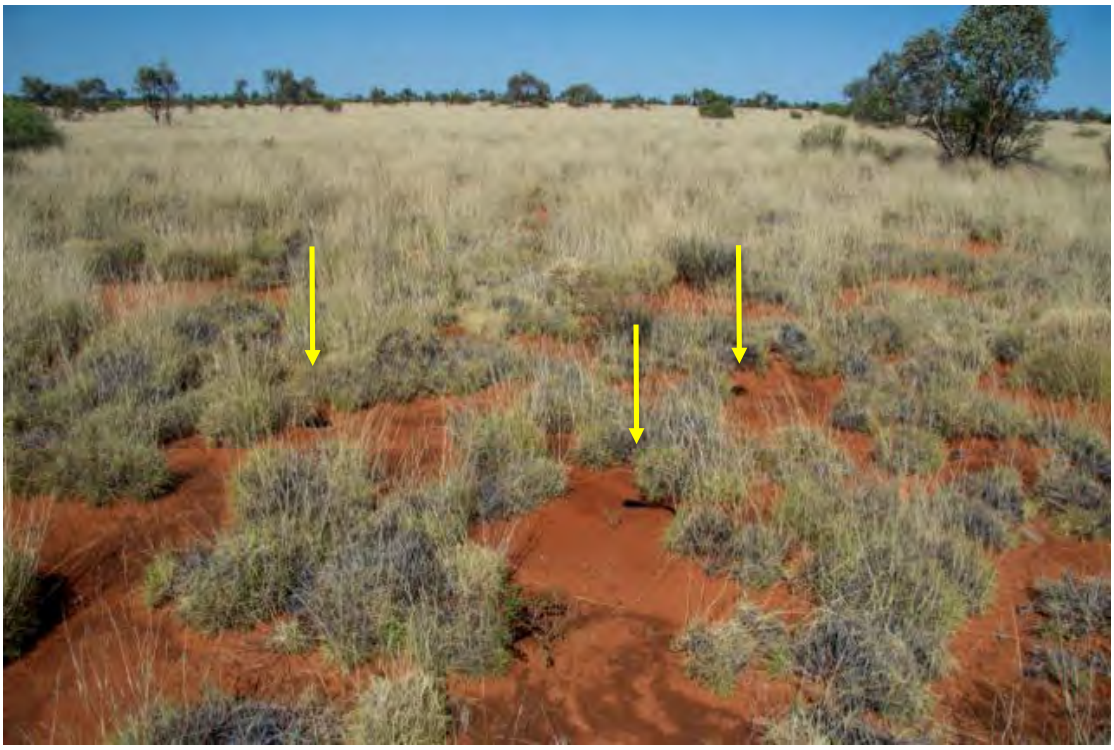


Plate 28. Great Desert Skink burrow system in Spinifex sandplain habitat, arrows showing burrow entrances.

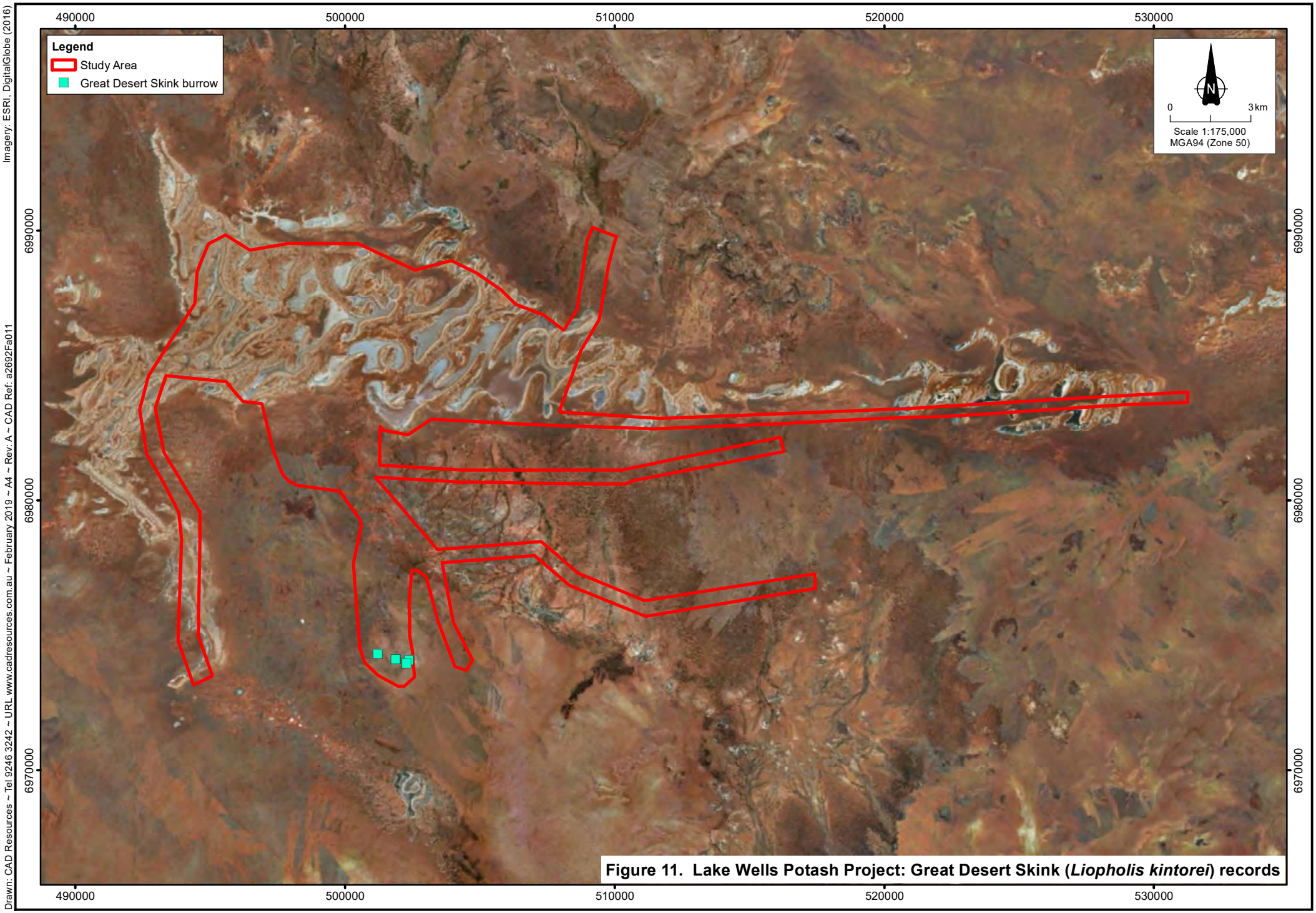


Figure 11. Lake Wells Potash Project: Great Desert Skink (*Liopholis kintorei*) records

Plate 29. Great Desert Skink on camera trap set outside burrow entrance.

Priority Species

Buff-snouted Blind Snake *Anilios margaretae*
This species is listed as Priority 2 by DBCA.

The **Buff-snouted Blind Snake** is a poorly known species, hence its listing as Priority 2. In Western Australia it was first recorded from Lake Throssell (about 120km east-southeast of the Study Area) in 1962 and it is also known from the southern edge of the Great Victoria Desert in South Australia (Wilson and Swan 2017). Although the first record of this species was from Casuarina woodland and playas at Lake Throssell, subsequent records have been from other arid habitats, indicating it is not restricted to a specific habitat type. Although infrequently recorded, the Buff-snouted Blind Snake is listed as 'Least Concern' by the IUCN as it occurs across an area of extensive habitat that appears not to be under threat (IUCN 2019). As this species is so rarely recorded, it is difficult to determine its likelihood of occurrence in the Study Area. It is considered that it may potentially occur, as this species appears to have a large range and potential habitat is present.

Locally significant species

Woma *Aspidites ramsayi*

The **Woma** is a large python that generally occurs in sandy areas. It is secretive, sheltering in burrows that it digs itself or modifies from the burrows of other fauna (Bruton *et al*. 2017). The population in southwest Western Australia is listed as Priority 1 by DBCA as is thought to be declining. However, the population that potentially occurs in the study area is part of the population that extends through the arid interior of Australia and has no formal conservation listing in Western Australia. Threats to the species are thought to include destruction of burrows (though intensive cropping or trampling by livestock) and possibly the historical loss of burrowing mammals (Bruton *et al*. 2017). Predation by cats and foxes appears to be less of a threat due to the Woma's large size, rapid maturation and use of burrows (Bruton *et al*. 2017).

The Woma is listed as locally significant in the Study Area as it is infrequently recorded in the region and as a large terrestrial python, it may be vulnerable to road mortalities. The Woma was not recorded during the fauna survey, but may occur on sandplain habitats.

5.3 Birds

There are 145 species of bird that potentially occur in the Study Area, of which 92 species have been recorded in the Study Area thus far (Appendix 7). A total of 66 species were recorded in 2018 and 84 were recorded in the 2016/2017 survey (Table 10). Many of the species present are likely to use a range of habitats across the Study Area, and though the bird assemblage is likely to vary between more wooded habitats, such as Mulga Woodlands and open habitats, such as Spinifex sandplains, these habitats are widespread in the Bioregion.

Between six and 22 species were recorded at each trapping site in 2018, with further species observed opportunistically across the Study Area (Table 10). Particularly common were the Black-faced Woodswallow (*Artamus cinereus*), Crested Bellbird (*Oreoica gutteralis*), Singing Honeyeater (*Gavicallis virescens*), Yellow-throated Miner (*Manorina flavigula*) and Zebra Finch (*Taeniopygia gutatta*). However, many species were only represented by one or two records.

The bird assemblage is likely to include a core suite of species that is resident in the Study Area, a second group that makes regular or nomadic movements into and through the Study Area and a third group of vagrants, that may occur in the Study Area on occasion. Resident species include many of the small insectivores such as fairywrens, thornbills, whistlers and robins. Resident species are present all year, though their populations may fluctuate in response to rainfall and fire.

Birds that make regular seasonal movements include the Rainbow Bee-eater (*Merops ornatus*), cuckoos and some birds of prey. Honeyeaters are also likely to make seasonal or nomadic movements to take advantage of flowering events. Although not present all year, these species are likely to use the Study Area for foraging, breeding or shelter on a seasonal basis or when conditions are suitable. Wetland dependent bird species, (e.g. ducks, swans, herons, grebes and migratory shorebirds), are also likely to occur as visitors after significant rainfall events. Several species were recorded by Harewood (2017) as one of the survey periods was after rain had inundated the playas and claypans, though this survey was in April and after the primary survey period for migratory shorebirds. No wetland dependent species were recorded in 2018, as the playas and claypans were dry.

Table 10. Birds recorded in the Study Area.

Names in alphabetical order, see Appendix 7 for scientific names.

Species	Site and habitat										Opportunistic
	2016/2017 (Harewood 2017) Note: no individual site data available	2018: Frequency of occurrence, n=6 (this survey)									
		7	8	9	10	11	12	13	14	15	
		Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Australian Bustard	Recorded										+
Australian Hobby											+
Australian Kestrel	Recorded										+
Australian Magpie	Recorded		2						1		
Australian Owlet-nightjar	Recorded										
Australian Pipit	Recorded						3				
Australian Ringneck	Recorded	3	3						1		
Australian Shelduck	Recorded										
Australian Wood Duck	Recorded										
Banded Lapwing	Recorded										
Black Swan	Recorded										
Black-eared Cuckoo	Recorded										
Black-faced Cuckoo-shrike	Recorded								1	3	
Black-faced Woodswallow	Recorded	1	4		3		1	2	2		
Black-winged Stilt	Recorded										
Brown Falcon	Recorded		1		1			1			
Brown Songlark	Recorded										+
Bourke's Parrot	Recorded										
Budgerigar	Recorded		1								
Chestnut Teal	Recorded										
Chestnut-rumped Thornbill	Recorded									1	
Collared Sparrowhawk	Recorded									1	
Common Bronzewing	Recorded										+
Crested Bellbird	Recorded	3	3	1		1		4	2	6	
Crested Pigeon	Recorded		5				2	5	4		
Crimson Chat	Recorded										+
Diamond Dove				2							
Emu	Recorded						1				
Galah	Recorded		6		1			1	1		
Grey Butcherbird	Recorded										+
Grey Shrike-thrush	Recorded		1						1	3	
Grey Teal	Recorded										
Grey-fronted Honeyeater	Recorded										

Table 10 (cont.)

Species	Site and habitat										Opportunistic
	2016/2017 (Harewood 2017) Note: no individual site data available	2018: Frequency of occurrence, n=6 (this survey)									
		7	8	9	10	11	12	13	14	15	
		Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Ground Cuckoo-shrike	Recorded										+
Hoary-headed Grebe	Recorded										
Hooded Robin	Recorded										+
Horsfield's Bronze-cuckoo	Recorded										+
Inland Thornbill	Recorded			1						2	
Jacky Winter	Recorded										
Little Button-quail	Recorded			1							
Little Crow	Recorded										+
Magpie-Lark	Recorded										
Marsh Sandpiper **(Mi)**	Recorded										
Masked Woodswallow	Recorded										
Mistletoebird	Recorded			1					1	3	
Mulga Parrot	Recorded		2								
Orange Chat	Recorded										
Pallid Cuckoo	Recorded										
Pied Butcherbird	Recorded	2	4			1			1	3	
Pied Honeyeater	Recorded										
Pink-eared Duck	Recorded										
Rainbow Bee-eater											+
Red-backed Kingfisher	Recorded										+
Red-browed Pardalote	Recorded	1	1								
Red-capped Plover	Recorded										
Red-capped Robin	Recorded			4				1		1	
Red-kneed Dotterel	Recorded										
Red-necked Avocet	Recorded										
Redthroat	Recorded			2						2	
Rufous Fieldwren	Recorded										
Rufous Songlark	Recorded										+
Rufous Whistler	Recorded			5				1		5	
Rufous-crowned Emu-wren					1						
Singing Honeyeater	Recorded	6	6	2	2	5		5	6	5	
Slaty-backed Thornbill	Recorded			3						3	
Southern Whiteface	Recorded			1							
Spiny-cheeked Honeyeater	Recorded	1	6	1		1		4	5	2	
Splendid Fairy-wren	Recorded			4							

Table 10 (cont.)

Species	Site and habitat										Opportunistic
	2016/2017 (Harewood 2017) Note: no individual site data available	2018: Frequency of occurrence, n=6 (this survey)									
		7	8	9	10	11	12	13	14	15	
		Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Spotted Harrier											+
Spotted Nightjar	Recorded										+
Striated Pardalote	Recorded										
Tawny Frogmouth											+
Torresian Crow	Recorded									1	
Varied Sittella	Recorded										+
Variegated Fairy-wren	Recorded							1		1	
Wedge-tailed Eagle	Recorded									1	
Weebill	Recorded	1		2						6	
Western Bowerbird	Recorded										
Western Gerygone	Recorded									1	
Western Quail-thrush	Recorded										
White-backed Swallow	Recorded						3	3	2		
White-browed Babbler	Recorded										+
White-faced Heron	Recorded										
White-fronted Honeyeater	Recorded	1	2					1	1	2	
White-plumed Honeyeater									1		
White-winged Fairy-wren	Recorded				1	4		2			
White-winged Triller	Recorded										+
Willie Wagtail	Recorded		1				1	3	3	2	
Yelllow-plumed Honeyeater					1				4		
Yellow-rumped Thornbill	Recorded			1							
Yellow-throated Miner	Recorded	1	5		1	2		2	6	1	
Zebra Finch	Recorded	1	2	4	1			2	1		
Total species:		**11**	**18**	**16**	**9**	**6**	**6**	**16**	**19**	**22**	

5.3.1 Birds of Conservation Significance

Two terrestrial birds listed as Migratory under the EPBC Act were listed on databases for the area; the Grey Wagtail (*Motacilla cinerea*) and Yellow Wagtail (*Motacilla flava*). These species are considered unlikely to occur except as occasional vagrants. Both occur around wetlands and are generally recorded in the north of the State (Johnstone and Storr 2004, DoE 2015). They are not included in the list in Appendix 7 and are not discussed further.

There are 16 birds of conservation significance that have been recorded or potentially occur in the Study Area, four threatened species, one specially protected species, ten Migratory species and one Priority species. Each species is listed in the boxes below, and discussed.

Threatened Species

Malleefowl *Leipoa ocellata*
This species is listed as Vulnerable under the EPBC Act and as Vulnerable under the WC Act.

Grey Falcon *Falco hypoleucos*
This species is listed as Vulnerable under the BC Act.

Princess Parrot *Polytelis alexandrae*
This species is listed as Vulnerable under the EPBC Act and as Priority 4 by DBCA.

Night Parrot *Pezoporus occidentalis*
This species is listed as Endangered under the EPBC Act and as Critically Endangered fauna under the BC Act.

The **Malleefowl** occurs in semi-arid shrublands and low woodlands across southern Australia, favouring habitats dominated by mallee eucalypts and/or *Acacia* (Garnett *et al*. 2011). They nest in large mounds that they construct in areas with a sandy substrate and abundant leaf litter (Benshemesh 2007). Key threats to this species include habitat degradation by feral herbivores, altered fire regimes and predation by feral Cats (Benshemesh 2007). The Study Area represents the northernmost extent of the range of this species in Western Australia. There are four records on DBCAs Threatened and Priority Fauna Database, all undated historical records (Table 10, Figure 8). A review of Malleefowl records in the Great Victoria Desert shows that although there are recent records in the south, there are no records after 1990 in the vicinity of the study area (DPAW 2016). It is probable that the Malleefowl is locally extinct in the Study Area, however, as a large, mobile bird species, it may potentially move into the region in times of high productivity.

The **Grey Falcon** may number fewer than 1000 individuals, though it occurs across a large portion of arid and semi-arid Australia with its distribution centered on inland drainages (Garnett *et al*. 2011). It forages over timbered plains, including *Acacia* shrublands, also ranging out onto treeless plains. The Grey Falcon nests in tall trees on watercourses (Garnett *et al*. 2011) and occasionally on man-made structures such as transmission line towers (pers. obs.). Threats to this species are unknown, but may include habitat degradation due to overgrazing or clearing and provision of water in arid areas favouring the closely related Peregrine Falcon (Garnet *et al*. 2011). The Study Area lacks suitable breeding habitat for this species. The Grey Falcon may forage during the non-breeding season, but the species is at the southern limit of its range in the vicinity of the Study Area.

The **Princess Parrot** occurs across inland arid Australia where it inhabits shrublands and open woodlands over Spinifex in the swales between dunes (Garnett *et al*. 2011). There is limited information on population trends, as this species generally occurs in unpopulated areas and can be irruptive (TSSC 2018). The Princess Parrot can congregate in large flocks to breed in response to rainfall events (TSSC 2018). It nests in hollows and has been recorded nesting in River Red Gum (*Eucalyptus camaldulensis*), Marble Gum (*Eucalyptus gongylocarpa*) and Desert Oak (*Allocasuarina decaisneana*) (Garnett *et al*. 2011). Though no threats are known for the species, it may be adversely affected by altered fire regimes and completion with introduced grazing herbivores (Garnett *et al*. 2011). The conservation priority for the species is to undertake active fire management to protect breeding habitat (TSSC 2018). This species potentially occurs as a foraging visitor to the Study Area. Breeding habitat is absent, though stands of Marble Gum occur nearby.

Historically, the **Night Parrot** was recorded across a large range in the arid and semi-arid interior of Australia (Garnett *et al*. 2011). In recent times however, there are very few verified records of the species. Reliable records in recent times are from two main areas, one in western Queensland and one Western Australia (TSSC 2016b). Western Australia records are from Lake Gregory in the north, a site near Wiluna and near the Fortescue Marsh in the Pilbara (NPRT 2019, Davis and Metcalf 2008). There are no recent records of the Night Parrot in this Bioregion. There is an 1896 record from a site that is presumed to be north of Lake Carnegie (about 160km north of the Study Area) of a Night Parrot on a stony rise with Spinifex and Mulga (Storr 1985). There have also been unconfirmed sightings from Lorna Glen (Hamilton *et.al*. 2017), about 180km northwest of the Study Area.

The key habitats for the Night Parrot are thought to be chenopod shrublands and Spinifex grasslands, with the chenopod shrublands a refuge during dry conditions (Garnett *et al*. 2011). Nesting sites are in mature Spinifex, often large ring-forming clumps (DPAW 2017). Foraging habitats are likely to vary across Australia, but include herbs, grasses, grass-like plants, *Sclerolaena spp*. and other chenopods (DPAW 2017). With the reasons for its decline unknown, potential threats to the species remain unconfirmed (TSSC 2016b). Possible threats include predation by feral cats or foxes, human-induced fire and degradation of soil around watering points (TSSC 2016b).

Knowledge about the current distribution and habitat requirements of the Night Parrot in Western Australia is based on very few records. Therefore, there is considerable uncertainty when assessing the likelihood of occurrence of this species. The survey with passive acoustic detectors across 12 sites failed to detect the Night Parrot, however, Spinifex grasslands and chenopod shrublands (on the salt lake) are present and may support this species. The Spinifex observed was generally small and probably unsuitable for roosting or nesting, but around the claypans large prickly shrubs, (*Cratystylis subspinescens*) may provide habitat. The herbs and grasses on the claypans and salt lake playas that may be foraging habitat were heavily impacted by feral herbivores (Plate 12).

Specially Protected Species

Peregrine Falcon *Falco peregrinus*
This falcon is listed as Other Specially Protected Fauna under the BC Act.

The **Peregrine Falcon** is a widespread bird of prey that globally has a very large range and a very large population that appears to be secure (BirdLife International 2018). In Western Australia the population is secure, though this species may experience reductions at a local level due to human disturbance at nesting sites (Debus 1998). The Peregrine Falcon nests mainly on ledges on cliffs or rocky outcrops, and it may also use tall trees (Johnstone and Storr 1998). This species often takes advantage of man-made structures such as abandoned open pits or quarries. The Study Area lacks suitable breeding habitat for this species as the rocky hills present are low and lack cliffs, though it may breed nearby in other ranges. The Peregrine Falcon may forage over the Study Area if breeding nearby, or during the non-breeding season.

Migratory Species

Oriental Plover *Charadrius veredus*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Sharp-tailed Sandpiper *Calidris acuminata*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Red-necked Stint *Calidris ruficollis*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Pectoral Sandpiper *Calidris melanotos*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Wood Sandpiper *Tringa glareola*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Common Sandpiper *Tringa hypoleucos*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Common Greenshank *Tringa nebularia*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Marsh Sandpiper *Tringa stagnatilis*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Gull-billed Tern *Sterna nilotica*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

Fork-tailed Swift *Apus pacificus*
This species is listed as migratory under the EPBC Act and migratory under the BC Act.

The **Oriental Plover**, **Sharp-tailed Sandpiper**, **Red-necked Stint**, **Pectoral Sandpiper**, **Wood Sandpiper**, **Common Sandpiper**, **Common Greenshank** and **Marsh Sandpiper** are migratory shorebirds that occur on inland waterbodies, as well as in coastal habitats. The Oriental Plover favours dry grasslands and open plains, including recently burnt areas (Geering *et al*. 2007). These species are non-breeding summer visitors to Australia, migrating from Siberia and east China through the East Asian-Australasian Flyway (Geering et al. 2007). The Study Area is only likely to be an internationally significant site for these species if it supports 20,000 birds or 1% or more of the flyway population of a species, or a nationally significant site if it supports 2,000 birds or 0.1% or more of the flyway population of a species (DoEE 2017). As a guide to how many individuals this refers to, these criteria are shown in Table 11. Lake Wells is not known to support significant numbers of shorebirds. This may be due to lack of survey effort in this region and/or the ephemeral nature of the foraging resource, though even ephemeral systems can be important (DoEE 2017). Migratory shorebirds are only likely to occur after heavy summer rainfall events when water collects in the claypans and salt lake playas. When the lake is dry, shorebirds will be absent.

Only the Marsh Sandpiper has been recorded in the Study Area, with a single bird recorded during the April 2017 survey (Harewood 2017) (Table 10, Figure 10). Other migratory shorebirds potentially occur on the salt lake playas or claypans after summer rainfall. The habitats in the Study Area are unlikely to support significant numbers of shorebirds, however, no surveys have been undertaken in the peak survey time for these species (December – February).

Table 11. Flyway population estimates and important site criteria for selected shorebirds.

Species	Population criteria (after Hansen *et al*. 2016)		
	Flyway population estimate	1% Flyway population (internationally important)	0.1% flyway population (nationally important)
Sharp-tailed Sandpiper (*Calidris acuminata*)	85,000	850	85
Red-necked Stint (Calidris ruficollis)	475,000	4,750	475
Pectoral Sandpiper (*Calidris melanotos*)	1,220,000 – 1,930,000	12,200	1,220
Wood Sandpiper *(Tringa glareola*)	130,000	1,300	130
Common Greenshank (*Tringa nebularia*)	110,000	1,100	110
Marsh Sandpiper (*Tringa stagnatilis*)	130,000	1,300	130
Common Sandpiper (*Tringa hypoleucos*)	190,000	1,900	190
Oriental Plover (*Charadrius veredus*)	230,000	2,300	230

The **Gull-billed Tern** occurs on sheltered seas and estuaries as well as on inundated inland claypans and salt lakes (Johnstone and Storr 1998). It has been recorded to the north of the Study Area on DBCA's Threatened and Priority Fauna Database (Figure 10). This species is likely to occur on occasion, and may possibly breed on Lake Wells.

The **Fork-tailed Swift** is a non-breeding visitor to Australia between September and April (Boehm 1962, Johnstone and Storr 1998). The bird is primarily observed foraging for insects in proximity to cyclonic weather (Boehm 1962). Although a migratory species, the Fork-tailed Swift has a large range and a large population that appears to be stable (BirdLife International 2018). The Fork-tailed Swift is largely an aerial species and is unlikely to be affected by changes to the Study Area.

Priority Species

Striated Grasswren (sandplain) *Amytornis striatus striatus*
This species is listed as Priority 4 by DBCA.

The sandplain subspecies of the **Striated Grasswren** occurs across much of arid Australia, inhabiting Spinifex sandplains, usually with an overstorey of shrubs or mallee eucalypts (Garnett *et al*. 2011, Johnstone and Storr 2004). It is listed as 'Near Threatened' in the Action Plan for Australian Birds due to its decline in the central and south-eastern parts of its range (Garnett *et al*. 2011). The key threat to the Striated Grasswren is extensive fires that burn mature Spinifex grasslands. The Striated Grasswren was not recorded in the Study Area and there are no nearby records of this species. It potentially occurs in Spinifex sandplains and dune habitats in the Study Area, although some of this area was regenerating after fire at the time of survey.

5.4 Mammals

There are 41 species of mammal that have the potential to occur in the Study Area, of which 32 are native and nine introduced (Appendix 8). A total of 33 species have been recorded from the Study Area thus far, of which 25 are native (including eight species of bat) and eight are introduced. Between two and six native mammals were recorded at each trapping site in 2016/2017 and between three and seven in 2018 (Table 12, Plate 30). The number of dasyurid marsupials recorded was particularly high at ten species, with only the Threatened Sandhill Dunnart (*Sminthopsis psammophila*) and rock-dwelling Woolley's Pseudantechinus (*Pseudantechinus woolleyae*) remaining unrecorded.

The assemblage of small terrestrial mammals is likely to be informed by ground surface, with a different suite of species present on sandy, clayey and rocky substrates. Most species are likely to be widespread across the arid regions of Western Australia. The mammal assemblage is likely to be relatively intact, with the exception of species that are extinct in the Bioregion. Australia has a history of mammal extinctions since European settlement, most likely due to changed fire regimes and the impacts of feral Cats and Foxes (Woinarski *et al*. 2015).

Table 12. Mammals recorded in the Study Area.

Species	Site and habitat															Opportunistic only
	2016/2017 (Harewood 2017)						2018 (this survey)									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Sandplain	Clay-loam dune	Mulga woodland	Sand dune	Mulga woodland	Gypsum dune	Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Echidnas																
Tachyglossus aculeata								+								
Dasyurid marsupials																
Antechinomys laniger																+
Dasycercus blythi **(P4)**										7						
Ningaui ridei	4/1		-/1	2/1						5					6	
Sminthopsis crassicaudata												1				
Sminthopsis dolichura			-/1		-/4				1						1	
Sminthopsis hirtipes													2			
Sminthopsis longicaudata **(P4)**																+
Sminthopsis macroura								2								
Sminthopsis ooldea	4/1		2/-	1/-	1/1										1	
Sminthopsis youngsoni		1/1		2/-	2/-				4							
Kangaroos																
Osphranter robustus	+															+
Osphranter rufus								+			+	+	+			+
Insectivorous Bats																
Austronomus australis																A
Ozimops petersi																A
Chaerophon jobensis																A
Nyctophilus geoffroyi		A														
Saccolaimus flaviventris												A		A		
Chalinolobus gouldii						A	A	A	A	A	A	A			A	
Scotorepens balstoni							A									
Vespadelus finlaysoni														A		
Rodents																
Notomys alexis		2/1	-/1	-/2			3		8	8		2	2		1	
Pseudomys bolami				-/3	-/9			1	1		1			1		
Pseudomys desertor										3					1	
Pseudomys hermannsburgensis		-/11	1/1	1/6	13/6	-/4	6	2	3	5		3			4	

Table 12 (cont.)

Species	Site and habitat															Opportunistic only
	2016/2017 (Harewood 2017)						2018 (this survey)									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Sandplain	Clay-loam dune	Mulga woodland	Sand dune	Mulga woodland	Gypsum dune	Sand dune	Gypsum dune	Mulga woodland	Sandplain	Samphire	Samphire	Clay-loam dune	Gypsum dune	Sand dune	
Introduced Mammals																
Bos taurus							+				+		+			
Camelus dromedarius								+		+						
Canis familiaris									+		+					
Equus asinus																+
Equus caballus							+	+			+	+	+	+		
Felis catus		-/1					+									
Mus musculus	-/1	1/1	-/3		-/3						2	2				
Oryctolagus cuniculus								+			+			+		
Total native species:	3	4	5	6	5	2	4	6	6	6	3	6	3	3	7	
Total introduced species:	1	2	1	0	1	0	3	3	1	1	5	2	2	2	0	

Note that numbers may represent the same individuals recorded over successive days. + = Opportunistic, A = Anabat recording.

Many species favour sandy habitats, including spinifex sandplain, sand dunes, clay-loam dunes and sandier parts of the mulga woodlands. Species such as the Spinifex Hopping Mouse (*Notomys alexis*) occur commonly across sandy areas, though they also range into the sandier parts of mulga woodland (Plate 30). A small suite of species favour stony or rocky habitats, including Woolley's Pseudantechinus (*Pseudantechinus woolleyae*), Long-tailed Dunnart (*Sminthopsis longicaudata*) and Kultarr (*Antechinomys laniger*). These species are unlikely to occur on sandy habitats, unless dispersing between rocky hills.

Bats may forage over much of the Study Area at night, by day roosting in either tree hollows or in caves. Although there are no caves in the Study Area, some cave-roosting species may roost in rock crevices or in caves in nearby hills.

Plate 30. Spinifex Hopping Mice (*Notomys alexis*) in the Study Area.

5.4.1 Mammals of Conservation Significance

There are six mammals of conservation significance that may occur in the Study Area. Each species is listed and discussed below.

Threatened Species

Sandhill Dunnart *Sminthopsis psammophila*
This species is listed as Endangered under the EPBC Act and the BC Act.

Bilby *Macrotis lagotis*
This species is listed as Vulnerable under the EPBC Act and the BC Act.

The **Sandhill Dunnart** has declined significantly in both range and abundance. It is currently known only from the Great Victoria Desert in both Western Australia and South Australia, and the Eyre Peninsula in South Australia (Woinarski *et al*. 2014). The Sandhill Dunnart occurs in Spinifex grasslands on sand dunes, nesting in large Spinifex hummocks (Woinarski *et al*. 2014, Van Dyck and Strahan 2008). A recent survey involving camera trapping for Sandhill Dunnart, including sites in De La Poer Range Nature Reserve and along Lake Wells Road to the south of the Study Area, failed to detect the species nearby, though a dunnart was detected about 320km to the south (Greening Australia 2018). Although recent unpublished work modelling the probable distribution of the Sandhill Dunnart indicates that this species is relatively unlikely to occur in the vicinity of the Study Area, specimens have been recorded about 85km to the southwest of the study area (J. Riley *pers.comm.* 2018).

On the basis on the current known distribution of the species and the habitats available in the Study Area, it is considered possible that the Sandhill Dunnart occurs in the Study Area, but the likelihood is low. If present it may occur on sand dunes or sandplains. A single area of dunes was noted to support potentially suitable unburnt habitat (Figure 12), though this area is relatively isolated. The remaining areas of sandplain and sand dune visited were considered too sparsely vegetated or too recently burnt to currently support the species.

The **Bilby** currently occurs patchily across the Pilbara and inland northern Australia with the total population estimated at less than 10,000 individuals and in decline (Woinarski *et al*. 2014). The Bilby inhabits spinifex on plains and alluvial areas, mulga on ridges and rises and tussock grasslands on uplands and hills (Pavey 2006). Current threats to the Bilby in the northern part of its range include too-frequent fires and introduced herbivores and water-points (TSSC 2016c). Potential threats include predation by Cats and Foxes, land clearing and mining developments (TSSC 2016c). There is a 2012 record of Bilby within 100km on DBCA's Threatened and Priority Fauna Database (Figure 10), though it is based on secondary signs and not a confirmed sighting. The Study Area is outside the modelled distribution of the species as shown on the EPBC Act Protected Matters Search Tool, so with the lack of records in the region, it is uncertain whether the Bilby occurs in the vicinity. As the Bilby can move its home range in response to the changing availability of food (Van Dyck and Strahan 2008), they may not always be present despite suitable habitat being available. If present, the Bilby would favour spinifex sandplains or in mulga over spinifex in the Study Area.

Priority Species

Brush-tailed Mulgara *Dasycercus blythi*
This species is listed as Priority 4 by DBCA.

Long-tailed Dunnart *Sminthopsis longicaudata*
This species is listed as Priority 4 by DBCA.

Southern Marsupial Mole *Notoryctes typhlops*
This species is listed as Priority 4 by DBCA.

Central Long-eared Bat *Nyctophilus major tor*
This species is listed as Priority 3 by DBCA.

The **Brush-tailed Mulgara** is widely distributed across arid Australia, and though its population has declined in the past, it is currently thought to be stable or declining only slowly (Woinarski *et al*. 2014). It is thought that its ability to use a variety of food resources, tolerate severe declines in bodyweight, enter torpor and dig deep burrows has buffered the species from the impacts of feral predators and a variable climate and resource availability (Masters and Dickman 2012). It is therefore listed as of 'Least Concern' in the Action Plan for Australian Mammals 2012 (Woinarski *et al*. 2014). The Brush-tailed Mulgara occurs mostly on Spinifex grasslands, sheltering during the day in burrows.

Tracks, burrows and diggings of the Brush-tailed Mulgara were observed, records were obtained on camera traps and several individuals were trapped at Site 10 (Figure 12, Table 12, Plate 31, front cover image). Secondary evidence (e.g. burrows or tracks) of this species was scarce, but the camera traps were successful at detecting this species at several sites across the Study Area. Although not recorded in 2016, the population of this species is likely to fluctuate from year to year. In the Study Area, this species is likely to occur in the Spinifex sandplains and Mulga woodlands with a spinifex understory.

Plate 31. Brush-tailed Mulgara on camera trap.

The **Long-tailed Dunnart** is associated with breakaways and scree slopes, but also occurs on gravel or stony plains (Van Dyck and Strahan 2008). This species was recorded on a camera trap on rocky hills in the Study Area (Plate 32,Figure 12). This species potentially occurs on low rocky hills and stony plains in the Study Area, and may disperse through adjacent habitats.

Plate 32. Long-tailed Dunnart on camera trap.

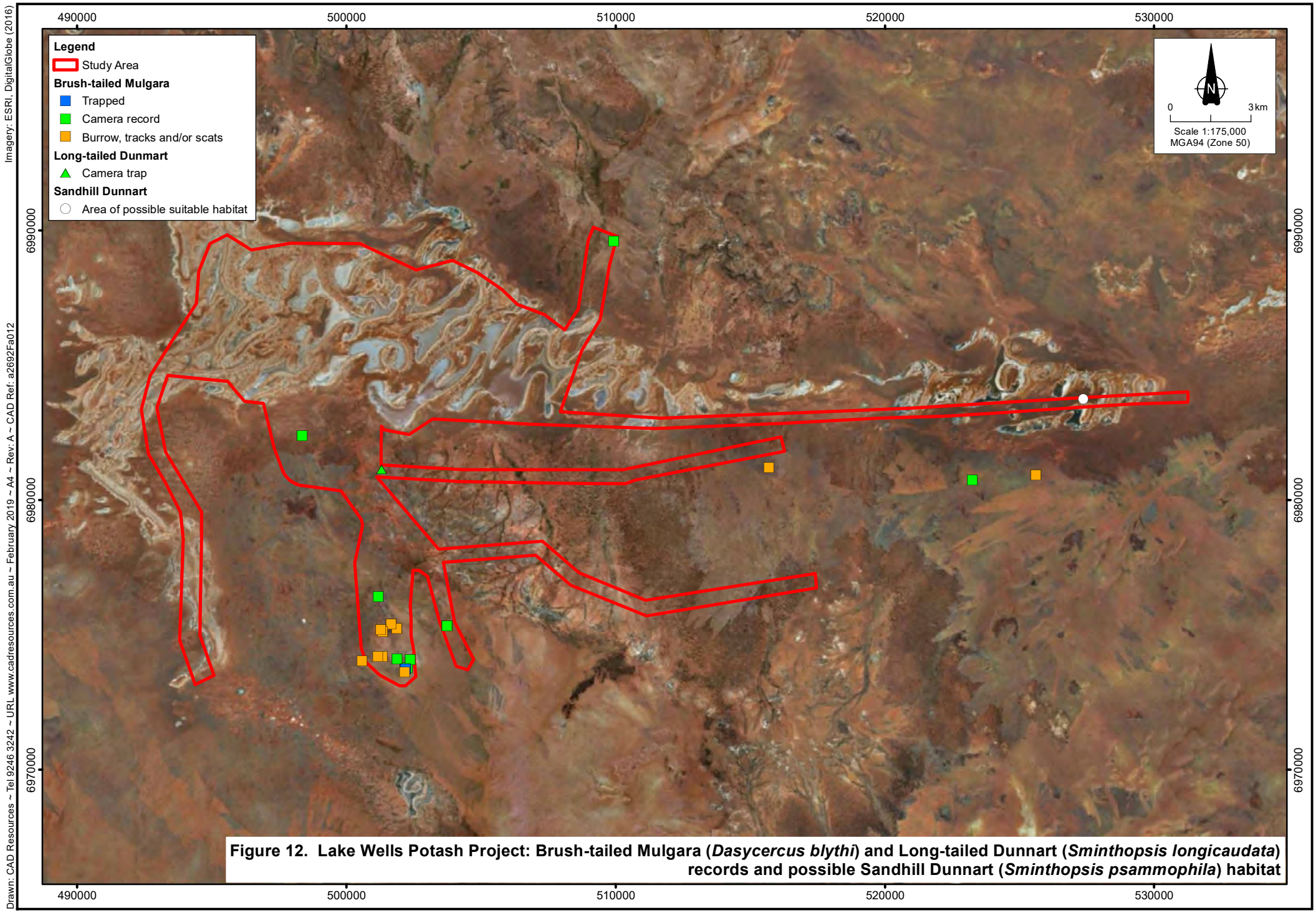


Figure 12. Lake Wells Potash Project: Brush-tailed Mulgara (*Dasycercus blythi*) and Long-tailed Dunnart (*Sminthopsis longicaudata*) records and possible Sandhill Dunnart (*Sminthopsis psammophila*) habitat

The **Southern Marsupial Mole** is widespread across the deserts of central Australia, occurring where its sand dune habitat is present (Woinarski *et al*. 2014). Although there are no robust estimates of population size, there is no evidence of on-going population decline and it is listed as of 'Least Concern' in the Action Plan for Australian Mammals 2012 (Woinarski *et al*. 2014). The Southern Marsupial Mole spends most of its time underground, where it 'swims' through the sand. Its underground lifestyle means that it may be less vulnerable to predation by feral Cats and Foxes (Woinarski *et al*. 2014). The Southern Marsupial Mole potentially occurs throughout the sand dune habitat in the Study Area, though the dunes present tend to be patchy and unconnected compared to the sand dune deserts in the eastern part of the Bioregion.

The **Central Long-eared Bat** occurs across southern central Australia, inhabiting woodlands, mallee and thickets (Woinarski *et al*. 2014). Although there are no estimates of population size, it is not thought to be declining and the there is no evidence that its range has contracted (Woinarski *et al*. 2014). The Central Long-eared Bat potentially occurs in the mulga woodlands of the Study Area. Although *Nyctophilus sp*. were present, this species was not positively identified as the calls of the Central Long-eared Bat are difficult to distinguish from other species of *Nyctophilus* in range (Appendix 11). Therefore, the presence of this species in the Study Area remains unconfirmed.

5.4.2 Feral Mammals

Eight feral mammal species were recorded in the Study Area, with only the Fox (*Vulpes vulpes*) remaining unrecorded (Table 12, Appendix 8). Feral herbivores were common with Horses (*Equus caballus*) being controlled by shooting during the 2018 survey. Rabbits and evidence of Camels (*Camelus dromedarius*) were also common. Camels cause environmental damage through their foraging behaviour and trampling of vegetation, competing with native species for food and shelter (Edwards *et al*. 2008). 'Competition and Land Degradation by Feral Rabbits' is listed as a key threatening process under the EPBC Act.

Plate 33. Feral Cats on Cam 04-1 (left) and Cam 28-1 (right) in the Study Area.

The Cat (*Felis catus*), Fox (*Vulpes vulpes*) and Wild Dog (*Canis familiaris*) are feral predators known to prey on native fauna species. 'Predation by Feral Cats' and 'Predation by the European Red Fox' are listed as a key threatening processes under the EPBC Act. Foxes prey on 'critical weight range' mammals (i.e. those between 35g and 5.5kg) and ground-nesting birds (Commonwealth of Australia 2008). Feral Cats have contributed to the extinction of many small to medium sized native mammals and ground-nesting birds in the arid zone (Commonwealth of Australia 2015a). Though mammals tend to be the dominant prey (Commonwealth of Australia 2015a), each Feral Cat in natural environments kills on average 225 reptiles per year, with cats in arid areas taking even more, equating to the predation of about 1.8 million reptiles per day (Woinarski *et al*. 2018). Though the overall impact on reptile populations remains undetermined, Cats are known to prey on the Great Desert Skink (*Liopholis kintorei*). Predation by Cats and/or Foxes is listed as a threat to many EPBC-listed species, including the Bilby (*Macrotis lagotis*) (Woinarski *et al*. 2014, Commonwealth of Australia 2015a).

The relationships between feral predators are complex, as they may compete for prey, prey on each other or kill to remove a competitor. The presence of one predator, such as a wild dog or dingo, may affect the behaviour or suppress the abundance of smaller species, such as Cats (Commonwealth of Australia 2015b). Also, the presence of feral prey species such as Rabbits (*Oryctolagus cuniculus*) can support Fox populations (Commonwealth of Australia 2008). These complex interactions mean that control of these species is not straightforward, as reducing the population of one species may result in the increase in another.

6. Survey Adequacy

6.1 Species Accumulation Curves

Species accumulation curves were calculated for reptiles (Figure 13), mammals (Figure 14) and birds (Figure 15) in each habitat. For reptiles and small terrestrial mammals, data from both this survey and Harewood (2017) were used. For birds, only the data from this survey was used, as no other systematic data were available.

Estimates of species richness for reptiles, mammals are given in Table 13, using the Chao1 estimator for abundance-based trapping data. Species richness estimates for birds in each habitat are given in Table 14, using the Chao2 estimator for incidence-based bird survey data. These are good indicators of the lower bound of the total species richness with small sample sizes. However, the number of singletons in many samples is high, indicating that the sample size is low and the accuracy of these estimates may be poor.

When interpreting species accumulation curves and estimators of species richness in the context of a Level 2 fauna survey, it is vital to remember that the data collected is influenced by the sampling methods. All sampling methods have inherent biases that favour the detection of some species over others, i.e. some species will be readily trapped and others may be trapped rarely or not at all. Thus the species accumulation curves and estimates of species richness are that of the 'trappable' component of the fauna only. Species may not be trappable if they are temporarily absent from the site (e.g. migratory, nomadic species or irruptive species), are too large to be targeted by standard trapping techniques (e.g. kangaroos) or are shy of entering traps. Fauna may also be patchy in their distribution within a habitat, and may only be trapped if the trapping site intersects their home-range.

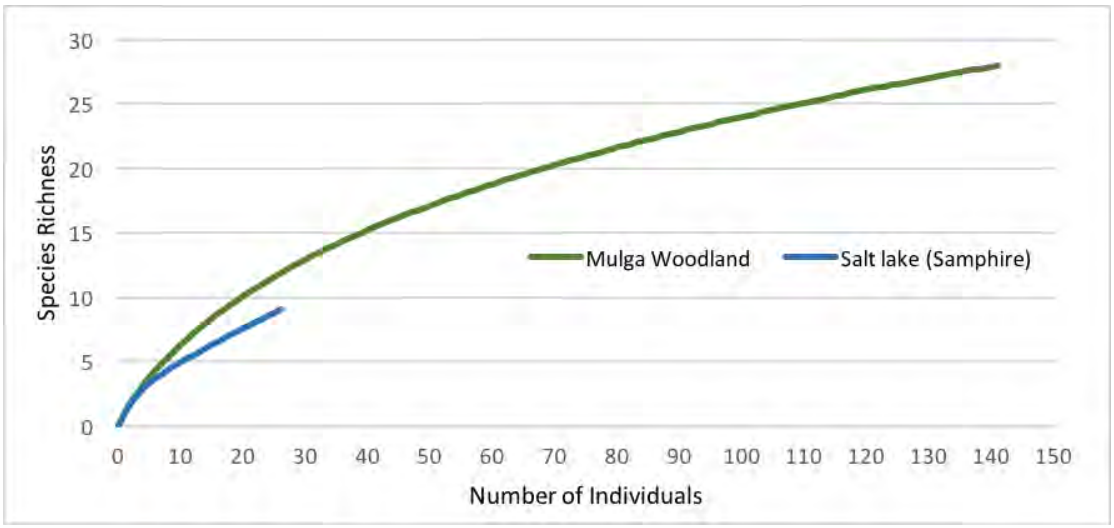
In addition, the trappable component of the fauna is likely to vary due to the prevailing conditions, e.g. frogs may be trappable after heavy rains, but virtually impossible to sample in dry conditions. Long-term drought conditions may reduce some species to undetectable levels, or cool conditions may result in reptiles being inactive.

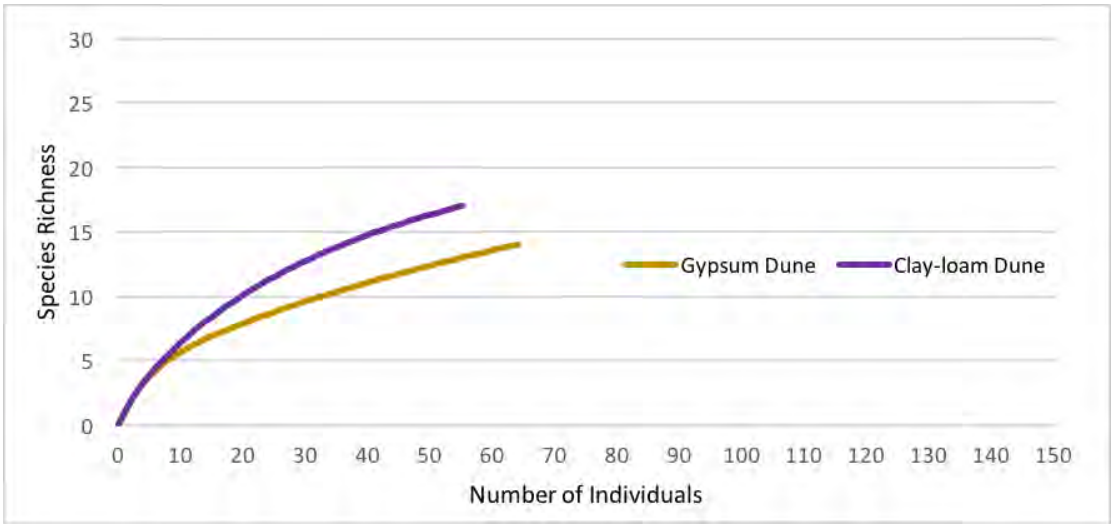
For reptiles, in most cases, the species accumulation curve did not reach asymptote, suggesting that if trapping had continued, more species would have been recorded in each habitat. The exception to this is the reptiles captured on sandplains, which was close to asymptote at 17 species (Table 13).

The species accumulation curves for mammals reached asymptote for most habitats, suggesting that all the trappable species had been recorded. The curves for the sand dune and salt lake (samphire) habitats were close to asymptote, with the Chao1 estimation of species richness only a little higher than the observed species richness (Table 13).

For birds, the species accumulation curves did not reach asymptote, though for the clay-loam dune habitat the estimated species richness was close to the observed species richness. These curves are based only on the 2018 data, so sample sizes were small. Birds are generally more mobile than reptiles and mammal, and are likely to occur across several habitats.

It is important to note that although each habitat supports its own faunal assemblage, individual species can occur across more than one assemblage. This is particularly the case for habitats with similar substrates such as sandplains, sand dunes and clay-loam dunes, or for birds, habitats with similar vegetation structure, such as mulga woodlands and clay-loam dunes. Therefore, even if a species has not been recorded in a particular habitat, it may have been recorded in a similar habitat and still be a part of the overall species inventory for the Study Area.





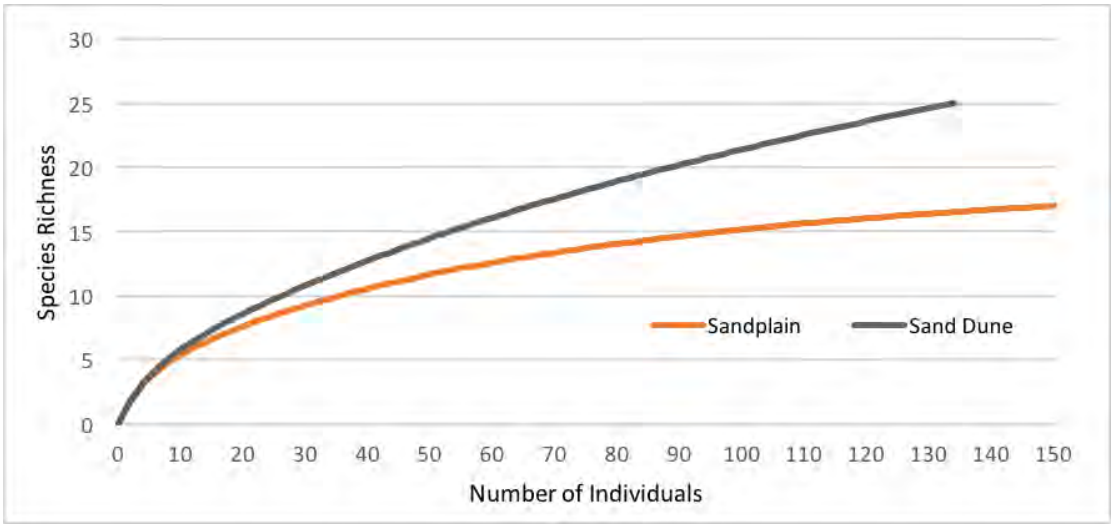


Figure 13. Species accumulation curves for reptiles in each habitat.

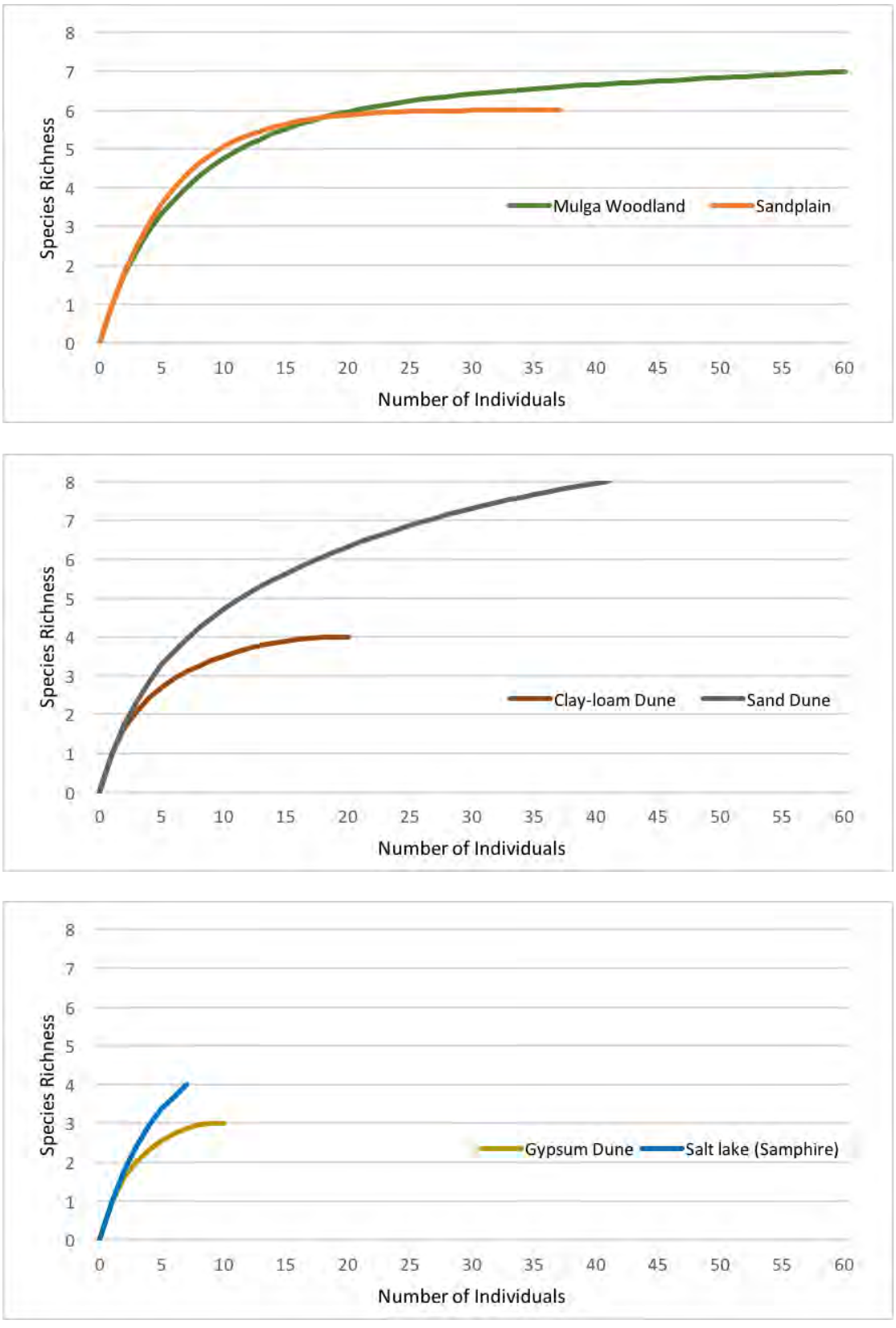


Figure 14. Species accumulation curves for mammals in each habitat.

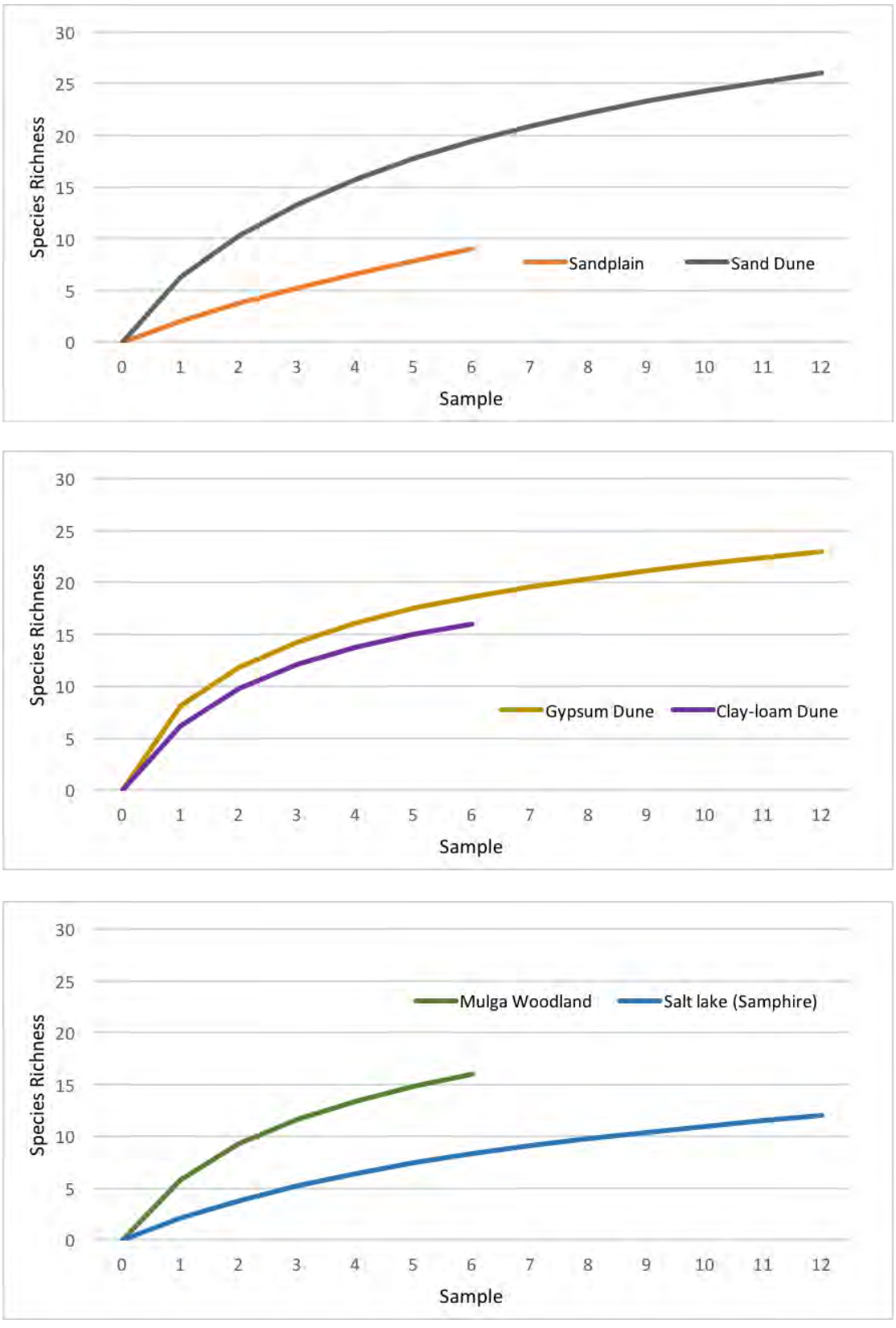


Figure 15. Species accumulation curves for birds in each habitat.

Table 13. Estimated species richness for reptiles and mammals in each habitat.

Species Group	Habitat	Observed species richness	Sample Size (number of individuals)	Number of singletons in the sample	Chao1 Estimate of species richness (±SD)
Reptiles	Sand dune	25	134	13	40.48 ± 11.57
	Gypsum Dune	14	64	7	20.89 ± 7.02
	Sandplain	17	150	4	18.19 ± 1.83
	Clay-loam Dune	17	55	7	21.12 ± 4.27
	Mulga woodland	28	141	12	38.92 ± 8.42
	Salt lake (samphire)	9	26	6	16.21 ± 7.88
Mammals	Sand dune	8	41	2	8.32 ± 0.9
	Gypsum Dune	3	10	0	3.0 ± 0.45
	Sandplain	6	37	0	6.0 ± 0.25
	Clay-loam Dune	4	20	0	4.0 ± 0.47
	Mulga woodland	7	60	1	7.0 ± 0.5
	Salt lake (samphire)	4	7	2	4.42 ± 1.14

Table 14. Estimated species richness for birds in each habitat.

Species Group	Habitat	Observed species richness	Sample Size (number of records)	Number of uniques in the sample	Chao2 Estimate of species richness (±SD)
Birds	Sand dune	26	76	10	37.46 ± 9.84
	Gypsum Dune	23	98	7	29.42 ± 6.57
	Sandplain	9	12	7	17.75 ± 8.9
	Clay-loam Dune	16	38	6	18.5 ± 2.92
	Mulga woodland	16	35	7	19.5 ± 3.7
	Salt lake (samphire)	12	25	6	16.58 ± 5.12

6.2 Proportion of the Fauna Identified

Species accumulation curves are not the complete picture, as they are based only on the systematically collected trapping and bird survey data. Many species are observed opportunistically, and these records often add considerably to the total species inventory of a particular site. The total number of species observed can be compared to the number of species potentially occurring on the site. A total of ten frogs, 116 reptiles, 145 birds, 33 native mammals and nine introduced mammals potentially occur, based on the literature review (Table 7, Appendices 5 - 8). Of these, 50.0% of frogs, 61.2% of reptiles, 63.4% of birds, 75.8% of native mammals and 88.9% of exotic mammals were recorded in the Study Area between 2016 and 2018.

For each species group, at least half the expected species were recorded. As the list of potentially occurring species in Appendices 5 to 8 is relatively conservative, it is quite likely that some of the unrecorded species, though known from the region, do not in fact occur in the Study Area. Bird populations in arid areas are likely to fluctuate markedly in response to local and regional climatic conditions. Potentially occurring species that remain unrecorded include some waterbirds and terrestrial species that may move into the area after summer rains. Of the reptiles that remain unrecorded, many are species that are on the edge of their known range in the Study Area and are not represented by records in the surrounding region. A large proportion of the native mammals were recorded, the few remaining unrecorded including threatened species and one species that favours rocky hills.

It is likely that further work in the survey area will result in more species being recorded. This is the case with all Level 1 and Level 2 fauna surveys, as the short survey periods only provide a 'snapshot' of the fauna occurring in the study area. However, the current survey has resulted in a significant proportion of the fauna being recorded, and field data are supported by a review of the relevant literature.

7. Conclusions

7.1 Faunal Assemblage

The faunal assemblage of the Study Area is likely to be diverse, though many of the species that occur are widely distributed through arid Australia. The predicted faunal assemblage includes up to ten frogs, 116 reptiles, 145 birds and 33 native mammals and nine introduced mammals. The observed assemblage thus far includes five frogs, 71 reptiles, 92 birds and 25 native mammals and eight introduced mammals.

7.2 Conservation Significant Fauna

Twenty-five conservation significant fauna have been recorded or potentially occur in the Study Area, though at least one of these is considered likely to be locally extinct (Table 15). The species have been grouped into their conservation significance categories and discussed below.

1. Threatened species.

Seven threatened species potentially occur in the Study Area, of which one was recorded:

- Great Desert Skink (*Liopholis kintorei*) – **Recorded**
- Malleefowl (*Leipoa ocellata*)
- Grey Falcon (*Falco hypoleucos*)
- Princess Parrot (*Polytelis alexandrae*)
- Night Parrot (*Pezoporus occidentalis*)
- Sandhill Dunnart (*Sminthopsis psammophila*)
- Bilby (*Macrotis lagotis*)

Threatened species are those that are considered in danger of extinction as their populations have declined and/or are still declining, and their total population size is small and/or fragmented or geographically restricted. Sites that support these species may be important for their long-term conservation, particularly if the site supports a resident breeding population.

The Great Desert Skink was recorded on spinifex sandplain in the south of the Study Area (Figure 11). It appeared to be restricted to this area of relatively treeless plain and further searching in sandplain with a greater cover of mallee eucalypts failed to locate it. It is likely that the population extends south of the Study Area, as there are extensive areas of treeless sandplain, though this was not confirmed during the fauna survey. The record of this species is important as it is only the second in this part of its range in more than 40 years. The distribution of this species in and around the Study Area is likely to have been influenced by extensive fires, the presence of feral predators and possibly also by feral horses or camels trampling burrow systems. As a large diurnal lizard, this species may also be susceptible to road mortalities when active during the warmer months. As this species is terrestrial and lives in small groups, even the loss of a few individuals could cause a large impact on a local level.

The status of the Night Parrot, Sandhill Dunnart and Bilby in the Study Area is difficult to assess, as these species are represented very few records in the region and/or very few records overall, so their patterns of distribution and abundance are not clear.

The Night Parrot was not recorded during the survey. However, so little is known about this species in Western Australia, that it is difficult to state with any certainty the likelihood of it occurring, other than to say that the species is very rare and thus has a low likelihood of occurrence at any site. The Study Area has habitats (chenopod shrublands on the salt lake, claypans, spinifex sandplain) that may support the Night Parrot, however, most areas are heavily impacted by feral herbivores and are recently burnt. The Study Area lacks the *Triodia longiceps* habitats that this species is associated with at occupied sites.

The Sandhill Dunnart has recently been recorded 85km to the southwest of the Study Area. This species may possibly occur, though the available habitat is very patchy and it is currently unknown whether its distribution extends as far north as the Study Area.

The Bilby may be a scarce resident or occur in years of high productivity, but it is widely considered to be locally extinct in the subregion (GVDBT 2015). The one nearby record of this species is based on secondary evidence and is thus unconfirmed, and the Study Area is to the south of its current known range of the species.

Study Area is unlikely to provide important habitat for the Malleefowl, Grey Falcon or Princess Parrot. The Grey Falcon and Princess Parrot are not likely to breed in the Study Area, though they may forage on occasion. The Malleefowl appears to be locally extinct, though the Study Area is within its historical range.

2. Migratory species.

Ten Migratory species potentially occur in the Study Area, of which a single species has been recorded:

- Oriental Plover (*Charadrius veredus*)
- Sharp-tailed Sandpiper (*Calidris acuminata*)
- Red-necked Stint (*Calidris ruficollis*)
- Pectoral Sandpiper (*Calidris melanotos*)
- Wood Sandpiper (*Tringa glareola*)
- Common Sandpiper (*Tringa hypoleucos*)
- Common Greenshank (*Tringa nebularia*) - **Recorded**
- Marsh Sandpiper (*Tringa stagnatilis)*
- Gull-billed Tern (*Sterna nilotica*)
- Fork-tailed Swift (*Apus pacificus*)

Migratory species are not always present at a site, but a particular site may have significance as a seasonal or ephemeral foraging, breeding or shelter area. Impacts to these sites may then impact the population both within the site and further afield.

It is unlikely but unknown whether the Study Area provides important habitat for migratory shorebirds. Surveys for shorebirds would need to be undertaken during the summer months, (when the birds are present in Australia), and after sufficient rainfall has occurred to fill the claypans and lake playas to provide foraging habitat. Inland salt lakes are generally undersurveyed as they are remote and inhospitable in summer, so there is also a lack of regional data for comparison.

The Fork-tailed Swift is a Migratory species that is thought to be almost entirely aerial when visiting Australia, so the Study Area is not likely to provide important habitat for this species.

3. Specially Protected species.

A single Specially Protected species potentially occurs in the Study Area:

- Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is likely to occur as a foraging visitor. The Study Area is unlikely to be important for this species as its population is large and secure, and breeding habitat is absent.

4. Priority species

Six Priority species potentially occur in the Study Area, of which two have been recorded:

- Buff-snouted Blind Snake (*Anilios margaretae*)
- Striated Grasswren (*Amytornis striatus striatus*)
- Brush-tailed Mulgara (*Dasycercus blythi*) - **Recorded**
- Long-tailed Dunnart (*Sminthopsis longicaudata*) - **Recorded**
- Southern Marsupial Mole (*Notoryctes typhlops*)
- Central Long-eared Bat (*Nyctophilus major tor*)

The Buff-snouted Blind Snake is data deficient and known from only a few locations. It was not recorded during the fauna survey, though this is unsurprising as only a single blind snake of a common species was recorded (Table 9). Blind snakes are difficult to sample due to their nocturnal and fossorial habits, as they are often only trapped during warm, humid conditions. Although conditions during the 2018 survey appeared suitable, no blind snakes were recorded. This species may occur, but the Study Area is unlikely to provide important habitat as the Buff-snouted Blind Snake occurs across a large part of arid Australia and is not thought to be restricted to a particular habitat type.

The Brush-tailed Mulgara was widely recorded throughout the Study Area. The distribution of this species may be influenced by fire, as they would be more susceptible to predation in open habitats, and extensive fires could cause local extinctions. The Southern Marsupial Mole is less susceptible to the impacts of fire and feral predators due to its subterranean habits, and potentially occurs in sand dunes in and around the Study Area.

The Long-tailed Dunnart was recorded and is likely to be restricted to the rocky hills and surrounding stony plains. It is only likely to range into other habitats when dispersing between isolated rocky hills.

The Central Long-eared Bat and Striated Grasswren may occur in the Study Area, though the habitats that these species rely on are relatively widespread in the region. The presence of the Striated Grasswren is likely to be influenced by fire, as it prefers long-unburnt spinifex habitats. The Central Long-eared Bat, if present, roosts in tree hollows which are present mainly in the gypsum dune, mulga woodland and sandplain habitats.

5. Locally significant species

A single locally significant species is potentially occurs in the Study Area:

- Woma (*Aspidites ramsayi*)

If present, the Woma is likely to occur on the sandplain.

7.3 Important Habitats

All habitats have some importance in that they support native fauna, however, habitats may be of particular importance if they:

- support very diverse or unique faunal assemblages
- are restricted or rare in the region (and thus the faunal assemblages are restricted or rare)
- are refugia (e.g. from drought or fire)
- provide ecological linkage
- support conservation significant fauna

The habitats in the Study Area are common and widespread in the subregion. Habitats around the salt lake may have some local importance as refugia for fauna, where the bare lake bed and complex mosaic of vegetation provides pockets of protection from bushfire. The rocky hills in the study area may be locally important refugia, providing crevices and cracks to shelter fauna, but are unlikely to be regionally important like the larger hills and ranges such as the De La Poer Range. Except on a local scale, the habitats present are unlikely to be important for ecological linkage.

Of the habitats present in the Study Area, the sandplain habitat is important as it provides habitat for the Threatened Great Desert Skink (*Liopholis kintorei*), as well as the Priority 4 Brush-tailed Mulgara (*Dasycercus blythi*).

Table 15. Summary of conservation significant fauna.

Key to status: Cr = Critically Endangered, En = Endangered, Vu = Vulnerable, Mi = Migratory, Sp = Specially Protected, P1 – P4 = Priority 1 – 4, LS = Locally Significant.

Species	Conservation Status				Records within 100km (DBCA 2018, see also Figure 10)	Recorded in Study Area (this survey or Harewood 2017)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area	Explanatory notes
	EPBC Act	BC Act	DBCA Priority	Locally significant						
Threatened Species										
Pezoporus occidentalis **Night Parrot**	En	Cr	-	-	No records within 100km	No	Low (?)	Scarce resident or visitor (if present)	• Sandplain (where old-growth Spinifex present) • Sand dune (where old-growth Spinifex present) • Salt lake (where chenopod shrublands are present)	The paucity of data on this species means it is difficult to state with certainty its potential status in the Study Area. The habitats present lack the *Triodia longiceps* present at known Night Parrot localities but chenopod, claypan and other spinifex habitats are present, though impacted by introduced herbivores.
Sminthopsis psammophila **Sandhill Dunnart**	En	En	-	-	No DBCA records within 100km, but recorded within 85km (J. Riley pers.comm.)	No	Low (?)	Resident (if present)	• Sand dune	Current research on the habitat requirements of this species suggests that it has a low likelihood of occurring in the area, but potentially suitable habitat is present.
Liopholis kintorei **Great Desert Skink**	Vu	Vu	-	-	No records within 100km	Yes	Known to occur	Resident	• Sandplain	This species was recorded on the sandplain during the 2018 fauna survey.

Table 15. (cont.)

Species	Conservation Status				Records within 100km (DBCA 2018, see also Figure 10)	Recorded in Study Area (this survey or Harewood 2017)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area	Explanatory notes
	EPBC Act	BC Act	DBCA Priority	Locally significant						
Leipoa ocellata **Malleefowl**	Vu	Vu	-	-	Four historical records: • Lake Wells, secondary sign (undated) • Lake Wells, dead bird (undated) • Lake Wells, day sighting (undated) • Lake Wells, secondary sign (undated)	No	Very low	Locally extinct	• Unlikely to currently use any habitat in the Study Area, but would have occurred in Mulga woodland.	This species is only known from historical records in the region. No mounds or other evidence was detected during the fauna survey. It is likely that its range has contracted south. As a large diurnal bird with distinctive mounds, it is unlikely that this species would remain unrecorded if still present in the region.
Polytelis alexandrae **Princess Parrot**	Vu	-	P4	-	No records within 100km	-	Moderate	Non-breeding visitor (if present)	• Sandplain	The Study Area lacks breeding habitat, but this wide-ranging species may occur as a foraging visitor. An irruptive species, it may occur in some years and not others.
Macrotis lagotis **Bilby**	Vu	Vu	-	-	Two records (likely to be one duplicated record): • Yilka (2012) • Cosmo Newberry, secondary signs (2012)	-	Very Low	Scarce resident or visitor (if present)	• Sandplain. • May also forage across adjoining habitats.	Though not known to occur as far south as the Study Area, this wide-ranging nocturnal species can be cryptic and therefore difficult to record.

Table 15. (cont.)

Species	Conservation Status				Records within 100km (DBCA 2018, see also Figure 10)	Recorded in Study Area (this survey or Harewood 2017)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area	Explanatory notes
	EPBC Act	BC Act	DBCA Priority	Locally significant						
Falco hypoleucos **Grey Falcon**	-	Vu	-	-	No records within 100km	No	Low	Non-breeding visitor (if present)	• May forage over any habitat	The Study Area lacks breeding habitat for this species and is distant from potential breeding habitat such as larger rivers.
Migratory Species										
Charadrius veredus **Oriental Plover**	Mi	Mi			No records within 100km	No	Moderate	Non-breeding summer visitor	• Claypans • Salt lake playas • Burnt or open areas in other habitats	This species is known to occur at inland sites. It may occur in low numbers.
Calidris acuminata **Sharp-tailed Sandpiper**	Mi	Mi	-	-	No records within 100km	No	Moderate	Non-breeding summer visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species is known to occur on inland waters and may occur in summer after rainfall.
Calidris ruficollis **Red-necked Stint**	Mi	Mi	-	-	No records within 100km	No	Moderate	Non-breeding summer visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species is known to occur on inland waters and may occur in summer after rainfall.

Table 15. (cont.)

Species	Conservation Status				Records within 100km (DBCA 2018, see also Figure 10)	Recorded in Study Area (this survey or Harewood 2017)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area	Explanatory notes
	EPBC Act	BC Act	DBCA Priority	Locally significant						
Calidris melanotos **Pectoral Sandpiper**	Mi	Mi	-	-	No records within 100km	No	Moderate	Non-breeding summer visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species is known to occur on inland waters and may occur in summer after rainfall.
Tringa glareola **Wood Sandpiper**	Mi	Mi	-	-	No records within 100km	No	Moderate	Non-breeding summer visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species is known to occur on inland waters and may occur in summer after rainfall.
Tringa hypoleucos **Common Sandpiper**	Mi	Mi	-	-	No records within 100km	No	Moderate	Non-breeding summer visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species is known to occur on inland waters and may occur in summer after rainfall.
Tringa nebularia **Common Greenshank**	Mi	Mi	-	-	No records within 100km	No	Moderate	Non-breeding summer visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species is known to occur on inland waters and may occur in summer after rainfall.
Tringa stagnatilis **Marsh Sandpiper**	Mi	Mi	-	-	One record: • Lake Wells (2017)	Yes	Known to occur	Non-breeding summer visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species is known to occur on inland waters. A single bird was recorded in April 2017 (Harewood 2017).

Table 15. (cont.)

Species	Conservation Status				Records within 100km (DBCA 2018, see also Figure 10)	Recorded in Study Area (this survey or Harewood 2017)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area	Explanatory notes
	EPBC Act	BC Act	DBCA Priority	Locally significant						
Sterna nilotica **Gull-billed Tern**	Mi	Mi	-	-	Two records: • Unnamed site about 95km NE of the Study Area (1978) • Unnamed site about 95km NE of the Study Area (1980)	No	Moderate	Seasonal visitor, possible breeding visitor	• Salt lake playas (when inundated) • Claypans (when inundated)	This species has been recorded in the region and is known to occur on inland claypans and salt lakes.
Apus pacificus **Fork-tailed Swift**	Mi	Mi	-	-	No records within 100km	No	Moderate	Non-breeding visitor	• May overfly any habitat.	This species is largely aerial in Australia, thought to sleep on the wing. Though not recorded nearby, it occurs across most of Australia.
Specially Protected										
Falco peregrinus **Peregrine Falcon**	-	Sp	-	-	Two records: • Great Central Rd (2007) • Great Central Rd, Cosmo Newberry (2010)	No	Moderate	Non-breeding visitor	• May forage over any habitat.	The Study Area lacks breeding habitat, though potential breeding habitat occurs in nearby hills and ranges. Known to occur in the region, if a pair is nesting nearby they may forage over the Study Area.

Table 15. (cont.)

Species	Conservation Status				Records within 100km (DBCA 2018, see also Figure 10)	Recorded in Study Area (this survey or Harewood 2017)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area	Explanatory notes
	EPBC Act	BC Act	DBCA Priority	Locally significant						
Priority Species										
Anilios margaretae **Buff-snouted Blind Snake**			P2		No records within 100km	No	Moderate (?)	Resident (if present)	• Gypsum Dune • Other habitats (?)	This species is rarely recorded so its requirements are poorly known. It is known to occur at Lake Throssell, another salt lake in the region.
Nyctophilus major tor **Central Long-eared Bat**	-	-	P3	-	No records within 100km	No	Moderate	Resident (if present)	• Mulga woodland • Gypsum dune (more wooded portions)	The Study Area is within the known range of this species, and Mulga potentially provides roosting and foraging habitat.
Amytornis striatus striatus **Striated Grasswren (sandplain)**			P4		No records within 100km	No	Moderate	Resident (if present)	• Sandplain	Though not recorded in the Study Area, this species is known to occur in sandplain habitats in the Great Victoria Desert.

Table 15. (cont.)

Species	Conservation Status				Records within 100km (DBCA 2018, see also Figure 10)	Recorded in Study Area (this survey or Harewood 2017)	Likelihood of Occurrence	Likely Status in Study Area	Potential habitat use in the Study Area	Explanatory notes
	EPBC Act	BC Act	DBCA Priority	Locally significant						
Dasycercus blythi **Brush-tailed Mulgara**			P4		Nine records: • De La Poer Range Nature Reserve (1994) • Lake Wells (2014) • Warburton Rd area (undated) • Six records of *Dasycercus sp*. from Cosmo-Newberry (2012)	Yes	Known to occur	Resident	• Sandplain • Mulga woodland (where there is Spinifex understory and sandier soils)	This species is known to occur in the region and was positively identified in the Study Area from trapped individuals and multiple camera trap records.
Sminthopsis longicaudata **Long-tailed Dunnart**			P4		No records within 100km	Yes	Known to occur	Resident	• Rocky hills • Stony plains	This species was positively identified in the Study Area from a camera trap record.
Notoryctes typhlops **Southern Marsupial Mole**	-	-	P4	-	No records within 100km.	No	Moderate	Resident (if present)	• Sand dunes	Though not recorded in the Study Area, this species is known to occur in sand dune habitats in the Great Victoria Desert.
Locally Significant										
Aspidites ramsayi **Woma**	-	-	-	LS	No records within 100km	No	Low	Resident (if present)	• Sandplain	Though not recorded in the Study Area, this species is known to occur in sandplain habitats in the Great Victoria Desert.

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Appendices.

Appendix 1. Daily weather observations during each survey period.

Data after BOM (2018).

Survey	Date	Minimum	Maximum	Rainfall (mm)
September 2016 (Harewood 2017)	11-Sep-16	9.8	25.8	0.0
	12-Sep-16	8.8	17.9	0.0
	13-Sep-16	5.8	16.7	0.0
	14-Sep-16	6.4	16.6	0.0
	15-Sep-16	3.8	21.9	0.0
	16-Sep-16	8.6	19.1	0.0
	17-Sep-16	4.5	18.3	0.0
	18-Sep-16	6.9	23.5	0.0
	19-Sep-16	9.3	15.0	0.2
	20-Sep-16	1.8	19.5	2.2
April 2017 (Harewood 2017)	24-Apr-17	14.5	24.2	1.4
	25-Apr-17	12.2	23.8	0.0
	26-Apr-17	11.1	22.4	0.0
	27-Apr-17	10.9	20.4	0.0
	28-Apr-17	12.9	23.3	0.0
	29-Apr-17	10.8	23.7	0.0
	30-Apr-17	8.7	24.3	0.0
	01-May-17	9.9	22.9	0.0
November 2018 (this survey)	22-Nov-18	15.3	31.7	0.0
	23-Nov-18	20.6	30.2	0.0
	24-Nov-18	14.4	27.9	0.0
	25-Nov-18	16.7	34.1	0.0
	26-Nov-18	16.1	26.4	0.0
	27-Nov-18	11.3	*	0.0
	28-Nov-18	16.0	34.4	0.0
	29-Nov-18	20.7	39.2	0.0
	30-Nov-18	16.4	35.7	0.0
	01-Dec-18	19.4	32.7	0.0
	02-Dec-18	19.1	29.4	0.0
	03-Dec-18	18.4	37.6	0.4
	04-Dec-18	15.8	38.4	21.0

* no data

Appendix 2. SM4 and Anabat locations.

SM4 (passive acoustic detector) locations

Site	Start Date	Stop Date	Nights Recording	Zone	Easting	Northing
SM4-01-23-11-18	23/11/18	28/11/18	5	51 J	502782	6983514
SM4-01-28-11-18	28/11/18	4/12/18	6	51 J	508805	6986549
SM4-02-23-11-18	23/11/18	28/11/18	5	51 J	499741	6989340
SM4-02-28-11-18	28/11/18	4/12/18	6	51 J	501797	6987149
SM4-03-23-11-18	23/11/18	28/11/18	5	51 J	504626	6987077
SM4-03-28-11-18	28/11/18	4/12/18	6	51 J	501221	6985987
SM4-04-23-11-18	23/11/18	28/11/18	5	51 J	494055	6979331
SM4-04-28-11-18	28/11/18	4/12/18	6	51 J	495490	6985315
SM4-05-23-11-18	23/11/18	28/11/18	5	51 J	520464	6983220
SM4-05-28-11-18	28/11/18	4/12/18	6	51 J	494351	6986642
SM4-06-23-11-18	23/11/18	28/11/18	5	51 J	529176	6983650
SM4-06-28-11-18	28/11/18	4/12/18	6	51 J	494859	6974144

Anabat (bat detector) locations

Site	Date	GPS Co-ordinate	Habitat/Location
Bat 497962-01-12-18	1/12/2018	51 J 500602 6980190	Open mulga woodland (flowering Mulga)
Bat 497962-23-11-18	23/11/2018	51 J 504034 6985894	Gypsum dune (LW Site 08)
Bat 497962-24-11-18	24/11/2018	51 J 508107 6980812	Mulga woodland (LW Site 09)
Bat 497962-25-11-18	25/11/2018	51 J 493454 6977204	Eucalypt woodland on gypsum dune
Bat 497962-26-11-18	26/11/2018	51 J 502210 6973732	Sandplain (LW Site 10)
Bat 497962-27-11-18	27/11/2018	51 J 504677 6983250	Mallee over spinifex on sand dune (LW Site 15)
Bat 497962-28-11-18	28/11/2018	51 J 494696 6977230	Samphire (LW Site 11)
Bat 497962-29-11-18	29/11/2018	51 J 501554 6981588	Degraded mulga woodland, water at tank
Bat 497962-30-11-18	30/11/2018	51 J 500881 6978037	Mallee over spinifex sandplain
Bat 498038-24-11-18	24/11/2018	51 J 500762 6985392	Sand dune (LW Site 07)
Bat 498038-25-11-18	25/11/2018	51 J 501415 6984790	Samphire (LW Site 12)
Bat 498038-26-11-18	26/11/2018	51 J 492762 6982913	Mulga woodland (LW Site 13)
Bat 498038-27-11-18	27/11/2018	51 J 493990 6984659	Gypsum dune (LW Site 14)
Bat 498038-28-11-18	28/11/2018	51 J 507558 6978015	Mulga woodland in drainage line
Bat 498038-29-11-18	29/11/2018	51 J 506417 6980802	Degraded mulga woodland, water at tank
Bat 498038-30-11-18	30/11/2018	51 J 498338 6982407	Mulga woodland

Appendix 3. Targeted transects and search sites.

Site name	Zone	Easting	Northing	Habitat	Date	Distance (km)	Time spent (minutes)
W013_RL	51	516795	6977416	Sand-loam plain	3/12/18	4	60
W014_RL	51	516078	6976687	Sand dunes	3/12/18	2.5	40
W001-JW	51	497802	6981748	Sandplain	26/11/18	3.1	66
W002-JW	51	499016	6981605	Sandplain	26/11/18	3.2	73
W003-JW	51	494937	6986730	Sand dunefield, samphire, gypsum dune	27/11/18	2.8	58
W004-JW	51	508131	6977374	Sand dunefield, samphire, gypsum dune	27/11/18	4	94
W005-JW	51	516078	6976687	Sand dunefield, samphire, gypsum dune	27/11/18	2.4	54
W006-JW	51	509006	6988873	Sandplain, Mallee sandplain, Mulga woodland on sandy-loam	28/11/18	5.3	105
W007-JW	51	501312	6975326	Stony plain, drainage lines	1/12/18	3.5	88
W008-JW	51	505404	6986839	clay-loam dune, claypans	1/12/18	3.5	73
W009-JW	51	501047	6977438	Sandplain, mulga on sandy-loam	1/12/18	3.5	62
W01 MB	51	506087	6980872	Sandplain	26/11/18	2.42	62
W010-JW	51	515614	6981870	clay-loam dune, claypans, mulga woodland, sandplain	2/12/18	5.2	107
W011-JW	51	499487	6982143	Mulga woodland on clay-loam, mallee sandplain	2/12/18	3.8	83
W012-JW	51	506325	6978174	Gypsum dune, samphire, sand dunefield	3/12/18	4.8	100
W013-JW	51	509653	6988841	Stony plain, drainage, mulga on clay-loam	3/12/14	3.5	97
W014-JW	51	527248	6983597	Mulga woodland on clay-loam	3/12/18	4.3	97
W015-JW	51	519612	6983133	Sandplain, mulga on sandy-loam	4/12/18	4.5	128
W016_RL	51	501994	6972804	Sandplain	4/12/18	2.5	50
W02 MB	51	501312	6975326	Sandplain	26/11/18	2.8	104
W03 MB	51	504603	6983911	Samphire, gypsum dune	27/11/18	2.98	61
W04 MB	51	505404	6986839	Gypsum dune, sand dunefield	27/11/18	3.4	72
W05 MB	51	501190	6986044	Gypsum dune, sand dunefield	27/11/18	2.2	43
W06 MB	51	501047	6977438	Sandplain, Mallee sandplain, Mulga woodland on sandy-loam	28/11/18	4.8	100
W07 MB	51	506087	6980872	Stony plain, drainage lines	1/12/18	3.56	74
W08 MB	51	515401	6983069	clay-loam dune, claypans	1/12/18	4.69	84
W09 MB	51	515614	6981870	Sandplain, mulga on sandy-loam	1/12/18	3.93	73
W10 MB	51	498092	6982224	Sandplain, mulga woodland	2/12/18	4.6	104
W11 MB	51	499487	6982143	Mulga woodland on clay-loam	2/12/18	3.5	76
W12 MB	51	494278	6986204	Gypsum dune	3/12/18	4.85	102
W13 MB	51	506325	6978174	Stony plain, drainage lines	3/12/18	4.7	88
W14 MB	51	516795	6977416	Sandplain, mulga on sandy-loam	3/12/18	5.47	59
W15 MB	51	509653	6988841	Sandplain	4/12/18	4.96	119

Appendix 3. (cont.)

Site name	Zone	Easting	Northing	Habitat	Date	Distance (km)	Time spent (minutes)
T001-BM	51	501962	6973804	Spinifex Sandplain	26/11/18	3.3	74
T002-BM	51	501032	6974205	Spinifex Sandplain	26/11/18	2.9	67
T003-BM	51	501953	6974794	Samphire - Salt lake	27/11/18	3	64
T004-BM	51	501044	6974989	Samphire - Salt lake	27/11/18	3	50
T005-BM	51	496080	6985697	Samphire - Salt lake	27/11/18	1.7	28
T006-BM	51	504453	6984094	Spinifex Sandplain	28/11/18	1.7	30
T007-BM	51	503900	6974743	Mulga Woodland on drainage line	29/11/18	0.62	30
T008-BM	51	505204	6986662	Clay/loam plain and closed depression	1/12/18	5	80
T009-BM	51	507476	6978035	Spinifex Sandplain	1/12/18	3.6	76
T010-BM	51	501846	6986336	Spinifex Sandplain	1/12/18	3.1	52
T011-BM	51	493461	6980403	Mulga Woodland over mixed shrubs and/or spinifex	2/12/18	3.7	68
T012-BM	51	501187	6977184	Mulga Woodland over mixed shrubs and/or spinifex	2/12/18	4.6	87
T013-BM	51	525064	6980608	Mulga Woodland over mixed shrubs and/or spinifex	2/12/18	2.2	47
T014-BM	51	504331	6980807	Closed Depression/Clay-Loam Plain/Gypsum Dune	3/12/18	5.3	89
T015-BM	51	520715	6980588	Sandy Clay-loam Plain	3/12/18	3.5	66
T016-BM	51	514321	6983049	Clay-Loam Plain/Gypsum Dune	3/12/18	2.8	48
T017-BM	51	498411	6983253	Closed Depression/Clay-Loam Plain/Gypsum Dune	3/12/18	3	50
T018-BM	51	515069	6981975	Spinifex Sandplain/Clay-loam Plain	4/12/18	2.6	40
T019-BM	51	501084	6974426	Clay-loam Plain/Gypsum Dune	4/12/18	1.4	19
W001_RL	51	499803	6982979	Sandplain	26/11/18	2.5	60
W002_RL	51	500723	6982433	Sandplain	26/11/18	2.5	50
W003_RL	51	510352	6983003	Closed Depression	27/11/18	3	50
W004_RL	51	513070	6981289	Sandplain	28/11/18	2	30
W006_RL	51	519612	6983133	Clay-Loam Plain	1/12/18	5.5	70
W007_RL	51	501994	6972804	Sandplain	1/12/18	3.5	50
W008_RL	51	504603	6983911	Sandplain	1/12/18	2	30
W009_RL	51	501190	6986044	Sand-loam plain	2/12/18	4	60
W010_RL	51	515401	6983069	Sand-loam plain	2/12/18	4.5	75
W011_RL	51	498092	6982224	Clay-Loam Plain	2/12/18	1.5	30
W012_RL	51	494278	6986204	Closed Depression	3/12/18	3	35
W015_RL	51	509006	6988873	Sand-loam plain	3/12/18	3.5	50
S001_BM	51	501535	6981552	Open Mulga woodland (degraded)	30/11/18	-	10
W005_RL	51	527248	6983597	Clay-Loam Plain	29/11/18	-	30

Appendix 4. Camera Trap Locations.

Camera	Zone	Easting	Northing	Habitat	Start date	Stop date	Trap-nights
Cam 02-1	51	494038	6979395	Salt lake samphire	23/11/18	28/11/18	5
Cam 02-2	51	495475	6985285	Salt lake samphire	28/11/18	4/12/18	6
Cam 03-1	51	510393	6980629	Mulga woodland	24/11/18	28/11/18	4
Cam 03-2	51	501130	6981810	Rocky hillslope	29/11/18	4/12/18	5
Cam 04-1	51	498116	6979314	Sandplain	23/11/18	24/11/18	1
Cam 04-2	51	500893	6983577	Sand dunes	24/11/18	30/11/18	6
Cam 04-3	51	498353	6982381	Mulga woodland	30/11/18	4/12/18	4
Cam 05-1	51	505108	6987599	Salt lake samphire	25/11/18	3/12/18	8
Cam 06-1	51	501180	6976404	Sandplain	25/11/18	3/12/18	8
Cam 07-1	51	500584	6980148	Rocky hillslope	25/11/18	3/12/18	8
Cam 08-1	51	515872	6981904	Mulga woodland	24/11/18	28/11/18	4
Cam 08-2	51	501882	6974104	Sandplain	28/11/18	4/12/18	6*
Cam 09-1	51	510106	6976457	Rocky plain	24/11/18	4/12/18	10
Cam 18-1	51	496660	6986082	Gypsum Dune	25/11/18	27/11/18	2
Cam 19-1	51	499920	6989151	Gypsum Dune	23/11/18	27/11/18	4
Cam 19-2	51	502006	6987066	Sand dunes	28/11/18	4/12/18	6
Cam 20-1	51	502273	6973786	Sandplain	24/11/18	4/12/18	10
Cam 21-1	51	520341	6983251	Drainage	23/11/18	28/11/18	5
Cam 21-2	51	494518	6986449	Gypsum dunefield	28/11/18	4/12/18	6
Cam 22-1	51	529135	6983558	Salt lake samphire	23/11/18	28/11/18	5
Cam 22-2	51	502369	6974072	Sandplain	28/11/18	4/12/18	6*
Cam 23-1	51	503733	6975332	Sandplain	24/11/18	4/12/18	10
Cam 25-1	51	506750	6977960	Rocky hillslope	24/11/18	4/12/18	10
Cam 26-1	51	504937	6982725	Sand dunes	25/11/18	29/11/18	4
Cam 26-2	51	494221	6986511	Gypsum Dune	30/11/18	4/12/18	4
Cam 27-1	51	523260	6980745	Sandplain	28/11/18	3/12/18	5
Cam 28-1	51	509722	6983362	Sand dunes	23/11/18	28/11/18	5
Cam 28-2	51	501311	6981135	Rocky hillslope	29/11/18	4/12/18	5
Cam 29-1	51	502135	6985734	Salt lake samphire	25/11/18	3/12/18	8
Cam 31-1	51	494263	6974337	Gypsum dunefield	25/11/18	4/12/18	9
Cam 32-1	51	509934	6989596	Sandplain	24/11/18	4/12/18	10
Cam 35-1	51	509296	6988877	Mulga woodland	24/11/18	4/12/18	10

* Camera set to target Great Desert Skink Burrow.

Appendix 5. Amphibians potentially occurring in the Study Area.

2018 = species recorded in this survey, November/December 2018.
2016 – 17 = species recorded in or adjacent to the Study Area by Harewood (2017).
Peterswald = species recorded in the Peterswald Map Sheet, 85km north-east of the Study Area (Cowan and Burbidge 2014).
Gruyere = species recorded at the Gruyere Project, 100km southeast of the Study Area (Rapallo Environment 2015).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 4).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 4).
ALA = species recorded on the Atlas of Living Australia Database (see Table 4).
TF = species recorded in the area on DBCA's Threatened and Priority Fauna Database (see Table 4).
EPBC = species or species habitat in the area on the EPBC Protected Matters Search Tool (see Table 4).

Species		Conservation Status	Records							
			2018	2016 - 17	Peterswald	Gruyere	WAM	FSDB	TF	EPBC
Pelodraydidae (tree frogs and water-holding frogs)										
Main's Frog	*Cyclorana maini*		+	+			+			
Western Water-holding Frog	*Cyclorana occidentalis*		+				+			
Limnodynastidae (burrowing frogs)										
Centralian Burrowing Frog	*Platyplectrum spenceri*									
Northern Burrowing Frog	*Neobatrachus aquilonius*			+						
Kunapalari Frog	*Neobatrachus kunapalari*									
Desert Trilling Frog	*Neobatrachus sudellae*									
Shoemaker Frog	*Neobatrachus sutor*			+						
Plonking Frog	*Neobatrachus wilsmorei*									
Desert Spadefoot	*Notaden nichollsi*		+	+						
Myobatrachidae (ground frogs)										
Orange-crowned Toadlet	*Pseudophryne occidentalis*									
# frog species expected:		**10**								

Appendix 6. Reptiles potentially occurring in the Study Area.

2018 = species recorded in this survey, November/December 2018.
2016 – 17 = species recorded in or adjacent to the Study Area by Harewood (2017).
Peterswald = species recorded in the Peterswald Map Sheet, 85km north-east of the Study Area (Cowan and Burbidge 2014).
Gruyere = species recorded at the Gruyere Project, 100km southeast of the Study Area (Rapallo Environment 2015).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 4).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 4).
TF = species recorded in the area on DBCA's Threatened and Priority Fauna Database (see Table 4).
EPBC = species or species habitat in the area on the EPBC Protected Matters Search Tool (see Table 4).

Species		Conservation Status	Records							
			2018	2016 - 17	Peterswald	Gruyere	WAM	FSDB	TF	EPBC
Carphodactylidae (knob-tailed geckoes)										
Three-lined Knob-tailed Gecko	*Nephrurus levis*									
Pale Knob-tailed Gecko	*Nephrurus laevissimus*		+	+	+	+				
Midline Knob-tailed Gecko	*Nephrurus vertebralis*		+							
Barking Gecko	*Underwoodisaurus milii*		+	+						
Diplodactylidae (ground geckoes)										
Desert Fat-tailed Gecko	*Diplodactylus laevis*		+							
Fat-tailed Gecko	*Diplodactylus conspicillatus*		+		+	+				
Western Stone Gecko	*Diplodactylus granariensis*		+	+	+					
Western Saddled Ground Gecko	*Diplodactylus pulcher*		+							
Beaded Gecko	*Lucasium dameum*					+				
	Lucasium squarrosus									
	Lucasium stenodactylum		+							
Beaked Gecko	*Rhynchoedura ornata*		+		+	+				
Goldfield's Spiny-tailed Gecko	*Strophurus assimilis*									
Northern Spiny-tailed Gecko	*Strophurus ciliaris*		+							
Jewelled Gecko	*Strophurus elderi*				+	+				
Southern Spiny-tailed Gecko	*Strophurus intermedius*									
	Strophurus strophurus		+	+	+	+				
	Strophurus wellingtonae									
Gekkonidae (geckoes)										
Purple Dtella	*Gehyra purpurescens*		+	+	+	+				
Variegated Dtella	*Gehyra variegata*		+	+	+	+	+			
Asian House Gecko	*Hemidactylus frenatus*	Int.		+						
Bynoe's Gecko	*Heteronotia binoei*		+	+	+	+				
Pygopodidae (legless lizards)										
Red-tailed Worm-lizard	*Aprasia inaurita*			+				+		
	Delma australis			+				+		
	Delma butleri		+	+	+					
	Delma desmosa									
	Delma nasuta		+		+	+				
	Delma petersoni									
Burton's Legless Lizard	*Lialis burtonis*		+	+	+	+				
Hooded Scaly-foot	*Pygopus nigriceps*		+	+	+	+				

Appendix 6. (cont.)

Species		Conservation Status	Records							
			2018	2016 - 17	Peterswald	Gruyere	WAM	FSDB	TF	EPBC
Agamidae (dragon lizards)										
Western Ring-tailed Dragon	*Ctenophorus caudicinctus*			+	+					
Collared Dragon	*Ctenophorus clayi*									
Bicycle Dragon	*Ctenophorus cristatus*									
Mallee Sand Dragon	*Ctenophorus fordi*									
Military Dragon	*Ctenophorus isolepis*		+	+	+	+				
Central Netted Dragon	*Ctenophorus nuchalis*		+	+	+	+				
Painted Dragon	*Ctenophorus pictus*									
Western Netted Dragon	*Ctenophorus reticulatus*		+	+	+	+				
Salt Pan Dragon	*Ctenophorus salinarum*		+							
Lozenge-marked Dragon	*Ctenophorus scutulatus*		+	+	+	+				
Mulga Dragon	*Diporiphora amphiboluroides*		+		+	+				
Grey-striped West'n Desert Dragon	*Diporiphora paraconvergens*				+	+				
	Diporiphora reginae									
Long-nosed Dragon	*Gowidon longirostris*									
Thorny Devil	*Moloch horridus*		+	+		+				
Bearded Dragon	*Pogona minor*		+	+	+	+				
Pebble Dragon	*Tympanocryptis cephalus*									
Scincidae (skink lizards)										
	Cryptoblepharus buchananii		+							
	Cryptoblepharus carnabyi									
	Ctenotus ariadnae									
	Ctenotus brooksi		+		+	+				
	Ctenotus calurus		+		+	+				
	Ctenotus dux			+	+	+	+			
	Ctenotus grandis		+	+	+		+			
	Ctenotus greeri			+			+			
	Ctenotus hanloni									
	Ctenotus helenae		+	+	+	+				
	Ctenotus leae									
	Ctenotus leonhardii		+	+	+	+	+			
	Ctenotus nasutus					+				
Leopard Ctenotus	*Ctenotus pantherinus*		+	+	+	+				
	Ctenotus piankai				+	+	+			
	Ctenotus quattuordecimlineatus		+	+	+	+	+			
	Ctenotus schomburgkii		+	+	+	+				
	Ctenotus severus									
	Ctenotus uber			+	+	+				
Slender Blue-tongue	*Cyclodomorphus melanops*				+					
Southern Pygmy Spiny-tailed Skink	*Egernia depressa*									

Appendix 6. (cont.)

Species		Conservation Status	Records							
			2018	2016 - 17	Peterswald	Gruyere	WAM	FSDB	TF	EPBC
Scincidae (cont.)										
Goldfields Crevice Skink	*Egernia formosa*		+	+						
Western Narrow-banded Skink	*Eremiascincus pallidus*			+	+	+				
Broad-banded Sand Swimmer	*Eremiascincus richardsonii*		+		+					
	Lerista bipes		+	+	+	+	+	+		
	Lerista desertorum		+	+	+	+	+			
	Lerista kingi									
Ribbon Slider	*Lerista taeniata*									
	Lerista timida		+	+	+	+				
Desert Skink	*Liopholis inornata*		+	+	+					
Great Desert Skink	*Liopholis kintorei*	T	+							
Night Skink	*Liopholis striata*		+			+				
Dwarf Skink	*Menetia greyii*			+	+					
	Morethia butleri			+	+					
	Morethia ruficauda		+				+			
	Proablepharus reginae									
Central Blue-tongue	*Tiliqua multifasciata*			+	+					
Western Bluetongue	*Tiliqua occidentalis*									
Varanidae (goanna or monitor lizards)										
Spiny-tailed Goanna	*Varanus acanthurus*									
Short-tailed Pygmy Goanna	*Varanus brevicauda*					+				
Stripe-tailed Pygmy Monitor	*Varanus caudolineatus*									
Pygmy Desert Goanna	*Varanus eremius*		+	+	+					
Perentie	*Varanus giganteus*		+	+	+	+				
Pygmy Mulga Monitor	*Varanus gilleni*			+	+					
Sand Goanna	*Varanus gouldii*		+	+		+	+			
Yellow-spotted Monitor	*Varanus panoptes*					+				
Black-tailed Monitor	*Varanus tristis*		+	+	+	+				
Typhlopidae (blind snakes)										
Dark-spined Blind Snake	*Anilios bicolor*									
Interior Blind Snake	*Anilios endoterus*			+			+	+		
Northern Hook-nosed Blind Snake	*Anilios hamatus*									
Buff-snouted Blind Snake	*Anilios margaretae*	P								
	Anilios waitii									
Boidae (pythons)										
Stimson's Python	*Antaresia stimsoni*		+	+						
Woma	*Aspidites ramsayi*	LS								

Appendix 6. (cont.)

Species		Conservation Status	Records							
			2018	2016 - 17	Perterswald	Gruyere	WAM	FSDB	TF	EPBC
Elapidae (front-fanged snakes)										
Desert Death Adder	*Acanthophis pyrrhus*									
North-western Shovel-nosed Snake	*Brachyurophis approximans*					+				
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolatus*									
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*		+							
Yellow-faced Whipsnake	*Demansia psammophis*			+	+					
Moon Snake	*Furina ornata*			+						
Black-naped Snake	*Neelaps bimaculatus*									
Monk Snake	*Parasuta monachus*			+	+					
Mulga Snake	*Pseudechis australis*		+	+	+	+				
Spotted Mulga Snake	*Pseudechis butleri*									
Ringed Brown Snake	*Pseudonaja modesta*			+	+	+				
Gwardar	*Pseudonaja mengdeni*		+	+						
Desert Banded Snake	*Simoselaps anomalus*		+	+		+				
Jan's Banded Snake	*Simoselaps bertholdi*		+	+						
Rosen's Snake	*Suta fasciata*									
Number of species expected:			**116**							

Appendix 7. Birds potentially occurring in the Study Area.

2018 = species recorded in this survey, November/December 2018.
2016 – 17 = species recorded in or adjacent to the Study Area by Harewood (2017).
Perterswald = species recorded in the Peterswald Map Sheet, 85km north-east of the Study Area (Cowan and Burbidge 2014).
Gruyere = species recorded at the Gruyere Project, 100km southeast of the Study Area (Rapallo Environment 2015).
Birdata = species recorded in the area by Birds Australia 2010 – 2018 (see Table 3).
Atlas = species recorded in the area on Birds Australia's Atlas Database 1998 – 2009 (see Table 4).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 4).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 4).
TF = species recorded in the area on DBCA's Threatened and Priority Fauna Database (see Table 4).
EPBC = species or species habitat in the area on the EPBC Protected Matters Search Tool (see Table 4).

Species	Conservation Status	Records									
		2018	2016 - 17	Peterswald	Gruyere	Birdata	Atlas	WAM	FSDB	TF	EPBC
Dromaiidae (emus)											
Emu *Dromaius novaehollandiae*		+	+	+	+						
Anatidae (ducks & swan)											
Chestnut Teal *Anas castanea*			+								
Grey Teal *Anas gracilis*			+								
Australasian Shoveler *Anas rhynchotis*											
Pacific Black Duck *Anas superciliosus*											
Hardhead *Aythya australis*											
Australian Wood Duck *Chenonetta jubata*			+								
Black Swan *Cygnus atratus*			+								
Pink-eared Duck *Malacorhynchus membranaceus*			+								
Australian Shelduck *Tadorna tadornoides*			+								
Megapodiidae (mound-builders)											
Malleefowl *Leipoa ocellata*	T									+	+
Phasianidae (quails)											
Stubble Quail *Coturnix pectoralis*											
Podicipedidae (grebes)											
Hoary-headed Grebe *Poliocephalus poliocephalus*			+								
Australasian Grebe *Tachybaptus novaehollandiae*											
Ardeidae (herons, egrets, bitterns & night-herons)											
White-faced Heron *Ardea novaehollandiae*			+								
White-necked Heron *Ardea pacifica*											
Accipitridae (osprey, hawks, eagles & harriers)											
Black-shouldered Kite *Elanus caeruleus*											
Square-tailed Kite *Hamirostra isura*											
Black-breasted Buzzard *Hamirostra melanosternon*											
Black Kite *Milvus migrans*											
Whistling Kite *Haliastur sphenurus*					+						
Brown Goshawk *Accipiter fasciatus*					+						
Collared Sparrowhawk *Accipiter cirrocephalus*		+	+								
Little Eagle *Hieraaetus morphnoides*											
Wedge-tailed Eagle *Aquila audax*		+	+	+	+		+				
Spotted Harrier *Circus assimilis*		+									

Appendix 7. (cont.)

Species	Conservation Status	Records									
		2018	2016 - 17	Peterswald	Gruyere	Birdata	Atlas	WAM	FSDB	TF	EPBC
Otididae (bustard)											
Australian Bustard *Ardeotis australis*		+	+	+							
Rallidae (crakes, rails, coots & allies)											
Eurasian Coot *Fulica atra*											
Black-tailed Native-hen *Gallinula ventralis*											
Turnicidae (button-quails)											
Little Button-Quail *Turnix velox*		+	+	+							
Burhinidae (stone-curlews)											
Bush Stone-Curlew *Burhinus grallarius*											
Recurvirostridae (stilts & avocets)											
Banded Stilt *Cladorhynchus leucocephalus*											
Black-winged Stilt *Himantopus himantopus*			+								
Red-necked Avocet *Recurvirostra novaehollandiae*			+								
Charadriidae (plovers, dotterels & lapwings)											
Black-fronted Dotterel *Charadrius melanops*											
Red-capped Plover *Charadrius ruficapillus*			+								
Oriental Plover *Charadrius veredus*	Mi										+
Red-kneed Dotterel *Erythrogonys cinctus*			+								
Inland Dotterel *Peltohyas australis*											
Banded Lapwing *Vanellus tricolor*			+								
Scolopacidae (sandpipers, curlews, stints & allies)											
Sharp-tailed Sandpiper *Calidris acuminata*	Mi										+
Red-necked Stint *Calidris ruficollis*	Mi										
Pectoral Sandpiper *Calidris melanotos*	Mi										
Wood Sandpiper *Tringa glareola*	Mi										
Common Sandpiper *Tringa hypoleucos*	Mi										+
Common Greenshank *Tringa nebularia*	Mi										
Marsh Sandpiper *Tringa stagnatilis*	Mi		+							+	
Laridae (gulls & terns)											
Gull-billed Tern *Sterna nilotica*	Mi									+	
Columbidae (pigeons and doves)											
Common Bronzewing *Phaps chalcoptera*		+	+		+						
Crested Pigeon *Ocyphaps lophotes*		+	+	+	+						
Diamond Dove *Geopelia cuneata*		+									
Cuculidae (cuckoos)											
Pallid Cuckoo *Cacomantis pallidus*			+								
Black-eared Cuckoo *Chrysococcyx osculans*			+								
Horsfield's Bronze-Cuckoo *Chrysococcyx basalis*		+	+	+							
Tytonidae (barn owls)											
Barn Owl *Tyto alba*											

Appendix 7. (cont.)

Species	Conservation Status	Records									
		2018	2016 - 17	Peterswald	Gruyere	Birdata	Atlas	WAM	FSDB	TF	EPBC
Strigidae (hawk owls)											
Southern Boobook *Ninox boobook*					+						
Podargidae (frogmouths)											
Tawny Frogmouth *Podargus strigoides*		+		+							
Caprimulgidae (nightjars)											
Spotted Nightjar *Eurostopodus argus*		+	+	+	+						
Aegothelidae (owlet-nightjars)											
Australian Owlet-Nightjar *Aegotheles cristatus*		+	+		+						
Apodidae (swifts)											
Fork-tailed Swift *Apus pacificus*	Mi										
Alcedinidae (kingfishers)											
Red-backed Kingfisher *Todiramphus pyrrhopygius*		+	+	+	+						
Meropidae (bee-eaters)											
Rainbow Bee-eater *Merops ornatus*		+									
Falconidae (falcons)											
Brown Falcon *Falco berigora*		+	+	+	+						
Australian Kestrel *Falco cenchroides*		+	+	+	+	+					
Australian Hobby *Falco longipennis*		+			+						
Grey Falcon *Falco hypoleucos*	T										
Peregrine Falcon *Falco peregrinus*	Sp									+	
Cacatuidae (cockatoos)											
Galah *Cacatua roseicapilla*		+	+	+	+		+				
Cockatiel *Nymphicus hollandicus*				+	+						
Psittacidae (parrots, lorikeets & rosellas)											
Princess Parrot *Polytelis alexandrae*	T										+
Australian Ringneck *Platycercus zonarius*		+	+	+	+		+				
Mulga Parrot *Platycercus varius*		+	+	+	+						
Bourke's Parrot *Neophema bourkii*			+	+	+						
Scarlet-chested Parrot *Neophema splendens*											
Budgerigar *Melopsittacus undulatus*		+	+	+							
Night Parrot *Pezoporus occidentalis*	T										+
Ptilonorhynchidae (bowerbirds)											
Western Bowerbird *Ptilonorhynchus maculatus guttatus*		+	+	+	+						
Climacteridae (treecreepers)											
White-browed Treecreeper *Climacteris affinis*											

Appendix 7. (cont.)

Species		Conservation Status	Records									
			2018	2016 - 17	Peterswald	Gruyere	Birdata	Atlas	WAM	FSDB	TF	EPBC
Maluridae (fairy-wrens, grasswrens & emu-wrens)												
Striated Grasswren	*Amytornis striatus striatus*	P										
Variegated Fairy-wren	*Malurus lamberti*		+	+	+	+						
White-winged Fairy-wren	*Malurus leucopterus*		+	+	+				+			
Splendid Fairy-wren	*Malurus splendens*		+	+	+	+						
Rufous-crowned Emu-wren	*Stipiturus ruficeps*		+		+							
Meliphagidae (honeyeaters & chats)												
Red Wattlebird	*Anthochaera carunculata*											
Brown Honeyeater	*Lichmera indistincta*											
Black Honeyeater	*Sugomel niger*				+							
Grey Honeyeater	*Lacustroica whitei*				+							
Pied Honeyeater	*Certhionyx variegatus*			+								
Singing Honeyeater	*Gavicalis virescens*		+	+	+	+		+				
Grey-headed Honeyeater	*Ptilotula keartlandi*											
Yellow-plumed Honeyeater	*Ptilotula ornata*		+									
Grey-fronted Honeyeater	*Ptilotula plumula*			+	+	+						
White-plumed Honeyeater	*Ptilotula penicillata*		+									
Yellow-throated Miner	*Manorina flavigula*		+	+	+	+		+				
White-fronted Honeyeater	*Purnella albifrons*		+	+	+			+				
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		+	+	+	+		+				
Crimson Chat	*Epthianura tricolor*		+	+	+			+				
Orange Chat	*Epthianua aurifrons*			+								
Pardalotidae (pardalotes)												
Red-browed Pardalote	*Pardalotus rubricatus*		+	+		+						
Striated Pardalote	*Pardalotus striatus*			+					+			
Acanthizidae (thornbills, gerygones & allies)												
Rufous Fieldwren	*Calamanthus campestris*			+								
Weebill	*Smicrornis brevirostris*		+	+	+	+		+				
Western Gerygone	*Gerygone fusca*		+	+	+							
Redthroat	*Pyrrholaemus brunneus*		+	+	+	+						
Inland Thornbill	*Acanthiza apicalis*		+	+	+	+			+			
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		+	+								
Slender-billed Thornbill	*Acanthiza iredalei iredalei*											
Slaty-backed Thornbill	*Acanthiza robustirostris*		+	+	+	+						
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		+	+	+							
Southern Whiteface	*Aphelocephala leucopsis*		+	+					+			
Banded Whiteface	*Aphelocephala nigricincta*				+							
Pomatostomidae (babblers)												
White-browed Babbler	*Pomatostomus superciliosus*		+	+	+	+		+				

Appendix 7. (cont.)

Species	Conservation Status	Records									
		2018	2016 - 17	Peterswald	Gruyere	Birdata	Atlas	WAM	FSDB	TF	EPBC
Psophodiidae (whipbirds, wedgebills & quail-thrush)											
Western Wedgebill *Psophodes occidentalis*											
Copperback Quail-thrush *Cinclosoma clarum*											
Western Quail-thrush *Cinclosoma marginatum*		+	+	+	+						
Artamidae (woodswallows)											
Masked Woodswallow *Artamus personatus*			+		+						
Black-faced Woodswallow *Artamus cinereus*		+	+	+	+		+				
Little Woodswallow *Artamus minor*				+	+						
Cracticidae (butcherbirds & magpie)											
Grey Butcherbird *Cracticus torquatus*		+	+	+							
Pied Butcherbird *Cracticus nigrogularis*		+	+	+	+		+				
Australian Magpie *Cracticus tibicen*		+	+		+		+				
Campephagidae (cuckoo-shrikes and trillers)											
Black-faced Cuckoo-Shrike *Coracina novaehollandiae*		+	+	+	+						
Ground Cuckoo-shrike *Coracina maxima*		+	+	+	+						
White-winged Triller *Lalage tricolor*		+	+	+							
Neosittidae (sittellas)											
Varied Sitella *Daphoenositta chrysoptera*		+	+	+	+			+			
Oreoicidae (bellbirds)											
Crested Bellbird *Oreoica gutturalis*		+	+	+	+		+	+			
Pachycephalidae (shrike-tits, whistlers and allies)											
Rufous Whistler *Pachycephala rufiventris*		+	+	+	+						
Grey Shrike-thrush *Colluricincla harmonica*		+	+	+	+		+				
Rhipiduridae (fantails)											
Grey Fantail *Rhipidura albiscapa*											
Willie Wagtail *Rhipidura leucophrys*		+	+	+	+						
Monarchidae (flycatchers, monarchs and magpie-lark)											
Magpie-Lark *Grallina cyanoleuca*		+	+		+		+				
Corvidae (ravens and crows)											
Torresian Crow *Corvus orru*		+	+		+						
Little Crow *Corvus bennetti*		+	+	+	+			+			
Petroicidae (robins)											
Red-capped Robin *Petroica goodenovii*		+	+	+	+						
Hooded Robin *Melanodryas cucullata*		+	+	+	+		+				
Jacky Winter *Microeca fascinans*	`		+		+						

Appendix 7. (cont.)

Species	Conservation Status	Records									
		2018	2016 - 17	Peterswald	Gruyere	Birdata	Atlas	WAM	FSDB	TF	EPBC
Hirundinidae (swallows and martins)											
White-backed Swallow *Cheramoeca leucosterna*		+	+								
Welcome Swallow *Hirundo neoxena*											
Tree Martin *Petrochelidon nigricans*					+						
Fairy Martin *Petrochelidon ariel*				+	+						
Locustellidae (warblers, songlarks and grassbirds)											
Rufous Songlark *Cincloramphus mathewsi*		+	+		+						
Brown Songlark *Cincloramphus cruralis*		+	+								
Dicaeidae (flowerpeckers)											
Mistletoebird *Dicaeum hirundinaceum*		+	+								
Estrildidae (grassfinches, sparrows and allies)											
Zebra Finch *Taeniopygia guttata*		+	+	+	+						
Motacillidae (pipits and wagtails)											
Australian Pipit *Anthus australis*		+	+	+							
Number of species expected:		**145**									

Appendix 8. Mammals potentially occurring in the Study Area.

2018 = species recorded in this survey, November/December 2018.
2016 – 17 = species recorded in or adjacent to the Study Area by Harewood (2017).
Peterswald = species recorded in the Peterswald Map Sheet, 85km north-east of the Study Area (Cowan and Burbidge 2014).
Gruyere = species recorded at the Gruyere Project, 100km southeast of the Study Area (Rapallo Environment 2015).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 4).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 4).
TF = species recorded in the area on DBCA's Threatened and Priority Fauna Database (see Table 4).
EPBC = species or species habitat in the area on the EPBC Protected Matters Search Tool (see Table 4).

Species		Conservation Status	Records							
			2018	2016 - 17	Peterswald	Gruyere	WAM	FSDB	TF	EBPC
Tachyglossidae (echidnas)										
Echidna	*Tachyglossus aculeatus*		+	+		+				
Dasyuridae (dasyurid marsupials)										
Kultarr	*Antechinomys laniger*		+							
Brush-tailed Mulgara	*Dasycercus blythi*	P	+		+				+	
Wongai Ningaui	*Ningaui ridei*		+	+	+	+				
Woolley's Pseudantechinus	*Pseudantechinus woolleyae*				+					
Fat-tailed Dunnart	*Sminthopsis crassicaudata*		+							
Little Long-tailed Dunnart	*Sminthopsis dolichura*		+	+						
Long-tailed Dunnart	*Sminthopsis longicaudata*	P	+							
Striped-faced Dunnart	*Sminthopsis macroura*		+		+		+			
Hairy-footed Dunnart	*Sminthopsis hirtipes*		+		+	+				
Ooldea Dunnart	*Sminthopsis ooldea*		+	+						
Sandhill Dunnart	*Sminthopsis psammophila*	T								+
Lesser Hairy-footed Dunnart	*Sminthopsis youngsoni*		+	+						
Thylacomyidae (bilbies)										
Bilby	*Macrotis lagotis*	T							+	
Notoryctidae (marsupial moles)										
Southern Marsupial Mole	*Notoryctes typhlops*	P			+					
Macropodidae (kangaroos & wallabies)										
Euro	*Osphranter robustus*		+	+	+	+				
Red Kangaroo	*Osphranter rufus*		+	+	+	+				
Muridae (rats & mice)										
House Mouse	*Mus musculus*	Int.	+	+	+	+				
Spinifex Hopping Mouse	*Notomys alexis*		+	+	+	+				
Bolam's Mouse	*Pseudomys bolami*		+	+						
Desert Mouse	*Pseudomys desertor*		+		+		+			
Sandy Inland Mouse	*Pseudomys hermannsburgensis*		+	+	+	+	+			
Leporidae (rabbits & hares)										
Rabbit	*Oryctolagus cuniculus*	Int.	+	+		+				
Emballonuridae (sheathtail bats)										
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*		+	+						
Hill's Sheathtail bat	*Taphozous hilli*									

Appendix 8. (cont.)

Species		Conservation Status	Records							
			2018	2016 - 17	Peterswald	Gruyere	WAM	FSDB	TF	EBPC
Molossidae (freetail bats)										
White-striped Freetail Bat	*Austronomus australis*			+						
Northern Freetail Bat	*Chaerephon jobensis*			+						
Inland Freetail Bat	*Ozimops petersi*			+						
Vespertilionidae (ordinary bats)										
Gould's Wattled Bat	*Chalinolobus gouldii*		+	+		+				
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			+						
Central Long-eared Bat	*Nyctophilus major tor*	P								
Inland Broad-nosed Bat	*Scotorepens balstoni*		+	+		+	+			
Finlayson's Cave Bat	*Vespadelus finlaysoni*		+	+		+				
Inland Forest Bat	*Vespadelus baverstocki*									
Canidae (dogs and foxes)										
Dog / Dingo	*Canis familiaris*	Int.	+	+	+	+				
Fox	*Vulpes vulpes*	Int.			+					
Felidae (cats)										
Feral Cat	*Felis catus*	Int.	+	+	+	+				
Equidae (horses and donkeys)										
Donkey	*Equus asinus*	Int.	+	+	+					
Horse	*Equus caballus*	Int.	+	+						
Camelidae (camels)										
Camel	*Camelus dromedarius*	Int.	+	+	+	+				
Bovidae (horned ruminants)										
Cow	*Bos taurus*	Int.	+	+	+	+				
Number of species expected:			**41**							

Appendix 9. EPBC Protected Matters Search Tool results.

Species listed for the area 20km in radius from 26.29ºS, 123.06ºE on the EPBC Act Protected Matters Search Tool.

Species	Status	Author's Comment
Malleefowl *Leipoa ocellata*	Vulnerable	Unlikely to occur (locally extinct).
Night Parrot *Pezoporus occidentalis*	Endangered	May occur.
Princess Parrot *Polytelis alexandrae*	Vulnerable	May occur.
Sandhill Dunnart *Sminthopsis psammophila*	Endangered	May possibly occur.
Fork-tailed Swift *Apus pacificus*	Migratory (marine)	May occur.
Grey Wagtail *Motacilla cinerea*	Migratory (terrestrial)	Unlikely to occur (vagrant to the area).
Yellow Wagtail Motacilla flava	Migratory (terrestrial)	Unlikely to occur (vagrant to the area).
Common Sandpiper *Tringa hypoleucos*	Migratory (wetland)	May occur.
Sharp-tailed Sandpiper *Calidris acuminata*	Migratory (wetland)	May occur.
Pectoral Sandpiper *Calidris melanotos*	Migratory (wetland)	May occur.
Oriental Plover *Charadrius veredus*	Migratory (wetland)	May occur.

Appendix 10. Conservation Significant Fauna Records in the Study Area.

Zone	Easting	Northing	Species	Site	Status	Record Type	Date
51	503733	6975332	*Dasycercus blythi*	Cam 23-1	P4	Camera trap photo	24/11/2018
51	503733	6975332	*Dasycercus blythi*	Cam 23-1	P4	Camera trap photo	24/11/2018
51	509934	6989596	*Dasycercus blythi*	Cam 32-1	P4	Camera trap photo	24/11/2018
51	501180	6976404	*Dasycercus blythi*	Cam 06-1	P4	Camera trap photo	25/11/2018
51	502273	6973786	*Dasycercus blythi*	Cam 20-1	P4	Camera trap photo	25/11/2018
51	502199	6973729	*Dasycercus blythi*	LW Site 10	P4	Trapped	26/11/2018
51	501867	6975245	*Dasycercus blythi*	T002_BM	P4	Burrow	26/11/2018
51	501656	6975404	*Dasycercus blythi*	T002_BM	P4	Burrow	26/11/2018
51	501339	6974204	*Dasycercus blythi*	W001-JW	P4	Burrow, tracks	26/11/2018
51	501173	6974197	*Dasycercus blythi*	W001-JW	P4	Digging	26/11/2018
51	500581	6974032	*Dasycercus blythi*	W001-JW	P4	Burrow, Tracks, Scats	26/11/2018
51	501353	6975115	*Dasycercus blythi*	W002-JW	P4	Burrow	26/11/2018
51	502199	6973729	*Dasycercus blythi*	LW Site 10	P4	Trapped	27/11/2018
51	501271	6975200	*Dasycercus blythi*	W02 MB	P4	Burrow	28/11/2018
51	501882	6974104	*Dasycercus blythi*	Cam 08-2	P4	Camera trap photo	28/11/2018
51	523260	6980745	*Dasycercus blythi*	Cam 27-1	P4	Camera trap photo	28/11/2018
51	502369	6974072	*Dasycercus blythi*	Cam 22-2	P4	Camera trap photo	29/11/2018
51	502199	6973729	*Dasycercus blythi*	LW Site 10	P4	Trapped	29/11/2018
51	502199	6973729	*Dasycercus blythi*	LW Site 10	P4	Trapped	29/11/2018
51	502199	6973729	*Dasycercus blythi*	LW Site 10	P4	Trapped	30/11/2018
51	501311	6981135	*Sminthopsis longicaudata*	Cam 28-2	P4	Camera trap photo	30/11/2018
51	502158	6973604	*Dasycercus blythi*	no site	P4	Burrow, tracks	30/11/2018
51	515692	6981213	*Dasycercus blythi*	W09 MB	P4	Tracks; Burrow	1/12/2018
51	498353	6982381	*Dasycercus blythi*	Cam 04-3	P4	Camera trap photo	1/12/2018
51	502199	6973729	*Dasycercus blythi*	LW Site 10	P4	Trapped	1/12/2018
51	502199	6973729	*Dasycercus blythi*	LW Site 10	P4	Trapped	1/12/2018
51	525608	6980925	*Dasycercus blythi*	T009_BM	P4	Burrow	1/12/2018
51	501216	6974292	*Liopholis kintorei*	W01 MB	Vu	Burrow; Scats	26/11/2018
51	501885	6974100	*Liopholis kintorei*	W001_RL	Vu	Burrow	26/11/2018
51	502370	6974073	*Liopholis kintorei*	W001_RL	Vu	Burrow	26/11/2018
51	502285	6973951	*Liopholis kintorei*	W001_RL	Vu	Burrow	26/11/2018
51	501882	6974104	*Liopholis kintorei*	Cam 08-2	Vu	Camera trap photo	28/11/2018
51	502369	6974072	*Liopholis kintorei*	Cam 22-2	Vu	Camera trap photo	29/11/2018

Appendix 11. Bat Call Analysis

Specialised Zoological

Bat call identification from Lake Wells, WA

Type:	Acoustic analysis
Prepared for:	Western Wildlife Pty Ltd
Date:	17 December 2018
Job No.:	SZ471
Prepared by:	Kyle Armstrong and Yuki Konishi Specialised Zoological ABN 92 265 437 422 Tel 0404 423 264 kyle.n.armstrong@gmail.com http://szool.com.au

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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2018). Bat call identification from Lake Wells, WA. Acoustic analysis. Unpublished report by Specialised Zoological for Western Wildlife Pty Ltd, 17 December 2018, Job number SZ471.

SZ471: *Bat call identification from Lake Wells, WA*

Summary

Bat identifications from acoustic recordings are provided from Lake Wells, north-east of Laverton, Western Australia. Six species of bat were identified as being present (**Tables 1** and **2**). Representative echolocation calls for each identification are illustrated (**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, observation of pulse shape, and the pattern of harmonics. Some calls could not be attributed unambiguously to one species. The calls of long-eared bats *Nyctophilus* spp. are difficult to distinguish from each other, and often from the types of calls that other species make in 'clutter' (close to vegetation or other surfaces). In this report, I have allocated broadband calls with a minimum frequency of c. 40 kHz to the Central Long-eared Bat *Nyctophilus major tor*, and calls with a minimum frequency of c. 40 kHz to the Lesser Long-eared Bat *Nyctophilus geoffroyi*. Trapping is required to make unambiguous identifications of these two species. In addition, calls of the Inland Free-tailed Bat *Ozimops* (=*Mormopterus*) *petersi* can overlap with the variation from calls of Gould's Wattled Bat, so calls of *O. petersi* might be amongst those attributed to *C. gouldii*.

Methods

Data were recorded in full spectrum WAV format with Titley Scientific AnaBat Swift bat detectors (sampling rate 500 kHz, set to turn on automatically at sunset and off at sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong and Aplin 2014; Armstrong et al. 2016) 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 1.8.3 (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 Churchill (2008), and nomenclature follows Jackson and Groves (2015).

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general locality of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a site visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design of this bat survey, including its timing, recording site placement, nor degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.

References

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

Armstrong, K.N. and Aplin, K.P. (2014). Identifying bats in an unknown acoustic realm using a semi-automated approach to the analysis of large full spectrum datasets. Oral presentation at the 16th Australasian Bat Society Conference 22–25 April 2014, Townsville, Queensland. *The Australasian Bat Society Newsletter* 42: 35–36.

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

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

EMBALLONURIDAE	
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Inland Broad-nosed Bat	*Scotorepens balstoni*
Finlayson's Cave Bat	*Vespadelus finlaysoni*
Ambiguous	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*
Central Long-eared Bat	*Nyctophilus major tor*

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

Date	Coordinates	*C. gouldii*	*N. geoffroyi*	*N. major tor*	*S. balstoni*	*S. flaviventris*	*V. finlaysoni*
AnaBat Swift 497962							
23/11/2018	26.105533 S, 127.747040 E	◆	NC	—	—	—	—
24/11/2018	26.097422 S, 127.775002 E	◆	NC	NC	—	—	—
25/11/2018	26.090715 S, 127.811757 E	◆	NC	NC	—	◆	◆
26/11/2018	26.090715 S, 127.811757 E	◆	—	—	—	—	—
27/11/2018	26.082218 S, 127.723785 E	◆	—	NC	—	—	—
28/11/2018	26.076362 S, 127.722762 E	◆	NC	—	—	—	—
29/11/2018	26.057737 S, 127.541523 E	◆	NC	NC	—	◆	◆
30/11/2018	26.057725 S, 127.541493 E	◆	NC	NC	◆	—	—
1/12/2018	26.120248 S, 127.689888 E	◆	NC	NC	—	◆	—
AnaBat Swift 498038							
24/11/2018	27.254487 S, 123.008238 E	◆	NC	NC	◆	—	—
25/11/2018	27.259113 S, 123.015782 E	◆	NC	NC	—	◆	—
26/11/2018	27.276708 S, 122.926837 E	—	NC	NC	—	—	—
27/11/2018	27.260913 S, 122.939367 E	—	NC	NC	—	◆	◆
28/11/2018	27.320938 S, 123.076383 E	◆	NC	NC	◆	—	—
29/11/2018	27.295462 S, 123.064983 E	◆	NC	NC	◆	◆	◆
30/11/2018	27.295462 S, 123.064983 E	◆	NC	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.

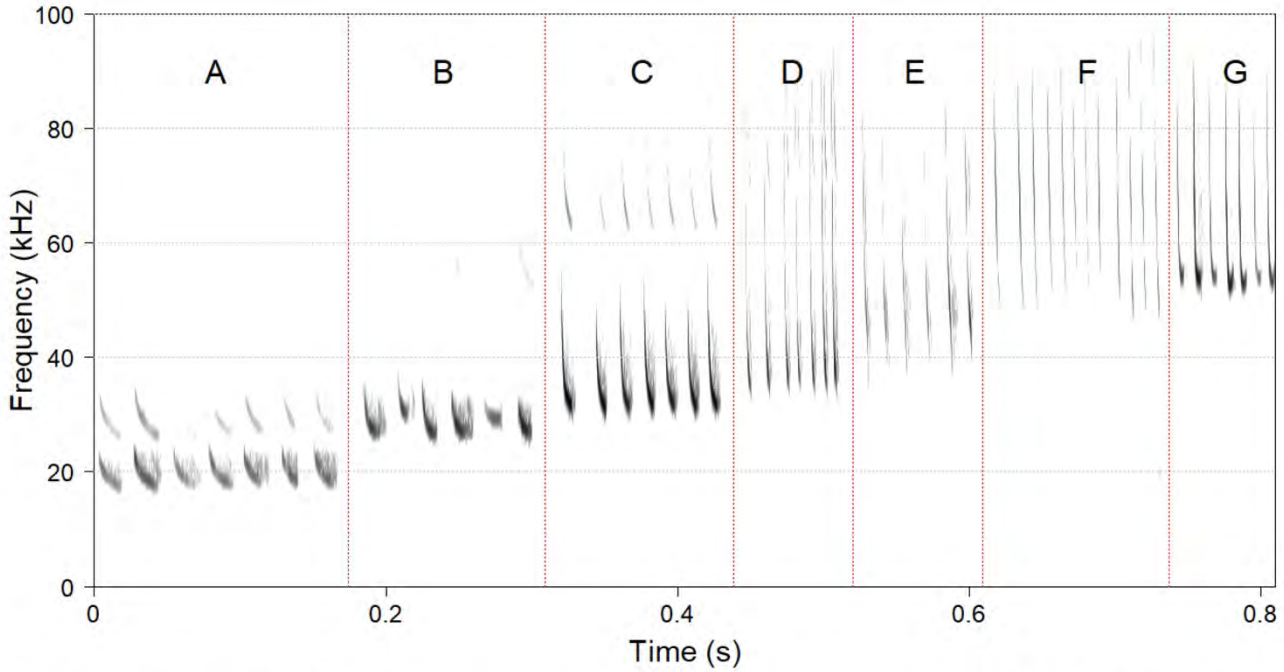

Figure 1. Representative echolocation call sequence portions of the species identified (**A**: *Saccolaimus flaviventris*; **B,C**: *Chalinolobus gouldii*; **D**: *Scotorepens balstoni*; **E**: *Nyctophilus major tor?*; **F**: *Nyctophilus geoffroyi?*; **G**: *Vespadelus finlaysoni*; time between pulses has been compressed).