Biota Environmental Sciences

Caramulla Miscellaneous Licence Level 1 and Targeted Vertebrate Fauna Survey

Prepared for BHP WAIO

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Caramulla Vertebrate Fauna Survey

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1.0 Summary

1.1 Background

Biota Environmental Sciences (Biota) was commissioned by BHP WAIO to undertake a single-phase Level 1 targeted vertebrate fauna survey to document vertebrate fauna of conservation significance and fauna habitats within the Caramulla Miscellaneous Licence (hereafter referred to as the 'study area'), a 6,935 ha area located approximately 60 km east of Newman.

The purpose of this assessment is to present zoological and ecological information on the study area through desktop review and field survey, to enhance the level of knowledge at the locality scale and place this into context at the regional scale. The purpose of this report is to inform future environmental assessment in relation to the study area.

1.2 Methodology

A desktop review of relevant database records and past surveys from the locality was undertaken to identify conservation significant fauna known from, or potentially occurring within, the study area and to inform survey design and preliminary habitat mapping.

The field survey was conducted from March 9 to 18, 2020 in accordance with Environmental Protection Authority (EPA) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) guidance.

Sampling effort within the study area included:

- Targeted searches conducted at 19 sites with over 97 km walked and a total search effort of 45 hours;
- Nocturnal searches conducted at four sites with over 17 km walked and a total search effort of over 11 hours;
- Deployment of remote infrared motion cameras primarily to target ground-dwelling mammals and the Night Parrot at eight sites for a total of 46 nights;
- Deployment of SongMeter echolocation call recorders targeting the bat assemblage at six locations for a total of 30 recording nights;
- Deployment of SongMeter acoustic call recorders targeting Night Parrots at four locations for six consecutive nights for a total 30 nights;
- Avifauna censuses conducted twice at each of five sites, totaling five hours of dedicated unbounded area searches;
- Fauna landscape mapping and habitat assessment; and
- Non-systematic survey activities including night-spotting, ground foraging, identification of secondary signs and opportunistic records.

1.3 Results

1.3.1 Vertebrate Species

Based on the desktop review, a total of 356 vertebrate species, comprising 25 native and nine introduced non-volant mammal species, 14 bat species, nine amphibian species, 134 reptile species and 165 bird species, were identified as potentially occurring in the study area locality. Of these, 28 are State and Commonwealth listed conservation significant fauna species.

A total of 93 vertebrate species were recorded during the survey, including two bird and one bat species not previously recorded from the study area locality.

No conservation significant species were recorded within the study area during the current survey or previous surveys, however it was determined that eight conservation significant species

identified from the desktop review are likely to occur or may occur within the study area:

- Bilby, *Macrotis lagotis* (Vulnerable under both the EPBC Act and the *Biodiversity Conservation Act 2016*);
- Pilbara Olive Python, *Liasis olivaceus barroni* (Vulnerable under both the EPBC Act and the *Biodiversity Conservation Act 2016*);
- Brush-tailed Mulgara, *Dasycercus blythi* (Priority 4 listed by the Department of Biodiversity Conservation and Attractions (DBCA));
- Western Pebble-mound Mouse, *Pseudomys chapmani* (Priority 4 listed by DBCA);
- Princess Parrot, *Polytelis alexandrae* (Vulnerable under the EPBC Act; Priority 4 listed by DBCA);
- Fork-tailed Swift, *Apus pacificus* (Migratory under the EPBC Act);
- Glossy Ibis, *Plegadis falcinellus* (Migratory under the EPBC Act); and
- Peregrine Falcon, *Falco peregrinus* (Other Specially Protected Fauna under the *Biodiversity Conservation Act 2016*).

While these conservation significant species may utilise the study area, none are expected to be restricted to the study area.

1.3.2 Vertebrate Fauna Habitats

Four fauna landscapes were identified: sandy drainage systems, sandy *Triodia* plains, sandy clay loam Mulga dominated Floodplains, and rocky hills.

Based on desktop and field survey results, three species listed under the EPBC Act as Matters of National Environmental Significance (MNES) are likely to occur or may occur within the study area (Bilby, Olive Python and Princess Parrot) and all may utilise the three dominant fauna landscapes, mainly as foraging habitat, especially after flooding events.

All three fauna landscapes identified as having the potential to be utilised by MNES species within the study area are common within the locality and occur contiguously with the same habitat types outside of the study area.

2.0 Introduction

2.1 Project Background and Purpose

BHP Western Australia Iron Ore (BHP WAIO) required assessment of the Caramulla miscellaneous licence, an area located approximately 60 km east of Newman, encompassing approximately 6,935 ha, hereafter referred to as the 'study area' (see Figure 2.1). The study area encompasses active and non-active BHP Geoscience (Exploration) tenure, land off BHP tenure, Pastoral Lease and Unallocated Crown Land. In addition, for context, BHP WAIO also required assessment of up to three potential bat roosting sites located beyond the study area.

Biota Environmental Sciences (Biota) was commissioned by BHP WAIO to undertake a single-phase Level 1 targeted vertebrate fauna survey to document vertebrate fauna of conservation significance and fauna habitats within the study area.

The purpose of this report is to present zoological and ecological information on the study area through desktop review and field survey, to enhance the level of knowledge at the locality scale and place this into context at the regional scale. This report will be used to inform future environmental impact assessment in relation to the study area, however it is not its purpose to assess any specific development proposed by BHP WAIO.

2.2 Scope and Objectives

The scope of this study was to undertake a Level 1 and Targeted terrestrial fauna survey of the study area consistent with Environmental Protection Authority (EPA) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) guidance. The key elements of the scope comprised:

1. preparation of a desktop assessment including database and literature searches, in order to consolidate all available and relevant existing data for contextual comparison;
2. assessment and description of fauna habitats, including those deemed significant for supporting known or potential populations of fauna of conservation significance; and
3. identification and assessment of the likelihood of occurrence of fauna of conservation significance, or their preferred habitat, within the study area.

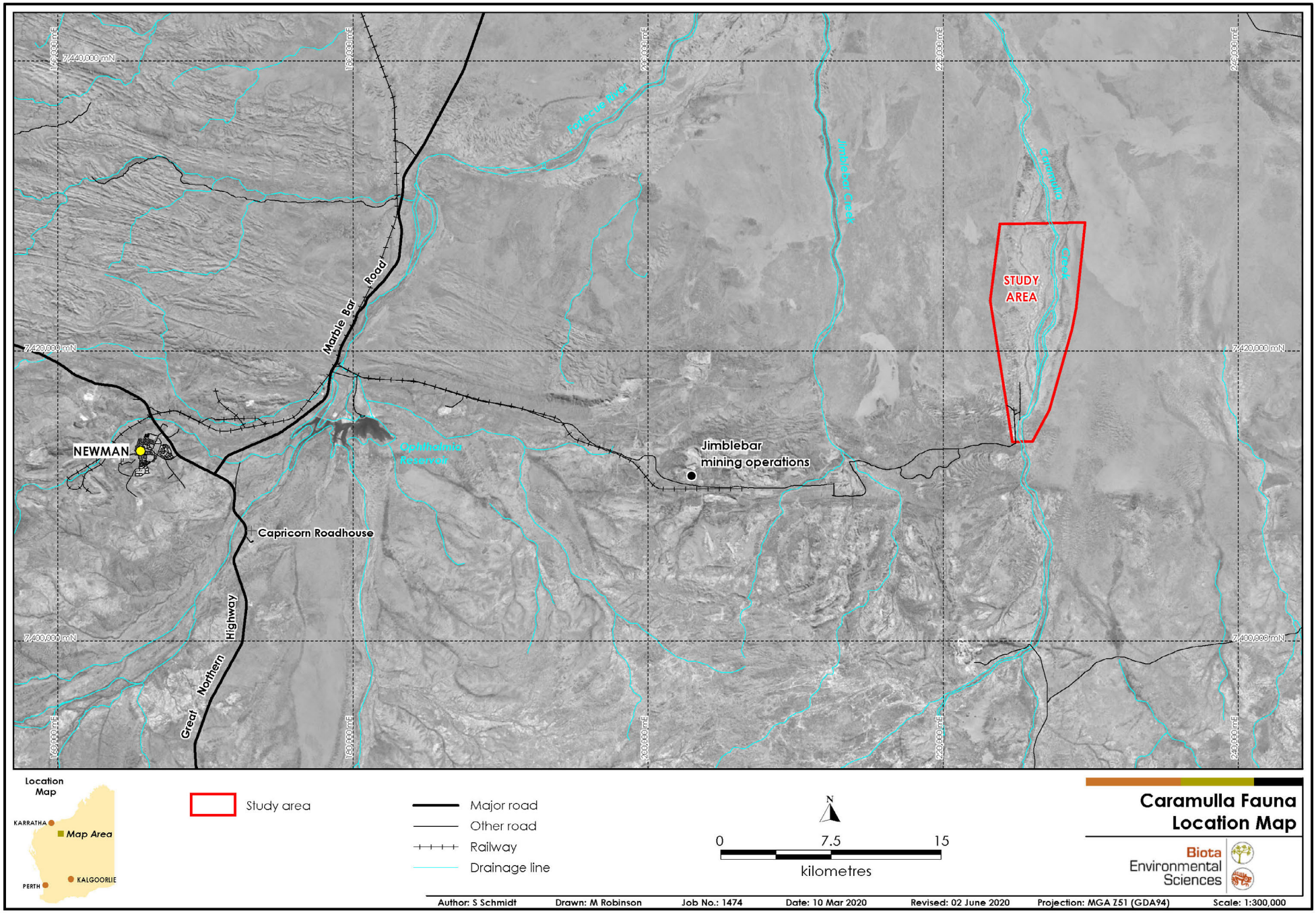

Figure 2.1: Study area location map.

3.0 Methodology

3.1 Desktop Assessment

The aim of the desktop assessment was to review information relevant to the study area to identify known features of conservation significance and identify target species potentially present. This review considered regional information and previous biological surveys completed in the locality (Section 3.1.1) and the results of database searches (Section 3.1.2).

3.1.1 Literature Review

The literature review comprised:

- regional information, including bioregion and subregion data (Kendrick 2003), land systems mapping (van Vreeswyk et al. 2004), vegetation descriptions and mapping by Beard (1975a, 1975b), and surface geology (Geoscience Australia 2008).
- relevant biological surveys previously completed in the locality since 2005.

The results of the literature review and database searches are summarised in Section 4.2 and detailed results are provided in Appendix 1.

3.1.2 Database Searches

The following databases were searched as part of the desktop assessment:

1. NatureMap, a joint project of the Department of Biodiversity, Conservation and Attractions (DBCA) and the Western Australian Museum (WAM), was searched to obtain a list of all fauna species recorded within or adjacent to the study area, primarily to identify records of conservation significant fauna known from the locality. This database represents the most comprehensive source of information on the distribution of Western Australia's fauna, comprising records from:
    a. WA Department of Biodiversity Conservation and Attractions (DBCA) Threatened Fauna database (to identify species listed under the WA *Biodiversity Conservation Act 2016*, or those species listed as Priority by DBCA, that have previously been recorded within or adjacent to the study area);
    b. Fauna Survey Returns Database (managed by the DBCA);
    c. WAM Specimen Database;
    d. BirdLife Australia Atlas of Australian Birds; and
    e. Federal Department of Agriculture, Water and the Environment (DAWE) Protected Matters Search Tool (to identify fauna species listed under the EPBC Act potentially occurring within the study area);
2. International Union for Conservation of Nature and Natural Resources (IUCN) Red List (to identify species listed as Critically Endangered, Endangered, Vulnerable or Near Threatened that potentially occur within the study area); and
3. The Atlas of Living Australia on-line database (to identify species previously recorded within or adjacent to the study area).

All searches were centred on the coordinate 23.1722° S, 120.1901° E, with search results requested from a 40 km radius, except for IUCN, which returns a 25 km radius.

3.1.3 Assessment of Likelihood of Occurrence in the Study Area

Results from the literature review and database searches were used to compile a list of terrestrial fauna species of conservation significance that had previously been recorded from the locality. The likelihood that each taxon would occur in the study area was then assessed using the rankings and criteria provided in Table 3.1, based on consideration of:

- the documented distribution of the species;
- the proximity of the study area to existing records; and
- preferred habitats.

Habitats were defined according to vegetation units, landforms apparent on aerial imagery, and taking into account existing information regarding the environment. The term 'close proximity' is defined as being within 20 km of the study area, while the broader 'locality' comprises the area up to 50 km from the study area.

Table 3.1: Criteria used to assign the likelihood of occurrence of a species within the study area.

Rank	Criteria
Recorded	1. The species has been previously recorded in the study area.
Likely to occur	1. There are existing records of the species in close proximity to the study area (within 20 km); and • the species is strongly linked to a specific habitat, which is present in the study area; or • the species has more general habitat preferences, and suitable habitat is present.
May occur	1. There are existing records of the species from the locality (within 50 km), however • the species is strongly linked to a specific habitat, of which only a small amount is present in the study area; or • the species has more general habitat preferences, but only some suitable habitat is present. 2. There is suitable habitat in the study area, but the species is recorded infrequently in the locality.
Unlikely to occur	1. The species is linked to a specific habitat, which is absent from the study area; or 2. Suitable habitat is present, however there are no existing records of the species from the locality despite reasonable previous search effort in suitable habitat; or 3. There is some suitable habitat in the study area, however the species is very infrequently recorded in the locality or the only records are historic (>40 years ago).
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the study area; or 2. The species' range is very restricted and does not include the study area; or 3. The species is not considered extant in the locality.

The likelihood of occurrence for each taxon was revised following habitat ground-truthing and fauna sampling conducted during the survey (see Section 5.3.2)

3.1.4 Habitat Mapping

Vertebrate fauna landscapes and landforms of the study area were identified based on Biota's fauna landscape approach (Biota 2013), which characterises habitats based on functional landforms within a broader landscape. Preliminary fauna habitat descriptions were based on land systems, as the main framework, as these are mapped more widely at regional scale, and additionally considered available digital aerial imagery, contour mapping, regional vegetation mapping and surface geology in order to validate and inform the extent of identified habitats. Fauna landscapes, while not necessarily equating to the distribution of any single species, offer a parallel grouping of landforms and substrates comprising a suite of ecological niches distinct from those in other landscapes. Preliminary habitat mapping was ground-truthed in the field and revised after the survey. This included identification and classification of potential core habitat for species listed as Matters of National Environmental Significance (MNES) under the EPBC Act, adopting criteria aligned with the broad criteria used by DAWE (DotE 2013, 2016), and as inferred from previous controlled action decisions for Pilbara mining projects (see Section 5.3.3).

All sampling sites were assigned to a land system and fauna landscape to place these into broader context within the study area and locality. In addition, more detailed attributes were documented for each sampling site to provide for finer scale habitat assessment.

3.1.5 Nomenclature

Consistent with the EPA (2016a) Technical Guidance, species nomenclature for herpetofauna and mammals follows the standards of the WAM fauna taxonomic checklist, which is revised and released every six months or as necessary[1]. Nomenclature for avifauna follows Christidis and Boles (2008).

3.1.6 Threatened Fauna Statutory Framework

Native fauna species that are rare, threatened with extinction, or have high conservation value, are specially protected by law under either or both of the State *Biodiversity Conservation Act 2016* and/or the Federal EPBC Act. Migratory and Marine species are also protected under the EPBC Act as MNES. In addition, the DBCA also maintains a list of Priority fauna species that have not been assigned statutory protection under the *Biodiversity Conservation Act 2016*, but are still considered to be of conservation priority, or are considered to be rare but not threatened and are in need of monitoring. Appendix 2 details the categories of conservation significance recognised under these three frameworks.

3.2 Survey Timing and Weather

3.2.1 Survey Team

The field survey was conducted by a team of two Biota zoologists from 9 to 18 March 2020 (Table 3.2). The survey was completed under "Fauna Taking (Biological Assessment)" Licence No. BA27000217 and "Authorisation to take or disturb threatened species' FRA 2020-0019 issued to Dr. Sylvie Schmidt (Appendix 3).

Table 3.2: Summary of personnel involved in the fauna survey.

Name	Position at Biota	Qualification	Years of Experience	Survey Role
Garth Humphreys	Director / Principal Ecologist	BSc. Hons	32	Project Director Final report review
Sylvie Schmidt	Senior Zoologist	BSc. Hons PhD MBA	15	Project Manager Survey design Desktop review Field Team Leader Field survey (Vertebrates) Data analysis and reporting
Michael Greenham	Senior Zoologist	BSc.	20	Field survey (Vertebrates, Avifauna)
Dan Kamien	Principal Zoologist	BSc. Hons	22	Bat call analysis Peer report review
John Graff	Zoologist	BSc. Hons	10	Bird call analysis
Josh Keen	Zoologist	BSc.	3	Desktop review

3.2.2 Daily Weather Observations

Weather data were obtained from the Bureau of Meteorology weather station at Newman Airport (No. 001767), located approximately 52 km west of the southern end of the study area. Weather conditions were hot and dry during the survey, with temperatures ranging from a minimum of 21.5°C to a maximum of 40.2°C and no rainfall recorded (Table 3.3). However large ephemeral pools were present in the main drainage within the study area, especially in the south (see site pictures provided in Appendix 4).

[1] Current checklist released April 2020 (http://museum.wa.gov.au/research/departments/terrestrial-zoology/checklist-terrestrial-vertebrate-fauna-western-australia)

Table 3.3: Weather at Newman Aero during the survey period in March 2020.

	09/03	10/03	11/03	12/03	13/03	14/03	15/03	16/03	17/03	18/03	Mean/ Total
Maximum temperature (°C)	39.6	39.8	40.1	37.8	37.6	38.1	39.5	40.2	40.0	39.1	**39.2** ± 0.31
Minimum temperature (°C)	21.5	22.1	24.2	28.2	24.8	24.6	24.0	25.3	26.0	24.4	**24.5** ± 0.59
Rainfall (mm)	0	0	0	0	0	0	0	0	0	0	**0**

3.2.3 Climate

Long-term climate data were obtained from the Newman Airport weather station (Figure 3.1). Maximum and minimum temperatures in the twelve months preceding the survey were consistent with long-term averages, although the survey was conducted during a hotter than average period. Conditions for the survey were wetter than average, with total rainfall for January, two months prior to the survey being far above average with a total of 198.2mm of rainfall over a period of less than 3 weeks, which is over 2.8 times the long-term mean January rainfall.

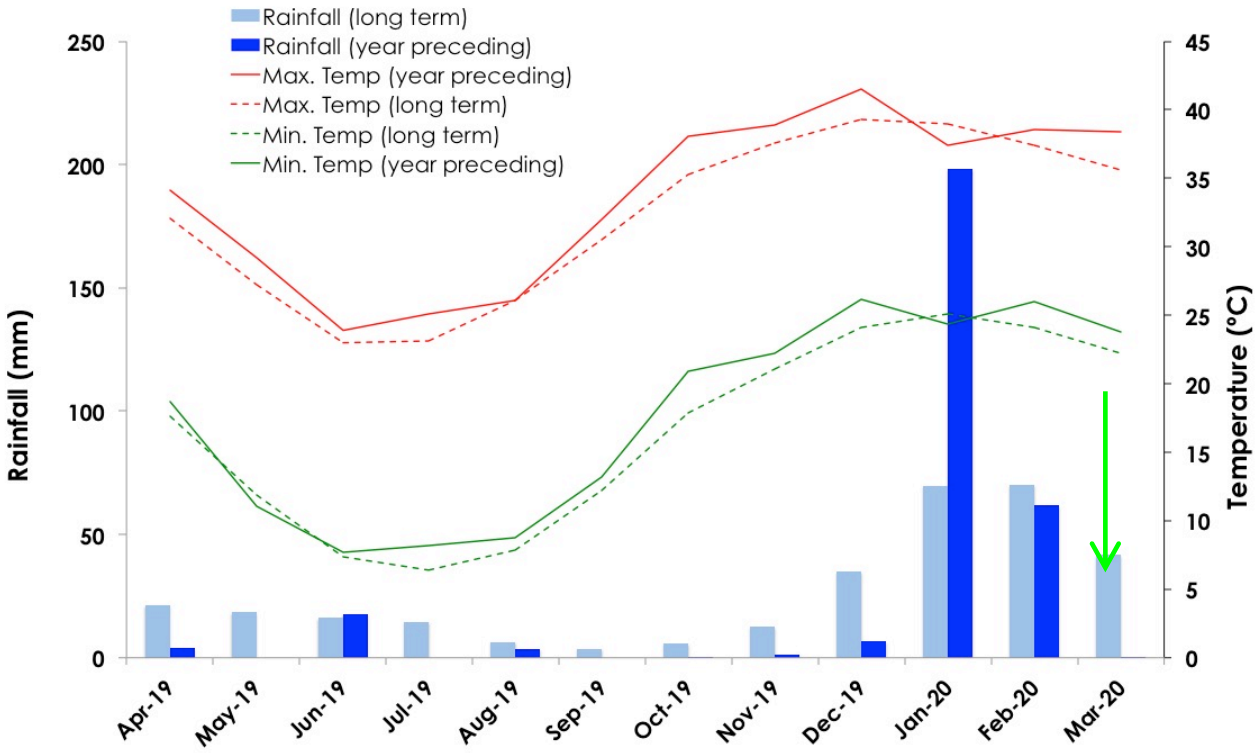

Figure 3.1: Climate and weather graph depicting long-term averages and the twelve months preceding the survey (April 2019 – March 2020).
(Long-term data rainfall 1971-2020, temperatures 1996 – 2020; green arrow indicates survey timing).

3.3 Survey Design

3.3.1 Survey Methods

The methodology was developed with reference to the following guidance documents:

- Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016a);
- Technical Guidance – Terrestrial Fauna Surveys (EPA 2016b);
- Environmental Factor Guidelines – Terrestrial Fauna (EPA 2016c);
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010a);

- Survey Guidelines for Australia's Threatened Mammals (DSEWPaC 2011a);
- Survey Guidelines for Australia's Threatened Bats (DSEWPaC 2010);
- Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b);
- Survey Guidelines for Australia's Threatened Frogs (DEWHA 2010b);
- Statement of Environmental Principles, Factors and Objectives (EPA 2015);
- Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DotE 2013);
- Guidelines for surveys to detect the presence of bilbies, and asses the importance of habitat in Western Australia (DBCA 2017a); and
- BHP WAIO's Guidance for Vertebrate Fauna Surveys in the Pilbara (SPR-IEN-EMS-015).

The vertebrate fauna survey consisted of a combination of systematic and non-systematic opportunistic sampling and targeted searching (Section 3.3.3).

Preliminary site selection was determined through assessment of aerial photography and thematic layers including land systems, geology and Beard's vegetation mapping (see Section 4.1), and also included three specific locations of potential bat sampling sites supplied by BHP WAIO, an artificial cave (adit), a potential cave/overhang, and a sink hole (see Section 3.3.3.6 and Figure **3.3**). Preliminary site selection was revised in the field based on microhabitat and access limitations. Two of the indicative additional bat sampling sites outside the study area were suitable for sampling and safe to access (the adit and sink hole, see Sections 3.3.3.6 and 3.3.3.7).

3.3.2 Target Species

Based on the desktop review (see Section 4.2) 23 conservation significant vertebrate species were identified as having the potential to occur within the study area, either due to previous records from the locality or due to the likely presence of suitable habitat (see Table 4.6). Table 3.4 summarises these species and the sampling methods used to target them during the survey (detailed descriptions of sampling methods and sites are provided in Sections 3.3.3.2 to 3.3.3.9).

While the survey was targeted at these specific vertebrate fauna species, any opportunistic sightings or signs of other vertebrate fauna detected were also recorded, including introduced fauna.

3.3.3 Fauna Sampling

In addition to the sampling methods outlined in Table 3.4, additional fauna observation techniques were used to investigate fauna habitats identified from the desktop review and microhabitats identified during the course of the survey:

- habitat-specific targeted searches for conservation significant fauna (including nocturnal searches) and opportunistic searches for reptiles, frogs and small mammals;
- identification of secondary signs (where possible) including tracks, scats, skins, mounds, hollows, nests and diggings; and
- identification of road-kill and other animal remains (where encountered).

Table 3.4: Summary of target species and sampling methods.

Family	Species Name	Common Name	Conservation Status	Sampling Methods
Non-volant mammals				
Dasyuridae	*Dasycercus blythi*	Brush-tailed Mulgara	Priority 4	Targeted searches, Nocturnal searches, Habitat assessment. Hair traps (if active burrows detected)
	Dasyurus hallucatus	Northern Quoll	Endangered	
	Sminthopsis longicaudata	Long-tailed Dunnart	Priority 4	
Macropodidae	*Lagorchestes conspicillatus leichardti*	Spectacled Hare-wallaby	Priority 4	
Thylacomyidae	*Macrotis lagotis*	Bilby	Vulnerable	
Muridae	*Leggadina lakedownensis*	Short-tailed Mouse	Priority 4	
	Pseudomys chapmani	Western Pebble-mound Mouse	Priority 4	
Bats				
Rhinonycteridae	*Rhinonicteris aurantia*	Pilbara Leaf-nosed Bat	Vulnerable	Echolocation call recorders, Nocturnal searches, Habitat assessment.
Megadermatidae	*Macroderma gigas*	Ghost Bat	Vulnerable	
Herpetofauna				
Typhlopidae	*Anilios ganei*	Gane's Blind Snake	Priority 1	Targeted searches, Nocturnal searches, Habitat assessment.
Pythonidae	*Aspidites ramsayi*	Woma	Priority 1	
	Liasis olivaceus barroni	Pilbara Olive Python	Vulnerable	
Avifauna				
Apodidae	*Apus pacificus*	Fork-tailed Swift	Migratory	Avifauna censuses, Targeted searches, Nocturnal searches, Habitat assessment, Acoustic recorders.
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	Migratory	
Falconidae	*Falco hypoleucos*	Grey Falcon	Vulnerable	
	Falco peregrinus	Peregrine Falcon	Other Specially Protected Fauna	
Charadriidae	*Charadrius veredus*	Oriental Plover	Migratory	
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	Migratory	
	Calidris acuminata	Sharp-tailed Sandpiper	Migratory	
	Calidris ferruginea	Curlew Sandpiper	Critically Endangered; Migratory	
Laridae	*Gelochelidon nilotica*	Gull-billed Tern	Migratory	
Psittacidae	*Polytelis alexandrae*	Princess Parrot	Priority 4; Vulnerable	
	Pezoporus occidentalis	Night Parrot	Critically Endangered; Endangered	

3.3.3.1 Sampling Locations

Table 3.5 and Figure 3.3 give an overview of all sampling locations and methods used across the study area. The following sections provide additional information for each sampling method employed, including dates and survey effort.

Table 3.5: Summary of sampling sites and methods.

Site ID	Latitude (°S)	Longitude (°E)	Land System	Sampling Methods
CRA-01	-23.367656	120.193543	Newman*	Bat (echolocation) call recorder
CRA-02	-23.363689	120.313635	River	Bat (echolocation) call recorder
				Nocturnal search
CRA-03	-23.360752	120.313513	River	Motion camera
CRA-04	-23.287963	120.336214	Fortescue	Bat (echolocation) call recorder
CRA-05	-23.287874	120.336219	Fortescue	Targeted search
CRA-06	-23.288709	120.336267	Fortescue	Avifauna census
				Targeted search
CRA-07	-23.264896	120.340419	Fortescue	Avifauna census
				Targeted search
CRA-08	-23.234099	120.338337	Fortescue	Avifauna census
				Targeted search
CRA-09	-23.256190	120.316747	Fortescue	Avifauna census
				Targeted search
CRA-10	-23.248511	120.350865	Divide	Targeted search
				Acoustic (bird call) recording unit
				Motion camera
CRA-11	-23.256689	120.318462	Fortescue	Bat (echolocation) call recorder
				Motion camera
CRA-12	-23.278834	120.302055	Divide	Acoustic (bird call) recording unit
				Motion camera
CRA-13	-23.308144	120.299319	Divide	Acoustic (bird call) recording unit
CRA-14	-23.329413	120.323726	Fortescue	Bat (echolocation) call recorder
CRA-15	-23.233728	120.300502	Divide	Motion camera
CRA-16	-23.279875	120.349821	Divide	Targeted search
				Motion camera
CRA-17	-23.291563	120.401881	Divide*	Bat (echolocation) call recorder
CRA-18	-23.351312	120.321698	Cadgie	Motion camera
				Acoustic (bird call) recording unit
				Targeted search
CRA-19	-23.258918	120.301287	Divide	Targeted search
CRA-20	-23.354636	120.323820	Cadgie	Targeted search
CRA-21	-23.346879	120.324889	Divide	Targeted search
CRA-22	-23.340012	120.323029	Fortescue	Targeted search
CRA-23	-23.327334	120.312731	River	Targeted search
CRA-24	-23.340564	120.305009	Fortescue	Targeted search
CRA-25	-23.349095	120.313199	River	Nocturnal search
CRA-26	-23.342469	120.316826	Fortescue	Nocturnal search
CRA-27	-23.360943	120.310030	Fortescue	Targeted search
				Motion camera (x2)
CRA-28	-23.349700	120.314507	Fortescue	Targeted search
CRA-29	-23.348030	120.312151	Fortescue	Targeted search
CRA-30	-23.359042	120.313642	River	Avifauna census
				Targeted search
CRA-31	-23.342524	120.312555	Fortescue	Nocturnal search
CRA-32	-23.331375	120.327940	Fortescue	Targeted search

- outside study area

3.3.3.2 Targeted Searches

Targeted searches were conducted at 19 sites with over 97 km walked and a total search effort of over 45 hours. Table 3.6 details each targeted search conducted and Figure 3.2 shows individual zoologist's tracks walked for each targeted and nocturnal search.

Table 3.6: Targeted search sites and effort.

Site	Landform	Date	Number of Zoologists	Search Effort (minutes)*	Distance (km)*
CRA-05	Major Drainage Line	11/03//20	1	207	4.67
		12/03//20	1	112	2.67
		13/03//20	1	104	2.62
CRA-06	Drainage Area/ Floodplain	11/03//20	1	15	0.81
		13/03//20	1	15	1.04
CRA-07	Drainage Area/ Floodplain	11/03//20	1	15	1.02
		13/03//20	1	15	0.87
CRA-08	Drainage Area/ Floodplain	11/03//20	1	15	1.27
		12/03//20	1	15	0.88
CRA-09	Drainage Area/ Floodplain	11/03//20	1	15	1.59
		12/03//20	1	15	1.45
CRA-10	Sandplain	11/03//20	2	40	1.33
CRA-16	Sandplain	12/03//20	2	158	2.82
		13/03//20	2	244	9.46
CRA-18	Drainage Area/ Floodplain	12/03//20	2	80	2.60
CRA-19	Sandplain	13/03//20	2	162	4.88
CRA-20	Drainage Area/ Floodplain	14/03//20	2	142	6.82
CRA-21	Drainage Area/ Floodplain	14/03//20	2	152	7.48
CRA-22	Drainage Area/ Floodplain, Sandplain	14/03//20	2	150	6.20
CRA-23	Drainage Area/ Floodplain	15/03//20	2	242	11.97
CRA-24	Drainage Area/ Floodplain	15/03//20	2	202	7.61
CRA-27	Drainage Area/ Floodplain	16/03//20	2	242	4.61
CRA-28	Drainage Area/ Floodplain	16/03//20	1	62	2.10
CRA-29	Drainage Area/ Floodplain	16/03//20	1	114	3.95
CRA-30	Major Drainage Line	16/03//20	1	15	1.27
		17/03//20	1	15	1.13
CRA-32	Sandplain	17/03//20	2	150	4.19
* combined effort where two zoologists involved			**Total**	**2,713 (45h13m)**	**97.31**

3.3.3.3 Nocturnal Searches

Nocturnal searches were conducted at four sites with over 17 km walked and a total search effort of over 11 hours. Nocturnal searching was limited to the most southern part of the study area where light vehicle track access was available.

Table 3.7 details each targeted search conducted and Figure 3.2 shows individual zoologist's tracks walked for each targeted and nocturnal search.

Table 3.7: Nocturnal search sites and effort.

Site	Landform	Date	Number of Zoologists	Search Effort (minutes)*	Distance (km)*
CRA-02	Major Drainage Line	14/03//20	2	244	6.10
CRA-25	Major Drainage Line	15/03//20	2	156	4.37
CRA-26	Drainage Area/Floodplain	15/03//20	2	120	3.71
CRA-31	Hillcrest/Upper Hillslope	16/03//20	2	150	3.16
* combined effort where two people involved			**Total**	**670 (11h10m)**	**17.34**

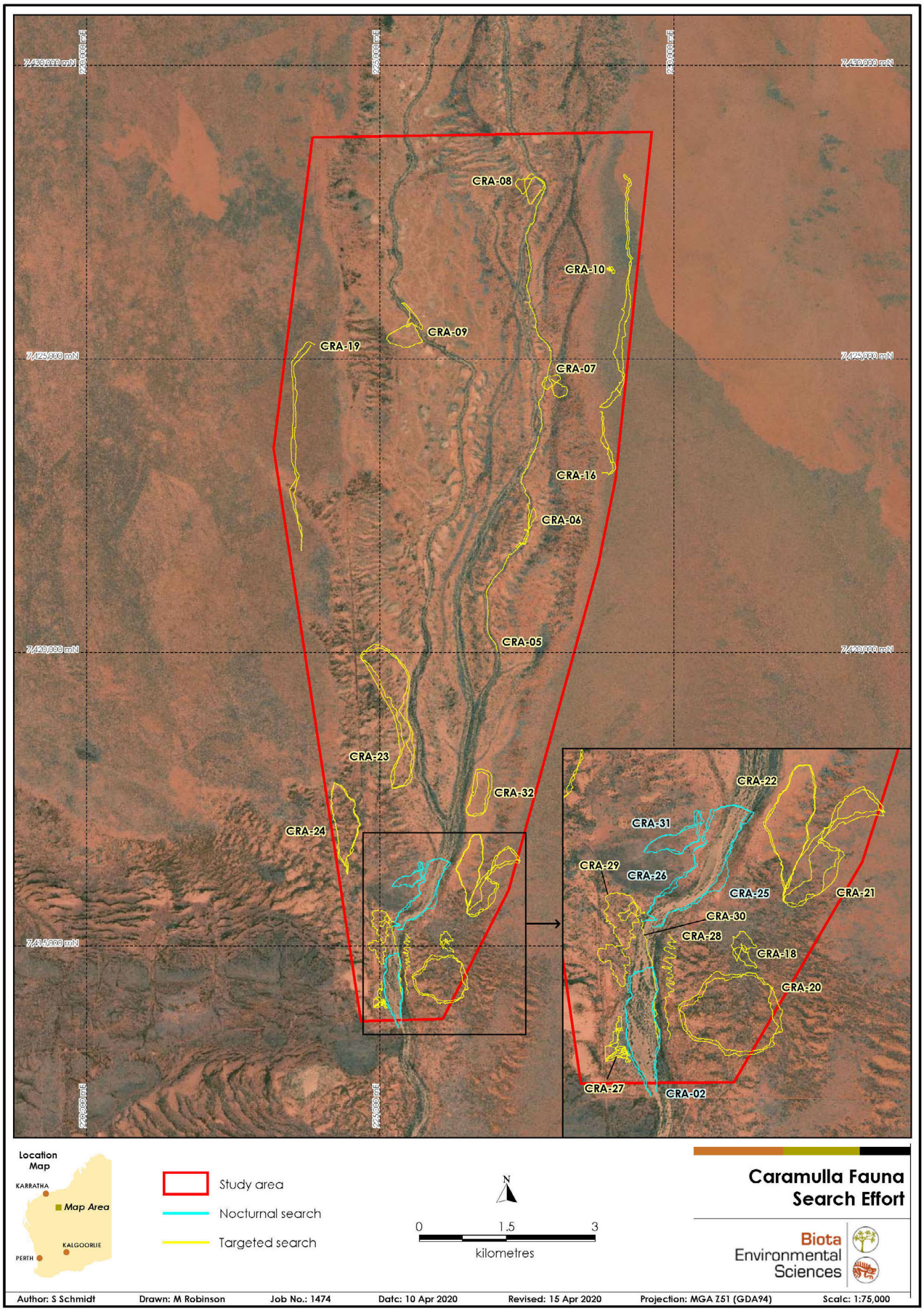

Figure 3.2: Vertebrate fauna targeted and nocturnal searches in the study area.

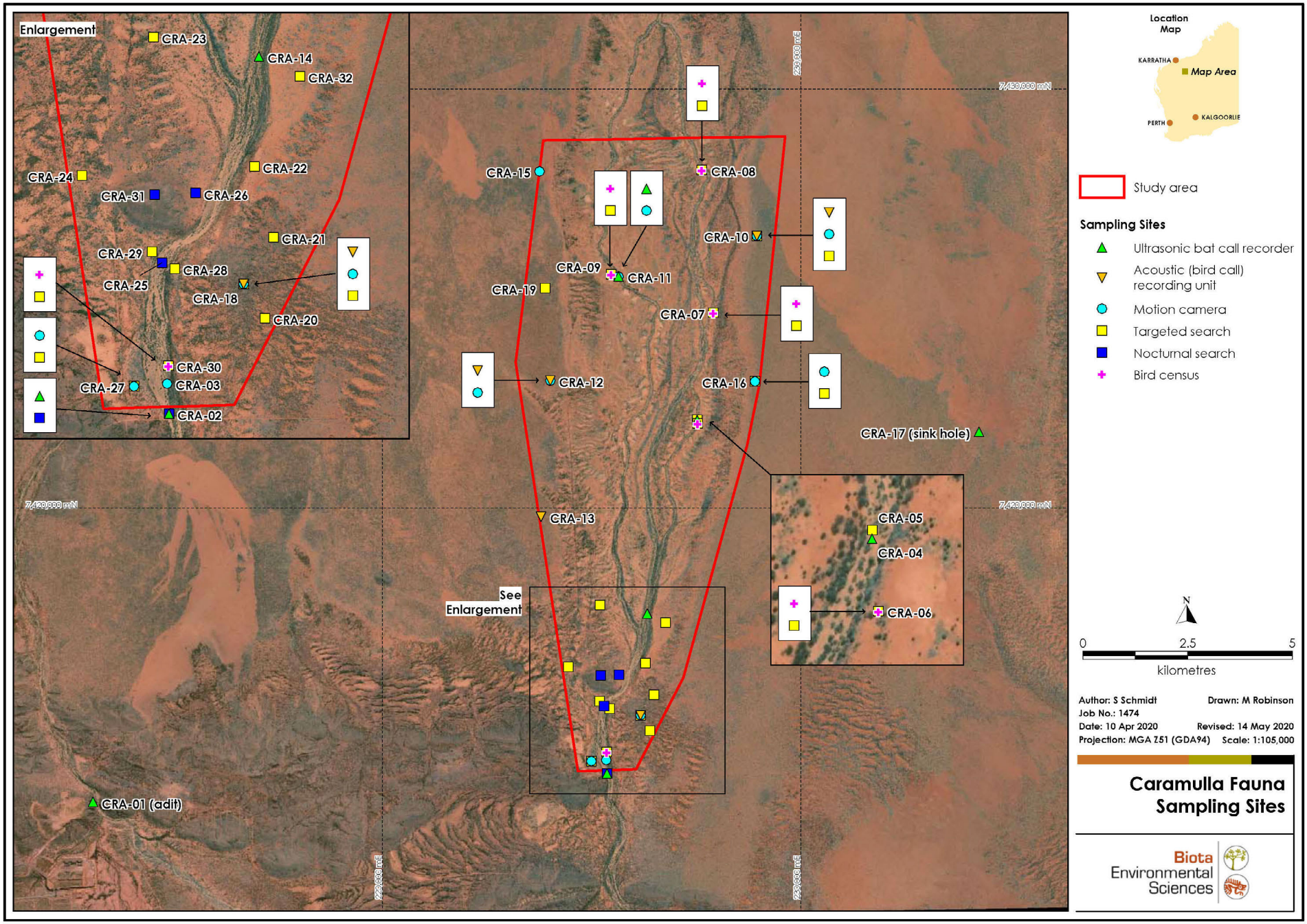

Figure 3.3: **Vertebrate fauna sampling sites in the study area.**

3.3.3.4 Remote Cameras

Remote infrared motion cameras were deployed primarily to target ground-dwelling mammals and the Night Parrot. Cameras set up at eight sites within the study area mainly in *Triodia* sandplain habitat or adjacent to ephemeral pools (Figure **3.3**). A bolus of universal bait was placed on the ground in the camera's field of view to attract animals. Motion cameras were deployed for a total of 46 nights (Table 3.8).

Table 3.8: Remote camera sites and effort.

Site	Landform	Start Date	End Date	Sampling Nights
CRA-03	Major Drainage Line (pool)	10/03//20	16/03//20	6
CRA-10	Sandplain	11/03//20	17/03//20	6
CRA-11	Major Drainage Line (pool)	11/03//20	17/03//20	6
CRA-12	Sandplain	11/03//20	17/03//20	6
CRA-15	Sandplain	11/03//20	17/03//20	6
CRA-16	Sandplain	12/03//20	18/03//20	6
CRA-18	Drainage Area/Floodplain	12/03//20	18/03//20	6
CRA-27	Drainage Area/Floodplain	12/03//20	18/03//20	4*
* two cameras deployed for two nights			**Total**	**46**

3.3.3.5 Hair Traps

No hair traps were deployed as no active burrows of target species were detected within the study area.

3.3.3.6 Bat Echolocation Recorder

Sampling was conducted within the study area to target all potentially occurring bat species. Echolocation calls were recorded using SM2BAT and SM4BAT SongMeters, which detect and record ultrasonic echolocation calls emitted during bat flight. The selectable filters and triggers, jumper and audio settings used followed the manufacturer's recommendations for bat detection (Wildlife Acoustics 2010, 2019).

Sampling was undertaken at six locations, with SongMeters deployed for a total of 36 sampling nights (Table 3.9). The SongMeters were placed in locations considered likely to provide records of a range of species, including fresh water, potential flyways through drainage lines, at a sink hole east of the study area, and an adit west of the study area (Figure **3.3**).

Table 3.9: Bat sampling sites and effort.

Site	Landform	Start Date	End Date	Sampling Nights
CRA-01	Artificial cave in Ironstone Outcrops (adit west of study area)	10/03//20	16/03//20	6
CRA-02	Major Drainage Line (pool)	10/03//20	16/03//20	6
CRA-04	Major Drainage Line (pool)	11/03//20	17/03//20	6
CRA-11	Major Drainage Line (pool)	11/03//20	17/03//20	6
CRA-14	Major Drainage Line (pool)	11/03//20	17/03//20	6
CRA-17	Sink hole in Ironstone Outcrops (east of study area)	12/03//20	18/03//20	6
			Total	**36**

Bat echolocation call analysis was conducted by Dan Kamien of Biota using Kaleidoscope Pro software (version 5.0.3), and following methods recommended by the Australasian Bat Society (2006) in conjunction with available reference data (Churchill 2008, McKenzie and Bullen 2009). Only sequences containing good quality search phase calls were considered for identification.

3.3.3.7 Cave Searches

No caves were present within the study area. The indicative bat sampling sites outside the study area (see Section 3.3.1) were investigated and while the adit and sink hole were included as bat sampling sites, no cave or overhang suitable for use by target bat species was found at the third indicative bat sampling site location provided prior to the survey (120.112094°E, -23.409691°S), and this was not sampled.

3.3.3.8 Systematic Avifauna Sampling

Avifauna sampling used a combination of techniques including:

- unbounded area searches (30 minutes duration); and
- opportunistic observations of birds recorded in the study area during the survey.

Ten unbounded area searches were completed across five sampling sites (Table 3.10). Individual censuses were confined to discrete landforms, typically corresponding to vegetation type at each site. Censuses were conducted either in the morning (as early as possible) or just before sunset, with a total of five hours dedicated to systematic avifauna censusing during the survey.

Table 3.10: Systematic avifauna census sites and effort.
Census start times indicated.

Site	Landform	11/03/20	12/03/20	13/03/20	16/03/20	17/03/20	Total Effort (minutes)
CRA-06	Drainage Area/ Floodplain	8:35	–	8:15	–	–	**60**
CRA-07		9:34	–	7:21	–	–	**60**
CRA-08		10:27	8:29	–	–	–	**60**
CRA-09		11:23	7:33	–	–	–	**60**
CRA-30		–	–	–	16:57	9:58	**60**
						Total	**300**

3.3.3.9 Acoustic Recording Units

The Interim Guideline for Preliminary Surveys of the Night Parrot (*Pezoporus occidentalis*) (DBCA 2017b) recommends passive acoustic surveys as an effective low impact survey method. SM4 SongMeter Acoustic Recording Units were deployed at prospective sites within the study area (predominantly *Triodia* grassland with large hummocks), and set to record from dusk until dawn, to detect Night Parrot calls. Sampling was undertaken at four locations for six consecutive nights, with SongMeters deployed for a total of 24 sampling nights (Table 3.11).

Audio files were analysed by John Graff of Biota using SongScope software (version 4.1.5), with a recogniser built using Night Parrot calls recorded in Western Australia (calls sourced from https://nightparrot.com.au/index.php/resources/night-parrot-calls). Potential matches were then assessed manually by visually inspecting the spectra and listening to the recordings.

Table 3.11: Night Parrot sampling sites and effort.

Site	Landform	Start Date	End Date	Sampling Nights
CRA-10	Sandplain	11/03//20	17/03//20	6
CRA-12	Sandplain	11/03//20	17/03//20	6
CRA-13	Sandplain	11/03//20	17/03//20	6
CRA-18	Drainage Area/Floodplain (*Mulga* over *Triodia*)	11/03//20	17/03//20	6
			Total	**24**

3.4 Study Limitations

In accordance with the EPA Technical Guidance 'Terrestrial Fauna Surveys' (EPA 2016d), potential constraints and limitations of the survey are addressed in Table 3.12.

Table 3.12: Potential constraints and limitations of the fauna survey.

Potential Constraint	Statement of Limitations
1. Availability of contextual information	• There is abundant contextual information available on a regional level and there has been adequate recent vertebrate fauna survey effort in the study area locality. Two of the six previous surveys conducted in the locality were two-phase systematic surveys, three surveys were single-phase targeted and Level 1 surveys and the remaining survey was a reconnaissance survey conducted as part of a flora and vegetation survey. • However most previous surveys were conducted to the south of the study area in habitats different to those occurring in the study area, i.e. in rocky habitats, while the Caramulla study area is dominated by sandy drainage systems with adjacent floodplains and sandy *Triodia* plains. • Local level contextual information is considered to be a minor limiting factor for this study.
2. Competency and experience of survey team	• The field survey team consisted of two senior zoologists with 15 and 20 years of experience, including numerous similar surveys in the Pilbara bioregion. • Required resources were available. • There were therefore no limitations due to resourcing or experience.
3. Proportion of fauna recorded and any identification issues	• A single-season Level 1 vertebrate fauna survey of the study area was required and this was adequately completed in accordance with relevant guidance documents. • Records and identification of fauna were not considered to be a limitation.
4. Appropriate area fully surveyed	• The study area was surveyed thoroughly with 32 sampling sites assessed and extensive foot traverses completed. • Sampling techniques and effort were adequate to inform future environmental impact assessment. • Survey techniques and effort targeted at detecting the presence of the Bilby were in accordance with DBCA (2017a) recommendations. • Survey techniques and effort targeted at detecting the presence of Night Parrot were in accordance with recommendations by DBCA (2017b). • Survey effort and extent was not considered to be a limitation.
5. Access constraints	• The majority of the study area was not accessible by vehicle but was able to be accessed by helicopter (no time or access/landing site constraints) and on foot. • Vehicle track access was limited to the southern part of the study area, so only areas accessible on foot from vehicle tracks could be searched at night. • Access to the entire study area at night was considered to be a minor limitation as aerial surveying and daytime foot-traverses were used to verify that the habitats sampled were representative of areas that were not able to be accessed at night.
6. Survey timing, rainfall and season	• Historical climate data were not available for the study area, but were taken from the closest weather station located approximately 52 km to the west. • Seasonal survey timing and conditions including rainfall prior to survey were optimal.
7. Disturbance that may have affected the survey results	• The majority of the study area was undisturbed with only a small proportion cleared (vehicle tracks). Disturbance was not considered to be a limitation.

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4.0 Desktop Assessment

4.1 Regional Context of the Study Area

4.1.1 IBRA Bioregion and Subregion

The study area lies within the Pilbara bioregion, one of 89 bioregions defined by the Interim Biogeographic Regionalisation for Australia (IBRA) (DSEWPaC 2012). The Pilbara bioregion is divided into four subregions. The study area lies within the Fortescue plains subregion, more specifically in the south west of the subregion, where it borders the adjacent Gascoyne (bioregion) Augustus subregion. The Fortescue plains subregion is described by Kendrick (2003) as follows:

"Alluvial plains and river frontage. Extensive salt marsh, mulga-bunch grass, and short grass communities on alluvial plains in the east. Deeply incised gorge systems in the western (lower) part of the drainage. River gum woodlands fringe the drainage lines. Northern limit of Mulga (*Acacia aneura*). An extensive calcrete aquifer (originating within a palaeo-drainage valley) feeds numerous permanent springs in the central Fortescue, supporting large permanent wetlands with extensive stands of river gum and cadjeput *Melaleuca* woodlands. Climatic conditions are semi desert tropical, with average rainfall of 300 mm, falling mainly in summer cyclonic events. Drainage occurs to the north-west. Subregional area is 2,041,914 ha"

4.1.2 Land Systems

A total of 105 land systems have been identified and mapped in the Pilbara bioregion[2]. Land systems mapping covering the study area has been prepared by Payne et al. (1988). The study area intersects six land systems (Fortescue, Washplain, Divide, Cadgie, River and Jamindie), as summarised in Table 4.1 and shown in Figure 4.1.

Five of the land systems are widespread and well-represented in the Pilbara. The sixth, Cadgie land system, has a very small extent in the southern Pilbara bioregion but also occurs within the Gascoyne bioregion (Augustus subregion), which is near the southern boundary of the study area. The study area contains only a very small proportion of the regional extents of most of the land systems it intersects, but contains 12.5% of the Fortescue and over 8% of the Cadgie land system in the Pilbara (Table 4.1).

[2] This information was obtained by merging the Ashburton land system mapping (Payne et al. 1988) and Pilbara land system mapping (van Vreeswyk et al. 2004) and intersecting this with the Pilbara bioregion (Environment Australia 2000).

Table 4.1: Land systems intersected by the study area.
(Data from Payne et al. 1988, and van Vreeswyk et al. 2004.)

Land System	Description	Total Area of Land System in the Pilbara Bioregion (ha)	Extent within Study Area (ha) & Proportion of Study Area	Proportion of Total Land System that occurs in the Study Area
Fortescue (RGEFTC)	Alluvial plains and Floodplains supporting patchy grassy woodlands, shrublands and tussock grasslands	33,783	4,232.0 (61.1%)	12.5%
Divide (RGEDIV)	Sandplains and occasional dunes supporting shrubby hard spinifex grasslands	437,577	1,429.2 (20.6%)	0.3%
Washplain (RGEWSP)	Hardpan plains supporting groved mulga shrublands	66,434	1,043.9 (15.1%)	1.6%
Cadgie (REGCAD)	Hardpan plains with thin sand cover and sandy banks supporting mulga shrublands with soft and hard spinifex	1,718	139.2 (2.0%)	8.1%
River (RGERIV)	Active Floodplains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands	797,421	82.0 (1.2%)	<0.02%
Jamindie (RGEJAM)	Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey	192,227	2.3 (0.03%)	<0.01%

4.1.3 Surface Geology

Four surface geology units occur within the study area (Geoscience Australia 2008) (Figure 4.2 and Table 4.2). The majority of the study area (85%) is dominated by alluvial and colluvial sediment with the eastern and western boundaries of the study area intersecting the adjacent extensive sandplain areas.

Table 4.2: Geological units of the study area.

Geological Age	Code	Geological Description	Extent within Study Area (ha) & Proportion of Study Area
Holocene	Qa	Alluvial sediment - Channel and Floodplain alluvium; gravel, sand, silt, clay, locally calcreted	3,170.9 (46%)
Quaternary	Qrc	Colluvial sediment - Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite	2,697.0 (39%)
Cenozoic	Czs	Sand – residual - Sand or gravel plains; quartz sand sheets commonly with ferruginous pisoliths or pebbles, minor clay; local calcrete, laterite, silcrete, silt, clay, alluvium, colluvium, aeolian sand	964.9 (14%)
Paleoproterozoic	Lchb	Iron formation, chert, jaspilite, shale - Fine-grained, finely laminated, dark grey-brown to black flaggy iron-formation, minor chert, jaspilite, shale.	95.8 (1%)

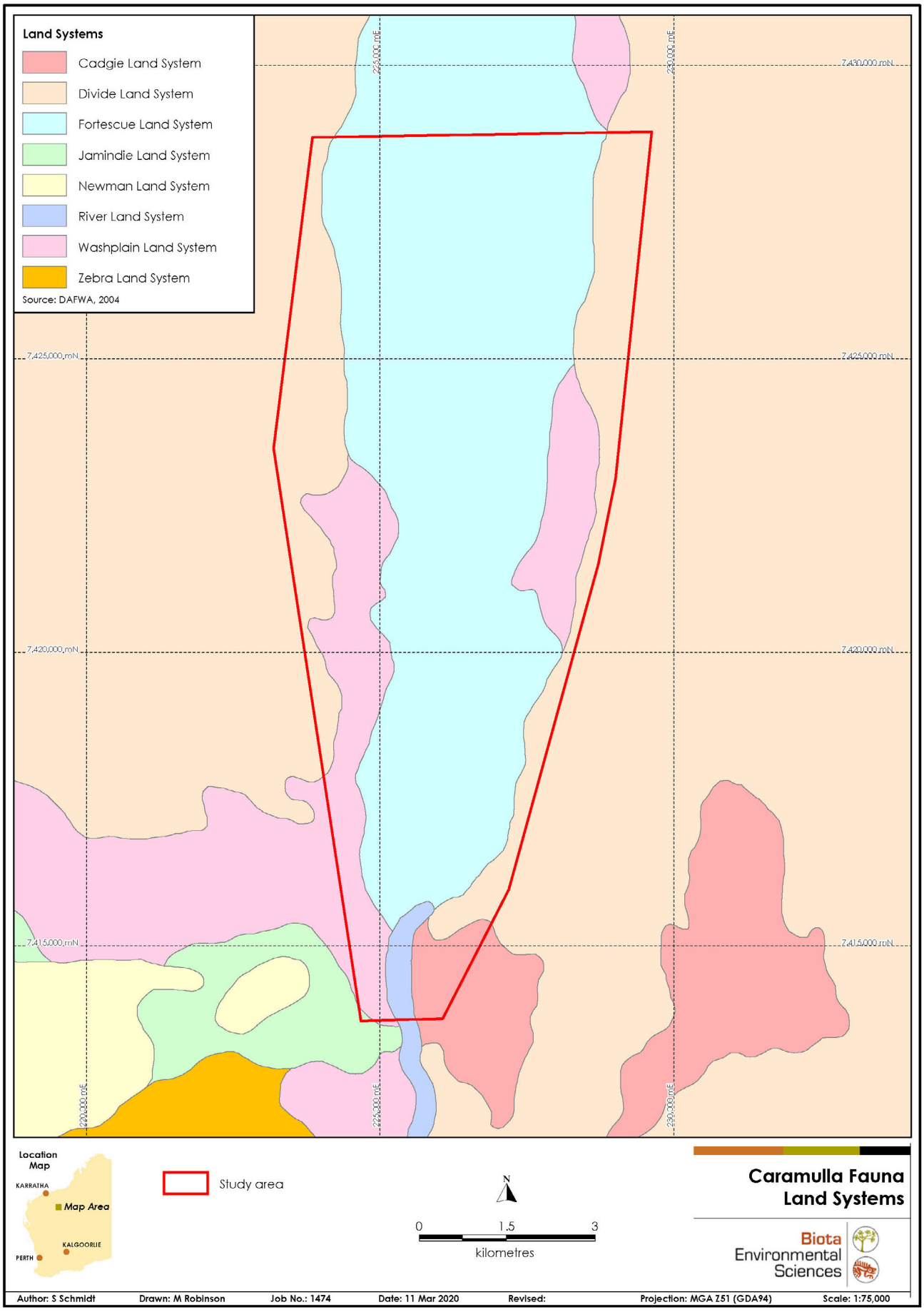

Figure 4.1: Land systems of the study area.

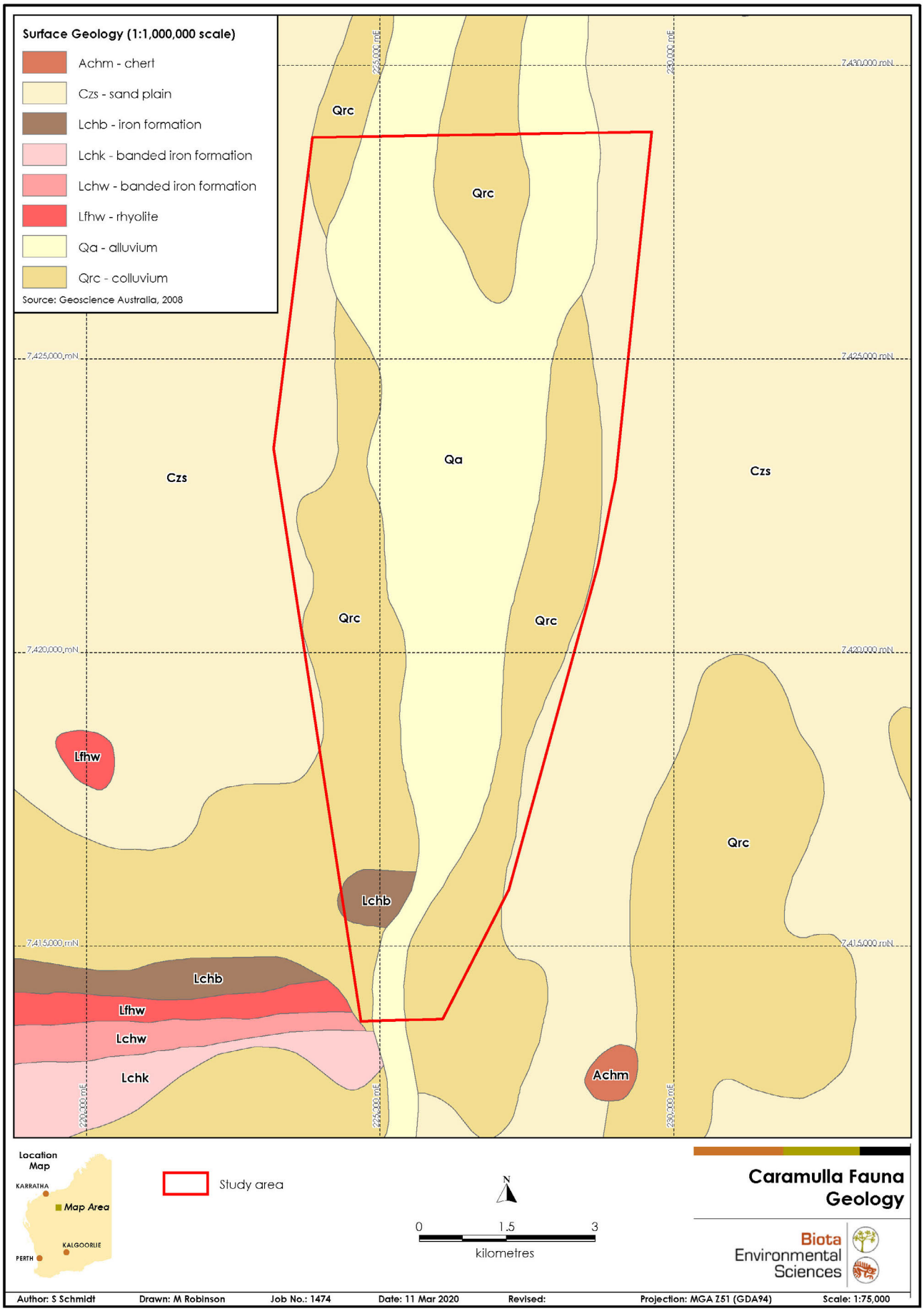

Figure 4.2: Surface geology of the study area.

4.1.4 Vegetation

Beard (1975b, 1975a) described and mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The study area is located on the Hamersley Plateau, which lies within the Fortescue Botanical District (generally characterised by tree and shrub steppes) of the Eremaean Botanical Province as defined by Beard (1975b, 1975a). The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypts.

The study area intersects three Beard vegetation units (Table 4.3 and shown in Figure 4.3).

Table 4.3: Beard's vegetation units in the study area.

Vegetation Unit	Description	Extent within Study Area (ha) & Proportion of Study Area
Fortescue Valley 29	Sparse low woodland; mulga, discontinuous in scattered groups	5,332.8 (77%)
Fortescue Valley 111	Hummock grasslands, shrub steppe; *Eucalyptus gamophylla* over hard spinifex	1589.6 (23%)
Fortescue Valley 82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	6.2 (<0.1%)

The study area is dominated by sparse low woodland with discontinuous scattered mulga (Fortescue Valley 29), with bands of hummock grasslands/shrub steppe along the eastern and western study area boundaries (Fortescue Valley 111). Both vegetation units are widespread in the Fortescue subregion and have been subject to limited clearing. The extent of the Fortescue Valley 82 vegetation unit is negligible within the study area.

4.1.5 Conservation Reserves in the Locality

The closest DBCA managed land is a section of Roy Hill pastoral lease proposed for conservation approximately 85 km to the northwest of the study area, and the Karlamilyi National Park is located approximately 140 km northwest of the study area.

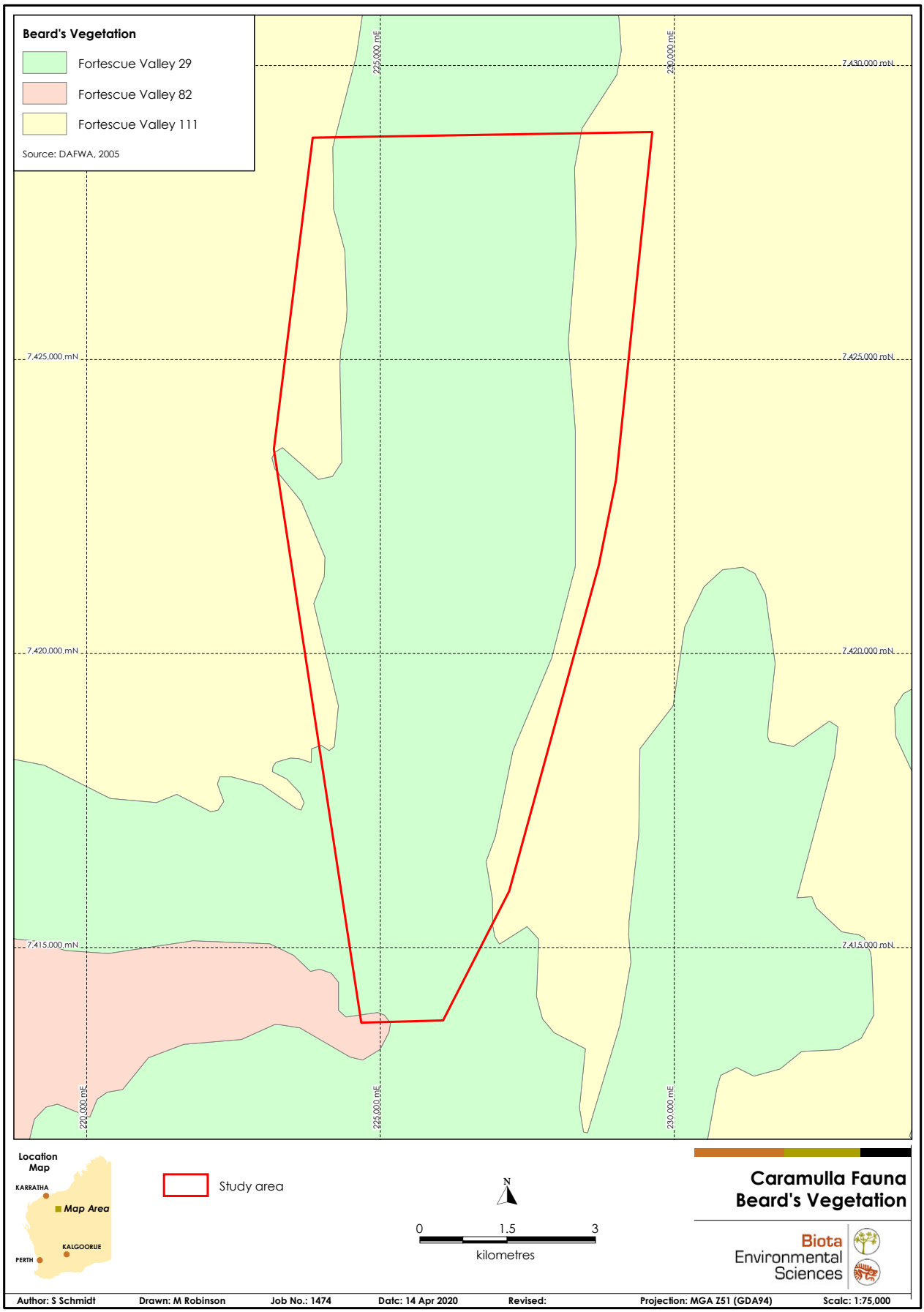

Figure 4.3: Vegetation of the study area.

4.2 Database Searches and Previous Fauna Surveys

Previous surveys conducted in the locality (within 50 km of the study area) are summarised in Table 4.4, Table 4.5 and Figure 4.4 and detailed results of the literature review and database searches are provided in Appendix 1.

Table 4.4: Vertebrate species identified from the desktop review.

Vertebrate Fauna Group	Number of Species	Number of Conservation Significant Species
Ground mammals	34	8
Bats	14	2
Amphibians	9	-
Reptiles	134	3
Birds	165	15
Total	**356**	**28**

A total of 356 vertebrates were identified as potentially occurring in the locality of the study area, based on the results of the desktop review (Table 4.4; Appendix 1). Of these, 28 are State and Commonwealth listed conservation significant fauna species (Table 4.5). As none of the Marine listed species are true marine species, these are excluded from further discussion in this report, as they are considered to be listed erroneously, given that none rely upon marine environments for survival, and all are relatively common and widespread.

The following taxonomic and nomenclature changes have occurred for species recorded during previous surveys since the time of those studies:

- *Macropus rufus* is now *Osphranter rufus* (Red Kangaroo);
- *Mormopterus lumsdenae* is now *Ozimops lumsdenae* (Northern Free-tailed Bat);
- *Ramphotyphlops ganei* is now *Anilios ganei* (Priority 1);
- *Amphibolurus longirostris* is now *Gowidon longirostris* (Long-nosed dragon);
- *Diplodactylus conspicillatus* 2014 has been split into *D. laevis, D. bilybara, D. conspiculatas,* and *D. custos,* with *D. laevis* occurring in the central and eastern Pilbara (locality of the study area);
- *Gehyra punctata* has been split into several species in 2018, and specimens previously recorded from the study area locality as *G. punctata* may be any of *G. punctata*, *G. fenestrula* or *G. micra*;
- *Gehyra variegata* has been split into several species in 2018, and specimens previously recorded from the study area locality as *G. variegata* may be any of *G. variegata*, *G. crypta, G. montium* or *G. incognita*; and
- *Cyclorana platycephala* was revised in 2016 with specimens from the study area locality now recognised as *Cyclorana occidentalis* (Western Water-holding Frog).

The following conservation status changes have occurred for species recorded during previous surveys since the time of those studies:

- *Rhinonicteris aurantia* (Pilbara Leaf-nosed Bat) was recorded as *Rhinonicteris aurantius* (Orange Leaf-nosed Bat) and listed as Priority 1 at State level when recorded by Ecologia (2006) and is now listed as Vulnerable at both State and Commonwealth levels;
- *Macroderma gigas* (Ghost Bat) was listed as Priority 4 at State level when recorded by Ecologia (2006) and is now listed as Vulnerable at both State and Commonwealth levels;
- *Macrotis lagotis* (Bilby) WA conservation status was Schedule 3 when recorded by Biologic (2018) and is currently listed as Vulnerable at both State and Commonwealth levels; and
- *Ardeotis australis* (Australian Bustard) was listed as Priority 4 at State level at the time of Ecologia (2005), GHD (2009) and Outback Ecology (2009) but is no longer listed.

Table 4.6 presents the likelihood of occurrence in the study area of these taxa. The potential occurrence of these species within the study area was reassessed after taking into account the results of this survey (see Section 5.3 and Table 5.3).

Table 4.5: Summary of previous relevant surveys conducted in the locality of the study area.

Survey (Reference)	Survey Timing & Type	Seasonal Conditions	Fauna Survey Techniques & Effort	Summary of Species Richness	Current Conservation Significant Species	Limitations
East Jimblebar Exploration Project Biological Survey (Ecologia 2005)	February 2005 single-phase fauna assessment	Drier than average conditions (no significant rainfall prior to survey)	Avifauna census, Hand foraging, Ultrasonic recorders, Spotlighting (vehicle), Opportunistic records,	60 vertebrate taxa: 4 non-volant mammal, 6 bat, 1 amphibian, 19 reptile and 41 bird species.	n/a	Additional effort would have likely resulted in additional species
Hashimoto Terrestrial Vertebrate Fauna Assessment (Ecologia 2006)	August/ September 2005 February 2006 two-phase Level 2 systematic survey	Favourable conditions, higher than average rainfall prior to survey	Pit & funnel trap lines, Elliott & cage traps, Nocturnal searches, Active foraging, Targeted searches, Ultrasonic recorders, Opportunistic records	170 vertebrate taxa: 14 non-volant mammal, 9 bat, 5 amphibian, 57 reptile and 85 birds species.	• Vulnerable Pilbara Leaf-nosed Bat, *Rhinonicteris aurantia* • Vulnerable Ghost Bat, *Macroderma gigas* (Priority 4 at time of survey)	Records of both conservation significant bat species subsequently determined to be misidentifications (Outback Ecology 2009)
Caramulla Exploration Area Flora and Vegetation Survey and Fauna Assessment (GHD 2009)	December 2008 Single-phase Level 1 survey – habitat assessment and reconnaissance field survey.	Drier than average conditions (no significant rainfall prior to survey)	Habitat assessments & mapping, Targeted Searches (daytime only), Opportunistic records	34 vertebrate taxa: 6 non-volant mammal, 2 reptile and 26 bird species.	n/a	Reconnaissance fauna survey only, dry conditions resulted in 'under-collection' of species
Jimblebar Iron Ore Project-Terrestrial Vertebrate Fauna Assessment (Outback Ecology 2009)	June 2008 October 2008 Two-phase systematic and targeted survey	Consistent with long-term conditions	Habitat assessments & mapping, Pit/Elliott/cage/funnel trap lines, Systematic hand-searching, Nocturnal searches, Avifauna census, Opportunistic records	92 vertebrate taxa: 16 non-volant mammal, 2 amphibian, 27 reptile and 47 bird species.	• Priority 4 Western Pebble-mound Mouse, *Pseudomys chapmani*	No bat sampling, Phase 1: reduced reptile activity due to rainfall and low temperature
Caramulla Level 1 Vertebrate Assessment (Biologic 2018)	February 2018 Single-phase Level 1 fauna assessment	Consistent with long-term conditions	Habitat assessments & mapping, Targeted & drone searches, Ultrasonic & acoustic recorders, Motion cameras, Opportunistic records	36 vertebrate taxa: 8 non-volant mammal, 8 reptile and 20 bird species.	• Vulnerable Bilby, *Macrotis lagotis* • Priority 4 Brush-tailed Mulgara, *Dasycercus blythi*	None relevant
Jimblebar North-Level Vertebrate Fauna Survey (Onshore Environmental 2019)	September 2018 Single-phase Level 1 fauna assessment	Poor seasonal conditions due to below average rainfall prior to survey	Habitat assessments & mapping, Targeted Searches, Active foraging, Ultrasonic recorders, Opportunistic records	71 vertebrate taxa: 7 non-volant mammal, 6 bat, 7 reptile and 51 bird species.	n/a	Reduced bird activity due to poor seasonal conditions (dry ephemeral drainage lines)

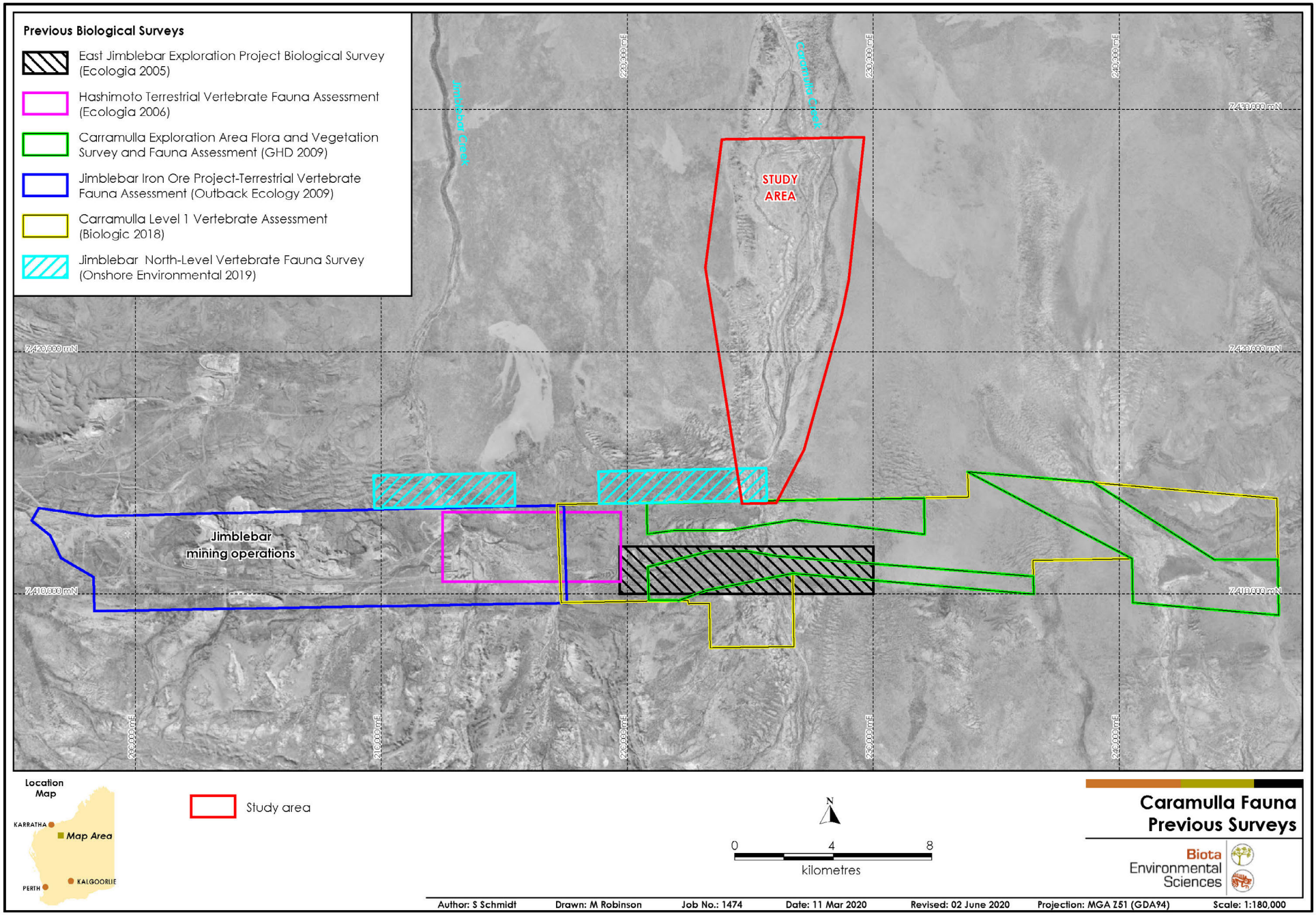

Figure 4.4: Previous relevant surveys conducted in the locality of the study area.

Table 4.6: Vertebrate species of conservation significance identified through the desktop review.
(species likely to occur or may occur highlighted in grey)

Family	Species Name	Common Name	Conservation Status		Likelihood of Occurrence
			State	Commonwealth	
Non-volant mammals					
Dasyuridae	*Dasycercus blythi*	Brush-tailed Mulgara	Priority 4		Likely to occur
	*Dasycercus cristicauda**	Crest-tailed Mulgara	Priority 4	Vulnerable	Would not occur
	Dasyurus hallucatus	Northern Quoll	Endangered	Endangered	May occur
	Sminthopsis longicaudata	Long-tailed Dunnart	Priority 4		Unlikely to occur
Macropodidae	*Lagorchestes conspicillatus leichardti*	Spectacled Hare-wallaby	Priority 4		Unlikely to occur
Thylacomyidae	*Macrotis lagotis*	Bilby	Vulnerable	Vulnerable	Likely to occur
Muridae	*Leggadina lakedownensis*	Short-tailed Mouse	Priority 4		Unlikely to occur
	Pseudomys chapmani	Western Pebble-mound Mouse	Priority 4		May occur
Bats					
Rhinonycteridae	*Rhinonicteris aurantia*	Pilbara Leaf-nosed Bat	Vulnerable	Vulnerable	May occur
Megadermatidae	*Macroderma gigas*	Ghost Bat	Vulnerable	Vulnerable	May occur
Herpetofauna					
Typhlopidae	*Anilios ganei*		Priority 1		May occur
Pythonidae	*Aspidites ramsayi*	Woma	Priority 1		Unlikely to occur
	Liasis olivaceus barroni	Pilbara Olive Python	Vulnerable	Vulnerable	May occur
Avifauna					
Apodidae	*Apus pacificus*	Fork-tailed Swift	Migratory	Migratory	Likely to occur
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	Migratory	Migratory	May occur
Falconidae	*Falco hypoleucos*	Grey Falcon	Vulnerable		May occur
	Falco peregrinus	Peregrine Falcon	Other Specially Protected Fauna		Likely to occur
Charadriidae	*Charadrius veredus*	Oriental Plover	Migratory	Migratory	May occur
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	Migratory	Migratory	May occur
	Calidris melanotos	Pectoral Sandpiper	Migratory	Migratory	Would not occur
	Calidris acuminata	Sharp-tailed Sandpiper	Migratory	Migratory	Unlikely to occur
	Calidris ferruginea	Curlew Sandpiper	Critically Endangered, Migratory	Critically Endangered, Migratory	Unlikely to occur
Laridae	*Gelochelidon nilotica*	Gull-billed Tern	Migratory	Migratory	Unlikely to occur
Psittacidae	*Polytelis alexandrae*	Princess Parrot	Priority 4	Vulnerable	May occur
	Pezoporus occidentalis	Night Parrot	Critically Endangered	Endangered	Unlikely to occur
Hirundinidae	*Hirundo rustica*	Barn Swallow	Migratory	Migratory	Would not occur
Motacillidae	*Motacilla tschutschensis (flava)*	Eastern Yellow Wagtail	Migratory	Migratory	Would not occur
	Motacilla cinerea	Grey Wagtail	Migratory	Migratory	Would not occur

5.0 Results and Discussion

5.1 Fauna Habitats

Four different fauna landscapes (broad fauna habitats) were determined on the basis of the approach outlined in Section 3.1.4, in combination with on-ground habitat assessment and consideration of the ecological niches relevant to fauna. These are mapped in Figure 5.1 and described in Table 5.1. Sampling sites were selected based on landforms and access within the study area. Habitat assessment data including photos of all sampling sites are presented in Appendix 4.

Table 5.1: Fauna habitats identified within the study area including area and dominant characteristics.

Fauna Habitat	Area & (proportion)	Representative photo
Landscape 1: Sandy drainage systems Landforms: Major/minor river/creek bed and banks, ephemeral pools (including flood out) Substrate: Sand Land systems: Fortescue, River Surface geology: predominantly alluvium Vegetation: Low open *Acacia* and *Melaleuca* woodland and shrubland with scattered trees (incl. *Eucalyptus camaldulensis, Corymbia hamersleyana*) and grasses, sedges and herbs	2,337.4 ha (33.7%)	
Landscape 2: Sandy *Triodia* plains Landforms: Sandplain Substrate: Sandy clay loam Land systems: Divide Surface geology: sandplain Vegetation: *Acacia* mixed open woodland with scattered *Eucalyptus gamophylla and Hakea* sp. over shrub steppe and hard spinifex	1,461.9 ha (21.1%)	

Fauna Habitat	Area & (proportion)	Representative photo
Landscape 3: Sandy clay loam Mulga dominated Floodplains Landforms: Floodplain (including flood fringe), colluvial plain, hard pan Substrate: Sandy clay loam Land systems: Washplain, Cadgie, Fortescue Surface geology: predominantly colluvium Vegetation: Sparse low *Acacia* and banded Mulga woodland - *Acacia aneura* discontinuous in scattered groups over low shrubland	3,042.9 ha (43.9%)	
Landscape 4: Rocky hill Landforms: Rocky rise, crest, hill slope Substrate: Gravelly sandy clay loam Land system: Fortescue Surface geology: iron formation Vegetation: Scattered low *Acacia* over scattered low shrubs (e.g. *Senna* sp.) over hard spinifex	86.4 ha (1.2%)	

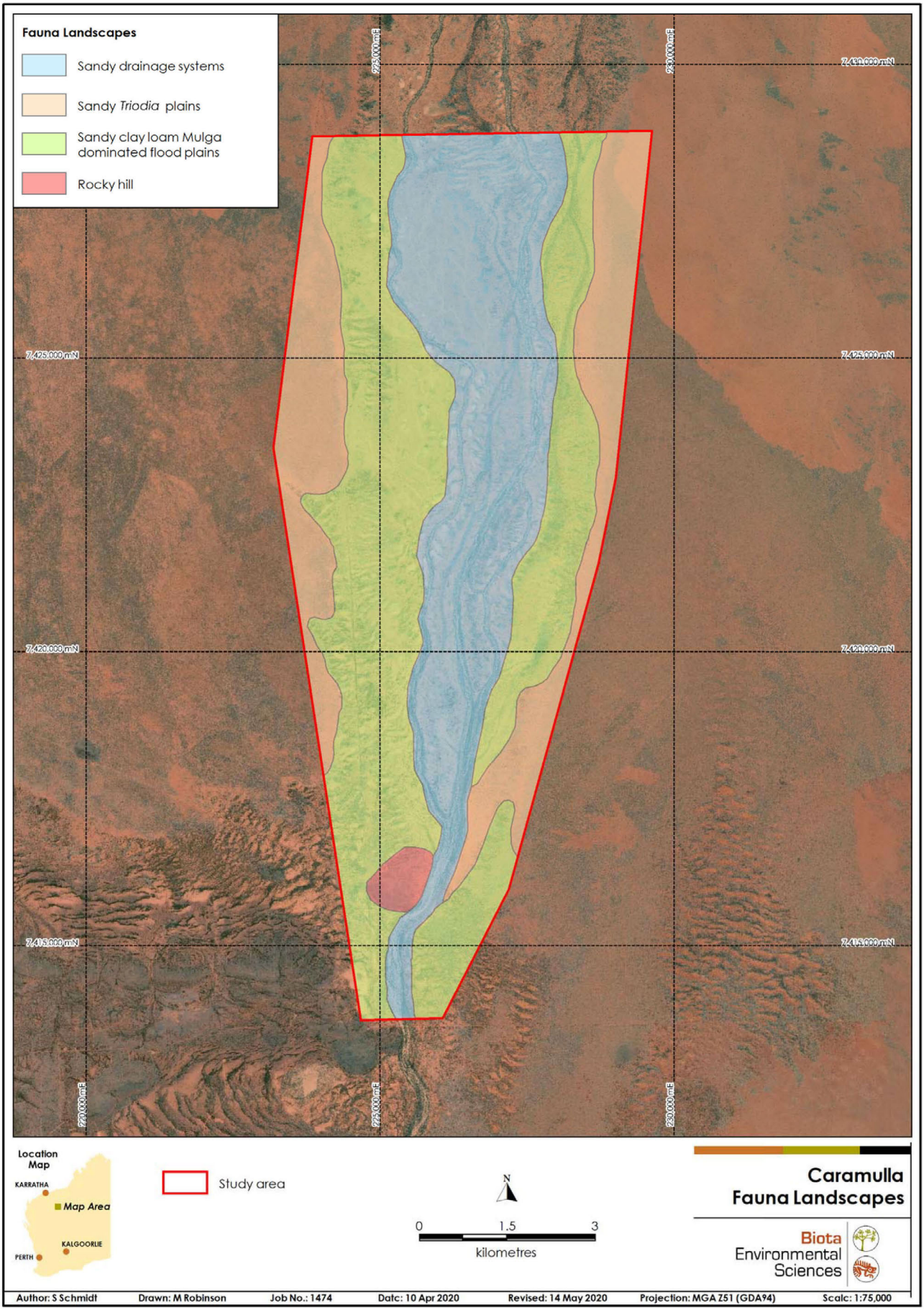

Figure 5.1: Fauna landscapes within the study area.

5.2 Vertebrate Fauna

5.2.1 Vertebrate Fauna Overview

A total of 93 vertebrate species were recorded during the survey. Table 5.2 provides a summary of the number of species recorded from each major vertebrate group. The fauna recorded during the survey represent over 26% of the total of 356 species identified from the locality of the study area (Appendix 1 and Section 4.2).

Table 5.2: Vertebrate fauna recorded during the survey and known from the locality.

	Number of Species	
Vertebrate Fauna Group	**This Survey**	**Desktop Review**
Non-volant Mammals	7	34
Bats	9	14
Birds	60	165
Reptiles[3]	14	134
Amphibians	3	9
Total	**93**	**356**

5.2.2 Non-volant Mammals

Seven ground-dwelling mammal species were recorded from the study area, representing 21% of all ground-dwelling mammal species known from the locality (n=34) based on database records and previous surveys (Appendix 1). The species total comprised one kangaroo species (Macropodidae), one rodent species (Muridae), Camel, Dingo, Cat, Donkey and Cattle.

No ground-dwelling mammals of conservation significance were recorded during the survey.

5.2.3 Bats

Nine bat species from three families were recorded from the study area. These include eight of the 14 species known from the locality based on database records and previous surveys (64%) and one previously unrecorded species: *Nyctophilus daedalus* (Pallid long-eared bat) (Appendix 1).

No bat species of conservation significance were recorded during the survey.

5.2.4 Birds

Sixty bird species from 27 families were recorded from the study area. These include 57 of the 165 species known from the locality based on database records and previous surveys (36%) and two new species: White-breasted Woodswallow (*Artamus leucorynchus*), and White-fronted Honeyeater (*Purnella albifrons*) (Appendix 1).

No bird species of conservation significance were recorded during the survey.

5.2.5 Reptiles

Fourteen reptile species were recorded from the study area. These include species from eight of the ten families known from the locality based on database records and previous surveys (Appendix 1).

The species total comprised one freshwater turtle, four geckos, one legless lizard, two dragons, two skinks, two goannas, and two elapid snake species.

No reptile species of conservation significance were recorded during the survey.

[3] This represents the minimum number of species recorded, as *Gehyra* spp. in the Pilbara have recently undergone extensive taxonomic revision (see Section 4.2 and Appendix 1)

5.2.6 Amphibians

Three amphibian species were recorded from the study area, representing one third of all amphibian species and all species of Pelodryadidae known from the locality (n=9) based on database records and previous surveys (Appendix 1).

No amphibian species of conservation significance were recorded during the survey.

5.3 Conservation Significance

5.3.1 Conservation Significant Vertebrates Occurring in the Study Area

No conservation significant species were recorded from the study area during the current or previous surveys.

5.3.2 Conservation Significant Vertebrates Potentially Occurring in the Study Area

Table 5.3 summarises the 28 conservation significant species that, although not recorded within the study area, were identified in the desktop review (see Section 4.2). The likelihood of occurrence of each species was revised after taking into account the habitat assessment and sampling conducted during the field survey.

Twenty of the 28 species were considered 'unlikely to occur' or 'would not occur' in the study area (Table 5.3). This is likely in part, due to the abundance of rocky landscapes adjacent to, but outside of the study area. Such areas represent core habitat for a number of conservation significant species known from the locality, but these habitats were not present within the study area.

Detailed descriptions of the eight species that are likely to occur or may occur within the study area are provided below. While these conservation significant species may utilise the study area, none are expected to be restricted to the study area.

Bilby, *Macrotis lagotis*
Vulnerable under both the WA *Biodiversity Conservation Act 2016* the Commonwealth EPBC Act.

Distribution: The distribution of the Bilby is discontinuous with the species occurring in a number of desert locations between south-west Queensland and the Pilbara.

Ecology: The Bilby is a solitary nocturnal omnivorous species inhabiting deep, often complex burrows. Remaining subpopulations occupy three major vegetation types: open tussock grassland on uplands and hills, mulga woodland/shrubland growing on ridges and rises, and hummock grassland in plains and alluvial areas.

Likelihood of occurrence: Based on a recent record nearby (approximately 6 km east of the southern end of the study area (Biologic 2018) and availability of suitable habitat, this species is likely to occur in the study area.

Brush-tailed Mulgara, *Dasycercus blythi*
DBCA listed Priority 4 species.

Distribution: The Brush-tailed Mulgara occurs in scattered populations at relatively low density, but may be locally abundant over much of arid central Western Australia.

Ecology: The Brush-tailed Mulgara is known to inhabit spinifex grasslands on sandplains and sandy swales between low dunes from south-western Queensland across the Simpson, Tanami, and Great Sandy Deserts of southern and central Northern Territory and central Western Australia. It is also known to inhabit areas on gibber (rock and pebble covered flat plains), and is closely associated with gently sloping to flat topographic positions rather than steep-sided sand ridges (Pavey et al. 2011).

Likelihood of occurrence: One dead individual and several active burrows were recorded recently (Biologic 2018) approximately 7 km southeast of the study area in sandy *Triodia* plains

habitat intersected by the eastern border of the study area. The species was also recorded approximately 32 km from the study area within *Triodia* plains habitat which is contiguous with that present in the study area. Based on multiple records from the locality and availability of suitable habitat, this species is likely to occur in the study area.

Western Pebble-mound Mouse, *Pseudomys chapmani*
DBCA listed Priority 4 species.

Distribution: The Western Pebble-mound Mouse typically occurs in the central and eastern Pilbara (Menkhorst and Knight 2011), but also indicates records in the western Pilbara (NatureMap).

Ecology: The species is typically found on stony hillsides with hummock grasslands (Menkhorst and Knight 2011). It is well known for its behaviour of constructing extensive mounds of small stones covering areas from 0.5 to 9.0 m^2 (van Dyck and Strahan 2008). Mounds are most common on spurs and gentle slopes where suitably sized stones are present (van Dyck and Strahan 2008).

Likelihood of occurrence: This species has been recorded on multiple occasions within 40 km of study area and as close as 6 km west of the study area, but limited stony habitat is available within the study area. This species may occur within the study area.

Pilbara Olive Python, *Liasis olivaceus barroni*
Vulnerable under the WA *Biodiversity Conservation Act 2016* and Vulnerable under the Commonwealth EPBC Act.

Distribution: The Pilbara Olive Python has a known distribution that coincides roughly with the Pilbara bioregion (DSEWPaC 2012). It is known from 17 localities in the Pilbara and apparently stable populations occur in four areas: Pannawonica, Millstream, Tom Price and the Burrup Peninsula. At some of these sites, the species occurs in sizeable numbers (DAWE 2020).

Ecology: Preferred habitat for the Pilbara Olive Python includes gorges, escarpments, rocky outcrops and water holes where it may find suitable prey. It seeks shelter in caves, beneath boulders, in pools of water and occasionally in trees overhanging water (Bush and Maryan 2011). It is often associated with ephemeral or permanent water, but may also be recorded in rocky habitats some distance from these features (Biota 2009), demonstrating that the species can have a large range (estimated between 88 ha and 449 ha) (DAWE 2020).

Likelihood of occurrence: There is one record from the locality approximately 42 km west of the study area. This species may occur within the study area where it would forage within the Sandy drainage systems (Figure 5.1) as several large pools were present, and core habitat is likely present nearby, particularly along the continuation of the drainage line within the rocky areas south and southwest of the study area.

Princess Parrot, *Polytelis alexandrae*
Vulnerable under the Commonwealth EPBC Act and DBCA listed Priority 4 species.

Distribution: The Princess Parrot is a highly nomadic species confined to arid regions of the Northern Territory, South Australia and Western Australia.

Ecology: The Princess Parrot inhabits sand dunes and sand flats in the arid zone of western and central Australia. It occurs in open savanna woodlands and shrublands. Princess Parrots are often observed in swales between sand dunes, where they feed on a variety of seeds, flowers, fruits and foliage of shrubs and trees.

Likelihood of occurrence: Recorded on one occasion (several individuals) from the locality, approximately 18 km east of the study area. The nomadic nature of this species means that it may occur within the study area on occasion, where it would likely forage in the sandy *Triodia* plain and Floodplain areas during seeding after flooding events, however it would be difficult to confirm this unless survey timing coincided with this species' occasional presence.

Peregrine Falcon, *Falco peregrinus*
Specially Protected under the WA *Biodiversity Conservation Act 2016.*

Distribution: This species occurs Australia-wide, and inhabits a wide range of habitats including forest, woodlands, wetlands and open country (Pizzey and Knight 2007).

Ecology: Home ranges are probably defended year-round and are variable in size, though not typically less than 480 ha (Marchant and Higgins 1993). The species typically nests on ledges in cliffs, granite outcrops and quarries, but also in hollow trees and in old nests constructed by other species such as Wedge-tailed Eagles and Ravens (Johnstone and Storr 1998).

Likelihood of occurrence: According to NatureMap, this species has previously been recorded within close proximity (2 km) of the south-western border of the study area, and on two further occasions within the locality (approximately 19 km southeast and 45 km west of the study area). It occurs in a range of habitats including those present in the study area. Therefore, this species is likely to occur in the study area

Fork-tailed Swift, *Apus pacificus*
Migratory under the WA *Biodiversity Conservation Act 2016* and Migratory under the Commonwealth EPBC Act.

Distribution: The Fork-tailed Swift occurs across much of Australia from September to April, particularly in the northern half of the continent. The species is most common closer to the coast, but occurs over much of the Pilbara.

Ecology: The species is a non-breeding migrant to Australia and is generally present from September to April. In Australia, the species is entirely aerial in habits, foraging for flying insects and even sleeping on the wing. The species is highly mobile, often occurring in association with unsettled weather and low pressure systems (Johnstone and Storr 1998).

Likelihood of occurrence: While the species has not been recorded from the locality, with the nearest record approximately 90 km northwest of the study area, it occurs over much of the Pilbara and over most terrestrial habitat types, and is therefore considered likely to occur over the study area, though occurrence is likely to be irregular.

Glossy Ibis, *Plegadis falcinellus*
Migratory under the WA *Biodiversity Conservation Act 2016* and Migratory under the Commonwealth EPBC Act.

Distribution: In Western Australia the Glossy Ibis predominantly occurs in the Kimberley and the Swan Coastal Plain. However there are also vagrant records from the Pilbara.

Ecology: The species is mainly a non-breeding visitor to Australia and is generally uncommon. Preferred habitat includes shallows and adjacent flats of freshwater lakes, swamps and river pools (Johnstone and Storr 1998).

Likelihood of Occurrence: There are six records of this species from the locality approximately 45 km west of the study area and there is some suitable habitat present in the study area within the sandy drainage systems and adjacent floodplains. The species occurs over much of the Pilbara and it may occur in the study area.

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Table 5.3: Conservation significant species from the desktop review that were not recorded in the study area, and their likelihood of occurrence (species likely to occur or may occur highlighted in grey).
(species likely to occur or may occur highlighted in grey)

ecies Name	mmon Name			Preferred Habitat	Habitat Available in Study Area	Occurrence in Locality	Likelihood of Occurrence in Study Area
		Sta	Commonwealth				
syurus hallucatus	thern Quoll	Endang	Endangered	Core habitat: gorges, gullies, tree faces, breakaways, boulder piles, incised hills. Secondary habitat: permanent and semi-permanent water, drainage systems	(secondary habitat)	Nearest record approximately 100 km northwest of study area	Unlikely to occur
sycercus blythi	sh-tailed Mulgc	Priori	-	Spinifex grasslands, shrublands, desert, burrows in flats between sand dunes.		One dead individual and several active burrows recorde in 2018 approximately 7 – 17 km southeast of the study area, and in 2010 and 2008 between approximately 32 and 45 km southeast of the study area, within contiguous habitat intersecting the eastern border of the study area several individuals trapped in 2018 approximately 33 km	Likely to occur
sycercus cristicauda	st-tailed Mulgc	Priori	Vulnerable	Sand dunes with sparse vegetation, herblands, sparse tussock grasslands bordering salt lakes		Previous records from the locality are likely misidentified Brush-tailed Mulgara prior to taxonomic resolution (Wooll 2005).	Would not occur
gorchestes conspicillatus chardti	ectacled Hare-llaby	Priori	-	In the Hibbard commonly occupies spinifex sandplains interspersed with low shrubs and a diversity of either soft grasses, sedges, or forb species.		southwest of the study area from 1959, nearest recent (2014) record approximately 220 km northwest of the stu area.	Unlikely to occur
ggadina lakedownensis	ort-tailed Mouse	Priori	-	Found primarily in areas of cracking clay and adjacent habitats including open grasslands, acacia shrubland and savannah woodland on alluvial clay and sandy soils.		Nearest record approximately 70 km northwest of the study area	Unlikely to occur
nonicteris aurantia	ara Leaf-nosec	Vulner	Vulnerable	Core habitat: gorges, gullies, free faces, breakaways, incised hills, permanent and semi-permanent water. Secondary habitat: drainage systems, alluvial plains and Floodplains	(secondary habitat)	Records reported from locality by Ecologia (2006) later determined to be misidentified calls (Outback Ecology 2009), with nearest confirmed record approximately 65 k west of the study area	Unlikely to occur
acroderma gigas	ost Bat	Vulner	Vulnerable	Range of habitats that provide suitable caves for roost sites, Core habitat: gorges, gullies, free faces, incised hills. Secondary habitat: drainage systems, alluvial plains and Floodplains.	(secondary habitat)	Records reported from locality by Ecologia (2006) later determined to be misidentified calls (Outback Ecology 2009), with nearest confirmed record approximately 60 k west of the study area.	Unlikely to occur
sis olivaceus barroni	ara Olive Pytho	Vulner	Vulnerable	Gorges, escarpments, rocky outcrops and water holes	(secondary habitat)	One record from the locality approximately 42 km west c the study area.	May occur
pidites ramsayi	ma	Priori	-	This species is associated with desert and semi-arid areas predominantly found in sandy areas, but is also found in spinifex grassland, *Eucalyptus* and *Acacia* woodlands on clay soils, rocky areas, and other non-sandy habitats.		The two nearest records approximately 250-260 km northeast and east of the study area.	Unlikely to occur
zoporus occidentalis	ht Parrot	Critic Endang	Endangered	Arid or semi-arid spinifex grasslands with large, established and unburnt hummocks. Foraging habitat includes areas of samphire, bluebush and saltbush.	**X**	Nearest records located approximately 90 km northeast the study area from 1970 and approximately 150 km northwest of the study area from 2005.	Unlikely to occur

co hypoleucos	ey Falcon	Vulner	-	Wide range of habitats in the arid zone, appears to be least rare in lightly wooded coastal and riverine plains.		Nearest record located approximately 80 km northwest o the study area.	Unlikely to occur
co peregrinus	egrine Falcon	Oth Spec Protec Faur	-	Wide range of hot as well as cool and dry as well as wet habitats		Three records from the locality, one within 2 km of the southwestern border of the study area, and two approximately 19 km southeast and 45 km west of the study area.	Likely to occur
gadis falcinellus	ssy Ibis	Migra	Migratory	Freshwater wetlands and pasture, also Floodplains		Six records from the locality approximately 45 km west of the study area.	May occur
aradrius veredus	ental Plover	Migra	Migratory	wastes near inland swamps or tidal mudflats, bare claypans, margins of coastal marshes, grassy airfields, lawns and coastal dunes		Nearest record located approximately 105 km northwest of the study area.	Unlikely to occur
lidris melanotos	ctoral Sandpipe	Migra	Migratory	Lightly vegetated coastal or inland swamps	**X**	Single record located approximately 60 km west of the study area.	Would not occur
lochelidon nilotica	ll-billed Tern	Migra	Migratory	Shoals, saltmarshes, saltpans, freshwater lagoons, estuaries, deltas, inland lakes, rivers, marshes and swamps	**X**	Single record from the locality approximately 45 km west of the study area.	Unlikely to occur
tacilla cinerea	ey Wagtail	Migra	Migratory	Fast-flowing streams, often at high altitude. Outside of the breeding season it is found in greater variety of habitats. Rare migrant to Australia, very rare south of Kimberley region.	**X**	Single record approximately 170 km northwest of the stuc area.	Would not occur

5.3.3 Fauna Habitat Conservation Value

Based on reviews of aerial imagery and land systems, vegetation, and surface geology mapping, none of the fauna habitats identified during the fauna survey are confined to the study area, and most are common and widespread within the Fortescue subregion. The limited rocky habitat within the study area reflects the limited availability of such habitats within the subregion.

When assessing the value of habitat in the study area, it is informative to consider the core habitat of individual species of conservation significance. Core habitat for species of conservation significance equates to "habitat critical to the survival of a species" as recognised for the purposes of the EPBC Act (DotE 2013).

For each MNES species, fauna habitats may be classified as:

1. "core", equivalent to "habitat critical to the survival of the species" (DotE 2013); this comprises habitat considered to potentially contain roosting, denning or breeding sites, primary foraging areas, or refugia during drought, fire or other stress; or
2. "secondary" – these comprise the remaining habitats of the study area, which may be used on a transitory, dispersing or occasional basis, but do not represent core habitat.

It is assumed that some proportion of core habitat must be maintained across the species' range to ensure the persistence of the species in the region. Secondary habitats may be used for less regular foraging or on a transitory, dispersing, or occasional basis, but do not represent core habitat.

Five MNES species were identified as potentially occurring in the study area (Section 5.3.2 and Table 5.3). Based on desktop and field survey results, the MNES species that are likely to occur or may occur within the study area may utilise three of the identified fauna landscapes (Section 5.1) as presented in Table 5.4.

Table 5.4: Probable MNES species habitat utilisation.

	Habitat		
	Fauna Landscape 1:	**Fauna Landscape 2:**	**Fauna Landscape 3:**
MNES Species	**Sandy drainage systems**	**Sandy *Triodia* plains**	**Sandy clay loam Mulga dominated Floodplains**
Bilby	Foraging	Breeding and Foraging	Foraging
Pilbara Olive Python	Occasional*	–	–
Princess Parrot	–	–	Occasional*

Orange cells indicate core habitat; yellow cells indicate secondary habitat.

*After flooding events when pools are present in drainages and Floodplain vegetation is seeding.

All three fauna landscapes identified as having the potential to be utilised by MNES species within the study area are common within the locality and occur contiguously with the same habitat types outside of the study area.

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6.0 Glossary

Biota	Biota Environmental Sciences.
Conservation significant	A species listed under the *Biodiversity Conservation Act 2016* and/or the Federal EPBC Act and/or as a DBCA Priority species.
DBCA	Department of Biodiversity, Conservation and Attractions formerly Department of Parks and Wildlife, Department of Environment and Conservation (DEC), and Department of Conservation and Land Management (CALM).
EPA	Environmental Protection Authority of Western Australia.
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
IBRA	Interim Biogeographic Regionalisation for Australia.
Landform	A geomorphological unit that is largely defined by its surface form and location in the landscape.
MNES species	Species that are listed as Matters of National Environmental Significance under the EPBC Act.
Opportunistic record	Recorded by non-systematic sampling methods.
SM2Bat, SM4Bat	SongMeter 2 or 4 ultrasonic bat call recorder.
sp. (plural: spp.)	Abbreviation of "species".
Study area	Caramulla miscellaneous licence.
WAM	Western Australian Museum.

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Appendix 1

Vertebrate Database Search Results and Previous Surveys in the Locality, Including Current Survey Records

Non-volant Mammals

			Conservation status		Databases				Previous surveys					
Family/Species	**Common Name**	**This survey**	**State**	**Commonwealth**	**NatureMap**	**EPBC**	**ALA**	**IUCN**	**Ecologia (2005)**	**Ecologia (2006)**	**GHD (2009)**	**Outback (2009)**	**Biologic (2018)**	**Onshore (2019)**
Tachyglossidae														
Tachyglossus aculeatus	Short-beaked Echidna							•				•		
Dasyuridae														
Dasycercus blythi	Brush-tailed Mulgara, Ampurta		Priority 4		•			•					•	
Dasycercus cristicauda	Crest-tailed Mulgara		Priority 4	Vulnerable	•									
Dasykaluta rosamondae	Kaluta				•		•	•		•		•		
Dasyurus hallucatus	Northern Quoll		Endangered	Endangered		•								
Ningaui ridei	Wongai Ningaui							•						
Ningaui timealeyi	Pilbara Ningaui				•		•	•		•				
Pseudantechinus roryi	Rory's Pseudantechinus				•		•	•						
Pseudantechinus woolleyae	Woolley's Pseudantechinus				•		•	•						
Sminthopsis crassicaudata	Fat-tailed Dunnart				•					•		•		
Sminthopsis longicaudata	Long-tailed Dunnart		Priority 4		•		•	•						
Sminthopsis macroura	Stripe-faced Dunnart				•		•	•		•		•		
Sminthopsis ooldea	Ooldea Dunnart				•		•	•						
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart				•		•	•				•		
Thylacomyidae														
Macrotis lagotis	Bilby, Dalgyte		Vulnerable	Vulnerable	•	•		•					•	
Macropodidae														
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby		Priority 4				•							
Macropus robustus	Euro, Biggada				•			•	•	•		•		•
Osphranter rufus	Red Kangaroo, Marlu	•			•			•	•	•	•	•	•	
Petrogale rothschildi	Rothschild's Rock-wallaby				•									
Muridae														
Leggadina lakedownensis	Short-tailed Mouse		Priority 4					•						
Mus musculus	House Mouse				•	•	•	•		•		•		
Notomys alexis	Spinifex Hopping-mouse	•			•		•	•		•				
Pseudomys chapmani	Western Pebble-mound Mouse		Priority 4		•		•	•				•		
Pseudomys desertor	Desert Mouse				•		•	•		•				
Pseudomys hermannsburgensis	Sandy Inland Mouse				•		•	•		•		•		
Zyzomys argurus	Common Rock-rat				•		•			•		•	•	
Leporidae														
Oryctolagus cuniculus	Rabbit				•	•					•			•
Canidae														
Canis familiaris	Dog	•				•			•	•	•	•	•	•
Vulpes vulpes	Red Fox					•		•						
Felidae														
Felis catus	Cat	•			•	•			•		•	•	•	•
Equidae														
Equus asinus	Donkey	•			•	•				•		•		
Equus caballus	Horse											•		•
Camelidae														
Camelus dromedarius	Dromedary, Camel	•			•	•					•		•	•
Bovidae														
Bos taurus	European Cattle	•			•	•				•	•	•	•	•

Bats

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Rhinonycteridae														
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat		Vulnerable	Vulnerable		•								
Megadermatidae														
Macroderma gigas	Ghost Bat		Vulnerable	Vulnerable	•	•	•	•						
Emballonuridae														
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat				•			•	•	•				
Taphozous georgianus	Common Sheath-tailed Bat	•			•		•	•		•				
Taphozous hilli	Hill's Sheath-tailed Bat				•									•
Molossidae														
Austromomus australis	White-striped Free-tailed Bat	•						•						
Chaerephon jobensis	Greater Northern Free-tailed Bat	•			•			•	•					•
Ozimops lumsdenae	Northern Free-tailed Bat	•						•		•				•
Vespertilionidae														
Chalinolobus gouldii	Gould's Wattled Bat	•			•			•	•	•				•
Chalinolobus morio	Chocolate Wattled Bat							•						
Nyctophilus daedalus	Pallid Long-eared Bat	•												
Nyctophilus geoffroyi	Lesser Long-eared Bat	•			•			•	•	•				
Scotorepens balstoni	Inland Broad-nosed Bat				•			•						
Scotorepens greyii	Little Broad-nosed Bat	•			•			•	•	•				•
Vespadelus finlaysoni	Finlayson's Cave-bat	•			•			•	•	•				•

Amphibians

			Conservation status		Databases				Previous surveys					
Family/Species	**Common Name**	**This survey**	**State**	**Commonwealth**	**NatureMap**	**EPBC**	**ALA**	**IUCN**	**Ecologia (2005)**	**Ecologia (2006)**	**GHD (2009)**	**Outback (2009)**	**Biologic (2018)**	**Onshore (2019)**
Pelodryadidae														
Cyclorana maini	Sheep Frog	•			•		•	•		•				
Cyclorana occidentalis	Western water-holding Frog	•			•			•		•				
Litoria rubella	Little Red Tree Frog	•			•		•	•	•	•		•		
Limnodynastidae														
Neobatrachus pelobatoides	Humming Frog											•		
Neobatrachus sutor	Shoemaker Frog							•						
Notaden nichollsi	Desert Spadefoot				•		•	•						
Platyplectrum spenceri	Centralian Burrowing Frog				•		•	•		•				
Myobatrachidae														
Uperoleia russelli	Northwest Toadlet				•			•		•		•		
Uperoleia saxatilis	Pilbara Toadlet						•							

Reptiles

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Cheluidae														
Chelodina steindachneri	Flat-shelled Turtle	•								•				
Carphodactylidae														
Nephrurus laevissimus								•						
Nephrurus levis								•						
Nephrurus wheeleri	Southern Banded Knob-tailed							•						
Diplodactylidae														
Crenadactylus pilbarensis	Pilbara Clawless Gecko							•						
Diplodactylus bilybara	Western Fat-tailed Gecko						•							
Diplodactylus conspicillatus	Variable Fat-tailed Gecko	•			•		•	•	•	•		•		
Diplodactylus laevis	Desert Fat-tailed Gecko						•	•						
Diplodactylus pulcher					•		•	•						•
Diplodactylus savagei	Southern Pilbara Beak-faced				•									
Lucasium stenodactylum		•			•		•	•	•	•		•		
Lucasium wombeyi					•		•			•				
Oedura fimbria	Western Marbled Velvet Gecko				•		•	•						
Rhynchoedura ornata	Western Beaked Gecko	•			•		•	•	•	•				•
Strophurus ciliaris								•	•					
Strophurus elderi					•		•	•	•					
Strophurus jeanae					•		•	•	•					
Strophurus strophurus														
Strophurus wellingtonae					•		•	•	•	•				
Gekkonidae														
Gehyra montium							•	•						
Gehyra pilbara					•		•	•						
*Gehyra punctata**					•		•	•		•		•		•
Gehyra purpurascens								•		•				
*Gehyra variegata***		•			•		•	•	•	•		•		
Heteronotia binoei	Bynoe's Gecko				•		•	•	•	•		•		•
Heteronotia planiceps							•							
Heteronotia spelea	Pilbara Cave Gecko				•		•	•		•				•
Pygopodidae														
Delma butleri								•						
Delma desmosa					•			•						
Delma elegans					•					•				
Delma nasuta					•		•	•						
Delma pax					•		•	•		•		•		
Delma tincta					•							•		
Lialis burtonis		•			•		•			•		•		
Pygopus nigriceps					•			•		•				
Agamidae														
Ctenophorus caudicinctus	Ring-tailed Dragon				•		•	•	•	•	•	•	•	•
Ctenophorus isolepis	Military Dragon	•			•		•	•	•				•	
Ctenophorus nuchalis	Central Netted Dragon				•		•	•		•		•	•	
Ctenophorus reticulatus	Western Netted Dragon				•		•	•						

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Diporiphora amphiboluroides	Mulga Dragon				•		•	•						
Diporiphora paraconvergens	Grey-striped Western Desert							•						
Diporiphora valens	Southern Pilbara Tree Dragon				•			•						
Gowidon longirostris	Long-nosed Dragon	•			•		•	•	•	•	•		•	
Moloch horridus	Thorny Devil				•		•							
Pogona minor					•		•	•		•				
Tympanocryptis fortescuensis	Fortescue pebble-mimic dragons							•						
Scincidae														
Carlia munda					•			•		•				
Carlia triacantha					•		•	•						
Cryptoblepharus buchananii					•			•						•
Cryptoblepharus ustulatus					•		•	•						
Ctenotus ariadnae					•		•	•						
Ctenotus brooksi								•						
Ctenotus calurus								•						
Ctenotus duricola					•		•	•		•		•		
Ctenotus dux								•						
Ctenotus grandis		•			•		•	•		•		•		
Ctenotus hanloni					•			•						
Ctenotus helenae					•		•	•		•		•		
Ctenotus inornatus							•							
Ctenotus leonhardii					•		•	•	•					
Ctenotus nasutus								•						
Ctenotus pallasotus	Western Pilbara Lined Ctenotus						•							
Ctenotus pantherinus	Leopard Ctenotus	•			•		•	•		•		•		
Ctenotus quattuordecimlineatus					•									
Ctenotus rubicundus								•						
Ctenotus rutilans					•		•	•		•				
Ctenotus saxatilis	Rock Ctenotus				•			•		•		•		
Ctenotus schomburgkii					•			•		•				
Ctenotus serventyi								•						
Ctenotus uber					•		•	•		•		•		
Cyclodomorphus melanops	Slender Blue-tongue				•		•	•		•				
Egernia cygnitos	Western Pilbara Spiny-tailed Skink				•		•	•						
Egernia depressa	Southern Pygmy Spiny-tailed Skink				•		•	•		•				
Egernia formosa								•						
Egernia kingii	King's Skink							•						
Eremiascincus richardsonii	Broad-banded Sand Swimmer				•		•		•	•				
Lerista amicorum								•						
Lerista bipes					•		•	•		•				
Lerista flammicauda					•									
Lerista ips								•						
Lerista macropisthopus								•						
Lerista muelleri					•		•	•		•		•		
Lerista neander					•		•	•		•		•		
Lerista timida					•		•	•						

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Lerista varia								•						
Lerista xanthura								•						
Lerista zietzi					•		•	•		•				
Liopholis striata	Night Skink				•			•						
Menetia greyii					•		•	•		•		•		
Menetia surda					•			•						
Morethia ruficauda					•		•	•		•				
Notoscincus ornatus					•		•	•						
Proablepharus reginae								•						
Tiliqua multifasciata	Central Blue-tongue				•		•		•	•		•		
Varanidae														
Varanus acanthurus	Spiny-tailed Goanna				•		•	•		•		•	•	
Varanus brevicauda	Short-tailed Pygmy Goanna				•			•						
Varanus bushi	Pilbara Mulga Goanna							•						
Varanus caudolineatus					•		•	•				•		
Varanus eremius	Pygmy Desert Goanna	•			•		•	•						
Varanus giganteus	Perentie				•			•		•			•	
Varanus gilleni	Pygmy Mulga Goanna							•						
Varanus gouldii	Bungarra or Sand Goanna	•			•			•		•		•	•	
Varanus hamersleyensis	Southern Pilbara Rock Goanna						•	•						
Varanus panoptes	Yellow-spotted Goanna				•			•	•	•				
Varanus pilbarensis	Northern Pilbara Rock Goanna				•									
Varanus tristis	Racehorse Goanna				•			•		•		•		
Typhlopidae														
Anilios ammodytes								•						
Anilios endoterus								•						
Anilios ganei			Priority 1				•	•						
Anilios grypus							•	•		•				
Anilios hamatus							•	•		•		•		
Anilios waitii								•						
Pythonidae														
Antaresia perthensis	Pygmy Python				•		•	•		•				
Antaresia stimsoni	Stimson's Python				•			•	•					
Aspidites melanocephalus	Black-headed Python							•		•				
Aspidites ramsayi	Woma		Priority 1					•						
Liasis olivaceus barroni	Pilbara Olive Python		Vulnerable	Vulnerable		•		•						
Elapidae														
Acanthophis pyrrhus	Desert Death Adder							•						
Acanthophis wellsi	Pilbara Death Adder							•						
Brachyurophis approximans					•		•	•						
Brachyurophis fasciolatus								•						
Demansia psammophis	Yellow-faced Whipsnake				•		•	•	•	•				
Demansia shinei								•						
Furina ornata	Moon Snake							•						
Parasuta monachus								•						
Pseudechis australis	Mulga Snake	•			•			•		•		•		

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Pseudonaja modesta	Ringed Brown Snake				•		•	•		•				
Pseudonaja nuchalis	Gwardar; Northern Brown Snake	•			•		•	•	•	•		•	•	
Simoselaps anomalus	Desert Banded Snake							•						
Simoselaps bertholdi	Jan's Banded Snake							•						
Suta fasciata	Rosen's Snake				•			•						
Suta punctata	Spotted Snake				•			•						
Vermicella snelli								•						

**Gehyra punctata* split into several species in 2018, specimens recorded from the locality of the study area as *G. punctata* may be *G. punctata*, *G. fenestrula* or *G. micra* (Doughty et al. 2018).

***Gehyra variegata* split into several species in 2018, specimens recorded from the locality of the study area as *G. variegata* may be *G. variegata*, *G. crypta, G. montium* or *G. incognita*. This includes *Gehyra* specimens observed during the current survey as species cannot be readily identified morphologically in the field (Kealley et al. 2018).

Avifauna

			Conservation status		Databases				Previous surveys					
Family/Species	**Common Name**	**This survey**	**State**	**Commonwealth***	**NatureMap**	**EPBC**	**ALA**	**IUCN**	**Ecologia (2005)**	**Ecologia (2006)**	**GHD (2009)**	**Outback (2009)**	**Biologic (2018)**	**Onshore (2019)**
Casuariidae														
Dromaius novaehollandiae	Emu	•			•		•	•						•
Phasianidae														
Coturnix pectoralis	Stubble Quail			Marine	•				•					
Coturnix ypsilophora	Brown Quail							•						
Anatidae														
Dendrocygna eytoni	Plumed Whistling-duck							•						
Dendrocygna arcuata	Wandering Whistling-duck			Marine				•						
Cygnus atratus	Black Swan						•	•						
Tadorna tadornoides	Australian Shelduck				•		•	•						
Chenonetta jubata	Australian Wood Duck													
Malacorhynchus membranaceus	Pink-eared Duck							•						
Anas gracilis	Grey Teal				•		•	•						
Anas superciliosa	Pacific Black Duck				•		•	•						
Aythya australis	Hardhead							•						
Podicipedidae														
Tachybaptus novaehollandiae	Australasian Grebe							•						
Poliocephalus poliocephalus	Hoary-headed Grebe							•						
Podiceps cristatus	Great Crested Grebe							•						
Columbidae														
Phaps chalcoptera	Common Bronzewing				•		•	•		•				
Phaps histrionica	Flock Bronzewing							•						
Ocyphaps lophotes	Crested Pigeon	•			•		•	•	•	•	•	•	•	•
Geophaps plumifera	Spinifex Pigeon	•			•		•			•	•	•		•
Geopelia cuneata	Diamond Dove	•			•		•	•	•	•			•	•
Geopelia striata	Peaceful Dove				•		•	•		•				
Podargidae														
Podargus strigoides	Tawny Frogmouth				•		•	•	•	•	•			
Eurostopodidae														
Eurostopodus argus	Spotted Nightjar	•		Marine	•		•	•	•	•				•
Aegothelidae														
Aegotheles cristatus	Australian Owlet-nightjar				•		•	•	•	•	•			
Apodidae														
Apus pacificus	Fork-tailed Swift		Migratory	Marine/Migratory		•								
Anhingidae														
Anhinga novaehollandiae	Australasian Darter							•	•					
Phalacrocoracidae														
Phalacrocorax carbo	Great Cormorant				•			•						
Phalacrocorax sulcirostris	Little Black Cormorant				•			•						
Pelecanidae														
Pelecanus conspicillatus	Australian Pelican			Marine				•						
Ardeidae														
Ardea pacifica	White-necked Heron	•			•		•	•						
Ardea modesta	Eastern Great Egret			Marine	•	•	•	•						
Ardea intermedia	Plumed Egret			Marine				•						

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth*	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Ardea ibis	Cattle Egret			Marine		•								
Egretta novaehollandiae	White-faced Heron				•		•							
Egretta garzetta	Little Egret			Marine	•		•	•						
Nycticorax caledonicus	Nankeen Night-Heron			Marine	•		•	•						
Threskiornithidae														
Plegadis falcinellus	Glossy Ibis		Migratory	Marine/Migratory	•			•						
Threskiornis spinicollis	Straw-necked Ibis			Marine	•		•	•						
Platalea flavipes	Yellow-billed Spoonbill				•			•						
Accipitridae														
Elanus axillaris	Black-shouldered Kite	•			•		•	•						
Lophoictinia isura	Square-tailed Kite				•		•	•						
Hamirostra melanosternon	Black-breasted Buzzard				•		•	•	•			•		
Haliastur sphenurus	Whistling Kite	•		Marine	•		•					•	•	•
Milvus migrans	Black Kite	•			•		•	•				•		•
Accipiter fasciatus	Brown Goshawk			Marine	•		•	•						
Accipiter cirrocephalus	Collared Sparrowhawk				•		•	•						
Circus assimilis	Spotted Harrier	•			•		•	•					•	•
Aquila audax	Wedge-tailed Eagle				•		•	•				•	•	
Hieraaetus morphnoides	Little Eagle				•		•	•	•			•		
Falconidae														
Falco cenchroides	Nankeen Kestrel	•		Marine	•		•		•		•	•	•	•
Falco berigora	Brown Falcon	•			•		•	•	•		•	•	•	•
Falco longipennis	Australian Hobby	•			•		•	•	•					
Falco hypoleucos	Grey Falcon		Vulnerable					•						
Falco peregrinus	Peregrine Falcon		Other Specially Protected Fauna		•		•	•						
Rallidae														
Porzana pusilla	Baillon's Crake			Marine				•						
Porzana tabuensis	Spotless Crake			Marine				•						
Turnicidae														
Tribonyx ventralis	Black-tailed Native-hen				•		•	•						
Fulica atra	Eurasian Coot						•	•						
Otididae														
Ardeotis australis	Australian Bustard	•			•		•	•	•		•	•	•	
Burhinidae														
Burhinus grallarius	Bush Stone-curlew	•			•		•					•		
Recurvirostridae														
Himantopus himantopus	Pied Stilt (Black-winged)			Marine				•						
Charadriidae														
Charadrius ruficapillus	Red-capped Plover							•						
Charadrius veredus	Oriental Plover		Migratory	Migratory/Marine		•								
Elseyornis melanops	Black-fronted Dotterel				•			•		•				
Scolopacidae														
Actitis hypoleucos	Common Sandpiper		Migratory	Migratory/Marine	•	•		•						
Calidris melanotos	Pectoral Sandpiper		Migratory	Migratory/Marine		•								
Calidris acuminata	Sharp-tailed Sandpiper		Migratory	Migratory/Marine		•								

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth*	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Calidris ferruginea	Curlew Sandpiper		Critically Endangered; Migratory	Critically Endangered/ Migratory/Marine	•	•								
Turnix velox	Little Button-quail	•			•		•	•						
Laridae														
Gelochelidon nilotica	Gull-billed Tern		Migratory	Migratory/Marine	•			•						
Chlilonias hybrida	Whiskered Tern			Marine				•						
Cacatuidae														
Eolophus roseicapillus	Galah	•			•		•	•	•	•	•		•	•
Cacatua sanguinea	Little Corella	•			•		•	•		•		•		•
Nymphicus hollandicus	Cockatiel	•			•		•	•		•				
Psittacidae														
Polytelis alexandrae	Princess Parrot		Priority 4	Vulnerable	•	•								
Barnardius zonarius	Australian Ringneck	•			•		•	•	•	•	•	•	•	•
Psephotus varius	Mulga Parrot						•							
Melopsittacus undulatus	Budgerigar	•			•		•	•		•		•	•	•
Neopsephotus bourkii	Bourke's Parrot				•		•	•		•			•	
Pezoporus occidentalis	Night Parrot		Critically Endangered	Endangered		•		•						
Cuculidae														
Centropus phasianinus	Pheasant Coucal				•		•			•				
Chalcites basalis	Horsfield's Bronze-Cuckoo				•		•			•				•
Chalcites osculans	Black-eared Cuckoo			Marine	•	•				•				
Cacomantis pallidus	Pallid Cuckoo	•		Marine	•		•	•		•				•
Strigidae														
Ninox connivens	Barking Owl						•	•						
Ninox novaeseelandiae	Southern Boobook			Marine			•	•		•		•		
Tytonidae														
Tyto javanica	Eastern Barn Owl	•			•		•	•				•		
Halcyonidae														
Dacelo leachii	Blue-winged Kookaburra				•		•	•		•				•
Todiramphus pyrrhopygius	Red-backed Kingfisher	•			•		•	•		•	•	•		
Todiramphus sanctus	Sacred Kingfisher			Marine	•		•	•	•	•	•			
Meropidae														
Merops ornatus	Rainbow Bee-eater	•		Marine	•	•	•		•	•		•		•
Climacteridae														
Climacteris melanura	Black-tailed Treecreeper							•		•				
Ptilonorhychidae														
Ptilonorhynchus maculatus	Spotted Bowerbird				•									
Ptilonorhynchus guttatus	Western Bowerbird				•		•	•		•				
Maluridae														
Malurus splendens	Splendid Fairy-wren				•									
Malurus leucopterus	White-winged Fairy-wren	•			•		•		•	•		•		•
Malurus lamberti	Variegated Fairy-wren	•			•		•			•		•		•
Stipiturus ruficeps	Rufous-crowned Emu-wren				•		•			•				
Amytornis striatus	Striated Grasswren				•		•			•		•		•
Acanthizidae														
Pyrrholaemus brunneus	Redthroat				•			•						•

Family/Species	Common Name	This survey	Conservation status		Databases				Previous surveys					
			State	Commonwealth*	NatureMap	EPBC	ALA	IUCN	Ecologia (2005)	Ecologia (2006)	GHD (2009)	Outback (2009)	Biologic (2018)	Onshore (2019)
Smicrornis brevirostris	Weebill	•			•		•	•		•	•	•		•
Gerygone fusca	Western Gerygone				•		•				•	•		
Acanthiza robustirostris	Slaty-backed Thornbill				•		•	•		•				•
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				•		•	•		•				
Acanthiza uropygialis	Chestnut-rumped Thornbill	•			•		•	•		•				
Acanthiza apicalis	Inland Thornbill				•		•	•	•			•		•
Aphelocephala leucopsis	Southern Whiteface						•							
Aphelocephala nigricincta	Banded Whiteface				•		•							
Pardalotidae														
Pardalotus rubricatus	Red-browed Pardalote				•		•			•				•
Pardalotus striatus	Striated Pardalote				•		•	•						
Meliphagidae														
Certhionyx variegatus	Pied Honeyeater				•		•	•		•				•
Lichenostomus virescens	Singing Honeyeater	•			•		•	•	•	•		•		•
Lichenostomus keartlandi	Grey-headed Honeyeater	•			•		•					•		
Lichenostomus plumulus	Grey-fronted Honeyeater													
Lichenostomus penicillatus	White-plumed Honeyeater	•					•	•	•	•		•	•	•
Purnella albifrons	White-fronted Honeyeater	•												
Manorina flavigula	Yellow-throated Miner	•			•		•	•	•	•	•	•		•
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	•			•		•	•	•	•	•			
Conopophila whitei	Grey Honeyeater				•									
Epthianura tricolor	Crimson Chat	•			•		•	•		•	•			
Sugomel niger	Black Honeyeater							•		•				
Lichmera indistincta	Brown Honeyeater	•			•		•	•	•	•				•
Melithreptus gularis	Black-chinned Honeyeater	•			•									
Pomatostomidae														
Pomatostomus temporalis	Grey-crowned Babbler	•			•		•			•	•	•	•	•
Pomatostomus superciliosus	White-browed Babbler				•		•	•						
Eupetidae														
Cinclosoma castanotum	Chestnut Quail-thrush								•					
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush				•		•							
Psophodes occidentalis	Chiming Wedgebill													
Neosittidae														
Daphoenositta chrysoptera	Varied Sittella				•			•						
Campephagidae														
Coracina maxima	Ground Cuckoo-shrike				•		•			•				
Coracina novaehollandiae	Black-faced Cuckoo-shrike	•		Marine	•		•	•	•	•		•		•
Lalage sueurii	White-winged Triller	•			•		•	•		•				•
Pachycephalidae														
Pachycephala rufiventris	Rufous Whistler	•			•		•	•	•	•	•	•		•
Colluricincla harmonica	Grey Shrike-thrush	•			•		•		•	•	•	•	•	•
Oreoica gutturalis	Crested Bellbird	•			•		•	•		•				•
Artamidae														
Artamus leucorynchus	White-breasted Woodswallow	•												
Artamus personatus	Masked Woodswallow	•			•		•	•				•		
Artamus superciliosus	White-browed Woodswallow							•						

			Conservation status		Databases				Previous surveys					
Family/Species	**Common Name**	**This survey**	**State**	**Commonwealth***	**NatureMap**	**EPBC**	**ALA**	**IUCN**	**Ecologia (2005)**	**Ecologia (2006)**	**GHD (2009)**	**Outback (2009)**	**Biologic (2018)**	**Onshore (2019)**
Artamus cinereus	Black-faced Woodswallow	•			•		•	•	•	•		•		•
Artamus minor	Little Woodswallow				•		•	•		•				•
Cracticus torquatus	Grey Butcherbird				•		•		•	•	•			
Cracticus nigrogularis	Pied Butcherbird	•			•		•	•	•	•		•		•
Cracticus tibicen	Australian Magpie	•			•		•					•		•
Rhipidura albiscapa	Grey Fantail	•			•		•	•						
Rhipiduridae														
Rhipidura leucophrys	Willie Wagtail	•			•		•	•	•	•	•	•		•
Corvidae														
Corvus coronoides	Australian Raven								•					
Corvus bennetti	Little Crow	•			•		•			•				
Corvus orru	Torresian Crow	•			•		•	•	•	•	•	•		•
Monarchidae														
Grallina cyanoleuca	Magpie-lark			Marine	•		•		•	•	•	•	•	•
Petroicidae														
Petroica goodenovii	Red-capped Robin				•		•	•	•	•			•	•
Melanodryas cucullata	Hooded Robin				•		•	•		•		•		•
Alaudidae														
Mirafra javanica	Horsfield's Bushlark	•			•		•			•		•	•	
Megaluridae														
Cincloramphus mathewsi	Rufous Songlark	•					•	•		•		•		
Cincloramphus cruralis	Brown Songlark						•	•					•	
Eremiornis carteri	Spinifexbird	•			•		•	•				•		•
Hirundinidae														
Cheramoeca leucosterna	White-backed Swallow				•		•	•		•		•		
Hirundo rustica	Barn Swallow		Migratory	Migratory		•								
Hirundo neoxena	Welcome Swallow			Marine			•	•						
Petrochelidon ariel	Fairy Martin				•		•							•
Petrochelidon nigricans	Tree Martin			Marine	•		•	•						•
Nectariniidae														
Dicaeum hirundinaceum	Mistletoebird				•		•	•		•		•		
Estrildidae														
Taeniopygia guttata	Zebra Finch	•			•		•	•	•	•	•	•	•	•
Neochmia ruficauda	Star Finch						•							
Emblema pictum	Painted Finch				•		•	•		•				
Motacillidae														
Anthus novaeseelandiae	Australasian Pipit			Marine	•		•			•	•	•		•
Motacilla tschutschensis (flava)	Eastern Yellow Wagtail		Migratory	Migratory/Marine		•								
Motacilla cinerea	Grey Wagtail		Migratory	Migratory/Marine		•								

* None of the Marine listed species are true marine species and are considered to be listed erroneously as none rely upon marine environments for survival, and all are relatively common and widespread. These species are excluded from the discussion of species of conservation significance.

Appendix 2

Threatened Fauna Statutory Framework – Western Australia

Commonwealth *EPBC Act 1999*

Fauna species of national environmental significance are listed under the Commonwealth *EPBC Act*, and may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'lower risk', which are consistent with IUCN categories.

Critically Endangered (CR): a taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

Endangered (EN): a taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

Vulnerable (VU): a taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

Lower Risk (LR): a taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

1. **Conservation Dependent (CD).** Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. **Near Threatened (NT).** Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
3. **Least Concern (LC).** Taxa which do not qualify for Conservation Dependent or Near Threatened.

Migratory species are also protected under the *EPBC Act* as species of national environmental significance. Migratory species are those animals that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations. The list of migratory species consists of those species listed under the following international conventions:

1. Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
2. China-Australia Migratory Bird Agreement (CAMBA);
3. Japan-Australia Migratory Bird Agreement (JAMBA); and,
4. Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Marine species are also protected under the *EPBC Act*, and are listed to ensure the long-term conservation of the species. Marine species include all Australian sea snakes, seals, crocodiles, dugongs, marine turtles, seahorses and seabirds that naturally occur in the Commonwealth marine area.

Western Australian *Biodiversity Conservation Act 2016*

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 has been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the Biodiversity Conservation Act 2016:

Threatened Species

- **Critically Endangered (CR):** Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines.
- **Endangered (EN):** Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines".
- **Vulnerable (VU):** Threatened species considered to be "facing a high risk of extinction in the wild in the medium term future, as determined in accordance with criteria set out in the ministerial guidelines".

Extinct Species

- **Extinct Species (EX):** Species where "there is no reasonable doubt that the last member of the species has died"
- **Extinct in the wild (EW):** Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form"

Specially Protected Species

- **Migratory (MI):** Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth.
  -
  - Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program
- **Species of special conservation interest (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 fauna (OS):** Fauna otherwise in need of special protection to ensure their conservation

Department of Biodiversity, Conservation and Attractions Priority Listing

The DBCA maintains a list of Priority species that have not been assigned statutory protection under the *Biodiversity Conservation Act 2016*. Species on this list are considered to be of conservation priority because there is insufficient information to make an assessment of their conservation status or they are considered to be rare but not threatened and are in need of monitoring. Under this list, species are classified according to four Priority categories:

Priority 1: Poorly known species
Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

Priority 2: Poorly known species
Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

Priority 3: Poorly known species
Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

Priority 4: Rare, Near Threatened and other species in need of monitoring
(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy. conservation lands.

Appendix 3

Fauna Licence

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

FAUNA TAKING (BIOLOGICAL ASSESSMENT) LICENCE

Regulation 27, Biodiversity Conservation Regulations 2018

Licence Number: BA27000217

Licence Holder: Dr Sylvie Schmidt
Biota Environmental Sciences
Level 1 / 228 Carr Place
Leederville WA 6007

Date of Issue: 28/02/2020

Date Valid From: 28/02/2020
Date of Expiry: 30/06/2020

LICENSED ACTIVITIES

Subject to the terms and conditions on this licence, the licence holder may –

1. Take and disturb fauna for level 1 fauna survey for BHP Western Australia Iron Ore (BHP WAIO) Caramulla (north-east of Newman) using remote sensing cameras, ultrasonic bat detector, acoustic call recorders and hair traps. Short Range Endemic (SRE) survey to be undertaken using hand capture techniques (foraging, raking, excavation) specimens to be retained and specimens lodged with WA Museum.

LOCATIONS

1. Caramulla study Area, covering approximately 6,935 ha, currently including active and non-active BHP Geoscience (Exploration) tenure, off BHP tenure, Pastoral Lease and Unallocated Crown Land.

AUTHORISED PERSONS

The following persons or persons of the specified class may assist in carrying out the licensed activities:

1. Michael Greenham

CONDITIONS

1. Fauna must not be taken on CALM land, (as defined in the Conservation and Land Management Regulations 2002*),* unless authorised by a written notice of a lawful authority issued under regulations 4 and 8 of the Conservation and Land Management Regulations 2002.
2. If persons, other than the licence holder, are authorised to carry out/assist in carrying out the activities under the licence, the licence holder must ensure those persons have read and understand the licence terms and conditions.
3. The written authorisation of the person in possession or occupation of the land accessed and upon which fauna is taken, as required under regulation 101(2) and referred to in “Additional information” below, must:
   a) state location details (including lot or location number, street/road, suburb and local government authority);
   b) state land owner or occupier name, and contact phone number;
   c) specify the time period that the authorisation is valid for;

d) be signed and dated; and

e) be attached to this licence at all times.

4. This licence, and any written authorisation or lawful authority which authorises the take of fauna on specified locations must be carried at all times while conducting licensed activities and be produced on demand by a wildlife officer.

5. If a species of fauna listed as a threatened species under Section 19 of the *Biodiversity Conservation Act 2016* is inadvertently captured, that species is to be released immediately at the point of capture. If the fauna is injured or deceased, the licence holder shall contact the DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) for advice on treatment or disposal. Details of any capture of threatened fauna must be included in the "Return of Fauna Taken."

6. The licence holder must not:

   a) release any fauna in any area where it does not naturally occur;

   b) transfer fauna to any other person or authority (other than the Western Australian Museum) unless approved in writing by the CEO; or

   c) dispose of the remains of fauna in any manner likely to interfere the natural or present day distribution of the species.

7. The licence holder must not take and remove more than ten specimens of any one protected species of fauna from any location less than 20km apart. Where exceptional circumstances make it necessary to take a larger number of specimens from a particular location in order to obtain adequate statistical data, the collector must proceed with circumspection and justify their actions to the Director General in advance.

8. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this licence must be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range must be offered to the Western Australian Museum.

9. All specimens and material retained under the authority of this licence must be offered to the Western Australian Museum for loan, for inclusion in its collection, or on request be made available to other persons involved in relevant scientific studies.

10. The licence holder must create, compile and maintain records and information as required in a DBCA approved "Return of Fauna Taken" of all fauna taking activities as they occur.

11. A DBCA approved "Return of Fauna Taken" must be completed in full (including nil taking details) and submitted to DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) prior to the end of each annual period of the licence (from the valid from date) (refer to "Additional Information" section below).

Danny Stefoni
LICENSING OFFICER
WILDLIFE PROTECTION BRANCH

Delegate of CEO

ADDITIONAL INFORMATION

1. It is an offence to take any species of fauna listed as a threatened species under Section 19 of the *Biodiversity Conservation Act 2016* unless the person is authorised under Section 40. The penalty ranges between $300 000 and $500 000; Section 150 Biodiversity Conservation Act 2016.
2. Regulation 82 empowers the CEO to add, substitute or delete a term or condition of a licence or to correct errors. Such power may be exercised on application of a licence holder or by the CEO's own initiative. If an amendment to a licence term or condition is required, please contact the CEO or the Licensing Section on wildlifelicensing@dbca.wa.gov.au in the first instance. The licence holder, if adversely affected by a condition imposed in this licence, may apply to the State Administrative Tribunal for review of the decision of the CEO to impose that condition on a licence: regulation 89(2) Biodiversity Conservation Regulations 2018.
3. A person must not contravene a condition of a licence. The penalty for an offence involving the contravention of a condition of a licence is a fine of $10 000: regulation 84 of the Biodiversity Conservation Regulations 2018.
4. It is an offence for persons authorised by this licence to enter land that is not in their possession or under their control without first having the *prior* written authorisation of the current owner or occupier of the land to:

   a) enter the land; and

   b) carry out the activity authorised by this licence.

   The penalty for this offence is a fine of $5 000: regulation 101(2) of the Biodiversity Conservation Regulations 2018.
5. The licence holder must be able to produce for inspection upon request any information or records required by regulation 85(2) of the Biodiversity Conservation Regulations 2018 Penalty $10 000. It is an offence to knowingly include false or misleading information or make statements in records: regulation 85(3) of the Biodiversity Conservation Regulations 2018 Penalty $10 000. It is an offence to include any information or make any statement in a return that the licence holder knows to be false or misleading in a material particular: regulation 86 (2) of the Biodiversity Conservation Regulations 2018 Penalty $10 000.
6. The approved DBCA "Return of Fauna Taken" data file can be downloaded from the DBCA webpage (https://www.dpaw.wa.gov.au/plants-and-animals/licences-and-authorities).
7. The issuing of a licence under the Biodiversity Conservation Regulations 2018 does not constitute an animal ethics approval or a licence to use animals for scientific purposes as required under the *Animal Welfare Act 2002,* Animal Welfare (Scientific Purposes) Regulations 2003. It is the responsibility of a licence applicant / licence holder to ensure that they comply with the requirements of all applicable legislation. Enquiries relating to the Animal Welfare Act licences and animal ethics approvals are to be directed to the Department of Primary Industries and Regional Development (https://www.agric.wa.gov.au/animalwelfare).
8. Threatened fauna can only be taken under a *Biodiversity Conservation Act 2016* Section 40 authorisation, Occurrences of threatened species must be reported to the CEO. For more information please see https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals.
9. Any interaction involving Nationally Listed Threatened Fauna that may be invasive and/or harmful to the fauna may require approval from the Commonwealth Department of the Environment and Energy http://www.environment.gov.au/about-us/business-us/permits-assessments-licences. Interaction with such species is controlled by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and Environment Protection and Biodiversity Conservation Regulations 2000 as well as the *Biodiversity Conservation Act 2016* and Biodiversity Conservation Regulations 2018.

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

AUTHORISATION TO TAKE OR DISTURB THREATENED SPECIES

Section 40 of the Biodiversity Conservation Act 2016

AUTHORISATION DETAILS

Authorisation type: Fauna

Authorisation number: TFA 2020-0019

Authorisation duration: From date signed by Minister's delegate, below, until 30 June 2020.

AUTHORISATION HOLDER

Sylvie Schmidt
Biota Environmental Sciences
Level 1/228 Carr Place
Leederville WA 6007

AREA TO WHICH THIS AUTHORISATION APPLIES

Caramulla, north-east of Newman (Pilbara Region).

AUTHORISED ACTIVITY

Purpose of taking/disturbance:

Level 1 vertebrate fauna survey to inform future environmental approvals across the area of interest and assessment of two to three potential bat roosting sites in the vicinity (within 25 km) of the study area.

Threatened species authorised to be taken/disturbed (including conservation status):

Bilby, *Macrotis lagotis* (Vulnerable)

Quantity of threatened species authorised to be taken/disturbed:

Any number of individual animals of the above listed threatened fauna species may potentially be captured and released during the trapping program and/or disturbed by the survey.

Authorised taking/disturbance methodology:

Baited hair traps will be utilised to target bilbies if active dens or burrows are found or if the targeted species has not been detected using remote cameras or during active searches for secondary signs. Hair traps will be deployed for a maximum of six nights and will be placed in open areas to reduce the chances of catching non-target reptile species.

..... (Delegate's initials)

ADDITIONAL AUTHORISED PERSONS

Michael Greenham

Additional personnel who are suitably qualified and experienced in the authorised activities working under the direction of the authorisation holder.

Field assistants assisting with the authorised activities working under the direct supervision of the authorisation holder or suitably qualified and experienced additional authorised person.

CONDITIONS

1. The written authorisation of the person in possession or occupation of the land accessed and upon which threatened fauna is taken or disturbed must:
   a) state location details (including lot or location number, street/road, suburb and local government authority);
   b) state land owner or occupier name, and contact phone number;
   c) specify the time period that the authorisation is valid for;
   d) be signed and dated; and
   e) be attached to this Authorisation to take or disturb threatened species at all times.
2. This Authorisation to take or disturb threatened species, and any other written authorisation or lawful authority which authorises the take or disturbance of fauna on specified locations for the authorised activities must be carried at all times while conducting authorised activities and be produced on demand by a wildlife officer.
3. Named additional authorised persons who are not suitably qualified and experienced in the authorised activities, and volunteer field assistants assisting with the authorised activities, must be working under direct supervision of experienced and competent named authorised persons.
4. Any inadvertently captured species of non-target threatened fauna or non-threatened fauna (threatened fauna as defined in *Biodiversity Conservation Act 2016* Section 19) is to be released immediately at the point of capture. Details of such fauna must be included in the fauna taking return as required under this authorisation.
5. The authorisation holder, unless specified in the authorised activities, must not:
   a) release any threatened fauna in any area where it does not naturally occur;
   b) transfer threatened fauna to any other person or authority (other than the Western Australian Museum) unless the fauna is injured or abandoned fauna (condition 5); or
   c) dispose of the remains of threatened fauna in any manner likely to confuse the natural or present-day distribution of the species.
6. All threatened fauna injuries, unexpected deaths, unplanned euthanasia, and abandoned young or eggs, must be reported by the authorisation holder to the DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) to notify of the incident and for advice on treatment or disposal. All deceased threatened fauna must be offered to the Western Australian Museum.

……IB…… (Delegate's initials)

7. All holotypes and syntypes and a half share of paratypes of species or subspecies permitted to be permanently taken under this authorisation must be donated to the Western Australian Museum. Duplicates (one pair in each case) of any species collected, which represents a significant extension of geographic range must be offered to the Western Australian Museum.
8. To prevent any unnecessary collecting in this State, all specimens and material taken and retained under this authorisation, that remain at the conclusion of the activities, must be offered to the Western Australian Museum for loan, for inclusion in its collection, or made available to other persons involved in relevant scientific studies if so required.
9. The authorisation holder must create, compile and maintain records and information as required in a DBCA approved "Return of Fauna Taken" of all fauna taking activities as they occur.
10. A DBCA approved "Return of Fauna Taken" must be completed in full (including nil taking details) and submitted to DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au) prior to the end of the authorisation duration and, if the authorisation duration is greater than 12 months, prior to the end of each annual period of the authorisation (from the date signed by the Minister's delegate) (refer to "Additional Information" section below). Where a licence to take or disturb fauna is issued in conjunction with this Authorisation to take or disturb threatened species, a combined "Return of Fauna Taken" may be completed and submitted.
11. A written report detailing the undertaken authorised activities, outcome, unintended incidents, injuries and mortalities of threatened fauna, implemented monitoring, mitigation and management, and explaining the records and information as required in a DBCA approved "Return of Fauna Taken" must be submitted, in addition to a "Return of Fauna Taken", to DBCA Wildlife Licensing Section (wildlifelicensing@dbca.wa.gov.au).

ADDITIONAL INFORMATION

1. Before undertaking the Authorised Activity, permission must be obtained from: (a) the owner or occupier of private land; or (b) the Department or Authority controlling Crown land, on which the Threatened Fauna occur. This includes obtaining the written endorsement from Department of Biodiversity, Conservation and Attractions (DBCA) if the authorised activity is proposed for land managed by DBCA.
2. This Authorisation to take or disturb threatened species does not constitute lawful authority issued under regulations 4 and 8 of the *Conservation and Land Management Regulations 2002*. Contact the applicable Department District Officer for further information.
3. The approved DBCA "Return of Fauna Taken" data file can be downloaded from the DBCA webpage (https://www.dpaw.wa.gov.au/plants-and-animals/licences-and-authorities).
4. Any interaction involving nationally listed threatened fauna that may be harmful to the fauna and/or invasive may require approval from the Commonwealth Department of the Environment and Energy (http://www.environment.gov.au/biodiversity/threatened/permits). Interaction with such species is controlled by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and *Environment Protection and Biodiversity Conservation Regulations 2000*.
5. It is the responsibility of the authorisation holder to ensure that they comply with the requirements of all applicable legislation.

..... (Delegate's initials)

6. An Authorisation to take or disturb threatened species does not constitute an animal ethics approval or a licence to use animals for scientific purposes as required under the *Animal Welfare Act 2002, Animal Welfare (Scientific Purposes) Regulations 2003*. Enquiries relating to the Animal Welfare Act licences and animal ethics approvals are to be directed to the Western Australian Department of Primary Industries and Regional Development (https://www.agric.wa.gov.au/animalwelfare).

Margaret Byrne

Dr Margaret Byrne

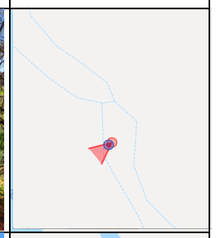
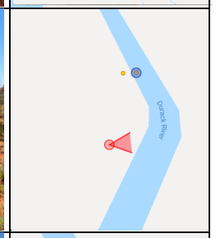
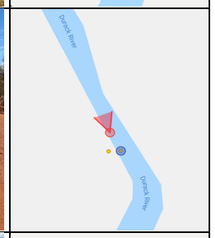
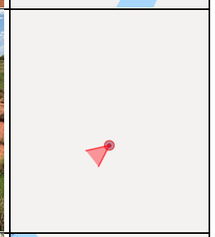
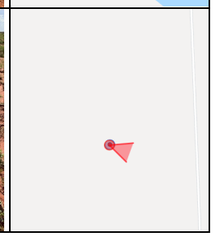
Executive Director of Biodiversity and Conservation Science

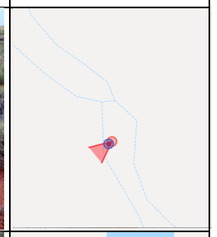
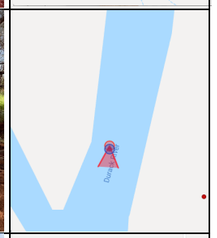
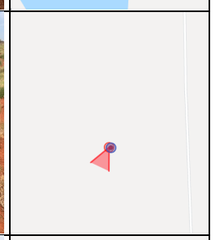
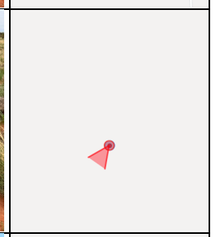
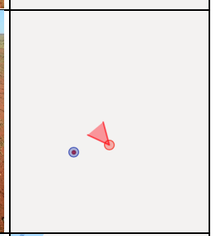
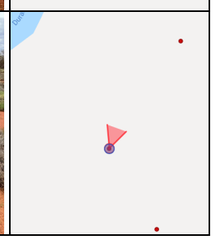
AS DELEGATE OF THE MINISTER

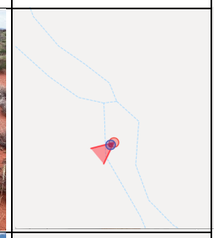
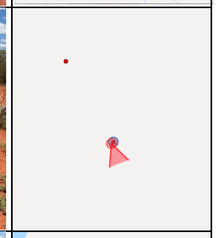
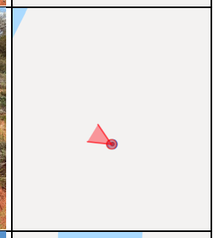
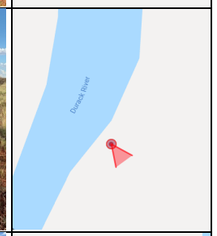
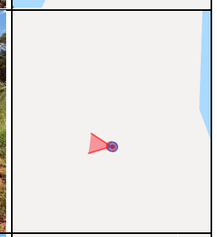
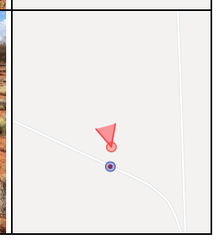
DATE: 27/2/2020

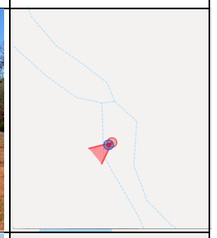
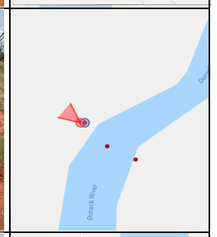
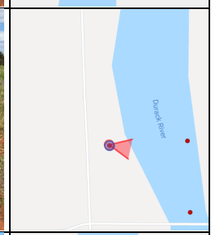
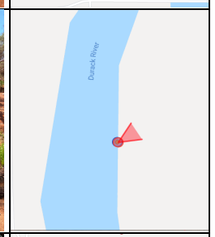
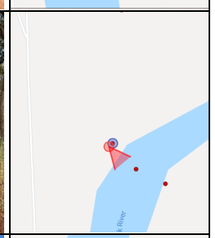
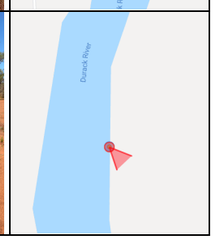
Appendix 4

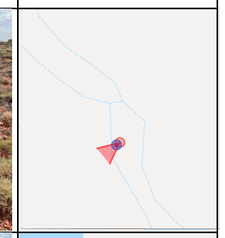
Habitat Assessment

Site ID	Latitude (°S)	Longitude (°E)	Fauna Habitat	Landform	Aspect	Slope	Soil Type	Soil Availability	Amount of Outcropping	Outcropping Rock Type	Rock Size	Vegetation Litter Cover	Hollow Bearing Trees	Time Since Last Fire	Disturbances	Fauna Landscape	Picture	Direction of view
CRA-07	-23.264896	120.340419	Major Drainage Line, Vegetation Grove	Drainage Area/ Floodplain	Flat	Flat	Sandy Clay Loam	Evenly Spread	Negligible	None Discernible	Negligible	Evenly Spread	0	Old (6+ yr)	Cattle grazing	Sandy drainage systems		
CRA-08	-23.234099	120.338337	Major Drainage Line, Vegetation Grove	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Evenly Spread	Negligible	None Discernible	Negligible	Evenly Spread	0	Old (6+ yr)	Cattle grazing	Sandy drainage systems		
CRA-09	-23.256190	120.316747	Major Drainage Line, Vegetation Grove	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	None Discernible	Negligible	Few Small Patches	0	Old (6+ yr)	Cattle grazing	Sandy drainage systems		
CRA-10	-23.248511	120.350865	Hardpan Plain, Sand Plain	Sand Plain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	None discernible	Sandy *Triodia* plains		
CRA-11	-23.256689	120.318462	Major Drainage Line	Major Drainage Line	Flat	Flat	Sand	Evenly Spread	Negligible	None Discernible	Negligible	Few Small Patches	0	Old (6+ yr)	Cattle grazing	Sandy drainage systems		
CRA-12	-23.278834	120.302055	Hardpan Plain, Sand Plain	Sand Plain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	None discernible	Sandy *Triodia* plains		

Site ID	Latitude (°S)	Longitude (°E)	Fauna Habitat	Landform	Aspect	Slope	Soil Type	Soil Availability	Amount of Outcropping	Outcropping Rock Type	Rock Size	Vegetation Litter Cover	Hollow Bearing Trees	Time Since Last Fire	Disturbances	Fauna Landscape	Picture	Direction of view
CRA-13	-23.308144	120.299319	Hardpan Plain, Sand Plain	Sand Plain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy *Triodia* plains		
CRA-14	-23.329413	120.323726	Major Drainage Line	Major Drainage Line	Flat	Flat	Sand	Evenly Spread	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy drainage systems		
CRA-15	-23.233728	120.300502	Hardpan Plain, Sand Plain	Sand Plain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	None discernible	Sandy Triodia plains		
CRA-16	-23.279875	120.349821	Hardpan Plain, Sand Plain	Sand Plain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy *Triodia* plains		
CRA-17	-23.291563	120.401881	Other	Ironstone Outcrops	Flat	Flat	Silty Clay Loam	Many Large Patches	Major Outcropping	Other (Ironstone)	Gravel (1-4cm)	Scarce	0	Old (6+ yr)	Other (fenced)	n/a (outside study area)		
CRA-18	-23.351312	120.321698	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy clay loam Mulga dominated Floodplains		

Site ID	Latitude (°S)	Longitude (°E)	Fauna Habitat	Landform	Aspect	Slope	Soil Type	Soil Availability	Amount of Outcropping	Outcropping Rock Type	Rock Size	Vegetation Litter Cover	Hollow Bearing Trees	Time Since Last Fire	Disturbances	Fauna Landscape	Picture	Direction of view
CRA-19	-23.258918	120.301287	Hardpan Plain, Sand Plain	Sand Plain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy *Triodia* plains		
CRA-20	-23.354636	120.323820	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Road/ Access Track	Sandy clay loam Mulga dominated Floodplains		
CRA-21	-23.346879	120.324889	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Many Large Patches	Negligible	None Discernible	Negligible	Few Small Patches	0	Old (6+ yr)	Road/ Access Track	Sandy clay loam Mulga dominated Floodplains		
CRA-22	-23.340012	120.323029	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam Sandy	Many Large Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy clay loam Mulga dominated Floodplains/Sandy *Triodia* plains		
CRA-23	-23.327334	120.312731	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam	Few Small Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	None Discernible	Sandy clay loam Mulga dominated Floodplains		
CRA-24	-23.340564	120.305009	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Sandy Clay Loam	Many Large Patches	Negligible	None Discernible	Negligible	Few Small Patches	0	Old (6+ yr)	Road/ Access Track	Sandy clay loam Mulga dominated Floodplains		

Site ID	Latitude (°S)	Longitude (°E)	Fauna Habitat	Landform	Aspect	Slope	Soil Type	Soil Availability	Amount of Outcropping	Outcropping Rock Type	Rock Size	Vegetation Litter Cover	Hollow Bearing Trees	Time Since Last Fire	Disturbances	Fauna Landscape	Picture	Direction of view
CRA-25	-23.349095	120.313199	Major Drainage Line	Major Drainage Line	Flat	Flat	Sand	Evenly Spread	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy drainage systems		
CRA-26	-23.342469	120.316826	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Clay Loam Sandy	Many Small Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy clay loam Mulga dominated Floodplains; Rocky Hill		
CRA-27	-23.360943	120.310030	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Sandy Clay Loam	Few Small Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy clay loam Mulga dominated Floodplains		
CRA-28	-23.349700	120.314507	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Flat	Sandy Clay Loam	Few Small Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy clay loam Mulga dominated Floodplains		
CRA-29	-23.348030	120.312151	Drainage Area/ Floodplain	Drainage Area/ Floodplain	Flat	Low	Clay Loam Sandy	Few Small Patches	Negligible	None Discernible	Negligible	Few Small Patches	0	Old (6+ yr)	Cattle grazing	Sandy clay loam Mulga dominated Floodplains		
CRA-30	-23.359042	120.313642	Major Drainage Line, Vegetation Grove	Major Drainage Line	Flat	Flat	Sand	Evenly Spread	Negligible	None Discernible	Negligible	Few Small Patches	0	Old (6+ yr)	Cattle grazing	Sandy drainage systems		

Site ID	Latitude (°S)	Longitude (°E)	Fauna Habitat	Landform	Aspect	Slope	Soil Type	Soil Availability	Amount of Outcropping	Outcropping Rock Type	Rock Size	Vegetation Litter Cover	Hollow Bearing Trees	Time Since Last Fire	Disturbances	Fauna Landscape	Picture	Direction of view
CRA-31	-23.342524	120.312555	Hillcrest/ Hillslope	Hillcrest/ Upper Hillslope	North/ East	Low	Sandy Clay Loam	Few Small Patches	Limited Outcropping	Other	Gravel (1-4cm)	Scarce	0	Old (6+ yr)	Road/ Access Track	Rocky hill		
CRA-32	-23.331375	120.327940	Hardpan Plain, Sand Plain	Sand Plain	Flat	Flat	Sandy Clay Loam	Few Small Patches	Negligible	None Discernible	Negligible	Scarce	0	Old (6+ yr)	Cattle grazing	Sandy *Triodia* plains