Biota Environmental Sciences

Yandi Billiards Phase 1 Seasonal Fauna Survey

Prepared for Rio Tinto

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Biota Environmental Sciences

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Yandi Billiards Phase 1 Seasonal Fauna Survey

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1.0 Introduction

1.1 Project Background and Study Area

Rio Tinto proposes to develop two channel-iron deposits at Yandi Billiards, located approximately 7 km east of the existing Yandi mine. Given the proximity of these deposits to Weeli Wolli Creek and the Fortescue Marsh catchment, Biota Environmental Sciences (Biota) was commissioned to conduct a Level 2 fauna survey of the study area to assist with environmental impact assessment (EIA).

1.2 Study Objectives and Scope

The key component of the current study comprised Phase 1 of a two-phase Level 2 terrestrial vertebrate fauna survey, which was completed in March 2014. This interim report documents the methods, results and key findings of the first phase of the fauna survey.

The scope of the study was to:

- undertake Phase 1 of a Level 2 fauna survey of the study area consistent with relevant EPA Guidance Statements;
- establish systematic trapping grids to document the vertebrate fauna assemblage within the study area;
- complete targeted searches and non-systematic data collection within habitats suitable for Short Range Endemic (SRE) species or fauna of National Environmental Significance (NES species); and,
- conduct fauna habitat mapping and potential NES species habitat mapping.

The survey was planned and implemented in accordance with:

- EPA Position Statement No. 3 – Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002);
- EPA Guidance Statement No. 56 – Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004); and
- EPA and the then Department of Environment and Conservation (DEC) Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010).

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2.0 Survey Methodology

2.1 Timing

The field survey was completed over a 10-day period, from the 8th until the 18th of March 2014. This survey comprised installation of the systematic trapping sites (8th-10th March) and completion of a first phase of trapping.

2.2 Fauna Sampling

The fauna survey consisted of baseline trapping combined with opportunistic and targeted searching for SREs and conservation significant vertebrates.

2.2.1 Systematic Trapping of Vertebrate Fauna

Systematic terrestrial fauna sampling was carried out at 11 sites located in land systems that were not sampled, or were sampled less, during previous surveys in the study area (based on findings of Biota 2013)(Figure 2.1).

The trapping sites comprised:

- Five pitfall trapping grids, consisting of a single row of ten pit-fall traps (alternating 20 litre buckets and PVC tubes), spaced at approximately 10 m intervals and connected with a 100 m single length of 30 cm high flywire fence.
- Four funnel trapping grids, consisting of 8-10 pairs of funnel traps (i.e. 16-20 traps) placed adjacent to a 100 m single length of 30 cm high flywire fence.
- Two Elliott trap transects, consisting of 25 medium and ten large Elliott box traps, and four cage traps.

Table 2.1: Location of sites and trap effort for Phase 1 of the Yandi Billiards fauna survey.

Site	Latitude	Longitude	Trap Type (Number)	Nights Open	Trap Effort
YBL001F	22°46'31"S	119°19'54"E	Funnel (10)	7	70
YBL002P	22°44'28"S	119°20'43"E	Pit-trap (10)	7	70
YBL003P	22°43'22"S	119°21'36"E	Pit-trap (10)	7	70
YBL004F	22°43'44"S	119°20'28"E	Funnel (8)	2	16
YBL005P	22°45'46"S	119°18'15"E	Pit-trap (10)	7	70
YBL006P	22°50'52"S	119°16'30"E	Pit-trap (10)	7	70
YBL007P	22°48'02"S	119°17'10"E	Pit-trap (10)	7	70
YBL008F	22°48'26"S	119°16'56"E	Funnel (10)	7	70
YBL009E	22°47'01"S	119°17'23"E	Elliott traps (35), Cage traps (4)	7	273
YBL010E	22°50'06"S	119°15'32"E	Elliott traps (35), Cage traps (4)	6	234
YBL011F	22°45'26"S	119°19'26"E	Funnel (10)	6	60
				Pits	**350**
				Funnels	**216**
				Elliotts	**507**

2.2.2 Avifauna Sampling

Sampling of avifauna was conducted using a combination of techniques including:

- unbounded, habitat-specific area searches (30 minute duration) conducted at each of the systematic trapping sites; and,
- opportunistic observations of birds while traversing the study area.

Two systematic avifauna surveys were conducted at each of the systematic sites; in addition, four additional avifauna surveys were also conducted. These surveys provided a total of 11.5 person hours of systematic avifauna survey for the study area.

2.2.3 Bat Sampling

Bats were sampled at five sites from echolocation call recordings using SongMeter SM2BAT bat detector units, which detect and record ultrasonic echolocation calls emitted by bats during flight (Table 2.2). Bat sampling locations are shown on Figure 2.1.

Table 2.2: Bat site locations and effort for Phase 1 of the Yandi Billiards fauna survey.

Site	Latitude	Longitude	Date Opened	Date Closed	Nights Open
YBLSM2-01	22°46'58"S	119°17'20"E	11/03/14	15/03/14	4
YBLSM2-03	22°43'10"S	119°20'20"E	13/03/14	16/03/14	3
YBLSM2-04	22°46'58"S	119°17'18"E	15/03/14	17/03/14	2
YBLSM2-06	22°48'15"S	119°17'41"E	16/03/14	18/03/14	2
YBLSM2-07	22°47'38"S	119°18'07"E	17/03/14	18/03/14	1

2.2.4 Non-Systematic Targeted Searches

Non-systematic sampling targeting vertebrate NES species and other cryptic or additional species that are not likely to be trapped systematically was conducted at 11 locations (Table 2.3).

A range of non-systematic techniques were used during these targeted searches, including:

- motion camera trapping;
- nocturnal searches;
- searches for evidence and secondary signs in suitable NES species habitat; and,
- audio recording for night birds and amphibian calls using the SongMeter bat detector units configured to record audible noise.

The locations of each targeted search site and the effort applied across these sites is detailed in Table 2.3.

Table 2.3: Non-systematic sampling locations and effort for Phase 1 of the Yandi Billiards fauna survey.

Site	Site Type	Species Targeted	Latitude	Longitude	Nights Open	Search Time (mins)
YBLMC01	Motion camera	Brush-tailed Mulgara (*Dasycercus blythi*)	22°45'49"S	119°18'27"E	6	-
YBLSM2-02	SM2 site	Night Parrot (*Pezoporus occidentalis*)	22°43'33"S	119°21'59"E	3	-
YBLSM2-05	SM2 site	Night Parrot (*Pezoporus occidentalis*)	22°43'10"S	119°20'20"E	2	-
YBLNoct01	Nocturnal	All species	22°47'34"S	119°17'29"E	-	150
YBLNoct02	Nocturnal	All species	22°47'37"S	119°18'16"E	-	195
YBLNoct03	Nocturnal	All species	22°50'27"S	119°16'06"E	-	30
YBLNoct04	Nocturnal	All species	22°45'10"S	119°20'41"E	-	195
YBLNoct05	Nocturnal	All species	22°48'44"S	119°17'38"E	-	35
YBLNoct06	Nocturnal	All species	22°48'17"S	119°17'42"E	-	64
YBLTarget01	Search	Star Finch (*Neochmia ruficauda subclarescens*)	22°47'02"S	119°17'30"E	-	60

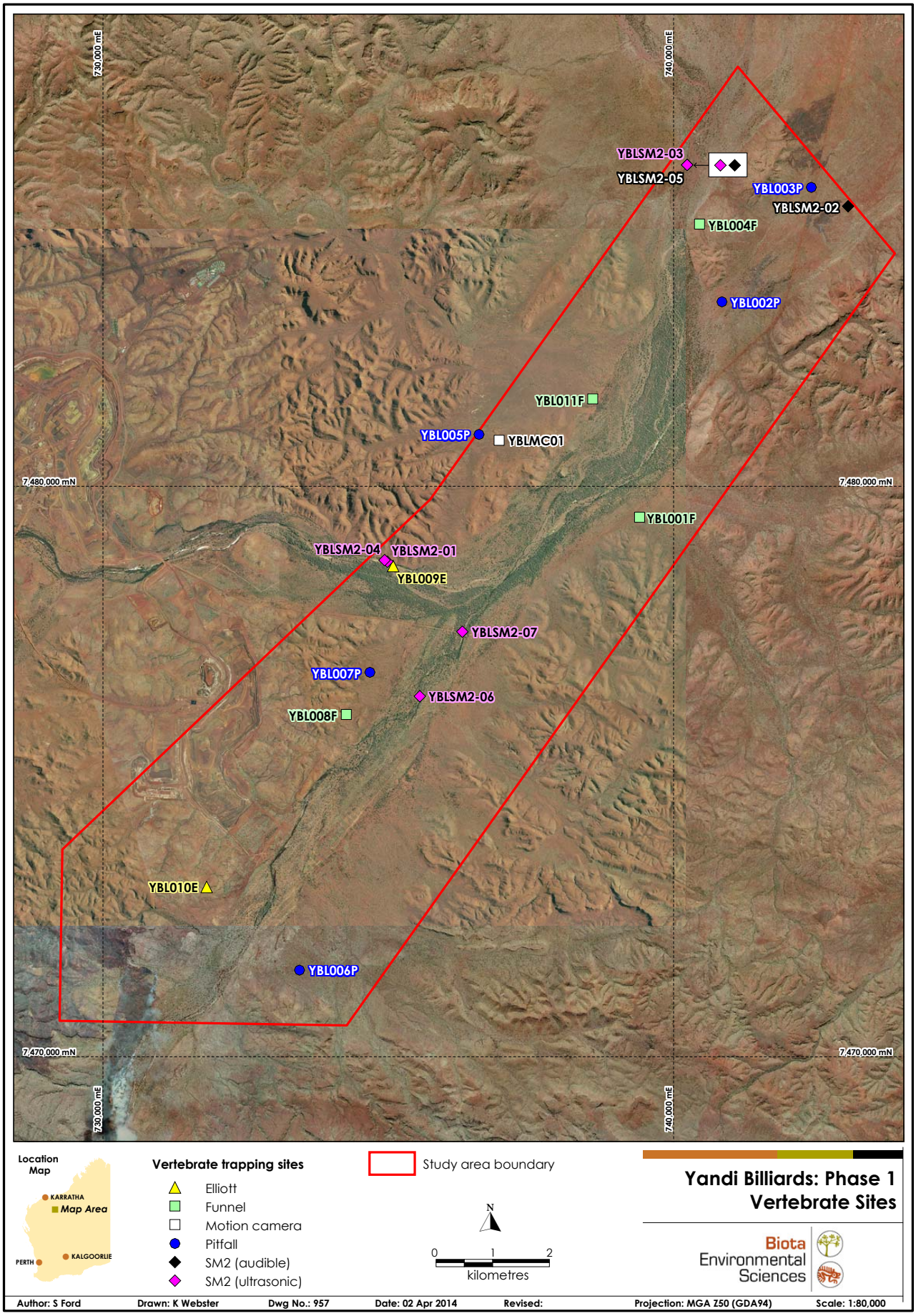

Figure 2.1: Location of systematic vertebrate fauna sampling sites.

2.2.5 Short Range Endemic Searches

Non-systematic sampling for invertebrate groups supporting potential SRE taxa was conducted at 13 sites across the study area (Table 2.4 and Figure 2.2). SRE groups targeted during these surveys included mygalomorph (trap door) spiders, pseudoscorpions, scorpions, millipedes and terrestrial snails. A total of 1,940 minutes (32 hours) was spent searching for SRE specimens.

Table 2.4: Short Range Endemic sampling locations for Phase 1 of the Yandi Billiards fauna survey.

Site	Latitude	Longitude	Date	Search Time (mins)	Number of People	Search Effort (min)
YBLSRE01	22°44'34"S	119°18'34"E	13/03/14	120	4	480
YBLSRE02	22°49'27"S	119°16'46"E	14/03/14	80	2	160
YBLSRE03	22°48'32"S	119°17'47"E	14/03/14	30	2	60
YBLSRE04	22°50'40"S	119°16'18"E	15/03/14	45	2	90
YBLSRE05	22°50'44"S	119°16'52"E	15/03/14	55	2	110
YBLSRE06	22°46'24"S	119°20'38"E	16/03/14	60	2	120
YBLSRE07	22°46'24"S	119°20'05"E	16/03/14	45	2	90
YBLSRE08	22°50'59"S	119°16'38"E	16/03/14	60	4	240
YBLSRE09	22°45'43"S	119°18'11"E	17/03/14	60	2	120
YBLSRE10	22°46'32"S	119°19'56"E	17/03/14	40	2	80
YBLSRE11	22°50'50"S	119°16'09"E	16/03/14	60	2	120
YBLSRE12	22°50'04"S	119°15'56"E	17/03/14	60	3	180
YBSRE13	22°50'40"S	119°15'28"E	17/03/14	30	3	90
					Total	**1,940**

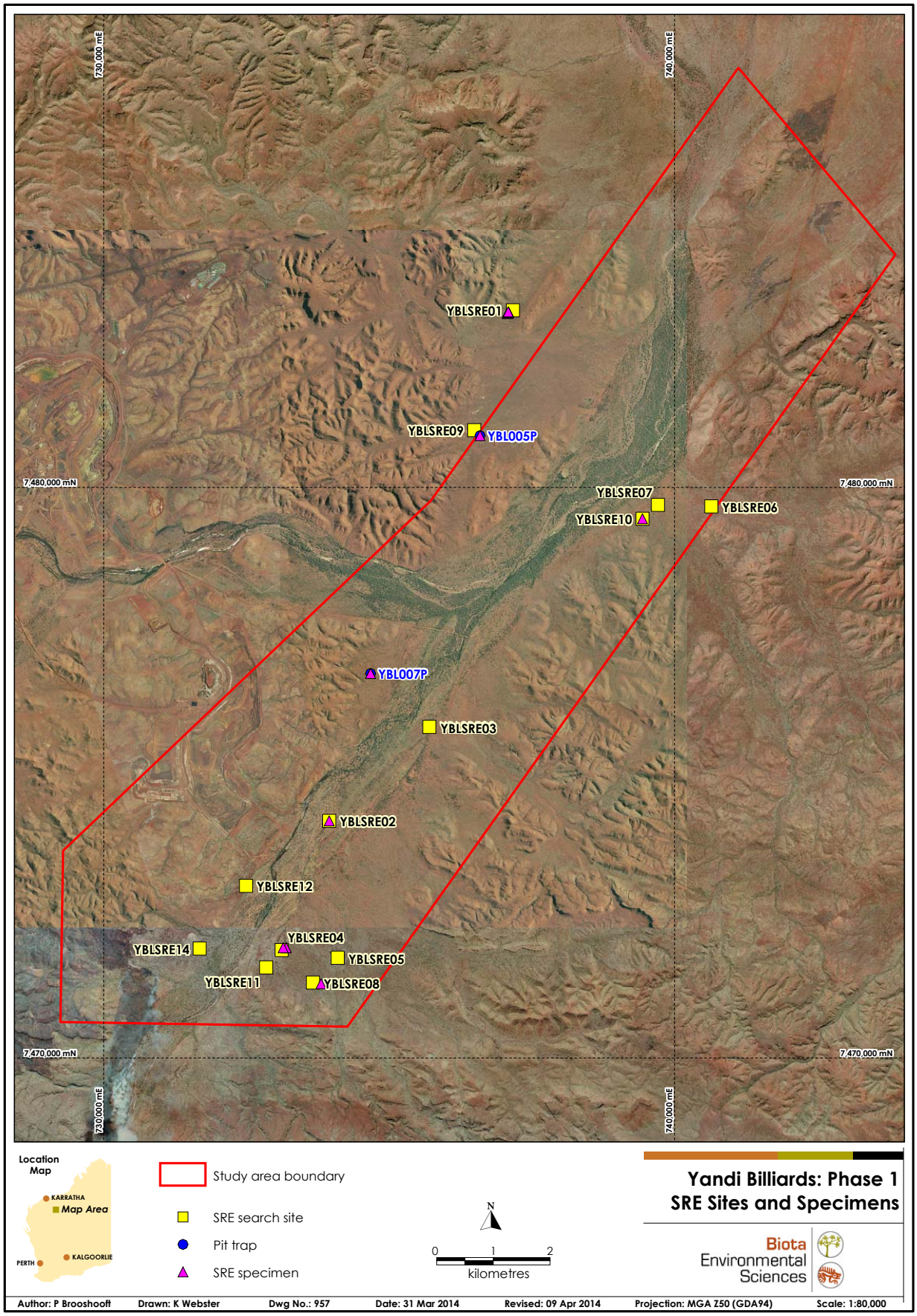

Figure 2.2: SRE search locations, specimen records and trapping locations at which SRE taxa were collected.

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3.0 Results

3.1 Habitat Mapping

Initial fauna habitat mapping based on Biota's fauna landscape approach is shown in Figure 3.1 and potential habitat for NES species is shown in Figure 3.2. The latter suggested that suitable habitat for the Pilbara Olive Python and foraging habitat for the Orange Leaf-nosed Bat is widespread in the study area, primarily associated with the major drainage channels of the Marillana-Weeli Wolli creek system (Figure 3.2). Our field appraisal, and past survey data, suggest there is very limited core habitat for the Northern Quoll in the study area.

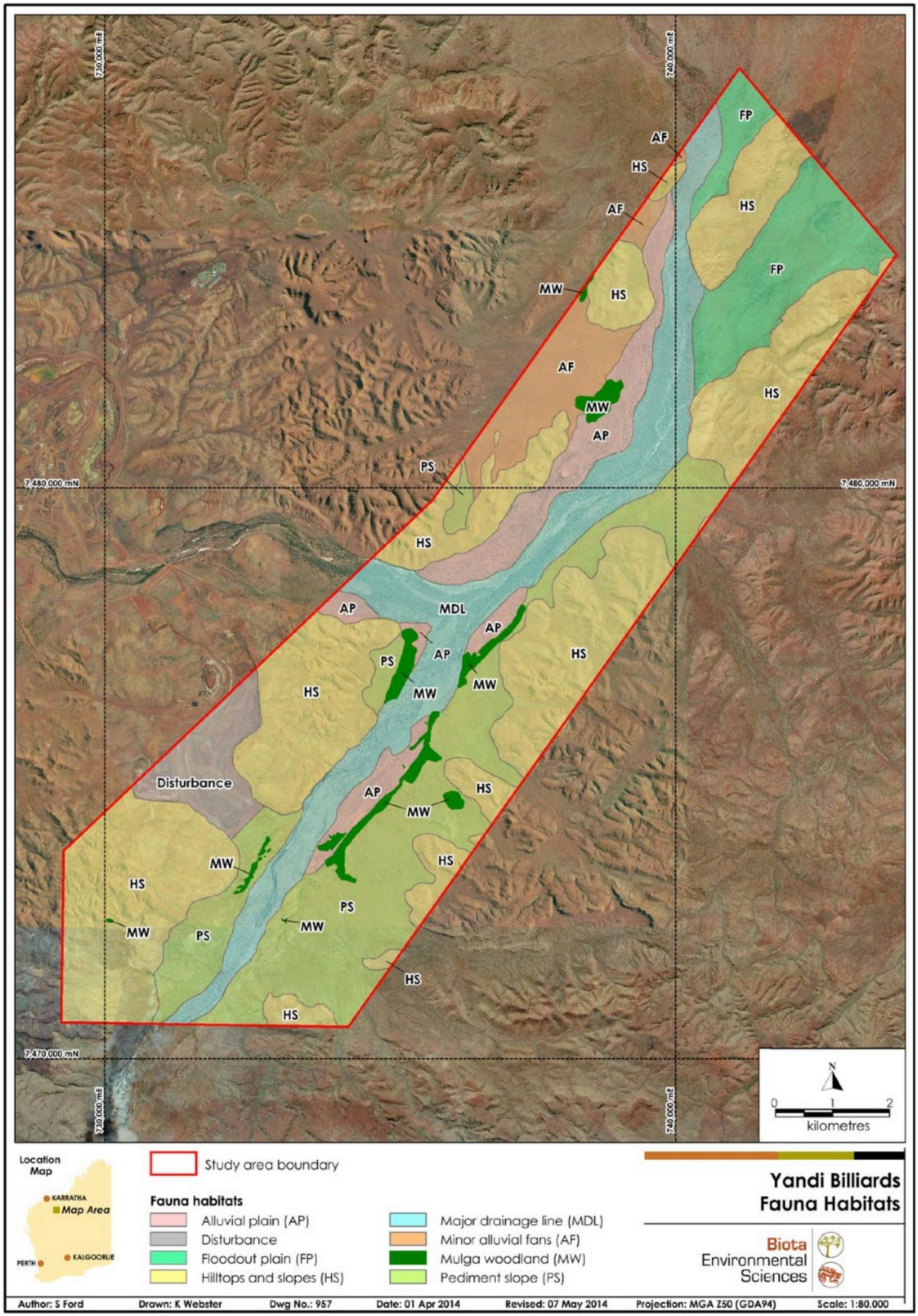

Figure 3.1: Preliminary fauna landscape mapping.

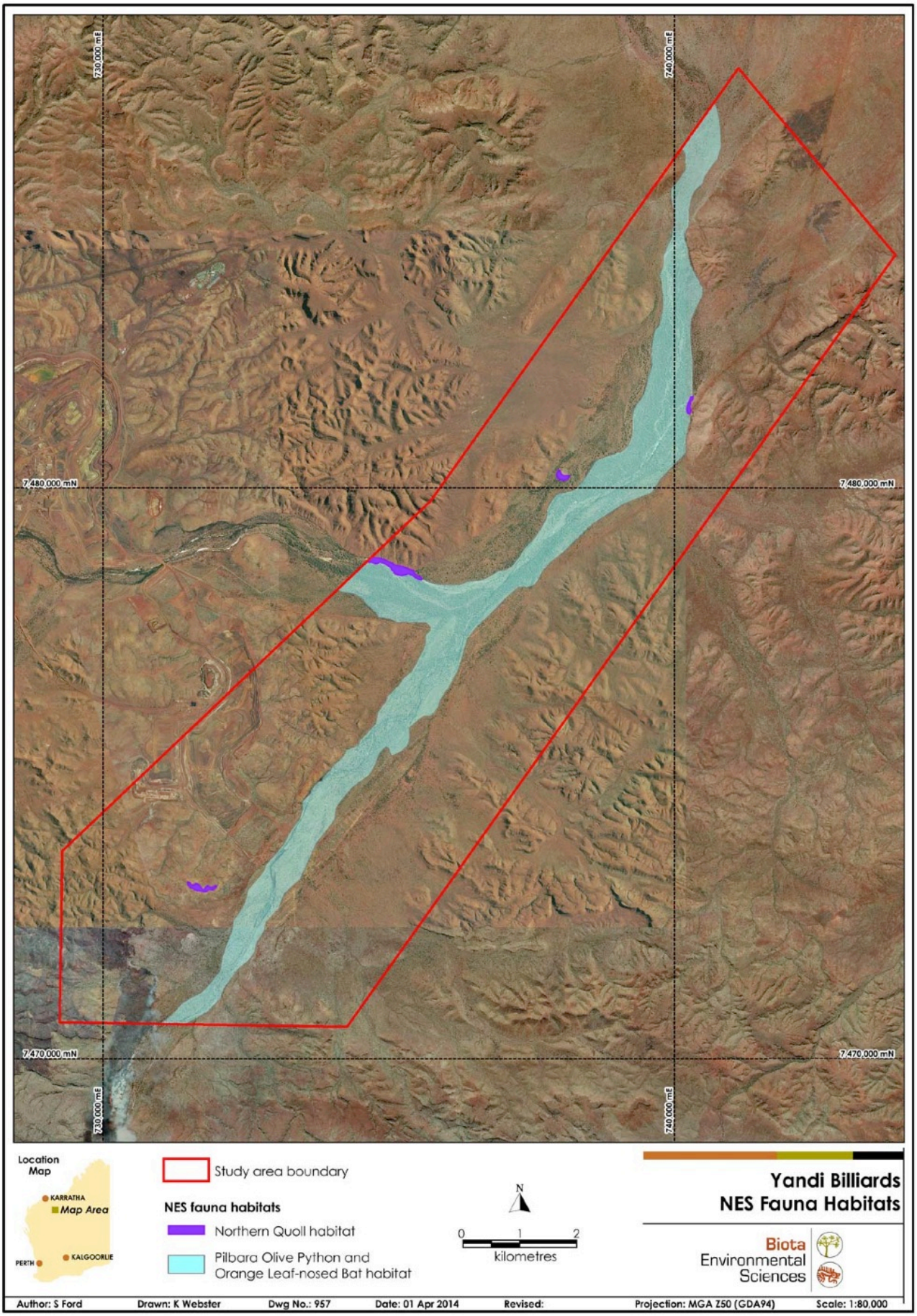

Figure 3.2: Preliminary NES species habitat mapping.

3.2 Vertebrate Fauna Overview

The Phase 1 fauna survey yielded a total of 155 vertebrate species. Table 3.1 provides a summary of the number of species recorded from each major vertebrate group during the survey.

Table 3.1: Number of species and families recorded during the survey.

Fauna Group	Number of Species	Number of Families
Native Mammals	12	4
Introduced Mammals	2	2
Bats	7	2
Avifauna	78	37
Reptiles	54	10
Amphibians	2	2
Total	**155**	**57**

3.3 Vertebrate Fauna of Conservation Significance

Based on database and literature searches, a total of 22 terrestrial Schedule, Priority and Migratory species may occur in the study area (Biota 2013). Of these, seven species of conservation significance were recorded during the survey (Table 3.2). The locations of these fauna within the study area are presented in Table 3.3 and Figure 3.3.

Table 3.2: Conservation significant species recorded during Phase 1 of the fauna survey and others potentially occurring based on database searches.

Scientific name	Common name	Conservation Status		Database Search	This Survey
		State	Federal		
Species Recorded During Phase 1					
Liasis olivaceus barroni	Pilbara Olive Python	S1	Vu	✓	✓
Dasycercus blythi	Brush-tailed Mulgara	P4	-	✓	✓
Neochmia ruficauda subclarescens	Star Finch	P4	-	✓	✓
Ardeotis australis	Australian Bustard	P4	-	✓	✓
Pseudomys chapmani	Western Pebble-mound Mouse	P4	-	✓	✓
Apus pacificus	Fork-tailed Swift	S3	Migratory	✓	✓
Merops ornatus	Rainbow Bee-eater	S3	Migratory	✓	✓
Other Species Potentially Occurring Based on Database Searches					
Pezoporus occidentalis	Night Parrot	S1	En	✓	
Dasyurus hallucatus	Northern Quoll	S1	En	✓	
Macrotis lagotis	Bilby	S1	Vu	✓	
Rhinonicteris aurantius	Orange Leaf-nosed Bat	S1	Vu	✓	
Falco peregrinus	Peregrine Falcon	S4	-	✓	
Ramphotyphlops ganei	An unnamed blindsnake	P1	-	✓	
Sminthopsis longicaudata	Long-tailed Dunnart	P4	-	✓	
Leggadina lakedownensis	Short-tailed Mouse	P4	-	✓	
Falco hypoleucos	Grey Falcon	P4	-	✓	
Burhinus grallarius	Bush Stone-curlew	P4	-	✓	
Macroderma gigas	Ghost Bat	P4	-	✓	
Ardea modesta	Eastern Great Egret	S3	Migratory	✓	
Ardea ibis	Cattle Egret	S3	Migratory	✓	
Charadrius veredus	Oriental Plover	S3	Migratory	✓	

Table 3.3: Locations of conservation significant fauna recorded during Phase 1 of the survey.

Species Name **Common Name**	**Latitude**	**Longitude**	**Site**	**Number Recorded**
Dasycercus blythi Brush-tailed Mulgara	22°45'49"S	119°18'27"E	YBLMC01	Burrow
Pseudomys chapmani Western Pebble-mound Mouse	22°43'43"S	119°20'28"E	Opportunistic	Mound
	22°49'50"S	119°15'40"E	Opportunistic	Mound
	22°49'32"S	119°15'01"E	Opportunistic	Mound
	22°44'29"S	119°19'36"E	Opportunistic	Mound
	22°45'33"S	119°19'05"E	Opportunistic	Mound
	22°46'34"S	119°18'11"E	Opportunistic	Mound
	22°47'56"S	119°17'10"E	Opportunistic	Mound
	22°47'35"S	119°19'27"E	Opportunistic	Mound
	22°49'40"S	119°14'31"E	Opportunistic	Mound
	22°44'14"S	119°19'36"E	Opportunistic	Mound
	22°46'42"S	119°17'42"E	Opportunistic	Mound
Liasis olivaceus barroni Pilbara Olive Python	22°45'10"S	119°20'41"E	YBLNoct04	1
Apus pacificus Fork-tailed Swift	22°47'33"S	119°17'30"E	Opportunistic	9
Ardeotis australis Australian Bustard	22°45'42"S	119°18'12"E	YBL005P	1
	22°49'02"S	119°17'35"E	YBLBRD04	Track
	22°50'52"S	119°16'30"E	YBL006P	Track
Merops ornatus Rainbow Bee-eater	22°44'29"S	119°20'40"E	YBL002p	2
	22°44'51"S	119°20'06"E	YBLBRD03	1
	22°46'50"S	119°18'45"E	YBLBRD02	3
	22°46'59"S	119°17'18"E	YBL09E	1
	22°47'40"S	119°18'07"E	YBLBRD01	13
	22°48'27"S	119°16'56"E	YBL008F	1
	22°50'03"S	119°16'28"E	Opportunistic	3
	22°50'07"S	119°15'30"E	YBL010E	3
	22°50'52"S	119°16'30"E	YBL006P	1
Neochmia ruficauda subclarescens Star Finch	22°47'40"S	119°18'07"E	YBLBRD01	3
	22°47'38"S	119°18'06"E	YBLSTF01	6

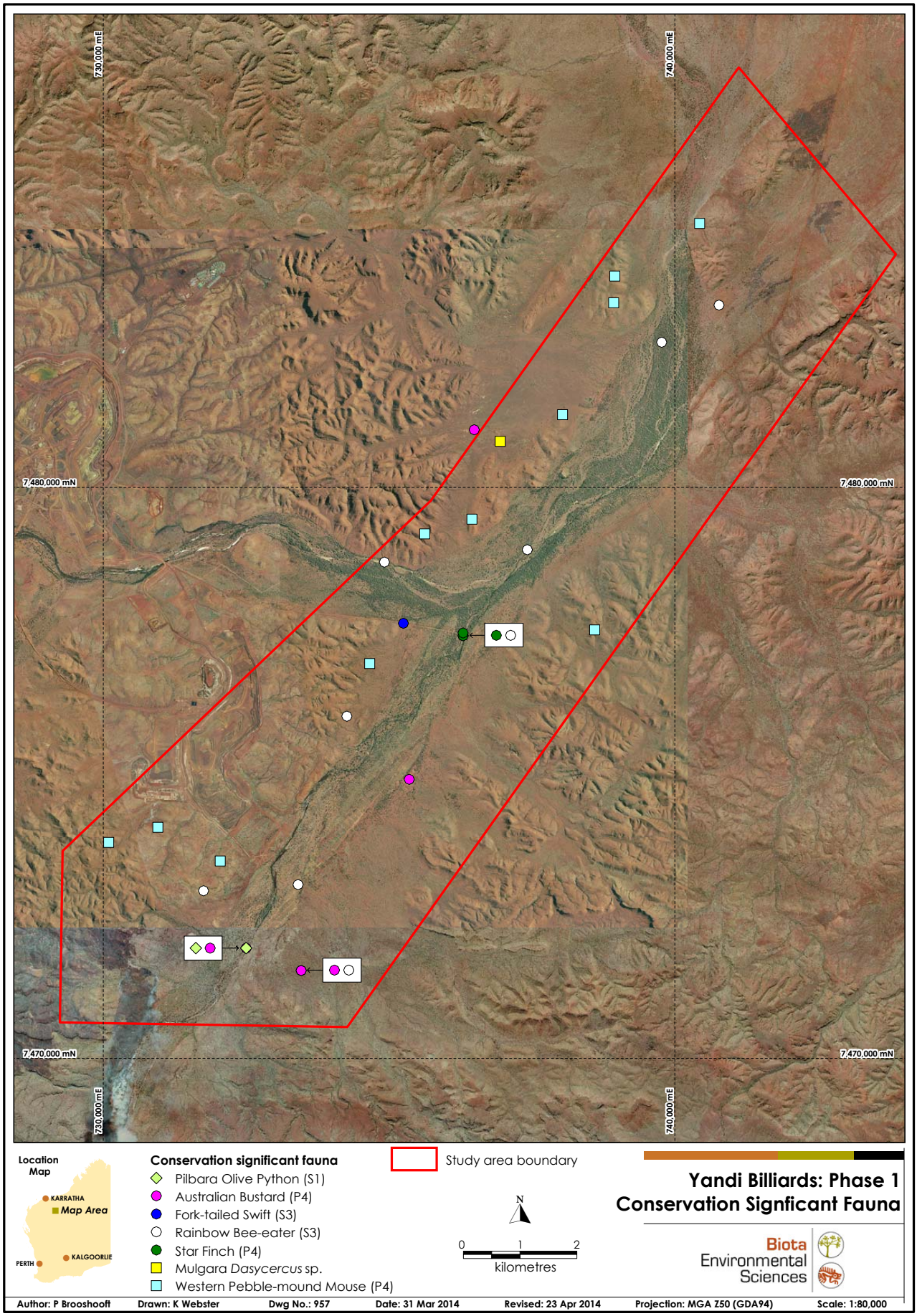

Figure 3.3: Locations of conservation significant fauna records.

3.3.1 Conservation Significant Fauna Recorded from the Study Area

Pilbara Olive Python, *Liasis olivaceus barroni* (State: Schedule 1, Federal: Vulnerable)
This species was observed in Weeli Wolli Creek during the nocturnal search YBLNoct04. Regarded as a Pilbara endemic, this subspecies has a known distribution that coincides roughly with the Pilbara bioregion (Environment Australia 2000). This species occurs in rocky areas within the Pilbara, showing a preference for rocky habitats often, but not always, near rock pools or other water bodies. This species has been recorded in the area previously, with several sightings made at the existing Yandi operations and it has also been recorded from Marillana Creek.

Brush-tailed Mulgara, *Dasycercus blythi* (DPaW Priority 4)
Secondary signs of this species were recorded from a burrow complex at site YBLMC01. Baited motion cameras were placed on the burrow complex to determine whether the burrows were still active, however the species was not recorded. This, and an absence of fresh tracks and/or scats suggested that the burrows were inactive. Previous surveys have recorded active Mulgara diggings, burrows and burrow complexes and individuals in the northwestern section of the study area (S Ford pers. obs.). Despite the inactivity of the burrows, the recordings suggest that this species was recently present within the study area, but may indicate the individuals have moved from the site in search of new resources.

Star Finch, *Neochmia ruficauda subclarescens* (DPaW Priority 4)
This species was recorded during a targeted search of riparian habitat along Weeli Wolli Creek at site YBLTarget01. This species is typically recorded from reed beds and adjacent vegetation communities along permanent waterways in the Pilbara. This species has also been recorded previously from similar habitat along Weeli Wolli Creek (Biota 2010a).

Australian Bustard, *Ardeotis australis* (DPaW Priority 4)
This species was recorded opportunistically on three occasions during this survey, from tracks and from an observation of a juvenile resting near a pool of water along Weeli Wolli Creek. This species prefers open or lightly wooded grassland, including sandplains with *Triodia* spp., and is considered scarce to common depending on season and habitat (Johnstone and Storr 1998). This species has also been recorded multiple times from previous surveys within the study area.

Western Pebble-mound Mouse, *Pseudomys chapmani* (DPaW Priority 4)
Eleven mounds of the species were found, six of which were considered to be active. This species is typically found on stony hillsides with hummock grasslands (Menkhorst and Knight 2011), and is common to very common in suitable habitat within the Hamersley and Chichester subregions of the Pilbara bioregion. This species is well known for its behaviour of constructing extensive mounds of small stones covering areas from 0.5 to 9.0 square meters (van Dyck and Strahan 2008). Mounds are most common on spurs and gentle slopes where suitably sized stones are present. This species has been recorded previously within the study area during the Yandi Billiards fauna survey (Biota 2010b) and routinely in the wider Yandicoogina locality.

Fork-tailed Swift, *Apus pacificus* (State: Schedule 3, Federal: Migratory)
An opportunistic observation of nine Fork-tailed Swift individuals flying overhead was made during the survey. This species is expected to be a transient visitor to the study area, and is unlikely to rely on any terrestrial habitats present because it is entirely aerial Australia, occurring here as a non-breeding visitor (Johnstone and Storr 1998).

Rainbow Bee-eater, *Merops ornatus* (State: Schedule 3, Federal: Migratory)
This species was observed on numerous occasions opportunistically and whilst conducting systematic avifauna surveys throughout the study area. This species, which is very common in the bioregion, is likely to be a breeding resident or non-breeding visitor to the region, with Weeli Wolli Creek providing attractive wetter habitat with ample tall trees from which to forage (Johnstone and Storr 1998). No evidence of nesting was found within the study area, however.

3.4 Short Range Endemic Taxa

Specimens belonging to two invertebrate groups known to contain SREs, the pseudoscorpions and mygalomorph spiders, were collected during the survey. Specimens were collected from five out of the 13 sites that were searched (YBLSRE01, YBLSRE02, YBLSRE04, YBLSRE08 and YBLSRE10) (Figure 2.2).

In addition to these, three specimens from target groups were collected from pitfall traps at the systematic sites YBL005P and YBL007P after the study area received localised rainfall on the night of the 16th of March. Moist conditions coincide with male mygalomorph activity increases, suggesting that some species search for mates following rainfall events or periods of high humidity, when desiccation risk is reduced. The pseudoscorpion and mygalomorph spider specimens were submitted to Helix Molecular Solutions for molecular sequencing to assign them to known taxa (where possible) to assist in determining their potential SRE status.

During the survey, mygalomorph spiders belonging to the genus *Aganippe* were collected from the same location at which the specifically targeted *Aganippe* 'MYG086' had been previously collected. Sequencing of WA Museum specimens of *Aganippe* 'MYG086' and the specimens collected by Biota revealed that they were different taxa, despite occurring in the same location. Consequently additional survey effort will be allocated to determining whether *Aganippe* 'MYG086' is still present in the study area during Phase 2 of the survey.

4.0 References

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Yandicoogina Expansion Billiard Deposit Fauna Survey

Prepared for Rio Tinto Iron Ore

January 2011

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Yandicoogina Expansion Billiard Fauna Survey

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DEC Regulation 17 "Licence to take fauna for scientific purposes"

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Bat Call Identifications

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1.0 Summary

1.1 Background

The Yandicoogina iron ore mine is located approximately 75 km north-west of Newman, in the Pilbara region of Western Australia (Figure 2.1). This mine site is owned and operated by Rio Tinto Iron Ore (RTIO).

Rio Tinto is seeking to expand their current mining operations at Yandicoogina. This involves a development site at Billiard, located to the east of the existing mine. A further two expansion sites, Junction South West and Oxbow are located to the west of the existing Yandicoogina operation. These two sites are the subject of a related, but separate, report.

Biota Environmental Sciences (Biota) was commissioned to complete a fauna survey of the proposed the Billiard project area, which is currently intended for use as a dewatering site. The survey was planned and implemented in accordance with the EPA Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004).

The scope of the study was to:

- identify the fauna habitats, particularly those with conservation significance, within the study area;
- document the vertebrate and SRE invertebrate fauna assemblage within the study area; and
- identify fauna (particularly Schedule and Priority listed fauna as well as potential short-range endemic taxa) of particular conservation significance occurring within the area.

1.2 Methods

The initial survey took place during a single phase conducted in July 2008. This was followed in March 2010 by a four-day survey phase specifically targeting invertebrate SRE (Short-range endemic) fauna.

Systematic censusing of terrestrial fauna assemblages, including avifauna, mammals and herpetofauna, was carried out at nine sites, each located within defined habitats. The central component of the censusing consisted of trapping grids at six sites comprising 10 pit-fall traps (alternating 20 litre buckets and 20 cm diameter PVC tubes) spaced at 10 m intervals and connected by a single length (90 m) of 30 cm high flywire fence. One further sampling site exclusively comprised 50 Elliott traps, while two funnel trap sites were also utilised.

Seventeen avifauna censuses were conducted during the surveys across eight sites. Censuses were conducted between approximately 7:10 am and 12:00 pm, and were supplemented by opportunistic sightings of birds while traversing the study area.

Invertebrates were collected from both systematic sampling sites and opportunistic sampling sites. Groups targeted during these activities included:

- mygalomorph (trap-door) spiders;
- pseudoscorpions;
- scorpions;
- millipedes; and
- terrestrial snails.

Additional non-systematic collection techniques were undertaken by the survey team to supplement trapping efforts, and to investigate habitats not sampled using systematic methods.

1.3 Fauna

The single phase survey of vertebrate taxa in the Billiard study area yielded a total of 62 species, comprising 44 avifauna species, 18 mammals and 10 herpetofauna species: two frogs and eight reptiles (Table 1.1; Section 5.0).

Table 1.1: Number of vertebrate fauna species recorded during the fauna survey of the study area.

Fauna Group	Number of Species	Number of Individuals
Avifauna	44	860
Non-volant mammals	5	15
Bats	3	-
Amphibians	2	2
Reptiles	8	29
Total	**62**	**906**

One Priority 4 listed species was recorded by Biota from the survey area (Table 1.2). A further seven Schedule and six Priority listed species have either previously been recorded or may occur in the region (as determined by a search of the DEC Threatened Fauna Database and the WAM FaunaBase; Appendix 1 and Appendix 2). The Northern Quoll and the Night Parrot are listed as Endangered at the Federal level, while the Bilby, Pilbara Orange Leaf-nosed Bat and Pilbara Olive Python are listed as Vulnerable under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. The Rainbow Bee-eater was also recorded during the survey and is listed as Migratory under the *EPBC Act 1999*. These species are discussed further in Section 6.4.

Table 1.2: Fauna of conservation significance recorded during the fauna survey, or with the potential to occur within the study area (* denotes recorded during the survey).

Threatened Fauna Species	Status	
	State	Federal
Pezoporus occidentalis Night Parrot	Schedule 1	Endangered
Dasyurus hallucatus Northern Quoll	Schedule 1	Endangered
Macrotis lagotis Bilby	Schedule 1	Vulnerable
Rhinonicteris aurantius Pilbara Orange Leaf-nosed Bat	Schedule 1	Vulnerable
Lerista olivaceus barroni Pilbara Olive Python	Schedule 1	Vulnerable
Falco peregrinus Peregrine Falcon	Schedule 4	
Ramphotyphlops ganei	Priority 1	
Neochmia ruficauda subclarescens Star Finch	Priority 4	
Falco hypoleucos Grey Falcon	Priority 4	
Ardeotis australis Australian Bustard	Priority 4	
Burhinus grallarius Bush Stone-curlew	Priority 4	
**Pseudomys chapmani* Western Pebble-mound Mouse	Priority 4	
Leggadina lakedownensis Short-tailed Mouse	Priority 4	
Macroderma gigas Ghost Bat	Priority 4	

Only one Priority 4 species, the Western Pebble-mound Mouse, was confirmed from the study area (Table 1.2). This species is not restricted to the study area and is well represented in similar habitats across the Pilbara bioregion. The conservation status of this species is not expected to change as result of the Billiard development.

Searches for invertebrates during the initial survey phase, as well as during the targeted effort in 2010, yielded no taxa considered likely to represent potentially SREs

2.0 Introduction

2.1 Project Background and Study Area

The Yandicoogina iron ore mine is located approximately 75 km north-west of Newman, in the Pilbara region of Western Australia (Figure 2.1). This mine site is owned and operated by Rio Tinto Iron Ore (RTIO).

A further two expansion sites; Junction South West (JSW) and Oxbow are located to the west of the existing Yandicoogina operation. These two sites are the subject of a related, but separate, report.

Rio Tinto is seeking to expand their current mining operations at Yandicoogina. This involves a development site at Billiard, located to the east of the existing mine. The site at Billiard is intended for use as a dewatering area. The other two study areas, JSW and Oxbow, are located to the west of the existing Yandicoogina operation. These two study areas are the subject of a related, but separate report.

The project footprint was altered subsequent to the field survey and reduced in extent (see Section 4.0). For the purposes of this report, the original extent has been referred to as the 2007 survey boundary and the modified footprint the 2009 survey boundary.

2.2 Study Objectives and Scope

Biota Environmental Sciences (Biota) was commissioned to complete a fauna survey of the proposed Billiard project area. The survey was planned and implemented in accordance with the EPA Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 56 "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004).

The scope of the study was to:

- identify the fauna habitats, particularly those with conservation significance, within the study area;
- document the vertebrate and SRE invertebrate[1] fauna assemblage within the study area; and
- identify fauna (particularly Schedule and Priority listed fauna as well as potential short-range endemic taxa) of particular conservation significance occurring within the area.

2.3 Purpose of this Report

This report describes the methodology employed for the fauna survey of the Billiard project area. It documents the methods and results of the survey and identifies potential fauna of conservation significance occurring within the project area. Its intended use is as a supporting document for the environmental assessment of the project. Both the survey and report are subject to specific limitations that are discussed in detail in Section 4.5.

[1] Note that the survey referred to here was completed prior to publication of SRE survey guidelines (EPA 2009).

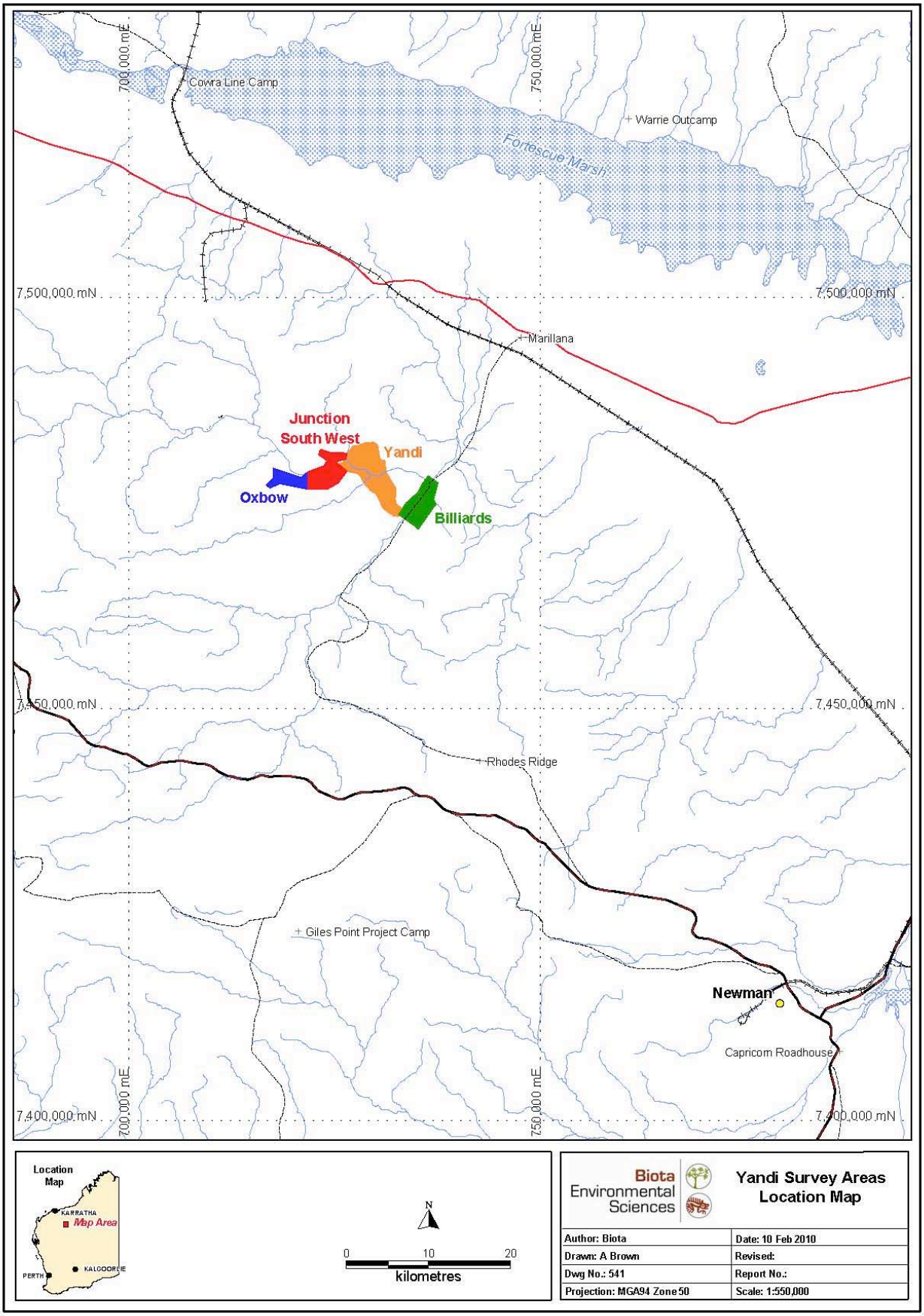

Figure 2.1: Location Map for the Yandicoogina Expansion fauna survey.

3.0 Existing Environment

3.1 Geological and Physiographic Context of the Study Are

3.1.1 Geology

Thorne and Trendall (2001) surveyed the geological units present within the proposed Yandicoogina Expansion study area, as part of a wider Pilbara project. There are six of their geological units present within the study area (Table 3.1; Figure 3.1).

Table 3.1: Geological units present in the study area.

Unit	Description
Czk	Calcrete - sheet carbonate, found along major drainage lines
Qw	Alluvium and colluvium - red-brown sandy and clayey soil; on low slope and sheetwash areas
PLHj	Weeli Wolli Formation: banded iron-formation (commonly jaspilitic), pelite, and numerous metadolerite sills
Czc	Colluvium - partly consolidated quartz and rock fragments in silt and sand matris; old valley-fill deposits, locally derived
Qa	Alluvium - unconsolidated silt, sand, and gravel; in drainage channels and adjacent floodplains
PLHb	Brockman Iron Formation: banded iron-formation, chert, and pelite

3.1.2 Land Systems

Land Systems (Rangelands) mapping covering the study area has been prepared to a draft stage by the Western Australian Department of Agriculture (van Vreeswyk et al. 2004). Land Systems are comprised of repeating patterns of topography, soils, and vegetation (Christian and Stewart 1953) (i.e. a series of "land units" that occur on characteristic physiographic types within the Land System).

A total of 107 Land Systems occur in the Pilbara bioregion. [This information was obtained by combining the Land System mapping for the Pilbara (van Vreeswyk et al. 2004) and Ashburton (Payne et al. 1988), and intersecting this with the Pilbara bioregion in ArcView 3.2.]

Land Systems mapped by the Department of Agriculture (van Vreeswyk et al. 2004) for the region including the Billiard study area are shown in Figure 4.3. Descriptions for each Land System within the project area are provided in Table 3.2.

Table 3.2: Land systems present in the study area (based on the 2009 survey boundary).

Land System	Description	Extent within bioregion (ha)	Extent within study area (ha)	% of total within bioregion
Boolgeeda (RGEBGD)	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.	961,635	587	0.06
McKay (RGEMCK)	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands.	426,142	29	0.007
Newman (RGENEW)	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,993,742	390	0.02
River (RGERIV)	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	482,176	506	0.1
		3,863,695	**1,512**	

3.2 Biological Context of the Study Area

3.2.1 IBRA Bioregions and Subregions

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions (Environment Australia 2000). The Billiard study area lies entirely within the Pilbara bioregion.

The Pilbara bioregion is divided into four subregions, described in Environment Australia (2000) as the four major components of the Pilbara Craton. The Billiard study area is located within a crossover section between the east of the Hamersley subregion and the Fortescue subregion (Figure 4.3):

- Fortescue Plains (PIL2): alluvial plains and river frontages with salt marsh, Mulga-bunch grass and short grass communities on alluvial plains and River Gum (*Eucalyptus camaldulensis*) woodlands fringing drainage lines; and
- Hamersley (PIL3): mountainous area of Proterozoic ranges and plateaux with low Mulga (*Acacia aneura*) woodland over bunch grasses on fine textured soils, and Snappy Gum (*Eucalyptus leucophloia*) over *Triodia brizoides* on the skeletal sandy soils of the ranges.

3.2.2 Previous Fauna Surveys

Numerous surveys have been undertaken adjacent to the proposed project area, or are otherwise relevant because they have been undertaken nearby in the same sub-region of the Pilbara Craton. These include:

- Yandi (HI) biological survey (Ninox Wildlife Consulting 1995);
- BHPIO Yandi Stage II biological survey (Ecologia 1995);
- Mining Area C biological survey (see Woodward-Clyde 1997);
- Seasonal survey of the Hope Downs mine area (Ecologia 1997);
- Weeli Wolli Springs biological survey (Ecologia 1998a);
- West Angelas biological survey (Ecologia 1998b);
- BHPIO Marillana Creek biological surveys (summarised in Halpern Glick Maunsell 1999);
- BHPIO Marillana Creek rare fauna survey (Bamford and Associates 2003);
- Western Rail Corridor survey from the Hope Downs mine to the vicinity of Coondewanna Flats (Halpern Glick Maunsell 2000);
- Eastern Rail Corridor survey from the Hope Downs mine to Weeli Wolli siding (Halpern Glick Maunsell 2000);
- Vertebrate fauna survey of the proposed Hope Downs rail corridor from Weeli Wolli Siding to Port Hedland (Biota 2002a);
- Mulgara *Dasycercus cristicauda* and Bilby *Macrotis lagotis* surveys completed in late October 2001 (Biota 2002b);
- Vertebrate fauna survey of a proposed extension to the Hope Downs rail corridor through the Hamersley Range (Biota 2004a);
- Vertebrate fauna survey of a proposed addition to the Hope Downs rail corridor through the Chichester Range (Biota 2004b);
- An assessment of the fauna habitats and fauna assemblage of the proposed Fortescue Metals Group (FMG) Stage A rail corridor (Biota 2004c);
- An assessment of the fauna habitats and fauna assemblage of the proposed FMG Stage B rail corridor and mine areas (Biota 2004d);

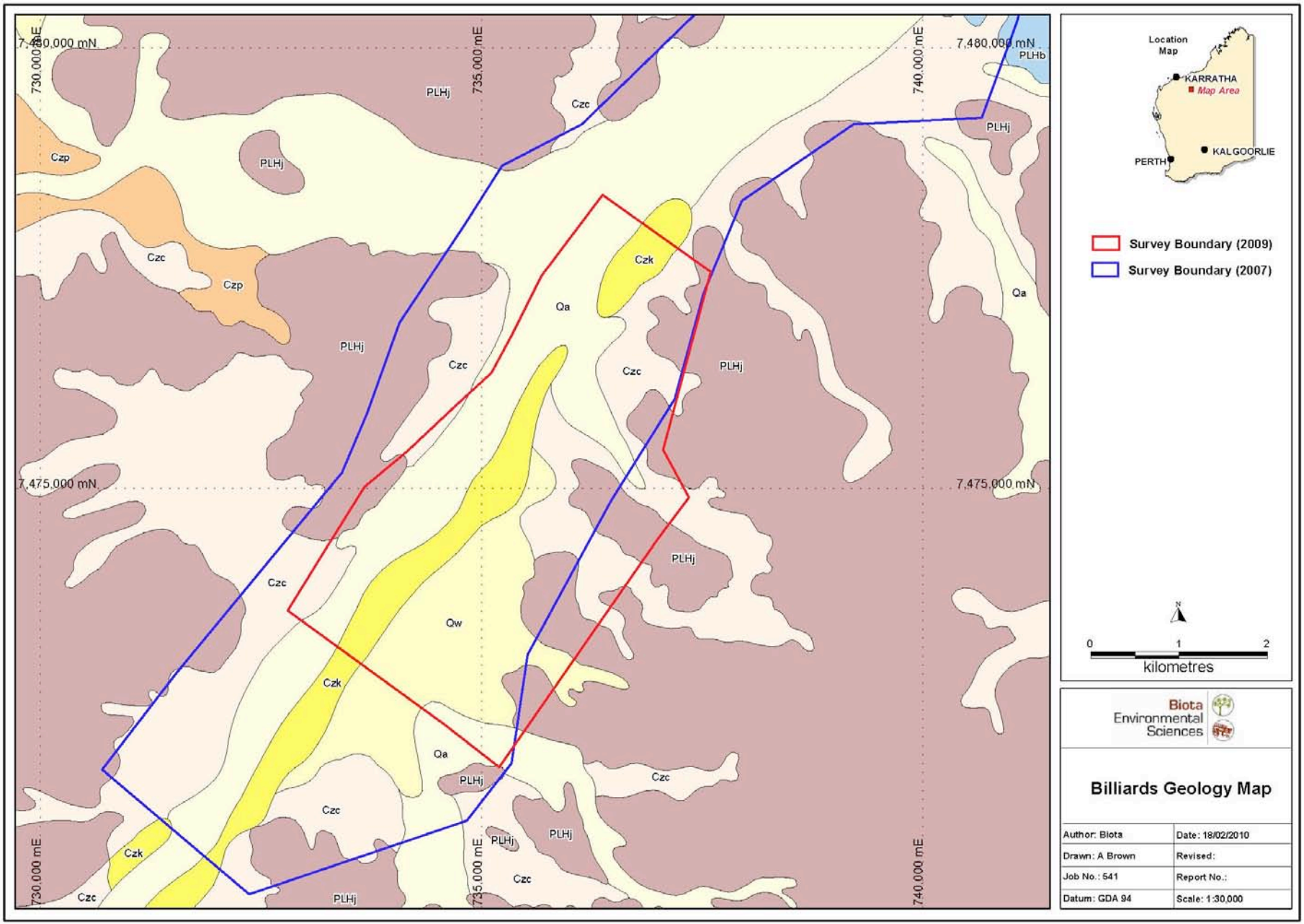

Figure 3.1: Geology mapping for the Billiard study area.

- A desktop fauna assessment and targeted invertebrate survey of the Yandi Expansion (Biota 2004e); and
- Yandicoogina Targeted Northern Quoll Survey (Biota 2009).

3.2.3 Conservation Reserves in the Locality

The main conservation reserve in the locality is the A-class Karijini National Park, approximately 100 km to the west-northwest of the study area.

While not listed as a conservation reserve the area known as Fortescue Marshes, approximately 45 km northeast of the study area, is listed as a Wetland of National Significance (Figure 2.1).

The Pilbara bioregion is listed as a medium priority for funding for land purchased under the National Reserves System Co-operative Program due to the limited representation of the area in conservation reserves. Portions of various pastoral leases in the region have been nominated for exclusion for public purposes in 2015, when the leases come up for renewal. Many of the submissions are from the Department of Environment and Conservation (DEC), with the intention of adding these areas to the existing conservation estate in order to provide a comprehensive, adequate and representative reserve system. None of these proposed exclusions are located in the vicinity of the expansion areas.

4.0 Study Methodology

4.1 Database Searches

Database searches were conducted of the DEC Threatened Fauna database (Appendix 1), the WA Museum FaunaBase (Appendix 2), and the *EPBC Act 1999* Protected Matters database (Appendix 3). These were completed using a point search utilising a 50 km buffer on the study area. The central coordinates for this search were:

- 22°47'5.61"S and 119°13'18.62"E

4.2 Survey Timing and Weather

The initial survey was conducted over a 7-day period between 5th July and 12th July 2008. Minimum temperatures during the survey ranged from 2.3°C to 11.5°C and maximum temperatures ranged from 20.4°C to 26.6°C (Table 4.1). No rainfall was recorded in Newman during the survey (Table 4.1).

The weather experienced during the fauna survey was comparable to the long-term climatic averages for Newman (Figure 4.1). The long-term averages for July include a maximum temperature of 22.3°C and a minimum temperature of 8.1°C. While the average rainfall for the month is 12.6 mm, rainfall events are typically only recorded sporadically at this time of year.

An additional survey phase targeting only invertebrate SRE taxa was completed between March 4th and 7th 2010.

Table 4.1: Daily meteorological observations at Newman Airport for July 2008 during the fauna survey (data provided by the Western Australian Bureau of Meteorology).

	5/07	6/07	7/07	8/07	9/07	10/07	11/07	12/07	Average
Min. Temp. (°C)	11.5	7.9	6.7	2.6	4.0	2.3	3.5	8.1	5.8
Max. Temp. (°C)	23.7	21.1	20.4	23.8	24.7	24.8	26.6	22.4	23.4
Rainfall (mm)	0	0	0	0	0	0	0	0	

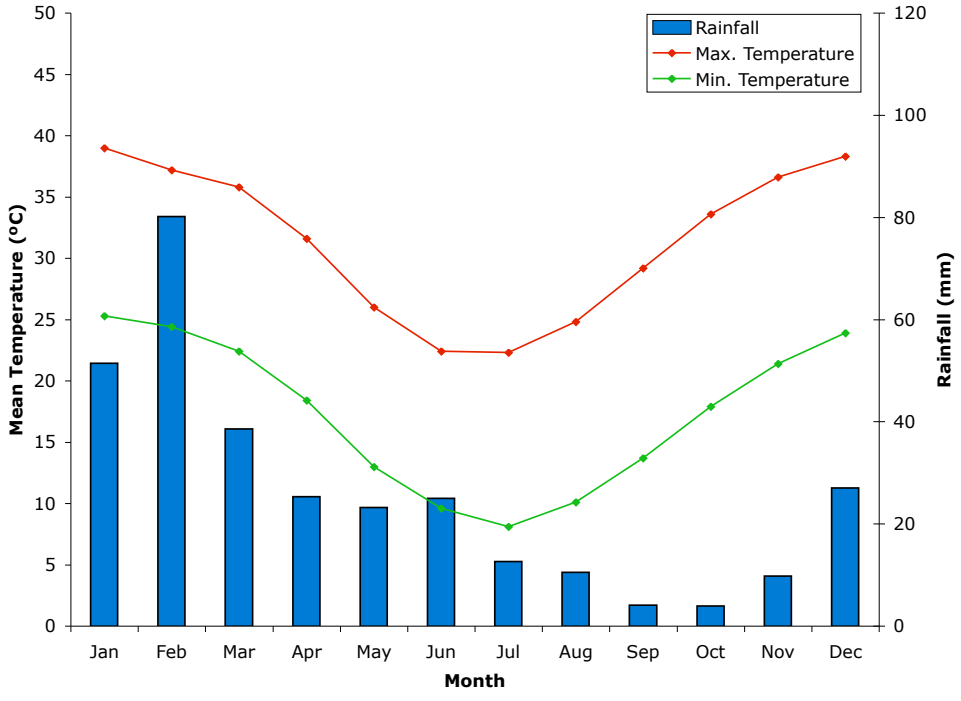

Figure 4.1: Long-term climatic averages for Newman (data provided by the Bureau of Meteorology).

4.3 Fauna Survey Team

The vertebrate fauna sampling for the field survey component of this study in 2008 was conducted under "Licence to Take Fauna for Scientific Purposes" No. SF006426 issued to Dr Phil Runham (Appendix 4). The fauna survey team comprised Dr Phil Runham, Mr Dan Kamien, Ms Erin Harris and Ms Jessica Cairnes (all of Biota Environmental Sciences). Mr Michael Greenham and Mr Ashley Johnsen participated in the set-up process for the fauna survey. The targeted SRE survey phase in 2010 was completed by Dr Phil Runham and Ms Erin Harris.

4.4 Systematic Censusing

4.4.1 Selection and Location of the Survey Sites

The principal component of the field survey consisted of systematic fauna sampling centred on a total of nine trapping sites, including six grids of 10 pit-traps in environments considered to represent the range of habitats available within the study area. Two funnel trap sites, each with 20 traps, and one site of 50 Elliott traps were also utilised.

Each survey site was installed within a defined habitat and was selected such that equal weight was given to accessibility of the sites in terms of regular inspection of traps (Plate 5.1 - Plate 5.9). Locations of trapping sites are presented in Table 4.2 and Figure 4.3.

4.4.2 Trapping Effort and Layout of the Trapping Grids

The trapping effort at each of the systematic trapping sites is detailed in Table 4.2. The locations of the trapping sites are shown in Figure 4.3.

During the fauna survey, pit-traps at six sites were arranged in a single row of ten traps, alternating between 20 litre buckets (~40 cm diameter) and PVC tubes (~20 cm diameter). Pit-traps were spaced at ~10 m intervals and connected with a single length of 30 cm tall flywire fence (Figure 4.2). Funnel traps were placed in a layout similar to that used for pit-traps, whilst Elliott traps were spaced at 5 - 10 m intervals along the base of breakaways or other suitable landscape features.

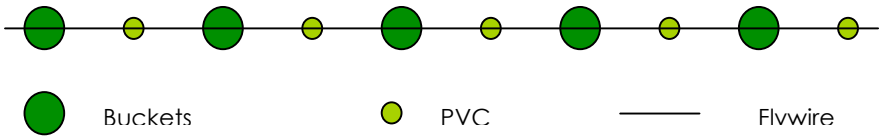

Figure 4.2: Indicative layout of trapping grids for the fauna survey.

Table 4.2: Trapping effort and trap location (WGS84, Zone 50) for the fauna survey.

Site	Location	Trap Type	Date Opened	Date Closed	Nights Open	No. of Traps	Total Trapping Effort
BIL02	740112mE; 7480997mN	Pit-traps	6/07/08	12/07/08	6	10	60
BIL05	737520mE; 7478340mN	Pit-traps	6/07/08	12/07/08	6	10	60
BIL07	736885mE; 7476102mN	Pit-traps	6/07/08	12/07/08	6	10	60
BIL08	735490mE; 7475184mN	Pit-traps	6/07/08	12/07/08	6	10	60
BIL10F	733398mE; 7473929mN	Funnel traps	6/07/08	12/07/08	6	20	120
BIL11	734617mE; 7472530mN	Pit-traps	6/07/08	12/07/08	6	10	60
BIL12	734812mE; 7474730mN	Pit-traps	6/07/08	12/07/08	6	10	60
BIL13F	736431mE; 7477689mN	Funnel traps	6/07/08	12/07/08	6	20	120
BIL14E	736249mE; 7477246mN	Elliott traps	7/07/08	12/07/08	5	50	250
					Pit-trapping Nights		**360**
					Funnel Trap Nights		**240**
					Elliott Trap Nights		**250**
					Total Trap Nights		**850**

4.4.3 Avifauna Sampling

The avifauna of the project area was sampled using a combination of techniques, which included:

- unbounded area searches conducted at the systematic sampling grids (Table 4.3);
- unbounded area searches conducted at opportunistic locations containing habitats or microhabitats likely to support previously unrecorded species; and
- opportunistic observation of birds while driving around the study area.

A total of 17 avifauna censuses were completed across eight sites during the survey period (Table 4.3). Avifauna were sampled using 30 or 40-minute censuses comprising a total of 10 hours of dedicated avifauna sampling.

Censuses were supplemented by recording avifauna species observed opportunistically within the study area.

Table 4.3: Timing of avifauna censuses during the fauna survey.

Site	7/7/08	8/7/08	9/7/08	10/7/08	11/7/08	Total (min)
BIL02		0715 - 0745				30
BIL05	1500 - 1530	0800 - 0830				60
BIL07			0825 - 0905	1010 - 1050		80
BIL08		1130 - 1200	0920 - 1000			70
BIL10F		0930 - 1000		0720 - 0800	0731 - 0811	110
BIL11	*	0840 - 0910	1010 - 1050			70
BIL12		1040 - 1110		0825 - 0905		70
BIL13F & BIL14E			0725 - 0805	0910 - 0950	0947 - 1027	110
					Total	**600 min**

4.4.4 Bat Sampling

Bats were sampled at one site using an Anabat echolocation call detector (Table 4.4 and Figure 4.3; Plate 4.1).

Table 4.4: Location of bat sampling during the Billiard fauna survey.

Site	Location	Structure	Type	Date Opened	Date Closed	No. of Nights
BILANA01	736435mE; 7477590mN	Creekline	Anabat	8/07/08	12/07/08	4
					Total Bat Sampling Nights	**4**

Plate 4.1: Site BILANA01.

4.4.5 Non-systematic Sampling of Vertebrate Fauna

A range of non-systematic fauna survey activities was also undertaken by the Biota survey team to supplement the trapping and investigate additional habitats identified during the course of the survey. These included:

- habitat-specific searches for Schedule and Priority listed fauna species;
- searching of microhabitats for reptile, frog and small mammal species;
- opportunistic sightings and records;
- identification of road kills and other animal remains; and
- recording and identification of secondary signs including tracks, scats and diggings.

4.4.6 Invertebrate Sampling

Hand foraging was undertaken for pseudoscorpions, involving peeling bark and lifting rocks. The latter technique was also used to search for scorpions, with additional specimens collected from pit traps. Millipedes were searched for whilst raking leaf litter and other debris and whilst searching for land snails. Representative samples of other invertebrates from pit traps were collected, sorted to morphotype, placed in 70% ethanol and lodged with the WA Museum."

Groups targeted during these activities included:

- mygalomorph (trap-door) spiders;
- pseudoscorpions;
- scorpions;
- millipedes; and
- terrestrial snails.

Invertebrates were collected from systematic sampling sites in the course of removing vertebrates from traps, as well as searches being conducted in these habitats. Additional non-systematic sampling for invertebrate groups supporting potential short-range endemic (SRE) taxa was also conducted across four sites (Table 4.5) through bulk sampling of leaf litter under vegetation.

Table 4.5: SRE sampling sites within the Billiard study area.

Site	Easting (mE)	Northing (mN)
BIL SRE03	739 019	7 479 322
BIL SRE04	732 777	7 472 371
BIL SRE05	736 627	7 477 820
BIL SRE08	736 422	7 475 639

4.5 Survey Limitations

The following limitations should be recognised by the reader of this report:

- The Billiard fauna survey represents a single phase of sampling with an additional phase targeting SRE taxa. It is probable that a broad seasonal survey would augment the number of species recorded from the study area.
- Not all sections of the study area were ground-truthed or equally sampled for fauna. Parts of the study area were inaccessible by vehicle hence regular checking of fauna traps in these areas would not have been possible. However, systematic fauna sampling was completed on the basis of trapping grid installation in habitats considered to be representative of the range of units present within the development area.
- It should be noted that nightspotting was not undertaken during the survey in accordance with site operational and safety procedures.

- Terrestrial invertebrate sampling was targeted at a small number of specific groups that are known to potentially harbour SRE taxa. Whilst the survey guidelines for SRE sampling were not published prior to completion of the survey, retrospective analysis has demonstrated that the sampling techniques utilised are in accordance with the EPA Guidelines for this type of work (EPA 2009).

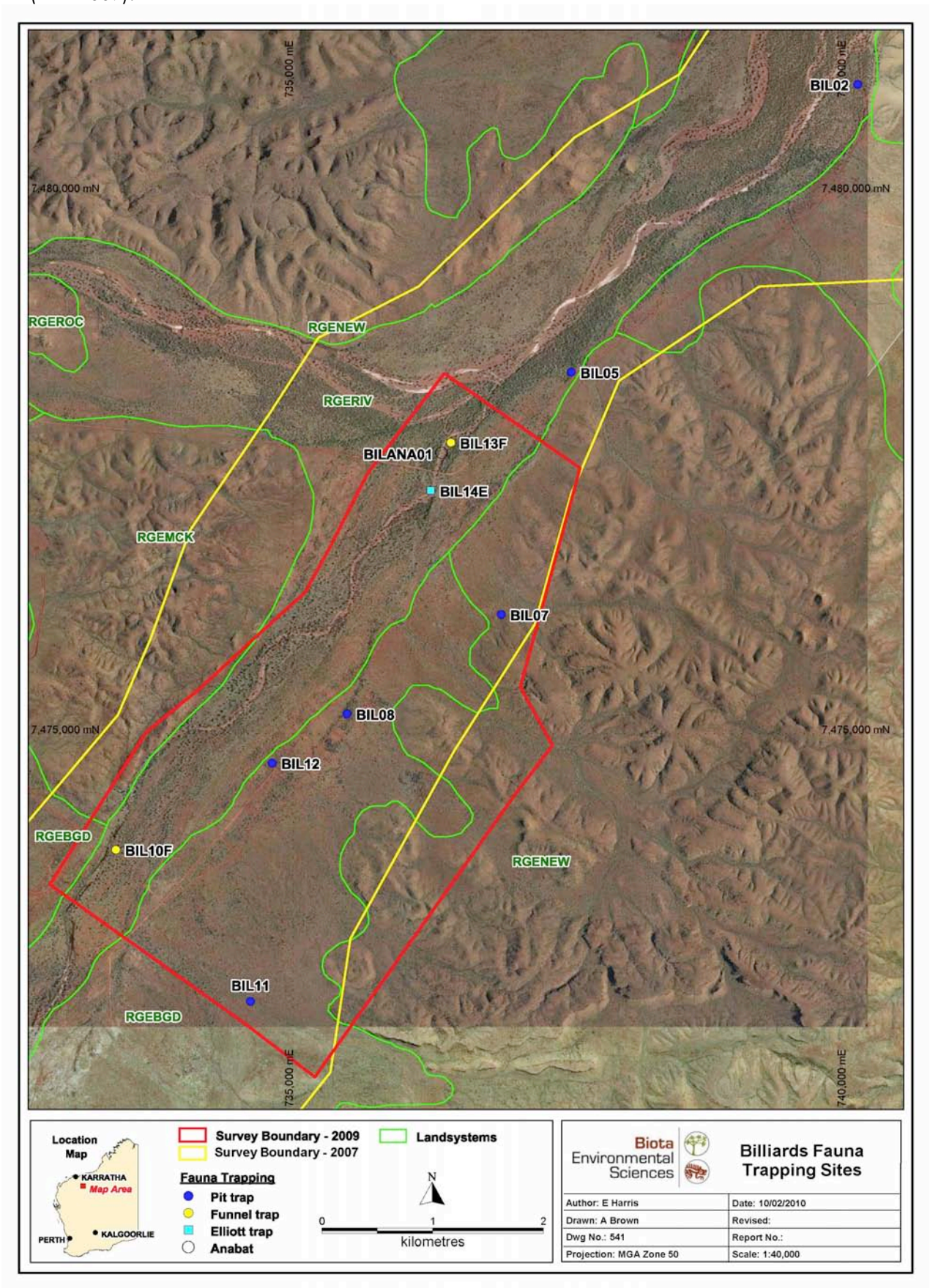

Figure 4.3: Fauna trapping site locations in the Billiard study area.

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5.0 Results

5.1 Fauna Habitats

Six separate fauna habitat units were identified during the Billiard fauna survey (Table 5.1). The fauna habitats were distinguished primarily on the basis of landforms, but also on their associated vegetation and soil types.

Table 5.1: Fauna habitats utilised during the Billiard fauna survey, distinguished by landform.

Vegetation Description and Substrate	Site	Plate
MAJOR DRAINAGE LINE		
Eucalyptus victrix. over *Acacia citrinoviridis* and *A. pruinocarpa*. over mixed shrubs over *Triodia* spp. and tussock grasses on river gravel.	BIL14E	Plate 5.9
	BIL10F	Plate 5.5
	BIL13F	Plate 5.8
MAJOR DRAINAGE LINE		
Eucalyptus and *Corymbia* spp. woodland over *Cenchrus ciliaris* (Buffel Grass) on stony loam.	BIL05	Plate 5.2
MINOR DRAINAGE LINE		
Eucalyptus spp. over *Acacia* spp. over *Triodia* spp. and grasses on stony loam.	BIL11	Plate 5.6
PLAIN		
Acacia aneura (Mulga) over *Eremophila forrestii* and small mixed shrubs on loam.	BIL08	Plate 5.4
Acacia sp. woodland over *Cenchrus ciliaris* (Buffel Grass) on loam.	BIL02	Plate 5.1
PLAIN		
Scattered *Eucalyptus* spp. over *Acacia* spp. over *Triodia* spp. on gravelly loam with calcrete.	BIL12	Plate 5.7
LOW STONY HILL SLOPE		
Scattered *Corymbia* spp. over *Acacia* spp. shrubland over *Triodia* on stony slope.	BIL07	Plate 5.3

Plate 5.1: Site BIL02.

Plate 5.2: Site BIL05.

Plate 5.3: Site BIL07.

Plate 5.4: Site BIL08.

Plate 5.5: Site BIL10F.

Plate 5.6: Site BIL11.

Plate 5.7: Site BIL12.

Plate 5.8: Site BIL13F.

Plate 5.9: Site BIL14E.

5.2 Overview

The fauna survey of the Billiard project area yielded a total of 62 vertebrate fauna species representing 33 families (Table 5.2). Forty-four species of avifauna, eight species of mammals and 10 species of herpetofauna were recorded during the survey (Table 5.2).

Table 5.2: Vertebrate Fauna Groups recorded during the fauna survey.

Fauna Group	Number of Species	Number of Individuals
Avifauna	44	860
Non-volant mammals	5	15
Bats	3	-
Amphibians	2	2
Reptiles	8	29
Total	**62**	**906**

5.3 Avifauna

5.3.1 The Assemblage

A total of 44 species of birds was recorded during the Billiard fauna survey, comprising 23 families. This included 14 non-passerine species and 30 passerine species (Table 5.3).

The most commonly recorded species was the Zebra Finch *Taeniopygia guttata* with a total of 176 records, representing 20.5% of all avifauna records. The Masked Woodswallow *Artamus personatus* was also relatively common, with 14.0% of the total of all avifauna records for the survey. The most abundant family was the Estrildidae (finches) with 176 records accounting for 20.5% of all records (it should be noted these are all Zebra Finch records). The Meliphagidae (honeyeaters) was also an abundant family with 158 records representing 18.4% of the total avifauna records. The Meliphagidae was also the most speciose family with six species recorded (Table 5.3).

The most species rich sites were BILF13 with 28 species, followed by BILF10 (both situated on major drainage lines) with 27 species (Table 5.3).

5.3.2 Avifauna of Conservation Significance

One Migratory species, the Rainbow Bee-eater *Merops ornatus* was recorded during the Billiard fauna survey (Table 5.3).

A further five avifauna species of elevated conservation significance may occur within the study area.

Further information on these species of elevated conservation significance can be found in Section 6.4.

5.4 Mammals

5.4.1 The Assemblage – Non-volant mammals

A total of five species of non-volant mammals was recorded during the survey, comprising four families. This total includes four native mammal species and one non-native species (a total of 46.7% of all non-volant mammal records for the survey). The most commonly recorded native species was the Red Kangaroo Macropus rufus, with a total of four records, representing 26.7% of all non-volant mammal records.

Table 5.3: Avifauna species recorded during the Billiard fauna survey.

FAMILY Common Name	Species Name	BIL02	BIL05	BIL07	BIL08	BILF10	BIL11	BIL12	BILF13	TOTAL
ARDEIDAE										
White-faced Heron	*Ardea novaehollandiae*					1				1
ACCIPITRIDAE										
Black-breasted Buzzard	*Hamirostra melanosternon*						2			2
Whistling Kite	*Haliastur sphenurus*					1				1
FALCONIDAE										
Brown Falcon	*Falco berigora*		1							1
CHARADRIIDAE										
Black-fronted Dotterel	*Charadrius melanops*					6				6
COLUMBIDAE										
Crested Pigeon	*Ocyphaps lophotes*					15	3			18
Peaceful Dove	*Geopelia striata*	6							2	8
PSITTACIDAE										
Little Corella	*Cacatua sanguinea*					53		1	31	85
Australian Ringneck	*Platycercus zonarius*	4				8			5	17
CUCULIDAE										
Pallid Cuckoo	*Cuculus pallidus*			1	1		1			3
Horsfield's Bronze Cuckoo	*Chrysococcyx basalis*					2			1	3
HALCYONIDAE										
Blue-winged Kookaburra	*Dacelo leachii*		1			2			1	4
Red-backed Kingfisher	*Todiramphus pyrrhopygia*							1	2	3
MEROPIDAE										
Rainbow Bee-eater	*Merops ornatus*		7			9			5	21
MALURIDAE										
Variegated Fairy-wren	*Malurus lamberti*		7			3		7		17
PARDALOTIDAE										
Red-browed Pardalote	*Pardalotus rubricatus*					2			6	8
Striated Pardalote	*Pardalotus striatus*	2				3				5
ACANTHIZIDAE										
Weebill	*Smicrornis brevirostris*	2	10	3	2	9	1	7	9	43
Western Gerygone	*Gerygone fusca*				2	3		1	1	7
MELIPHAGIDAE										
Brown Honeyeater	*Lichmera indistincta*		2	8		5	1	9	1	26
Singing Honeyeater	*Lichenostomus virescens*			1	5	3	9	6	1	25
Grey-headed Honeyeater	*Lichenostomus keartlandi*					1				1

FAMILY Common Name	Species Name	BIL02	BIL05	BIL07	BIL08	BILF10	BIL11	BIL12	BILF13	TOTAL
White-plumed Honeyeater	*Lichenostomus penicillatus*	11	8			22			20	61
Yellow-throated Miner	*Manorina flavigula*			9	11		4	16		40
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*					1		3	1	5
PETROICIDAE										
Red-capped Robin	*Petroica goodenovii*				1				1	2
POMATOSTOMIDAE										
Grey-crowned Babbler	*Pomatostomus temporalis*	3		1		2			11	17
PACHYCEPHALIDAE										
Crested Bellbird	*Oreoica gutturalis*	1			1	1	2	2	1	8
Rufous Whistler	*Pachycephala rufiventris*	2	3		1				4	10
Grey Shrike-thrush	*Colluricincla harmonica*					3			1	4
DICRURIDAE										
Grey Fantail	*Rhipidura fuliginosa*	1								1
Willie Wagtail	*Rhipidura leucophrys*		2	3		11			5	21
Magpie-lark	*Grallina cyanoleuca*		1	1	1	12		1	6	22
CAMPEPHAGIDAE										
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*						2		7	9
ARTAMIDAE										
Masked Woodswallow	*Artamus personatus*				50				70	120
Black-faced Woodswallow	*Artamus cinereus*			7			4			11
Little Woodswallow	*Artamus minor*								2	2
CRACTICIDAE										
Grey Butcherbird	*Cracticus torquatus*				4					4
Pied Butcherbird	*Cracticus nigrogularis*						2		1	3
Australian Magpie	*Cracticus tibicen*					1				1
CORVIDAE										
Torresian Crow	*Corvus orru*	6	1	1	1	6		1	4	20
Little Crow	*Corvus bennetti*								1	1
DICAEIDAE										
Mistletoebird	*Dicaeum hirundinaceum*	13	4							17
ESTRILDIDAE										
Zebra Finch	*Taeniopygia guttata*	3				137	22		14	176
	Total Number of Individuals	**54**	**47**	**35**	**80**	**322**	**53**	**55**	**214**	**860**
	Total Number of Species	**12**	**12**	**10**	**12**	**27**	**12**	**12**	**28**	**44**

The most abundant family was the Macropodidae, with six records accounting for 40.0% of all records. The most speciose family observed was also the Macropodidae, which comprised two species (Table 5.4).

The most speciose site during the fauna survey was BIL07 (low stony hill slope), recording three species.

5.4.2 The Assemblage – Bats

Three species of bats were identified on the basis of ultrasonic call analysis from one site within the Billiard project area (Appendix 5). These comprised one Emballonuridae and two Vespertilionidae (Table 5.5).

5.4.3 Mammals of Conservation Significance

One mammal species of elevated conservation significance was recorded during the fauna survey; this was the Western Pebble-mound Mouse *Pseudomys chapmani* (see Section 6.4).

A further five mammal species of elevated conservation significance may occur within the study area, but were not recorded during the survey (see Section 6.4).

Table 5.4: Non-volant mammal species recorded during the Billiard fauna survey.

FAMILY Common Name	Species Name	BIL07	BILF10	BILF13	Total
DASYURIDAE					
Little Red Kaluta	*Dasykaluta rosamondae*	1			1
MACROPODIDAE					
Euro	*Macropus robustus*	2			2
Red Kangaroo	*Macropus rufus*		4		4
MURIDAE					
Western Pebble-mound Mouse	*Pseudomys chapmani*	1			1
BOVIDAE					
European Cattle	*Bos taurus*		6	1	7
Total Number of Individuals		**4**	**10**	**1**	**15**
Total Number of Species		**3**	**2**	**1**	**5**

Table 5.5: Bat species recorded during the Billiard fauna survey.

FAMILY Common Name	Species Name	BILANA01
EMBALLONURIDAE		
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	C
VESPERTILIONIDAE		
Gould's Wattled Bat	*Chalinolobus gouldii*	C
Finlayson's Cave Bat	*Vespadelus finlaysoni*	C
	Total Number of Species	**3**

5.5 Herpetofauna

5.5.1 The Assemblage

A total of 10 species of herpetofauna were recorded during the fauna survey, comprising four families (Table 5.6). This total comprised two tree frogs (Hylidae), two dragons (Agamidae), five skinks (Scincidae) and two front-fanged snakes (Elapidae).

The most commonly recorded species was the dragon *Amphibolurus longirostris* with a total of 13 records, representing 42.0% of all herpetofauna records. The most abundant herpetofauna families were the Agamidae and the Scincidae; each with 14 records each accounting for 45.2% of all herpetofauna records. The most speciose family observed was the Scincidae, which comprised five species.

The most speciose site was BILF10 (major drainage line) with five species recorded (Table 5.6).

5.5.2 Herpetofauna of Conservation Significance

Two herpetofauna species of elevated conservation significance may occur within the study area, but were not recorded during the survey (see Section 6.4).

Table 5.6: Herpetofauna species recorded during the Billiard fauna survey.

FAMILY Species Name	BIL02	BIL05	BIL07	BILF10	BIL11	BIL12	BILF13	Total
HYLIDAE								
Cyclorana maini				1				1
Litoria rubella				1				1
AGAMIDAE								
Ctenophorus caudicinctus			1					1
Amphibolurus longirostris	1	1		5			6	13
SCINCIDAE								
Carlia munda	1	3						4
Ctenotus duricola			1		2			3
Ctenotus leonhardii				1				1
Ctenotus pantherinus			1		1	1		3
Menetia greyii		2			1			3
ELAPIDAE								
Demansia psammophis		1						1
Parasuta monachus				1				
Total Number of Individuals	**2**	**7**	**3**	**9**	**4**	**1**	**6**	**31**
Total Number of Species	**2**	**4**	**3**	**5**	**3**	**1**	**1**	**10**

5.6 Short-range Endemic (SRE) Taxa

A total of only three invertebrate taxa were collected from one site during the survey phases. None of these represented taxa considered to contain potential SRE fauna (Section 4.4.6). A further three sites (see Section 4.4.6) from which leaf litter samples were taken yielded no invertebrates at all. This result was probably attributable to the general lack of suitable microhabitats in the study area.

Site	Location		Habitat Type	Taxon	Specimen Number
	Easting (mE)	Northing (mN)			
BILSRE04	736 627mE	7477 820mN	Colluvial drainage line	Diplopoda	3
				Coleoptera	1
				Blattodea	1
				Total	**5**

6.0 Discussion

The discussion following provides a synopsis of the significance of the fauna habitats and assemblages documented in the Billiard study area in the context of both the Pilbara Bioregion and the local area. The fauna assemblage is discussed predominantly in terms of the vertebrate families recorded and later in terms of fauna of elevated conservation significance.

6.1 Fauna Habitats

The survey of the Billiard study area identified six primary habitat types on the basis of landform, substrate types and vegetation assemblages (see Section 5.1). These six habitat types can be simplified into four habitat types based solely on landform:

- Major Drainage Line;
- Minor Drainage Line;
- Plain; and
- Low Stony Hill Slope.

This compares favourably with the previously available data, which indicate the potential for six habitat types (Biota 2004e). The four habitat types identified within the Billiard study area broadly comprise spinifex hummock grasslands on low stony hills, with open Eucalypt woodlands and *Acacia* shrublands over spinifex on valley floors, and Eucalypt woodlands along creeks. Creeklines were divided into the major creek habitat of Weeli Wolli and Marillana Creeks, and smaller secondary creeklines. The two habitat types not represented within the Billiard study area were low stony hills comprising areas of Mulga on hillcrests and rocky ridges / breakaways.

These habitats represent a small subset of the available habitats within the Pilbara and are largely considered to be ubiquitous throughout the Bioregion.

It should be noted here also that the habitats identified in the Billiard study area were characterised by high levels of degradation due to the presence of cattle and the frequency of fires. Relatively small, regenerating plants dominated much of the Triodia hummock grassland habitat, while the open areas between plants were frequently disturbed by cattle tracks. The dominant trees present in the *Acacia* groves close to the drainage line appeared largely intact, but understoreys were significantly impacted by cattle and / or the native vegetation replaced with *Cenchrus ciliaris*.

6.2 Fauna Assemblage

The fauna assemblage recorded during the survey of the Billiard study area comprised a total of 62 species, representing 33 families. This assemblage is considered to represent a subset of the vertebrate taxa that might be expected to occur in the study area, which has previously been estimated at 147 species across 51 families (Biota 2004e). For the greater part, the absence from the current study of families included in the earlier list can be attributed to factors including disturbed or unsuitable habitats, seasonality or the vagaries of species biologies.

Comparison of the avifauna assemblage with that compiled earlier (Biota 2004e) reveals the absence of nine families from the assemblage documented during this study. The absence of many of these species can be related to the state and/or availability of suitable habitat.

For instance, it is likely that members of avifauna families such as the Casuariidae (Emu), Otididae (Australian Bustard) and Turnicidae (Little Button-quail) were absent due to the extent of habitat that were highly degraded due to the presence of cattle. These areas were vegetated with only very small *Triodia* in most places and would have offered little foraging for frugivorous or

insectivorous species, and little protection for taxa reliant on *Triodia* respectively (Johnstone and Storr 1998). Portions of Weeli Wolli Creek influenced by existing dewatering activity (Figure 2.1) provide standing water within the study area, which accounts for the presence of the Ardeidae and Charadriidae (Table 5.3), however other water dependant taxa that may have been expected (Anatidae, Phalacrocoracidae, Threskiornithidae etc.) were not observed. Night birds (Tytonidae, Strigidae etc.) were not observed during the survey, this is likely due to nightspotting not occurring in accord with site operational procedures (see Section 4.5).

Amongst the mammals, there were only minor differences in the families recorded during the survey and those appearing in the earlier list (Biota 2004e). The sole native mammal family appearing in other documents (Biota 2004e) not documented by the current survey was the Molossidae. The one species representing this family in the vicinity of Billiard is the Northern Free-tail Bat *Chaerephon jobensis*. While this species may forage within the study area, it requires a core habitat that includes caves, this habitat is not available within the Billiard study area.

Although the herpetofauna documented during the current survey comprised representatives of four of the families, represented by 31 individuals, expected to occur in the Billiard study area, the numbers of both species and individuals were significantly below what might be expected for the area. However, this result is unsurprising given the low temperatures (both minima and maxima) experienced during the survey.

6.3 Fauna of Conservation Significance

6.3.1 Threatened Fauna Statutory Framework

Native fauna species that are rare, threatened with extinction, or have high conservation value are specially protected by law under the Western Australian *Wildlife Conservation Act 1950-1979*. In addition, many of these species are listed under the Federal *EPBC Act 1999*.

6.3.1.1 *EPBC Act 1999*

Fauna species of national conservation significance are listed under the *EPBC Act 1999*, and may be classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent' (consistent with IUCN categories: http://www.iucn.org/themes/ssc/redlist2006/categories.htm).

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

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

6.3.1.2 *Wildlife Conservation Act 1950-1979*

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 2010* recognises four distinct schedules of taxa:

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

In addition to the above, fauna are also classified under five different Priority codes:

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

Priority Two Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands.
Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority Three Taxa with several, poorly known populations, some on conservation lands.
Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

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

Priority Five Taxa in need of monitoring.
Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

6.4 Threatened Fauna Species from the Study Area

Two species of elevated conservation significance were recorded during the Billiard fauna survey during (Table 6.1). The Western Pebble-mound Mouse *Pseudomys chapmani* is listed as Priority 4 species under State legislation. The Rainbow Bee-eater *Merops ornatus* is listed under Federal legislation as Migratory.

A further five species listed under Federal legislation as either Endangered or Vulnerable (and as Schedule 1 under State legislation) may also occur in the study area (Table 6.1). One Schedule 4 State-listed species may be present. A further seven Priority listed species under State legislation may also be present within the study area.

Table 6.1: Threatened Fauna Species possibly occurring within the Yandicoogina vicinity (* denotes species recorded during the Billiard fauna survey).

Threatened Fauna Species	Status	
	State	Federal
Pezoporus occidentalis Night Parrot	Schedule 1	Endangered
Dasyurus hallucatus Northern Quoll	Schedule 1	Endangered
Macrotis lagotis Bilby	Schedule 1	Vulnerable
Rhinonicteris aurantius Pilbara Orange Leaf-nosed Bat	Schedule 1	Vulnerable
Lerista olivaceus barroni Pilbara Olive Python	Schedule 1	Vulnerable
Falco peregrinus Peregrine Falcon	Schedule 4	
Ramphotyphlops ganei	Priority 1	
Neochmia ruficauda subclarescens Star Finch	Priority 4	
Falco hypoleucos Grey Falcon	Priority 4	
Ardeotis australis Australian Bustard	Priority 4	
Burhinus grallarius Bush Stone-curlew	Priority 4	
**Pseudomys chapmani* Western Pebble-mound Mouse	Priority 4	
Leggadina lakedownensis Short-tailed Mouse	Priority 4	
Macroderma gigas Ghost Bat	Priority 4	

6.4.1 Schedule Fauna Species

***Pezoporus occidentalis* Night Parrot**
State: Schedule 1 'Critically Endangered'
Federal: Endangered

Distribution: Night Parrots have been reported from every state on the Australia mainland. Suitable habitat occurs, or has occurred, across most of the inland, covering at least half of the continent. Records are sparsely distributed through this area, however there do appear to be concentrations of records in western Queensland and the eastern Pilbara (Higgins 1999). There is a confirmed record from Minga Well north of the Fortescue Marsh (approx. 100 km north of Newman, and 250 km east of Brockman) and an unconfirmed sighting from near Yandicoogina on the edge of the Marshes (Mr Roy Teale, Biota, pers. obs.).

Ecology: Night Parrots inhabit areas where there is dense, low vegetation, which provides them shelter during the day. Most records come from hummock grasslands with spinifex (*Triodia*), from areas dominated by samphire, or particularly, where these two habitats are juxtaposed. It has been suggested that birds move into the grasslands when *Triodia* is seeding. They have also been reported in low chenopod shrublands with saltbush and bluebush, and from areas of Mitchell grass (*Astrebla*) with scattered chenopods.

Many records have come from waterholes, and almost all reports from areas of *Triodia* have noted the presence of nearby water. The species is secretive and almost all confirmed sightings of feeding or drinking birds have come after dark. Sightings during the day have almost always been of birds flushed from hiding places by herds of stock, dogs or fire. Birds typically sit very tight, flushing only if the disturbance is very close, actually affecting the clump of vegetation in which they are hiding. Early observers stressed the dependence of the parrot upon dense spinifex or samphire for daytime roosting spots and for nesting.

The Night Parrot is presumably like other arid zone birds in being markedly nomadic. The extent of the movements and the possibility of some seasonality in any part of the range are unknown. Several possible reasons have been proposed for the decline of this species in recent years, including (1) habitat loss through clearing, (2) changes in habitat from burning practices, (3) changes in habitat caused by or competition from stock, (4) reduced availability of water holes or surrounding suitable food plants and (5) predation from feral animals, particularly cats and foxes (cats were mentioned as a major problem by several early observers).

Likelihood of occurrence: While the proposed expansion areas contain areas of dense *Triodia*, this habitat is not restricted to these areas. Additionally, there are no areas vegetated with samphire in the vicinity of the study area.

Potential Impacts: As a Schedule 1 and federally listed species the Night Parrot is considered fauna in need of special protection. However the Night Parrot is considered unlikely to occur within the study area, and therefore the conservation status of this species would not be altered by the current proposal.

***Dasyurus hallucatus* Northern Quoll**
State: Schedule 1 'Endangered'
Federal: Endangered

Distribution: The Northern Quoll was originally recorded across Northern Australia from the Northwest Cape, Western Australia to south-east Queensland but has declined in recent years. Its distribution is now restricted to six main areas: the north and western top end of the Northern Territory, north of Cape York, the Atherton-Cairns area, the Carnarvon Range-Bowen area of Queensland (Menkhorst and Knight 2001), and the northwest Kimberley and Pilbara regions of Western Australia (Braithwaite and Griffiths 1994). It also occurs on numerous islands off the Australian coast (Abbott and Burbidge 1995, Burbidge and McKenzie 1978).

Ecology: The Northern Quoll, *Dasyurus hallucatus*, is classed as a medium-sized marsupial, with adult weight ranging from 300 g up to 1,200 g. It is considered a partially arboreal and aggressive carnivore, preying on a varied diet of small invertebrates and vertebrates, including lizards, birds, snakes, small mammals and frogs (Oakwood 1997).

The Northern Quoll is a short-lived mammal with both sexes maturing at 11 months. Females reproduce only once each year, and all males die shortly after reproducing (Dickman and Braithwaite 1992, Oakwood 2000). The discrete male cohorts that arise within populations make quolls vulnerable to extinction. If no juvenile male quolls survive to adulthood, there will be no males for females to mate with the following year, and the local population will rapidly become extinct (Braithwaite and Griffiths 1994, Oakwood 2000). Therefore, any factor that results in significant increases in mortality rates of female and juvenile quolls could cause local extinction of quoll populations. This species is most abundant near major creek lines and rivers and in open, rocky habitat and is also commonly found in gorges, where breeding is successful (Oakwood 2008).

Likelihood of Occurrence: The Northern Quoll may occur in the rocky gorge located in the nearby Oxbow study area (OXB06E), as suitable habitat is available. However it is unlikely to occur within the Billiard project area due to a lack of suitable habitat.

Potential Impacts: Under the *EPBC Act 1999*, an action requires referral to the Federal Environment Minister if it is deemed likely to have a significant impact on a matter of national environmental significance (eg. a listed threatened species such as the Northern Quoll *Dasyurus hallucatus*). Given the apparently broad distribution of the Northern Quoll in the Pilbara bioregion, the relatively small scale of clearing required for the current proposal, and the lack of suitable habitat for this species in the current study area, it is considered that the action will not result in a significant impact to the Northern Quoll.

***Macrotis lagotis* Bilby**
State: Schedule 1 'Vulnerable'
Federal: Vulnerable

Distribution: The former range of the Bilby included most of the semi-arid areas of mainland Australia, however, it is now confined to *Triodia* hummock grassland and *Acacia* scrub across parts of northern Australia. It has been reintroduced to parts of the south-west of Western Australia (eg. Dryandra Woodlands).

Ecology: The Bilby *Macrotis lagotis* is a medium sized ground mammal, ranging in weight from 1.0 - 2.5 kg. The species is apparently strictly nocturnal and constructs a substantial burrow system, which may be up to 3 m in length (Flannery 1990; Strahan 1995). Similar to the Mulgara, the species has been documented as holding temporary home ranges and showing relatively rapid changes in distribution in response to variation in habitat resources (Johnson 1995).

Likelihood of Occurrence: This species is considered unlikely to occur within the study area due to a lack of suitable habitat. It has never been recorded during any previous surveys in the vicinity of the Yandicoogina operations (see Section 3.2.2).

Potential Impacts: As a Schedule 1 and federally listed species the Bilby is considered fauna in need of special protection. However, the proposed development is not considered likely to have a significant impact upon this species.

***Rhinonicteris aurantius* Pilbara Orange Leaf-nosed Bat**
State: Schedule 1 'Vulnerable'
Federal: Vulnerable

Distribution: The Pilbara Orange Leaf-nosed Bat is a relictual monotypic genus of the family Hipposideridae. It occurs in the Pilbara region of Western Australia, through the Kimberley and across the Top End into north-western Queensland (Churchill 1991).

Ecology: Occurrence of this species is influenced by the availability of suitable roost caves (Churchill 1998). That is, deep caves offering suitable humidity and a stable temperature. In the Pilbara, they are thought to be restricted to caves where at least semi-permanent water is nearby (Dr Kyle Armstrong, Kyoto University Museum, pers. comm. 2005).

Likelihood of Occurrence: The gorge located in the nearby Oxbow study area (OXB06E) may provide foraging opportunities for this species, but does not contain core roosting habitat. The Billiard study area does not contain suitable habitat for this species, and it is considered unlikely to occur.

Potential Impacts: As a Schedule 1 and federally listed species the Pilbara Orange Leaf-nosed Bat is considered fauna in need of special protection. However, the proposed development is not considered likely to have a significant impact upon this species.

***Liasis olivaceus barroni* Pilbara Olive Python**
State: Schedule 1 'Vulnerable'
Federal: Vulnerable

Distribution: Regarded as a Pilbara endemic, this subspecies has a known distribution that coincides roughly with the Pilbara bioregion (Environment Australia 2000).

Ecology: The Pilbara Olive Python occurs in rocky areas within the Pilbara, showing a preference for rocky habitats near water, particularly rock pools.

Likelihood of Occurrence: This species may occur within the study area, as suitable habitat is available along the drainage lines.

Potential Impacts: As a Schedule 1 and federally listed species the Pilbara Olive Python is considered fauna in need of special protection. However, while the proposed development may impact on individuals it is not considered likely to have a significant impact upon this species.

***Falco peregrinus* Peregrine Falcon**
State: Schedule 4

Distribution: The Peregrine Falcon has an almost cosmopolitan distribution, but is absent from most deserts and the Nullarbor Plain (Johnstone and Storr 1998). The only subspecies in Australia, *F. p. macropus*, is widespread throughout Australia and Tasmania (Marchant and Higgins 1993). The Australian population has been estimated at 3,000 to 5,000 pairs (Cade 1982). Whilst its status is difficult to determine in the Pilbara, it is certainly more common than its Priority 4 listed cogener *Falco hypoleucos*.

Ecology: This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country (Pizzey and Knight 1997). The availability of prey is apparently more important than habitat in determining its distribution. Home ranges are probably defended year round and are variable in size, though typically not less than 480 ha (Marchant and Higgins 1993).

This species typically nests on cliffs (81% of nests Australia-wide) but also on stick nests (11%) and in tree hollows (8%). Breeding typically occurs from August to November (Johnstone and Storr 1998). Food is almost exclusively birds such as pigeons, parrots and passerines, which are captured in flight (Johnstone and Storr 1998). Mammals such as possums and rabbits have been recorded as rare prey items (Marchant and Higgins 1993).

Likelihood of Occurrence: This species may occur within the study area, as suitable habitat is available.

Potential Impacts: Loss of potential nesting and foraging habitat. With its cosmopolitan distribution, the conservation status of this species is unlikely to be affected by the proposal. The reason for initially listing this species was a global decline associated with the use of DDT.

6.4.2 Priority Fauna Species

Ramphotyphlops ganei
State: Priority 1

Distribution: This blind snake is poorly collected, being represented by just 15 specimens in the WA Museum collection. This distribution places them across the Pilbara Bioregion from Pannawonica in the west, to Millstream in the north, to Newman in the east.

Ecology: This species is poorly known, but as for most blind snakes, individuals are likely to mostly inhabit the topsoil, termitaria and ant nests. Blind snake diet typically consists of the eggs, larvae and pupae of ants (Storr et al. 2002). A single specimen (R151749) of this species was recorded from a pitfall trap in *Triodia epactia* hummock grassland on a scree slope of the Chichester Range near Redmont Camp (22°01'02"E, 118°58'57"E; Biota database).

Likelihood of Occurrence: There is insufficient data known about the ecology of this species to determine whether it may occur within the habitats available within the study area.

Potential Impacts: Some potential habitat loss and possible direct mortality associated with construction of mines and infrastructure. The conservation status of this species is difficult to ascertain from the small number of known records. However, the records of the species suggest that it does not have a restricted distribution, and therefore its conservation status is unlikely to be affected by the proposal.

***Neochmia ruficauda subclarescens* Star Finch**
State: Priority 4

Distribution: This species is endemic to Australia where it is found from the Pilbara to south-eastern Australia. It remains most common in the tropics. Its population has not been estimated but the species is typically patchy and highly variable in abundance.

Ecology: This species is typically confined to reedbeds and adjacent vegetation communities along permanent waterways in the Pilbara. It is considered to be resident in most of its range but, as with all finches, the species can wander widely. Its ecology in the Pilbara is not well known but it has been observed feeding on the seed of sedges (*Cyperus* spp.) and Buffel Grass (*Cenchrus ciliaris*) (Dr Mike Craig, pers. obs.). In other parts of its range it feeds mainly on seeds, but insects are a common part of the diet during the breeding season. It typically nests in March and April, as seeds are maturing after summer cyclones, and its domed nest is usually built in reeds up to several metres from the ground. The clutch is between three and six and the young usually fledge after about 16 days. In captivity, Star Finches may produce as many as three broods per year.

The main threat to the species is considered to be overgrazing by stock along waterways, which destroys the riparian vegetation on which they depend (Garnett and Crowley 2000).

Likelihood of occurrence: This species was recorded during the Yandicoogina Expansion survey, at the nearby Junction South-West project area (Biota Internal Database). This species is likely to be found throughout the study area where suitable habitat is available.

Potential Impacts: Impacts would include loss of habitat and deaths of individuals, but are unlikely to make an impact on the conservation status of this species.

***Falco hypoleucos* Grey Falcon**
State: Priority 4

Distribution: The Grey Falcon is endemic to Australia, where it is widespread but rare throughout the arid zone. Occurs in the northern half of Western Australia (Johnstone and Storr 1998). The Grey Falcon is a resident or nomadic visitor to inland parts of Australia (Pizzey and Knight 1997), but its movements are poorly understood. Its population has been estimated at 1,000 pairs, with about 5,000 individuals present post-breeding (Marchant and Higgins 1993).

Ecology: This species inhabits a wide range of habitats in the arid zone but appears to be least rare in lightly wooded coastal and riverine plains (Johnstone and Storr 1998). In the Pilbara, the Grey Falcon is mostly recorded from the coastal plain between the de Grey and Ashburton Rivers (Storr 1984). Little is known of the ecology of the species but it appears to feed primarily on birds, with mammals and insects forming variably important parts of the diet depending on season and location (Marchant and Higgins 1993; Johnstone and Storr 1998). It breeds in trees, such as *Eucalyptus* spp., typically in the abandoned nests of crows and butcherbirds (Marchant and Higgins 1993; Johnstone and Storr 1998). Eggs have been recorded in July and August but its breeding season is not certain.

Likelihood of Occurrence: This species may occur within the study area, as suitable habitat is available.

Potential Impacts: Potential impacts are likely to be similar to that of the Peregrine Falcon, such as loss of potential nesting and foraging habitat. The conservation status of this species, if present in the study area, is unlikely to be affected by the proposal.

***Ardeotis australis* Australian Bustard**
State: Priority 4

Distribution: The Australian Bustard occurs over much of Western Australia, with the exception of the more heavily wooded southern portions of the state (Johnstone and Storr 1998). Its wider distribution includes eastern Australia and New Guinea. This species is classified as Near Threatened by Garnett and Crowley (2000).

Ecology: This species prefers open or lightly wooded grassland including Triodia sandplains (Johnstone and Storr 1998) and is considered scarce to common depending on season and habitat. It has an omnivorous diet and occurs in a relatively broad range of habitats, but appears to have some preference for grasshoppers and is often attracted to recently burnt areas (Marchant and Higgins 1993). This species is typically nomadic and has a large home range (Marchant and Higgins 1993). This species breeds from March to September and the eggs are laid on bare, preferably stony, ground (Johnstone and Storr 1998), which makes the eggs and young vulnerable to predation by foxes and cats.

Likelihood of Occurrence: This species has previously been recorded in the vicinity of the study area (Ecologia 1995 and Ecologia 1998a), and is likely to occur periodically within the study area as suitable habitat is available.

Potential Impacts: Impacts would include loss of habitat and deaths of individuals, but are unlikely to make an impact on the conservation status of this species.

***Burhinus grallarius* Bush Stone-curlew**
State: Priority 4

Distribution: This species is widespread in Australia and southern New Guinea. It remains common in tropical Australia, but has declined alarmingly in temperate Australia and has disappeared from many regions (Marchant and Higgins 1993). It is found in the Kimberley and western portion of the remainder of the state west of a line joining Port Hedland, Leonora and Albany.

Populations are apparently secure in the Pilbara (Ron Johnstone, WA Museum, pers. comm. 2003). The Australian population has been estimated at c. 15,000 individuals.

Ecology: The nocturnal Bush Stone-curlews inhabit sparsely grassed, lightly timbered forest or woodland. In southern Australia, they persist most often where there is a well-structured litter layer and fallen timber debris. Individuals have an estimated home range of about 250 ha (Johnson and Baker-Gabb 1993). Foxes are usually considered to be the primary cause for their decline, hence their relative abundance in the tropics, but habitat clearance has also been identified as a threatening process (Garnett and Crowley 2000).

Likelihood of Occurrence: This species may occur within the study area, as suitable habitat is available.

Potential Impacts: Impacts would include loss of habitat and deaths of individuals, but are unlikely to make an impact on the conservation status of this species.

***Pseudomys chapmani* Western Pebble-mound Mouse**
State: Priority 4

Distribution: *Pseudomys chapmani* is confined to the central and eastern Pilbara including Karijini National Park (Menkhorst and Knight 2001). This species is found on stony hillsides with hummock grasslands (Menkhorst and Knight 2001) and is common to very common in suitable habitat within the Hamersley and Chichester subregions of the Pilbara bioregion.

Ecology: The Western Pebble-mound Mouse is well known for its behaviour of constructing extensive mounds of small stones covering areas from 0.5 to 9.0 square meters (Start 2008). This mound formation is most common on spurs and gentle slopes with suitable size class stones.

Likelihood of Occurrence: This species was recorded during the Billiard fauna survey. This species is likely to be found throughout the study area where suitable habitat is available.

Potential Impacts: Impacts would include loss of habitat and deaths of individuals, however given the broad distribution of the Western Pebble-mound Mouse and the habitats occupied by the species in the Pilbara, it is unlikely that the conservation status of this species will be affected by the current proposal.

***Leggadina lakedownensis* Short-tailed Mouse**
State: Priority 4

Distribution: Since 1997, the number of records of this species has increased substantially, such that it has now been recorded from over 20 locations (Armstrong et al. in prep). In Western Australia the distribution includes the Pilbara and Kimberley regions (Menkhorst and Knight 2001). We have recorded this species on cracking clay communities from Cape Preston (60 km west of Dampier) in the west to the northern flanks of the Fortescue Marshes in the east (Halpern Glick Maunsell and Biota 2000).

A recent taxonomic revision of *Leggadina* (Cooper et al. 2003) found that despite morphological variation, *L. lakedownensis* are genetically similar across their range and the variation is insufficient to warrant subspecific status for any regional populations.

Ecology: Regional records suggest that the primary mainland habitat comprises areas of cracking clay and adjacent habitats, although this species has also been recorded from hill tops (Dr Peter Kendrick, DEC Karratha, pers. comm. 2003) and sandy coastal areas near Onslow (Mr Garth Humphreys, Biota, pers. obs.). At Cape Preston this species was recorded from *Acacia xiphophylla* open shrubland over a mosaic of *Triodia wiseana* and *Eragrostis xerophila* mixed hummock and tussock grassland (Halpern Glick Maunsell and Biota 2000). At the Southern Plains study site (near Tom Price), numerous individuals were recorded from *Acacia xiphophylla* shrubland over *Triodia longiceps* and annual grasses (Biota 2002a). Along the proposed Hope Downs rail alignment, this species was recorded from *Astrebla pectinata* tussock grassland (Biota 2002b). During the FMG Stage A rail corridor survey (Biota 2004), this species was recorded from

Astrebla pectinata, *Aristida latifolia* tussock grassland on the self-mulching clays at a similar location in the Chichester Range.

Likelihood of occurrence: Not recorded to date and considered unlikely to occur within the study area due to a lack of suitable habitat.

Potential Impacts: The conservation status of this species is unlikely to be affected by the proposal.

***Macroderma gigas* Ghost Bat**
State: Priority 4

Distribution: Previously distributed across most of inland and northern Australia, but now restricted to the tropical north of the continent (Churchill 1998). Occurs in a broad range of habitats, with their distribution being influenced by the availability of suitable caves and mines for roost sites (Churchill 1998). The distribution of Ghost Bats is fragmented, with each population showing some genetic differentiation (Armstrong and Wilmer 2004; Biota 2004f; and Dr. Kyle Armstrong, pers. comm. 2004). Populations in the Pilbara bioregion appear to be isolated from those in the Kimberley and Northern Territory.

Ecology: Ghost Bats are efficient predators of small birds, mammals and reptiles, and large insects, and they have highly developed echolocation, visual and hearing systems (Churchill 1998). Vocalisations audible to humans are used in their complex social interactions (Churchill 1998). Bats forage over large distances (ranges of ~ 60 ha; Churchill 1998), and the size of their foraging area is probably inversely related to the productivity of their landscape. Bats are known to have overlapping ranges (Churchill 1998).

Scat material from *M. gigas* is quite distinctive and can be used to identify temporary roosts or feeding sites. Fairy Martin (*Hirundo ariel*) nests within culverts provide a roosting substrate for *M. gigas* and culverts may function either as a night or feeding roost or (probably less commonly) as a temporary day roost. This is an example of where man-made habitat has benefited bats (Biota 2002c).

Likelihood of Occurrence: As for the Pilbara Orange Leaf-nosed Bat, the gorge located in the Oxbow study area (OXB06E) may provide foraging opportunities for this species, but does not contain core roosting habitat. This species is unlikely to occur within the Billiard study area as suitable habitat is not available.

Potential Impacts: Possible loss or disturbance of roosting sites and foraging habitat. No effect on the conservation status of the species is expected.

6.4.3 Migratory and Marine Avifauna Species

Avifauna species can be listed as migratory and/or marine species under the *EPBC Act 1999*. Database searches completed for this study indicate the following species listed as Migratory under the act could occur in the study area: Rainbow Bee-eater, Night Parrot, Great Egret and Cattle Egret. The following species listed as Marine could also be present: Fork-tailed Swift, Great Egret, Cattle Egret, Oriental Plover and Rainbow Bee-eater. Of these taxa, only the Rainbow Bee-eater has been confirmed as occurring in the study area.

The proposed Yandicoogina Expansion is unlikely to adversely affect the conservation status of any of these species. Therefore they would not require further specific consideration as part of the assessment process.

6.5 Short-range Endemic (SRE) Fauna

The small number of invertebrate taxa collected during the survey may be considered indicative of the suitability of the available microhabitats for potential SRE taxa. A large proportion of the

study area comprising loamy substrates adjacent to the drainage line exhibited the detrimental effects of cattle.

The lack of ground level vegetation due to grazing or trampling by cows corresponds with low levels of leaf litter, which may otherwise provide habitat for such groups as millipedes (Diplopoda) and some trapdoor spiders (Mygalomorphae). Additionally, the high quantity of disturbance to open ground, and to vegetation by frequent burning, reduce the faunal values of the available habitats for target groups.

6.6 Conclusions

The fauna habitats and assemblages recorded for the Billiard study area during this fauna survey represent a subset of those that might be expected to occur across the Pilbara Bioregion. The fauna habitats in particular are considered to be widespread and common throughout the local area and within the wider region. Additionally, the relatively poor quality of the available habitats due to the presence of cattle and the frequency of fires reduces the value of the habitats for fauna that might typically be adversely affected by the proposed expansion.

On this basis, the expansion of existing operations at Yandicoogina is unlikely to adversely affect the conservation value of the fauna habitats and assemblages in the local area or wider Bioregion. Similarly, the development is not considered likely to detrimentally alter the conservation significance of those fauna species having elevated conservation significance, including Schedule and Priority listed fauna as well as SRE invertebrate fauna.

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Appendix 1

DEC Threatened Fauna Database Search Results

Threatened and Priority Fauna Database Page 1 of 2

22.3436 °S 118.7243 °E / 23.2377 °S 119.7228 °E Yandi area (plus ~50km buffer)

#	Date	Certainty	Seen	Location Name	Method
Schedule 1 - Fauna that is rare or is likely to become extinct					
Dasyurus hallucatus				**Northern Quoll**	*1 records*
This carnivorous marsupial occurs across much of northern Australia with a disjunct population in the Pilbara. Occurs in a wide range of habitats but most suitable habitat appear to be rocky areas.					
	1980	1		NULLAGINE	
Liasis olivaceus barroni				**Pilbara Olive Python**	*1 records*
	2004	1	1	Newman	Caught or trapped
Priority Two: Taxa with few, poorly known populations on conservation lands					
Ctenotus uber johnstonei					*1 records*
This species of skink is associated with small rock outcrops on open sandy and stony plains.					
	2001	1	2	Fortescue Valley	Caught or trapped
Priority Four: Taxa in need of monitoring					
Macroderma gigas				**Ghost Bat**	*2 records*
This species is Australia's only carnivorous bat and has a patchy distribution across northern Australia. It shelters in caves, mine shafts and deep rock fissures and is sensitive to disturbance.					
	1998	1	1	West Angela Hill	Caught or trapped
	2007	1	1	Newman	Caught or trapped
Pseudomys chapmani				**Western Pebble-mound Mouse, Ngadji**	*30 records*
This species is well-known for the characteristic pebble-mounds which it constructs over underground burrow systems. These mounds are most common on spurs and lower slopes of rocky hills.					
	1979	1	2	West Angela Hill	Caught or trapped
	1979	1	2	West Angela Hill	Caught or trapped
	1980	1	1	Marillana	Caught or trapped
	1992	1	1	Packsaddle Hill	Caught or trapped
	1993	1	1	The Governor	Caught or trapped
	1994	1	0	Rhodes Ridge	Definite signs
	1994	1	0	The Governor	Definite signs
	1994	1	0	Weeli Wolli Creek	Definite signs
	2001	1	1	Hamersley Range	Caught or trapped
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs
	2006	1	0	Marillana	Definite signs

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Threatened and Priority Fauna Database

22.3436 °S 118.7243 °E / 23.2377 °S 119.7228 °E Yandi area (plus ~50km buffer)

*	Date	Certainty	Seen	Location Name	Method
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs
	2008	1	0	Newman	Definite signs

Ardeotis australis **Australian Bustard** *3 records*

This species is uncommon and may occur in open or lightly wooded grasslands.

	2007	1	1	Newman	Day sighting
	2007	0	1	Newman	Day sighting
	2008	1	1	Newman	Day sighting

Burhinus grallarius **Bush Stonecurlew** *1 records*

A well camouflaged, ground nesting bird which prefers to 'freeze' rather than fly when disturbed. It inhabits lightly timbered open woodlands.

	2007	1	2	Newman	Day sighting

Neochima ruficauda subclarescens **Star Finch (western)** *1 records*

A nomadic species inhabiting grasslands and eucalypt woodlands near water.

	2008	1	1	Newman	Day sighting

Leiopotherapon aheneus **Fortescue Grunter** *1 records*

A species of freshwater fish restricted to the Prince Regent and Roe River systems of the Kimberley region of Western Australia. Inhabits open rocky pools with minimal aquatic vegetation.

		1		Karijini NP	

* Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

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Appendix 2

WA Museum FaunaBase Search Results

Amphibia collected between -22.5018, 118.8420 and -23.0666, 119.5959

Hylidae
Cyclorana maini
Litoria rubella

Myobatrachidae
Uperoleia russelli

Birds collected between -22.5018, 118.8420 and -23.0666, 119.5959

Acanthizidae
Gerygone fusca mungi

Caprimulgidae
Eurostopodus argus

Columbidae
Geopelia striata placida
Phaps chalcoptera

Pachycephalidae
Pachycephala rufiventris rufiventris

Ptilonorhynchidae
Ptilonorhynchus maculatus guttatus

Strigidae
Ninox connivens connivens
Ninox novaeseelandiae boobook

Turnicidae
Turnix velox

Mammals collected between -22.5018, 118.8420 and -23.0666, 119.5959

Dasyuridae
Dasykaluta rosamondae
Ningaui ridei
Ningaui timealeyi
Planigale sp
Pseudantechinus woolleyae
Sminthopsis macroura
Sminthopsis ooldea
Sminthopsis youngsoni

Emballonuridae
Saccolaimus flaviventris
Taphozous hilli

Macropodidae
Macropus robustus erubescens

Molossidae
Chaerephon jobensis
Mormopterus beccarii
Tadarida australis

Muridae
Mus musculus
Notomys alexis
Pseudomys chapmani
Pseudomys desertor
Pseudomys hermannsburgensis
Zyzomys argurus

Vespertilionidae
Chalinolobus gouldii
Chalinolobus morio
Nyctophilus bifax daedalus
Nyctophilus geoffroyi
Scotorepens greyii
Vespadelus finlaysoni

Reptiles collected between -22.5018, 118.8420 and -23.0666, 119.5959

Agamidae
Caimanops amphiboluroides
Ctenophorus caudicinctus caudicinctus
Ctenophorus isolepis
Ctenophorus isolepis gularis
Ctenophorus isolepis isolepis
Ctenophorus nuchalis
Ctenophorus reticulatus
Diporiphora valens
Lophognathus longirostris
Pogona minor
Pogona minor minor

Boidae
Antaresia perthensis
Liasis olivaceus barroni

Elapidae
Acanthophis wellsi
Brachyurophis approximans
Demansia psammophis cupreiceps
Parasuta monachus
Pseudechis australis
Pseudonaja modesta
Pseudonaja nuchalis
Suta fasciata

Gekkonidae
Diplodactylus conspicillatus
Diplodactylus pulcher
Diplodactylus savagei
Diplodactylus stenodactylus
Diplodactylus wombeyi
Gehyra pilbara
Gehyra punctata
Gehyra purpurascens

Gehyra variegata
Heteronotia binoei
Heteronotia spelea
Nephrurus wheeleri cinctus
Oedura marmorata
Rhynchoedura ornata
Strophurus elderi
Strophurus jeanae

Pygopodidae
Delma haroldi
Delma nasuta
Delma pax
Delma tincta
Lialis burtonis

Scincidae
Carlia munda
Cryptoblepharus carnabyi
Cryptoblepharus plagiocephalus
Ctenotus ariadnae
Ctenotus duricola
Ctenotus grandis titan
Ctenotus hanloni
Ctenotus helenae
Ctenotus pantherinus ocellifer
Ctenotus rubicundus
Ctenotus rutilans
Ctenotus saxatilis
Ctenotus schomburgkii
Ctenotus serventyi
Cyclodomorphus melanops melanops
Egernia depressa
Egernia formosa
Lerista bipes
Lerista labialis
Lerista muelleri
Lerista neander
Lerista zietzi
Menetia greyii
Menetia surda surda
Morethia ruficauda exquisita
Proablepharus reginae
Tiliqua multifasciata

Typhlopidae
Ramphotyphlops ammodytes
Ramphotyphlops ganei
Ramphotyphlops grypus
Ramphotyphlops waitii

Varanidae
Varanus acanthurus
Varanus brevicauda
Varanus caudolineatus
Varanus giganteus
Varanus gouldii
Varanus panoptes rubidus
Varanus pilbarensis
Varanus tristis tristis

Appendix 3

EPBC Act 1999 Protected Matters Report

Matters of National Environmental Significance		
Threatened Species	**Status**	**Type of Presence**
Birds		
Pezoporus occidentalis Night Parrot	Endangered	Species or species habitat likely to occur within area
Mammals		
Dasyurus hallucatus Northern Quoll	Endangered	Species or species habitat may occur within area
Macrotis lagotis Greater Bilby	Vulnerable	Species or species habitat may occur within area
Rhinonicteris aurantius (Pilbara form) Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area
Migratory Species	**Status**	**Type of Presence**
Migratory Terrestrial Species		
Birds		
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act		
Listed Marine Species	**Status**	**Type of Presence**
Birds		
Apus pacificus Fork-tailed Swift	Listed – overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret	Listed – overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed – overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover	Listed – overfly marine area	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Listed – overfly marine area	Species or species habitat may occur within area

Appendix 4

DEC Regulation 17 "Licence to take fauna for scientific purposes" SF006426

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA
Telephone: 08 9334 0333
Facsimile: 08 9334 0242

Correspondence: **Locked Bag 30**
Bentley Delivery Centre WA 6983

PAGE 1
NO. SF006426

RECEIPT NO. **AMOUNT**
$0.00

WILDLIFE CONSERVATION ACT 1950
REGULATION 17

LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES

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

DIRECTOR GENERAL

CONDITIONS

1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.

2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.

3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.

4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.

5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTORGENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.

6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.

7 **********ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE COMMONWEALTH DEPT OF THE ENVIRONMENT AND WATER RESOURCES, PHONE 02 6274 1900. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.**********

8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.

9 FURTHER CONDITIONS (NUMBERED TO) ARE ATTACHED.

PURPOSE BASELINE FAUNA INVENTORY SURVEY OF YANDI JUNCTION SW AND BILLIARDS FOR IMPACT ASSESSMENT.

AUTHORISED PERSONS
ROY TEALE
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ZOE HAMILTON
MICHAEL GREENHAM
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DAN KAMIEN
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WILDLIFE CONSERVATION ACT 1950
WILDLIFE CONSERVATION REGULATIONS

DATE OF ISSUE 30/06/2008
VALID FROM 01/07/2008
DATE OF EXPIRY 30/06/2009

LICENSING OFFICER

(PHILIP BERNARD)

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ADDRESS BIOTA ENVIRONMENTAL SCIENCES
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W.A. 6903

Appendix 5

Bat Call Identifications

Specialised Zoological

Bat call identification

from Yandi, WA

Type:	Bat Call Analysis
Prepared for:	Biota Environmental Sciences
Date:	10 April 2009
Job No.:	SZ098
Prepared by:	Specialised Zoological Kyle Armstrong and Yuki Konishi ABN 92 265 437 422 0404 423 264 kyle.armstrong@graduate.uwa.edu.au kyle.n.armstrong@gmail.com

SUMMARY

Bat identifications from Anabat echolocation call recordings are provided from Yandi, Western Australia. Six species were identified as being present (Table 1).

The calls of the yellow-bellied sheath-tailed bat *Saccolaimus flaviventris* can sometimes be confused with those of the northern free-tailed bat *Chaerephon jobensis*. In all cases the calls appeared to be from *S. flaviventris*.

Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). A summary of pulse parameters is provided in Table 2, and representative call sequences are illustrated in Figure 1. Further data is available should verification be required.

METHODS

Signals as recorded with Anabat SD1 and Anabat II – CF-ZCAIM units were supplied as downloaded sequences, which were examined in AnalookW 3.7a software. Three call variables were measured on good quality search phase pulses in representative call sequences: pulse duration (milliseconds), maximum frequency (kHz) and characteristic frequency (equivalent to minimum frequency; kHz). Species were identified based on information in McKenzie and Muir (2000). Nomenclature follows Armstrong and Reardon (2006).

REFERENCES

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

Armstrong, K. and Reardon, T. (2006). Standardising common names of bats in Australia. *The Australasian Bat Society Newsletter* 26: 37–42.

McKenzie, N.L. and Muir, W.P. (2000). Bats of the southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum* Supplement 61: 465–477.

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

Date	Site	*C. gouldii*	*S. flaviventris*	*S. greyii*	*T. australis*	*T. georgianus*	*V. finlaysoni*
Serial 683							
8/07/2008	BILANA01	H	H	—	—	—	H
Serial 3709							
8/07/2008	YANBAT01	H	H	—	—	—	H
9/07/2008	YANBAT01	H	H	—	H	—	H
10/07/2008	YANBAT01	H	H	—	H	H	H
11/07/2008	YANBAT01	H	—	—	—	H	H
Serial 3726							
8/07/2008	OXBANA01	—	—	—	—	H	H
9/07/2008	OXBANA01	—	—	—	—	H	H
10/07/2008	OXBANA01	H	—	H	—	H	H

Definition of confidence level codes:

H High. Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or submission of a specimen/tissue to a museum.

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

TABLE 2. Summary of variables from representative call sequences.

Species	s,p[1]	Duration (msec)[2]	Max Frequency (kHz)[2]	Char frequency (kHz)[2]
Gould's wattled bat *Chalinolobus gouldii*	1,8	6.5 ± 2.3 3.2 – 10.3	35.8 ± 0.7 34.8 – 37.0	31.8 ± 1.5 30.3 – 34.6
Yellow-bellied sheath-tailed bat *Saccolaimus flaviventris*	2,18	9.1 ± 2.6 2.3 – 12.5	20.1 ± 2.4 16.2 – 23.3	17.9 ± 1.3 15.6 – 20.8
Little broad-nosed bat *Scotorepens greyii*	2,25	3.5 ± 0.8 1.6 – 4.8	59.0 ± 5.1 47.3 – 66.7	36.5 ± 1.1 34.9 – 38.7
White-striped free-tailed bat *Tadarida australis*	1,10	8.1 ± 1.5 5.9 – 9.9	19.0 ± 1.7 16.5 – 21.2	13.7 ± 1.0 11.9 – 15.2
Common sheath-tailed bat *Taphozous georgianus*	3,22	9.0 ± 2.1 5.7 – 13.5	25.9 ± 1.0 24.5 – 28.1	23.8 ± 0.3 23.3 – 24.4
Finlayson's cave bat *Vespadelus finlaysoni*	4,100	4.8 ± 0.8 0.4 – 7.6	65.1 ± 5.0 54.8 – 83.3	54.3 ± 0.7 52.6 – 55.9

[1] s,p: number of sequences measured, combined total number of pulses measured;

[2] Mean ± SD; range.

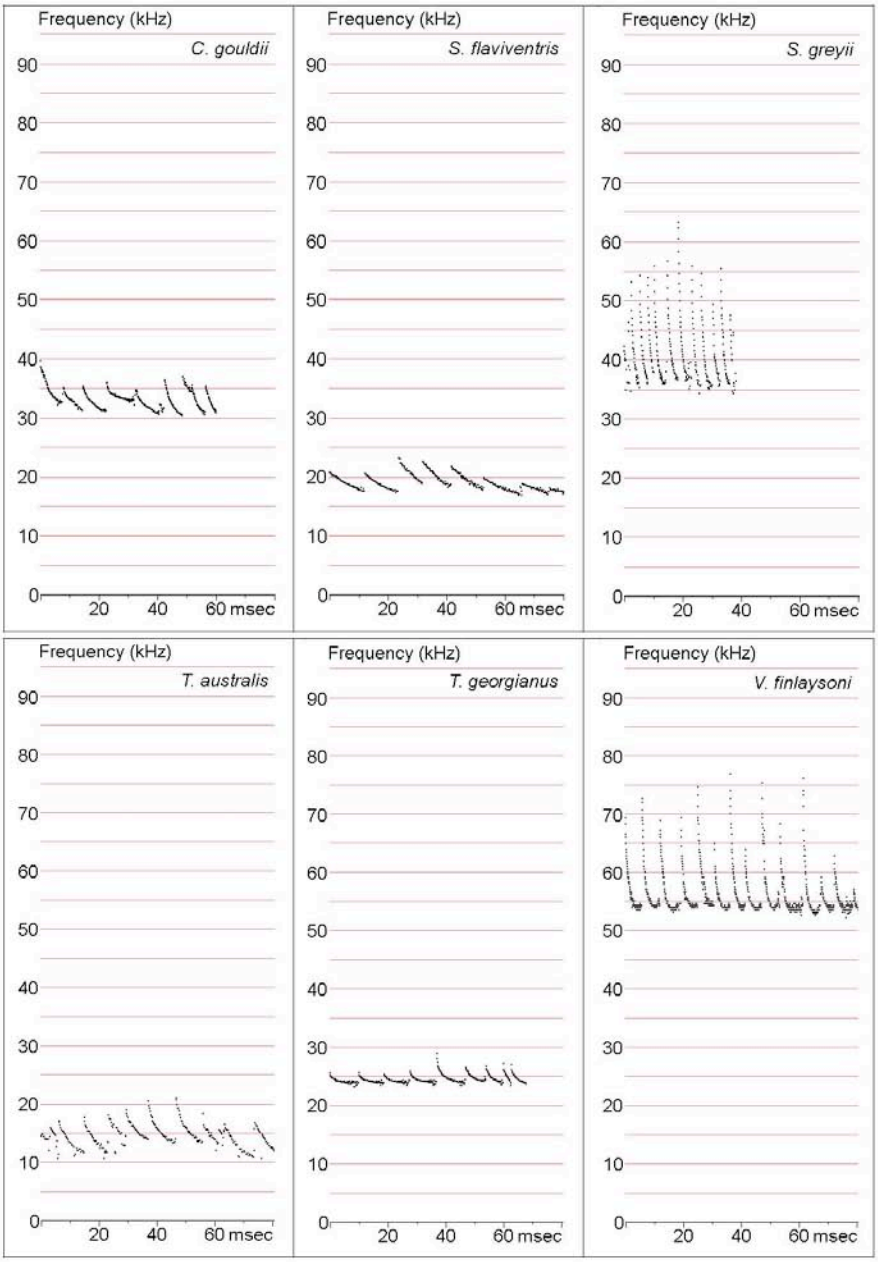

FIGURE 1. Representative call sequences of the six species identified (time is compressed between pulses).