Biota Environmental Sciences

Rio Tinto Rail Duplication Fauna Survey Cape Lambert to Emu Siding

Prepared for Rio Tinto Iron Ore

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Biota Environmental Sciences

ABN 49 092 687 119
Level 1, 228 Carr Place
Leederville Western Australia 6007
Ph: (08) 9328 1900 Fax: (08) 9328 6138

Project No.: 470

Prepared by: D. Kamien, E. Harris, P. Runham

Checked by: G. Humphreys

Approved for Issue: G. Humphreys

Rio Tinto Iron Ore Rail Duplication Fauna Survey: Cape Lambert-Emu Siding

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1.0 Summary

1.1 Background

Rio Tinto seeks to duplicate its existing rail network from Cape Lambert Port to Juna Downs to accommodate additional iron ore output from the expansion of existing mines and the development of new operations. The planned rail duplication complements Rio Tinto's proposal to expand port facilities as part of its Cape Lambert Port B Development (Biota 2008a and b).

Biota Environmental Sciences (Biota) was commissioned to complete a fauna survey along approximately 80 km of planned Rail Duplication from Cape Lambert to Emu Siding (hereafter the RDCLE study area).

The scope of the study was to:

- document the vertebrate and short range endemic (SRE) invertebrate fauna assemblage within the defined study area using established sampling techniques;
- identify and assess the local and regional conservation significance of the fauna habitats and assemblage present in the project area; and
- identify fauna (particularly Schedule and Priority listed fauna as well as potential SRE taxa) of particular conservation significance.

1.2 Methods

The survey took place over a single phase conducted in early April 2008. Systematic censusing of terrestrial fauna assemblages, including avifauna, mammals and herpetofauna, was carried out at twenty sites, each located within defined habitats. Seven primary habitat types were identified from the study corridor, comprising:

- Native tussock grasslands on cracking clays;
- Scattered to open *Acacia* sp. shrublands over *Triodia* sp. on clayey loam;
- Samphires on heavy clay;
- Rocky hill slopes with *Triodia* sp., sometimes with scattered *Acacia* sp.;
- Small drainage line with *Acacia* sp. over *Triodia* sp.;
- Boulder piles with *Triodia* sp.; and
- Major drainage line with *Eucalyptus* sp. over Buffel grass.

The central component of the censusing consisted of trapping grids at sixteen sites; comprising ten pit-fall traps (alternating 20 litre buckets and 20 cm diameter PVC tubes) spaced at 10 m intervals and connected by a single length (100 m) of 30 cm high flywire fence. A further two sampling sites exclusively comprised 45 and 25 Elliott traps each, and two more sites comprised 16 Funnel traps each.

Thirty-six avifauna censuses were conducted during the surveys at each site. Censuses were conducted between approximately 6:30 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:

- Mygalomorphae (Trapdoor Spiders);
- Diplopoda (Millipedes);
- Pulmonata (Land Snails); and

- Pseudoscorpionida (Pseudoscorpions).

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 Results

1.3.1 Vertebrates

The survey of the RDCLE project area yielded a combined total of 118 vertebrate species, comprising 53 avifauna species, 19 mammals and 46 herpetofauna species: three frogs and 43 reptiles (Table 1.1; Section 4.0).

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

Fauna group	Total
Avifauna	53
Native non-volant mammals	9
Bats	7
Introduced mammals	3
Amphibians	3
Reptiles	43
Total	**118**

The fifty-three bird species recorded during the recent survey, included 26 non-passerine species and 27 passerine species, representing 29 families. The most abundant family recorded was the Psittacidae with 321 records representing 30.1% of the total avifauna records. The most speciose family of birds was the Meliphagidae (Honeyeaters), with five species of Honeyeater recorded at most of the census sites. Sites adjacent to drainage lines (i.e. PIR05, PIR09 and PIR17) exhibited the highest avifauna diversity within the study area. Twenty-four species were recorded at site PIR09 (on the Harding River), representing 45.3% of the total recorded species in the study area.

A total of 12 species of non-volant mammals were recorded during the survey, representing six families. This total included nine native species and three introduced. The most commonly recorded native species was the Stripe-faced Dunnart *Sminthopsis macroura* with a total of 15 records, representing 23.8% of all non-volant mammal records. No bats were captured during the survey, but analysis of recorded call sequences identified seven species from the study area. These include four evening bats (Vespertilionidae), one free-tail bat (Molossidae), and two sheath-tail bats (Emballonuridae),

A total of 46 herpetofauna species was recorded from the study area. This comprised two tree frogs (Hylidae), one ground frog (Myobatrachidae), six geckos (Gekkonidae), three legless lizards (Pygopodidae), 21 skinks (Scincidae), seven dragons (Agamidae), three monitors (Varanidae), two blind snakes (Typhlopidae) and one front-fanged snake (Elapidae). Main's frog *Cyclorana maini* was particularly abundant, with 296 individuals representing 47.3% of all herpetofauna recorded during the survey. This species was recorded from all habitat types sampled, with the exception of the dolerite boulder piles. Amongst the remaining herpetofauna, the gecko *Diplodactylus conspicillatus* and the skink *Ctenotus saxatilis* were relatively common, representing 7.0% and 6.8% of the herpetofauna recorded respectively. In general, *Acacia* sp. over *Triodia* hummock grassland habitat exhibited high herpetofauna diversity, as did buffel grass habitat.

1.3.2 Invertebrates

Mygalomorph spiders, pseudoscorpions and pulmonate snails that may include potential SRE taxa were recorded within the Rail Duplication study area. While the conservation significance of these species is not currently known, the specimens have been lodged with the Western Australian Museum with the Mygalomorph spiders and snails being currently the subject of a long-term phylogeographic study examining the broader distribution of putative taxa.

Ideally, we would directly determine the broader distribution of these potential SRE taxa recorded within and outside the RDCLE study area. That is, to determine if the species recorded within the RDCLE study area also occur further afield. However, the lack of taxonomic framework and suitable regional distribution datasets means this is not currently possible. In regards to the potential SRE invertebrates recorded during the survey, a risk-based assessment was adopted here using defined habitat units as a surrogate for inferring distributional boundaries. Based on the broad distribution of habitat types and vegetation units from which the potential SREs were recorded in the study area, the wider occurrence of the Land Systems to which these belong, and that several taxa have demonstrated wider distributions, it was concluded that the taxa are likely to be more widely distributed beyond the confines of the study corridor.

1.4 Conservation Significance

Two Priority 4 listed species were recorded from the study area (Table 1.2). No Schedule listed species were recorded during the survey. A further five Schedule and 16 Priority listed species / subspecies have either 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).

Table 1.2: Fauna of conservation significance occurring or potentially occurring within the RDCLE study area.

Species Name	Common Name	Status	
		State	Federal
Dasycercus blythi	Brush-tailed Mulgara	Schedule 1	Vulnerable
Dasyurus hallucatus ©	Northern Quoll	Schedule 1	Endangered
Rhinonicteris aurantius ©	Orange Leaf-nosed Bat	Schedule 1	Vulnerable
Liasis olivaceus barroni ©	Pilbara Olive Python	Schedule 1	Vulnerable
Falco peregrinus ©	Peregrine Falcon	Schedule 4	
Lerista quadrivincula ©		Priority 1	
Ramphotyphlops ganei ©		Priority 1	
Mormopterus loriae cobourgiana ^©	Little Northern Freetail Bat	Priority 1	
Antipodogomphus hodgkini ©	Pilbara Dragonfly	Priority 2	
Nososticta pilbara ©	Pilbara Damselfly	Priority 2	
Lagorchestes conspicillatus leichardti	Spectacled Hare Wallaby	Priority 3	
Sminthopsis longicaudata	Long-tailed Dunnart	Priority 3	
Neochmia ruficauda subclarescens *^©	Star Finch	Priority 4	
Falco hypoleucos	Grey Falcon	Priority 4	
Macroderma gigas ©	Ghost Bat	Priority 4	
Pseudomys chapmani ©	Western Pebble-mound Mouse	Priority 4	
Leggadina lakedownensis *©	Short-tailed Mouse	Priority 4	
Ardeotis australis ©	Australian Bustard	Priority 4	
Burhinus grallarius ©	Bush Stone-curlew	Priority 4	
Phaps histrionica ©	Flock Bronzewing	Priority 4	
Notoscincus butleri ©		Priority 4	
Leiopotherapon aheneus ©	Fortescue Grunter	Priority 4	
Numenius madagascariensis ^©	Eastern Curlew	Priority 4	Migratory
Hirundo rustica ©	Barn Swallow		Migratory
Merops ornatus ©	Rainbow Bee-eater		Migratory
Apus pacificus	Fork-tailed swift		Migratory
Charadrius veredus ©	Oriental Plover		Migratory

* denotes species recorded in the recent Rail Duplication Cape Lambert to Emu survey.
^ denotes species recorded during the Cape Lambert Port Expansion Survey (Biota 2008b).
© denotes species listed in either the DEC Threatened Fauna Database, WAM FaunaBase, or EPBC Protected Matters Report.

The survey of the RDCLE project area yielded a combined total of 118 vertebrate species (53 avifauna species, 19 mammals and 46 herpetofauna species). This tally appears in keeping with

other similar surveys completed in the region and does not appear to indicate a particularly diverse assemblage. The species recorded were also representative of the taxa commonly recorded in this part of the bioregion. This is consistent with the available habitat data, which indicates that no restricted or uncommon geological units or land systems occur in the study corridor (see Table 2.1 and Table 2.2).

No Schedule listed fauna, or fauna species listed under the *EPBC Act 1999*, were recorded during the survey. Reviews of habitats present and known distributions suggested that four Schedule fauna species may occur in the corridor. The relatively linear nature of the development, which is also consolidated with an existing disturbance corridor, indicates a low risk of significant impact to these Schedule species in the event that they do occur. Two Priority fauna species, the Western Star Finch and the Short-tailed Mouse, were recorded during the survey. In both cases, only a relatively small proportion of local habitat suitable for these taxa would be cleared for the rail duplication, in addition to their wider distribution in the region.

2.0 Introduction

2.1 Project Background

Rio Tinto seeks to duplicate its existing rail network from Cape Lambert Port to Juna Downs to accommodate additional iron ore output from the expansion of existing mines and the development of new operations. The planned rail duplication complements Rio Tinto's proposal to expand port facilities as part of its Cape Lambert Port B Development (Biota 2008a and b).

A proposed provisional layout of the rail section from Cape Lambert to Emu Siding is shown in Figure 2.1.

2.2 Study Objectives and Scope

Biota Environmental Sciences (Biota) was commissioned to complete a fauna survey along approximately 80 km of planned Rail Duplication from Cape Lambert to Emu Siding.

The survey was planned and implemented in accordance with Environmental Protection Authority (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 2003).

The scope of the study was to:

- document the vertebrate and short-range endemic (SRE) invertebrate fauna assemblage within the defined study area using established sampling techniques;
- identify and assess the local and regional conservation significance of the fauna habitats and assemblage present in the project area; and
- identify fauna (particularly Schedule and Priority listed fauna as well as potential SRE taxa) of particular conservation significance.

2.3 Purpose of Report

This report describes the methodology employed for the fauna survey of the RDCLE study area. It documents the results of the survey and assesses the fauna habitats and assemblages on a local and regional scale by discussing the data in the context of previous surveys in the vicinity and published data. Its intended use is as a supporting document for the statutory environmental assessment of the project. Both the survey and report are subject to specific limitations that are discussed in detail in Section 3.6.

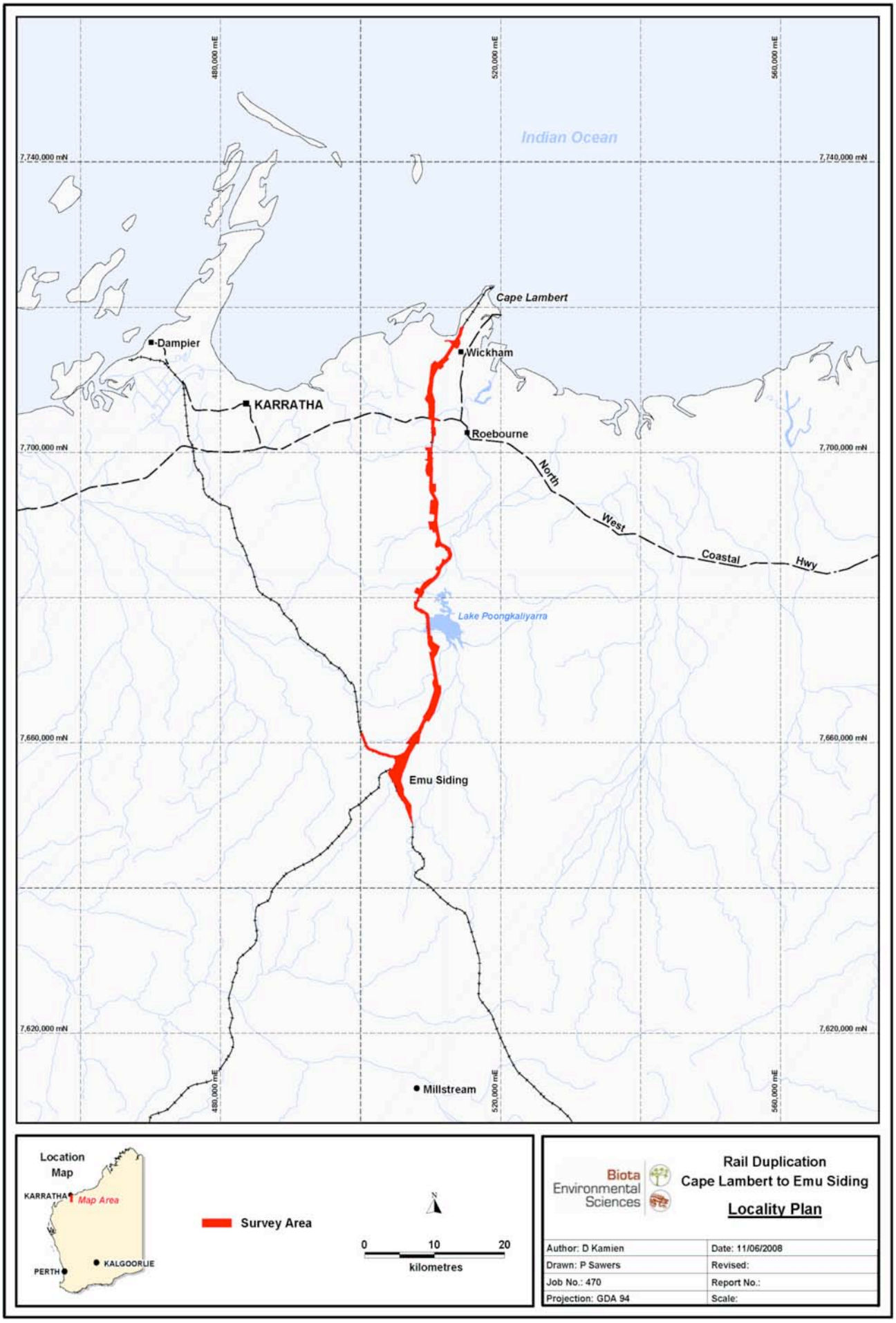

Figure 2.1: Location of the RDCLE study area.

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2.4 Geological and Physiographic Context of the Study Area

2.4.1 Geology

The RDCLE study area comprised 29 major geological types (Table 2.1; Figure 2.2 and Figure 2.3):

Table 2.1: Geological types occurring within the RDCLE study area.

Code	Geological Description
AUb	Bradley Basalt; pillow basalt, massive basalt, dolerite sills, and minor units of felsic tuff and chert; metamorphosed.
AFr	Mount Roe Basalt - massive, vesicular, and glomeroporphyritic basalt.
AUw	Woodbrook Formation - rhyolite tuff and agglomerate; minor basalt and rare thin banded iron-formation; metamorphosed.
Qc	Colluvium - sand, silt, and gravel in outwash fans; scree and talus; proximal mass-wasting deposits.
AFh	Hardey Formation - sandstone, conglomerate, siltstone, shale, and mafic to felsic tuff; includes Lyre Creek Member.
Ao	Gabbro and dolerite; metamorphosed.
AFdc	Cooya Pooya Dolerite - fine- to medium-grained dolerite; includes ultramafic layers.
ARw	Ruth Well Formation - metabasalt and serpentinized peridotite, and thin chert units.
Qwb	Sand, silt, and clay in distal outwash fans, with gilgai surface in areas of expansive clay.
ARnx	Brecciated chert and silicified mafic rock.
Qab	Alluvial sand, silt, and clay in floodplains, with gilgai surface in areas of expansive clay.
ARru	Serpentinized peridotite; locally peridotitic komatiite with olivine spinifex texture; metamorphosed.
AGl	Metamorphosed leucogranite; biotite (-tourmaline)-bearing; nonfoliated.
Czrf	Residual ferricrete; includes ferruginous duricrust and pisolitic ironstone; dissected by present-day drainage.
Qao	Alluvial sand, silt, and clay on floodplains.
Qw	Low-gradient sheetwash deposits - silt, sand, and pebbles on distal outwash fans; no defined drainage.
Amm	Mylonite and mylonitic gneiss; chiefly in Sholl Shear Zone.
AaAo	Gabbro, leucogabbro, and minor anorthosite.
AaAu	Serpentinized peridotite and dunite; local metapyroxenite.
AgH	Metamorphosed granitoids ranging from monzogranite to tonalite; weakly foliated to banded and gneissic.
Arr	Regal Formation - pillowed and massive basalt, with a basal unit of peridotitic komatiite; minor chert; metamorphosed.
Qhms	Coastal sand in beach deposits and dunes; chiefly marine sand reworked by wind, but includes some reworked alluvium near deltas; shelly sand contains *Anadara granosa*.
Qs	Eolian sand - red-yellow, wind-blown sand; local ridges.
Qaa	Alluvial sand and gravel in rivers and creeks; clay, silt, and sand in channels on floodplains.
Czc	Colluvium - dissected consolidated clay, silt, and sand, and gravel deposits; derived from adjacent rock outcrop.
AFhy	Lyre Creek Member - felsic agglomerate and felsic pyroclastic rocks.
AFhj	Coolajacka Member - fine-grained ultramafic lava; abundant quartz xenocrysts.
AFhst	Medium- to coarse-grained, poorly sorted sandstone and minor well-laminated siltstone.
Qws	Sand in distal outwash fans; no defined drainage.

2.4.2 Major Physiographic Units

The Pilbara Bioregion occurs within the Fortescue Botanical District, within the Eremaean Botanical province of Beard (1975). The four major physiographic units identified within the Fortescue District are:

- Abydos Plain - extending from Cape Preston east to Pardoo Creek, and south to the Chichester Range; including alluvial plains, low stony hills and granite outcrops; comprising largely granitic soils, with alluvial sands on the coastal portion;
- Chichester Plateau - a plateau of mainly basalts, with included siltstone, mudstone, shale, dolomite and jaspilite; forming a watershed between numerous rivers flowing north through the Abydos Plain to the coast, and the Fortescue drainage on the southern side of the range;
- Fortescue Valley - occupying a trough between the Chichester and Hamersley Plateaux; the eastern portion drains into the Fortescue Marshes; and
- Hamersley Plateau - rounded hills and ranges, mainly of jaspilite and dolomite with some shale, siltstone and volcanics.

The RDCLE study area traverses both the Abydos Plain and Chichester Plateau physiographic units.

2.4.3 Land Systems

Land System (Rangelands) mapping covering the study area has been prepared by Agriculture Western Australia (van Vreeswyk *et al*. 2004). These represent broad units that each consist of a series of "land units" that occur on characteristic physiographic types within the Land System. 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 (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 (Environment Australia 2000) in ArcView 3.2.]. The nine Land Systems mapped by the Department of Agriculture (van Vreeswyk et al. 2004) for the region including the RDCLE study area are shown in Figure 2.4 and Figure 2.5. Table 2.2 provides a summary of the extent of each of these land systems within the survey area and the proportion this represents of their extent in the region..

Table 2.2: Land systems (rangelands) within the proposed RDCLE study area and their wider representation in the Chichester and Roebourne subregions (source: van Vreeswyk et al. 2004).

Land System	Description	Subregion	Extent within subregion (ha)	Extent within survey area (ha)	% of total within subregion
Boolgeeda (RGEBGD)	Stony plains adjacent to hills.	Chichester	167,663	871.07	0.52
Calcrete (RGECAL)	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.	Chichester	47,936	135.51	0.28
Capricorn (RGECPN)	Rugged sandstone hills and ridges; hard spinifex or stony short grass forb pasture in fair to good condition; no erosion.	Chichester	482,692	463.27	0.1
Horseflat (RGEHOF)	Gilgaied clay plains supporting tussock grasslands and minor grassy snakewood shrublands.	Chichester	27,140	587.96	2.17
		Roebourne	125,456	118.18	0.15
Pyramid (RGEPYR)	Stony gilgai plains supporting hard spinifex grasslands and minor tussock grasslands.	Chichester	20,750	243.76	1.17
River (RGERIV)	Active flood plains and major rivers supporting grassy eucalypt woodlands	Chichester	258,779	466.49	0.18
		Roebourne	107,322	72.15	0.07
Rocklea (RGEROC)	Basalt hills.	Chichester	2,125,314	1,338.25	0.06
Ruth (RGERUT)	Hills and ridges of volcanic and other rocks supporting hard spinifex (and occasionally soft spinifex) grasslands.	Chichester	137,109	126.24	0.91
		Roebourne	11,940	8.26	0.07
Uaroo (RGEUAR)	Broad sandy plains supporting shrubby hard and soft spinifex grasslands.	Chichester	488,753	125.14	0.03

2.5 Biological Context of the Study Area

2.5.1 IBRA Bioregions

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions (May and McKenzie 2002). The Rail Duplication Cape Lambert to Emu Siding study area lies within the Pilbara bioregion, which is divided into four subregions: Roebourne Plains, Chichester, Fortescue Plains and Hamersley. These subregions are largely equivalent to the physiographic regions of Beard (1975), although the coastal portion of Beard's Abydos Plain unit comprises the Roebourne Plains subregion, while the inland portion is included under the Chichester subregion.
With increasing survey work, it is becoming apparent that the Pilbara Bioregion is one of the centres of biodiversity in the State. This appears to be related to the diversity of geological, altitudinal and climatic elements in the region, as well as a function of its location. The Pilbara is located in a transitional zone between the floras of the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions, and contains elements of all of these floras (see for example van Leeuwen and Bromilow (2002) for a detailed discussion of the significance of the Hamersley Range). The Pilbara is similarly an area of transition for fauna. In recognition of this high species diversity and the high levels of endemism in the region, the Pilbara has been nominated as one of 15 national biodiversity "hotspots" by the Minister for the Environment and Heritage (go to http://www.environment.gov.au/biodiversity/hotspots/national-hotspots.html#14).

The RDCLE study area comprises 5479 ha located within the PIL1 (Chichester) biological subregion within the Pilbara bioregion (Kendrick and McKenzie 2001). The PIL1 subregion is 9,044,560 ha in size and is described as:

> "The Chichester subregion (PIL 1) comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is Semi-desert-tropical and receives 300mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock)".

It should be noted that a small section of the RDCLE study area (268.6 ha) also passes through the western boundary of the PIL4 (Roebourne) subregion (Kendrick and Stanley 2001). The PIL4 subregion is 2,008,983 ha in size and is described as:

> "Quaternary alluvial and older colluvial coastal and sub- coastal plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera*. Uplands are dominated by *Triodia* hummock grasslands. Ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamersleyana* woodlands. Samphire, Sporobolus and mangal occur on marine alluvial flats and river deltas. Resistant linear ranges of basalts occur across the coastal plains, with minor exposures of granite. Islands are either Quaternary sand accumulations, or composed of basalt or limestone, or combinations of any of these three. Climate is arid (semi-desert) tropical with highly variable rainfall, falling mainly in summer. Cyclonic activity is significant, with several systems affecting the coast and hinterland annually".

2.5.2 Previous Fauna Surveys

A number of biological surveys have previously been conducted in the general vicinity of the current RDCLE fauna survey. The following surveys have been considered, along with database searches, during compilation of this report:

- Biota Environmental Sciences (2008b). Cape Lambert Ore Stockpile and Port Expansion Seasonal Fauna Survey. Unpublished Report for Rio Tinto Pty. Ltd.

- Biota Environmental Sciences (2007b). Cape Lambert – targeted SRE Fauna Survey. Unpublished report prepared for Cape Lambert Iron Ore Limited September 2007.
- Biota Environmental Sciences (2004). Sherlock Bay Nickel Fauna Survey. Unpublished Report for Sherlock Bay Nickel Corporation. Ltd.
- Department of Environment and Conservation – Pilbara Biological Survey (2003-2006).
- Ecologia Environmental Consultants (1998). West Angelas Iron Ore Project: Environmental Review and Management Programme. Unpublished Report for Robe River Mining Co. Pty. Ltd.

2.5.3 Conservation Reserves in the Locality

The Millstream-Chichester National Park (1,997 km^2) is the only conservation reserve in the immediate locality of the survey area. It is located at 21.27°S, 117.11°N, and the existing rail passes through the National Park (see Figure 2.1).

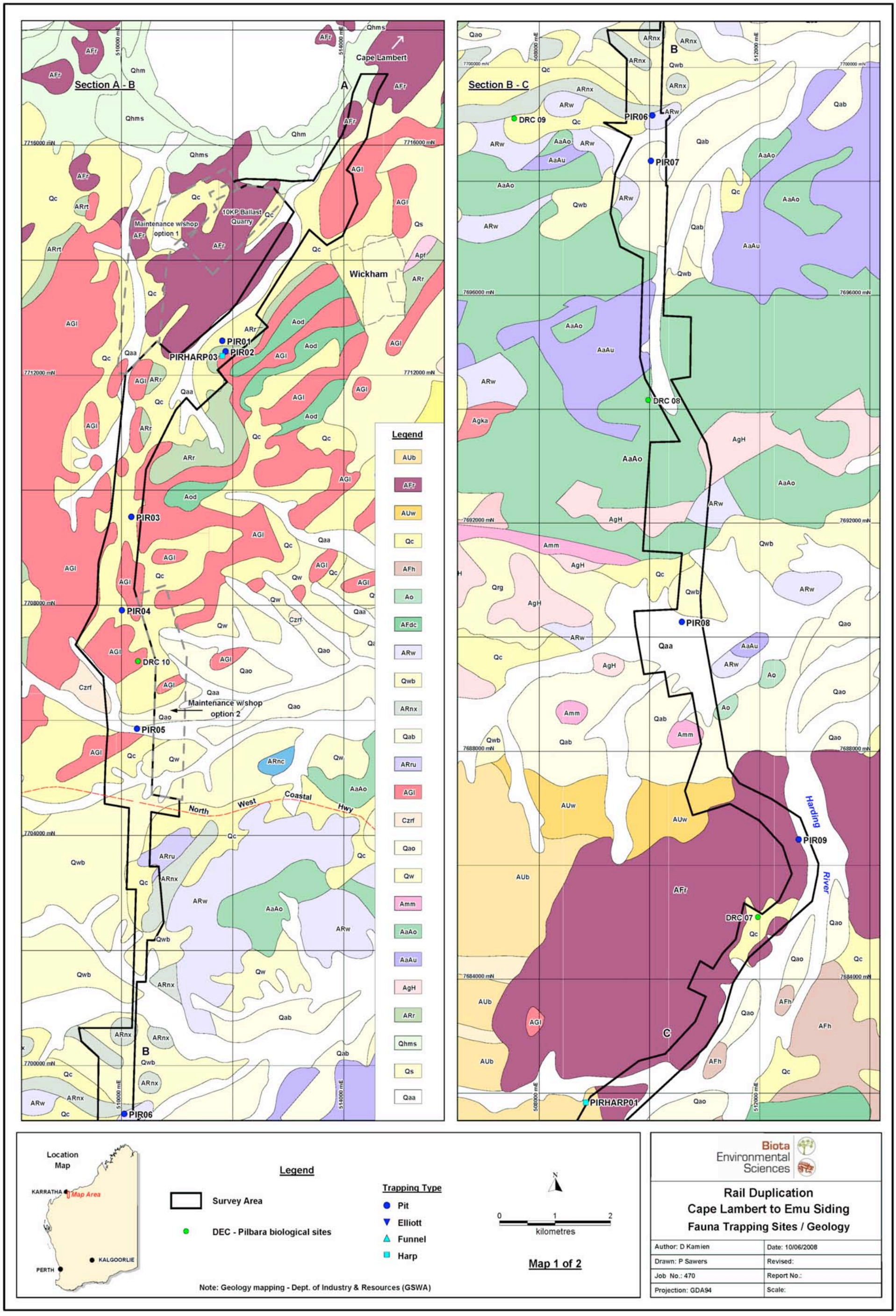

Figure 2.2: Geology types and fauna trapping sites within the RDCLE study area – northern section.

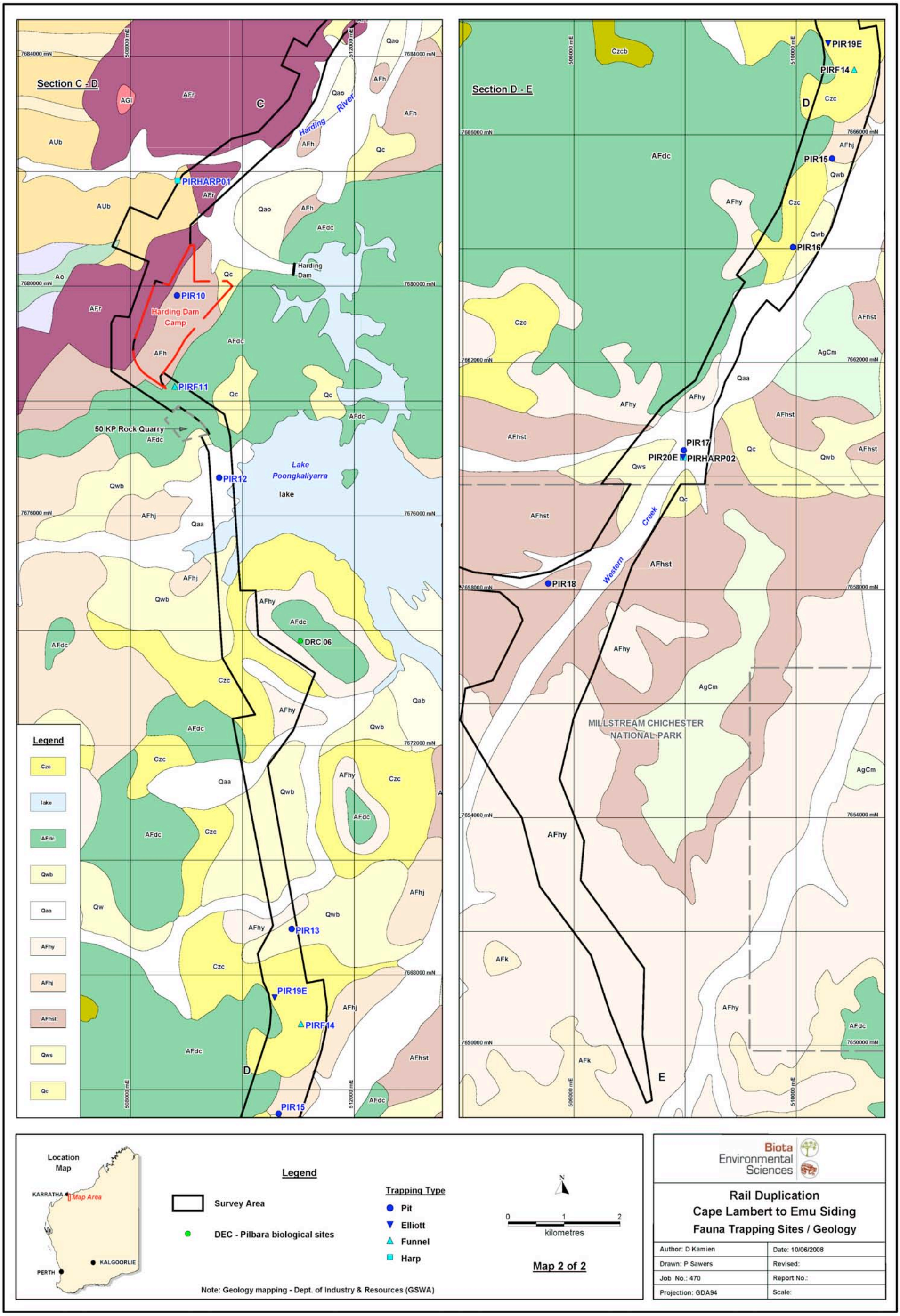

Figure 2.3: Geology types and fauna trapping sites within the RDCLE study area – southern section.

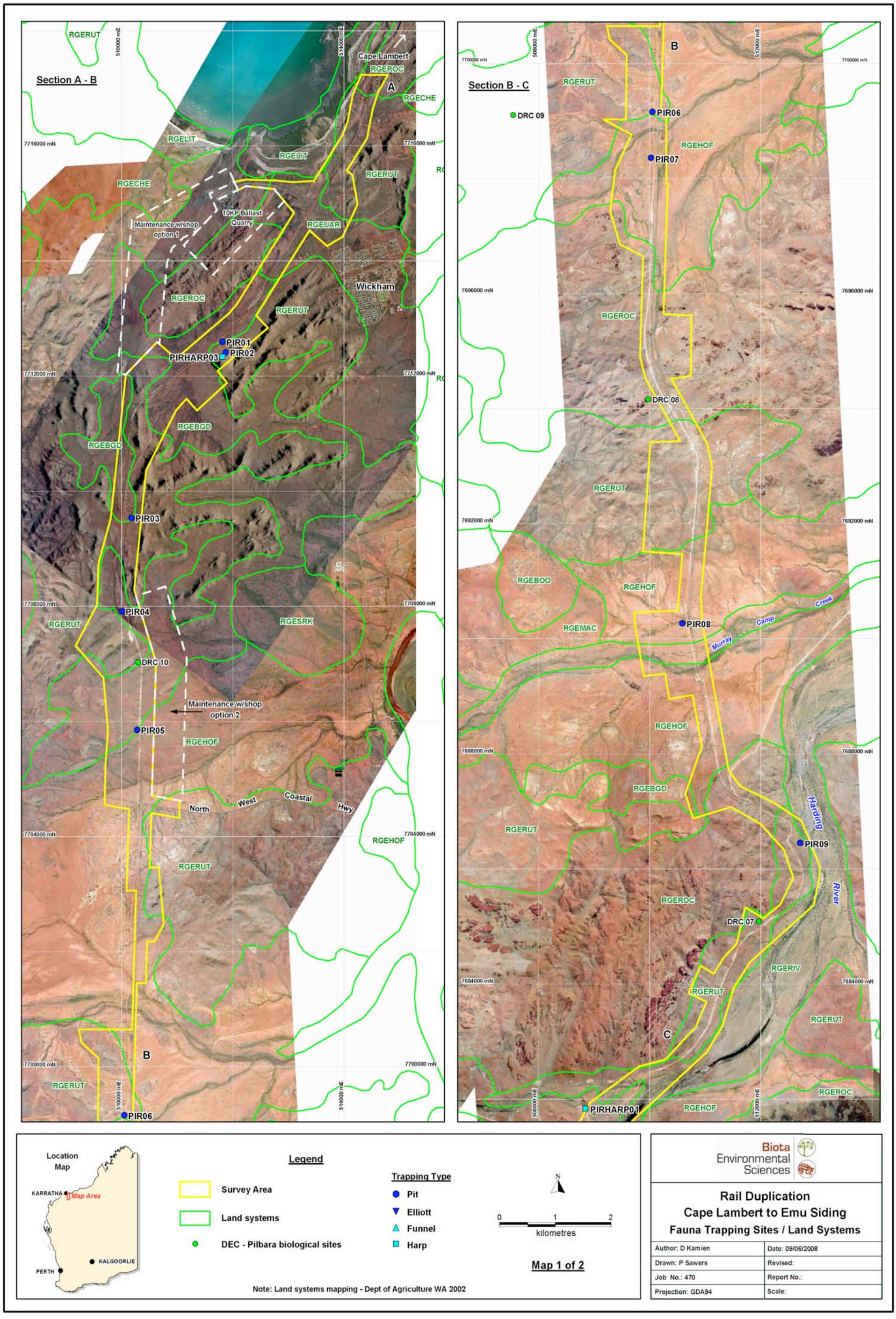

Figure 2.4: **Land systems and fauna trapping sites within the RDCLE study area – northern section**

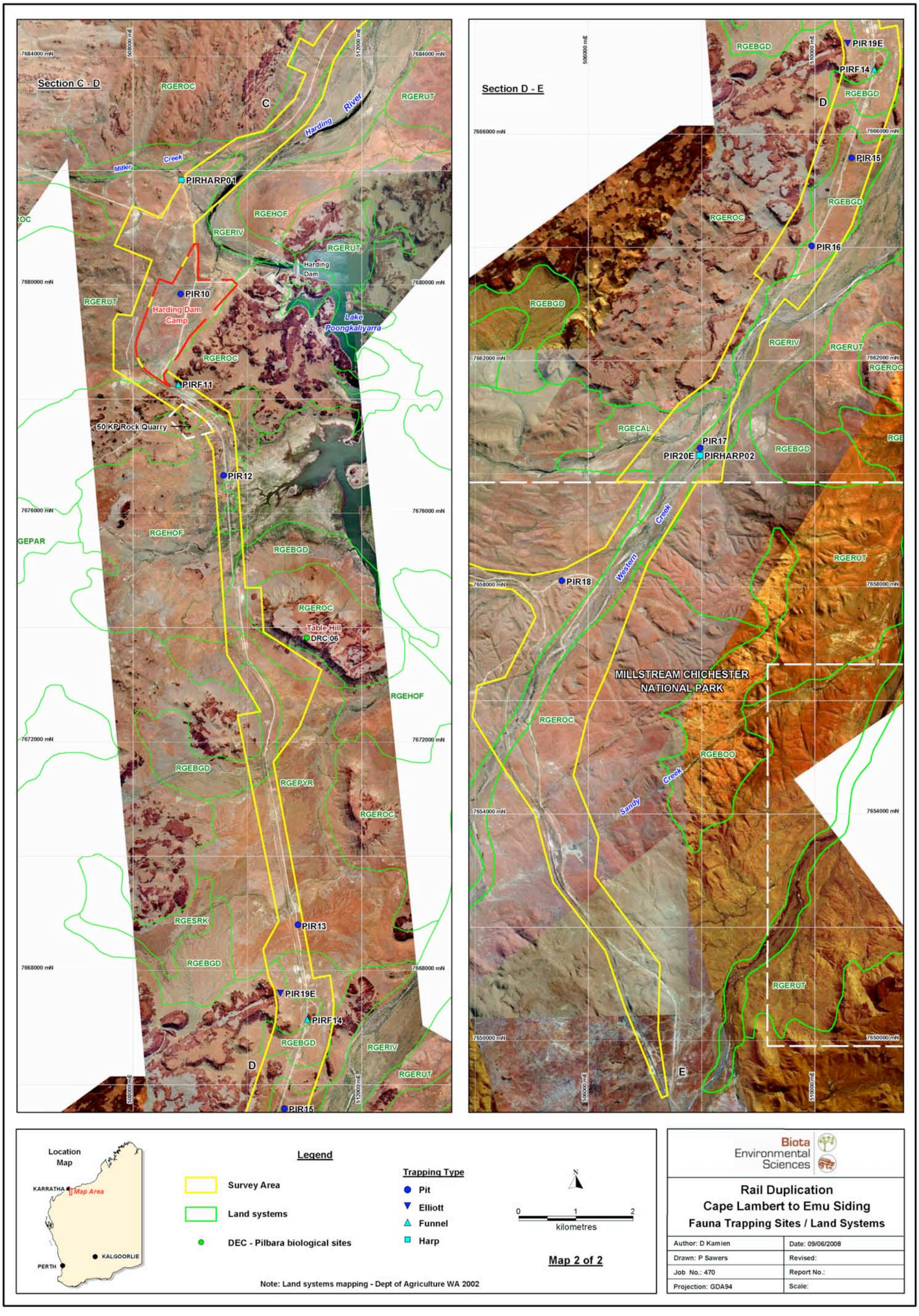

Figure 2.5: Land systems and fauna trapping sites within the RDCLE study area – southern section.

3.0 Survey Methodology

3.1 Database Searches

A search of the Department of Environment and Conservation (DEC) Threatened Fauna Database was conducted for the RDCLE study area (Appendix 1). The FaunaBase database of the Western Australian Museum was also searched for records of vouchered fauna from the area (Appendix 2). In addition, the *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters database was searched for fauna of environmental significance within the study area (Appendix 3).

The bounding coordinates delineating the search area for these databases were:
- 20.488°S, 116.622°E; and
- 21.678°S, 117.58°E.

The area defined by these coordinates included a 50 km buffer surrounding the study area. It should be noted that with the inclusion of a buffer, the search area encompassed marine environments. However, because marine environments will not be impacted during the proposed Rail Duplication, marine species extracted from database searches are not discussed further.

3.2 Survey Timing and Weather

The survey (including trap installation) was conducted over a 13-day period between April 1st and April 13th 2008. Minimum temperatures during the survey ranged from 20.6°C to 25.9°C and maximum temperatures ranged from 29.7°C to 40.9°C (Table 3.1). Minimal rainfall was recorded in Roebourne during the survey.

A total of 239.2 mm of rain fell in Roebourne in the six months prior to the survey, compared to an expected rainfall of 203.5 mm for this period (based on long term averages), indicating that the survey was conducted following a period of close to average rainfall (Figure 3.1 and Figure 3.2).

Table 3.1: Daily meteorological observations at Roebourne during the Rail Duplication survey (data provided by the Western Australian Bureau of Meteorology).

Date	1/4	2/4	3/4	4/4	5/4	6/4	7/4	8/4	9/4	10/4	11/4	12/4	13/4	Mean/Total
Maximum Temp. (°C)	32.2	33.6	29.7	32.4	34.5	35.6	39.1	37.7	38.3	40.9	36.8	36.0	36.7	35.7
Minimum Temp (°C)	24.0	24.8	23.1	20.6	22.1	25.0	25.1	25.9	25.6	25.4	23.7	22.0	21.3	23.7
Rainfall (mm)	0.2	0	0.2	0	0.2	0	0	0	0	0	0	0	0	0.6

3.3 Fauna Survey Team

Vertebrate fauna sampling for this survey took place under "Regulation 17: Licence to Take Fauna for Scientific Purposes" No. SF006301 and "Regulation 4: Authority to Enter DEC Land and/or Waters" No. CE001968 issued to R. Teale, which also authorised G. Humphreys, D. Kamien, P. Runham, M. Greenham, Z. Hamilton, J. Alexander, E. Harris, T. Sachse and G. Harold, (Appendix 4).

The fauna survey team comprised Mr D. Kamien (Biota), Mr T. Sachse (Biota), Mr. M. Greenham (Biota), Mr J. Alexander (Biota), Ms Z. Hamilton (Biota), Mr G. Harold (contractor) and Mr S. McCulloch (contractor).

Analyses of bat recordings were completed by Dr Kyle Armstrong (Specialised Zoological). Invertebrate identifications were undertaken by Mr Dan Kamien (Biota), and Dr Mark Harvey (WA Museum). Mr Brad Maryan (WA Museum) assisted with confirmation of herpetofauna identifications.

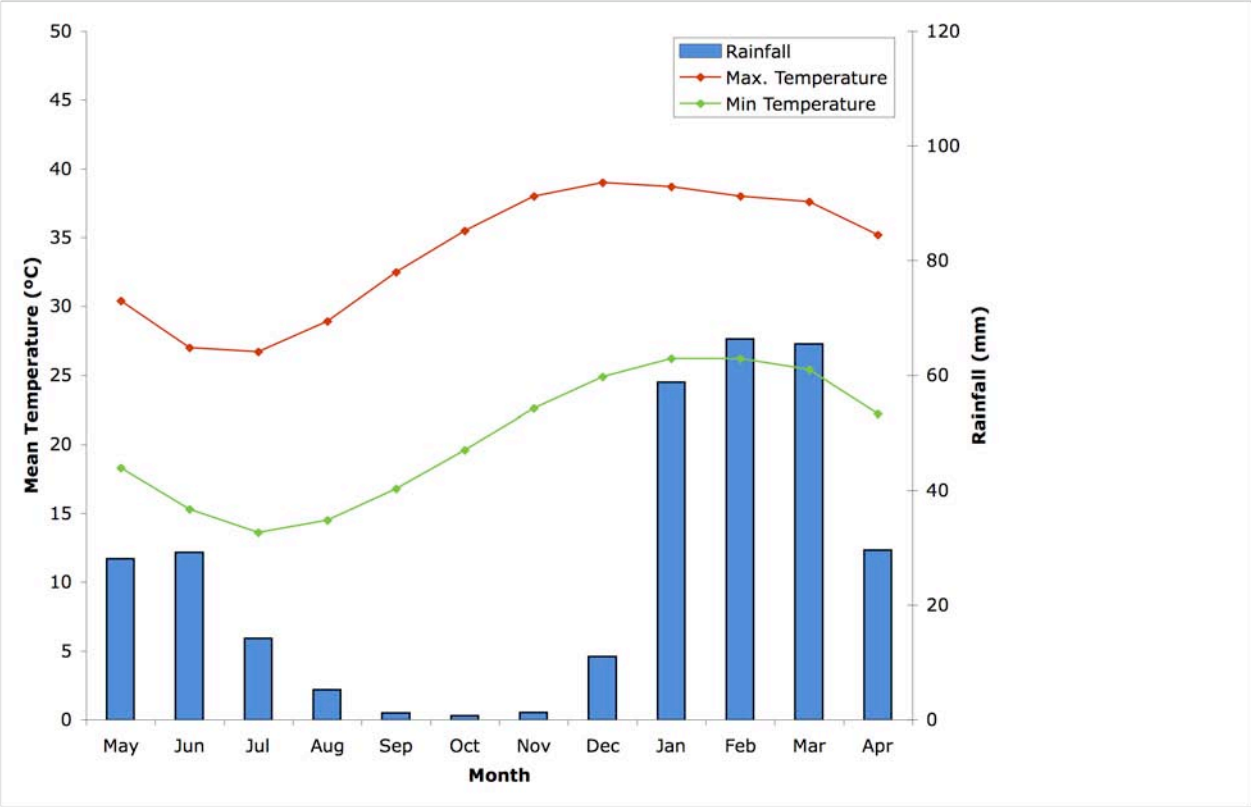

Figure 3.1: **Climatological summary for Roebourne using data from 1901 to 2000** (data provided by the Western Australian Bureau of Meteorology).

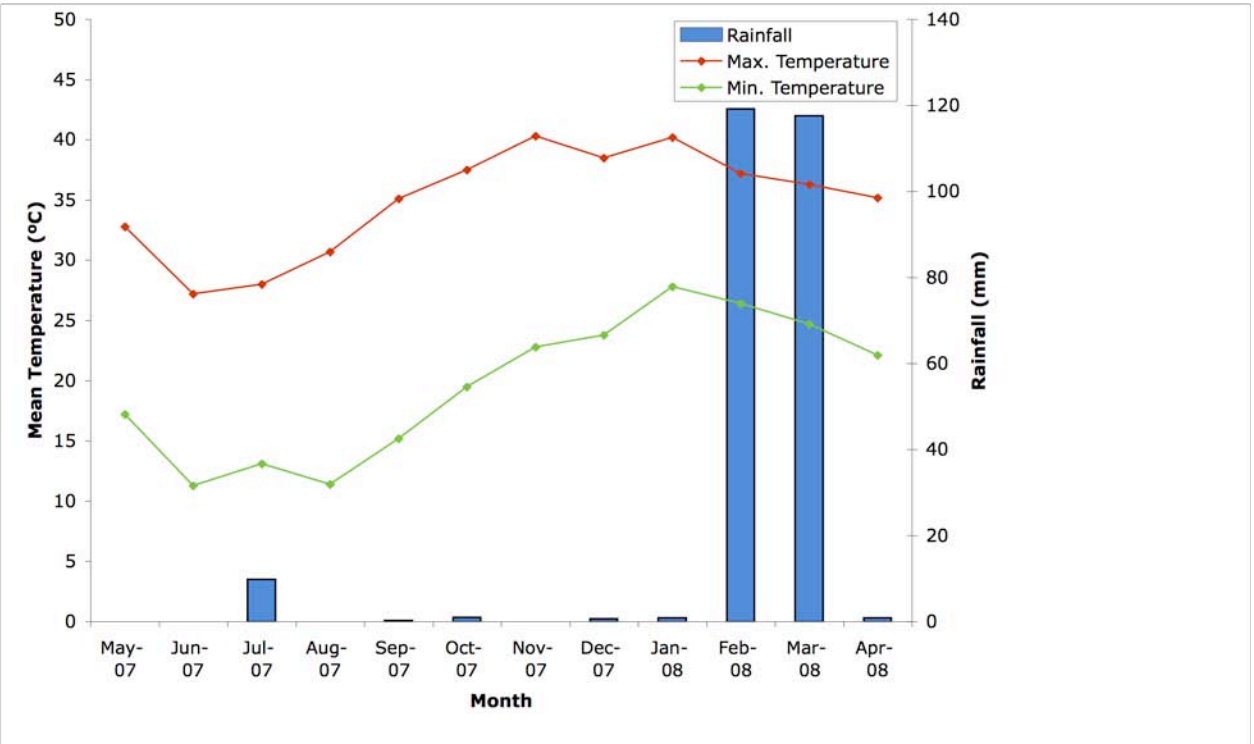

Figure 3.2: **Climatological summary for Roebourne 2007/2008** (Arrows indicate timing of survey; data provided by the Western Australian Bureau of Meteorology).

3.4 Fauna Sampling

3.4.1 Selection and Location of Sampling Sites

The principal component of this study consisted of systematic fauna sampling at 20 trapping grids installed in habitats considered to represent the range of those available within the study area.

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. Locations of trapping sites are presented in Figure 2.4 and Figure 2.5, whilst representative photos are presented in Plate 4.1 to Plate 4.20.

3.4.2 Trapping Effort and Design

Trapping effort at each location is shown in Table 3.2. Systematic censusing of terrestrial fauna assemblages, including mammals and herpetofauna, consisted of a single trapping line at each of the 20 sites (Plate 4.1 to Plate 4.20). Sixteen of these sites consisted of 10 pit-fall traps, comprising alternating twenty litre buckets and PVC tubes (150 mm diameter, 600 mm deep) spaced at 10 m intervals, connected by a 90 m long, 30 cm high flywire drift fence (Figure 3.3). An additional two sites consisted of eight pairs of funnel traps spaced at 7 m intervals, connected by a 60 m long by 30 cm high flywire drift fence.

Elliott box traps were also utilised during the survey. One line of 45 traps was placed in a rocky gorge, while another line consisting of 25 traps was placed in a river bank (Plate 4.19 and Plate 4.20).

Table 3.2: Trapping grid locations and effort within the RDCLE study area (Zone 50; WGS84).

Site	Easting	Northing	Trap Type	Number of Traps	Date Opened	Date Closed	Nights Open	Trap Effort
PIR01	511813	7712597	Pit-trap	10	6/4/08	12/4/08	6	60
PIR02	511872	7712412	Pit-trap	10	6/4/08	12/4/08	6	60
PIR03	510178	7709536	Pit-trap	10	6/4/08	12/4/08	6	60
PIR04	510008	7707911	Pit-trap	10	6/4/08	12/4/08	6	60
PIR05	510279	7705856	Pit-trap	10	6/4/08	12/4/08	6	60
PIR06	510051	7699158	Pit-trap	10	6/4/08	12/4/08	6	60
PIR07	510025	7698359	Pit-trap	10	6/4/08	12/4/08	6	60
PIR08	510587	7690267	Pit-trap	10	5/4/08	11/4/08	6	60
PIR09	512708	7686453	Pit-trap	10	5/4/08	11/4/08	6	60
PIR10	508831	7679838	Pit-trap	10	5/4/08	11/4/08	6	60
PIRF11	508793	7678256	Funnel	16	5/4/08	11/4/08	6	96
PIR12	509585	7676664	Pit-trap	10	5/4/08	11/4/08	6	60
PIR13	510881	7668801	Pit-trap	10	5/4/08	11/4/08	6	60
PIRF14	511046	7667147	Funnel	16	5/4/08	11/4/08	6	96
PIR15	510647	7665583	Pit-trap	10	5/4/08	11/4/08	6	60
PIR16	509943	7664026	Pit-trap	10	5/4/08	11/4/08	6	60
PIR17	507975	7660456	Pit-trap	10	5/4/08	11/4/08	6	60
PIR18	505533	7658115	Pit-trap	10	5/4/08	11/4/08	6	60
PIRE19	510576	7667608	Elliott trap	45	6/4/08	12/4/08	6	270
PIRE20	507961	7660335	Elliott trap	25	6/4/08	11/4/08	5	125
							Pit-trap Effort	960
							Funnel Trap Effort	192
							Elliott Trap Effort	395
							Total Trap Effort	**1547**

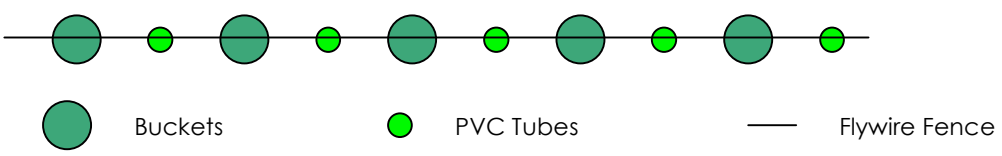

Figure 3.3: Pit-fall trapping grid layout.

3.4.3 Avifauna Sampling

Sampling of avifauna during the survey was carried out using a combination of techniques including:

- unbounded area searches conducted at all of the pit-fall sampling grids;
- unbounded area searches conducted opportunistically at locations containing habitats or microhabitats likely to support previously unrecorded species; and
- opportunistic observations of birds recorded while driving within the study area.

A total of 36 avifauna censuses were completed across the 18 pit-trapping and funnel trapping sites during the survey period (Table 3.3). Avifauna were sampled using 30 to 40-minute censuses at established trapping grids, comprising a total of over 22 person hours dedicated to avifauna sampling. Censuses were conducted between 6:30 am and 12:00 pm and were supplemented by recording avifauna species observed opportunistically within the study area.

Table 3.3: Time and date of systematic avifauna censuses undertaken at each fauna site.

Site	6/4/08	7/4/08	8/4/08	9/4/08	10/4/08	11/4/08	12/4/08	Total (min)
PIR01		6:40-7:10				6:40-7:20		80
PIR02					6:21-7:01		7:02-7:32	70
PIR03		7:50-8:20			7:14-7:54			70
PIR04		8:45-9:15			8:01-8:31			60
PIR05		9:25-10:00	9:30-10:10					75
PIR06			8:30-9:10		9:12-9:52			80
PIR07			7:56-8:26	10:04-10:45				70
PIR08			6:55-7:35	9:05-9:45				80
PIR09				8:10-8:50	7:07-7:42			80
PIR10				7:10-7:50	10:35-11:15			80
PIRF11			7:20-8:00	6:56-7:36				80
PIR12		9:00-9:40	9:00-9:40					80
PIR13		8:00-8:40	11:00-11:40					80
PIRF14		7:00-7:40		7:56-8:36				80
PIR15		7:08-7:48		8:38-9:18				80
PIR16	8:55-9:35		10:35-11:15					80
PIR17	7:08-7:48	8:06-8:46						80
PIR18	8:15-8:45	9:06-9:46						70
							Total	**1375 min**

3.4.4 Bats

Bats were sampled using both direct capture via harp traps and echolocation call recordings. During this study, harp traps were installed in both creek-line habitat and rock shelter entrances (Table 3.4 and Plates 3.1 - 3.3). Bat echolocation calls were recorded using Anabat II bat detectors, which detect and record ultrasonic echolocation calls emitted during bat flight.

The calls were stored on a compact flash card after being processed by an Anabat CF ZCAIM. Calls were visualised on Analook 3.3f software. Only sequences containing good quality search phase calls were considered for identification. Detailed analyses of bat recordings were completed by Dr Kyle Armstrong (Specialised Zoological).

Table 3.4: Locations and effort of Harp Traps and Anabat units during the survey (Zone 50; WGS84).

Site	Location	Date Opened	Date Closed	Sampling Method	Trap Effort (days)
PIRBAT01	508844 mE; 7681837 mN	7/4/08 6/4/08	12/4/08 12/4/08	Harp Trap Anabat	5 6
PIRBAT02	507968 mE; 7660329 mN	6/4/08 7/4/08	10/4/08 10/4/08	Harp Trap Anabat	4 3
PIRBAT03	511812 mE; 7712335 mN	10/4/08 10/4/08	12/4/08 12/4/08	Harp Trap Anabat	2 2
				Total Harp Trap Effort	**11**
				Total Anabat Effort	**11**

Plate 3.1: Site PIRBAT01

Plate 3.2: Site PIRBAT02

Plate 3.3: Site PIRBAT03

3.4.5 Invertebrate Fauna Sampling

Specific invertebrate groups were sampled using both systematic and non-systematic collections during the survey. Invertebrate groups targeted during the survey, primarily those considered to support short-range endemic taxa, included:

- Mygalomorphae (Trapdoor Spiders);
- Diplopoda (Millipedes);
- Pulmonata (Land Snails); and
- Pseudoscorpionida (Pseudoscorpions).

Trapdoor spiders were targeted by searching for, and excavating burrows. Individuals were preserved in 70% ethanol, with one or two legs removed and placed in 100% ethanol or liquid nitrogen for future molecular studies.

Pseudoscorpions and millipedes were searched for by removing bark from trees and turning rocks. Animals were preserved in 70% ethanol. Snail searches involved looking under rocks and beneath upturned *Triodia* hummocks. Individuals were kept alive and stored in calico bags pending molecular analysis. Any potential SRE invertebrates captured in pitfall traps during systematic sampling (Section 3.4.2) were also collected.

3.4.6 Non-systematic Sampling

Several non-systematic fauna survey activities were also undertaken by the survey team to supplement the trapping and investigate any additional habitats identified during the course of the survey. These included:

- habitat specific searches for Schedule and Priority listed fauna species;
- opportunistic sightings and records;
- identification of road kills and other animal remains; and
- identification of secondary signs (where possible) including tracks, scats and diggings.

3.5 Data Analysis

One means of assessing sampling adequacy comprises plotting species accumulation curves or rarefaction curves and examining the trend in the resultant curve over time. EstimateS v7.5 (Colwell 2005) was used to calculate species accumulation curves (rarefaction curves) based on 100 random sampling events of individuals recorded at each sampling site across both surveys. This produced a randomised or smoothed curve that generated the expected number of species with collections of decreasing sample sizes (Gotelli and Colwell 2001).

It should be noted that rarefaction alone, cannot be used to extrapolate predicted species richness for hypothetical future biological sampling. In order to estimate asymptotic richness (i.e. extrapolation of species richness) asymptotic estimators were utilised (Gotelli and Colwell 2001).

During this study, the average of four estimators was used to extrapolate species richness within the RDCLE study area (Colwell 2005). These include:

- ACE Mean - Abundance-based coverage estimator of species richness;
- ICE Mean - Incidence-based coverage estimator of species richness;
- Chao 2 Mean- Chao 2 richness estimator; and
- Jack 2 Mean - Second-order jackknife richness estimator.

3.6 Limitations

Not all sections of the study area were ground-truthed or equally sampled for fauna. However, systematic fauna sampling, the primary component of the study, was completed on the basis of trapping grid installation in habitats considered to be representative of the range of units present within the expansion area.

Terrestrial invertebrate sampling was targeted at a small number of specific groups and collection of other taxa was largely opportunistic.

Note that this report documents the results of a baseline terrestrial fauna survey and provides an assessment of conservation significance. Analysis of potential impacts specific to the rail duplication proposal, and related management measures, have not been discussed here as these will be considered as part of the forthcoming environmental assessment process.

4.0 Results

4.1 Habitat Classification and Vegetation Types

The study area comprised a range of habitat units, distinguished on the basis of differences in substrate, landform and vegetation. On this basis, the twenty trapping sites utilised for the survey yielded seven primary habitat types (Table 4.1 and Plate 4.1 to Plate 4.20). These primary habitat types comprised:

- Native tussock grasslands on cracking clays;
- Scattered to open *Acacia* sp. shrublands over *Triodia* sp. on clayey loam;
- Samphires on heavy clay;
- Rocky hill slopes with *Triodia* sp., sometimes with scattered *Acacia* sp.;
- Small drainage line with *Acacia* sp. over *Triodia* sp.;
- Boulder piles with *Triodia* sp.; and
- Major drainage line with *Eucalyptus* sp. over Buffel grass.

Table 4.1: Fauna habitats within the RDCLE study area.

Habitat Type	Site	Vegetation Description	Plate Reference
Native tussock grasslands on cracking clays	PIR07	*Eragrostis xerophila* tussock grassland on cracking clay.	Plate 4.7
	PIR08	*Eragrostis xerophila* tussock grassland on cracking clay.	Plate 4.8
	PIR13	*Neptunia dimorphantha* and *Phylanthus* sp. on stony gilgai clay.	Plate 4.13
Scattered to open *Acacia* sp. shrublands over *Triodia* sp. on clayey loam	PIR01	*Acacia pyrifolia* over dense *Triodia* sp. hummock grassland on clayey loam.	Plate 4.1
	PIR04	*Acacia pyrifolia* and *Acacia colei* over *Triodia* sp. hummock grassland on stony clayey loam.	Plate 4.4
	PIR10	Sparse *Acacia* sp. over *Triodia* sp. hummock grassland on stony clayey loam.	Plate 4.10
	PIR15	*Triodia* sp. hummock grassland and **Cenchrus ciliaris* (buffel) tussock grassland on stony clayey loam.	Plate 4.15
	PIR16	*Triodia* sp. hummock grassland and **Cenchrus ciliaris* (buffel) tussock grassland on stony clayey loam.	Plate 4.16
Samphires on heavy clay	PIR12	*Halosarcia* sp. (samphire) shrubland on clay/calcareous loam.	Plate 4.12
Rocky hill slopes with *Triodia* sp., sometimes with scattered *Acacia* sp.	PIR02	Sparse *Triodia* sp. hummock grassland on rock.	Plate 4.2
	PIR06	Very sparse *Triodia* sp. hummock grassland on rock.	Plate 4.6
	PIR18	Sparse *Acacia inaequilatera* over sparse *Triodia* sp. hummock grassland on rocky clayey loam.	Plate 4.18
	PIRE19	*Triodia* sp. hummock grassland on dolerite rock.	Plate 4.19
Small drainage line with *Acacia* sp. over *Triodia* sp.	PIR03	*Acacia bivenosa* and *Acacia pyrifolia* over *Triodia* sp. hummock grassland on stony loam.	Plate 4.3
	PIR05	*Corymbia* sp. over mixed grasses and *Triodia* sp. hummock grassland on stony clayey loam.	Plate 4.5
Boulder piles with *Triodia* sp.	PIRF11	Sparse *Triodia* sp. hummock grassland on dolerite rock.	Plate 4.11
	PIRF14	Very sparse *Triodia* sp. hummock grassland on dolerite rock.	Plate 4.14
Major drainage line with *Eucalyptus* sp. over Buffel grass	PIR09	**Cenchrus ciliaris* (buffel) tussock grassland on loam.	Plate 4.9
	PIR17	*Acacia* sp. over **Cenchrus sp.* (buffel) (*C. ciliaris* and *C. setiger*) tussock grassland on clay.	Plate 4.17
	PIRE20	*Eucalyptus victrix* over **Cenchrus sp.* (buffel) (*C. ciliaris* and *C. setiger*) and sparse *Triodia* sp hummock grassland on clay.	Plate 4.20

*denotes introduced non-native species

Plate 4.1: Site PIR01

Plate 4.2: Site PIR02

Plate 4.3: Site PIR03

Plate 4.4: Site PIR04

Plate 4.5: Site PIR05

Plate 4.6: Site PIR06

Plate 4.7: Site PIR07

Plate 4.8: Site PIR08

Plate 4.9: Site PIR09

Plate 4.10: Site PIR10

Plate 4.11: Site PIRF11

Plate 4.12: Site PIR12

Plate 4.13: Site PIR13

Plate 4.14: Site PIRF14

Plate 4.15: Site PIR15

Plate 4.16: Site PIR16

Plate 4.17: Site PIR17

Plate 4.18: Site PIR18

Plate 4.19: Site PIRE19

Plate 4.20: Site PIRE20

4.1.1 Relationship to Vegetation Types

The locations of the systematic fauna survey sites were spatially intersected with vegetation type mapping prepared as part of the flora and vegetation survey for the RDCLE rail duplication corridor (Biota 2008e). The vegetation types sampled at each fauna survey site are set out in Table 4.2.

Table 4.2: Vegetation types sampled at each of the systematic fauna sites from this study (vegetation codes and descriptions follow Biota (2008e)).

Site	Vegetation type
PIR01	ApyAbTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* hummock grassland
PIR02	ApyAarTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. arida* open shrubland over *Triodia epactia, T. wiseana* hummock grassland
PIR03	ApyAbTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* hummock grassland
PIR04	ApyAbTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* hummock grassland
PIR05	ApyAsyTe - *Acacia pyrifolia, A. synchronicia* open shrubland over *Triodia epactia* hummock grassland
PIR06	AanTw - *Acacia ancoistrocarpa* over *Triodia wiseana* hummock grassland plain -
PIR07	ERAx - *Eragrostis xerophila* open tussock grassland
PIR08	ERAx - *Eragrostis xerophila* open tussock grassland
PIR09	EvApyTwTeCE - *Eucalyptus victrix* low trees over Acacia pyrifolia open scrub to open shrubland over *Triodia wiseana, T. epactia* hummock grassland and **Cenchrus ciliaris, *C. setiger* open tussock grassland-
PIR10	ApyTw - *Acacia pyrifolia* scattered tall shrubs over *Triodia wiseana* hummock grassland
PIRF11	ApyAarTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. arida* open shrubland over *Triodia epactia, T. wiseana* hummock grassland
PIR12	Floodout mosaic
PIR13	H/G - Herbland/annual grassland
PIRF14	TERcTw - *Terminalia canescens* low open woodland over *Triodia wiseana* open hummock grassland
PIR15	Ta - *Triodia angusta* hummock grassland

Site	Vegetation type
PIR16	Tw/H - *Triodia wiseana* hummock grassland, with patches of herbs on clay
PIR17	EcEvMg - *Eucalyptus camaldulensis / E. victrix* low open woodland over *Melaleuca glomerata* tall shrubland
PIR18	ChApyAbTw - *Corymbia hamersleyana* scattered low trees over *Acacia pyrifolia, A. bivenosa* scattered shrubs over *Triodia wiseana* hummock grassland
PIRE19	ChAiTw - *Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera* tall open shrubland over *Triodia wiseana* open hummock grassland
PIRE20	EcEvMg – *Eucalyptus camaldulensis / E. victrix* low open woodland over *Melaleuca glomerata* tall shrubland

4.2 Vertebrate Fauna Overview

The RDCLE survey recorded a combined total of 118 vertebrate species representing 47 families. Table 4.3 provides a summary of the number of species recorded from each major vertebrate group during the survey.

Table 4.3: Number of vertebrate species recorded during the RDCLE fauna survey.

Fauna group	Total
Avifauna	53
Native non-volant mammals	9
Bats	7
Introduced mammals	3
Amphibians	3
Reptiles	43
Total	**118**

4.3 Avifauna

4.3.1 The Assemblage

Fifty-three bird species were recorded during the recent survey, including 26 non-passerine species and 27 passerine species, representing 29 families (Table 4.4).

The most abundant species recorded were the Zebra Finch *Taeniopygia guttata* and Little Corella *Cacatua sanguinea* (135 and 132 records respectively), both representing over 12% of all recorded avifauna during the survey. The most abundant family recorded was the Psittacidae with 321 records representing 30.1% of the total avifauna records. The most speciose family of birds was the Meliphagidae (Honeyeaters), with five species of Honeyeater recorded at most of the census sites.

Sites adjacent to drainage lines (i.e. PIR05, PIR09 and PIR17) exhibited the highest avifauna diversity within the study area. Twenty-four species were recorded at site PIR09, representing 45.3% of the total recorded species in the study area.

Table 4.4 presents data for all avifauna species recorded within the RDCLE study area during the fauna survey.

4.3.2 Breeding Records

There were no breeding records for any of the avifauna species recorded during the RDCLE fauna survey.

4.3.3 Regional Endemism and Restricted Taxa

The Pilbara subspecies of the Pheasant Coucal *Centropus phasianus highami* is considered to be endemic, or near-endemic, to the Pilbara Bioregion.

Table 4.4: Avifauna records from the RDCLE study area.

FAMILY Species Name	Common Name	PIR01	PIR02	PIR03	PIR04	PIR05	PIR06	PIR07	PIR08	PIR09	PIR10	PIRF11	PIR12	PIR13	PIRF14	PIR15	PIR16	PIR17	PIR18	Opp	Total
ANATIDAE																					
Cygnus atratus	Black Swan																			11	11
ANHINGIDAE																					
Anhinga melanogaster	Darter																			1	1
PHALACROCORACIDAE																					
Phalacrocorax melanoleucos	Little Pied Cormorant												1								1
ARDEIDAE																					
Ardea garzetta	Little Egret																			2	2
ACCIPITRIDAE																					
Aquila audax	Wedge-tailed Eagle					1															1
Circus assimilis	Spotted Harrier					1												2			3
Haliastur sphenurus	Whistling Kite					1			1	2		1				2				2	9
FALCONIDAE																					
Falco berigora	Brown Falcon							1	1						2						4
Falco cenchroides	Australian Kestrel	3	2			3	1		2	2			1	1				2			17
RALLIDAE																					
Fulica atra	Eurasian Coot																			9	9
TURNICIDAE																					
Turnix velox	Little Button-quail													3				1			4
SCOLOPACIDAE																					
Tringa glareola	Wood Sandpiper												1								1
CHARADRIIDAE																					
Charadrius melanops	Black-fronted Dotterel									2		1	1								4
COLUMBIDAE																					
Geopelia cuneata	Diamond Dove	22	5	3	7	4		1	1			1	1	2	2	3		1			53
Geopelia striata	Peaceful Dove							1		5			1				1	3			11
Geophaps plumifera	Spinifex Pigeon	3	2	18	8		1			2	2	3	1	3	3	2	3	1	10		62
Ocyphaps lophotes	Crested Pigeon	2	1	2	3																8
PSITTACIDAE																					
Cacatua roseicapilla	Galah	3	1					21		26		2			12	4		6	3		78
Cacatua sanguinea	Little Corella									2			77		33		5	15			132

FAMILY Species Name	Common Name	PIR01	PIR02	PIR03	PIR04	PIR05	PIR06	PIR07	PIR08	PIR09	PIR10	PIRF11	PIR12	PIR13	PIRF14	PIR15	PIR16	PIR17	PIR18	Opp	Total
Melopsittacus undulatus	Budgerigar		5							7					5	6		46	11		80
Nymphicus hollandicus	Cockatiel								2	14					1			1	13		31
CUCULIDAE																					
Cuculus pallidus	Pallid Cuckoo	1	1																		2
CENTROPODIDAE																					
Centropus phasianinus	Pheasant Coucal	1								2									1		4
HALCYONIDAE																					
Dacelo leachii	Blue-winged Kookaburra									6						1		2			9
Todiramphus pyrrhopygia	Red-backed Kingfisher					4				1					1			2			8
MEROPIDAE																					
Merops ornatus	Rainbow Bee-eater					4				7								1			12
MALURIDAE																					
Malurus lamberti	Variegated Fairy-wren		2	1			1											2			6
Malurus leucopterus	White-winged Fairy-wren						1		2												3
PARDALOTIDAE																					
Pardalotus rubricatus	Red-browed Pardalote					1				2						1	1	2			7
MELIPHAGIDAE																					
Lichenostomus keartlandi	Grey-headed Honeyeater	1	1				1					3				1			4		11
Lichenostomus penicillatus	White-plumed Honeyeater					6				5			2								13
Lichenostomus virescens	Singing Honeyeater	6		6	7	2						4	1		3						29
Lichmera indistincta	Brown Honeyeater		4		1	17	2					3	1			2	1	1	1		33
Manorina flavigula	Yellow-throated Miner	3								5		2									10
PACHYCEPHALIDAE																					
Oreoica gutturalis	Crested Bellbird																		1		1
DICRURIDAE																					
Grallina cyanoleuca	Magpie-lark					2				4		8	2		1			4			21
Rhipidura fuliginosa	Grey Fantail															1					1
Rhipidura leucophrys	Willie Wagtail												1								1

FAMILY Species Name	Common Name	PIR01	PIR02	PIR03	PIR04	PIR05	PIR06	PIR07	PIR08	PIR09	PIR10	PIRF11	PIR12	PIR13	PIRF14	PIR15	PIR16	PIR17	PIR18	Opp	Total
CAMPEPHAGIDAE																					
Coracina novaehollandiae	Black-faced Cuckoo-shrike			1		1	2			2					1	1		1	1		10
Lalage tricolor	White-winged Triller					2															2
ARTAMIDAE																					
Artamus cinereus	Black-faced Woodswallow	3	2	2	3	6	1						16		1						34
Artamus leucorynchus	White-breasted Woodswallow																			3	3
CRACTICIDAE																					
Cracticus nigrogularis	Pied Butcherbird	6	4	6	1		1	2	1	1	1	1				3	2	1	1		31
Cracticus tibicen	Australian Magpie			2		1		2												2	7
CORVIDAE																					
Corvus orru cecilae	Torresian Crow			2			2			4	1	4	2					2			17
HIRUNDINIDAE																					
Hirundo ariel	Fairy Martin												20							7	27
Hirundo nigricans	Tree Martin									10											10
SYLVIIDAE																					
Cincloramphus cruralis	Brown Songlark				1		2	9	9							1					22
Cincloramphus mathewsi	Rufous Songlark								2				4								6
ALAUDIDAE																					
Mirafra javanica	Singing Bushlark						1	5	15		2					3					26
PASSERIDAE																					
Emblema pictum	Painted Finch			2		3				1		19		4	2				10		41
Neochmia ruficauda	Star Finch									2											2
Taeniopygia guttata	Zebra Finch			6		45		3		26	2				2	31	8	12			135
	Number of Individuals	**54**	**30**	**51**	**31**	**104**	**16**	**45**	**36**	**140**	**8**	**52**	**133**	**13**	**69**	**62**	**21**	**108**	**56**	**37**	**1066**
	Number of Species	**12**	**12**	**12**	**8**	**18**	**12**	**10**	**10**	**24**	**5**	**13**	**17**	**5**	**14**	**15**	**7**	**21**	**11**	**8**	**53**

4.3.4 Avifauna of Conservation Significance

One avifauna species of elevated conservation significance was recorded during the RDCLE survey; this was the State-listed Priority 4 species the Star Finch *Neochmia ruficauda subclarescens*. The record came from typical habitat for the species, with two individuals at Site PIR09, adjacent to dense drainage habitat (Table 4.4).

A further nine avifauna species of elevated conservation significance could potentially occur within the study area. These are the Peregrine Falcon *Falco peregrinus*, Grey Falcon *Falco hypoleucos*, Australian Bustard *Ardeotis australis* Bush Stone-curlew *Burhinus grallarius*, Flock Pigeon *Phaps histrionica*, Eastern Curlew *Numenius madagascariensis*, Rainbow Bee-eater *Merops ornatus*, Fork-tailed Swift *Apus pacificus* and Oriental Plover *Charadrius veredus* (Table 6.1).

Further information on these avifauna species of elevated conservation significance can be found in Section 6.3.

4.3.5 Rarefaction Curve

In the case of avifauna the Cole rarefaction curve appears to be approaching an asymptote, indicating a significantly reduced rate at which additional new species were recorded with continued survey effort (Figure 4.1). That is, it is likely that a high percentage of the avifauna species occurring within the study area at the time of the study were recorded during the recent survey.

Non-parametric estimators predict total avifauna species richness within the Rail Duplication study area could range from 57 to 73 species (mean S_{max} estimate of 64.7 $\pm$ 3.45 species; Table 4.5). That is, between 4 to 23 (mean = 12) additional species could potentially occur within the study area that were not recorded during the recent survey. This translates to between 27% and 38% additional bird species.

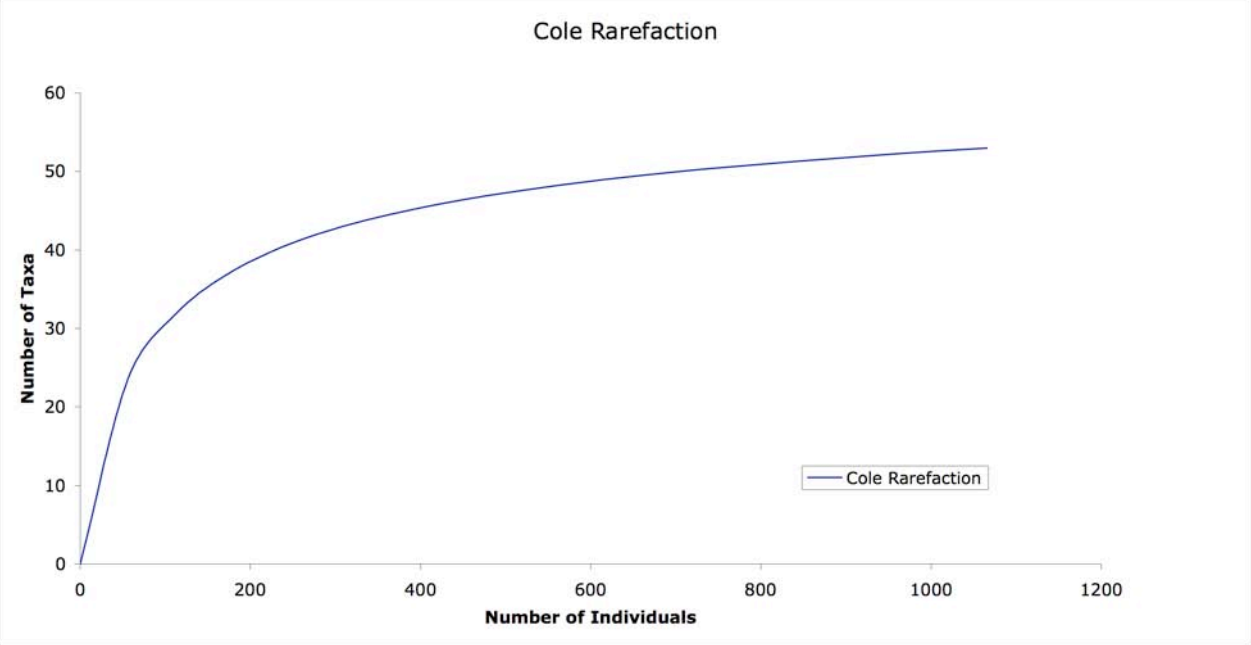

Figure 4.1: A sample based rarefaction curve for avifauna collected at the RDCLE study area.

Table 4.5: Observed and estimated avifauna species richness at the RDCLE study area.

Actual Observed	53

Species Richness Estimator	Estimated S_{max}
Ace Mean	57.1
Ice Mean	62.7
Chao 2 Mean	65.3
Jackknife 2 Mean	73.7

4.4 Mammals

4.4.1 The Assemblage – Non-volant Mammals

A total of 12 species of non-volant mammals were recorded during the survey, representing six families. This total includes nine native mammal species and three non-native species (Table 4.6).

The most commonly recorded native species was the Stripe-faced Dunnart *Sminthopsis macroura* with a total of 15 records, representing 23.8% of all non-volant mammal records. *Planigale* sp. T was also relatively common, with nine records representing a total of 14.3% of all non-volant mammal records for the survey. The most commonly recorded species overall was the introduced Horse *Equus caballas* with 18 records representing a total of 28.6% of all non-volant mammal records. The most abundant non-volant mammal family was the Dasyuridae, with 28 records accounting for 44.4% of all non-volant mammal records. The most speciose family recorded was the Muridae, which comprised four species.

The most speciose site for the RDCLE fauna survey was PIR01, with six species recorded. The most abundant site was PIR07 with thirteen individuals recorded representing 20.6% of all non-volant mammal records.

4.4.2 The Assemblage - Bats

No bats were captured in the harp traps deployed during the survey. However, based on analysis of recorded call sequences a total of seven bat species were found to occur within the study area. These include four evening bats (Vespertilionidae), one free-tail bat (Molossidae), and two sheath-tail bats (Emballonuridae) (Table 4.6 and Appendix 5).

4.4.3 Breeding Records

An adult female Pilbara Ningaui *Ningaui timealeyi* was recorded as lactating at PIR01.

4.4.4 Regional Endemism and Restricted Taxa

One species considered endemic to the Pilbara bioregion was recorded during the survey; this was the Pilbara Ningaui *Ningaui timealeyi* (Table 4.6).

4.4.5 Mammals of Conservation Significance

One species of elevated conservation significance was recorded during the survey; this was the State-listed Priority 4 species the Short-tailed Mouse *Leggadina lakedownensis* (Table 4.6).

A further eight species of mammals of elevation conservation significance could occur within the RDCLE study area. These are the Brush-tailed Mulgara *Dasycercus blythi*, Northern Quoll *Dasyurus hallucatus*, Pilbara Orange Leaf-nosed Bat *Rhinonicteris aurantius*, Little Northern Freetail Bat *Mormopterus loriae cobourgiana*, Spectacled Hare-wallaby *Lagorchestes conspicillatus leichardti*, Long-tailed Dunnart *Sminthopsis longicaudata*, Ghost Bat *Macroderma gigas* and Western Pebble-mound Mouse *Pseudomys chapmani* (Table 6.1).

Section 6.3 provides further information on mammal species of elevated conservation significance.

Table 4.6: Mammal records from the RDCLE study area.

FAMILY *Species Name*	Common Name	PIR01	PIR02	PIR03	PIR04	PIR05	PIR07	PIR08	PIR09	PIR10	PIRF11	PIR12	PIR13	PIRE14	PIR15	PIR16	PIR17	PIR18	PIRE19	PIRE20	PIRBAT1	PIRBAT2	PIRBAT3	Total
TACHYGLOSSIDAE																								
Tachyglossus aculeatus	Short-beaked Echidna	S									D													S,D
DASYURIDAE																								
Ningaui timealeyi	Pilbara Ningaui	1													1			1						3
Planigale sp. T		2			2		1					2	1			1								9
Planigale sp. K																1								1
Sminthopsis macroura	Stripe-faced Dunnart					1	3	6				1	3					1						15
MACROPIDAE																								
Macropus robustus	Euro	1	1																					2
MOLOSSIDAE																								
Chaerephon jobensis	Northern Freetail Bat																					C		C
VESPERTILIONIDAE																								
Chalinolobus gouldii	Gould's Wattled Bat																				C	C	C	C
Nyctophilus sp.	Long Eared Bat																				C	C		C
Scotorepens greyii	Little Broad-nosed Bat																				C	C	C	C
Vespadelus finlaysoni	Inland Cave Bat																				C	C	C	C
EMBALLONURIDAE																								
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat																				C	C		C
Taphozous georgianus	Common Sheathtail Bat																				C	C	C	C
MURIDAE																								
Leggadina lakedownensis	Short-tailed Mouse						1																	1
**Mus musculus*	House Mouse																			1				1
Pseudomys desertor	Desert Mouse	1		1						2		1	1		1			1						8
Pseudomys hermannsburgensis	Sandy Inland Mouse	1					1										2							4
FELIDAE																								
**Felis catus*	Cat				1										T									1,T
EQUIDAE																								
**Equus caballus*	Horse						7		11															18
	Number of Individuals	**6**	**1**	**1**	**3**	**1**	**13**	**6**	**11**	**2**	**D**	**4**	**5**	**0**	**2**	**2**	**2**	**3**	**0**	**1**	**C**	**C**	**C**	**63**
	Number of Species	**6**	**1**	**1**	**2**	**1**	**5**	**1**	**1**	**1**	**1**	**3**	**3**	**0**	**3**	**1**	**1**	**3**	**0**	**1**	**6**	**7**	**4**	**19**

Denotes non-native introduced species. C Denotes identification via echolocation calls. D Denotes identification via diggings. S Denotes identification via scats. T Denotes identification via tracks (not included in totals)

4.4.6 Rarefaction Curve

The rarefaction curve for non-volant mammals appears to be close to asymptotic, indicating that few additional new species are likely to be recorded with continued trapping effort at the time of the survey (Figure 4.2). Non-parametric estimators confirm this and predict the total non-volant mammalian species richness within the study area could range from 11 to 13 species (mean S_{max} estimate of 11.9 $\pm$ 0.33 species; Table 4.7). That is, based on the existing data, between zero and two additional species could potentially occur within the study area that were not recorded during the recent survey.

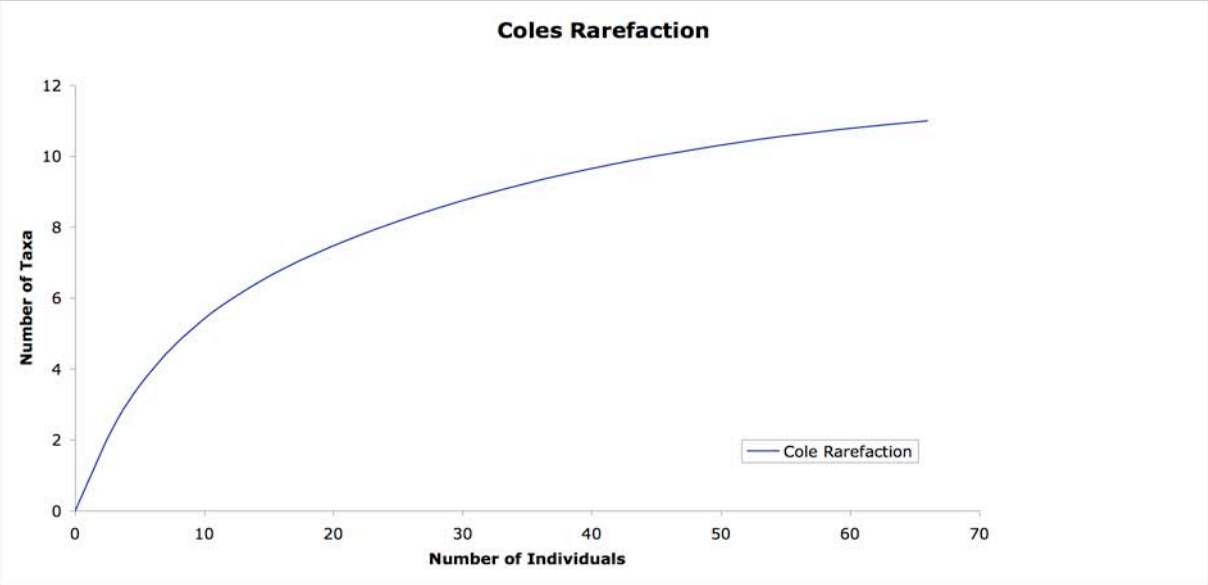

Figure 4.2: A sample based rarefaction curve for non-volant mammals collected at the RDCLE study area.

Table 4.7: Observed and estimated non-volant mammal species richness at RDCLE study area.

Actual Observed	11

Species Richness Estimator	Estimated S_{max}
Ace Mean	12.74
Ice Mean	12.16
Chao 2 Mean	11.50
Jackknife 2 Mean	11.29

4.5 Herpetofauna

4.5.1 The Assemblage

The survey yielded a total of 46 herpetofauna species from the study area (Table 4.8). The tally comprised two tree frogs (Hylidae), one ground frog (Myobatrachidae), six geckos (Gekkonidae), three legless lizards (Pygopodidae), 21 skinks (Scincidae), seven dragons (Agamidae), three monitors (Varanidae), two blind snakes (Typhlopidae) and one front-fanged snake (Elapidae).

Main's frog *Cyclorana maini* was particularly abundant, with 296 individuals, representing 47.3% of all herpetofauna recorded during the survey. This species was recorded from all habitat types sampled, with the exception of the dolerite boulder piles. Amongst the remaining herpetofauna, the gecko *Diplodactylus conspicillatus* and the skink *Ctenotus saxatilis* were relatively common, representing 7.0% and 6.8% of the herpetofauna recorded respectively.

The most abundant herpetofauna family recorded was the Hylidae with 316 records representing 50.5% of the total herpetofauna records for the survey (a function of the abundance of *C. maini*). The most speciose herpetofauna family was the Scincidae with 120 records comprising 21 species. Sites PIR01 and PIR03 exhibited the highest herpetofauna diversity within the study area, both comprising 13 species (28.3% of all herpetofauna species recorded in the study area). In general, *Acacia* sp. over *Triodia* hummock grassland habitat exhibited high herpetofauna diversity, as did buffel grass habitat.

Table 4.8 presents data for all herpetofauna species recorded within the RDCLE study area.

Table 4.8: Herpetofauna records from the RDCLE study area.

FAMILY Species Name	PIR01	PIR02	PIR03	PIR04	PIR05	PIR06	PIR07	PIR08	PIR09	PIR10	PIRF11	PIR12	PIR13	PIRF14	PIR15	PIR16	PIR17	PIR18	PIRE19	PIRE20	Total
HYLIDAE																					
Litoria rubella												1				1	18				20
Cyclorana maini	2		11	10	50	2	17	20	7	5		4	10		42	28	55	33			296
MYOBATRACHIDAE																					
Uperoleia russelli									1								20				21
GEKKONIDAE																					
Diplodactylus conspicillatus	3		7		4				9	20								1			44
Lucasium stenodactylum			1			1			2												4
Heteronotia binoei	1		3									2			1	1					8
Heteronotia sp.														1							1
Gehyra punctata		1									2										3
Rhynchoedura ornata									7	1							3				11
PYGOPODIDAE																					
Delma pax																	2				2
Delma tincta										1											1
Pygopus nigriceps						1															1
SCINCIDAE																					
Carlia munda	4	1	5	5								1									16
Cryptoblepharus buchananii																			1		1
Cryptoblepharus ustulatus sp. nov.											1										1
Ctenotus affin. *robustus*								1					1								2
Ctenotus duricola			1			2									1						4
Ctenotus grandis	1														2		2				5
Ctenotus hanloni										1											1
Ctenotus pantherinus	4					1			1	3					5	2					16
Ctenotus rubicundus																		2			2
Ctenotus saxatilis	6	1	3	3	2	1			2	4					7	4	1	8		1	43
Ctenotus schomburgkii							1														1
Ctenotus serventyi									2												2
Cyclodomorphus melanops															1	1					2
Egernia depressa		1																			1
Egernia pilbarensis														3							3
Glaphyromorphus isolepis																	5				5

FAMILY Species Name	PIR01	PIR02	PIR03	PIR04	PIR05	PIR06	PIR07	PIR08	PIR09	PIR10	PIRF11	PIR12	PIR13	PIRF14	PIR15	PIR16	PIR17	PIR18	PIRE19	PIRE20	Total
Lerista muelleri																	1				1
Lerista verhmens	1																				1
Menetia greyii	2		2	1																	5
Morethia ruficauda											2							1			3
Tiliqua multifasciata			2							1			1			1					5
AGAMIDAE																					
Ctenophorus caudicinctus		1	6	2		4			1	10		2					1	2			29
Ctenophorus isolepis					1							1					1				3
Ctenophorus nuchalis							1														1
Diporiphora affin. *valens*					1																1
Lophognathus longirostris					4																4
Pogona minor	1		5	1	5																12
Tympanocryptis cephala							2	1													3
VARANIDAE																					
Varanus acanthurus	1	1							1							1		1			5
Varanus brevicauda										1											1
Varanus pilbarensis																			1		1
TYPHLOPIDAE																					
Ramphotyphlops ammodytes	6		2					1	1									1			11
Ramphotyphlops grypus	3	3	8	3			1		4												22
ELAPIDAE																					
Pseudonaja modesta																		1			1
Number of Individuals	**35**	**9**	**56**	**25**	**67**	**12**	**22**	**23**	**38**	**47**	**5**	**11**	**12**	**4**	**59**	**39**	**109**	**50**	**2**	**1**	**626**
Number of Species	**13**	**7**	**13**	**7**	**7**	**7**	**5**	**4**	**12**	**10**	**3**	**6**	**3**	**2**	**7**	**8**	**11**	**9**	**2**	**1**	**46**

4.5.2 Breeding Records

Nine herpetofauna species were recorded at varying breeding stages during the RDCLE fauna survey (Table 4.9).

Table 4.9: Herpetofauna breeding records during the RDCLE fauna survey.

Species	Breeding record	Site
Ctenophorus isolepis	Gravid female	PIR12
Diplodactylus conspicillatus	Gravid female	PIR05, PIR10
Diplodactylus conspicillatus	Hatchling	PIR03, PIR09, PIR10
Pogona minor	Gravid female	PIR03, PIR05
Ctenophorus caudicinctus	Gravid female	PIR18
Ctenophorus caudicinctus	Hatchling	PIR02, PIR03, PIR06, PIR09, PIR18
Ctenophorus caudicinctus	Male in breeding colours	PIR10
Ctenotus grandis	Hatchling	PIR15
Ctenotus pantherinus	Hatchling	PIR16
Ctenotus saxatilis	Hatchling	PIR15, PIR18
Tympanocryptis cephala	Hatchling	PIR07
Carlia munda	Male in breeding colours	PIR01, PIR03, PIR04

4.5.3 Regional Endemism and Restricted Taxa

Four herpetofauna species recorded during the RDCLE fauna survey could be considered endemic, or near-endemic to the Pilbara Bioregion. These species are *Ctenotus duricola*, *Diporiphora* aff. *valens*, *Varanus pilbarensis* and *Heteronotia* sp.

4.5.4 Herpetofauna of Conservation Significance

No herpetofauna species of elevated conservation significance were recorded during the RDCLE survey. However, four herpetofauna species of elevated conservation significance could be recorded within the study area. These are the Pilbara Olive Python *Liasis olivaceus barroni*, *Lerista quadrivincula*, *Ramphotyphlops ganei* and *Notoscincus butleri* (Table 6.1). Further information on these herpetofauna species of elevated conservation significance can be found in Section 6.3.

4.5.5 Other Species of Interest

***Heteronotia* sp.**

The gecko, *Heteronotia* sp. (Plate 4.21) was recorded on one occasion from a funnel trap at site PIRF14, within the dolerite boulder pile habitat (WAM lodgement number R163243). This species is relatively new to science with five specimens recorded in 2004 from dolerite boulder piles located approximately 7 km north of site PIRF14 (21°02'11"S, 117°06'22"E).

Plate 4.21: *Heteronotia* sp.

4.5.6 Rarefaction Curve

Inspection of the rarefaction curve indicates that species accumulation is beginning to plateau, indicating that additional new species are likely to be recorded at a lower rate with additional trapping effort (Figure 4.3). Despite this, the rarefaction curve is still climbing and has not yet approached an asymptote, indicating that a high percentage of herpetofauna species potentially occurring in the study area were not recorded during the recent survey.

This is supported by the non-parametric estimators that predict total herpetofauna species richness within the RDCLE study area may potentially range from 59 to 82 species (mean S_{max} estimate of 73.2 $\pm$ 5.22 species; Table 4.10). That is, between 13 to 36 (mean = 27) additional species could potentially occur within the study area that were not recorded during the recent survey. This translates to between 28% and 78% additional herpetofauna species.

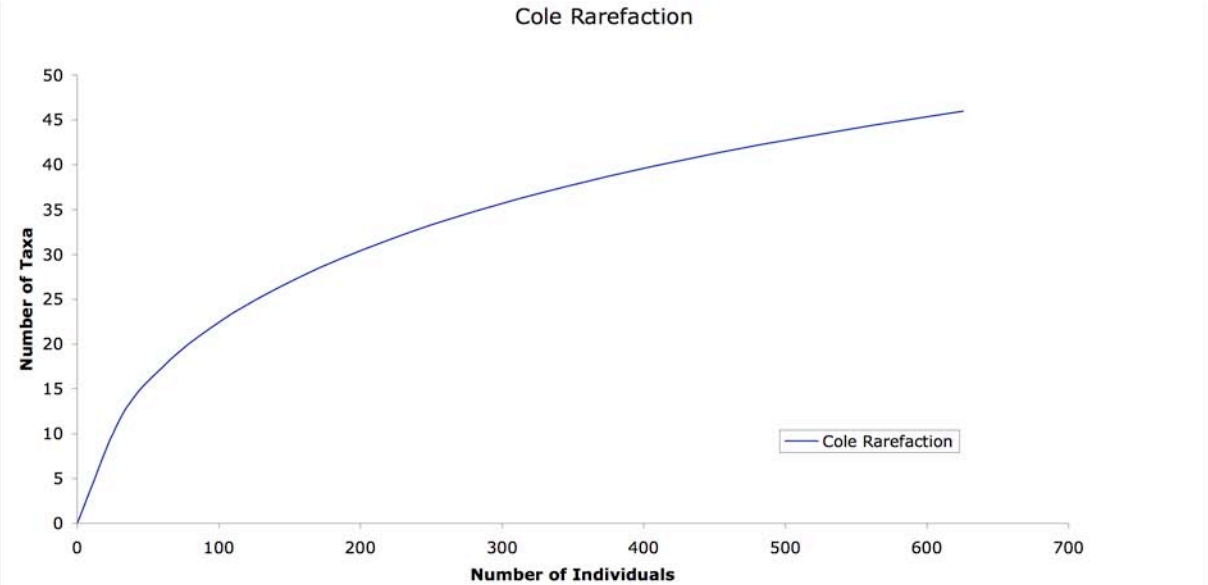

Figure 4.3: A sample based rarefaction curve for herpetofauna collected at the RDCLE study area.

Table 4.10: Observed and estimated herpetofauna species richness at RDCLE study area.

Actual Observed	46

Species Richness Estimator	**Estimated S_{max}**
Ace Mean	59.5
Ice Mean	70.7
Chao 2 Mean	82.8
Jackknife 2 Mean	79.7

4.6 Potential Short Range Endemic Invertebrates

Taxonomic groups of invertebrates with naturally small distributions are described as short-range endemics (SREs) and are in part characterised by poor dispersal capabilities, confinement to disjunct habitats and low fecundity (Harvey 2002, Ponder and Colgan 2002). Given the importance of short-range endemism to the conservation of biodiversity, the assessment of such invertebrate taxa is a potentially important component of impact assessment. Examples of taxonomic groups that show high levels of short-range endemism in this respect include mygalomorph spiders, millipedes, pseudoscorpions and freshwater and terrestrial molluscs.

4.6.1 Mygalomorph Spiders

Four species of mygalomorph spider were recorded from the RDCLE study area (Table 4.11 and Plate 4.22 to Plate 4.28). These represented the Nemesiidae, Barychelidae and Idiopidae families (Table 4.11).

Table 4.11: Mygalomorph spiders recorded within the RDCLE study area.

FAMILY *Species*	PIR03	PIR06	PIR08	PIR09	PIR10	PIR18	Opp	Total
NEMESIIDAE								
Aname sp. A	2	3	1	2	2		5	15
Aname sp. B							1	1
BARYCHELIDAE								
Sp. A						1		1
IDIOPIDAE								
Sp. A			1					1
						Total Individuals		**18**

Plate 4.22: *Aname* sp. A

Plate 4.23: *Aname* sp. A burrow

Plate 4.24: *Aname* sp. B

Plate 4.25: *Aname* sp. B burrow

Plate 4.26: Idiopidae sp. A

Plate 4.27: Idiopidae sp. A burrow and door

Plate 4.28: Barychelidae sp. A

4.6.2 Pseudoscorpions

Two pseudoscorpion species were recorded from the RDCLE study area (Table 4.12, Plate 4.29 and Plate 4.30). These were *Haplochernes* sp. of the family Chernetidae, and *Synsphyronus* sp. of the family Garypidae. Both species were collected opportunistically under the bark of *Eucalyptus* sp. and *Corymbia* sp. trees.

Table 4.12: Pseudoscorpions collected in the RDCLE study area (Zone 50; WGS84).

ID Number	Genus	Species	Easting	Northing	Number Collected
PS20080408.PIROPMG-01	*Haplochernes*	sp. 1	512795	7686609	9
PS20080408.PIROPMG-02A	*Haplochernes*	sp. 1	510633	7692267	1
PS20080408.PIROPMG-02B	*Haplochernes*	sp. 1	510633	7692267	2
PS20080408.PIROPMG-03A	*Haplochernes*	sp. 1	510114	7694573	7
PS20080408.PIROPMG-03B	*Synsphyronus*	sp. 1	510114	7694573	4
PS20080408.PIROPMG-03C	*Haplochernes*	sp. 1	510114	7694573	4
PS20080408.PIROPDK-01A	*Haplochernes*	sp. 1	505450	7658176	9
PS20080408.PIROPDK-01B	*Synsphyronus*	sp. 1	505450	7658176	1
PS20080408.PIROPDK-02A	*Haplochernes*	sp. 1	510294	7704994	5
PS20080408.PIROPDK-02B	*Haplochernes*	sp. 1	510294	7704994	5
PS20080408.PIROPDK-02C	*Synsphyronus*	sp. 1	510294	7704994	1
PS20080408.PIROPDK-03	*Haplochernes*	sp. 1	510122	7707761	1
				Total collected	**49**

Plate 4.29: *Synsphyronus* sp. 1 (Garypidae)

Plate 4.30: *Haplochernes* sp. 1 (Chernetidae)

4.6.3 Terrestrial Snails

4.6.3.1 Family Camaenidae

Live snails belonging to the species *Rhagada convicta* were collected from six sampling locations within the RDCLE study area (Table 4.13 and Plate 4.31). Additional *Rhagada* snails were collected from sampling location ZHMGSN02 (508808 mE, 7678162 mN) but based on shell morphology alone, these could not be assigned to a known species (Table 4.13 and Plate 4.32). A further sample of *Rhagada* was collected from site PIR17 (507975 mE, 7660456 mN) but as this specimen was not an adult snail it could not be confidently assigned to a described species.

Table 4.13: Camaenid land snails collected in the RDCLE study area (Zone 50; WGS84).

Genus	Species	Site	Easting	Northing	Number
Rhagada	*convicta*	PI001	511813	7712597	8
Rhagada	*convicta*	PIR03	510178	7709536	7
Rhagada	*convicta*	PIR04	510008	7707911	6
Rhagada	*convicta*	R1	510118	7707768	10
Rhagada	*convicta*	ZHSN01	471649	7715101	9
Rhagada	*convicta*	PIRHARP01	508844	7681837	6
Rhagada	sp. ?	ZHMGSN02	508808	7678162	6
Rhagada	sp. ?	PIR017	507975	7660456	1
				Total collected	**53**

Plate 4.31: ***Rhagada convicta*** **from sampling location ZHSN01 along the RDCLE study area.**

Plate 4.32: ***Rhagada*** **sp. from sampling location ZHMGSN02 along the RDCLE study area.**

4.6.3.2 Family Pupillidae

Dead shells of *Pupoides* aff. *beltianus* were collected from a single location within the RDCLE study area (510633 mE, 7692267 mN).

4.6.3.3 Family Succinidae

Live snails of an undetermined species from the genus *Succinea* (n=12) were recorded from a single location within RDCLE study area (509760 mE, 7682246 mN). These specimens have been lodged with Shirley-Slack Smith at the WA Museum.

4.6.4 Freshwater Snails

4.6.4.1 Family Planorbidae

Live planorbid snails (n >20) belonging to the genus *Glyptophysa* were collected from a temporary rock pool in the gorge located at PIRE19 (510576 mE, 7667608 mN). Specimens were lodged with Shirley Slack-Smith at the WA Museum. No taxonomic research has been carried out within this genus, however the specimens collected here may be *Glyptophysa egregia* (Preston 1906).

4.6.4.2 Unknown Family

A number of unidentified snail shells from a number of species were collected from Harding River. These shells have been sent to Vince Kessner (private contractor) and are awaiting identification. Given their collection location however, it is unlikely that they will be restricted to the immediate area of the rail duplication and no taxon level impacts would be expected.

4.6.5 Distribution and Wider Status of Recorded Potential SRE Taxa

Mygalomorph spiders, pseudoscorpions and pulmonate snails that are may include potential SRE taxa were recorded within the Rail Duplication study area. While the conservation significance of these species is not currently known, the specimens have been lodged with the Western Australian Museum with the mygalomorph spiders and snails being currently the subject of a long-term phylogeographic study examining the broader distribution of putative taxa.

Ideally, it would be beneficial to directly determine the broader distribution of the potential SRE taxa recorded within and outside the RDCLE study area. Although targeted searches outside the study area may result in confirmation of certain species being more widely distributed, targeting species that are often represented in surveys by few or single specimens may be unlikely to yield suitable results.

Determining the conservation significance of potential SRE taxa is therefore made difficult where:

- taxa are represented by one or few specimens;
- contextual information from the Western Australian Museum is unavailable; and
- additional targeted surveys are unlikely to yield results.

In regards to the potential SRE invertebrates recorded during the survey, the only practicable approach currently available is to adopt a risk-based assessment using defined habitat units as a surrogate for inferring distributional boundaries. To facilitate this, the spatial locations of the potential SRE taxa records from this survey were spatially intersected with the vegetation type mapping of Biota (2008e) using MapInfo GIS (Table 4.14). The vegetation types from which the potential SRE taxa were recorded were all represented elsewhere within the survey corridor (Biota 2008e), and the habitats are also widely distributed in the region at the coarser Land System scale (Table 4.14).

It is possible that these species are widely distributed and therefore may not be short-range endemic taxa as both genera have been recorded further a field during previous surveys. *Haplochernes* sp. has been recorded near Tom Price approximately 180 km SSE of Emu Siding (Biota 2008c). *Synsphyronus* sp. has been recorded in the Robe Valley approximately 100 km SW of Emu Siding (Biota 2007c.) and at West Turner Syncline near Tom Price approximately 150 km SSE of Emu Siding (Biota 2008d). However, until species level identifications and comparisons are conducted, their status as short range endemics remains undetermined. It is unlikely, however, that the relatively small proportion of these habitats that will be cleared to accommodate the rail would affect the conservation status of any of the recorded taxa.

Rhagada convicta has an extensive coastal distribution and as a result is not considered an SRE. Furthermore, molecular investigations of the species to date show no evidence of distinct populations or populations restricted to small geographical areas (Biota 2006a; Biota 2006b; Biota 2006c; Biota 2007). Long-term regional molecular investigations are likely to resolve the assignment of these collections to the species level. These collections are unlikely to qualify as SREs as distributions of *Rhagada* have been shown not to be restricted. This species has a wide distribution (Solem 1986) and does not qualify as an SRE.

Table 4.14: Locations of potential SRE taxa collection records in relation to vegetation types mapped by Biota (2008e) and Land Systems (Section 2.4.3).

Taxon	Sites	Vegetation Types	Land System and extent in subbioregions
Aname sp. A	PIR03	ApyAbTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* hummock grassland	RGEBGD (Boolgeeda) - Stony plains adjacent to hills; 167,663 ha
Aname sp. A	PIR06	AanTw - *Acacia ancoistrocarpa* over *Triodia wiseana* hummock grassland	RGERUT (Ruth) - Hills and ridges of volcanic and other rocks supporting hard spinifex grasslands – 149,049 ha
Aname sp. A	PIR08	ERAx - *Eragrostis xerophila* open tussock grassland	RGEHOF (Horesflat) - Gilgaied clay plains supporting tussock grasslands and grassy snakewood shrublands – 152,596 ha
Aname sp. A	PIR09	EvApyTwTeCE - *Acacia pyrifolia* tall shrubs over *A. arida* shrubland over *Triodia epactia, T. wiseana* or **C.cilliaris* hummock grassland	RGERUT (Ruth) - Hills and ridges of volcanic and other rocks supporting hard spinifex grasslands – 149,049 ha
Barychelidae	PIR18	ChApyAbTw - *Corymbia hamersleyana* low trees over *Acacia pyrifolia, A. bivenosa* shrubs over *Triodia wiseana* hummock grassland	RGECPN (Capricorn) - Rugged sandstone hills and ridges; hard spinifex or stony short grass forb pasture – 482,692 ha
Haplochernes	PIROPMG-02A	EvAtrTeCEc - *Eucalyptus victrix* low open woodland over *Acacia trachycarpa* tall open shrubland over *Triodia epactia* open hummock grassland and **Cenchrus ciliaris* tussock grassland	RGERUT (Ruth) - Hills and ridges of volcanic and other rocks supporting hard spinifex grasslands – 149,049 ha
Haplochernes	PIROPMG-02B		
Haplochernes	PIROPMG-03A	ApyAbTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* hummock grassland	RGEROC (Rocklea) – Basalt hills – 2,125,341 ha
Haplochernes	PIROPMG-03C		
Haplochernes	PIROPDK-01A	ChApyAbTw - *Corymbia hamersleyana* low trees over *Acacia pyrifolia, A. bivenosa* shrubs over *Triodia wiseana* hummock grassland	RGECPN (Capricorn) - Rugged sandstone hills and ridges; hard spinifex or stony short grass forb pasture – 482,692 ha
Haplochernes	PIROPDK-02A	ApyAsyTe - *Acacia pyrifolia, A. synchronicia* open shrubland over *Triodia epactia* hummock grassland	RGEHOF (Horesflat) - Gilgaied clay plains supporting tussock grasslands and grassy snakewood shrublands – 152,596 ha
Haplochernes	PIROPDK-02B		
Haplochernes	PIROPDK-03	ChAtuTeCE - *Corymbia hamersleyana* low woodland over *Acacia* tumida var. *pilbarensis* scrub over *Triodia epactia* open hummock grassland and *Cenchrus ciliaris, *C. setiger* tussock grassland	
Haplochernes sp. 1	PIROPMG-01	EvApyTwTeCE - *Eucalyptus victrix* low trees over Acacia pyrifolia open scrub to open shrubland over *Triodia wiseana, T. epactia* hummock grassland and **Cenchrus ciliaris, *C. setiger* open tussock grassland	RGERIV (River) - Active flood plains and major rivers supporting grassy eucalypt woodlands – 366,101 ha
Idipodidae sp. A	PIR08	ERAx - *Eragrostis xerophila* open tussock grassland	RGEHOF (Horesflat) - Gilgaied clay plains supporting tussock grasslands and grassy snakewood shrublands – 152,596 ha
Rhagada sp. ?	PIR017	EcEvMg - *Eucalyptus camaldulensis / E. victrix* low open woodland over *Melaleuca glomerata* tall shrubland	RGERIV (River) - Active flood plains and major rivers supporting grassy eucalypt woodlands – 366,101 ha
Rhagada sp. ?	ZHMGSN02	ApyAarTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. arida* open shrubland over *Triodia epactia, T. wiseana* hummock grassland	RGEROC (Rocklea) – Basalt hills – 2,125,341 ha
Rhagda convicta	PI001	ApyAbTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* hummock grassland	RGEBGD (Boolgeeda) - Stony plains adjacent to hills; 167,663 ha
Rhagda convicta	PIR03		
Rhagda convicta	PIR04		
Rhagda convicta	R1		
Rhagda convicta	PIRHARP01	EcEvMg - *Eucalyptus camaldulensis / E. victrix* low open woodland over *Melaleuca glomerata* tall shrubland	RGERIV (River) - Active flood plains and major rivers supporting grassy eucalypt woodlands – 366,101 ha
Synsphyronus	PIROPMG-03B	ApyAbTeTw - *Acacia pyrifolia* scattered tall shrubs over *A. bivenosa* open shrubland over *Triodia epactia, T. wiseana* hummock grassland	RGEROC (Rocklea) – Basalt hills – 2,125,341 ha

Taxon	Sites	Vegetation Types	Land System and extent in subbioregions
Synsphyronus	PIROPDK-01B	ChApyAbTw - *Corymbia hamersleyana* low trees over *Acacia pyrifolia, A. bivenosa* shrubs over *Triodia wiseana* hummock grassland	RGECPN (Capricorn) - Rugged sandstone hills and ridges; hard spinifex or stony short grass forb pasture – 482,692 ha
Synsphyronus	PIROPDK-02C	ApyAsyTe - *Acacia pyrifolia, A. synchronicia* open shrubland over *Triodia epactia* hummock grassland	RGEROC (Rocklea) – Basalt hills – 2,125,341 ha

5.0 Discussion

5.1 Overview

The species inventory recorded from the Rail Duplication Cape Lambert to Emu Siding study area, while comparatively low for seasonal sampling in the Pilbara Bioregion is representative of an adequate single-phase fauna survey. This is reflected in comparisons of the current results with two other recent systematic fauna surveys conducted in the vicinity of the RDCLE study area.

The seven basic habitat types of this study yielded a total of 118 vertebrate fauna species across a single-phase survey conducted in autumn. In comparison, Biota (2004) conducted a single-phase survey in the Sherlock Bay vicinity identifying three potential macrohabitats and utilising five trapping sites (that survey yielded a total of 56 fauna species). Similarly, five habitats identified in a study of the Cape Lambert Port area (Biota 2008b), over eleven sites, documented 120 species over two phases.

The following sections contain more detailed comparisons, and document specific examples of species not recorded during the RDCLE fauna survey and the habitats in which they occur.

5.2 Avifauna

The 53 avifauna species recorded during the single phase of the current study represents 84% of the 63 species recorded by Biota (2008b) for the Cape Lambert Port area, and 189% of the 28 species documented at Sherlock Bay (Biota 2004). Comparatively, the number of avifauna species recorded during this study is within expectations for the size of the study area and the available habitats.

The seven habitat types identified within the fauna survey area by this study (see Section 4.1), on the basis of vertical stratification and foraging opportunity, in effect yield only three avifauna habitat types comprising:

- Grassland plains;
- *Acacia* spp. shrubs over *Triodia* spp. on rocky hillslopes and small drainage lines; and
- *Eucalyptus* spp. over Buffel grass in a major drainage line.

The majority of avifauna species were recorded from habitats either comprising or adjacent to drainage lines (i.e. PIR05, PIR09 and PIR17; Table 4.1). Drainage lines provide both water and significant nesting/perching trees conducive to bird activity and high abundance. Sites away from water, with less vegetative cover and reduced vertical stratification (e.g. PIR13 and PIR16), exhibited lower diversity and abundance.

This relative lack of habitat diversity and vertical stratification accounts, at least in part, for the absence of avifauna species such as thornbills (*Acanthiza* spp.), which are characterised by a preference for denser habitats including *Acacia aneura* woodlands.

Notwithstanding the relatively low habitat diversity of the current study area, other factors have undoubtedly contributed to the apparent absence of other species that may be expected to occur in the area. Taxa such as the Emu *Dromaius novaehollandiae* and birds of prey (Accipitridae, Falconidae) have large ranges and may only occur periodically in any given area (meaning that longer or multiple phase sampling would be needed to record them). Still other species, such as Tree creepers (Climacteridae) and Sittellas (Neosittidae), are not commonly recorded. Finally, species characterised by nocturnal activity patterns were not documented during the fauna survey.

Based on species richness estimates (Colwell 2005), the total number of avifauna species recorded represent between 72% and 93% (mean = 82%) of the total predicted assemblage. As

previously noted, these figures are not definitive as different sampling outcomes can affect estimates (Colwell and Coddington 1994; Thompson and Withers 2003).

The estimated four to 21 species that remain unrecorded are likely to be at naturally low density, cryptic species, migratory or occur during specific seasonal/climatic conditions. As a result, it is likely that considerable additional sampling effort would be required, or sampling at another time of year, to add extra species to the current survey records.

5.3 Mammals

5.3.1 Non-volant Mammals

The total of twelve non-volant mammals documented during the RDCLE survey compares favourably with the twelve species recorded over two phases for the Cape Lambert Port area (Biota 2008b), and also with the six species recorded at Sherlock Bay (Biota 2004). The relative uniformity in species assemblages across these studies probably reflects the relative lack of habitat specificity in many of the small mammals found in the Pilbara Bioregion. Differences between the assemblages can largely be attributed to either the generally low abundances and distributional plasticity of many species over time combined with the small size of the study area, as well as habitat specificity in the small number of species where this is a factor.

Species that are considered to be common and non-specialists, including the Stripe-faced Dunnart *Sminthopsis macroura,* the House Mouse *Mus musculus*, the Euro *Macropus robustus* and the Desert Mouse *Pseudomys desertor* were typically recorded during all three studies.

Typically, where species were not recorded by one or more surveys, their absence can be attributed to a lack of suitable habitat or their relatively sparse distribution where habitat is available. The Lesser Hairy-footed Dunnart *Sminthopsis youngsoni* for example favours sandy substrates, which did not occur in the RDCLE study area. Alternatively, the Long-tailed Dunnart *Sminthopsis longicaudata* would be expected to occur in the rugged rocky areas in the RDCLE study area but was not recorded, whilst this survey was the only study to record the Short-tailed Mouse *Leggadina lakedownensis* (see Table 4.6). In both cases, this can be attributed to the relative scarcity of these species across their preferred habitats at the specific times when sampling was conducted.

The number of non-volant mammalian species recorded during the recent survey (n = 12) comprises 57% of the total number of terrestrial non-volant mammal species recorded by the Western Australian Museum (n=21, Appendix 2). Similar to the herpetofauna, this superficially indicates that the study area supports only half of the mammalian species typically found in this region. Again, it is pertinent to note that the Western Australian Museum FaunaBase search was conducted within a 50 km buffer of the study area and this most certainly includes habitat types not represented within the Rail Duplication study area.

Based on the calculated rarefaction curve and species richness estimates (Section 4.4.6), the number of non-volant mammalian species recorded in the study area is an adequate representation of the assemblage occurring within the habitats sampled. The total number of non-volant mammalian species recorded during the recent survey represent between 86% and 97% (mean = 92%) of the total predicted assemblage. Based on this, it is therefore unlikely that additional non-volant mammalian species would be recorded within the RDCLE study area as a result of further sampling effort at this time. Any additional species occurring within the study are likely to be at naturally low densities or less easily collectible and observable with the methods utilised in this study.

5.3.2 Bats

The total of seven bat species documented during the RDCLE fauna survey compares favourably with the inventories reported elsewhere. Biota recorded five bat species at both the Cape Lambert Port (Biota 2008b) and at Sherlock Bay (Biota 2004).

All seven of the bat species documented within the RDCLE study area were observed using echolocation call recording (see Section 3.4.4), rather than direct sampling techniques such as Harp trapping.

5.4 Herpetofauna

The inventory list compiled for the herpetofauna during the single phase of the RDCLE fauna survey, as with the mammal inventory, compares well with the species records from previous studies in the vicinity. The Cape Lambert Port area (Biota 2008b) recorded 40 herpetofauna species over two phases, while the current survey recorded 46 herpetofauna species (Table 4.8) over a single phase.

The number of herpetofauna species recorded during the recent survey (n = 46) comprises 48% of all herpetofauna recorded by the Western Australian Museum within the database search area ((n=95 (excluding marine and mangrove species), Appendix 2)). This indicates that the study area does not support a significant subset of herpetofauna typically found in this region. However, it should be noted that the Western Australian Museum FaunaBase search was conducted within a 50 km buffer of the study area and this most certainly includes habitat types not represented within the RDCLE study area. As a result, the total number of herpetofauna that may potentially be recorded from habitats occurring within the RDCLE study area may have been over represented.

Despite this, the low ratio of herpetofauna species recorded within the study area compared to museum records may indicate that the sampling regime in terms of trapping effort and/or survey would ideally have been more extenive and that additional, seasonal sampling may be warranted if a more comprehensive herpetofauna inventory is sought. The calculated rarefaction curve and non-parametric estimators (Table 4.10) support this.

Based on species richness estimates (Colwell 2005), the total number of herpetofauna species recorded represent between 55% and 77% (mean = 63%) of the total predicted assemblage within the study area. As discussed, it is likely that additional species would be recorded within the Rail Duplication study area as a result of further additional surveys.

Acacia sp. over *Triodia* hummock grassland habitat exhibited the greatest species richness within the study area (up to 13 species). This may be attributed to the fact that these habitats (PIR01, PIR03, PIR04, and PIR18) contain a relatively diverse flora assemblage with diverse microhabitats, thereby offering a variety of niches for reptiles to inhabit. The less floristically diverse buffel grass habitats (PIR09 and PIR17) also yielded high herpetofauna diversity. It should also be noted however, that the buffel grass habitats were not extensive and comprised of isolated pockets in the vicinity of *Triodia* sp. and creek-line habitat.

The survey data indicate that the more common and easily collected species were recorded during this exercise. The species that remain uncollected are likely to be at a naturally low density or less easily collectible with the methods utilised in this study. Alternatively, due to their behaviour and life history additional herpetofauna may be more conducive to capture during a different time of year.

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6.0 Conservation Significance

6.1 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 *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*).

6.1.1 *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).

6.1.2 *Wildlife Conservation Act 1950-1979*

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 2006* recognises four distinct schedules of taxa:

Schedule 1 - taxa are fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;
Schedule 2 - taxa are fauna which are presumed to be extinct and are declared to be fauna in need of special protection;
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
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.

6.2 Conservation Value of Fauna Habitats

There were no threatened ecological communities (TECs) recorded from within the boundaries of the RDCLE study area. No TECs would be expected in the study area as none are known to occur in the Chichester subregion of the Pilbara bioregion.

A number of community types in the Pilbara have been listed as Priority Ecological Communities by the DEC, however, none of these occur or would be expected within the boundaries of the expansion area (Kendrick and McKenzie 2001).

6.3 Threatened Fauna

Two species of Priority fauna were recorded within the RDCLE study area during the recent survey. No Schedule listed species were recorded.

Based on known fauna distributions, a total of 28 Schedule, Priority or Federal-listed species may potentially occur within the study area (Table 6.1, Appendices 1,2 and 3, Biota Internal Database).

The Banded Hare-wallaby *Lagostrophus fasciatus fasciatus* was listed in the DEC Threatened Fauna database search (Appendix 1) as recorded at Cossack, however we believe this to be an erroneous record due to its restricted distribution, both historical and current, to the southern half of Australia, and as such it will not be dealt with further in this report.

Table 6.1: Fauna of conservation significance occurring or potentially occurring within the RDCLE study area.

Species Name	Common Name	Status	
		State	Federal
Dasycercus blythi	Brush-tailed Mulgara	Schedule 1	Vulnerable
Dasyurus hallucatus ©	Northern Quoll	Schedule 1	Endangered
Rhinonicteris aurantius ©	Orange Leaf-nosed Bat	Schedule 1	Vulnerable
Liasis olivaceus barroni ©	Pilbara Olive Python	Schedule 1	Vulnerable
Falco peregrinus ©	Peregrine Falcon	Schedule 4	
Lerista quadrivincula ©		Priority 1	
Ramphotyphlops ganei ©		Priority 1	
Mormopterus loriae cobourgiana ^©	Little Northern Freetail Bat	Priority 1	
Antipodogomphus hodgkini ©	Pilbara Dragonfly	Priority 2	
Nosoticta pilbara ©	Pilbara Damselfly	Priority 2	
Lagorchestes conspicillatus leichardti	Spectacled Hare Wallaby (mainland)	Priority 3	
Sminthopsis longicaudata	Long-tailed Dunnart	Priority 3	
Neochmia ruficauda subclarescens *^©	Star Finch	Priority 4	

Species Name	Common Name	Status	
		State	Federal
Falco hypoleucos	Grey Falcon	Priority 4	
Macroderma gigas ©	Ghost Bat	Priority 4	
Pseudomys chapmani ©	Western Pebble-mound Mouse	Priority 4	
Leggadina lakedownensis *©	Short-tailed Mouse	Priority 4	
Ardeotis australis ©	Australian Bustard	Priority 4	
Burhinus grallarius ©	Bush Stone-curlew	Priority 4	
Phaps histrionica ©	Flock Bronzewing	Priority 4	
Notoscincus butleri ©		Priority 4	
Leiopotherapon aheneus ©	Fortescue Grunter	Priority 4	
Numenius madagascariensis ^©	Eastern Curlew	Priority 4	Migratory
Hirundo rustica ©	Barn Swallow		Migratory
Merops ornatus ©	Rainbow Bee-eater		Migratory
Apus pacificus	Fork-tailed swift		Migratory
Charadrius veredus ©	Oriental Plover		Migratory

* denotes species recorded in the recent Rail Duplication Cape Lambert to Emu survey.
^ denotes species recorded during the Cape Lambert Port Expansion Survey (Biota 2008b)
© denotes species listed in either the DEC Threatened Fauna Database, the WAM FaunaBase database, or *EPBC Act 1999* Protected Matters Report.

Accounts of the ecology, status and likelihood of occurrence and potential impacts on these threatened species follow.

6.3.1 Schedule Species

Brush–tailed Mulgara – *Dasycercus blythi*
State: Schedule 1
Federal: Vulnerable

Overview: Until recently, there has been considerable taxonomic confusion within the genus *Dasycercus*. For the last 30 years only one species, *D. cristicauda*, was recognized (Schedule 1, Vulnerable). More recently, based on genetic and morphological attributes, two species are now recognised, the Crest-tailed Mulgara, *D. cristicauda* and the Brush-tailed Mulgara, *D. blythi* (Woolley 2005, 2006). Woolley (2005, 2006) distinguished these two species on the following characteristics

- appearance of black hairs on the distal half of the tail (a brush in *D. blythi* versus a dorsal crest in *D. cristicauda*);
- the number of upper pre-molar teeth (two in *D. blythi* versus three in *D. cristicauda*); and
- in females, the number of teats (six in *D. blythi* versus eight in *D. cristicauda*).

It should be noted that os of the date of this report, the Western Australian Museum and the Department of the Environment, Water, Heritage and the Arts have yet to update their databases. As a result, both the Western Australian Museum FaunaBase search and the *EPBC Act 1999* Protected Matters report do not currently distinguish between the two species. That is, both species are currently registered as *D. cristicauda.*

Distribution: The Brush-tailed Mulgara occurs in spinifex sandplain habitat across the arid zone of Western Australia, the Northern Territory and Queensland. The Mulgara was formerly widespread in sandy deserts but they are now rare and patchily distributed. Recent records are from the Great Victoria, Gibson, Great Sandy, Little Sandy and Tanami deserts, the Pilbara, Gascoyne, Murchison, north-eastern Goldfields, the Central Ranges region and Carnarvon basin (Kennedy Range).

Ecology: The Brush-tailed Mulgara inhabits Spinifex grasslands and larger colonies coincide with relatively well watered areas such as paleo-drainage channels or drainage lines in sandplain or sand dune habitats (Maxwell *et al* 1996). They have a diet of small vertebrates and larger

invertebrates. Little is known about breeding of Brush-tailed Mulgaras, although females with up to six young in the pouch have been captured in September. Among captive animals, mating has been observed in May to June with young born in late June to August. Individuals have been known to come into breeding condition each year for six years (Woolley 2008).

Likelihood of Occurrence: This species may potentially occur within the RDCLE study area where undisturbed spinifex grassland occurs (eg. sites PIR06, PIR15 and PIR16).

Potential Impacts: The main impact to be considered is habitat loss. However, in the case of the proposed Rail Duplication habitat loss will be minimal and therefore it is unlikely to affect *D. blythi* or affect the conservation status of this species.

Northern Quoll – *Dasyurus hallucatus*
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 go 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.

Likelihood of Occurrence: It is likely that the Northern Quoll occurs within the study area, particularly near major creek lines and rivers. In addition to creek lines, this species is most abundant in open, rocky habitat and is also commonly found in gorges, where breeding is successful (Oakwood 2008). Aside from areas with major creeks and rivers, the majority of the RDCLE study area comprises sub-optimal habitat for this species as gorges and significant rocky habitat is absent.

Potential Impacts: As the proposed Rail Duplication will not significantly impact on any major creeks, rivers, or other habitat utilised by the Northern Quoll, it is unlikely to affect the Northern Quoll or affect the conservation status of the species.

Orange Leafnosed-bat – *Rhinonicteris aurantius*
State: Schedule 1 'Vulnerable'
Federal: Vulnerable

Distribution: The 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: Not recorded during the recent RDCLE survey. Although foraging may potentially occur within the study area, the lack of suitable habitat indicates this species is unlikely to roost within the project area.

Potential Impacts: As no major caves were observed to occur within the RDCLE study area, the proposed development will not affect *R. aurantius* or affect the conservation status of the species.

Pilbara Olive Python – *Liasis olivaceous barroni*
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: Given the species preference for gorges and escarpments this species may potentially occur within the RDCLE study area.

Potential Impacts: As the works associated with the Rail Duplication are unlikely to impact on gorge or escarpment habitat, the proposed Rail Duplication is unlikely to affect the Pilbara Olive Python or affect the conservation status of this species.

Peregrine Falcon – *Falco peregrinus*
State: Schedule 1

Distribution: The Peregrine Falcon has an almost cosmopolitan distribution, but is absent from most deserts and the Nullarbor Plain (Johnstone and Storr 1998).

Ecology: This species inhabits a wide range of habitats including forest, woodlands, wetlands and open country. The Peregrine Falcon feeds on small and medium-sized birds, as well as rabbits and other day-active mammals. The Peregrine Falcon maintains a home range of about 20 km to 30 km square. It nests in recesses of cliff faces, tree hollows and along rivers (Johnstone and Storr 1998)

Likelihood of Occurrence: Although not recorded during the recent RDCLE survey, the Peregrine Falcon is commonly recorded in the Pilbara. It is likely that the proposed Rail Duplication falls within the home range of one or more individual birds.

Potential Impacts: Habitat loss is a major threat, in particular, loss of woodland trees where the Peregrine Falcon nest in areas where there are no cliffs. Other threats include accidental poisoning from baits left for dingoes, and agricultural chemicals. The small-scale vegetation clearing associated with the Rail Duplication is unlikely to impact the conservation status of this species.

6.3.2 Priority Species

Lerista quadrivincula
State: Priority 1

Distribution: Known from a single specimen at Maitland River on the arid coastal plain near Karratha (Wilson and Swan 2008).

Ecology: No information available.

Likelihood of Occurrence: *L. quadrivincula* could potentially occur within the RDCLE study area, however very little is known about the distribution and habitat requirements of this species.

Potential Impacts: The conservation status of this species is unlikely to be altered by the proposed development given the relatively narrow area impacted.

Ramphotyphlops ganei
State: Priority 1

Distribution: This blind snake is poorly collected, being represented by just eight specimens in the WA Museum collection (Table 6.2).

Table 6.2: Locations in the Pilbara from which *Ramphotyphlops ganei* has been recorded.

Location	Latitude	Longitude
Pannawonica	21° 39' 00"S	116° 19' 00"E
Mt Whaleback	23° 20' 57"S	119° 34' 00"E
Millstream	21° 35' 00"S	117° 04' 00"E
Chichester Range	22° 01' 02"S	118° 58' 57"E
Chichester Range	22° 13' 49"S	118° 58' 55"E
Cathedral Gorge	23° 17' 30"S	119° 28' 00"E
An area 89 km west-northwest of Newman	23° 04' 00"S	118° 56' 00"E
Newman	23° 21' 00"S	119° 34' 00"E

Ecology: This species is poorly known, but individuals are likely to mostly inhabit the topsoil, in moist gorges and gullies (Wilson and Swan 2008) and may also frequent termitaria and ant nests. Blind snake diet typically consists of the eggs, larvae and pupae of ants (Storr *et al.* 2002).

Likelihood of Occurrence: Given that this species is known from areas between Newman and Pannawonica, including the Chichester Range, it may occur within the RDCLE study area.

Potential Impacts: The proposed Rail Duplication will not impact on any major gorges, gullies or termitaria and as a result, is unlikely to affect *R. ganei* or affect the conservation status of the species. Although the conservation status of *R. ganei* is difficult to ascertain from the small number of known records (hence its Priority 1 listing), these records indicate that it does not have a restricted distribution, and therefore its conservation status is unlikely to be affected by the proposal.

Little Northern Freetail Bat – *Mormopterus loriae cobourgiana*
State: Priority 1

Distribution: Endemic to Australia, this species' distribution encompasses the Western Australian coastal areas from Derby to the Exmouth Gulf (Churchill 1998).

Ecology: This species is a mangrove specialist, restricted to mangrove forest and adjacent areas. (Churchill 1998). This species has been found roosting in small spouts and crevices in dead upper branches of the mangrove *Avicennia marina*. Individuals emerge early in the evening in groups of up to 100 individuals above the mangrove canopy, before dispersing to forage alone or in pairs. *M. loriae* prey on insects above and beside the forest canopy. They give birth to single young, which are born in the wet season (summer) (Churchill 1998).

Likelihood of occurrence: This species was recorded by Biota during a recent survey at Cape Lambert (Biota 2008b).

Potential Impacts: Impacts through habitat loss are considered low as roosting occurs within the mangrove habitat and outside the proposed impact area. The conservation status of this species is unlikely to be altered by the proposed development.

Pilbara Dragonfly – *Antipodogomphus hodgkini*
State: Priority 2
Distribution: Holotype specimen collected from Millstream Spring, Millstream Station (Watson 1969). No additional published information is available for this species.

Ecology: No information available.

Likelihood of Occurrence: Although recorded solely from Millstream Spring (approximately 35 km south of Emu siding, 21.58°S, 117.07°E), this species may potentially occur further a field, including the Harding River.

Potential Impacts: As the proposed Rail Duplication will not impact on any major creeks, rivers or pools potentially providing breeding and nymph habitat, it is unlikely to affect the Pilbara Dragonfly or affect the conservation status of the species if it occurs in the area.

Pilbara Damselfly – *Nososticta pilbara*
State: Priority 2

Distribution: Similar to *Antipodogomphus hodgkini*, a holotype of *N. pilbara* was collected from Millstream Spring, Millstream Station (Watson 1969). No additional published information is available for this species.

Ecology: No information available.

Likelihood of Occurrence: Although recorded solely from Millstream Spring (approximately 35 km south of Emu siding, 21.58°S, 117.07°E), this species may potentially occur further a field, including the Harding River.

Potential Impacts: As the proposed Rail Duplication will not impact on any major creeks, rivers or pools potentially providing breeding and nymph habitat, it is unlikely to affect the Pilbara Dragonfly or affect the conservation status of the species if it occurs in the area.

Spectacled Hare Wallaby (mainland) – *Lagorchestes conspicillatus leichardti*
State: Priority 3

Overview: Although this species is listed by DEC as a Priority 3 species, DEC staff have expressed the opion it may required a higher level of protection. One of the primary concerns is the lack of current data to support the general belief that this species has undergone a dramatic decline in the Pilbara and WA as a whole.

Distribution: Occurs in the Pilbara and remains widespread and locally common through a broad swathe of the Northern Territory and northern Queensland. This species has declined drastically in the Great Sandy Desert (Menkhorst and Knight 2001). There are scattered records of this species from the Kimberley and Pilbara regions of Western Australia.

The distribution of the Spectacled Hare Wallaby is shown as an arc across much of northern Australia (Burbidge and Johnson 2008), with a sub-species (*L. c. conspicillatus*) also occurring on Barrow Island. The Western Australian populations appear to have declined drastically (Dr Dave Pearson, DEC, pers comm. 2006) and this species is now considered extinct in the Great Sandy and Gibson Deserts (Burbidge and Johnson 2008). Whilst the Barrow Island subspecies is listed as Vulnerable under the *EPBC Act 1999*, the WA mainland population is considered to be only Priority 3 despite localised extinctions and apparent substantial decline.

Ecology: Inhabits tussock or hummock grassland with mid-dense or sparse tree and shrub cover. Apparently prefers large spinifex (*Triodia*) clumps in which to shelter during the day, and the species' decline has been attributed to the absence of these hummocks, possibly as a result of increased frequency in burning and extensive grazing by cattle.

Likelihood of Occurrence: Potential habitat for this species exists over the project area, however much of the habitat has been fire affected in the past and is unlikely to support the Spectacled Hare Wallaby.

Potential Impacts: If this species does occur in the region, then impacts would include habitat clearing (although minimal in respect to the Rail Duplication proposal). Habitat modification through fire also poses a potential impact.

Long-tailed Dunnart – *Sminthopsis longicaudata*
State: Priority 3

Distribution: Inhabits rocky, rugged habitat from the Pilbara and adjacent upper Gascoyne region east to the central Northern Territory and South Australia (Menkhorst and Knight 2001).

Ecology: This species is a spring-summer breeder, and is a capable and active climber in rocky habitat (Burbidge *et al*. 2008). Records have come from plateaus near breakaways and screes, and rugged boulder strewn screes. Biota Environmental Sciences has recorded individuals from the Robe Valley (Biota 2006d) and at Mount Nicholas approximately 100 km north-east of Newman (Biota 2005b). This species was once considered to be rare and possibly threatened, however research has shown that it is relatively common and widespread, but is restricted to a specific habitat (Burbidge 2004).

Likelihood of Occurrence: There are few significant breakaways and screes within RDCLE study area. As a result, although possible, it is unlikely that significant populations of *S. longicaudata* occur within the study area.

Potential Impacts: Habitat loss is considered the main potential impact of *S. longicaudata*. However no major screes or breakaways will be impacted during the construction of the proposed rail duplication and as a result is unlikely to affect *S. longicaudata* or affect the conservation status of the species.

Star Finch (western) – *Neochmia ruficauda subclarescens*
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 and 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. 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: The Star Finch was recorded during the recent RDCLE survey on two occasions at site PIR09.

Potential Impacts: Destruction of habitat is likely to be the main potential impact on this species. The Rail Duplication will not significantly impact the core habitat of the Star Finch and as a result is unlikely to affect the conservation status of this species.

Grey Falcon – *Falco hypoleucos*
State: Priority 4

Distribution: The Grey Falcon is endemic to Australia, where it is widespread but rare throughout the arid zone. This species 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.

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).

Likelihood of Occurrence: Although the Grey Falcon may potentially occur within the RDCLE study area, it has not been recorded in previous surveys at nearby Cape Lambert (Biota 2008b).

Potential Impacts: Potential impacts are likely to be similar to that of the Peregrine Falcon. That is, loss of potential nesting and foraging habitat. The proposed RDCLE will not significantly impact nesting or foraging habitat of this species and as a result, the conservation status of this species, if present in the study area, is unlikely to be affected by the proposal.

Ghost Bat – *Macroderma gigas*
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). This species 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 2004; 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).

Likelihood of Occurrence: This species was not recorded during the recent RDCLE survey. The Ghost Bat is likely to occur within the study area, at least while foraging, however suitable roosting caves were not observed within the RDCLE study area.

Potential Impacts: As no major caves were observed to occur within the RDCLE study area, the proposed works will not affect *M. gigas* or affect the conservation status of the species.

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

Distribution: *P. 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 metres (Start 2008). This mound formation is most common on spurs and gentle slopes with suitable size class stones.

Likelihood of Occurrence: This species was not recorded during the recent RDCLE survey. The majority of the RDCLE study area occurs on clay substrate, however it does contain a number of stony hill slopes that have potential to support *P. chapmani*.

Potential Impacts: There is potential for mortality of *P. chapmani* during construction of the rail duplication. However, due to the relatively narrow area impacted (along the existing rail), the conservation status of this species is unlikely to be affected by the proposed development.

Short-tailed Mouse – *Leggadina lakedownensis*
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).

Ecology: *L. lakedownensis* occupies a diverse range of environments from monsoon tropical coast to semiarid climates including Spinifex and tussock grasslands, samphire and sedgelands (Moro and Kutt 2008). Regional records suggest that the primary mainland habitat comprises areas of cracking clay and adjacent habitats, although this species has also been recorded from hilltops (Dr Peter Kendrick, DEC Karratha, pers. comm. 2003) and sandy coastal areas near Onslow.

Likelihood of Occurrence: This species was recorded from one individual at PIR07 during the recent RDCLE survey.

Potential Impacts: The proposed Rail Duplication is likely to result in clearing of habitat inhabited by *L. lakedownensis*. However, given the large areas of clay habitat and the relatively small areas that may be cleared, the proposed development is unlikely to affect the conservation status of this species.

Australian Bustard – *Ardeotis australis*
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).

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). The Bustard 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 is common in the Pilbara and is likely to occur within the RDCLE study area.

Potential Impacts: Small-scale habitat loss associated with additional infrastructure and potentially altered fire regimes are potential impacts to the Australian Bustard. However, the proposed Rail Duplication would not affect the conservation status of this species at either the Pilbara bioregion or Chichester subregion level.

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

Distribution: The Bush Stone-curlew is widespread throughout much of Australia. The species remains common in tropical Australia but has declined alarmingly particularly in temperate regions (Marchant and Higgins 1993). Populations appear secure in the Pilbara (Ron Johnstone, WA Museum, pers. comm. 2003).

Ecology: The nocturnal Bush Stone-curlews inhabit sparsely grassed, lightly timbered forest or woodland. This species breeds from July to January. The eggs are either laid directly on the ground or in a small scrape (Johnstone and Storr 1998). The Bush Stone-curlew feeds primarily on invertebrates, particularly beetles, but also eats small lizards, frogs, snakes, vegetation and seeds (Marchant and Higgins 1993).

Likelihood of Occurrence: Although not recorded during the recent RDCLE fauna survey, the Bush Stone-curlew is likely to occur within the study area.

Potential Impacts: Foxes are 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). However, the proposed RDCLE is unlikely to affect the Bush Stone-curlew and will not affect the conservation status of this species.

Flock Pigeon – *Phaps histrionica*
State: Priority 4

Distribution: Inhabits coastal riverine plains of north-west WA, south to Carnarvon. Also in Kimberley and arid and semiarid north-eastern interior of Australia. (Johnstone and Storr 1998).

Ecology: The Flock Pigeon is typically found on treeless or sparsely wooded grassy plains and is probably nomadic (Marchant and Higgins 1993; Johnstone and Storr 1998). It has declined greatly in the last century due to the degradation of its habitat by livestock and there were no records of this species in the Pilbara during the most recent Birds Australia Bird Atlas Project (Barrett et al. 2003).

Likelihood of Occurrence: This species has potential to occur within the study area, but given its rarity in the Pilbara, this is unlikely. However, it should be noted that populations fluctuate dramatically throughout space and time and they are known as a 'boom-bust' species. They can be locally abundant following good seasons but then vanish and may not reappear in the area for decades.

Potential Impacts: The proposed RDCLE will not affect the conservation status of this species.

Eastern Curlew – *Numenius madagascariensis*
State: Priority 4
Federal: Migratory

Distribution: The Eastern Curlew occurs throughout coastal Western Australia, south to Bunbury (Johnstone and Storr 1998).

Ecology: This species occurs mainly on tidal mudflats, and also on sandy beaches and rarely near coastal lakes (including saltfields ponds) (Johnstone and Storr 1998). The Eastern Curlew breeds in northern Asia and is a summer migrant to Australia. It is moderately common in the Pilbara.

Likelihood of occurrence: This species was recorded by Biota during a recent survey at Cape Lambert (Biota 2008b).

Potential Impacts: The project is unlikely to present any significant habitat loss for this species as mangrove and intertidal habitats will not be affected by the proposed expansion.

Notoscincus butleri
State: Priority 4

Distribution: *Notoscincus butleri* is endemic to Western Australia and restricted to the arid northwest of the Pilbara bioregion (Storr *et al*. 1999).

Ecology: *N. butleri* has been associated with Spinifex-dominated areas near creek and river margins (Wilson and Swan 2003; Mr Greg Harold, pers. comm. 2004). This small skink is diurnal and oviparous (Wilson and Knowles 1988).

Likelihood of Occurrence: Although not recorded during the recent RDCLE survey, this species has potential to occur near creeks and rivers within the study area.

Potential Impacts: The proposed development is unlikely to affect *N. butleri* and will not affect the conservation status of this species.

Fortescue Grunter – *Leiopotherapon aheneus*
State: Priority 4

Distribution: Endemic to the Pilbara, and previously thought to be restricted to the Fortescue catchment until specimens were captured recently from the Ashburton and Robe Rivers (*Allen et al*. 2002 and *Morgan et al.* 2003).

Ecology: This species is found in slow to fast flowing streams and pools over sand or rock substrates, sometimes congregating at the base of small waterfalls. The diet typically includes small crustaceans and juvenile fishes. Little else is known about the biology of this species (*Allen et al.* 2002).

Likelihood of Occurrence: Although not recorded from the Harding River, *L. aheneus* may potentially occur there, given that it has been recorded from three nearby rivers.

Potential Impacts: As the proposed RDCLE will not impact on any major creeks or rivers potentially inhabited by the Fortescue Grunter, it is unlikely to affect the Fortescue Grunter or affect the conservation status of the species.

6.3.3 Migratory Species

Barn Swallow – *Hirundo rustica*
Federal: Migratory

Distribution: The Barn Swallow is highly migratory, with Australian migrants visiting predominantly northern Australia (Johnstone and Storr 1998).

Ecology: The Barn Swallow inhabits mainly towns and wetlands, visiting Australia from September to April (Johnstone and Storr 1998).

Likelihood of Occurrence: Although not recorded during the recent RDCLE fauna survey, the Barn Swallow has potential to occur within the study area, most likely near the Harding Dam during September to April.

Potential Impacts: The RDCLE will not significantly impact the core habitat frequented by the Barn Swallow (wetlands) and as a result is unlikely to affect the conservation status of this species.

Rainbow Bee-eater – *Merops ornatus*
Federal: Migratory

Distribution: The Rainbow Bee-eater is a regular breeding migrant to Western Australia.

Ecology: The species nests in small holes excavated in sandy banks or flat sandy surfaces (Johnstone and Storr 1998), occurring in habitats that provide suitable soil for nesting and a tall stratum of vegetation for perching (Higgins 1999).

Likelihood of Occurrence: The Rainbow Bee-eater was not recorded during the recent RDCLE survey, however it is likely this species will occur within the study area as suitable habitat is available.

Potential Impacts: The proposed development is unlikely to affect *M. ornatus* and will not affect the conservation status of this species.

Fork-tailed Swift – *Apus pacificus*
Federal: Migratory

Distribution: This species has a temporally and spatially extremely patchy distribution throughout Australia.

Ecology: Visitor to Australia from October to January, this species inhabits varied habitats including coasts and urban areas, with tendency to more arid areas (Simpson and Day 2004).

Likelihood of Occurrence: Although not recorded during the recent RDCLE survey, this species may occur in the study area at irregular intervals.

Potential Impacts: The proposed RDCLE is unlikely to affect *A. pacificus* and will not affect the conservation status of this species.

Oriental Plover – *Charadrius veredus*
Federal: Migratory

Distribution: The Oriental Plover occurs mainly in the Kimberley and north-eastern interior and is considered a casual visitor elsewhere.

Ecology: The species typically inhabits sparsely vegetated plains, beaches and tidal flats (Johnstone and Storr 1998).

Likelihood of Occurrence: *C. veredus* was not recorded during the recent RDCLE survey, however it may occur within the project area over the summer months (September to March).

Potential Impacts: The proposed RDCLE is unlikely to affect *C. veredus* and will not affect the conservation status of this species.

Other Migratory Species
The *EPBC Act 1999* Protected Matters Report (Appendix 3) also lists additional migratory species:

- White-bellied Sea-Eagle – *Haliaeetus leucogaster*
- Great Egret – *Ardea alba*
- Cattle Egret – *Ardea ibis*
- Ruddy Turnstone – *Arenaria interpres*
- Oriental Pratincole – *Glareola maldivarum*
- Little Curlew – *Numenius minutes*
- Whimbrel – *Numenius phaeopus*
- Common Greenshank – *Tringa nebularia*

However, these are considered unlikely to occur within the RDCLE study area and the proposed rail duplication is unlikely to affect these species.

6.4 Species of Interest

The *Heteronotia* sp. recorded during the RDCLE fauna survey (Table 4.8) is not currently assigned a conservation listing in either the *EPBC Act 1999* or the *Wildlife Conservation Act 1950-1979*, however it should be noted that to date records of this species are known solely from two locations. That is, from dolerite boulder habitat between 21°05'48"S, 117°06'23"E (PIRF14) and 21°02'11"S, 117°06'22"E, separated by only 7 km.

Based on aerial photography it is clear that the dolerite boulder piles are patchily distributed over an area of approximately 4,000 km^2 (approximately 80 km x 50 km). It is likely that *Heteronotia* sp. occurs on dolerite boulder pile habitat throughout this area.

6.5 Potential SRE Invertebrates

Several potential Short Range Endemic invertebrate species, (mygalomorph spiders, pseudoscorpions and pulmonate snails), were recorded from the Rail Duplication Cape Lambert to Emu Siding study area (Section 4.6). While the conservation significance of these species is not fully known, the specimens have been lodged with the Western Australian Museum and are currently the subject of a long-term phylogeographic study examining the broader distribution of putative taxa.

A risk-based assessment was adopted using defined habitat units as a surrogate for inferring distributional boundaries of potential SREs. Based on the broad distribution of habitat types and vegetation units from which the potential SREs were recorded in the study area, it was concluded that the taxa are likely to be more widely distributed beyond the relatively narrow confines of the study corridor. (see Section 4.6.5).

6.6 Conservation Significance Summary

The survey of the RDCLE project area yielded a combined total of 118 vertebrate species, comprising 53 avifauna species, 19 mammals and 46 herpetofauna species: three frogs and 43 reptiles. This tally appears in keeping with other similar surveys completed in the region and does not appear to indicate a particularly diverse assemblage. The species recorded were also representative of the taxa commonly recorded in this part of the bioregion. This is consistent with the available habitat data, which indicates that no restricted or uncommon geological units or land systems occur in the study corridor (see Table 2.1 and Table 2.2).

No Schedule listed fauna, or fauna species listed under the *EPBC Act 1999*, were recorded during the survey. Reviews of habitats present and known distributions suggested that four Schedule fauna species may occur in the corridor. The relatively linear nature of the development, which is also consolidated with an existing disturbance corridor, indicates a low risk of significant impact to these Schedule species in the even that they do occur. Two Priority fauna species, the Western Star Finch and the Short-tailed Mouse, were recorded during the survey. In both cases, only a relatively small proportion of local habitat suitable for these taxa would be cleared for the rail duplication, in addition to their wider distribution in the region.

7.0 References

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Appendix 1

DEC Threatened Fauna Database Search

Threatened and Priority Fauna Database

20.488 °S 116.622 °E / 21.678 °S 117.58 °E Pilbara Iron rail duplication area

*	Date	Certainty	Seen	Location Name	Method
Schedule 1 - Fauna that is rare or is likely to become extinct					
Dasyurus hallucatus				**Northern Quoll**	*14 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.					
		1		BULGARRA	
		1		ROEBOURNE	
	1900	1		MAITLAND	
	1900	1		ROEBOURNE	
	1958	1		MILLSTREAM	
	1958	1		MILLSTREAM	
	1958	1		MILLSTREAM	
	1967	1		POINT SAMSON	
	1975	1		WICKHAM	
	1988	1		FORTESCUE	
	1988	1		MILLSTREAM	
	1990	1		MAITLAND	
	1990	1		MAITLAND	
	1996	1	6	Fortescue	Night sighting
Lagostrophus fasciatus fasciatus				**Banded Hare-wallaby, Mernine**	*1 records*
This small macropod occurs in low shrubland and extant populations occur on Bernier and Dorre islands in Shark Bay. An attempted reintroduction to Peron Peninsula showed that the species is highly vulnerable to predation from cats as well as foxes.					
		2		Cossack	Day sighting
Rhinonicteris aurantius				**Orange Leaf-nosed Bat**	*1 records*
This species of bat occurs in a few scattered locations in the Pilbara, as well as the Kimberley. It roosts in caves and is sensitive to human disturbance.					
		1	1	Millstream-Chichester NP	Dead
Liasis olivaceus barroni				**Pilbara Olive Python**	*6 records*
	1923	1	1	Millstream-Chichester NP	Caught or trapped
	1986	1	1	Millstream-Chichester NP	Day sighting
	1993	3	1	Dolphin Island Nature Reserve	Day sighting
	2001	1	9	Burrup Rifle Range	
	2004	1	1	Burrup	Hair/skin
	2005	1	1	Dampier	Day sighting
Schedule 4 - Other specially protected fauna					
Falco peregrinus				**Peregrine Falcon**	*1 records*
This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.					
	2006	1	1	Burrup	Day sighting
Priority One: Taxa with few, poorly known populations on threatened lands					

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Threatened and Priority Fauna Database

20.488 °S 116.622 °E / 21.678 °S 117.58 °E Pilbara Iron rail duplication area

*	Date	Certainty	Seen	Location Name	Method
Mormopterus loriae cobourgiana				**Little North-western Mastiff Bat**	*2 records*
This species occurs along the northwest coast and is known to roost in mangroves.					
	2001	2		Cowrie Cove	Heard
	2006	1	1	Burrup	Caught or trapped
Lerista quadrivincula					*1 records*
This is skink known from only one locality on the Maitland River south east of Karratha Homestead.					
	1990	1	1	Mt Welcome	Caught or trapped
Priority Two: Taxa with few, poorly known populations on conservation lands					
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.					
	1958	1	12	Millstream-Chichester NP	
Antipodogomphus hodgkini				**(dragonfly)**	*1 records*
A species of dragonfly known from Millstream Spring and permanent pools of the Fortescue River and Tanberry Creek.					
	1958	1	2	Millstream-Chichester NP	
Nososticta pilbara				**(dragonfly)**	*2 records*
A species of dragonfly known from Millstream Spring.					
	1969	1		Millstream-Chichester NP	
	2002	1	4	Millstream-Chichester NP	
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.					
	1958	1		Millstream-Chichester NP	Day sighting
	2006	1	1	Burrup	Caught or trapped
Pseudomys chapmani				**Western Pebble-mound Mouse, Ngadji**	*6 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	2	0	Karratha	Definite signs
	1983	2	0	Burrup Peninsula	Definite signs
	1992	1	1	Millstream-Chichester NP	Caught or trapped
	1994	1		Millstream-Chichester NP	
	1994	2	0	Mt Anketel	
	1994	2	0	Zebra Hill	
Ardeotis australis				**Australian Bustard**	*1 records*
This species is uncommon and may occur in open or lightly wooded grasslands.					
	2007	1	2	Mount Anketell	Day sighting

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Threatened and Priority Fauna Database

20.488 °S 116.622 °E / 21.678 °S 117.58 °E Pilbara Iron rail duplication area

*	Date	Certainty	Seen	Location Name	Method
Burhinus grallarius				**Bush Stonecurlew**	*8 records*
A well camouflaged, ground nesting bird which prefers to 'freeze' rather than fly when disturbed. It inhabits lightly timbered open woodlands.					
	1999	1		MILLSTREAM	
	1999	1		MILLSTREAM	
	2000	1		MILLSTREAM	
	2000	1		SHERLOCK	
	2000	1		MILLSTREAM	
	2001	1		MILLSTREAM	
	2001	1		MILLSTREAM	
	2006	1	1	Burrup	Day sighting
Numenius madagascariensis				**Eastern Curlew**	*2 records*
This species is a migratory visitor and has been observed on reef flats and sandy beaches along the West Australian coast and in coastal estuaries.					
	1966	1		Nichol Bay	Day sighting
	2002	1	2	Nichol Bay	
Phaps histrionica				**Flock Bronzewing**	*2 records*
This species is gregarious and occurs in treeless or sparsely wooded grassy plains within reach of open water.					
	1968	1	300	Nickol River	Day sighting
	1985	1	50	Warambie	Day sighting

* 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

Western Australian Museum FaunaBase Database Search

Birds collected between -20.488, 116.622 and -21.678, 117.58

Acanthizidae
Gerygone tenebrosa
Smicrornis brevirostris

Accipitridae
Aquila audax
Circus assimilis
Haliaeetus leucogaster
Haliastur indus girrenera
Haliastur sphenurus
Pandion haliaetus cristatus

Aegothelidae
Aegotheles cristatus cristatus

Alaudidae
Mirafra javanica horsfieldii

Anatidae
Anas gracilis
Anas rhynchotis rhynchotis
Anas superciliosa
Chenonetta jubata

Anhingidae
Anhinga melanogaster novaehollandiae

Ardeidae
Ardea pacifica
Ardea sacra sacra
Ixobrychus flavicollis australis
Nycticorax caledonicus hilli

Artamidae
Artamus cinereus
Artamus cinereus melanops
Artamus leucorynchus
Artamus leucorynchus leucopygialis
Artamus minor

Campephagidae
Coracina novaehollandiae subpallida
Lalage tricolor

Caprimulgidae
Eurostopodus argus

Casuariidae
Dromaius novaehollandiae

Centropodidae
Centropus phasianinus highami

Charadriidae
Charadrius melanops
Charadrius ruficapillus

Climacteridae
Climacteris melanura wellsi

Columbidae
Geopelia cuneata
Geopelia humeralis
Geopelia striata placida
Geophaps plumifera
Phaps chalcoptera
Phaps histrionica

Corvidae
Corvus bennetti
Corvus orru cecilae

Cracticidae
Cracticus tibicen

Cuculidae
Chrysococcyx basalis
Cuculus pallidus
Cuculus saturatus optatus

Dicruridae
Grallina cyanoleuca
Rhipidura fuliginosa preissi
Rhipidura leucophrys leucophrys
Rhipidura phasiana

Falconidae
Falco berigora berigora
Falco longipennis longipennis

Haematopodidae
Haematopus longirostris

Halcyonidae
Dacelo leachii leachii
Todiramphus chloris pilbara
Todiramphus pyrrhopygia
Todiramphus sanctus sanctus

Hirundinidae
Hirundo nigricans nigricans

Laridae
Anous stolidus pileatus
Sterna albifrons

Maluridae
Amytornis striatus whitei
Malurus lamberti assimilis
Malurus leucopterus leuconotus
Stipiturus ruficeps ruficeps

Meliphagidae
Epthianura tricolor
Lichenostomus keartlandi
Lichenostomus penicillatus
Lichenostomus virescens
Lichmera indistincta indistincta
Melithreptus gularis laetior

Meropidae
Merops ornatus

Motacillidae
Anthus australis australis

Muscicapidae
Ficedula cyanomelana cyanomelana

Pachycephalidae
Colluricincla harmonica rufiventris
Pachycephala lanioides
Pachycephala melanura melanura
Pachycephala rufiventris rufiventris

Pardalotidae
Pardalotus rubricatus
Pardalotus striatus murchisoni

Passeridae
Emblema pictum
Neochmia ruficauda
Neochmia ruficauda clarescens
Taeniopygia guttata castanotis

Petroicidae
Eopsaltria pulverulenta
Petroica cucullata

Phalacrocoracidae
Phalacrocorax sulcirostris

Phasianidae
Coturnix ypsilophora australis
Coturnix ypsilophora cervina

Pittidae
Pitta moluccensis

Podargidae
Podargus strigoides
Podargus strigoides brachypterus

Pomatostomidae
Pomatostomus superciliosus
Pomatostomus temporalis rubeculus

Psittacidae
Cacatua roseicapilla assimilis
Cacatua sanguinea westralensis
Pezoporus occidentalis
Platycercus zonarius zonarius

Rallidae
Gallirallus philippensis mellori
Porphyrio porphyrio melanotus
Porzana tabuensis

Scolopacidae
Tringa glareola

Strigidae
Ninox novaeseelandiae boobook

Sylviidae
Acrocephalus australis
Acrocephalus australis gouldi
Cincloramphus cruralis
Cincloramphus mathewsi
Cisticola exilis exilis

Threskiornithidae
Threskiornis spinicollis

Zosteropidae
Zosterops luteus
Zosterops luteus balstoni

Mammals collected between -20.488, 116.622 and -21.678, 117.58

Canidae
Canis lupus dingo
Vulpes vulpes

Dasyuridae
Dasykaluta rosamondae
Dasyurus hallucatus
Ningaui timealeyi
Planigale sp
Pseudantechinus roryi
Pseudantechinus woolleyae
Sminthopsis macroura

Delphinidae
Lagenodelphis hosei

Dugongidae
Dugong dugon

Emballonuridae
Taphozous georgianus

Hipposideridae
Rhinonicteris aurantius

Macropodidae
Macropus robustus erubescens
Petrogale rothschildi

Molossidae
Chaerephon jobensis
Mormopterus beccarii

Muridae
Leggadina lakedownensis
Mus musculus
Notomys alexis
Pseudomys chapmani
Pseudomys delicatulus
Pseudomys hermannsburgensis
Rattus rattus
Rattus tunneyi
Zyzomys argurus

Pteropodidae
Pteropus alecto
Pteropus scapulatus

Tachyglossidae
Tachyglossus aculeatus

Vespertilionidae
Chalinolobus gouldii
Nyctophilus bifax daedalus
Scotorepens greyii
Vespadelus finlaysoni
Vespadelus regulus

Amphibia collected between -20.488, 116.622 and -21.678, 117.58

Hylidae
Cyclorana australis
Cyclorana maini
Litoria rubella

Myobatrachidae
Limnodynastes spenceri
Notaden nichollsi
Pseudophryne douglasi
Uperoleia russelli

Reptiles collected between -20.488, 116.622 and -21.678, 117.58

Agamidae
Ctenophorus caudicinctus
Ctenophorus isolepis isolepis
Ctenophorus nuchalis
Ctenophorus reticulatus
Lophognathus gilberti gilberti
Lophognathus longirostris
Pogona minor
Pogona minor mitchelli
Tympanocryptis cephala

Boidae
Antaresia perthensis
Antaresia stimsoni stimsoni
Aspidites melanocephalus
Liasis olivaceus barroni

Cheloniidae
Chelonia mydas
Eretmochelys imbricata bissa
Natator depressus

Cheluidae
Chelodina steindachneri

Colubridae
Fordonia leucobalia

Elapidae
Acalyptophis peronii
Acanthophis wellsi
Aipysurus apraefrontalis
Aipysurus laevis
Brachyurophis approximans
Demansia psammophis cupreiceps
Demansia rufescens
Furina ornata
Hydrelaps darwiniensis
Parasuta monachus
Pseudechis australis
Pseudonaja modesta
Pseudonaja nuchalis
Suta fasciata
Suta punctata
Vermicella snelli

Gekkonidae
Crenadactylus ocellatus
Crenadactylus ocellatus horni
Diplodactylus conspicillatus
Diplodactylus mitchelli
Diplodactylus savagei
Diplodactylus stenodactylus
Gehyra pilbara
Gehyra punctata
Gehyra purpurascens
Gehyra variegata
Heteronotia binoei
Nephrurus levis pilbarensis
Nephrurus wheeleri cinctus
Oedura marmorata
Rhynchoedura ornata
Strophurus ciliaris aberrans
Strophurus elderi

Pygopodidae
Delma elegans
Delma nasuta
Delma pax
Delma tincta
Lialis burtonis
Pygopus nigriceps

Scincidae
Carlia munda
Carlia triacantha
Cryptoblepharus carnabyi
Cryptoblepharus plagiocephalus
Ctenotus duricola
Ctenotus grandis titan
Ctenotus helenae
Ctenotus pantherinus ocellifer
Ctenotus robustus
Ctenotus rubicundus
Ctenotus saxatilis
Ctenotus serventyi
Cyclodomorphus melanops
Egernia depressa
Egernia formosa
Egernia pilbarensis
Eremiascincus richardsonii
Glaphyromorphus isolepis
Lerista bipes
Lerista flammicauda
Lerista muelleri
Lerista quadrivincula
Menetia greyii
Menetia surda surda
Morethia ruficauda exquisita
Notoscincus butleri
Notoscincus ornatus ornatus
Tiliqua multifasciata

Typhlopidae
Ramphotyphlops ammodytes
Ramphotyphlops australis
Ramphotyphlops braminus
Ramphotyphlops ganei
Ramphotyphlops grypus
Ramphotyphlops pilbarensis

Varanidae
Varanus acanthurus
Varanus brevicauda
Varanus eremius
Varanus gouldii
Varanus panoptes rubidus
Varanus pilbarensis
Varanus tristis

Appendix 3

EPBC Act 1999 Protected Matters Database Search

Matters of National Environmental Significance*		
Threatened Species	**Status**	**Type of Presence**
Mammals		
Dasycercus cristicauda Mulgara	Vulnerable	Species or species habitat likely to occur within area
Dasyurus hallucatus Northern Quoll	Endangered	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 Terrestrial Species	**Status**	**Type of Presence**
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Breeding known to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur with area
Migratory Wetland Species	**Status**	**Type of Presence**
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone	Migratory	Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Numenius phaeopus Whimbrel	Migratory	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank	Migratory	Species or species habitat likely to occur within area

* Note marine species have been excluded from EPBC protected Matters Report.

Appendix 4

DEC Regulation 17 and Regulation 4 Permits

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 NO. 1 SF006301

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	INVERTEBRATE AND VERTEBRATE SURVEY RUNNING ALONGSIDE THE EXISTING PILBARA IRON RAILWAY FROM JUNA DOWNS TO CAPE LAMBERT
AUTHORISED PERSONS	GARTH HUMPHREYS, DAN KAMIEN, DR PHIL RUNHAM, MICHAEL GREENHAM, ZOE HAMILTON, JASON ALEXANDER, ERIN HARRIS, TIM SASHSE, GREG HAROLD.

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

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Facsimile: 08 9334 0242

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

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NO. SF006301

DATE OF ISSUE 31/03/2008
VALID FROM 30/03/2008
DATE OF EXPIRY 30/03/2009

LICENSING OFFICER

(ROY JOHN)

LICENSEE: MR RJ TEALE
ADDRESS BIOTA ENVIRONMENTAL SERVICES
P.O. BOX 155
LEEDERVILLE WA 6903

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 NO. 1 CE001968

RECEIPT NO. **AMOUNT** $0.00

CONSERVATION AND LAND MANAGEMENT REGULATIONS 2002
REGULATION 4

AUTHORITY TO ENTER CALM LAND AND/OR WATERS

FOR THE PURPOSE(S) DESCRIBED

A LAWFUL AUTHORITY APPLICABLE TO REGULATIONS 8, 10, 12, 18 AND 31 OF THE CONSERVATION AND LAND MANAGEMENT REGULATIONS 2002.

DIRECTOR GENERAL

CONDITIONS

1. THIS AUTHORITY IS A WRITTEN NOTICE FOR THE PURPOSES OF REGULATION 4(1) OF THE CONSERVATION AND LAND MANAGEMENT REGULATIONS 2002 (THE REGULATIONS) AND IT AUTHORISES THE PERSON NAMED AS THE AUTHORITY HOLDER TO CARRY OUT CERTAIN ACTS AS DESCRIBED UNDER "PURPOSE" (BELOW), THAT WOULD OTHERWISE BE UNLAWFUL UNDER THE REGULATIONS CITED IN THIS AUTHORITY.
2. THIS AUTHORITY, TOGETHER WITH THE ACCOMPANYING ATTACHED CONDITIONS, PERMITS ACCESS TO "DEC LAND" (REGULATION 2) FOR THE PURPOSE OF TAKING FLORA OR FAUNA (REGULATION 8), FEEDING FAUNA (REGULATION 10), POSSESSING THINGS USED FOR TAKING FAUNA (REGULATION 12), TAKING NON-INDIGENOUS ANIMALS (REGULATION 18), AND/OR REMOVAL OF A NATURALLY OCCURRING FEATURE (REGULATION 31), AS APPLICABLE FOR THE PURPOSE DESCRIBED BELOW.
3. WHERE APPLICABLE, LICENCES ISSUED UNDER REGULATION 89 OR SECTION 15(1) AND/OR SECTION 23C OF THE WILDLIFE CONSERVATION ACT 1950 FOR THE TAKING OF FLORA AND/OR FAUNA ARE REQUIRED IN ADDITION TO THIS AUTHORITY.
4. THIS AUTHORITY DOES NOT COMPRISE A LAWFUL AUTHORITY TO ENTER "DEC LAND" THE SUBJECT OF DIVISION 1 OF PART 3 OF THE REGULATIONS UNLESS THE LAND AND/OR WATERS IS DESCRIBED BELOW. ("DEC LAND" IS DEFINED IN REGULATION 2 TO MEAN LAND, OR LAND AND WATERS, TO WHICH THE REGULATIONS APPLY, INCLUDING CAVES AND PARTS OF CAVES ON, OR UNDER THAT LAND. THE REGULATIONS APPLY TO THE LAND AND WATERS DESCRIBED IN REGULATION 3).
5. IT IS ESSENTIAL THAT DEC REGIONAL/DISTRICT OFFICE(S), AND WHERE APPLICABLE PARK RANGER(S), ARE CONTACTED BY THE AUTHORITY HOLDER AT LEAST 48 HOURS PRIOR TO ACTIVITIES TAKING PLACE IN DEC LAND UNDER THIS AUTHORITY.
6. 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.

LOCATIONS	MILLSTREAM -CHICHESTER NP KARINJINI NP
PURPOSE	INVERTEBRATE AND INVERTEBRATE FAUNA SURVEY ALONG SIDE THE EXISTING PILBARA IRON RAILWAY CAPE LAMBERT TO JUNA DOWNS WHICH RUNS THROUGH MILLSTREAM CHICHESTER AND KARINJINI NP.
AUTHORISED PERSONS	GARTH HUMPHREYS, DAN KAMIEN, DR PHIL RUNHAM, MICHAEL GREENHAM, ZOE HAMILTON, JASON ALEXANDER, ERIN HARRIS, TIM SACHSE, GREG HAROLD.

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P.O. BOX 155
LEEDERVILLE WA 6903

Appendix 5

Bat Call Identification

Specialised Zoological

Bat call identification

PI Rail Duplication: Cape Lambert to Emu

Type:	Bat Call Analysis
Prepared for:	Biota Environmental Sciences
Date:	19 May 2008
Job No.	SZ047
Prepared by:	Specialised Zoological Kyle Armstrong PhD and Yuki Konishi ABN 92 265 437 422 0404 423 264 kyle.armstrong@graduate.uwa.edu.au kyle.n.armstrong@gmail.com

Bat call identification from Cape Lambert, WA

SUMMARY

Bat identifications from Anabat echolocation call recordings are provided from between Cape Lambert and Emu siding, Western Australia. Seven species were identified with a medium to high level of confidence (Tables 1 and 2). 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 most cases the calls appeared to be from *S. flaviventris*, however at one site in a creekline, several sequences had characteristics of *C. jobensis*. The calls of long-eared bats *Nyctophilus* spp. are typically difficult to identify to species, and the sequences identified as *Nyctophilus* sp. may derive from either the northern long-eared bat *Nyctophilus arnhemensis*, the lesser long-eared bat *Nyctophilus geoffroyi* or the pallid long-eared bat *Nyctophilus bifax daedalus*.

Details supporting the identifications are provided, as recommended by the Australasian Bat Society (ABS 2006). A summary of pulse parameters is provided in Table 3, and representative call sequences are illustrated in Figure 1. Further data are available if verification is required.

METHODS

Signals recorded with an Anabat II – CF-ZCAIM unit were downloaded and supplied as Anabat sequence files. Sequences were examined and measured in AnalookW 3.5f 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. Site by species matrix of identifications, with the degree of confidence indicated by a code. Date and Anabat serial number correlates with site. See Table 2 for confidence level codes; and Table 3 for full species names.

Date	*C. gouldii*	*C. jobensis*	*Nyctophilus sp.*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
CF-ZCAIM 682							
7/04/2008	H	—	M	M	H	M	H
8/04/2008	H	—	—	M	H	—	H
9/04/2008	H	—	—	—	H	H	H
10/04/2008	H	—	—	—	H	—	—
11/04/2008	No data						
CF-ZCAIM 683							
7/04/2008	H	—	M	M	H	H	H
8/04/2008	H	M	M	H	H	H	H
9/04/2008	No data						
10/04/2008	—	—	—	—	H	H	H
11/04/2008	H	—	—	—	—	H	H

TABLE 2. Key to the confidence level of identifications in Table 1. The identification of each species is made based on one or more sequences at each site.

Code	Confidence level
R	Highest. Capture of the species was made at the site, and the identification is supported by measurements, a *Reference* call recording, and/or submission of a specimen/tissue to a museum.
H	High. Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material.
M	Medium. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated elsewhere in this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

TABLE 3. Summary of variables from representative call sequences. (Mean ± SD; range; s,p: number of sequences measured, combined total number of pulses measured).

Species	s,p	Duration (ms)	Max Frequency (kHz)	Char frequency (kHz)
Northern free-tailed bat *Chaerephon jobensis*	2,4	12.4 ± 2.9 5.4 – 15.6	30.9 ± 3.3 25.7 – 35.4	21.4 ± 1.6 19.6 – 23.4
Gould's wattled bat *Chalinolobus gouldii*	3,31	5.5 ± 1.4 2.9 – 9.4	40.3 ± 5.0 33.8 – 50.6	31.0 ± 1.4 28.7 – 34.0
Unidentified long-eared bat *Nyctophilus* sp.	3,29	3.2 ± 0.9 1.4 – 4.8	63.7 ± 7.8 54.4 – 80.8	40.9 ± 3.1 36.4 – 49.1
Yellow-bellied sheath-tailed bat *Saccolaimus flaviventris*	1,5	7.8 ± 1.5 5.7 – 9.2	23.0 ± 1.1 21.4 – 24.5	19.1 ± 1.0 18.4 – 20.7
Little broad-nosed bat *Scotorepens greyii*	4,55	5.9 ± 1.0 3.2 – 7.8	56.7 ± 7.3 42.3 – 68.4	37.7 ± 1.2 35.1 – 40.2
Common sheath-tailed bat *Taphozous georgianus*	4,47	13.1 ± 0.9 11.1 – 15.0	26.7 ± 0.8 25.7 – 29.3	24.6 ± 0.3 23.9 – 25.6
Finlayson's cave bat *Vespadelus finlaysoni*	4,37	4.8 ± 0.7 3.3 – 6.3	76.2 ± 8.2 58.0 – 89.9	55.6 ± 3.2 48.8 – 58.8

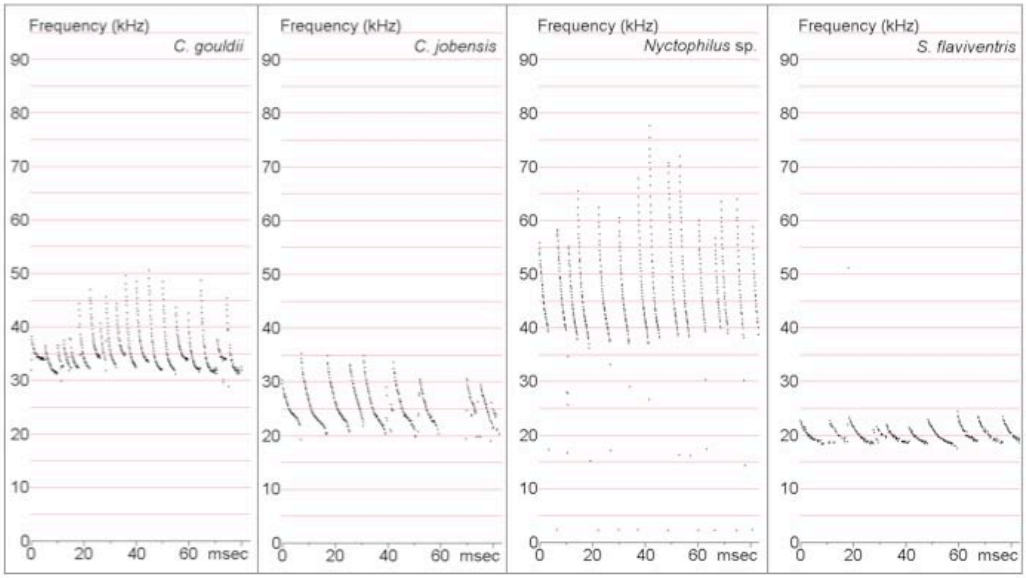

FIGURE 1A. Representative call sequences of the seven species identified (time is compressed between pulses).

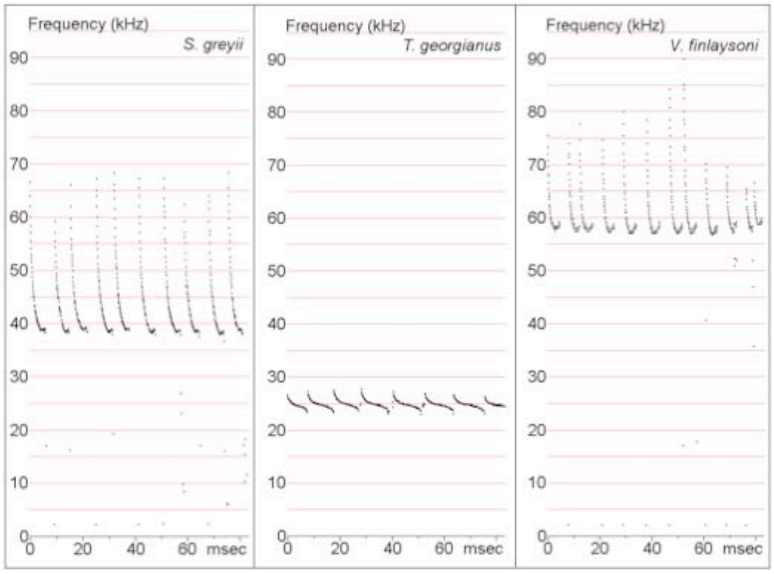

FIGURE 1B. Representative call sequences of the seven species identified (time is compressed between pulses).