

OCTOBER 2012



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**FORTESCUE METALS GROUP LIMITED
WESTERN HUB PROJECT – DELPHINE
TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT**

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FORTESCUE METALS GROUP LTD
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TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT



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				Name	Distributed To	Date
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ACRONYMS

ANOSIM	Analysis of Similarity
BoM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
DEC	Department of Environment and Conservation
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EP Act	<i>Environmental Protection Act 1986</i>
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
IBRA	Interim Biogeographical Regionalisation for Australia
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australian Migratory Bird Agreement
MDS	Multi-dimensional Scaling
MM	Michaelis-Menten
NHMRC	National Health and Medical Research Centre
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SAC	Species Accumulation Curve
SPRAT	Species Profile and Threats
WAM	Western Australian Museum
WC Act	<i>Wildlife Conservation Act 1950</i>

EXECUTIVE SUMMARY

Fortescue Metals Group commissioned *ecologia* Environment to undertake a Level 2 vertebrate fauna and targeted conservation significant fauna assessment of the Delphine Survey Area. The Delphine Survey Area is located on the southern boundary of the western side of the Hamersley Range and covers a total of 78,324 ha. A Level 1 fauna assessment was previously undertaken by Ecoscape (2012a) to identify the location and extent of fauna habitat types and areas that support conservation significant species. This information was reviewed and utilised to establish a survey design for the Level 2 vertebrate fauna and targeted conservation significant fauna assessment, the results of which are summarised in this document.

The Level 2 vertebrate fauna survey was conducted in May 2012, and the targeted conservation significant fauna survey was conducted in July 2012. During these surveys a total of 24 trapping sites (14 during the Level 2 vertebrate fauna assessment, 10 during the targeted conservation significant fauna assessment) were established in four different habitat types and six land systems. In addition, 22 opportunistic survey sites (16 during the Level 2 vertebrate fauna assessment, six during the targeted conservation significant fauna assessment) were located in habitat not suitable for trapping due to access limitations or difficulties in the establishment of pit fall traps.

Survey effort expended within the Delphine Survey Area included the following:

- trapping sites were open for 4,813 trap-nights;
- approximately 29 hours were spent surveying for birds;
- 44 hours spent on opportunistic diurnal searching;
- 25.7 hours spent on opportunistic nocturnal searching;
- Nine motion cameras were deployed for a total of 682 hours;
- 459.3 hours of SM2BAT recordings were analysed to determine bat assemblage and distribution;
- Northern Quoll: 34.7 hours were spent searching for scats in rocky habitats. Cage traps targeting this species in rocky habitats totalled 711 trap nights. Additionally, three motion sensor cameras were deployed and baited in gorge habitat for a total of 144 hours;
- Pilbara Olive Python: 6.3 hours were spent searching for individuals in rocky habitats close to water sources;
- Fortescue Grunter: 6.3 hours were spent searching pools along major watercourses for this species. Additionally, three funnel traps were baited and positioned in a large pool to capture individuals;
- Star Finch (Western): 4 hours were spent searching well-vegetated creeklines for this species;
- Pilbara Leaf-nosed Bat/Ghost Bat: 2 hours were spent searching potential roost caves for both species, and 459.3 hours of bat recordings were analysed to determine the presence of these species; and
- Bush Stone-curlew: 110 minutes were spent conducting nocturnal acoustic-lure (call-playback) along creeklines.

The main conclusions of the Level 2 vertebrate fauna and targeted conservation significant fauna assessment of the Delphine Survey Area are:

- The survey methods were consistent with the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*; Guidance Statement No. 56; Position Statement No. 3; and the EPBC Act Survey Guidelines for Australia’s Threatened Mammals, Reptiles, Bats and Birds, as well as Fortescue Metals Group’s *Terrestrial Vertebrate Fauna Assessment Guidelines*. Species accumulation curves showed that the current survey was adequate overall, though with additional survey effort additional species would likely be recorded.
- The land systems, vegetation communities and habitats in the area support a moderately diverse group of fauna, including conservation significant fauna, but these are not restricted to the Survey Area.
- Six habitat types were identified within the Survey Area:
 - gorges and gullies;
 - hilltops, hillslopes, ridges and cliffs;
 - footslopes and plains;
 - river systems;
 - mixed acacia woodlands; and
 - cracking clays.
- Statistical analyses of the terrestrial fauna data indicated that while the habitat types were different from each other, these were not large differences (the habitat types were not discrete). Insufficient avifauna data were available to demonstrate statistically significant differences between the habitat types utilised by birds.
- A total of 22 native and 4 introduced mammal species, 100 bird species, 58 reptile species, three amphibians and six fish species were recorded within the Survey Area during the current Level 2 vertebrate fauna and targeted conservation significant fauna assessment.
- Nine species of conservation significance were recorded during the current surveys, and one recorded from secondary evidence only:
 - Northern Quoll;
 - Pilbara Leaf-nosed Bat;
 - Western Pebble-mound Mouse (recorded from secondary evidence – one possibly-active mound).
 - Eastern Great Egret;
 - Grey Falcon;
 - Australian Bustard;
 - Bush Stone-curlew;
 - Rainbow Bee-eater;
 - *Notoscincus butleri*; and
 - Fortescue Grunter;

- A further eight conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the Delphine Survey Area.
- Results of the targeted conservation significant fauna assessment did not reveal any major roost sites for Pilbara Leaf-nosed Bat, although the timing of calls recorded indicates that two or three roost caves are likely present in the region.
- One Northern Quoll individual was recorded on motion camera during the Level 2 vertebrate fauna assessment; however, no evidence was recorded during the targeted conservation significant fauna assessment conducted in July. This indicates that significant populations are not expected to occur in the Delphine Survey Area.
- Based on aerial images and a short opportunistic survey conducted from a helicopter fly-over, large areas of potentially suitable denning, foraging and dispersal habitat are expected to be found in the western region of the Delphine Survey Area, potentially supporting Northern Quoll populations.
- No major limitations on survey techniques were experienced, though some access limitations were experienced with restricted access to the western half of the Delphine Survey Area. However, the majority of fauna habitats were surveyed and statistical analysis of the data suggests that the majority of the expected fauna species were recorded.

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group (Fortescue) commissioned *ecologia* Environment (*ecologia*) to undertake a Level 2 vertebrate fauna and targeted conservation significant fauna assessment of the Delphine survey area (Survey Area).

The Survey Area is located on the southern edge of the western side of the Hamersley Range, approximately 138 km north-west of Tom Price, and covers a total of 78,324 ha (Figure 1.1). A Level 1 fauna assessment was previously undertaken by Ecoscape (2012a) to identify the location and extent of habitat types and areas that support conservation significant species. This information was reviewed and utilised to establish the survey design for the Level 2 vertebrate fauna assessment, and targeted conservation significant fauna assessment, the results of which are summarised in this document.

1.2 LEGISLATIVE FRAMEWORK

The *Environmental Protection Act 1986* (EP Act) is “an Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.” Section 4A of this Act outlines five principles that must be addressed meet the objectives of the Act. Three of these principles are relevant to native fauna and flora:

- *The Precautionary Principle*

Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- *The Principle of Intergenerational Equity*

The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

- *The Principle of the Conservation of Biological Diversity and Ecological Integrity*

Conservation of biological diversity and ecological integrity should be a fundamental consideration.

In addition to these principles, projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines produced by the Environmental Protection Authority (EPA), in this case:

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

Native flora and fauna in Western Australia that are formally recognised as rare, threatened with extinction, or as having high conservation value are protected at a federal level under the

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and at a state level under the *Western Australian Wildlife Conservation Act 1950* (WC Act).

The EPBC Act also considers four international agreements related to migratory species, which include the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), the Japan-Australian Migratory Bird Agreement, the China-Australia Migratory Bird Agreement and the Republic of Korea-Australian Migratory Bird Agreement.

The EPBC Act was developed to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance, to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources, and to promote the conservation of biodiversity. The EPBC Act includes provisions to protect native species (and in particular to prevent the extinction and promote the recovery of threatened species) and to ensure the conservation of migratory species. In addition to the principles outlined in Section 4A of the EP Act, Section 3A of the EPBC Act includes a principle of ecologically sustainable development dictating that decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. Schedule 1 of the EPBC Act contains a list of species that are considered Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable and Conservation Dependent.

The WC Act provides for the conservation and protection of wildlife in Western Australia. Under Section 14 of this Act, all flora and fauna within Western Australia is protected; however, the Minister may, via a notice published in the *Government Gazette*, declare a list of fauna identified as rare, likely to become extinct, or otherwise in need of special protection. These species are considered Threatened Fauna. The current listing was gazetted in February 2012.

In addition, the Department of Environment and Conservation (DEC) maintains a list of specially protected fauna, which includes Threatened and Priority Fauna, ranked in order of priority for conservation management. Threatened fauna listed in Schedule 1 of the WC Act are further ranked by the DEC according to their level of threat using IUCN Red List categories and criteria. Priority Fauna are placed into five categories. The first three Priority Fauna categories are species that have not yet been adequately surveyed to be listed under Schedule 1 or 2. Species that are adequately known and are rare but not threatened, meet IUCN criteria for Near Threatened, or that have been recently removed from the Threatened list for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Species meeting criteria for the IUCN category of Conservation Dependent are placed in Priority 5.

Definitions of conservation categories as used by the DEC and as defined in the EPBC Act and the WC Act are provided in Appendix A.

1.3 SURVEY OBJECTIVES

Fortescue commissioned *ecologia* to undertake a comprehensive biological survey of the vertebrate fauna of the Survey Area as part of the EIA for the project.

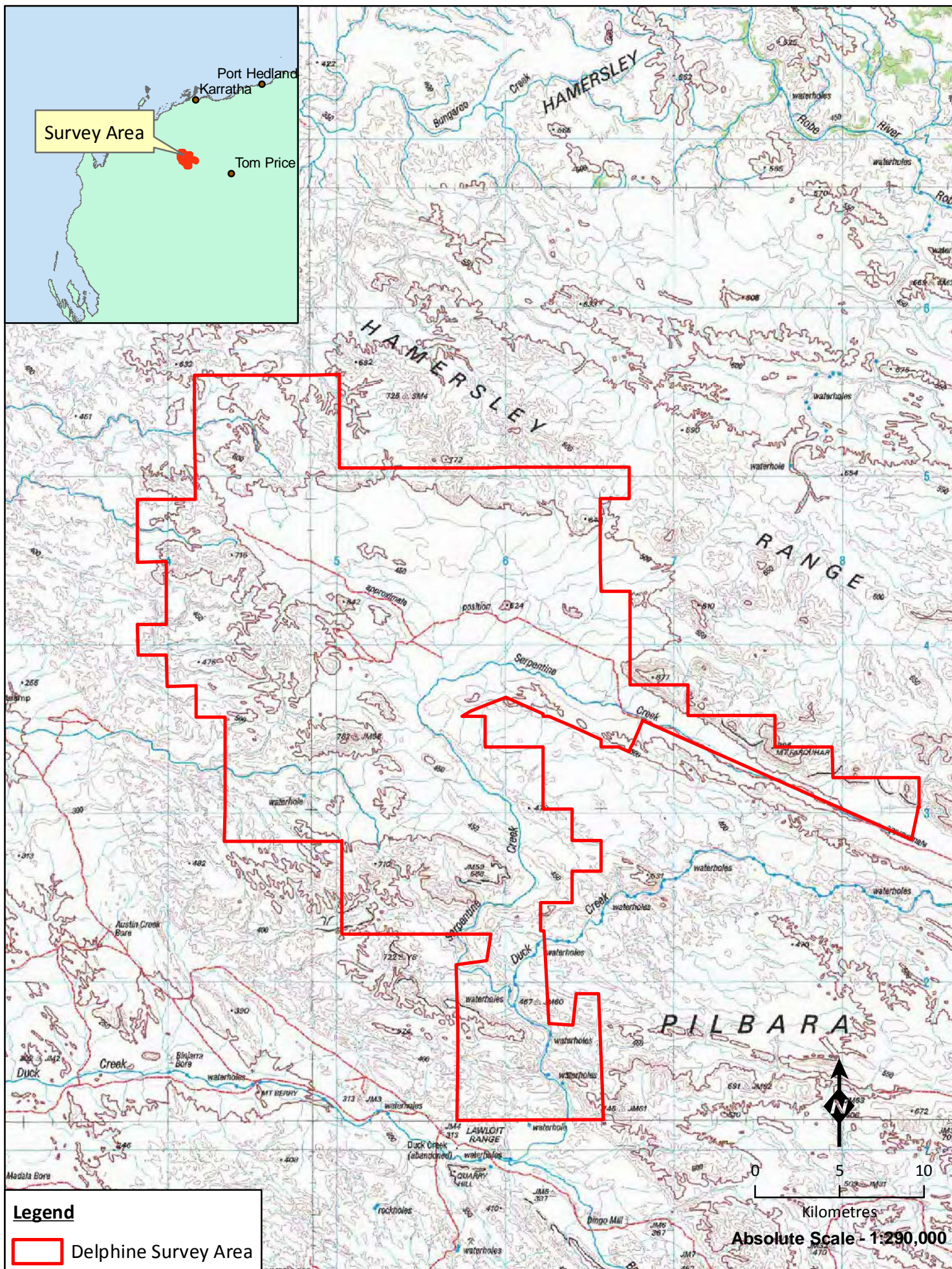
The EPA's objectives with regards to fauna management are to:

- maintain the abundance, species diversity and geographical distribution of terrestrial fauna; and
- protect Specially Protected (Threatened) fauna, consistent with the provisions of the WC Act.

The aim of this study was to provide sufficient information to the EPA to assess the impact of the project on the vertebrate fauna populations that occur in the regional areas associated with the project, thereby ensuring that these objectives will be upheld.

This report satisfies the objectives outlined in Fortescue's Scope of Works and satisfies the requirements documented in the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010), EPA Guidance Statement No. 56 and Position Statement No. 3 (EPA 2002, 2004), by providing:

- a desktop a review of background information (including literature and database searches);
- an inventory of vertebrate fauna species potentially occurring in the Survey Area, incorporating recent published and unpublished records;
- a review of regional and biogeographical significance, including the conservation status and significance of species recorded in the Survey Area.
- a discussion related to the species of biological and conservation significance recorded or likely to occur within the Survey Area and the surrounding region;
- an appraisal of the current knowledge base for the area, including a review of previous surveys conducted in the area that are relevant to the current study;
- a detailed fauna habitat assessment of the Survey Area;
- a detailed Level 2 vertebrate fauna assessment, including systematic trapping, observations, acoustic bat recording and overall assessment of the faunal assemblage recorded within the Survey Area; and
- a targeted conservation significant fauna assessment of EPBC-listed species identified during the Level 2 vertebrate fauna assessment and comprehensive conservation significant fauna habitat mapping;



2 EXISTING ENVIRONMENT

2.1 CLIMATE

The Survey Area is located in the Pilbara biogeographic region of Western Australia, where the climate is semi-arid to arid with two distinct seasons: a hot summer from October to April and a mild winter from May to September. Rainfall in the Pilbara generally occurs between the months of December to March but can be unpredictable due to cyclonic activity bringing heavy sporadic rainfall. Nearly 75% of the yearly rainfall is associated with thunderstorms and cyclonic activity between the months of December and March. Cold fronts continue to bring somewhat less rain to the region until June.

The closest Bureau of Meteorology (BoM) weather station that is representative of the Survey Area and documents a full set of meteorological records (including current and historical rainfall and temperatures) is at Paraburdoo (station number 007185, 23°12' S, 117°40' E), approximately 133 km from the southern section of the Survey Area. The Paraburdoo station provides climatic records closest to that experienced within the Survey Area, and its climate statistics are summarised in Figure 2.1 (BoM 2012).

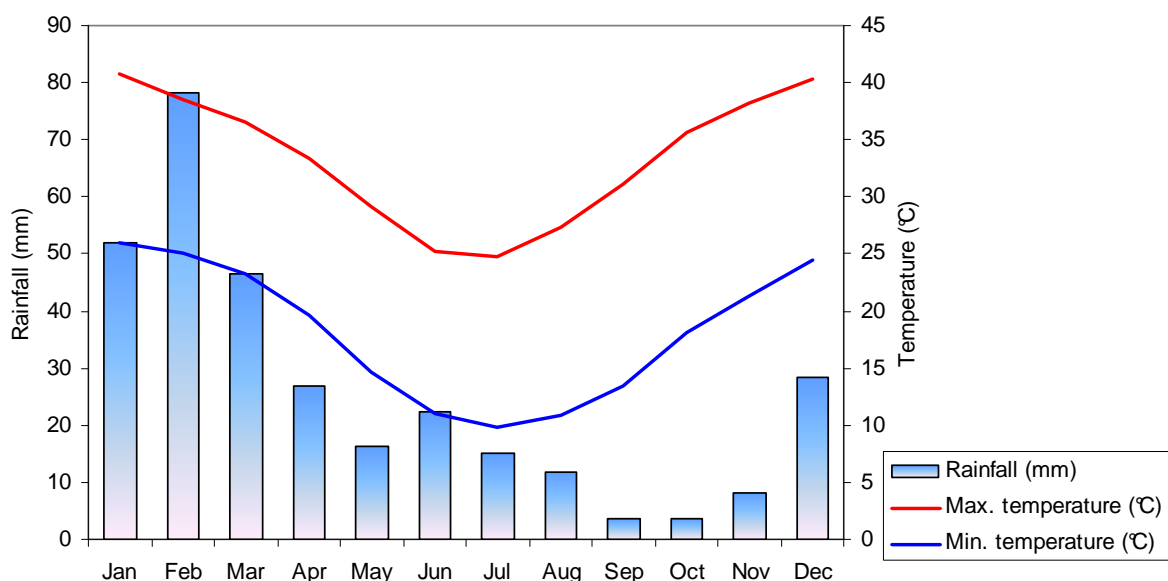


Figure 2.1 – Rainfall and temperature for the Paraburdoo weather station (1974-2012).

2.2 WEATHER DURING SURVEY

The weather conditions experienced during the fauna survey, as recorded by the Paraburdoo Aero weather station (BoM 2012), are listed in Appendix B. The Level 2 vertebrate fauna assessment was conducted over two 11-day periods in May due to the Survey Area's large size. The weather during the first period of the survey (1-11 May 2012) was warm, with an average daily maximum of 32.4 °C and minimum of 16.6 °C. The second period (18-28 May 2012) was mild-warm, with an average daily maximum of 27.4 °C and minimum of 12.0 °C. Based on the mean climatic data (Figure 2.1), these temperatures were within the normal range for the time the surveys were conducted.

The targeted conservation significant fauna assessment was conducted over a nine-day period in late July. The weather during this survey was mild, with an average daily maximum of 24.9 °C and minimum of 9.6 °C. Based on the mean climatic data (Figure 2.1), these temperatures were within the normal range for the time the targeted survey was conducted.

The amount of rainfall recorded at the Paraburdoo weather station in January 2012 was more than four times the mean for January. Following the heavy rainfall in January, precipitation was close to average for the three months preceding the survey. No rainfall was recorded on site during both periods of the Level 2 vertebrate fauna assessment (May) and the targeted conservation significant fauna assessment (July).

2.3 BIOGEOGRAPHY

The Interim Biogeographical Regionalisation for Australia (IBRA) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (DSEWPC 2010). Biogeographic regions each reflect a unifying set of major environmental influences which shape the occurrence of flora and fauna and their interaction with the physical environment across Australia. According to IBRA (version 6.1), the Survey Area is located in the Pilbara bioregion.

Dominant limiting factors and constraints for the Pilbara bioregion listed by Thackway and Creswell (1995) include extinction of critical weight range animals, wildfire, feral animals, weeds and grazing or pastoral activities. The reservation status of the bioregion is 1-5%, which is relatively low (some bioregions have greater than 10% reservation status).

With an area of 179,287 km², the Pilbara bioregion is in the largest area class. Other bioregions vary from 2,372 to 423,751 km², most being between 14,000 and 200,000 km². The size of the Pilbara bioregion is fairly typical of bioregions situated in remote arid and semi-arid areas (Thackway and Creswell 1995). The Pilbara bioregion is further divided into the Chichester, Fortescue Plains, Hamersley and Roebourne subregions.

The Survey Area is contained by a single subregion, Hamersley, PIL3 (Figure 2.2). The Hamersley subregion covers approximately 35% of the Pilbara bioregion. Dominant land uses for this subregion include native pasture grazing, Aboriginal lands and reserves, and conservation and mining leases.

The Hamersley subregion features mountainous areas of sedimentary ranges and plateaux, dissected by gorges; Mulga low woodland over bunch grasses on fine textured soils in valley floors; and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges (Kendrick 2001).

2.4 LAND SYSTEMS

Land systems are described using the biophysical characteristics of geology, landforms, vegetation and soils (van Vreeswyk *et al.* 2004). Van Vreeswyk *et al.* (2004) undertook a regional inventory of the Pilbara region to document land systems present and the condition of each. The area surveyed by van Vreeswyk *et al.* (2004) covered 181,723 km², bounded by the Indian Ocean and Roebourne Plains to the north and west, extending to Broome in the north-east and the Ashburton River catchment in the south.

The Survey Area contains nine of the land systems mapped by van Vreeswyk *et al.* (2004) (Figure 2.3). The land systems forming the largest proportion of the Survey Area are termed Newman (64.78%), Boolgeeda (27.39%) and Rocklea (4.28%). These three land systems are similar, describing mountains, ridges, plateaux, hills, lower slopes and plains supporting hard spinifex in the higher landforms and merging with soft spinifex and mulga shrublands on lower ground.

Table 2.1 – Land systems of the Survey Area

Land System	Description	Total Area in WA (ha)	Area in Survey Area (ha)	Percent of Survey Area (%)	Percent of Total Land System (%)
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,993,745	50,738	64.78	2.54
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	2,881,897	3,349	4.28	0.12
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	961,637	21,455	27.39	2.23
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands.	236,336	617	0.79	0.26
Brockman	Gilgai alluvial plains with cracking clay soils supporting tussock grasslands.	74,108	331	0.42	0.45
River	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	482,179	104	0.13	0.02
Robe	Low plateaux, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.	128,620	54	0.07	0.04
Table	Mesas, breakaways and stony plains with acacia or eucalypt woodland and halophytic shrublands.	15,959,208	1,311	1.67	0.008
Wannamunna	Wash plains on hardpan with mulga shrublands.	6,301,339	365	0.47	0.006

2.5 VEGETATION

The vegetation of Western Australia was originally mapped at the 1:1,000,000 scale by Beard (1979), and was subsequently reinterpreted and updated to reflect the National Vegetation Information System standards (Shepherd *et al.* 2002). The Survey Area lies in the Fortescue Botanical District within the larger Pilbara Botanical Province (Beard 1975). Four vegetation associations occur in the Survey Area (Shepherd *et al.* 2002), and these are described in Table 2.2 and displayed in Figure 2.4.

The Survey Area lies predominantly in Beard's Hamersley Plateau of the Fortescue Botanical District. The vegetation of the plateaux of jaspilite and dolomite is characteristically tree steppe of *Eucalyptus brevifolia* and *Triodia wiseana* association. Small trees and mallee of *Eucalyptus gamophylla* and a few large shrubs such as *Cassia desolata*, *Dodonaea viscoae* and *Grevillea wickhamii* may be present. On mountains, trees are replaced by mallee of *Eucalyptus kingsmillii*, *E. gamophylla* and *E. brevifolia*. Special habitats for local or endemic plants such as *Astrotricha hamptonii* are present on cliffs of the gorges of the Hamersley Range (Beard 1975).

Four Beard (1975) vegetation associations have been mapped within the Survey Area. The units consist of mainly spinifex dominated vegetation, with some areas of mulga and buffel grass (*Cenchrus ciliaris*) plains.

Table 2.2 – Vegetation associations of the Survey Area

Shepherd Unit	Vegetation Description	Total Area in WA (ha)	Area in the Survey Area (ha)	Percent of Survey Area (%)	Percent of Total Vegetation Unit (%)
82	Hummock grasslands, low tree steppe; snappy gum over <i>Triodia wiseana</i>	2,565,571.7	42,805.59	54.65	1.67
103	Hummock grasslands, shrub steppe; snakewood over soft spinifex and <i>Triodia wiseana</i>	614,275.3	362.60	0.46	0.06
567	Hummock grasslands, shrub steppe; mulga & kanji over soft spinifex and <i>Triodia basedowii</i>	776,997.6	4,074.51	5.20	0.52
569	Hummock grasslands, low tree steppe; bloodwood over soft spinifex and <i>Triodia wiseana</i>	102,296.8	31,081.63	39.68	30.38

2.6 PREVIOUS SURVEYS AND LAND USE

Several databases were consulted in the preparation of potential fauna (and conservation significant fauna) lists (Table 2.3). In addition, 17 publications reporting on vertebrate fauna surveys conducted within 135 km of the Survey Area were consulted (Table 2.4). The results of all database searches and previous surveys are presented in Appendix C. The online NatureMap database (DEC 2012) encompasses several datasets which include the Western Australian Museum, DEC threatened fauna database and DEC survey return database. The NatureMap database also indicates that the land of the Survey Area was previously used as either a Pastoral Lease or Scientific Site (DEC 2012).

Table 2.3 – Fauna databases searched to determine the potential vertebrate fauna assemblage

Database	Custodian	Search Details
NatureMap	DEC	40 km radius around the centre of the Survey Area. Coordinate: 452102 E 7534262 N Date accessed: 15/8/12
Species Profile and Threats (SPRAT) Database	Department of Sustainability, Environment, Water, Population and Communities (DSEWPoC)	Square around Western Hub area with a 40 km buffer
Birddata	BirdLife Australia	Records within one square decimal degree (100 km ²). Latitude: 500000 N to 602495.17 N Longitude: 7567173 E to 7456131 E
Threatened and Priority Fauna Database	DEC	Rectangle around Survey Area with a 40 km buffer

Table 2.4 – Previous biological survey reports within 135 km of the Survey Area

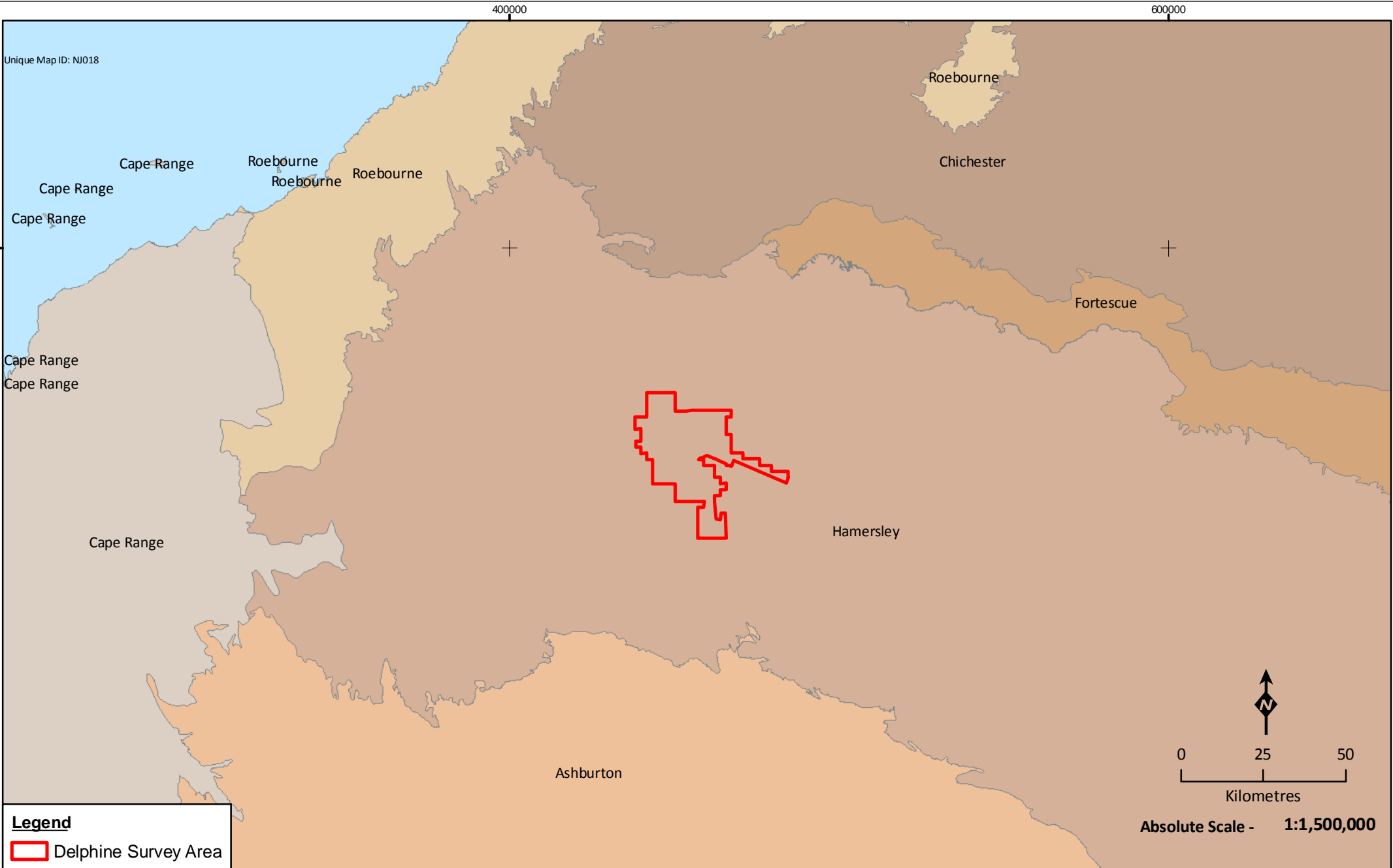
Survey Location and Author(s)	Distance to Survey Area (km)	Comments
<i>ecologia</i> internal database	4 – 46 km	Two Level 1 fauna assessments, one two-phase Level 2 vertebrate fauna assessment
Delphine (Ecoscape 2012a)	0 km	Level 1 fauna assessment and targeted conservation significant fauna assessment
Mt Farquhar (<i>ecologia</i> in prep-c)	1 km	Single-phase Level 2 vertebrate fauna and targeted conservation significant fauna assessment
Mt Farquhar (Ecoscape 2012d)	1 km	Level 1 fauna assessment and targeted conservation significant fauna assessment
Eliwana and Flying Fish (<i>ecologia</i> in prep-b)	5 km	Single-phase Level 2 vertebrate fauna and targeted conservation significant fauna assessment
Eliwana and Flying Fish (Ecoscape 2012b, c)	5 km	Level 1 fauna assessment and targeted conservation significant fauna assessment
West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	11-36 km	Two-phase Level 2 vertebrate fauna assessment
Raven (Ecoscape 2012e)	34 km	Level 1 fauna assessment and targeted conservation significant fauna assessment
Mesa A Transport Corridor (Biota 2006)	43-78 km	Single-phase Level 2 vertebrate fauna assessment
Mesa A and G (Biota 2005a)	51 km	Single-phase Level 2 vertebrate fauna assessment
Brockman Syncline (Biota 2005b)	52 km	Level 2 vertebrate fauna assessment
Brockman 2 Detritals (Mattiske and Ninnox 1990)	53 km	Level 1 fauna assessment
Central Pilbara Project (<i>ecologia</i> 2011b)	78 km	Two-phase Level 2 vertebrate fauna assessment
West Turner Section 10 (Biota 2009b)	93 km	Two-phase Level 2 vertebrate fauna assessment
Solomon Project Area (Coffey 2008)	105 km	Single-phase Level 2 vertebrate fauna assessment
Solomon Project (<i>ecologia</i> 2010)	105 km	Single-phase Level 2 vertebrate fauna assessment
Firetail mining area (Ecoscape 2010)	114 km	Single-phase Level 2 vertebrate fauna assessment
Marandoo to Great Northern Hwy (Kendrick 1995)	131 km	Single-phase Level 2 vertebrate fauna assessment

2.6.1 Results of literature review

The database searches and review of publications reporting on 17 vertebrate fauna surveys (described in Section 2.6) resulted in a total of 38 native and eight introduced mammal, 151 bird, 108 reptile, seven amphibian and six fish species potentially occurring in the Survey Area (Appendix C). Of these, 24 species are of conservation significance (six species of mammal, 14 species of bird, three species of reptile and one species of fish). Previous records of conservation significant fauna are mapped in Figure 2.5, Figure 2.6 and Figure 2.7, and discussed in greater detail in Section 5.3.

Table 2.5 – Number of species recorded during previous surveys and database searches

Source/Report	Mammals (Native/introduced)	Birds	Reptiles	Amphibians	Fish
<i>ecologia</i> internal database	18 / 5	77	63	0	0
Delphine (Ecoscape 2012a)	3 / 4	44	5	1	2
Mt Farquhar (<i>ecologia</i> in prep-c)	16 / 4	56	34	0	2
Mt Farquhar (Ecoscape 2012d)	3 / 2	36	9	0	0
Eliwana and Flying Fish (<i>ecologia</i> in prep-b)	19 / 5	76	60	2	1
Eliwana and Flying Fish (Ecoscape 2012b, c)	4 / 4	38	1	0	0
West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	22 / 4	78	59	3	0
Raven (Ecoscape 2012e)	3 / 0	36	7	0	0
Mesa A Transport Corridor (Biota 2006)	17 / 2	93	60	3	0
Mesa A and G (Biota 2005)	10 / 1	52	31	0	0
Brockman Syncline (Biota 2005b)	15 / 4	82	54	2	0
Brockman 2 Detritals (Mattiske and Ninox 1990)	4 / 4	64	15	0	0
Central Pilbara Project (<i>ecologia</i> 2011b)	24 / 4	99	84	4	0
West Turner Section 10 (Biota 2009b)	17 / 3	68	52	1	0
Kings Area Assessment (<i>ecologia</i> 2010)	21 / 4	80	81	4	4
Firetail mining area (Ecoscape 2010)	18 / 2	63	48	0	0
Marandoo to Great Northern Hwy (Kendrick 1995)	14 / 4	67	49	3	0
NatureMap (DEC 2012)	11 / 3	36	45	0	0
DEC Threatened Fauna Database	5 / 0	3	2	0	0
SPRAT Database	2 / 3	6	1	0	0
Birdata	-	122	-	-	-
Total	38 / 8	151	108	7	6



Legend

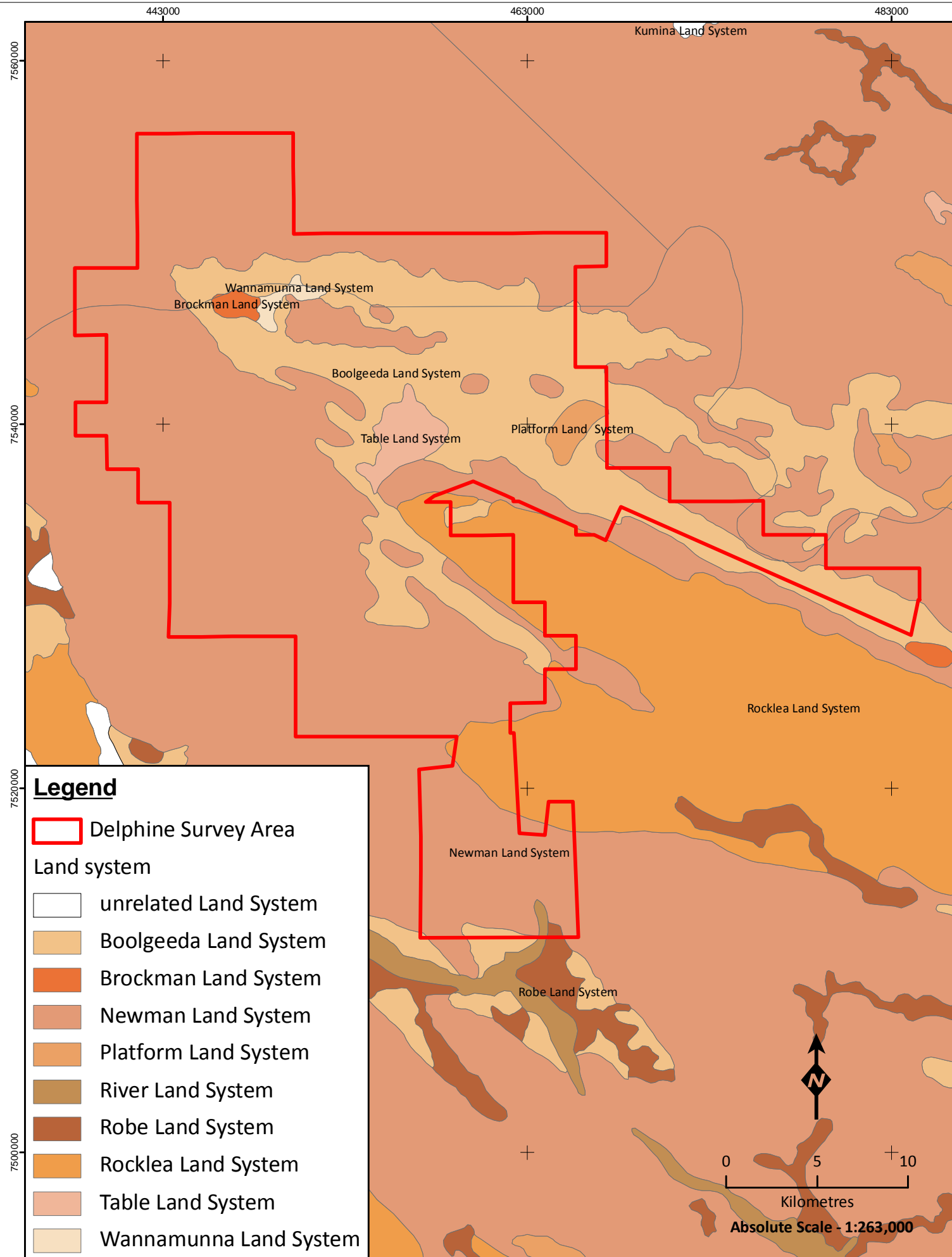
Delphine Survey Area

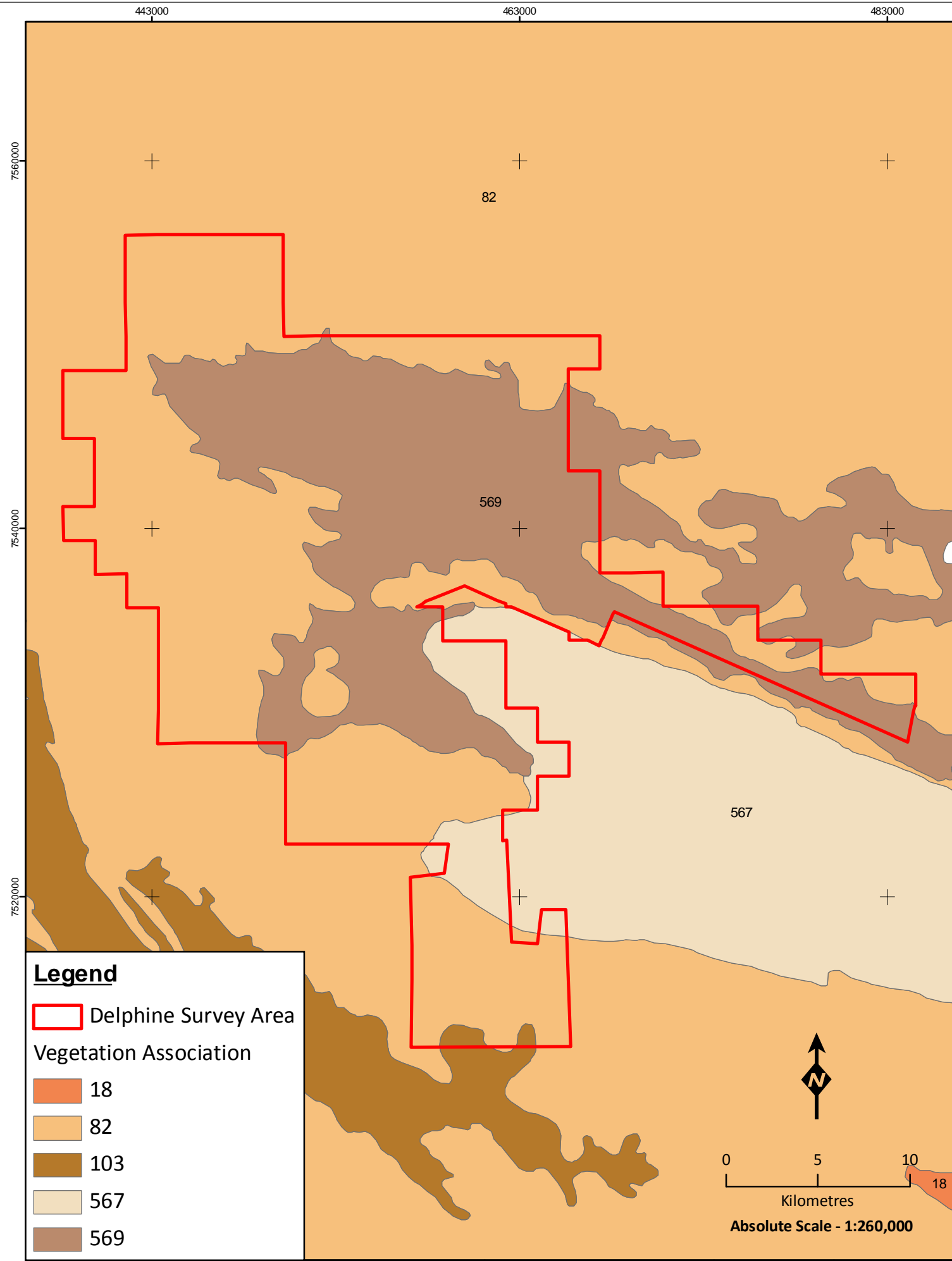


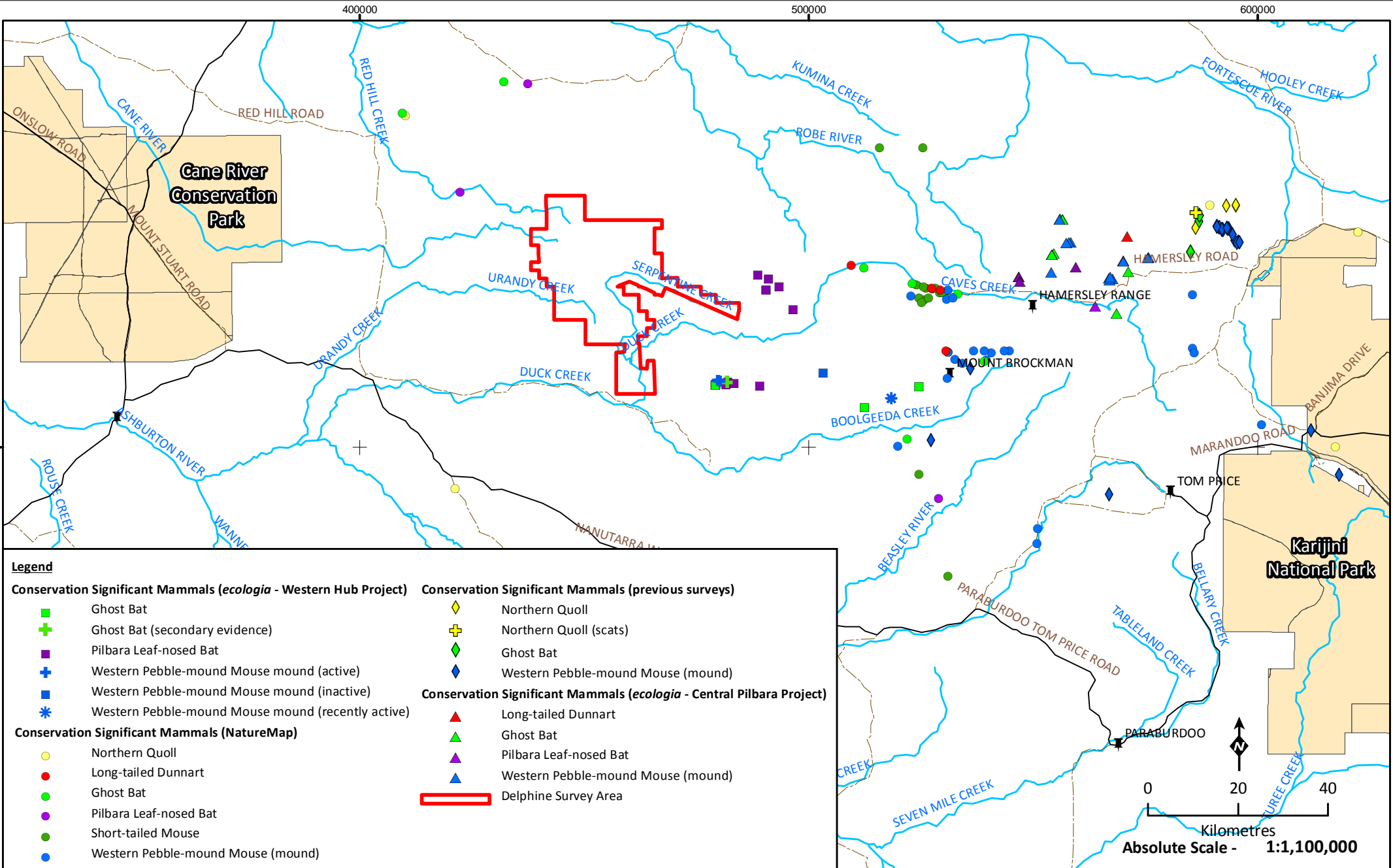
Biogeographic regions of the Survey Area

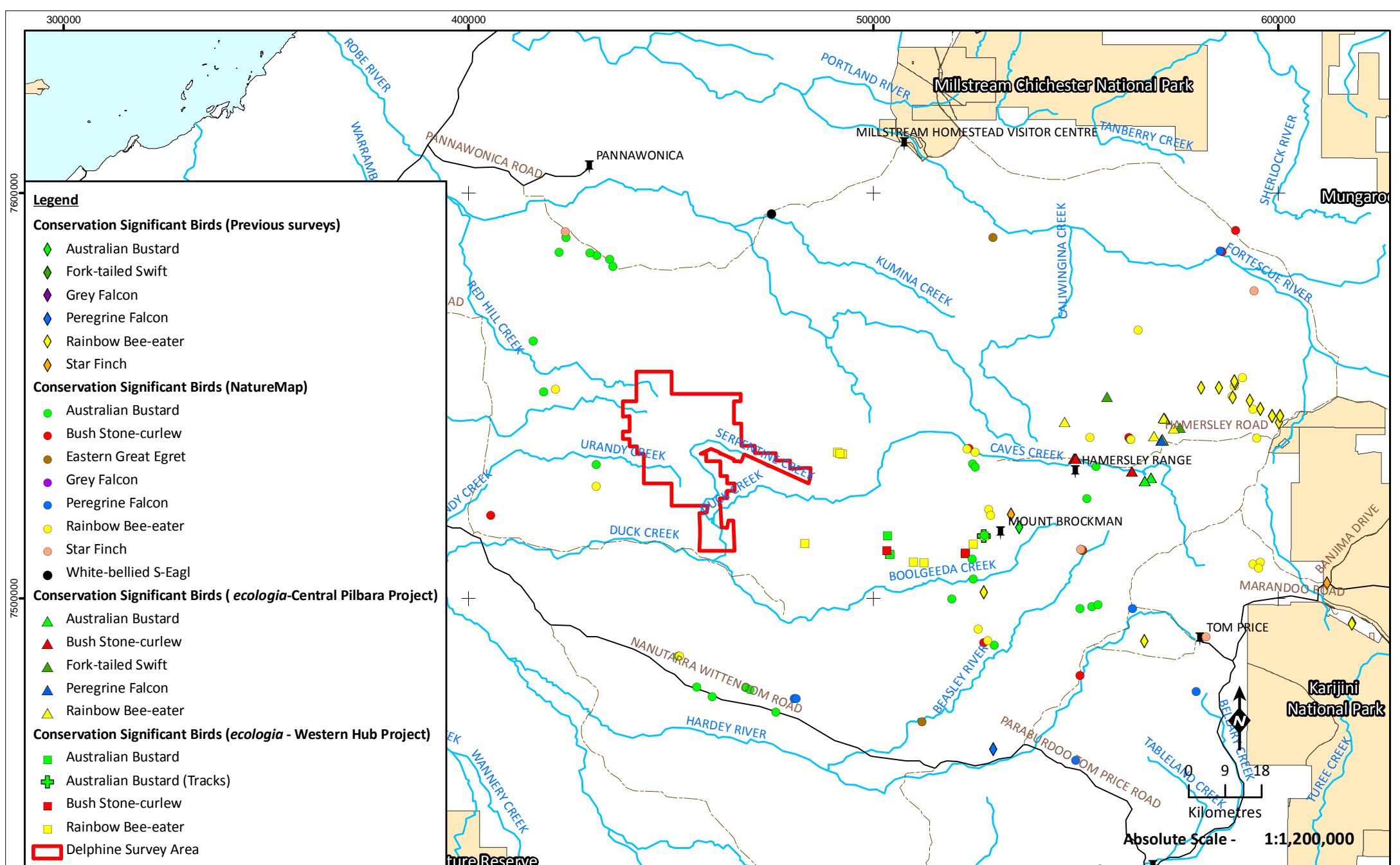
Figure: 2.2 Project ID: 1445	Drawn: NJ Date: 29/08/2012
<small>Coordinate System</small> Name: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994	

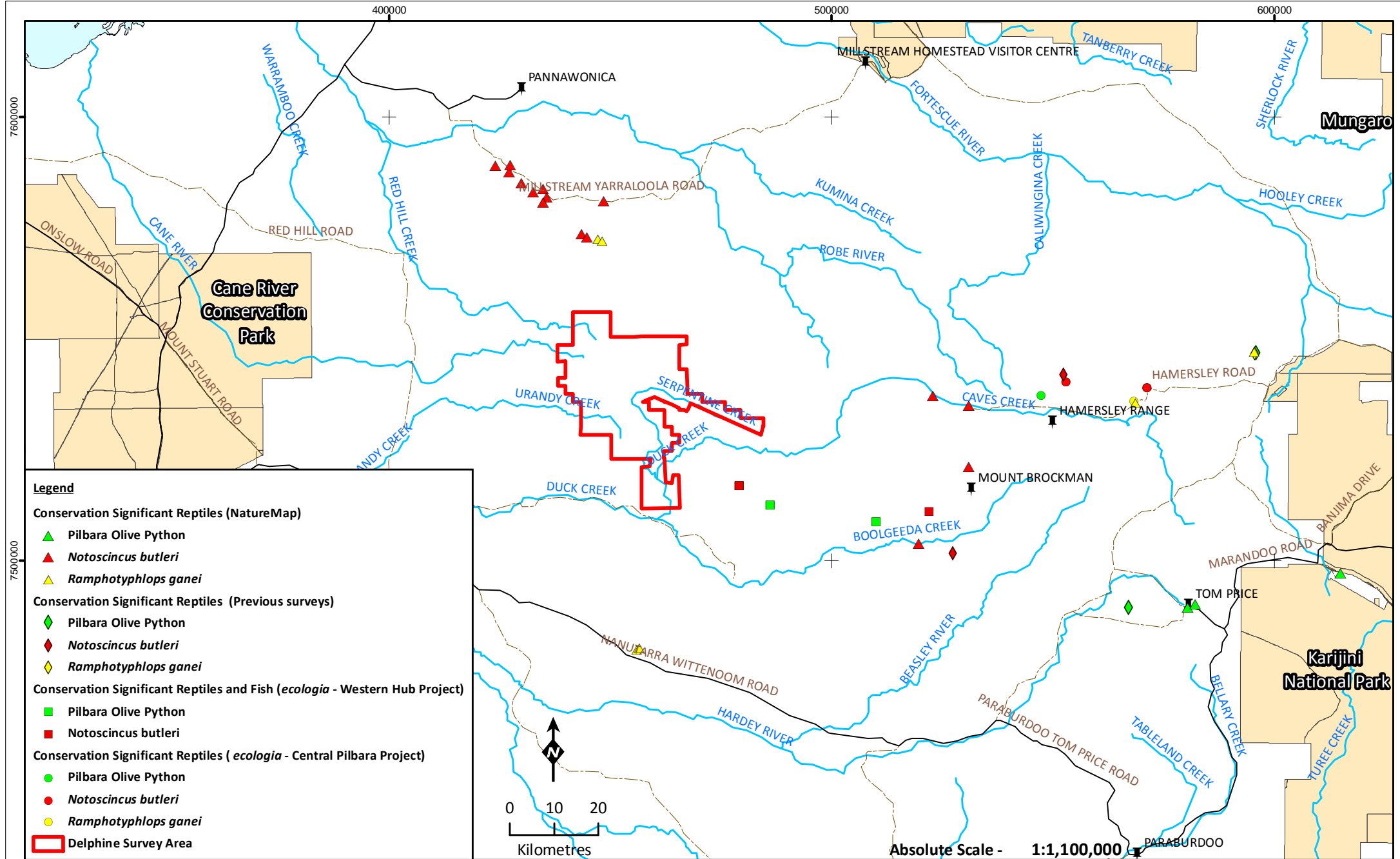
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3 METHODS

3.1 DETERMINATION OF SURVEY SAMPLING DESIGN AND INTENSITY

Prior to the development of field survey methods, a review was undertaken of factors likely to influence survey design and intensity (Table 3.1). Based on this review, it was deemed necessary for both a Level 2 vertebrate fauna and a targeted conservation significant fauna assessment to be conducted within the Survey Area.

Table 3.1 – Factors likely to influence survey design (EPA 2004)

Factor	Relevance
Bioregion – level of existing survey-knowledge of the region and associated ability to predict accurately.	The Pilbara bioregion (including the Hamersley subregion) has been well studied, and information was readily available.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The landforms associated with the Survey Area are typical for the region and do not present any rare or special characteristics.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present.	The best survey time for birds and amphibians is following seasonal rain events. Best survey timing for reptiles is from September to April. Survey timing for mammals is not constrained.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	20 previous terrestrial vertebrate fauna surveys have been carried out within 135 km of the Survey Area. Regional and local knowledge for the area is available.
Number of different habitats or degree of similarity between habitats within a survey area.	Six fauna habitat types were identified based on on-site observation, and mapped land systems and vegetation units. These were: hilltops, hillslopes, ridges and cliffs; footslopes and plains; river systems; gorges and gullies; mixed acacia woodlands; and cracking clays.
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods).	The Pilbara region experiences hot summers with occasional cyclonic rain events, followed by warm winters with little rain. Rainfall is highly unpredictable.
Sensitivity of the environment to the proposed activities.	The Survey Area contains habitat types which are well represented in the surrounding region.
Size, shape and location of the proposed activities.	The Survey Area comprises the Delphine exploration tenement and covers an area of 78,324 ha.
Scale and impact of the proposal.	The scale and impact of the proposal was not known and did not influence the design of this survey.

3.2 SURVEY TIMING

The Level 2 vertebrate fauna assessment was conducted in autumn over two periods with 12 sites being surveyed during the first period (1-11 May 2012) and the remaining two sites (sites 13 and 14) surveyed a week later during the Mt Farquhar Level 2 vertebrate fauna assessment (18-28 May 2012). The targeted conservation significant fauna assessment was conducted in winter (23-31 July 2012). The survey timing was determined as per guidelines (DEWHA 2010a, b; DSEWPaC 2011a, b, c; EPA 2004; EPA and DEC 2010; FMG 2011).

Table 3.2 – Summary of survey timing and duration

Survey	Duration (days)	Person Days
Level 2 vertebrate fauna assessment (sites 1-12)	11	74
Level 2 vertebrate fauna assessment (sites 13-14*)	11	52
Targeted conservation significant fauna assessment	9	36
Total	31	162

*Note: These sites were surveyed during the Mt Farquhar vertebrate fauna assessment (*ecologia* in prep-c). Days and person days are inclusive of both survey areas (Mt Farquhar and Delphine) for that field trip.

3.3 SITE SELECTION

Habitat types previously mapped by Ecoscape (2012a) were reviewed and interpreted for survey site selection, with locations of access tracks, land systems and the abundance of habitat types taken into consideration. Survey sites were selected to provide a good geographic spread over the Survey Area and to be representative of the habitat types in the Survey Area. Therefore, habitat types occurring over a larger proportion of the Survey Area were sampled by a larger number of trapping sites than less represented habitat types.

The majority of trapping sites (10 of 14) were installed in the Boolgeeda and Newman land systems (i.e. the most common land systems; Table 2.1). Six of the nine land systems occurring within the Survey Area were sampled systematically by installing trapping sites. The remaining three land systems (Brockman, River and Robe) only occur in small areas of the Survey Area, with the River and Robe land systems only occurring at the southernmost point of the Survey Area. The Brockman land system could only be accessed on foot and was, therefore, sampled opportunistically.

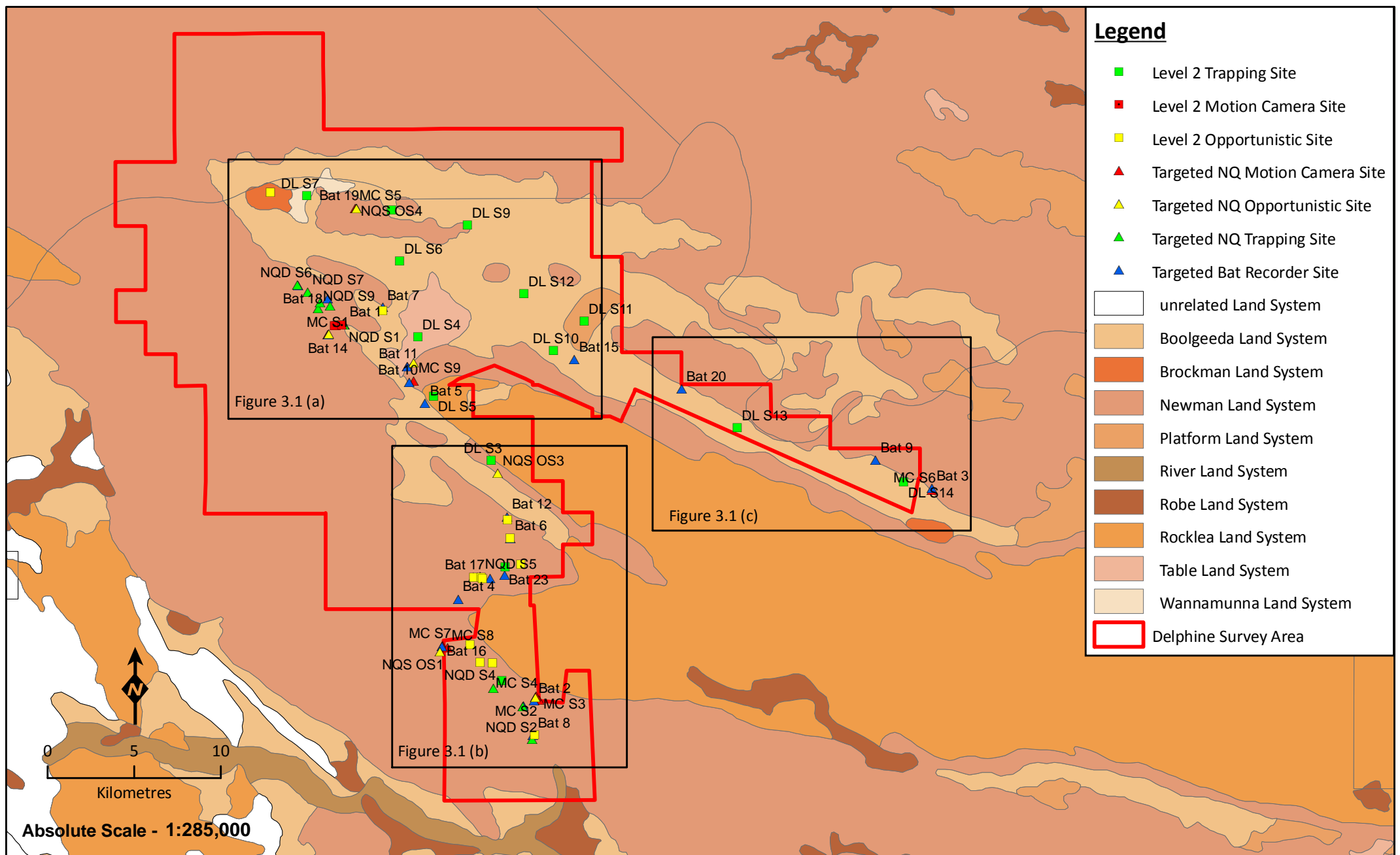
In addition to trapping, opportunistic searches were undertaken, targeting potentially sensitive habitats and habitat supporting conservation significant species. Locations and details of all survey sites are listed in Table 3.3 and mapped in Figure 3.1. Site photographs and descriptions are presented in Appendix D.

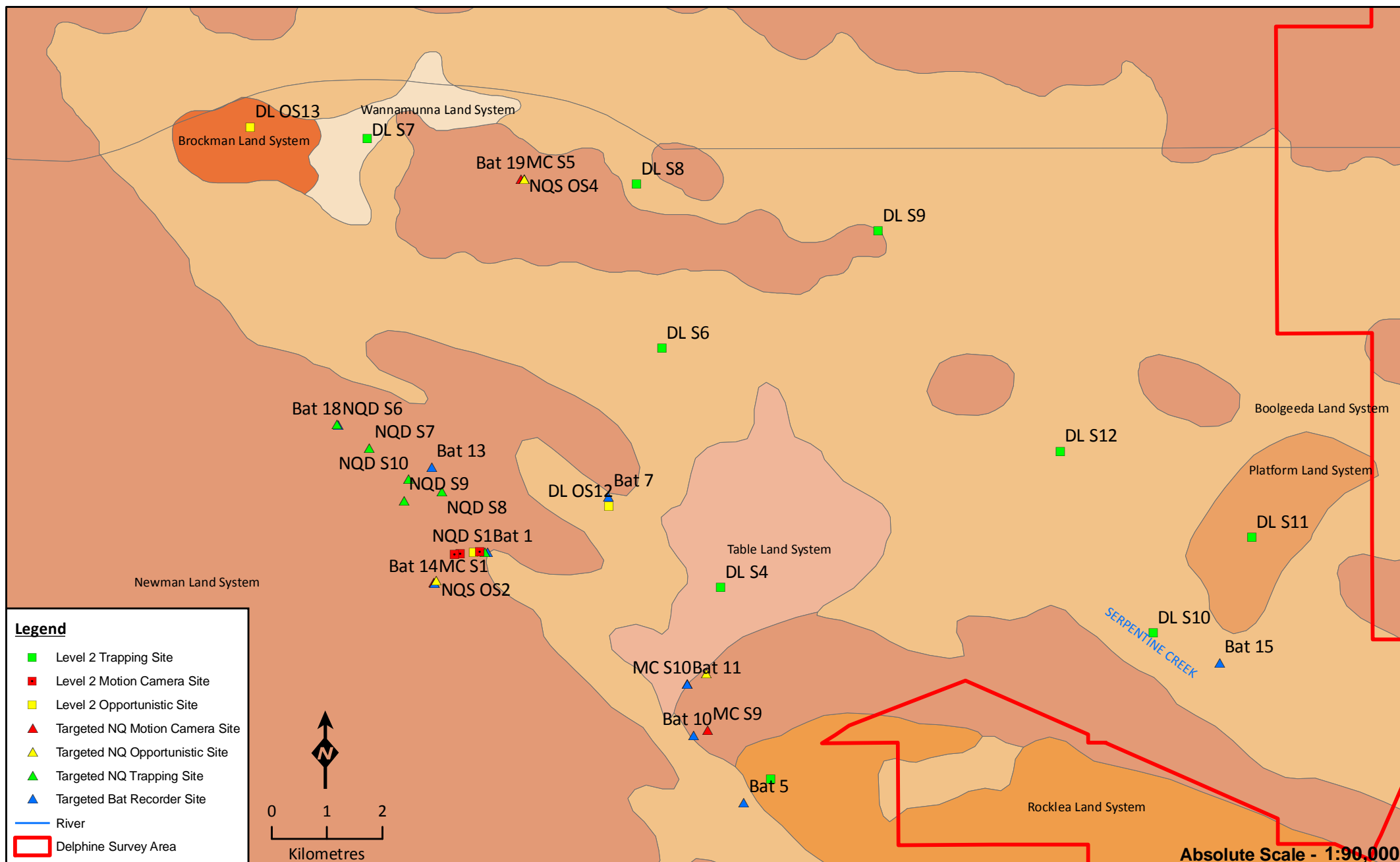
Table 3.3 – Survey site information

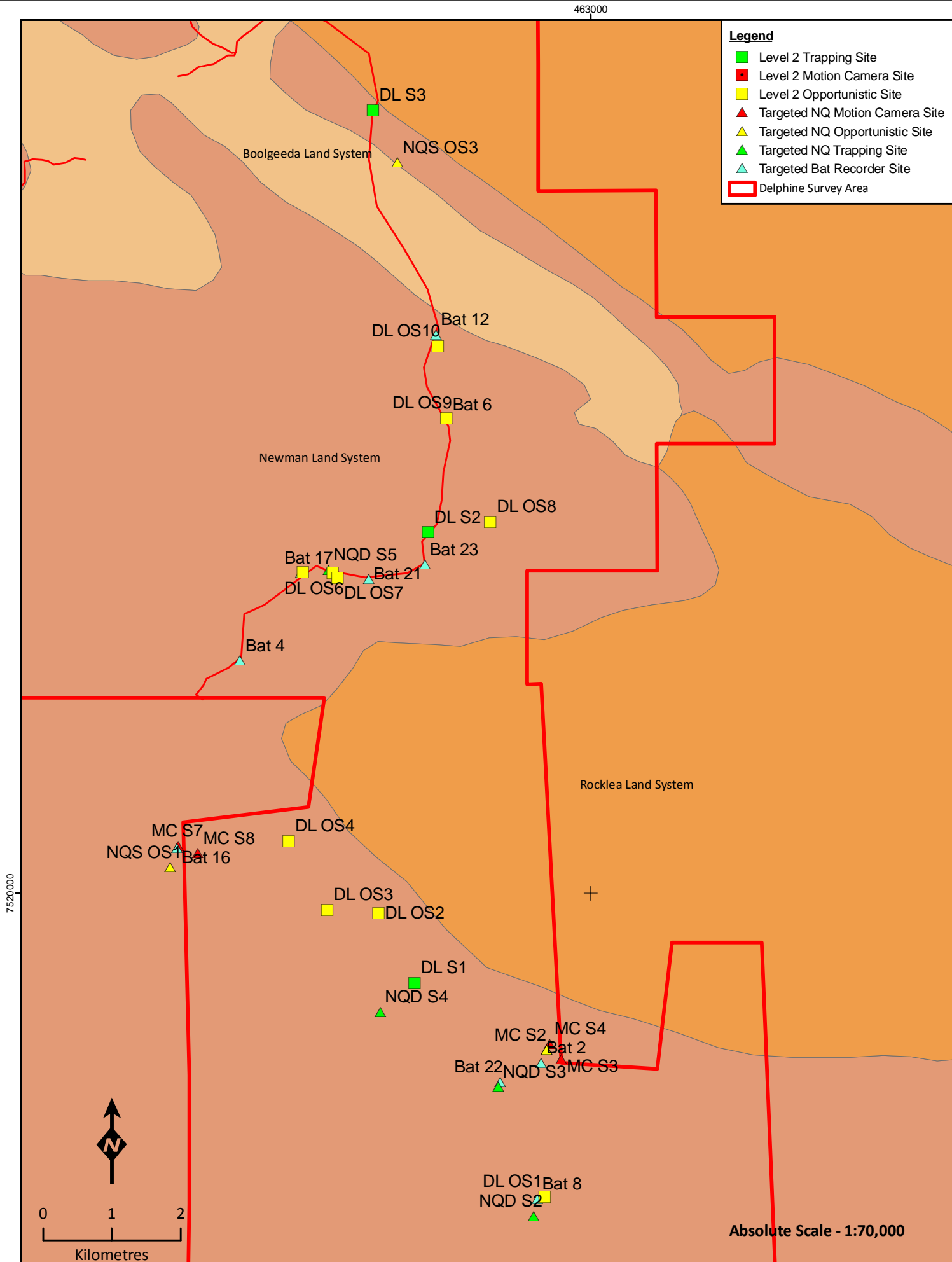
Site	Survey Site	Location		Land System	Vegetation Community
		Easting	Northing		
DL S1	Trapping	460442	7518691	Newman	82
DL S2	Trapping	460639	7525260	Newman	82
DL S3	Trapping	459836	7531398	Newman	567
DL S4	Trapping	455591	7538562	Table	569
DL S5	Trapping	456499	7535096	Rocklea	569
DL S6	Trapping	454532	7542890	Boolgeeda	569

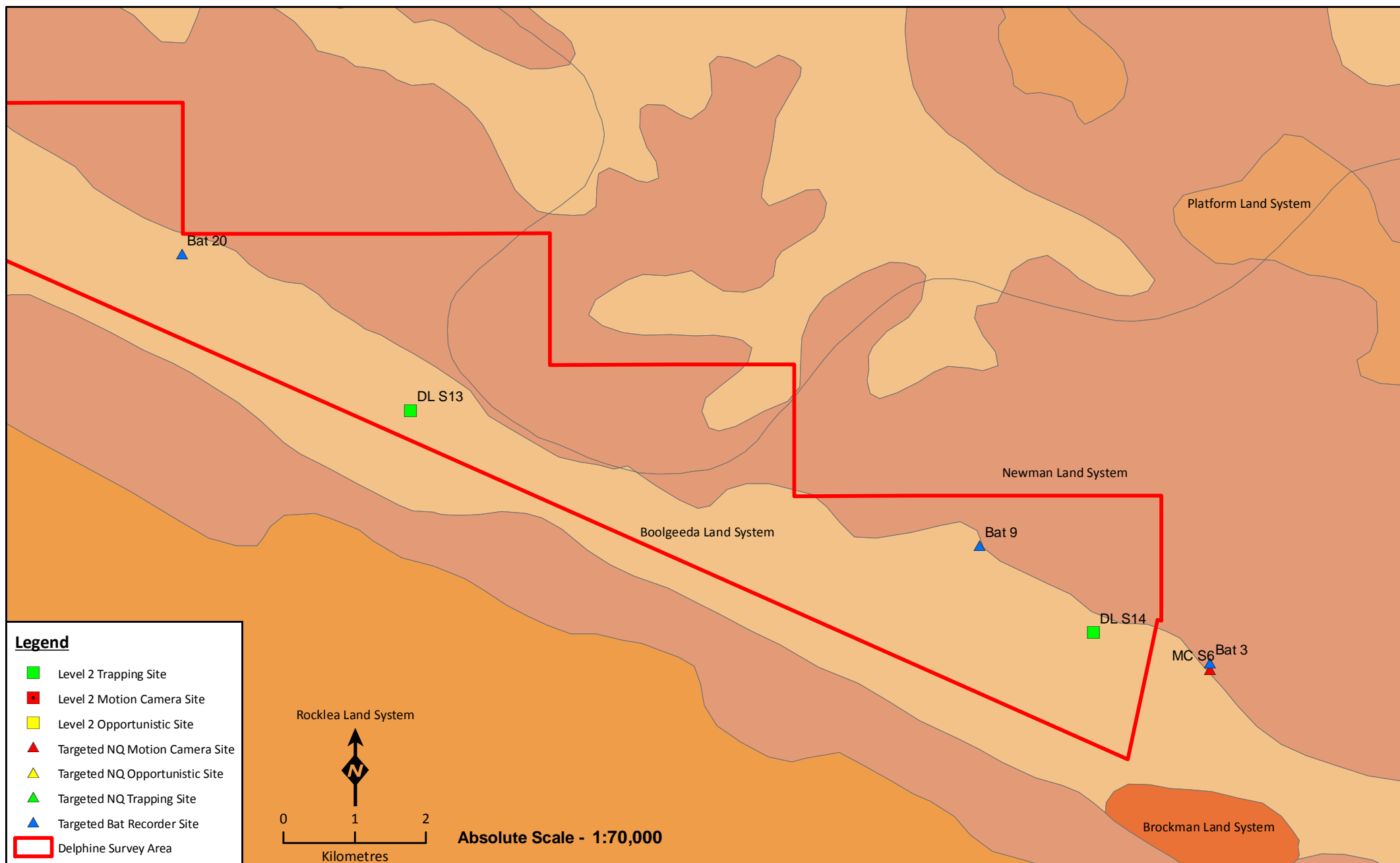
		Location			
DL S7	Trapping	449198	7546668	Wannamunna	569
DL S8	Trapping	454070	7545841	Boolgeeda	569
DL S9	Trapping	458442	7545000	Newman	569
DL S10	Trapping	463405	7537744	Boolgeeda	569
DL S11	Trapping	465196	7539462	Platform	569
DL S12	Trapping	461724	7541018	Boolgeeda	569
DL S13	Trapping	474014	7533307	Boolgeeda	569
DL S14	Trapping	483603	7530190	Boolgeeda	569
DL OS1	Opportunistic	462334	7515580	Newman	82
DL OS2	Opportunistic	459920	7519706	Newman	82
DL OS3	Opportunistic	459174	7519762	Newman	82
DL OS4	Opportunistic	458613	7520759	Newman	82
DL OS5	Opportunistic	458811	7524678	Newman	82
DL OS6	Opportunistic	459247	7524674	Newman	82
DL OS7	Opportunistic	459324	7524586	Newman	82
DL OS8	Opportunistic	461541	7525406	Newman	82
DL OS9	Opportunistic	460908	7526921	Newman	82
DL OS10	Opportunistic	460780	7527972	Newman	569
DL OS11	Opportunistic	451118	7539197	Newman	82
DL OS12	Opportunistic	453562	7540022	Boolgeeda	569
DL OS13	Opportunistic	447089	7546870	Brockman	569
DL OS14	Opportunistic	450879	7539168	Newman	82
DL OS15	Opportunistic	450781	7539160	Newman	82
DL OS16	Opportunistic	451229	7539203	Newman	569
NQD S1	Targeted trapping (Northern Quoll)	451323	7539197	Newman	569
NQD S2	Targeted trapping (Northern Quoll)	462175	7515292	Newman	82
NQD S3	Targeted trapping (Northern Quoll)	461661	7517179	Newman	82
NQD S4	Targeted trapping (Northern Quoll)	459940	7518271	Newman	82
NQD S5	Targeted trapping (Northern Quoll)	459192	7524708	Newman	82
NQD S6	Targeted trapping (Northern Quoll)	448654	7541501	Newman	82
NQD S7	Targeted trapping (Northern Quoll)	449239	7541074	Newman	82
NQD S8	Targeted trapping (Northern Quoll)	450548	7540288	Newman	82
NQD S9	Targeted trapping (Northern Quoll)	449860	7540134	Newman	82
NQD S10	Targeted trapping (Northern Quoll)	449937	7540513	Newman	82
NQD OS1	Targeted survey - opportunistic	456882	7520371	Newman	82
NQD OS2	Targeted survey – opportunistic	450441	7538690	Newman	82
NQD OS3	Targeted survey - opportunistic	460192	7530644	Newman	569
NQD OS4	Targeted survey - opportunistic	452034	7545936	Newman	569
NQS OS5	Targeted survey - opportunistic	455330	7537011	Newman	569
NQS OS6	Targeted survey - opportunistic	462366	7517715	Newman	82

Datum: GDA 94
Zone: 50K









3.4 CONSERVATION SIGNIFICANT FAUNA

After the results of the literature review, database searches and survey results were compiled, fauna species that are listed under current legislative frameworks were identified. Three conservation lists have been developed at national (EPBC Act) and state level (WC Act and DEC priority list).

The likelihood of a conservation significant species being present within the project was determined by examining the following:

- fauna habitats known to exist within the Survey Area and their condition as assessed during the survey;
- distance of previously recorded conservation significant species from the Survey Area;
- frequency of occurrence of conservation significant species records in the region; and
- time passed since conservation significant species were recorded within, or nearby the Survey Area.

Each conservation significant or biologically significant species potentially occurring in the Survey Area was assigned a likelihood of occurrence based on the four categories described below. The level of available information for each species was also taken into consideration so that species are not allocated a low likelihood of occurrence because of insufficient survey information or cryptic behaviours and ecology, in accordance with the precautionary principle.

- **Recorded** - Species recorded during current survey.
- **High** - Species recorded within, or in proximity to, the Survey Area within the last 20* years; suitable habitat occurs in the Survey Area.
- **Medium** - Species recorded within, or in proximity to, the Survey Area more than 20 years ago. Species recorded outside Survey Area, but within 50 km; suitable habitat occurs in the Survey Area.
- **Low** - Species rarely, or not, recorded within 50 km, and/or suitable habitat does not occur in the Survey Area.

**ecologia* chooses to incorporate regional data from the last 20 years to assess a high likelihood of occurrence of species. Species that have previously been recorded from an area within the last 20 years and where high quality, suitable habitat still persists within an area are considered by *ecologia* to still have potential for a high likelihood of occurrence, following the precautionary principle.

3.5 SAMPLING METHODS

The following survey methodology adopted by *ecologia* for the Level 2 vertebrate fauna and targeted conservation significant fauna assessment of the Survey Area was in accordance with:

- Guidance Statement No. 56 (EPA 2004);
- Position Statement No. 3 (EPA 2002);
- *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010);
- Survey Guidelines for Australia's Threatened Mammals, Reptiles Bats and Birds (DEWHA 2010b; DSEWPac 2011a, b, c); and
- Fortescue's *Terrestrial Vertebrate Fauna Assessment Guidelines* (FMG 2011).

The survey was undertaken using a variety of sampling techniques, both systematic and opportunistic. Systematic sampling refers to data methodically collected over a fixed time period in a discrete habitat type, using an equal or standardised sampling effort. The resulting information can be analysed statistically, facilitating comparisons between habitats. Opportunistic sampling includes data collected non-systematically from both fixed sampling sites and as opportunistic records from chance encounters with fauna.

3.5.1 Systematic Sampling

Terrestrial Mammals and Herpetofauna

Trapping for terrestrial mammals and herpetofauna was undertaken using a standardised trapping format comprising a combination of pit-fall traps, Elliott box traps, funnel traps and cage traps.

Each trapping site consisted of the following (Figure 3.2):

- Pit-trap and drift fence: Five PVC pipe (16 x 50 cm) and five 20 L plastic buckets (30 x 40 cm) were established at each site. A 10 metre flywire drift fence (30 cm high) bisected the pits, directing fauna into the traps.
- Elliott box traps: Ten medium sized Elliott box traps (9 x 9 x 32 cm) were placed at each site, and baited with Universal Bait (a mixture of peanut butter, rolled oats and sardines). Each Elliott trap was placed between the pit trap setups. Elliott traps were shaded using Air Cell roof insulation.
- Funnel traps: Funnel traps (Ecosystematica Type III) were placed in association with drift fences. Twenty funnel traps were used per site, with a trap being placed at each end of the drift fence. Funnel traps were shaded using Air Cell roof insulation.
- Cage traps: Two Sheffield small animal traps (22 cm x 22 cm x 55 cm) were used per site with one trap placed at each end of the trap line. Traps were baited with Universal Bait.

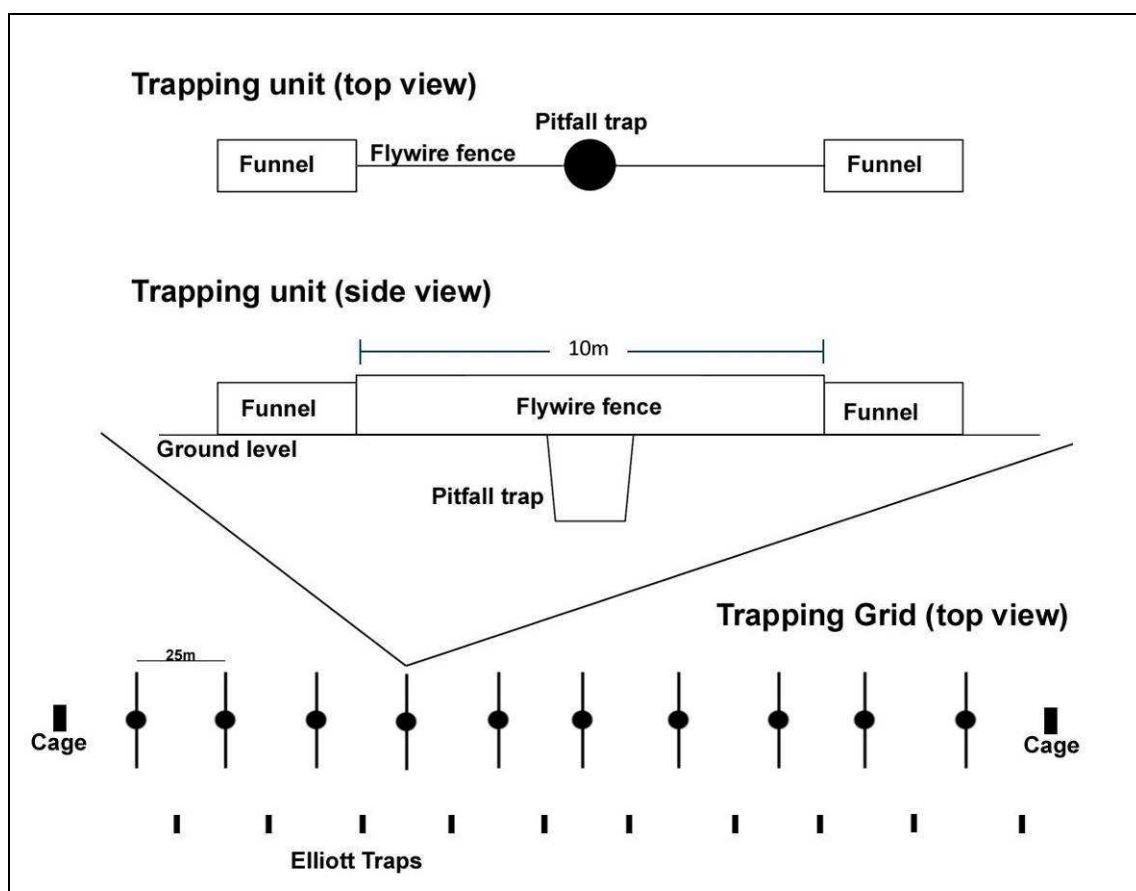


Figure 3.2 – Diagram of the systematic sampling trap arrangement



Figure 3.3 – Image of a single *ecologia* trap point

Avifauna

Thirty-minute set-time surveys were used to document the avifauna present at each of the trapping sites, and at least four set-time surveys were conducted at each site. During each set-time survey an ornithologist recorded the number of individuals of each species observed while actively searching similar habitat within 500 m of the survey site. This is in accordance with survey methodology outlined in the Survey Guidelines for Australia's Threatened Birds (DSEWPaC 2011), as well as for the ongoing Birds Australia *Atlas of Australian Birds* project.

Survey effort was concentrated at survey sites within 3 hours of dawn, as this time is deemed to be optimal to record most bird species. Opportunistic surveys during the day and near dusk were also conducted, as they may yield species less frequently observed in the early morning, e.g. diurnal raptors.

Bats

Bat echolocation calls were recorded using SM2BAT 384 kHz long term passive recorder. The SM2BAT has a high sampling frequency, enabling the full spectrum of the calls to be recorded without being transformed allowing greater accuracy and sensitivity. The SM2BAT was programmed to record from dusk to dawn (approximately 720 minutes) for each night that was surveyed. A single overnight recording was made at each systematic survey site. One night of recording is sufficient to provide an accurate record of the bat assemblage found in the area, as experience from previous surveys indicates that the species of bats recorded tend to remain the same over multiple nights.

SM2BAT bat recorders were set up at a total of 37 locations within the Survey Area. Of these, 14 locations were sampled during the Level 2 vertebrate fauna assessment (totalling 168 hours of bat recordings) (Table 3.4), and an additional 23 locations (totalling 291.3 hours) were sampled from rocky breakaways within the gorges and gullies habitat type and any other suitable areas for potentially recording bats during the targeted conservation significant fauna assessment.

3.5.2 Opportunistic Data

Nocturnal Searching

Areas of the Survey Area were searched at night using a combination of road transects and opportunistic ground searches using head torches to uncover nocturnal species, including geckos, snakes, frogs and birds.

Diurnal Searching

Both trapping and opportunistic sites were searched by hand for cryptic species, which comprised searching beneath the bark of dead trees, breaking open old logs, stumps and dead free-standing trees, investigating burrows and over-turning logs and stones. Diurnal search sites were selected on the basis of fauna habitat (targeting uncommon habitats and habitats poorly represented by trapping sites) and the possibility of their harbouring conservation significant fauna.

Fauna were also recorded while searching, travelling and during trap establishment within the Survey Area during the day and night. Tracks, diggings, scats, burrows and nests were recorded where possible.

Camera Trapping

A total of nine motion sensor cameras (Bushnell Trophy Cam, model number 119415) were used in areas with a high likelihood of animal activity, such as water sources, to detect fauna species. The camera is triggered by movement by a highly sensitive passive infra-red motion sensor and functions day and night taking either video footage or photos (Bushnell Outdoor Products 2009).

Three cameras were deployed during the Level 2 vertebrate fauna assessment, and six were deployed during the targeted conservation significant fauna assessment.

3.6 TARGETED CONSERVATION SIGNIFICANT FAUNA SURVEYING

Prior to the commencement of survey activity, the preferred habitat of the conservation significant species that potentially occur in the Survey Area was determined. These habitats were identified and targeted during survey activities using both systematic survey sites and opportunistic surveys.

On the basis of the habitats observed during surveying, specific searches were also undertaken to determine the presence of Northern Quoll, Pilbara Leaf-nosed Bat, Pilbara Olive Python, Ghost Bat, Bush Stone-curlew, Star Finch and Fortescue Grunter.

Targeted trapping sites were established for Northern Quoll during the targeted conservation significant fauna assessment. Trapping effort at these sites was dependent of habitat availability (i.e. larger areas of potential Northern Quoll habitat were sampled using a higher number of traps).

3.7 SURVEY EFFORT

Survey effort expended within the Survey Area, incorporating both the Level 2 vertebrate fauna and targeted conservation significant fauna assessment, is presented in Table 3.4 and included the following:

- Systematic trapping grids (pit traps, funnels, Elliott traps and cage traps) were open for 4,813 trap-nights.
- Approximately 29 hours were spent surveying for birds (during the Level 2 vertebrate fauna assessment).
- 44 hours were spent on opportunistic diurnal searching (Level 2 vertebrate fauna and targeted conservation significant fauna assessments).
- 25.7 hours were spent on opportunistic nocturnal searching (Level 2 vertebrate fauna assessment).
- Nine motion-sensing cameras were deployed for a total of 682 hours (total for both the Level 2 vertebrate fauna and targeted conservation significant fauna assessments).
- 459.3 hours of SM2BAT recordings were analysed to determine bat assemblage and distribution (Level 2 vertebrate fauna and targeted conservation significant fauna assessments).

Included in these totals was the following survey effort targetting conservation significant fauna:

- 18.6 hours (711 trap nights) conducting targeted searches for secondary evidence of the Northern Quoll were conducted primarily within gorges and gullies habitat type. Six Motion

cameras were set up in areas of identified suitable habitat for Northern Quoll (totalling 144 hours).

- 6.3 hours conducting targeted searches for Pilbara Olive Python individuals and secondary evidence, primarily within the gorges and gullies habitat type.
- 6.3 hours of fish trapping and searching for Fortescue Grunter at water pools. Additionally, three funnel traps were baited and positioned in a large pool to capture individuals.
- 4 hours of opportunistic bird surveys for Star Finch at water pools
- 2 hours of searching for potential roost caves for both species, and 459.3 hours of bat recordings were analysed to determine the presence of these species.
- 110 minutes of call playback for Bush-stone Curlew conducted during nocturnal searches.

Table 3.4 – Survey effort

Site	Pit Traps (trap nights)	Funnels (trap nights)	Elliott's (trap nights)	Cages (trap nights)	Bird Survey (min)	Diurnal Opp Search (min)	Bat Recording (min)	Nocturnal Opp Search (min)	Camera Trapping (min)
Level 2 Vertebrate Fauna Assessment									
DL S1	70	140	70	14	120	0	720	0	0
DL S2	70	140	70	14	120	60	720	0	0
DL S3	70	140	70	14	120	120	720	0	0
DL S4	70	140	70	14	120	0	720	0	0
DL S5	70	140	70	14	120	0	720	0	0
DL S6	70	140	70	14	120	0	720	0	0
DL S7	70	140	70	14	120	0	720	0	0
DL S8	70	140	70	14	120	0	720	0	0
DL S9	70	140	70	14	120	0	720	0	0
DL S10	70	140	70	14	120	60	720	0	0
DL S11	70	140	70	14	120	0	720	0	0
DL S12	70	140	70	0*	120	0	720	0	0
DL S13	70	140	70	14	120	0	720	60	0
DL S14	70	140	70	14	120	0	720	60	0
Opportunistic	0	0	0	0	60	1,520	0	1,420	1,640
Targeted Conservation Significant Fauna Assessment									
NQS S1	0	0	0	70	0	0	0	0	0
NQS S2	0	0	0	60	0	0	0	0	0
NQS S3	0	0	0	112	0	0	0	0	0
NQS S4	0	0	0	98	0	0	0	0	0

Site	Pit Traps (trap nights)	Funnels (trap nights)	Elliott's (trap nights)	Cages (trap nights)	Bird Survey (min)	Diurnal Opp Search (min)	Bat Recording (min)	Nocturnal Opp Search (min)	Camera Trapping (min)
NQS S5	0	0	0	112	0	0	0	0	0
NQS S6	0	0	0	70	0	0	0	0	0
NQS S7	0	0	0	70	0	0	0	0	0
NQS S8	0	0	0	35	0	0	0	0	0
NQS S9	0	0	0	56	0	0	0	0	0
NQS S10	0	0	0	28	0	0	0	0	0
Opportunistic	0	0	0	0	0	1,120	17,480	0	32,280
Total	980	1,960	980	893	1,740	2,640	27,560	1,540	40,920

*No cages were placed at DL S12 due to some field equipment being stolen during the survey. This site was considered the least likely to result in cage captures as it did not contain habitat suitable for Northern Quoll or Northern Brushtail Possum.

3.8 DATA ANALYSIS

3.8.1 Survey Adequacy

There are three general methods of estimating species richness from sample data: extrapolating species-accumulation curves (SACs), fitting parametric models of relative abundance, and using non-parametric estimators (Bunge and Fitzpatrick 1993; Colwell and Coddington 1994; Gaston 1996). In this report, the level of survey adequacy was estimated using SACs, which graphically illustrate the accumulation of new species as more individuals are recorded. Ultimately, the asymptotic plateau is reached at the level at which no new species are present. To eliminate inconsistent values caused by random or periodic temporal variation, an algorithm (Mao Tau) was applied using EstimateS (version 8, Colwell 2009), effectively smoothing out the curve of the number of species observed. In order to estimate the theoretical maximum number of species at each level of sampling effort, a Michaelis-Menten (MM) enzyme kinetic curve was calculated and used as a stopping rule technique. The MM equation creates a curve which best represents the typical rate of species accumulation during a fauna survey, and shows the plateau formed when survey effort is sufficient.

Only the results of trapping and set-time bird surveys during the Level 2 vertebrate fauna assessment are included in SAC analysis, as this form of analysis assumes a standard sampling effort. Therefore, species recorded through opportunistic methods are not included. Separate analyses were carried out for each species group (mammal, reptile, bird). Analyses were not conducted on the amphibian or fish fauna due to the paucity of results.

3.8.2 Habitat Assessment

Analysis of the fauna survey data was undertaken to determine the similarities in fauna communities and identify any unique fauna habitats.

To analyse differences in species diversity between habitats, the data was subjected to log+1 transformation. To test whether the differences in species diversity between habitat types were significant, analysis of similarity (ANOSIM) (Clarke 1993) comparisons were made using the one-way ANOSIM function. ANOSIM was calculated using the Bray-Curtis Similarity Index with 999 permutations. Non-metric multi-dimensional scaling (MDS) was also applied to the Bray-Curtis similarity matrix. Resulting stress values below 0.20 were considered to indicate a good fit of the scaling to the matrix. The dimensions that reduced the majority of the “raw stress” were chosen for the final scaling. Analysis was undertaken using the PAST software package (Hammer *et al.* 2001).

Separate analyses were carried out on terrestrial fauna (mammal and reptile) and avifaunal assemblages across different habitat types.

3.9 TAXONOMY AND NOMENCLATURE

Nomenclature for mammals, reptiles and amphibians within this report is as per *Western Australian Museum Checklist of the Vertebrates of Western Australia*, birds according to Christidis and Boles (2008). References used for fauna identification are listed in Table 3.5.

Table 3.5 – References used for identification

Fauna Group	Reference
Mammals	Menkhorst and Knight (2011), Van Dyck and Strahan (2008)
Bats	Churchill (2008) Menkhorst and Knight (2011)
Birds	Simpson and Day (2004)
Reptiles	Cogger (2000), Wilson and Swan (2010)
Geckos	Storr <i>et al.</i> (1990), Wilson and Swan (2010)
Skinks	Storr <i>et al.</i> (1999), Wilson and Swan (2010)
Dragons	Storr <i>et al.</i> (1983), Wilson and Swan (2010)
Varanids	Storr <i>et al.</i> (1983), Wilson and Swan (2010)
Legless Lizards	Storr <i>et al.</i> (1990), Wilson and Swan (2010)
Snakes	Storr <i>et al.</i> (2002), Wilson and Swan (2010)
Amphibians	Tyler and Doughty (2009), Cogger (2000)
Fish	Allen <i>et al.</i> (2002)

3.10 ANIMAL ETHICS AND LICENCES

Surveying was conducted as per *ecologia's* Animal Ethics Code of Practice, which conforms to Section 5 of the *Australian code of practice for the care and use of animals for scientific purposes* (NHMRC 2004).

In all cases, fauna were identified in the field and released at the point of capture. The survey was conducted under DEC Regulation 17 Licence SF008577.

3.11 SURVEY TEAM

Field survey team members are listed in Table 3.6 and external consultants listed in Table 3.7.

Table 3.6 – Field survey personnel

Survey Member	Expertise	Relevant Qualification	Experience
Damien Cancilla	Mammalogy	BSc. (Hons)	8 years
Nigel Jackett	Ornithology	BSc. (Hons)	7 years
Jordan Vos	Herpetology		7 years
John Graff	Ornithology	BSc.	5 years
Bruce Greatwich	Ornithology	BSc.	4 years
Sean White	Invertebrates	BSc.	4 years
Jesse Forbes-Harper		BA, BSc. (Hons)	3 years
Anna Nowicki		BSc. (Hons)	3 years
Leigh Smith	Herpetology	Cert. Vet Nursing	3 years
Adam Young		BSc.	2 years

Table 3.7 – External consultants

External Consultant	Institution	Relevant Experience
Bob Bullen	Bat Call WA	16 years – bat call IDs

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4 RESULTS

4.1 FAUNA HABITATS

Ecoscape (2012a) previously identified three habitat types within the Survey Area. During the current Level 2 vertebrate fauna assessment, these broad habitat types were reassessed and re-classified into six main fauna habitat types based on vegetation assemblages and geographical features. The habitat types identified in this survey correspond broadly with Ecoscape's habitat types, however some of the broader habitats identified by Ecoscape have been sub-divided into more detailed and defined habitat types (Table 4.1, Figure 4.7).

The six fauna habitats identified from the Survey Area during the current Level 2 vertebrate fauna assessment were:

- hilltops, hillslopes, ridges and cliffs;
- footslopes and plains;
- river systems;
- gorges and gullies;
- mixed acacia woodlands; and
- cracking clays.

Table 4.1 shows how the habitat types identified during the current Level 2 vertebrate fauna assessment correspond with Ecoscape's previously identified habitat types

Table 4.1 – Habitat comparisons from previous Level 1 fauna assessment to current Level 2 vertebrate fauna assessment

Habitat Types Identified during the Current Assessment	Habitat Types Identified by Ecoscape (2012a)
Footslopes and plains	Creeklines/drainage lines on lower slopes and valley floors
River systems	
Gorges and gullies	Sheltered gorges/gullies
Hilltops, hillslopes, ridges and cliffs	Open shrubland/open woodland over spinifex on slopes
Mixed acacia woodlands	
Cracking clays	

Of the habitat types identified during the current survey, hilltops, hillslopes, ridges and cliffs, and footslopes and plains were the most common fauna habitat type identified in the Survey Area, encompassing 97.2% of the total Survey Area. All habitat types are present in the surrounding area and not unique to the Survey Area. The gorges and gullies habitat, although small in terms of area, is important due to its potential to support a number of key conservation significant species.

The area of occupation of each habitat is shown in Table 4.2 and mapped in Figure 4.7.

Table 4.2 – Summary of fauna habitat types

Fauna Habitat	Area inside Survey Area (ha)	Percentage of Total Survey Area (%)
Hilltops, hillslopes, ridges and cliffs	49,227.32	62.8
Footslopes and plains	27,057.87	34.5
River systems	891.62	1.1
Gorges and gullies	596.82	0.8
Mixed acacia woodlands	666.42	0.8
Cracking clays	82.80	0.1

When survey effort is assessed against the habitats within the Survey Area (Table 4.3), it can be seen all fauna habitats within the Survey Area were adequately surveyed, including the gorges and gullies habitat.

Table 4.3 – Survey effort per fauna habitat type

Habitat type	Pit Traps (trap nights)	Funnels (trap nights)	Elliott's (trap nights)	Cages (trap nights)	Bird Survey (min)	Diurnal Opp. Search (min)	Bat Recording (min)	Nocturnal Opp. Search (min)	Camera Trapping (min)
Hilltops, hillslopes, ridges and cliffs	140	280	140	679	240	1,060	7,520	0	16,500
Footslopes and plains	700	1,400	700	140	1,200	60	8,720	570	0
River systems	70	140	70	200	120	500	10,600	0	15,780
Gorges and gullies ¹	0	0	0	0	0	960	0	430	8,640
Mixed acacia woodlands	70	140	70	14	120	0	720	0	0
Cracking clays ²	0	0	0	0	0	60	0	540	0
Total	980	1,960	980	893	1,680	2,640	27,560	1,540	40,920

¹Systematic trapping was not conducted in this habitat type due to the substrate being too hard and rocky to dig in traps. To ensure adequate survey effort was expended in this habitat type, additional diurnal and nocturnal searches and camera trapping were conducted.

²A lack of vehicle access prevented systematic sampling in the cracking clays habitat type for animal welfare reasons. Habitat types that could not be accessed for systematic sampling were targeted using opportunistic sampling methods

4.1.1 Hilltops, hillslopes, ridges and cliffs

Hilltops, hillslopes, ridges and cliffs is the dominant habitat within the Survey Area, comprising 62.7 % (49,227 ha) of the total area (Table 4.2, Figure 4.7). The hilltops and ridges comprise the most elevated level of all habitats and are usually dominated by a sparse vegetation of small shrubs and spinifex hummocks, on a continuous layer of bedrock and scattered pebbles and stones. Hillslopes are the regions between hilltops and footslopes, and support widely dispersed trees and shrubs over spinifex clumps on rocky loamy-clay, with a continuous layer of pebbles and stones. Cliffs exist along the side of ridges and hills where hillslopes open up to rock faces, with very sparse vegetation of scattered trees and smaller shrubs in some sheltered spots. The crevices and caves which occur in cliff faces can also provide shelter for a range of fauna species.



Figure 4.1 – Representative photo of hilltops, hillslopes, ridges and cliffs habitat type

4.1.2 Footslopes and plains

Footslopes and plains are the second most common habitat type, covering 34.5 % (27,057 ha) of the total Survey Area (Table 4.2). This habitat type consists of sparse *Eucalyptus leucophloia* trees and scattered acacia shrubs over medium to large clumps of spinifex hummock grassland on loam-clay with a continuous mantle of pebbles and stones. Wood litter is usually very sparse, but can be present in areas of recent fire history. Leaf litter can build up over time in denser areas which have not been subject to fire, such as the acacia thickets which occur along the numerous minor drainage lines. The majority of the footslopes and plains habitat occurs in the large northern basin of the Survey Area (Figure 4.7).



Figure 4.2 – Representative photo of footslopes and plains habitat type

4.1.3 River systems

Although the river system habitat only comprises 1.1 % (891.6 ha) of the Survey Area, it is a significant geographical feature. Serpentine Creek originates in the northern section of the Survey Area where a large basin channels water into the system. This weaves south before joining Duck Creek – a larger and much longer river system which passes through the southern section of the Survey Area. The River system habitat supports many large *Eucalyptus camaldulensis* and *Melaleuca argentea*, with frequent patches of dense mixed acacia shrubs as well as regions of *Buffel Grass, dense reeds and other grasses. The substrate consists of wide beds of river stones and gravel, with sections of topsoil and built-up debris. There are also numerous locations along Serpentine and Duck Creeks with permanent water, which support a large number of fauna species.

Minor creeklines which comprise acacia shrubland were not included in this habitat type, because the minor drainage channels usually do not provide areas large enough to support a different faunal assemblage.

This habitat type differs from the ‘major creeklines’ habitat type identified from the adjacent Western Hub survey areas (*ecologia* in prep-b, c), as this habitat type consists for larger water courses than those identified in the other survey areas.



Figure 4.3 – Representative photo of river systems habitat type

4.1.4 Gorges and gullies

Gorges and gullies were recorded in the southern and western parts of the Survey Area, covering a total of 0.8% (596.8 ha) of the total Survey Area. Due to access limitations, much of this habitat was mapped from aerial imagery during the assessment. Consequently, this habitat type may potentially cover a larger area than that identified during the survey. Gorges and gullies typically have many holes and crevices throughout their rock faces as well as frequent caves, and are usually bordered by rocky hills. This habitat type also supports a moderately dense vegetation layer consisting of rock figs (*Ficus brachypoda*) and large *Eucalyptus* spp. over numerous shrub and grass species. Such vegetation provides shelter and produces large amounts of moisture-preserving leaf litter, both of which attract insects and insect-eating species. Permanent or semi-permanent water also often collects in the drop pools which form in this habitat, providing an important resource to many fauna species, including several of conservation significance. Some pooled water was observed in this habitat type during the surveys.



Figure 4.4 – Representative photo of gorges and gullies habitat type

4.1.5 Mixed acacia woodlands

Mixed acacia woodland is a minor fauna habitat in the Delphine Survey Area, occupying a total of 0.8 % (666.4 ha) of the Survey Area. This habitat is comprised of Mulga (*Acacia aneura*) woodland and other mixed acacia shrubs over soft grasses and spinifex hummocks on soft to firm soil. Mixed acacia woodlands also include a variety of flowering shrubs and herbs, and therefore a good food source for bird species, particularly after rainfall. This habitat type was recorded in the north-western region of the Survey Area.



Figure 4.5 – Representative photo of mixed acacia woodlands habitat type

4.1.6 Cracking clays

The cracking clays habitat comprises the smallest proportion of the habitat types, covering only a small patch of 82.8 ha (0.1 %) in the north-west region of the Survey Area within the mixed acacia woodlands habitat type. This habitat consists almost entirely of open ground or sparse tussock grasses and occasional acacia shrubs over cracked clay soil, mainly bordered by open Mulga (*Acacia aneura*) woodland.



Figure 4.6 – Representative photo of cracking clays habitat type

4.2 FAUNA HABITAT ANALYSIS

Four of the six fauna habitats within the Survey Area were sampled with systematic trapping sites during the current survey. Ten systematic trapping sites were installed in the second largest habitat type, footslopes and plains. Only two systematic trapping sites could be installed in the largest habitat type (hilltops, hillslopes, ridges and cliffs due to accessibility issues. One systematic trap site was installed in the river systems habitat type, while the remaining systematic trap site was installed in the small area of mixed acacia woodlands. No systematic trapping sites were installed within the gorges and gullies or cracking clays habitat types. These habitat types were however, targeted with greater opportunistic survey effort (diurnal, nocturnal and camera trapping) to ensure adequate sampling of each habitat type across the Survey Area.

A one-way ANOSIM test and MDS plot of the trapping sites within the different habitat types was completed for data collected systematically for both birds and terrestrial trapped fauna. The results from these statistical analyses show a difference between the faunal assemblages in the different habitat types between birds and terrestrial trappable fauna. MDS plots for the analyses are shown in Figure 4.8.

The one-way ANOSIM test when comparing terrestrial trapped fauna against the different habitat types determined an R value of 0.2117 (R value ranges from -1 to 1, with 1 indicating that the groups are dissimilar and -1 indicating that the groups are similar) and a p-value of 0.0056 (p-value of <0.05 indicating a significant difference). The R value close to 0 and the very low p value from this analysis suggest that some differences between habitat types exist, although they are not highly different, and that the data collected are sufficient to make this analysis. The MDS plot for terrestrial trapped data provides a visual illustration, showing some overlap between habitats, but overall a difference between fauna assemblages recorded at different habitat types. A stress value of 0.2594 for this test indicates good fit of the scaling to the matrix, confirming differences in habitat types when comparing trapped fauna data.

In contrast to the results of the terrestrial trapped fauna analysis, statistical analysis of the avifauna recorded shows a distinct difference between habitat types and avifauna recorded. The one-way ANOSIM test determined an R value of 0.3174 and a p value of 0.0001. This indicates that differences between some of the avifauna habitats exist, although in general, they are not highly different from one another. The p value of 0.0001 suggests sufficient data was obtained to complete the analysis. The MDS plot reflects the results from the ANOSIM. Visually, it appears bird species recorded from the river systems habitat type are distinct from the remaining three habitat types, while mixed acacia woodlands and hillslopes, hilltops, ridges and cliffs appear distinct from each other. Hillslopes, hilltops, ridges and cliffs and footslopes and plains appear indistinct from one another. A stress value of 0.2298 for this test indicates good fit of the scaling to the matrix, confirming differences in some habitat types when comparing avifaunal data.

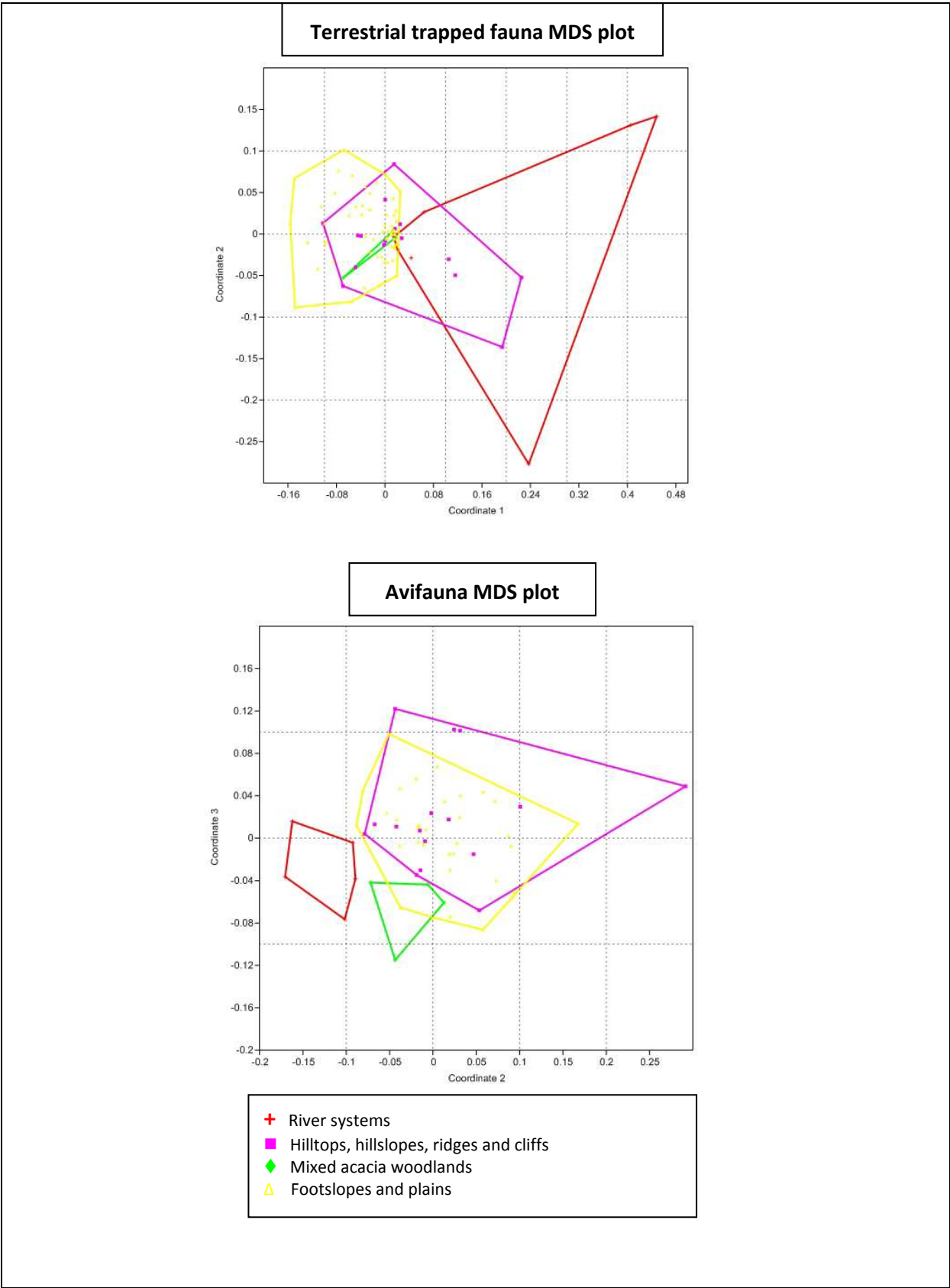


Figure 4.8 – Terrestrial trapped fauna and avifauna MDS plots

4.3 SURVEY ADEQUACY

Systematically obtained data (trapping results for terrestrial fauna and set-time survey for birds, excluding opportunistic data) was analysed for survey adequacy. Mammal, reptile and amphibian trapping data were combined for analysis as 'terrestrial fauna', as these fauna groups were sampled using the same methods. The results of trapping during the targeted conservation significant fauna assessment were not included in these analyses due to the different trapping methodology.

Analysis of the terrestrial vertebrate trapping data produced a reasonably smooth SAC, nearing the asymptotic plateau (Figure 4.9). Extrapolation of the Michaelis-Menten (MM) curve suggests that 90.69% of the theoretical total number of terrestrial fauna able to be trapped had been captured at the completion of the 98 trap nights of the Level 2 vertebrate fauna survey (Table 4.4). These results indicate that, although the majority of species were recorded during the survey, additional trapping would likely detect at least five additional species.

Species accumulation curve (SAC) analysis of the avifauna set-time survey dataset also produced a typical SAC, almost reaching the asymptotic plateau (Figure 4.10). Used as a stopping rule, the MM estimator indicated that the survey was 96.33% adequate at the completion of 58 set-time surveys. The MM estimator generated a theoretical maximum of 86 species, whilst other richness estimates were as high as 106 (Table 4.4), suggesting further survey effort may have identified as many as 23 more species.

Parametric analysis of systematically obtained survey data for birds and terrestrial faunal groups revealed that survey effort was adequate. Table 4.4 provides a summary of the theoretical maximum number of species using seven different methods of estimating richness. The Michaelis-Menten (MM) equation provides the most accurate representation of the potential species number. This is compared against the actual number of species observed, with any inconsistencies smoothed by an algorithm (Mao Tau) which simulates an infinite number of randomisations of the sample order.

Table 4.4 – Mean estimates of total species richness of the systematically sampled vertebrate fauna

Richness Estimators	Total Richness Estimate	
	Terrestrial Vertebrates	Birds
ACE	65.97	89.3
ICE	65.68	93.49
Chao-1	66.13	88
Jack-1	67.85	97.74
Jack-2	74.78	105.58
Bootstrap	59.86	89.84
Michaelis-Menten	58.44	86.16
Species Observed	53	83

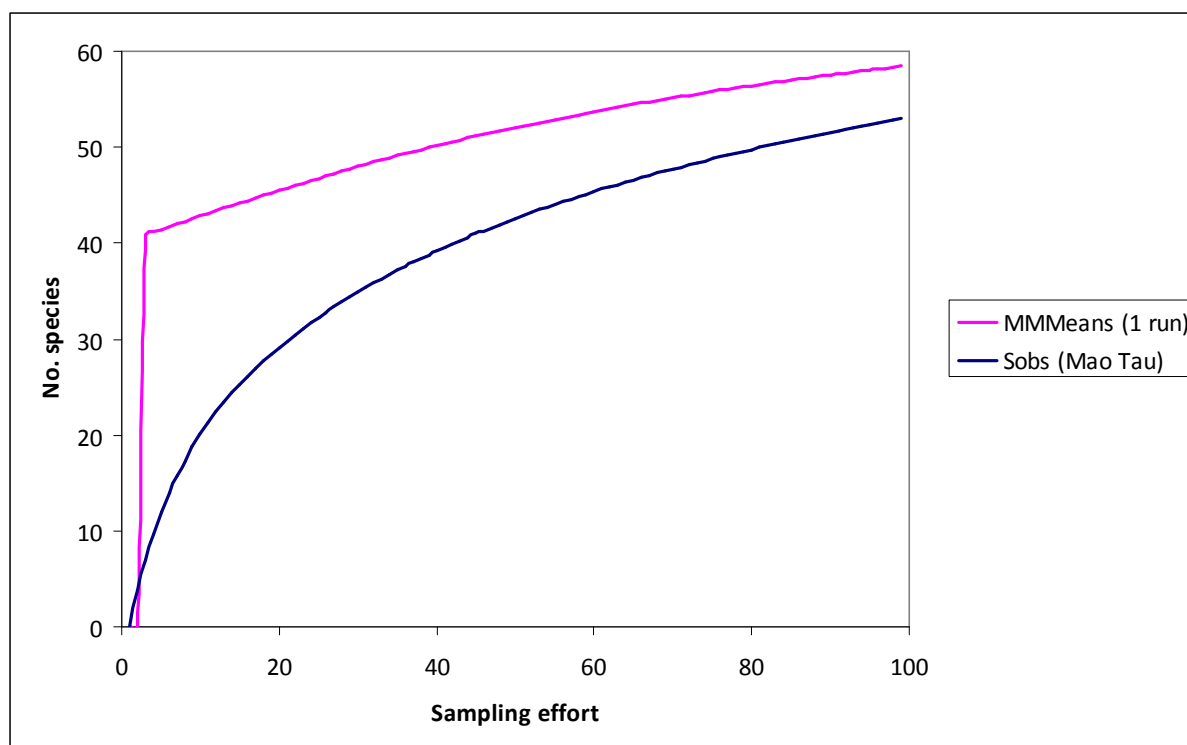


Figure 4.9 – Species accumulation curve for trapped terrestrial vertebrates

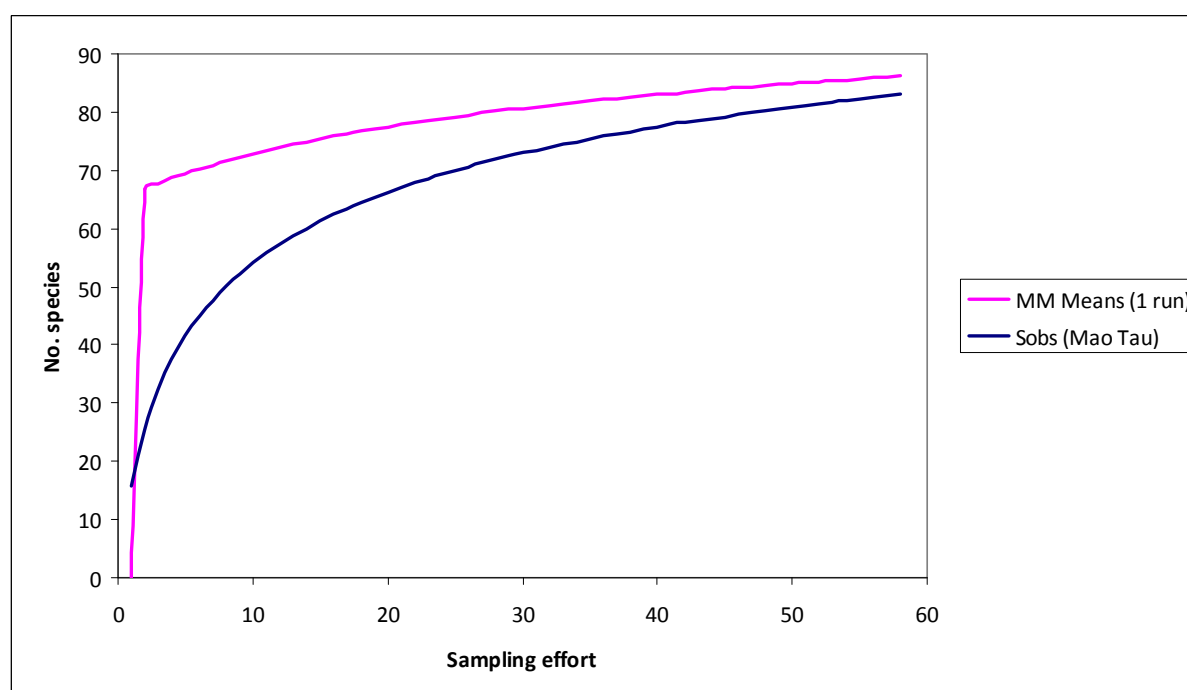


Figure 4.10 – Species accumulation curve for avifauna

4.4 FAUNA ASSEMBLAGE

A total of 22 native and four introduced mammal species, 100 bird species (including one introduced), 58 reptile species, three amphibian and six fish species were recorded within the Survey Area during the current surveys. Of the species recorded, 10 species were of conservation significance. The site by species matrix of species recorded during the Level 2 vertebrate fauna assessment can be seen in Appendix E.

4.4.1 Mammals

In total, 22 native and four introduced mammal species were recorded during the Level 2 vertebrate fauna and targeted conservation significant fauna assessment. The native mammal assemblage consisted of six dasyurids (small, carnivorous marsupials), three macropods (kangaroos), four murids (mice) and nine bats. Murids and dasyurids were captured in pitfall and Elliott traps at systematic trapping sites. Macropods were observed during diurnal and nocturnal opportunistic searches and nocturnal road spotting. Bats were identified from calls recorded on SM2BAT systems.

The most common terrestrial mammal species recorded included *Ningau timealeyi* (38), *Planigale* sp. (27), *Dasykaluta rosamondae* (19) and *Pseudomys hermannsburgensis* (16). Of the nine bat species recorded during the survey, two species (*Chalinolobus gouldii* and *Vespadelus finlaysoni*) were abundant, both of which were recorded at 13 of the 14 trapping sites during the Level 2 vertebrate fauna assessment.

Three species of conservation significant mammal were recorded during the survey: the Northern Quoll (EPBC Act Endangered, WC Act Schedule 1, DEC Endangered), Pilbara Leaf-nosed Bat (EPBC Act Vulnerable, WC Act Schedule 1, DEC Vulnerable) and the Western Pebble-mound Mouse (DEC Priority 4), which was recorded from secondary evidence (two inactive and one possibly active mounds) only.

4.4.2 Birds

In total, 100 species of bird were recorded within the Survey Area during the Level 2 vertebrate fauna and targeted conservation significant fauna assessment, including one introduced species.

The number of bird species recorded during the survey was relatively high compared to other surveys conducted in the region (Appendix E), and a total of 9,782 individuals were recorded. Several species were recorded in high numbers across most sites, and represented primarily nomadic species: For example Budgerigars (4,275 records), Masked Woodswallow (1,804), Zebra Finch (862) and Crimson Chat (596). The observation of the introduced Laughing Dove may represent the first record for the Pilbara, as this species is generally found in the south-western parts of Western Australia, occasionally extending as far north as Carnarvon (DEC 2012).

Five species of conservation significance were recorded: Eastern Great Egret (EPBC Migratory, WC Act Schedule 3), Rainbow Bee-eater (EPBC Migratory, WC Act Schedule 3), Australian Bustard (DEC Priority 4), Bush Stone-curlew (DEC Priority 4) and Grey Falcon (DEC Priority 4).

4.4.3 Herpetofauna

Fifty-eight species of reptile and three species of amphibian were recorded during the Level 2 vertebrate fauna and targeted conservation significant fauna assessment. The reptile assemblage of the Survey Area comprised 19 skinks, 14 geckos, seven elapids (front-fanged venomous snakes), seven varanids (monitors), four pygopods, three dragons, three pythons and one blind snake. The amphibian assemblage comprised of two hylids (tree frogs) and one myobatrachid (terrestrial frogs).

The most common species recorded were *Ctenotus pantherinus* (85), *Heteronotia binoei* (49), *Carlia munda* (33), *Ctenophorus caudicinctus* (26), *Ctenotus helenae* (25) and *Lophognathus longirostris* (21), all of which are common throughout the Pilbara region. Several locally uncommon species were also recorded, including *Eremiascincus fasciolatus* (1), *Egernia cygnitos* (1), *Ctenotus robustus* (3) and *Ctenotus schomburgkii* (2).

One reptile species of conservation significance was recorded, the skink *Notoscincus butleri* (DEC Priority 4).

4.4.4 Fish

All six potentially occurring fish species were recorded within the Survey Area. They are all restricted to large pools along Duck Creek and Serpentine Creek, in the Survey Area's southern region.

One species of conservation significance was recorded, the Fortescue Grunter (DEC Priority 4) which was recorded from a large pool of water near site DL S1 (Figure 3.1).

4.5 CONSERVATION SIGNIFICANT FAUNA

Based on database searches and the results of previous biological surveys in the surrounding region, 25 species (six mammal, 14 bird, three reptile, and one fish) of conservation significance potentially occur in the Survey Area. Nine species of conservation significance (two mammal, five bird, one reptile and one fish species) were recorded from within the Survey Area and these records are summarised in Table 4.5 and mapped in Figure 4.11. A tenth species, the Western Pebble-mound Mouse, was recorded based on secondary signs (inactive and possibly active mounds) only. An additional eight conservation significant species are assessed as having a medium to high likelihood of occurrence, with the remaining seven species assessed as having a low likelihood. Conservation significant species with medium to high likelihood of occurrence are described in greater detail in Section 5.3.

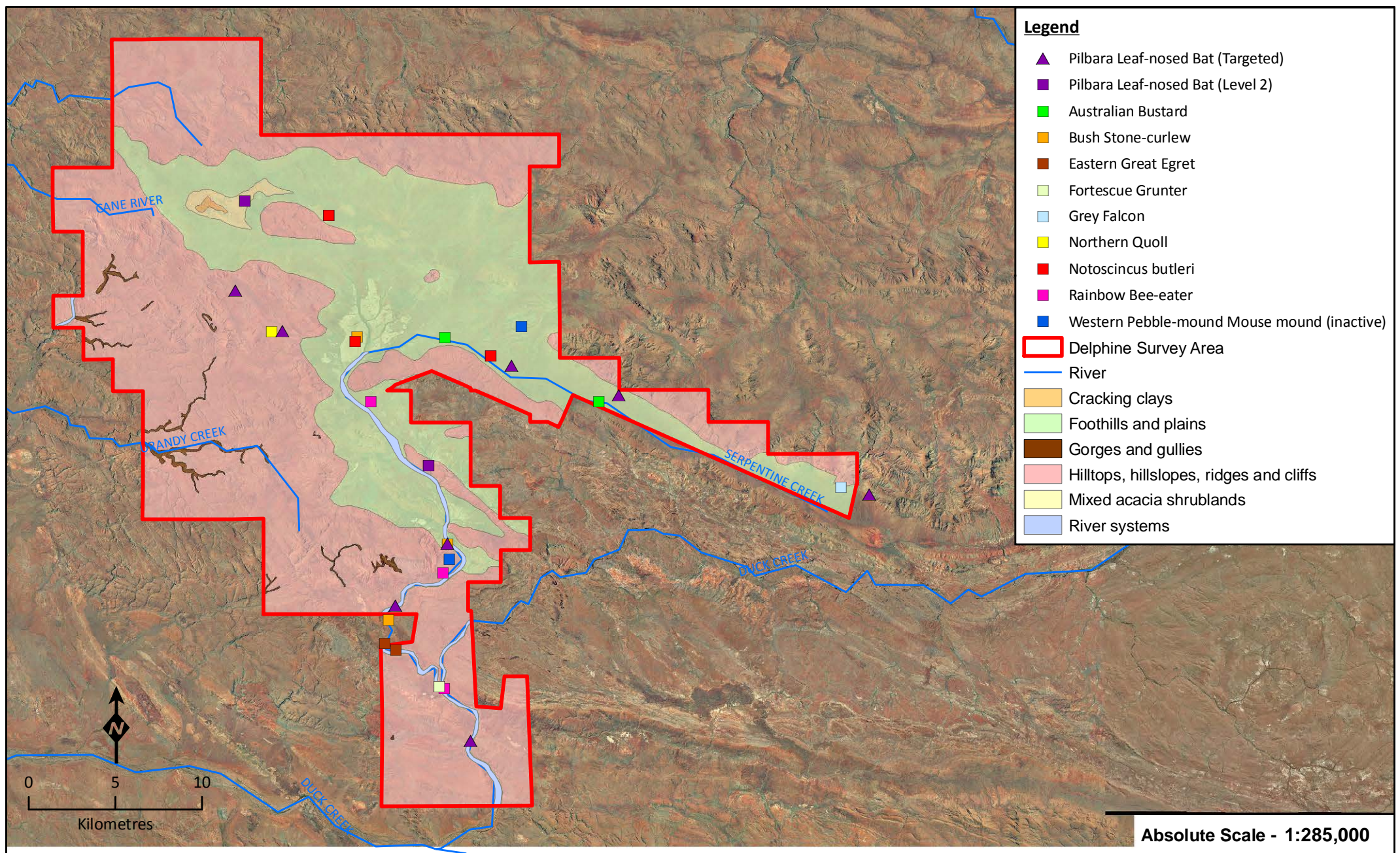
Table 4.5 – Conservation significant fauna recorded during the survey

Species	Location			Comments
	Easting	Northing	Site	
Mammals				
Northern Quoll (<i>Dasyurus hallucatus</i>)	451229	7539203	Opportunistic	Video footage of an individual captured on a motion-sensing camera
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	459836	7531398	DL S3	1 call recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	449198	7546668	DL S7	1 call recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	451374	7539197	Bat 1	1-5 calls recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	485239	7529766	Bat 3	1-2 calls recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	457902	7523388	Bat 4	1 call recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	460915	7526901	Bat 6	1-2 calls recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	462229	7515549	Bat 8	1 call recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	464610	7537199	Bat 15	1 call recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	448675	7541491	Bat 18	1-2 calls recorded on SM2BAT recorder
Pilbara Leaf-nosed Bat (<i>Rhinonictis aurantia</i>)	470803	7535500	Bat 20	2 calls recorded on SM2BAT recorder
Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>)	465167	7539455	DL S11	Inactive mound
Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>)	461020	7526042	Opportunistic	Inactive mound
Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>)	450137	7539676	Opportunistic	Inactive mound
Western Pebble-mound Mouse (<i>Pseudomys chapmani</i>)	451401	7539417	Opportunistic	Possibly active mound
Birds				
Eastern Great Egret (<i>Ardea modesta</i>)	457921	7520799	Opportunistic	Flushed from major watercourse
Australian Bustard (<i>Ardeotis australis</i>)	449198	7546668	DL S7	Tracks only
Australian Bustard (<i>Ardeotis australis</i>)	460742	7538797	Opportunistic	N/A
Australian Bustard (<i>Ardeotis australis</i>)	469635	7535083	Opportunistic	N/A

Species	Location			Comments
	Easting	Northing	Site	
Bush Stone-curlew (<i>Burhinus grallarius</i>)	457492	7522522	Opportunistic	Tracks only
Bush Stone-curlew (<i>Burhinus grallarius</i>)	455675	7538832	Opportunistic	Flushed from road north of DL S4
Bush Stone-curlew (<i>Burhinus grallarius</i>)	460908	7526921	Opportunistic	Responded to call playback and observed along watercourse
Rainbow Bee-eater (<i>Merops ornatus</i>)	460442	7518691	DL S1	N/A
Rainbow Bee-eater (<i>Merops ornatus</i>)	460639	7525260	DL S2	N/A
Rainbow Bee-eater (<i>Merops ornatus</i>)	459836	7531398	DL S3	N/A
Rainbow Bee-eater (<i>Merops ornatus</i>)	456499	7535096	DL S5	N/A
Rainbow Bee-eater (<i>Merops ornatus</i>)	454070	7545841	DL S8	N/A
Rainbow Bee-eater (<i>Merops ornatus</i>)	463405	7537744	DL S10	N/A
Rainbow Bee-eater (<i>Merops ornatus</i>)	460719	7518584	Opportunistic	N/A
Grey Falcon (<i>Falco hypoleucos</i>)	483603	7530190	DL S14	One individual
Reptiles				
<i>Notoscincus butleri</i>	463405	7537744	DL S10	Captured on three separate occasions
<i>Notoscincus butleri</i>	455591	7538562	DL S4	N/A
<i>Notoscincus butleri</i>	454070	7545841	DL S8	N/A
Fish				
Fortescue Grunter (<i>Leiopotherapon aheneus</i>)	460442	7518691	DL S1	Recorded from permanent pools within Duck Creek

Zone 50 K

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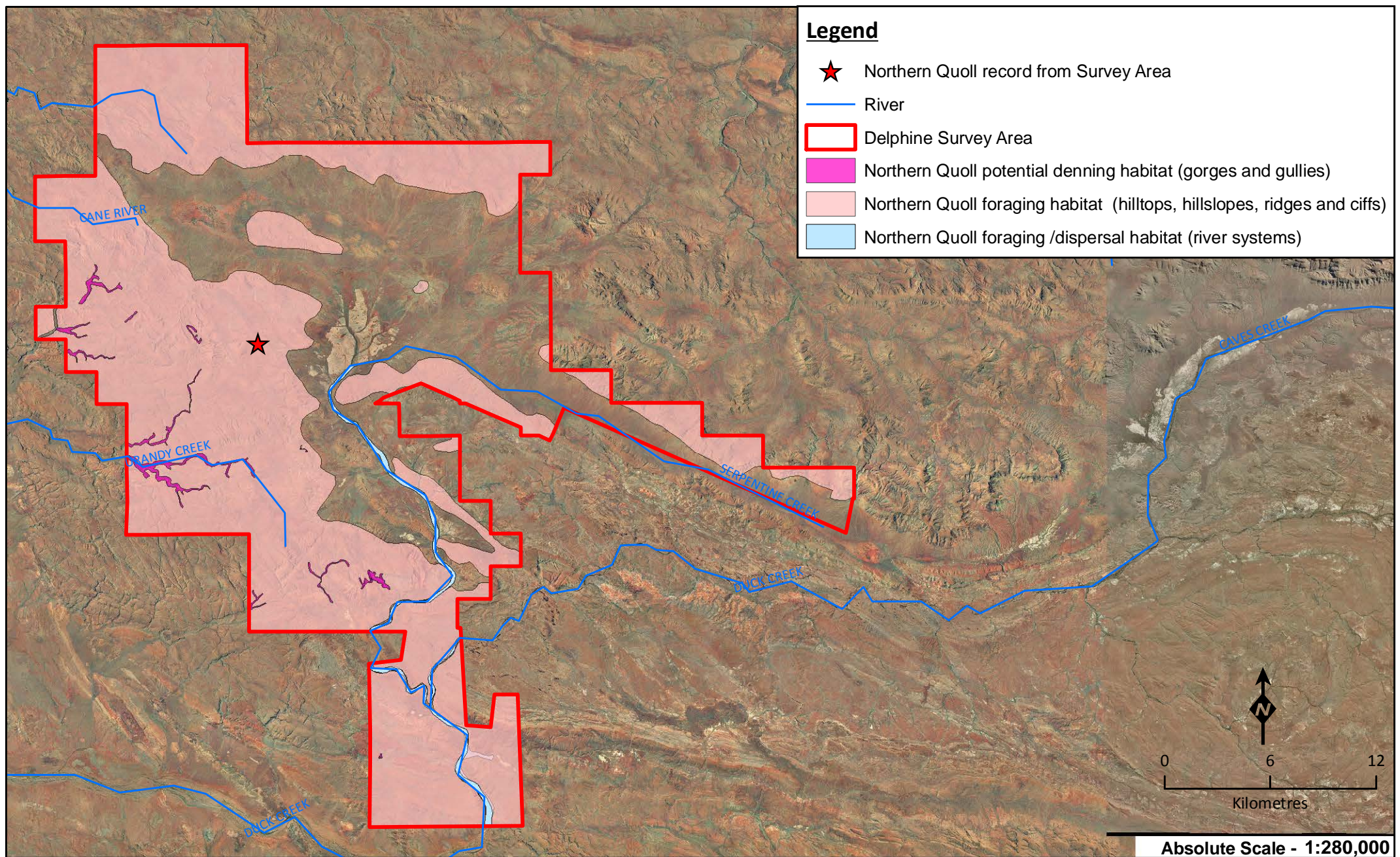
5 DISCUSSION

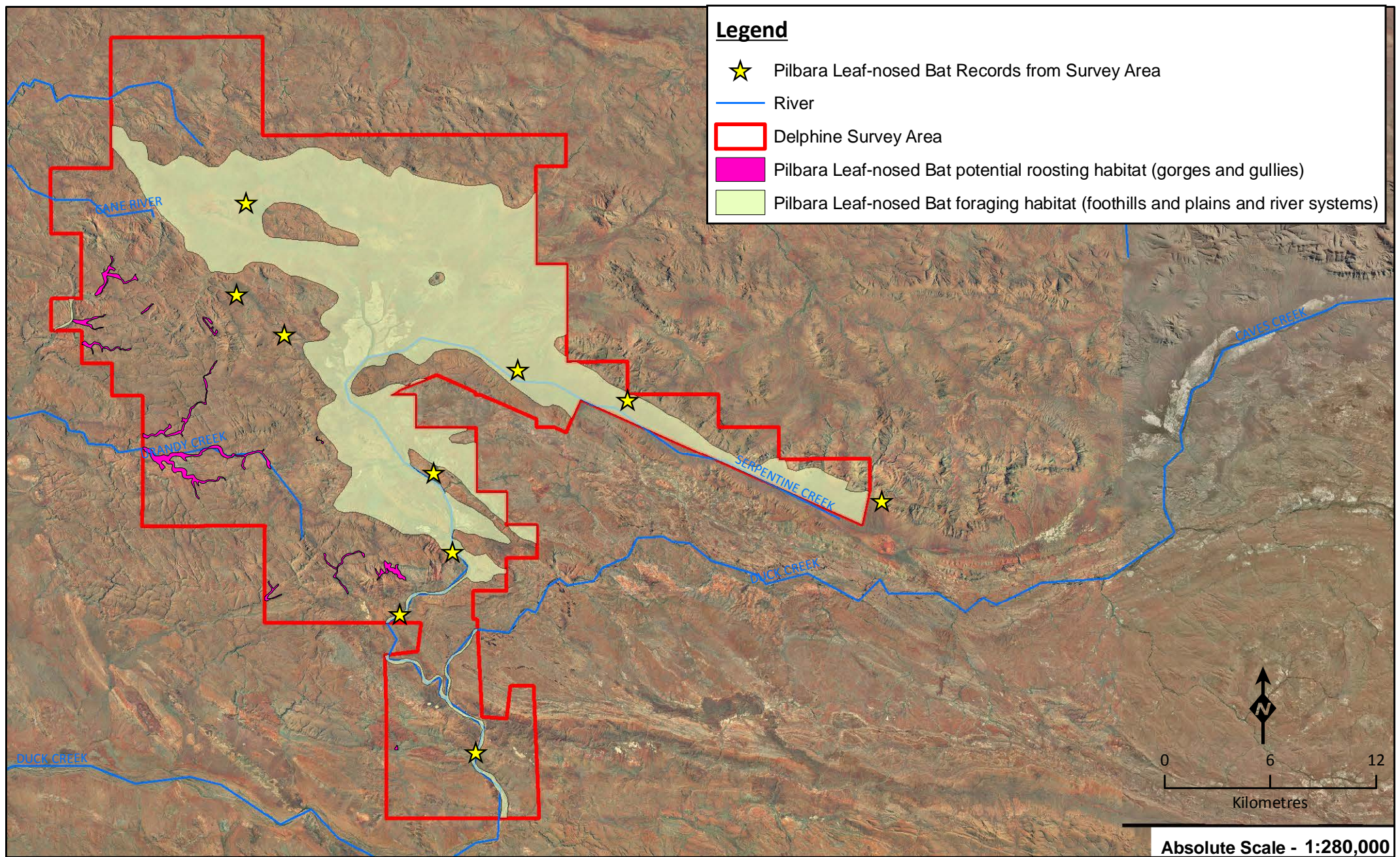
5.1 HABITATS

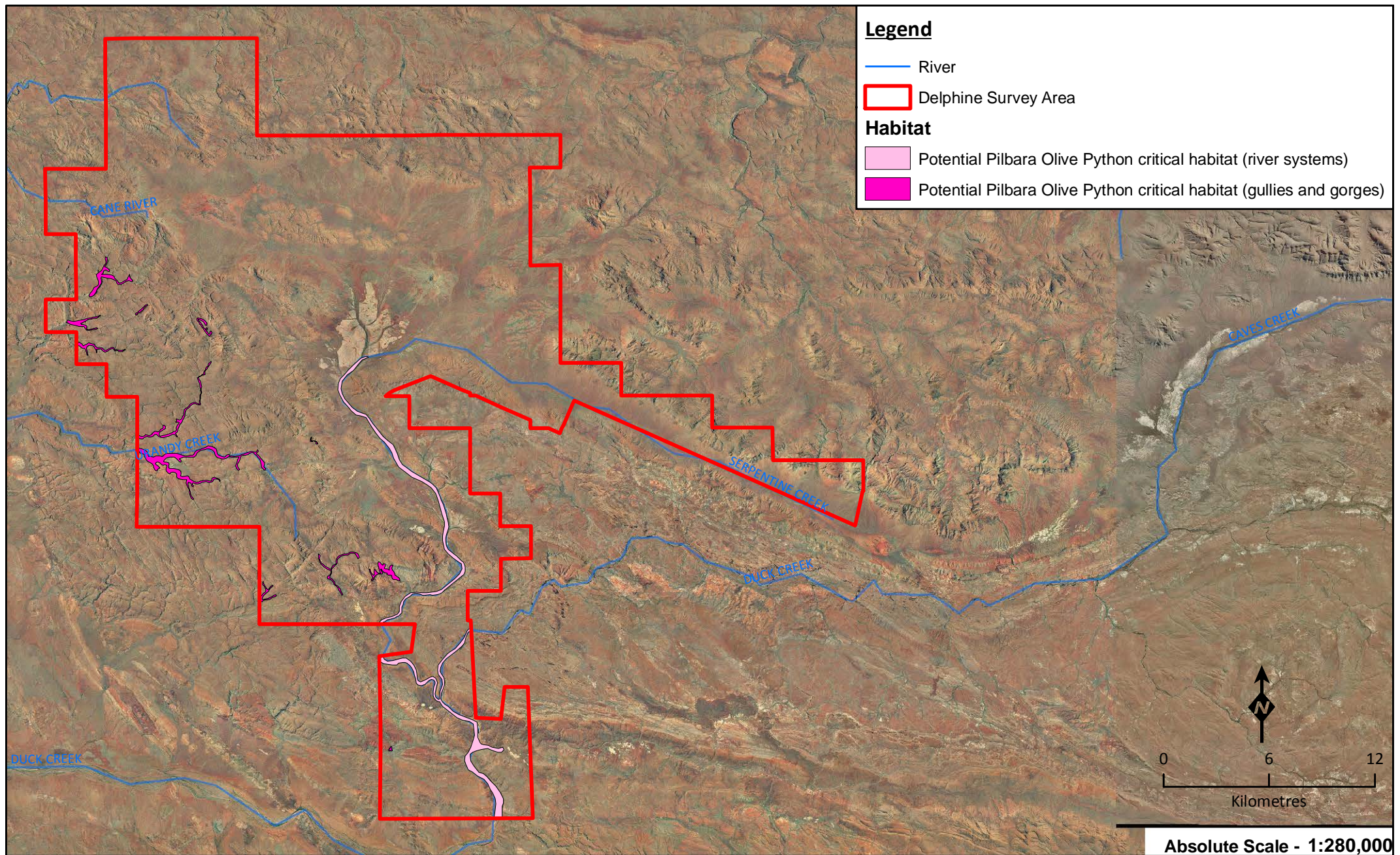
Habitat types were assessed for their suitability for the three EPBC Act listed conservation significant fauna that may potentially occur in the Survey Area (Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python). Areas of potentially suitable habitat for each of these species was identified and mapped in Figures 5.1 - 5.3. Detailed descriptions of the suitability of potential habitats identified for each species within the Survey Area and extent of these within the Survey Area are summarised Table 5.1 below.

Table 5.1 – Summary of potential habitats for EPBC Act listed fauna within the Survey Area

Species	Fauna Habitat	Area inside Survey Area (ha)	Percentage of Total Survey Area (%)
Northern Quoll	Potential denning habitat. Areas of rocky gorges and gullies in the Survey Area that may contain suitable den sites, preferably near a water source.	596.8	0.7
	Foraging/dispersal habitat. Well-vegetated and/or rocky areas used for foraging/hunting, often associated with a creekline or river system, as well as habitat traversed by the species when moving from potential denning areas to suitable foraging areas and when seeking mates during the breeding season (includes footslopes and plains).	50,118.9	64.0
Pilbara Leaf-nosed Bat	Potential roosting habitat. Areas of rocky gorges and gullies in the Survey Area that may contain suitable caves for roosting.	596.8	0.7
	Foraging habitat. Habitat over which the species may fly while foraging, preferably well-vegetated areas often associated with water and open valleys, which attract a higher number of insects.	27,949.0	35.7
Pilbara Olive Python	Potential critical habitat. Areas which may contain escarpments, gorges, preferably with rock crevices and outcrops near water holes, which attract prey species.	1,488.4	1.9







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5.1.1 Gorges and gullies

The mammals inhabiting gorges and gullies include rock dwelling specialists such as Woolley's False Antechinus (*Pseudantechinus woolleyae*), Rothschild's Rock-wallaby (*Petrogale rothschildi*) and Common Rock-rat (*Zyomys argurus*).

Gorges and gullies provide sheltering and roosting opportunities for many birds that prefer dark, dense vegetation, such as the Southern Boobook Owl. The Western Bowerbird lives in close association with rock figs, and is often a species characteristic of this habitat type. As water is often only present in this habitat in some parts of the Survey Area, many bird species can be found utilising the water for bathing and drinking.

The herpetofauna of gorges and gullies includes unique species that are specialised to occupy this fauna habitat type. Reptile species include the Pilbara endemic skink *Egernia pilbarensis*, the skink *Egernia formosa*, Pilbara Rock Monitor (*Varanus pilbarensis*) and the Russet Snake-eyed Skink (*Cryptoblepharus ustulatus*). In addition to reptiles, several amphibian species occur in this habitat.

Gorges and gullies represent suitable, good quality habitat for three mammal species of conservation significance: the Northern Quoll (*Dasyurus hallucatus*), the Pilbara Leaf-nosed Bat (*Rhinonictis aurantia*) and the Long-tailed Dunnart (*Sminthopsis longicaudata*). These species find shelter in crevices and caves and prey on the large number of insects and small vertebrates found in gorges and gully areas. The blind snake *Ramphotyphlops ganei* is known from few locations, mostly in rocky gullies. Gorges that contain water pools provide potential critical habitat for the Pilbara Olive Python (*Liasis olivaceus barroni*).

In general, this habitat type supports the largest number of conservation significant species, particularly during the wet season when the presence of water attracts fauna. The gorges and gullies habitat type was assessed containing areas of potential denning habitat for Northern Quoll (Figure 5.1), areas of potential roosting habitat for Pilbara Leaf-nosed Bat where suitable caves may potentially be present (Figure 5.2) and potential critical habitat for Pilbara Olive Python (Figure 5.3).

5.1.2 Hilltops, hillslopes, ridges and cliffs

The mammals of this habitat typically comprise the Common Rock-rat (*Zyomys argurus*), Woolley's Pseudantechinus (*Pseudantechinus woolleyae*) and Rothschild's Rock-Wallaby (*Petrogale rothschildi*). These species shelter in caves and crevices. The cliff faces of this habitat type also support cave structures which provide roosting habitat for a variety of bat species.

The avifauna of the hilltops, hillslopes, ridges and cliffs is of low variety and includes a number of generalists, such as the Painted Finch and the Spinifexbird, and some specialised bird species, such as the Striated Grasswren and Rufous-crowned Emu-wren. Cliffs can be inhabited by the Southern Boobook which will utilise overhangs and caves for nesting. This habitat type generally consists of open vegetation with a lack of dense cover of shrubs or trees and, therefore, birds inhabiting this habitat type are foraging and living within or between spinifex clumps.

The herpetofauna of this habitat can vary between the four individual habitat subtypes that make up this habitat type. These are divided into the hilltops habitat subtype, the hillslopes habitat subtype, ridges habitat subtype and the cliffs habitat subtype. Typical species inhabiting the hilltops habitat subtype include generalists such as the Fat-tailed Gecko (*Diplodactylus conspicillatus*) and the geckos *Lucasium wombeyi* and *Heteronotia binoei*, but also include specialists such as the Pilbara Barking Gecko (*Underwoodisaurus seorsus*). The herpetofauna of the hillslopes habitat subtype and the ridges habitat subtype usually comprises the skinks *Ctenotus rubicundus* and *C. rutilans*. The cliff habitat subtype is a fauna habitat type that is inhabited by specialised reptile species such as the

Pilbara Rock Monitor (*Varanus pilbarensis*), the Pygmy Python (*Antaresia perthensis*) and the Desert Cave Gecko (*Heteronotia spelea*).

In addition, the hilltops, hillslopes, ridges and cliffs habitat type is of medium value for the *EPBC Act* listed Northern Quoll (foraging/dispersal habitat, Figure 5.1) and the conservation significant Long-tailed Dunnart. This habitat type provides some suitable habitat for shelter and foraging. Cliff faces can also provide suitable breeding habitat for the Peregrine Falcon and the Grey Falcon. The Western Pebble-mound Mouse prefers the hilltops and hillslopes of this habitat type where spinifex clumps on rocky pebbles dominate the landscape.

5.1.3 Footslopes and plains

The mammal species of the footslopes and plains comprise a variety of generalists such as the Little Red Kaluta (*Dasykaluta rosamondae*), the Pilbara Ningai (*Ningai timealeyi*), the Planigale (*Planigale* sp.) and the Euro (*Macropus robustus*).

The avifauna of this habitat type is of relatively low diversity due to the low density of the tree and shrub layer. Bird species that can be found in this habitat include generalists such as Zebra Finch, Painted Finch, Diamond Dove, Little Button-Quail and Spinifex Pigeon. Footslopes and plains can also include patches of moderately dense to dense shrubs which can attract a relatively large number of bird species such as Singing Honeyeater, Masked Woodswallow, Black-faced Woodswallow and Variegated Fairy-wren. Birds of prey utilise the open vegetation for hunting and Brown Falcon, Spotted Harrier and Whistling Kite can often be seen foraging above the spinifex plains.

The herpetofauna of the footslopes and plains comprises a list of generalists that shelter within spinifex clumps, including the skinks *Ctenotus saxatilis* and *C. pantherinus*, Ring-tailed Dragon (*Ctenophorus caudicinctus*), Spiny-tailed Monitor (*Varanus acanthurus*), Pilbara Death Adder (*Acanthophis wellsii*), Moon Snake (*Furina ornata*), the legless lizard *Delma nasuta*, and Central Blue-tongue Lizard (*Tiliqua multifasciata*).

Footslopes and plains were assessed as comprising suitable foraging habitat for the *EPBC Act* listed Pilbara Leaf-nosed Bat (Figure 5.2). Footslopes and plains are also preferred habitat for two other species of conservation significance: the Western Pebble-mound Mouse and the Australian Bustard, the latter of which is generally restricted to the plains and rarely occurs along the footslopes.

5.1.4 River systems

The mammals of this habitat typically prefer areas of denser vegetation, and include the Planigale (*Planigale* sp.), Pilbara Ningai (*Ningai timealeyi*), Desert Mouse (*Pseudomys desertor*) and Euro (*Macropus robustus*). Bats are also commonly recorded in river systems and creek-lines, along which they forage.

The high diversity of avifauna found in this habitat reflects the preference of many species for trees and/or permanent water. Several pigeon and honeyeater species are commonly found in this habitat, as well as the Black-fronted Dotterel, Black-tailed Treecreeper, Western Bowerbird, Magpie-lark, Tree Martin, Mistletoebird, Barking Owl and Southern Boobook. Species such as the Australasian Grebe, Australasian Darter, Little Pied Cormorant, White-necked Heron, White-faced Heron, Australian Reed-warbler, Pacific Black Duck and Australian Pelican also depend upon the water found in this habitat type.

The herpetofauna of the river system habitat consists of species that prefer dense vegetation and associated leaf litter. These include skinks such as *Carlia munda*, the Robust Ctenotus (*Ctenotus robustus*), and species of the genus *Lerista*. Other species include the Long-nosed Dragon (*Amphibolurus longirostris*), Black-headed Monitor (*Varanus tristis*), Monk Snake (*Parasuta*

monachus) and legless lizards such as *Delma pax*. There are also frogs present like the locally common Northwest Toadlet (*Uperoleia saxatilis*) and the Little Red Tree Frog (*Litoria rubella*).

The numerous permanent water pools found in the river system habitat also support a number of fish species, such as the Bony Bream (*Nematalosa erebi*), Western Rainbowfish (*Melanotaenia australis*), Hyrtl's Tandan (*Neosilurus hyrtlii*), Barred Grunter (*Amniataba percoides*) and Spangled Perch (*Leiopotherapon unicolor*).

Several conservation significant species could be found in the river system habitat, including the Eastern Great Egret (*Ardea modesta*), Rainbow Bee-eater and Fortescue Grunter (*Leiopotherapon aheneus*). The river systems habitat was assessed as comprising potential critical habitat for EPBC Act listed Pilbara Olive Python (Figure 5.3), foraging/dispersal habitat for Northern Quoll (Figure 5.1) and foraging habitat for Pilbara Leaf-nosed Bat (Figure 5.2). Northern Quoll are expected to use this habitat type seasonally, during the breeding season, for dispersal. Where suitable tree hollows occur Northern Quolls may utilise this habitat for nesting also.

5.1.5 Mixed acacia woodlands

The mammal species inhabiting mixed acacia woodlands include generalists and the patches of this habitat type in the Eliwana and Flying Fish Survey Area were of small size and comprised the same species as adjacent habitats. The Pilbara Ningau, Planigale, and Euro are all common inhabitants of the mixed acacia woodlands habitat type.

The avifauna of the acacia woodland is usually most diverse after significant rainfall, and when acacia shrubs and trees are flowering. In particular, honeyeater species such as the Singing Honeyeater, Brown Honeyeater and, in good conditions, Black and White-fronted Honeyeater can be common, but other species also occur, including Crested Bellbird, Red-capped Robin, Grey-crowned Babbler, White-winged Triller, Chestnut-rumped Thornbill and Willie Wagtail. The presence of some of these species, such as Crested Bellbird, Grey-crowned Babbler, and Chestnut-rumped Thornbill, is less dependent on rainfall and flowering events, as they are more sedentary than species like Black & White-fronted Honeyeaters.

The herpetofauna of the mixed acacia woodland comprises mainly generalists with species occurring along the foothills and plains such as the Tree Dtella (*Gehyra variegata*), the Spiny-tailed Geckos *Strophurus strophurus* and *S. wellingtonae*, and the skink *Menetia greyii*. Some species unique to mulga woodlands can be found in large areas including shrubs and trees of *Acacia aneura* (Mulga): the two Monitor lizards *Varanus bushi* and, *V. caudolineatus*, and the Mulga Dragon (*Caimanops amhiboluroides*).

Acacia woodland does not specifically provide important habitat for conservation significant species, but can be utilised by the Australian Bustard.

5.1.6 Cracking clays

Species diversity within cracking clays is limited to a relatively small number which specialise in this less common and relatively homogenous habitat. Avifauna that can be found in this habitat include the Brown Songlark (*Cincloramphus cruralis*) and Horsfield's Bushlark (*Mirafra javanica*). Generalist reptiles such as the gecko *Gehyra variegata* and the Monk Snake (*Parasuta monachus*) may also be present.

The cracking clay habitat is the preferred habitat for the conservation significant Northern Short-tailed Mouse (*Leggadina lakedownensis*) which has been previously recorded from areas to the east of the Survey Area (DEC 2012).

5.2 FAUNA ASSEMBLAGES

5.2.1 Mammals

The relatively high diversity of mammals recorded (22 native / 4 introduced) within the Survey Area is likely to be due to a combination of factors, including the large size of the Survey Area, a variety of habitats including the presence of water, as well as good climatic conditions for sampling. Small mammals such as murids and dasyurids were captured in pitfall and Elliott traps at systematic trapping sites. Macropods were observed during diurnal and nocturnal opportunistic searches and nocturnal road spotting while bats were identified from calls recorded on SM2BAT recorders.

The Pilbara Ningau (38 records) and Planigale (27 records) were the most frequently recorded mammal species (excluding bat species). The Pilbara Ningau is a generalist, opportunistic species, and was therefore expectedly recorded at ten of the fourteen trapping sites within the Survey Area. Similarly, the Planigale is a widespread species of the Pilbara, and was recorded at nine of fourteen trapping sites.

Four introduced mammal species were recorded. Cattle were recorded frequently and in high numbers throughout the Survey Area, and were generally concentrated around watercourses. Horses were recorded near the cracking clays habitat, but secondary evidence suggests they frequent a number of open areas within the footslopes and plains habitat.

Two conservation significant mammal species were recorded, the Northern Quoll and Pilbara Leaf-nosed Bat. A third mammal species of conservation significance, the Western Pebble-mound Mouse, was recorded based on secondary evidence.

5.2.2 Birds

A very high diversity of bird species were recorded from the Survey Area. As with the mammals, this is also likely due to a number of contributing factors, such as the large size of the Survey Area, a diversity of habitats, and good climatic conditions for sampling. Of the 100 species recorded, the nomadic Budgerigar (4,275 records), Masked Woodswallow (1,804 records) and Zebra Finch (862 records) were the most frequently recorded. The presence of nomadic species suggests conditions within the Survey Area over the wetter summer months were very good, persisting through autumn. Many *Eucalyptus*, *Corymbia* and *Acacia* plant species were flowering during the Level 2 vertebrate fauna assessment. As a result, a high diversity and abundance of honeyeater species were recorded. Eleven of the potential twelve species were recorded, with Brown Honeyeaters, Black Honeyeaters and Crimson Chats being recorded in high numbers throughout the Survey Area.

Five birds of conservation significance were recorded, the Australian Bustard, Bush Stone-curlew, Grey Falcon, Rainbow Bee-eater and Eastern Great Egret.

5.2.3 Herpetofauna

The reptile diversity and abundance recorded during the Level 2 vertebrate fauna assessment was considered about average, based on previous surveys in the area (Table 2.5). Conditions for reptiles were considered less ideal than for mammals and birds, due to the cooler weather experienced during the latter half of the survey (Appendix B). This is likely to have resulted in less reptile activity and potentially fewer reptile records than what would be expected from warmer conditions.

The most frequently recorded species are all common and widespread species of the region. The most noteworthy records from the survey were records of *Egernia cygnitos*, *Ctenotus robustus* and

Ctenotus schomburgkii. *Ctenotus schomburgkii* is generally a widespread species, but, based on NatureMap (DEC 2012) records, has not been recorded in the western Hamersley Ranges prior to this survey. Similarly, *Ctenotus robustus* occurs throughout the northern and eastern parts of Australia, but reaches its distributional extremity in the Hamersley Ranges. The newly described skink, *Egernia cygnitos*, occurs in rock crevices in the Hamersley Range, but is infrequently recorded due to its secretive and specialised habits.

One reptile species of conservation significance was recorded, the skink *Notoscincus butleri*, and high quality habitat for the Pilbara Olive Python was identified from the Survey Area (Figure 5.3).

5.2.4 Fish

All six potentially occurring fish species were recorded from within the Survey Area. All species were recorded from small to large pools within the major river systems (Serpentine Creek and Duck Creek). During wet periods, it is likely that all of these species move throughout the river systems that occur in the Survey Area, and retreat to permanent pools during dry conditions.

One fish species of conservation significance was recorded during the survey, the Fortescue Grunter.

5.2.5 Endemic species and species of biological significance

Sixteen taxa endemic to the Pilbara region were recorded during the surveys. These species include: the Pilbara Ningau (*Ningau timealeyi*), Pilbara Leaf-nosed Bat (*Rhinonictis aurantia*), Black-tailed Treecreeper (*race wellsi*), Striated Grasswren (*race rowleyi*), *Diplodactylus savagei*, *Lucasium wombeyi*, Banded Knob-tailed Gecko (*Nephrurus wheeleri cinctus*), *Delma pax*, *Cryptoblepharus ustulatus*, *Ctenotus duricola*, *Ctenotus rubicundus*, *Notoscincus butleri*, Pilbara Rock Monitor (*Varanus pilbarensis*), *Ramphotyphlops ammodytes*, Northwest Toadlet (*Uperoleia saxatilis*) and Fortescue Grunter.

5.3 CONSERVATION SIGNIFICANT FAUNA

Based on database searches and the results of previous biological surveys in the surrounding region, six mammal, 14 bird, three reptile and one fish species of conservation significance could potentially occur in the Survey Area. Information regarding conservation significant species are summarised in Table 5.3. Species of conservation significance with a high to medium likelihood of occurrence are reviewed in greater detail in Section 5.3. The current surveys recorded two mammal, five bird, one reptile and one fish species of conservation significance.

Each conservation significant or biologically significant species potentially occurring in the Survey Area, was assigned a likelihood of occurrence based on the below categories (Table 5.2). The level of available information for each species was also taken into consideration so that species are not allocated a low likelihood of occurrence because of insufficient survey information or cryptic behaviours and ecology, in accordance with the precautionary principle.

Species of conservation significance with a high to medium likelihood of occurrence are reviewed in greater detail in Section 5.3.1.

Table 5.2 – Likelihood of occurrence categories

RECORDED	Species recorded during current survey
HIGH	Species recorded within, or in proximity to, the Survey Area within 20* years; suitable habitat occurs in the Survey Area
MEDIUM	Species recorded within, or in proximity to, the Survey Area more than 20 years ago. Species recorded outside Survey Area, but within 50 km; suitable habitat occurs in the Survey Area
LOW	Species rarely, or not recorded, within 50 km, and/or suitable habitat does not occur in the Survey Area

**ecologia* chooses to incorporate regional data from the last 20 years to assess a high likelihood of occurrence of species. Species that have previously been recorded from an area within the last 20 years and where high quality, suitable habitat still persists within an area are considered by *ecologia* to still have potential for a high likelihood of occurrence, following the precautionary principle.

Table 5.3 – Conservation significant fauna occurring or potentially occurring in the Survey Area

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Northern Quoll <i>Dasyurus hallucatus</i>	EN	S1	EN	In the Pilbara, most common on dissected rocky escarpments, but also found in eucalypt forest and woodland. Typically rocky areas with suitable denning sites and access to surface water.	Records from five locations within 115 km of the Survey Area (Coffey 2008; <i>ecologia</i> internal database; DEC 2012; Ecoscape 2010), including two records from 41 km south-west of the Survey Area.	RECORDED Recorded approximately 2.5 km south-west of the Delphine camp. Scats also recorded from nearby Eliwana and Flying Fish area (<i>ecologia</i> in prep-b). High quality habitat exists within Survey Area (Figure 5.1)
Pilbara Leaf-nosed Bat <i>Rhinonictis aurantia</i>	VU	S1	VU	Roost in caves with high humidity (95%) and temperature (32 °C). Forage along waterbodies with fringing vegetation.	Calls recorded from four locations at Central Pilbara Project (<i>ecologia</i> 2011b). Two records from approximately 20-26 km north-west and one record from 60 km south-east of the Survey Area (DEC 2012).	RECORDED Calls recorded from two locations within Survey Area during the Level 2 vertebrate fauna assessment and a further eight locations during the targeted conservation significant fauna assessment. Suitable foraging habitat exists, with potentially suitable habitat present for roost caves within or nearby the Survey Area (Figure 5.2).
Long-tailed Dunnart <i>Sminthopsis longicaudata</i>			P4	Rocky, hilly areas vegetated with spinifex; occasionally open areas with a stony, rocky mantle.	Recorded from two locations within the Central Pilbara Project, approx. 78 km north-east of the Survey Area (<i>ecologia</i> 2011b). NatureMap (DEC 2012) and DEC Rare Fauna Search state seven records within 50 km, the closest record within 26 km north-east of the Survey Area.	MEDIUM Extensive suitable habitat present within Survey Area in the hilltops, hillslopes, ridges and cliffs habitat type.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Ghost Bat <i>Macroderma gigas</i>			P4	Roost in caves, rockpiles and abandoned mines. Will travel 2 km from roost to hunt.	Calls recorded at Eliwana and Flying Fish (<i>ecologia</i> in prep-b). Calls recorded from six locations within the Central Pilbara Project (<i>ecologia</i> 2011b) and records from three locations at Solomon Project (Coffey 2008; <i>ecologia</i> 2010). NatureMap (DEC 2012) states six records within 50 km of the Survey Area.	HIGH Species recorded from nearby Eliwana and Flying Fish area. Suitable habitat is present in Survey Area and is synonymous with suitable habitat for the Pilbara Leaf-nosed Bat (Figure 5.2).
Short-tailed Mouse <i>Leggadina lakedownensis</i>			P4	Spinifex and tussock grassland on cracking clays. Also acacia shrubland, samphire, woodlands, and stony ranges.	Fourteen records within 50 km of the eastern end of the Survey Area (DEC 2012).	MEDIUM Several previous records close by. Some suitable habitat identified from the Survey Area in the footslopes and plain habitat type.
Western Pebble-mound Mouse <i>Pseudomys chapmani</i>			P4	Footslopes of rocky ranges and rocky hills where the ground has continuous small pebbles and vegetated by spinifex.	Mounds recorded from 60 locations within 100 km of the Survey Area (Biota 2005b, 2009b; Coffey 2008; <i>ecologia</i> 2010, 2011b; Kendrick 1995; Mattiske and Ninnox 1990), including active mounds during the Delphine Level 1 fauna assessment (Ecoscape 2012a)	HIGH Active mounds have previously been recorded within the Survey Area. Extensive suitable habitat present in the footslopes and plain, and hilltops, hillslopes, ridges and cliffs habitat types. Inactive and active mounds recorded during Level 2 vertebrate fauna and targeted conservation significant fauna assessment.
Birds						
Fork-tailed Swift <i>Apus pacificus</i>	M	S3		Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts.	Recorded from five locations at Central Pilbara Project and Solomon Project (<i>ecologia</i> 2010, 2011a), 70-100 km east of the Survey Area.	HIGH Likely to occur as an irregular summer migrant.
Eastern Great Egret <i>Ardea modesta</i>	M	S3		Wide range of wetland habitats, including floodwaters, rivers, shallows of wetlands, intertidal mudflats.	Recorded 60 km south-east of the Survey Area along the Beasley River (DEC 2012).	RECORDED Recorded during survey. Suitable habitat present in the river systems habitat type after substantial rainfall when water is present along major creek lines.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Cattle Egret <i>Ardea ibis</i>	M	S3		Grassy habitats, shallow wetlands and water bodies, particularly damp pastures.	DSEWPac states potential habitat in the region. No previous records within 100 km of Survey Area (DEC 2012).	LOW No previous records and no suitable habitat within Survey Area.
Glossy Ibis <i>Plegadis falcinellus</i>	M	S3		Shallows and adjacent flats of freshwater lakes and swamps; river pool; flooded samphire; sewage ponds. Nest in freshwater/brackish wetlands with tall, dense stands of emergent vegetation and low trees or bushes.	Recorded by Birddata, but no records from previous surveys.	LOW Very little suitable habitat present within the Survey Area (river systems habitat type).
White-bellied Sea-Eagle <i>Haliaeetus leucogaster</i>	M	S3		Coastal and near coastal water bodies, along river systems. Inhabits most types of habitats except closed forest.	DSEWPac states potential habitat in the region. A single records 46 km north of the Survey Area.	LOW Very rarely recorded in the Hamersley Range. Limited suitable habitat present within Survey Area.
Oriental Plover <i>Charadrius veredus</i>	M	S3		Open plains, including samphire; bare rolling country; bare claypans; open ground near inland swamps.	DSEWPac states potential habitat in the region. A single record within 100 km (north of the Hamersley Range) of the Survey Area (DEC 2012).	LOW Very little suitable habitat present within the Survey Area (river systems habitat type).
Oriental Pratincole <i>Glareola maldivarum</i>	M	S3		Plains, shallow wet and dry edges in open bare wetlands, tidal mudflats, beaches.	DSEWPac states potential habitat in the region. No previous records within 100 km of the Survey Area (DEC 2012).	LOW Very little suitable habitat present within the Survey Area (river systems habitat type).
Rainbow Bee-eater <i>Merops ornatus</i>	M	S3		Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water.	Twenty-one NatureMap (DEC 2012) records within 90 km of the Survey Area. In addition, 17 records from the Central Pilbara Project, 15 records from Solomon Project (<i>ecologia</i> 2010, 2011a). Species recorded during Ecoscape's Level 1 fauna assessment (2012a).	RECORDED Species recorded during this survey and numerous records in the region. Suitable foraging and breeding habitat present within the Survey Area in the river systems habitat type.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Peregrine Falcon <i>Falco peregrinus</i>		S4	Other	Widespread; coastal cliffs, riverine gorges and wooded watercourses.	One record from the Central Pilbara project (DEC 2012; <i>ecologia</i> 2011b; <i>ecologia</i> internal database). Species sighted within the Mt Farquhar Project (<i>ecologia</i> in prep-c) and during Ecoscape's Level 1 fauna assessment (2012a).	HIGH Recorded previously within Survey Area. Suitable habitat present throughout.
Black Bittern <i>Ixobrychus flavicollis</i>			P3	Freshwater pools, swamps and lagoons with dense surrounding vegetation.	Opportunistic record during Central Pilbara Project surveys on Fortescue River, approximately 15 km east of Survey Area (J. Vos pers. comm. 2012)	MEDIUM Suitable habitat occurs in sections of Duck Creek within the Survey Area, and species is known from this watercourse.
Grey Falcon <i>Falco hypoleucos</i>			P4	Lightly wooded coastal and riverine plains.	Not previously recorded within 100 km of the Survey Area (DEC 2012). Closest records are 116 km west) 136 km south-east, and 175 km east of Survey Area (DEC 2012).	RECORDED Recorded in Survey Area during the Level 2 vertebrate fauna assessment. Suitable habitat present throughout.
Australian Bustard <i>Ardeotis australis</i>			P4	Open grasslands, chenopod flats and low heathland.	Recorded during Level 1 fauna assessment of the Survey Area (Ecoscape 2012a) Additionally, recorded during concurrent Eliwana and Flying Fish survey (<i>ecologia</i> in prep-b), six records from Central Pilbara project, one record from previous surveys conducted by other consultancies (Biota 2005b, 2009b; Mattiske and Ninnox 1990).	RECORDED Recorded during this assessment and suitable habitat present in the footslopes and plains habitat type.
Bush Stone-curlew <i>Burhinus grallarius</i>			P4	Lightly wooded country next to daytime shelter of thickets or long grass.	Six records from within 100 km of the Survey Area, and nine records from Central Pilbara Project (DEC 2012; <i>ecologia</i> 2011b, in prep-a). In addition, Biota (2005b), Ecoscape (2010) and Birdata list records of this species in the region.	RECORDED Species observed along major watercourses within Survey Area, and responded to call-playback.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Star Finch (western) <i>Neochmia ruficauda subclarescens</i>			P4	Vegetation around watercourses, particularly thick reed beds.	Previously recorded 43 km north-west, and 68 km east of Survey Area (DEC 2012).	MEDIUM Areas of suitable habitat occur along major watercourses within Survey Area, particularly along Duck Creek and Serpentine Creek.
Reptiles						
Pilbara Olive Python <i>Liasis olivaceus barroni</i>	VU	S1	VU	Watercourses and areas of permanent water in rocky gorges, escarpments and gullies.	Recorded during the Level 2 vertebrate fauna assessment of nearby Eliwana and Flying Fish (<i>ecologia</i> in prep-b), as well as during the Central Pilbara project (<i>ecologia</i> 2011b).	HIGH Suitable habitat occurs throughout, particularly along Duck and Serpentine Creeks, as well as in the rugged terrain in the western parts of the Survey Area (Figure 5.3).
<i>Ramphotyphlops ganei</i>			P1	Variety of habitats; thought to prefer moist gorges.	Seven records within 100 km, including records 16 km north, and 32 km south of the Survey Area (DEC 2012).	HIGH Suitable habitat occurs along the Duck and Serpentine Creeks, as well as in the rugged terrain in the western parts of the Survey Area.
<i>Notoscincus butleri</i>			P4	Associated with stony/rocky, spinifex-dominated areas near creek and river margins.	Numerous records surrounding Survey Area, including 17 records 16-46 km north-west, and two records within 40 km east of the Survey Area (DEC 2012).	RECORDED Extensive suitable habitat occurs throughout Survey Area. Recorded at three sites during the Level 2 vertebrate fauna assessment.
Fish						
Fortescue Grunter <i>Leiopotherapon aheneus</i>			P4	Permanent water pools or streams.	Not previously recorded in Survey Area, but known from Ashburton River and its tributaries, including Duck Creek (Ecoscape 2012a).	RECORDED Fifty-two Fortescue Grunter were trapped from two pools at the junction of the Duck and Serpentine Creeks. Similar large pools are also present along these watercourses.

5.3.1 Mammals

5.3.1.1 Northern Quoll (*Dasyurus hallucatus*)

Conservation Status: EPBC Act Endangered, WC Act Schedule 1 (Endangered).

Distribution and Habitat: The Northern Quoll formerly occurred across northern Australia, from the Pilbara region in Western Australia to south-eastern Queensland. A 75% reduction of available habitat occurred during the 20th century, so that the species is now restricted to the Pilbara and northern Kimberley in Western Australia, and a few discrete populations across the Northern Territory and eastern Queensland (Braithwaite and Griffiths 1994). Northern Quolls are most common on dissected rocky escarpments, but are also found in eucalypt forest and woodland, where they are both arboreal and terrestrial and use a variety of den sites, including rock crevices, tree hollows, logs, termite mounds and goanna burrows (Oakwood 2008).

Ecology: Northern Quolls are the smallest of the Australian quolls, and are nocturnal and opportunistic omnivores feeding primarily on small vertebrates, large insects and soft fruits. Breeding tends to occur near creeklines, where individuals go to drink when water is available.

The most common cause of adult Northern Quoll mortality is predation by dingoes, feral cats, snakes, owls and kites (Maxwell *et al.* 1996; Oakwood 2008). Other causes of mortality include predation by domestic dogs, motor vehicle strikes and pesticide poisoning. The level of predation is increased through the removal of groundcover by fire.

Likelihood of Occurrence: Recorded. This species was recorded from the Survey Area during the Level 2 vertebrate fauna assessment. An individual Northern Quoll was detected on a motion-sensing camera at the entrance to a rocky gorge, approximately 2.5 km south-west of the Delphine camp. No quolls were recorded from the Survey Area during the targeted conservation significant fauna assessment. Suitable potential denning and foraging/dispersal habitat is present within the Survey Area (Figure 5.1).



Figure 5.4 – Northern Quoll recorded during the Level 2 vertebrate fauna assessment on a motion-sensing camera

Based on available aerial and topographic maps and observations made during a brief, opportunistic helicopter flight over the western parts of the Survey Area during the Level 2 vertebrate fauna assessment, significant areas of additional suitable Northern Quoll potential denning and foraging habitat are expected to occur within the gorges in the western parts of the Survey Area, which were inaccessible by vehicle or foot during the current survey (Figure 5.1). The extent and apparent quality of the potential denning and foraging habitat observed from this opportunistic helicopter assessment of this area indicates that the western parts of the Survey Area could potentially support a significant population of Northern Quoll. The single Northern Quoll individual recorded on the motion camera during the Level 2 vertebrate fauna assessment (Figure 5.4) is thought to be a foraging individual recorded from the fringing habitat of this area.

5.3.1.2 Pilbara Leaf-nosed Bat (*Rhinonictis aurantia*)

Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

Distribution and Habitat: The Pilbara Leaf-nosed Bat is the Pilbara form of the Orange Leaf-nosed Bat (*Rhinonictis aurantius*). While it is considered a separate form, formal reclassification has been hampered by the small sample size of the Pilbara population (Armstrong 2008).

Recent evidence suggests two main stronghold areas for the Pilbara Leaf-nosed Bat; in the western Pilbara and north of Marble Bar (Armstrong 2008). In the western Pilbara, they roost in caves formed in gorges that dissect siliceous sedimentary geology. They are most often observed in flight over waterholes in gorges, although they are rare even in the Hamersley Ranges where this habitat is common (Armstrong 2008). The Pilbara Leaf-nosed Bat roosts in disused mines and areas of high relief with gorges and watercourses (Armstrong 2001). They are unlikely to occur in the shallow 'breakaway' caves that occur along mesas and strike ridges.

Ecology: At dusk, Pilbara Leaf-nosed Bats emerge from their roosting sites to forage in gorges, small gullies and large watercourses for insects (van Dyck and Strahan 2008). They are susceptible to disturbance and will abandon roost caves if disturbed. Colonies in mines in the eastern Pilbara are subject to several pressures, including human visitation, and the collapse and flooding of disused mines (Armstrong 2008; DEWHA 2008b).

Likelihood of Occurrence: Recorded. Calls of the Pilbara Leaf-nosed Bats were recorded from 10 locations within the Survey Area, during the Level 2 vertebrate fauna and targeted conservation significant fauna assessment (Figure 4.11, Table 4.5). No potential roost caves were identified from within the Survey Area, though foraging and areas of potential roosting (if suitable caves are present) habitat for the Pilbara Leaf-nosed Bat was identified within the Survey Area (Figure 5.2).. An analysis of call times suggest individuals of this species are currently utilising the Survey Area for foraging only. Temporal pattern analyses of calls recorded during the targeted conservation significant fauna assessment are shown in Appendix F. The number of calls ranged from one to five, suggesting low numbers of individuals passing through an area, as opposed to large numbers of individuals suggesting proximity of a roost cave. However, calls were recorded between 18:00-18:30, at three sites along the eastern arm of the Survey Area suggesting a potential nearby roost. Based on the information gathered from this survey and concurrent Western Hub surveys (*ecologia* in prep-b, c), it appears a Pilbara Leaf-nosed Bat roost cave may be located within a 15 km radius of the Survey Area.

5.3.1.3 Short-tailed Mouse (*Leggadina lakedownensis*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: Populations of this small, elusive rodent are distributed across northern Australia, but records have been sporadic (Moro and Kutt 2008). They occupy a diverse range of habitats from the monsoon tropical coast to semiarid climates, including spinifex and tussock grasslands, samphire and sedgeland, acacia shrublands, tropical eucalypt and melaleuca woodlands and stony ranges. However, Short-tailed Mice are usually found in seasonally inundated habitats on red or white sandy-clay soils (Moro and Kutt 2008).

Ecology: The diet of the Short-tailed Mouse consists primarily of invertebrates, with plants supplementing their water requirements (Moro and Kutt 2008). Populations fluctuate greatly in response to rainfall, sometimes reaching plague proportions. The species is nocturnal and solitary, spending the day in simple, single-chambered burrows (Moro and Kutt 2008).

Likelihood of Occurrence: Medium. A small area of suitable habitat occurs within the Survey Area in the cracking clays habitat. This species has been recorded on fourteen occasions within 50 km east of the Survey Area; however, due to the relatively disconnected nature of suitable habitat to areas where this species has previously been recorded, its occurrence is of medium likelihood.

5.3.1.4 Ghost Bat (*Macroderma gigas*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Ghost Bat has a patchy but widespread distribution across northern Australia. Preferred roosting habitats in the Pilbara include caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles. Ghost Bats have also been known to roost in large colonies within sandstone caves, under boulder piles and in abandoned mines (Churchill 2008). Ghost Bats disperse widely during the non-breeding season but require warm caves with high relative humidity (80%) for rearing their young (Toop 1985). These maternity caves are uncommon with only eleven recorded in the Pilbara region (three natural caves and eight mines) (Armstrong and Anstee 2000).

Ecology: The Ghost Bat is carnivorous and takes prey to an established feeding site to be eaten. These feeding sites are usually a rock overhang or small cave, and are easily recognised by the accumulation of discarded prey parts littering the floor (Richards *et al.* 2008). Foraging occurs in an area of approximately 60 ha, in a radius of approximately 2 km from the bats' roost (Tidemann *et al.* 1985).

Likelihood of Occurrence: High. This species was not recorded during the current survey, despite relatively intense survey effort for bat species. Despite this, the Ghost Bat is considered a high likelihood of occurring due to six records within approximately 50 km of the Survey Area (Figure 2.5).

5.3.1.5 Western Pebble-mound Mouse (*Pseudomys chapmani*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Western Pebble-mound Mouse occurs across central and southern Pilbara and extends into the smaller ranges of the Little Sandy Desert (Start 2008). Abandoned mounds have been found in the Gascoyne and Murchison, indicating a recent decline in distribution. This decline is most likely attributable to foxes and exotic herbivores (Start 2008). However, the species appears relatively secure in its remaining range (Start 2008). The Western Pebble-mound Mouse inhabits gently sloping hills of rocky ranges where the ground is stony and vegetated by spinifex with a sparse overstorey of eucalypts and scattered shrubs of senna, acacia and *Ptilotus* spp.

Ecology: In suitable habitats, pebble mounds of this species can be found in large numbers, although not all of these mounds are active and occupied by Pebble-mound Mice at the same time. The demographic structure of the groups that inhabit the mounds and their patterns of movement around the mounds is still unknown (Anstee 1996; Anstee *et al.* 1997). Mounds can cover an area of 0.5 to 9.0 m², and a single mound can house up to 25 mice (Start 2008). Breeding occurs throughout the year with females producing several litters of four young per year (Start 2008).

Likelihood of Occurrence: High. This species is widespread in the region, with captures and active mounds recorded at over 60 locations (Coffey 2008; DEC rare fauna; DEC 2012; *ecologia* 2010, 2011b), including active mounds at Delphine (Ecoscape 2012a). A single possibly active mound was recorded during the survey, with several other inactive mounds also recorded. Due to the numerous nearby records, and suitable habitat within the hilltops, hillslopes, ridges and cliffs and footslopes and plains habitat types, this species has a high likelihood of occurrence.



Figure 5.5 – Possibly active Western Pebble-mound Mouse mound recorded during the targeted conservation significant fauna assessment

5.3.1.6 Long-tailed Dunnart (*Sminthopsis longicaudata*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: Long-tailed Dunnarts are mostly found in rocky country in the western arid zone and occasionally in open country with a gravel/stony mantle. Although rarely encountered, in Western Australia they occur in the Pilbara, Murchison, north-eastern Goldfields, Ashburton and Gibson Desert regions (Burbidge *et al.* 2008).

Ecology: The Long-tailed Dunnart is a small, carnivorous marsupial, distinguished from other *Sminthopsis* species by the length of its brush-tipped tail; more than twice the head-body length (Burbidge *et al.* 2008). The species feeds on arthropods such as beetles, ants, spiders, cockroaches, centipedes, grasshoppers and larvae. Its long tail is muscular at the base, allowing it to be held in a variety of positions, probably acting as a balancer; this, along with striated foot pads, suggest it is adapted to climbing (Burbidge *et al.* 2008).

Threatening processes have not been identified as only little is known about this species. Threats likely include inappropriate fire regimes and habitat modification as a result of the activities of introduced herbivores such as Horses and Cows, invasion by buffel grass and predation by feral cats and foxes (Pavey 2006).

Likelihood of Occurrence: Medium. No records of this species were made during the current survey. Previously recorded 30 km east of Survey Area in adjoining similar habitat. Within the Survey Area suitable habitat for this species occurs within the hilltops, hillslopes, ridges and cliffs habitat type. Additional survey effort in areas that were not accessible by vehicle or foot in the current surveys may result in this species being detected.

5.3.2 Birds

5.3.2.1 Fork-tailed Swift (*Apus pacificus*)

Conservation Status: EPBC Act Migratory, WC Act Schedule 3.

Distribution and Habitat: The Fork-tailed Swift is a small, insectivorous species with a white throat and rump, and a deeply forked tail (Morcombe 2000). Its distribution spans from central Siberia and throughout Asia, breeding in north-east and mid-east Asia, and wintering in Australia and south New Guinea. It is a relatively common trans-equatorial migrant from October to April throughout mainland Australia (Simpson and Day 2004). In Western Australia the species begins to arrive in the Kimberley in late September, the Pilbara in November and the South-west by mid-December (Johnstone and Storr 1998). In Western Australia the Fork-tailed Swift is considered uncommon to moderately common near the north-west, west and south-east coasts, common in the Kimberley and rare or scarce elsewhere (Johnstone and Storr 1998).

Ecology: Fork-tailed swifts are nomadic in response to broad-scale weather pattern changes. They are attracted to thunderstorms where they can be seen in flocks, occasionally of up to 2,000 birds. They rarely land, living almost exclusively in the air and feeding entirely on aerial insects, especially nuptial swarms of beetles, ants, termites and native bees (Simpson and Day 2004).

Likelihood of Occurrence: High. Fork-tailed Swifts were not observed during this survey but previous records exist from five locations at the Central Pilbara Project and Solomon Project (ecologia 2010, 2011b). Due to the transient and highly nomadic lifestyle of this species, there is a high likelihood it will occasionally fly through the Survey Area.

5.3.2.2 Eastern Great Egret (*Ardea modesta*)

Conservation Status: EPBC Act Migratory, WC Act Schedule 3.

Distribution and Habitat: Eastern Great Egrets mainly inhabit shallow water bodies; both fresh (lakes, lagoons, swamps and floodwaters) and saline (mangrove creeks, estuaries and tidal pools) (Johnstone and Storr 1998). They occur across a large part of Western Australia, including the South-west, Kimberley and Pilbara (Johnstone and Storr 1998). The Eastern Great Egret is common to very common in the well-watered Kimberley flatlands, and scarce to moderately common elsewhere within its range (Johnstone and Storr 1998).

Ecology: This species' diet consists predominantly of small fish and crustaceans. Eastern Great Egrets breed colonially in trees standing in water around wooded swamps and river pools, 4-13 m above water (Morcombe 2000). The nest is built as a rough, loose, shallow platform. Four eggs are laid in summer in the Kimberley and during the spring in regions further south (Johnstone and Storr 1998).

Likelihood of Occurrence: Recorded. An Eastern Great Egret was recorded opportunistically on two occasions along Serpentine Creek during this survey. This species infrequently occurs throughout the Hamersley Range, but can be found along drainage lines that contain permanent to semi-permanent water pools. It is expected that this species will be present within the Survey Area only occasionally, when water is available within the Serpentine and Duck Creeks.



Figure 5.6 – Eastern Great Egret recorded from Serpentine Creek

5.3.2.3 Rainbow Bee-eater (*Merops ornatus*)

Conservation Status: EPBC Act Migratory, WC Act Schedule 3.

Distribution and Habitat: The Rainbow Bee-eater is scarce to common throughout much of Western Australia, except for the arid interior, preferring lightly wooded, preferably sandy country near water (Johnstone and Storr 1998).

Ecology: In Western Australia the Rainbow Bee-eater can occur as a resident, breeding visitor, post-nuptial nomad, passage migrant or winter visitor. It nests in burrows usually dug at a slight angle on flat ground, sandy banks or cuttings, and often at the margins of roads or tracks (Simpson and Day 2004). Eggs are laid at the end of the metre-long tunnel from August to January (Boland 2004). Rainbow Bee-eaters are most susceptible to predation during breeding, as it spends significantly more time on the ground in this period.

Likelihood of Occurrence: Recorded. The Rainbow Bee-eater was recorded at six of the fourteen bird census sites during the Level 2 vertebrate fauna assessment (Appendix E), and is regularly recorded in the region (Figure 2.6). The river systems habitat, as well as major drainage lines within the footslopes and plains habitat, represent the best quality habitat for this species.



Figure 5.7 – Rainbow Bee-eater recorded in Serpentine Creek

5.3.2.4 Peregrine Falcon (*Falco peregrinus*)

Conservation Status: WC Act Schedule 4, DEC Specially Protected Fauna.

Distribution and Habitat: This nomadic or sedentary falcon is widespread in many parts of Australia and some of Australia's continental islands, but absent from most deserts and the Nullarbor Plain. The species is considered to be moderately common in the Stirling Range, uncommon in the Kimberley, Hamersley and Darling Ranges, and rare or scarce elsewhere (Johnstone and Storr 1998). The Peregrine Falcon occurs most commonly near cliffs along coasts, rivers and ranges, and around wooded watercourses and lakes.

Ecology: Peregrine Falcons feed almost entirely on birds, especially parrots and pigeons. They nest primarily on ledges on cliffs, granite outcrops and in quarries, but may also nest in tree hollows around wetlands. Eggs are predominantly laid in September (Johnstone and Storr 1998; Olsen *et al.* 2006).

Likelihood of Occurrence: High. This species has been recorded previously within the Delphine Survey Area (Ecoscape 2012a). Additionally, a single individual of this species was recorded during the nearby Mt Farquhar targeted conservation significant fauna assessment (*ecologia* in prep-c), foraging along a ridgeline. Within the Delphine Survey Area, potential nesting habitat exists within the hilltops, hillslopes, ridges and cliffs habitat type. Suitable foraging habitat exists throughout the Survey Area, but particularly within the river systems habitat.

5.3.2.5 Black Bittern (*Ixobrychus flavicollis australis*)

Conservation Status: DEC Priority 3

Distribution and Habitat: The Australian sub-species of the Black Bittern are distributed across three distinct areas, the Kimberley region, central Pilbara region and the south-west of Western Australia (Johnstone and Storr 1998). They are found in areas that have freshwater pools, swamps and

lagoons, with sufficiently dense screening vegetation in which the Black Bitterns shelter during the day.

Ecology: Black Bitterns eat a variety of invertebrate and vertebrate prey, ranging from dragonflies, molluscs, crayfish, fish, small reptiles and frogs. Breeding takes place during spring and summer, with nests consisting of a large structure of sticks lined with leaves in the fork of melaleuca trees.

Likelihood of Occurrence: Medium. The Black Bittern is rarely recorded throughout the non-coastal Pilbara. However, during the Central Pilbara Project surveys (*ecologia* 2011b), a Black Bittern was observed in a well-vegetated section of the Fortescue River (J. Vos pers. comm. 2012), approximately 15 km east of the Survey Area. As such, this species has a medium likelihood of occurrence along well-vegetated pools within the Duck and Serpentine Creeks.

5.3.2.6 Grey Falcon (*Falco hypoleucos*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: Grey Falcons are a rare, nomadic species sparsely distributed across much of arid and semi-arid Australia. In Western Australia, they are restricted to the northern half, occurring in a variety of habitats ranging from wooded drainage systems through to open spinifex plains. Grey Falcons once occurred across much of Western Australia, with sightings as far south as York and New Norcia during colonial times. However, the current distribution is now thought to be restricted to north of 26 °S (Johnstone and Storr 1998). Because the distribution of this species is scarce over an extremely large area, sightings of this species are very uncommon.

The Grey Falcon occurs in a wide variety of arid habitats, including open woodlands and open acacia shrubland, hummock and tussock grasslands and low shrublands, and may also be seen around swamps and waterholes that attract prey (Ehmann and Watson 2008).

Ecology: Like other falcons, this species preys primarily on birds such as parrots and pigeons, although reptiles and mammals are also taken (Ehmann and Watson 2008). Two to three eggs are laid in winter in the nests of other birds of prey and ravens, typically in tall eucalypt trees near water (Ehmann and Watson 2008; Garnett and Crowley 2000).

Likelihood of Occurrence: Recorded. A single Grey Falcon was recorded at the extreme eastern end of the Survey Area (Figure 4.11). This species is infrequently recorded throughout the Hamersley Range, reflected by few regional records (Appendix C). The footslopes and plains habitat type, as well as the hilltops, hillslopes, ridges and cliffs habitat type, provide suitable foraging and nesting habitat for this species.

5.3.2.7 Australian Bustard (*Ardeotis australis*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Australian Bustard occurs Australia-wide and utilises a number of open habitats, including open or lightly wooded grasslands, chenopod flats, plains and heathlands (Johnstone and Storr 1998).

Ecology: It is a nomadic species, ranging over very large areas, and its abundance varies locally and seasonally from scarce to common, largely dependent on rainfall and food availability. The Australian Bustard has an omnivorous diet, feeding on grasses, seeds, fruit, insects and small vertebrates.

Although the population size is still substantial, there has been a large historical decline in abundance, particularly south of the tropics, but also across northern Australia (Garnett and Crowley 2000). This is a result of hunting, degradation of its grassland habitat by sheep and rabbits, and predation by foxes and cats (Frith 1976; Garnett and Crowley 2000). Australian Bustards readily desert nests in response to disturbance by humans, sheep or cattle (Garnett and Crowley 2000).

Likelihood of Occurrence: Recorded. The Australian Bustard was recorded on two occasions during the current survey. It was also observed during the Level 1 fauna assessment of Delphine (Ecoscape 2012a). This widespread species is expected to occur throughout the footslopes and plains habitat type.

5.3.2.8 Bush Stone-curlew (*Burhinus grallarius*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Bush Stone-curlew occurs across much of Australia, except the arid interior and central south coast, preferring lightly wooded country near thickets or long grass that act as daytime shelters (Johnstone and Storr 1998). Historically, this species was widely distributed throughout most of WA, but has since declined, particularly in the southern part of the State. Recent estimates indicate an Australian population of 15,000 individuals (Garnett and Crowley 2000). The Bush Stone-curlew inhabits woodlands, dry and open grasslands, and croplands with cover nearby (NPWS 1999).

Ecology: The species is insectivorous, preying primarily upon beetles, although they will also eat seeds and shoots, frogs, lizards and snakes (Marchant and Higgins 1993; NPWS 1999). They are usually seen in pairs, although may occasionally flock together during the breeding season (August to January) and are generally nocturnal, being especially active on moonlit nights (NPWS 1999).

Since Bush Stone-curlews are a ground-dwelling and non-migratory species, they are quite susceptible to local disturbances by humans and to predation by cats and foxes (Frith 1976; Johnstone and Storr 1998). They are most common where land disturbance is minimal, and generally become rare or extinct around human settlements (Johnstone and Storr 1998).

Likelihood of Occurrence: Recorded. The Bush-stone Curlew was recorded twice during the current survey (Figure 4.11, Table 4.5), within the river systems and footslopes and plains habitats. Based on numerous local records, it is expected that this species occurs regularly throughout the Survey Area, within the river systems and footslopes and plains habitat types.

5.3.2.9 Star Finch (western subspecies) (*Neochmia ruficauda subclarescens*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The western subspecies of the Star Finch is found across northern Australia, including the Pilbara region where it is patchily distributed, with occasional concentrations at Exmouth and Millstream. Typical Star Finch habitat consists of long grass or rushes around swamps and lagoons or permanent pools. It is also found in irrigated crops and pastures (Johnstone and Storr 2004).

Ecology: Star Finches feed mainly on small grass seeds, but may also take flying ants, termites, and other small insects and spiders. It usually occurs in pairs or small flocks. Breeding occurs between February and October. Both parents incubate the eggs and care for the young (Johnstone and Storr 2004).

Likelihood of Occurrence: Medium. Relatively few local records exist for this species, with the closest records being approximately 43 km north-west, and 68 km east, of the Survey Area. Within the Survey Area, habitat is restricted to areas of well-vegetated pools, such as those found within the river systems habitat along the Duck and Serpentine Creeks.. Due to few surrounding records, and limited suitable habitat, this species has a medium likelihood of occurrence.

5.3.3 Reptiles

5.3.3.1 Pilbara Olive Python (*Liasis olivaceus barroni*)

Conservation Status: EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

Distribution and Habitat: The Pilbara subspecies of the Olive Python only occurs in the ranges of the Pilbara region of Western Australia. It inhabits watercourses and areas of permanent water in rocky gorges and gullies (Pearson 2006).

Ecology: This subspecies is an adept swimmer, often hunting in water, feeding on a variety of vertebrates such as rock wallabies, fruit bats, ducks and pigeons. Individuals spend the cooler winter months sheltering in caves and rock crevices. In the warmer months the pythons can move widely, usually in close proximity to water and rock outcrops (DEWHA 2008a). In late winter or early spring males will travel large distances to find and mate with females.

Population size estimates are difficult due to the Olive Python's cryptic nature and lack of reliable trapping or census techniques (DEWHA 2008a). The main threats to this subspecies come from predation by feral cats and foxes, particularly of juveniles, competition with foxes for food, and destruction of habitat (Pearson 2006).

Likelihood of Occurrence: High. The Pilbara Olive Python was recorded twice during the concurrent Eliwana and Flying Fish Level 2 vertebrate fauna assessment (*ecologia* in prep-b), located approximately 30 km south-east of the Survey Area. Based on the timing of the current survey, it is likely that this species had already retreated to rock crevices to avoid the cooler weather and was undetectable during the targeted conservation significant fauna assessment where it is likely to seek shelter within deep rocky crevices over the cooler winter months, when this species aestivates. Potential critical habitat for the Pilbara Olive Python includes areas where surface water collects such as deep bowls and depressions within rocky gorges, which are found within the gorges and gullies and river systems habitat types. These areas have been mapped in Figure 5.3.

5.3.3.2 *Ramphotyphlops ganeii*

Conservation Status: DEC Priority 1.

Distribution and Habitat: Very little is known about this elusive blind snake due to its fossorial lifestyle. Blind snakes are exclusively insectivorous, and like other members of their genus, *R. ganeii* probably burrow into social insect colonies to feed on termites and ants, as well as their eggs and pupae (Wilson and Swan 2010). *R. ganeii* has been found within the Pilbara region between Newman and Pannawonica (Wilson and Swan 2010).

Ecology: It has been suggested that *R. ganeii* prefer to live in subterranean habitats near moist gullies and gorges (Wilson and Swan 2010), although there is a record from sandy soil vegetated with spinifex (DEC 2012). This species is most likely threatened by removal of suitable habitat, and by drilling and/or any other mining activities impacting the subterranean environment.

Likelihood of Occurrence: High. This species has been recorded on seven occasions within 100 km of the Survey Area, including records 16 km north, and 32 km south (DEC 2012). Suitable habitat for this species exists within the gorges and gullies and river systems habitat type in the southern and western parts of the Survey Area. Due to the close proximity of several local records, and the cryptic nature of this species, this species has a high likelihood of occurrence.

5.3.3.3 *Notoscincus butleri*

Conservation Status: DEC Priority 4.

Distribution and Habitat: This small skink has a limited distribution, restricted to the arid north-west near-coastal Pilbara of the Dampier district to Harding River dam (Storr *et al.* 1999; Wilson and Swan 2010). Its habitat is typically spinifex dominated areas near creek and river margins (Wilson and Swan 2010).

Ecology: Very little is known about this species of skink. There are only two species belonging to the *Notoscincus* genus. These species are secretive, but readily bask in sunshine (Wilson and Swan 2010). *Notoscincus butleri* is an egg layer and feeds on invertebrates (Wilson and Swan 2010).

Likelihood of Occurrence: Recorded. *Notoscincus butleri* was recorded at three trapping sites during the current survey. The footslopes and plains habitat, particularly where spinifex dominated drainage lines occur, provides the most suitable habitat for this species (Figure 4.7).

5.3.4 Fish

5.3.4.1 Fortescue Grunter (*Leiopotherapon aheneus*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Fortescue Grunter belongs to the Terapontidae family of fishes, and is endemic and restricted to the Pilbara region of Western Australia (Allen *et al.* 2002). The Fortescue Grunter is found in slow to fast flowing streams and pools (Allen *et al.* 2002), and shows a preference for unstable sections of the catchment such as ephemeral pools (Beesley 2006). The species is only found in the Fortescue, Robe and Ashburton rivers (Beesley 2006).

Ecology: The Fortescue Grunter feeds on small crustaceans and juvenile fish, growing to a maximum length of 13 cm (Beesley 2006). When in suitable numbers, the species displays schooling behaviour, presumably as a defence mechanism against predators (Morgan and Gill 2004). Little else is known of its biology.

Likelihood of Occurrence: Recorded. The Fortescue Grunter was recorded during the current survey (Table 4.5, Figure 4.11), within the river systems habitat. This species is likely to occur in large pools within the Duck and Serpentine Creek systems, and move throughout these watercourses during wet periods.



Figure 5.8 – Fortescue Grunter recorded during Level 2 vertebrate fauna assessment

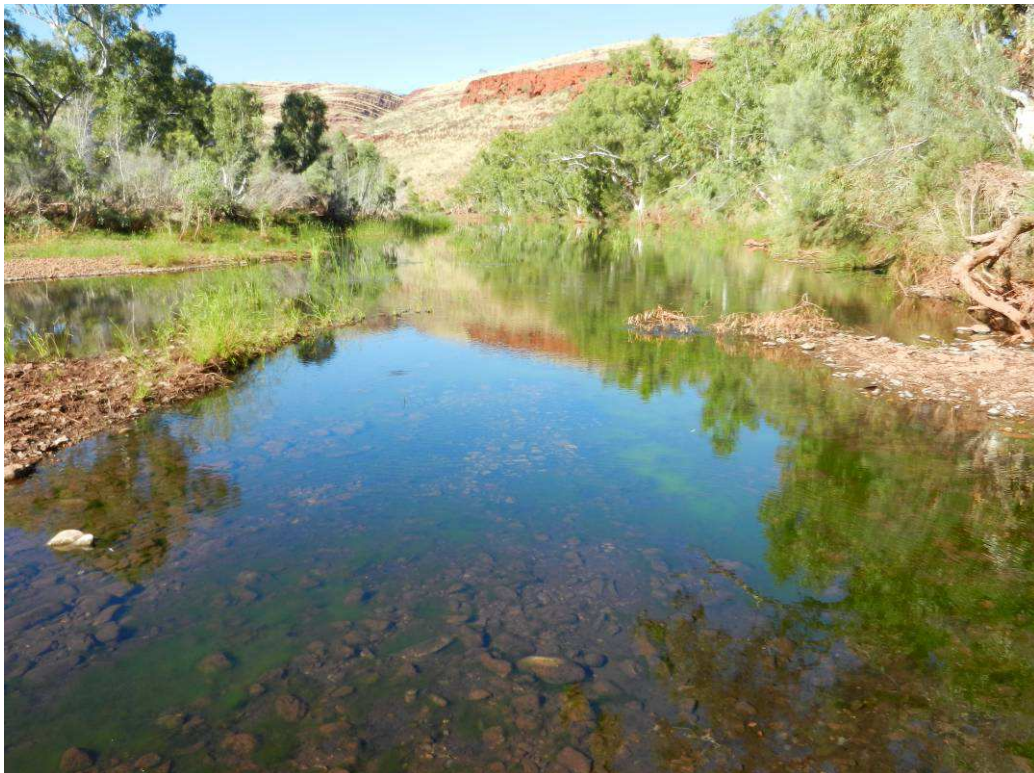


Figure 5.9 – Habitat of the Fortescue Grunter in the Survey Area

5.4 SURVEY ADEQUACY

Survey effort expended within the Survey Area is summarised in Table 3.4, which shows considerable systematic and opportunistic sampling effort was undertaken. In addition, Table 4.3 shows survey effort was adequate in sampling all fauna habitat types within the Survey Area. Table 4.3 shows that trapping effort was lacking in two habitat types; the gorges and gullies, and cracking clays, as a result of inaccessibility. To ensure adequate survey effort was expended in these habitat types, extra time was spent conducting opportunistic, diurnal and nocturnal searches and camera trapping in these areas.

Analysis of the observed avifauna assemblage recorded during the Level 2 vertebrate fauna assessment suggests the survey recorded 96.3% of the expected avifaunal assemblage, while analysis of data recorded during the Level 2 vertebrate fauna assessment of the trappable terrestrial faunal assemblage suggests the survey recorded 90.69% of the expected terrestrial faunal assemblage. Based on the shape of SACs, it is observed a plateau profile has not been achieved, particularly with trappable fauna. This suggests additional surveying is likely to reveal additional species not yet recorded. In summary, these results indicate that survey effort was adequate to provide an indication of the majority of the fauna assemblage present in the Survey Area. However, it is expected that a second phase of surveying during warmer climatic conditions would result in an increase in the number of species recorded.

5.5 SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in Table 5.4 below. No significant limitations were experienced during the surveys. Limitations in the form of limited access occurred, reducing the amount of search effort in two fauna habitats. Access within the Survey Area was restricted mainly to the northern, central, and eastern sections. However, most fauna habitats that could not be reached via vehicle were investigated on foot. Given no significant limitations were encountered, an adequate level of survey has been undertaken.

Table 5.4 – Summary of survey limitations

Limitation	Constraint (yes/no)	Comment
Competency/experience of the consultant carrying out the survey.	No	All members of the survey team were experienced in Pilbara fauna identification and fauna surveys.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	All faunal groups were adequately sampled.
Proportion of fauna identified, recorded and/or collected.	No	The majority of fauna species expected to occur within the Survey Area were recorded, as indicated by SACs (Section 5.4). All captured species were identified in the field.
Sources of information (previously available information as distinct from new data).	No	20 biological surveys have been conducted in the vicinity of the Survey Area. Data from these surveys were used included to provide regional context.
The proportion of the task achieved and further work which might be needed.	Yes	A single phase Level 2 vertebrate fauna assessment was completed. The level of assessment for the Project may require a second phase of surveying conducted during the spring season.
Timing/weather/season/cycle.	No	The Level 2 vertebrate fauna assessment was conducted during weather and seasonal conditions that are optimal for increased fauna activity. The timing of the targeted conservation significant fauna assessment was in accordance with guidelines (DSEWPac 2011b).
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	There were no disturbances recorded during the study.
Intensity (in retrospect was the intensity adequate).	No	The survey intensity was adequate, all habitat types were surveyed systematically or opportunistically, and most of the species expected to occur were recorded.
Completeness (e.g. was relevant area fully surveyed).	Yes	The rocky gorges, gullies and ridges in the western parts of the Survey Area were inaccessible due to rugged terrain and lack of tracks during the Level 2 vertebrate fauna assessment. This was mapped from an opportunistic helicopter fly-over. The remainder of the Survey Area was comprehensively surveyed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	All zoologists were suitably qualified and experienced in identification of Pilbara fauna. There were no resources issues encountered.
Remoteness and/or access problems.	Yes	All areas were accessible except for the rocky gorges, gullies and ridges in the western parts of the Survey Area. Survey sites were therefore restricted to the accessible eastern, northern and southern parts of the Survey Area.
Availability of contextual (e.g. biogeographic) information on the region).	No	Sufficient contextual information was available on the Pilbara region and the Survey Area.
Efficacy of sampling methods (i.e. any groups not sampled by survey methods).	No	Survey methods were suitable to record all terrestrial vertebrate fauna groups, including freshwater fish.

6 CONCLUSION

The main conclusions of the terrestrial vertebrate fauna survey of the Delphine Survey Area are:

- The survey methods were consistent with the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*; Guidance Statement No. 56; Position Statement No. 3; and the EPBC Act Survey Guidelines for Australia’s Threatened Mammals, Reptiles, Bats and Birds, as well as Fortescue Metals Group’s *Terrestrial Vertebrate Fauna Assessment Guidelines*. Species accumulation curves showed that the current survey was adequate overall, though with additional survey effort additional species would likely be recorded.
- The land systems, vegetation communities and habitats in the area support a moderately diverse group of fauna, including conservation significant fauna, but these are not restricted to the Survey Area.
- Six habitat types were identified within the Survey Area:
 - gorges and gullies;
 - hilltops, hillslopes, ridges and cliffs;
 - footslopes and plains;
 - river systems;
 - mixed acacia woodlands; and
 - cracking clays.
- Statistical analyses of the terrestrial fauna data indicated that while the habitat types were different from each other, these were not large differences (the habitat types were not discrete). Insufficient avifauna data were available to demonstrate statistically significant differences between the habitat types utilised by birds.
- A total of 22 native and 4 introduced mammal species, 100 bird species, 58 reptile species, three amphibians and six fish species were recorded within the Survey Area during the current Level 2 vertebrate fauna and targeted conservation significant fauna assessment.
- Nine species of conservation significance were recorded during the current surveys, and one recorded from secondary evidence only:
 - Northern Quoll;
 - Pilbara Leaf-nosed Bat;
 - Western Pebble-mound Mouse (recorded from secondary evidence – one possibly-active mound).
 - Eastern Great Egret;
 - Grey Falcon;
 - Australian Bustard;
 - Bush Stone-curlew;
 - Rainbow Bee-eater;
 - *Notoscincus butleri*; and

-
- Fortescue Grunter;
 - A further eight conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the Delphine Survey Area.
 - Results of the targeted conservation significant fauna assessment did not reveal any major roost sites for Pilbara Leaf-nosed Bat, although the timing of calls recorded indicates that two or three roost caves are likely present in the region.
 - One Northern Quoll individual was recorded on motion camera during the Level 2 vertebrate fauna assessment; however, no evidence was recorded during the targeted conservation significant fauna assessment conducted in July. This indicates that significant populations are not expected to occur in the Delphine Survey Area.
 - Based on aerial images and a short opportunistic survey conducted from a helicopter fly-over, large areas of potentially suitable denning, foraging and dispersal habitat are expected to be found in the western region of the Delphine Survey Area, potentially supporting Northern Quoll populations.
 - No major limitations on survey techniques were experienced, though some access limitations were experienced, with restricted access to the western half of the Delphine Survey Area. However, the majority of fauna habitats were surveyed and statistical analysis of the data suggests that the majority of the expected fauna species were recorded.

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APPENDIX A EXPLANATION OF CONSERVATION CODES

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Appendix A1 Definitions of categories under the *Environment Protection and Biodiversity Conservation Act 1999*

Category	Definition
Endangered (EN)	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable (VU)	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Migratory (M)	Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: <ul style="list-style-type: none"> the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state; the agreement between the Government of Australian and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their environment; or the agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment.

Appendix A2 Definition of Schedules under the *Wildlife Conservation Act 1950*

Schedule	Definition
Schedule 1 (S1)	Fauna which are rare or likely to become extinct, are declared to be fauna that is in need of special protection.
Schedule 2 (S2)	Fauna which are presumed to be extinct, are declared to be fauna that is in need of species protection.
Schedule 3 (S3)	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, are declared to be fauna that is in need of species protection.
Schedule 4 (S4)	Declared to be fauna that is in need of species protection, otherwise than for the reasons mentioned above.

Appendix A3 Definition of DEC Threatened and Priority Fauna Codes

Threatened	Definition
Critically Endangered (CR)	Considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Considered to be facing a high risk of extinction in the wild.
Priority	Definition
Priority 1 (P1)	<i>Taxa with few, poorly known populations on threatened lands.</i> Taxa which are known from few specimens or sight records from one or a few localities, on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2 (P2)	<i>Taxa with few, poorly known populations on conservation lands.</i> 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, e.g. national parks, conservation parks, nature reserves, State forest, vacant crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3 (P3)	<i>Taxa with several, poorly known populations, some on conservation lands.</i> 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 4 (P4)	<i>Taxa in need of monitoring.</i> 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 if present circumstances change. These taxa are usually represented on conservation lands.
Priority 5 (P5)	<i>Taxa in need of monitoring.</i> 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.

APPENDIX B DAILY WEATHER DATA DURING SURVEY

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Appendix B1 Level 2 Vertebrate Fauna Assessment

Sites	Date	Mean Minimum Temperature (°C)	Mean Maximum Temperature (°C)	Rainfall (mm)
DL S1 – DL S12	01/05/2012	16.9	33.5	0
	02/05/2012	18.7	33.1	0
	03/05/2012	17.4	32.3	0
	04/05/2012	16.8	33.3	0
	05/05/2012	15.6	32.5	0
	06/05/2012	17.8	30.9	0
	07/05/2012	16.6	31.8	0
	08/05/2012	12.8	29.1	0
	09/05/2012	14.7	32.7	0
	10/05/2012	17.8	32.8	0
	11/05/2012	18.0	34.2	0
DL S13 – DL S14	18/05/2012	13.8	31.9	0
	19/05/2012	11.8	30.9	0
	20/05/2012	15.8	30.6	0
	21/05/2012	13.6	28.7	0
	22/05/2012	11.3	28.0	0
	23/05/2012	12.4	26.8	0
	24/05/2012	12.4	24.2	0
	25/05/2012	11.1	24.3	0
	26/05/2012	11	24.7	0
	27/05/2012	9.4	25.2	0
	28/05/2012	9.3	25.6	0

Note: climate data recorded from Paraburdoo Aero weather station (BoM 2012).

Appendix B2 Targeted Conservation Significant Fauna Assessment

Sites	Date	Mean Minimum Temperature (°C)	Mean Maximum Temperature (°C)	Rainfall (mm)
NQD S1 – NQD S10	23/07/2012	11.9	26.5	0
	24/07/2012	6.9	27.0	0
	25/07/2012	13.2	25.9	0
	26/07/2012	12.2	22.4	0
	27/07/2012	10.2	23.0	0
	28/07/2012	7.1	23.5	0
	29/07/2012	8.9	24.7	0
	30/07/2012	7.7	24.6	0
	31/07/2012	8.0	26.2	0

Note: climate data recorded from Paraburdoo Aero weather station (BoM 2010).

APPENDIX C REGIONAL FAUNA DATA

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Appendix C1 – Mammals

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DEC																					
TACHYGLOSSIDAE																									
Tachyglossus aculeatus	Short-beaked Echidna												•						•	•	•				
DASYURIDAE																									
Dasykaluta rosamondae	Kaluta				•				•		•		•		•		•	•	•	•	•				•
Dasyurus hallucatus	Northern Quoll	EN	S1	EN							•			S			•	•	•	•	•			•	•
Ningau timealeyi	Pilbara Ningau				•		•		•		•		•	•			•	•	•	•	•	•			•
Planigale sp. (prev. maculata)	Common Planigale				•		•		•		•		•				•	•	•	•	•	•			•
Pseudantechinus woolleyae	Woolley's False Antechinus						•		#	•			•				•	•	•	•	•	•			#
Sminthopsis longicaudata	Long-tailed Dunnart			P4							•						•						•		
Sminthopsis macroura	Stripe-faced Dunnart				•						•		•				•	•	•	•	•	•			•
Sminthopsis ooldea	Ooldea Dunnart																				•				
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart												•												
PHALANGERIDAE																									
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum					•		•		•										•		•			
MACROPODIDAE																									
Macropus robustus	Euro				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•
Macropus rufus	Red Kangaroo				•				•		•				•	S	•	•	•		•				•
Petrogale rothschildi	Rothschild's Rock Wallaby						#										•								#
MEGADERMATIDAE																									
Macroderma gigas	Ghost Bat			P4					•		•		•	•			•		•				•		
HIPPOSIDERIDAE																									
Rhinonictis aurantia	Pilbara Leaf-nosed Bat	VU	S1	VU			•		•		•						•					•	•	•	•
EMBALLONURIDAE																									
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat				•		•		•		•						•	•	•	•					•
Taphozous georgianus	Common Sheathtail Bat				•		•		•		•	•	•		•		•	•	•	•		•			•
Taphozous hilli	Hill's Sheathtail Bat																•		•						
MOLOSSIDAE																									
Chaerophon jobensis	Northern Freetail Bat						•		•					•			•		•		•				•
Mormopterus beccarii	Beccari's Freetail Bat				•		•		•								•		•	•					•
Mormopterus loriae	Little Northern Freetail Bat													•											
Tadarida australis	White-striped Freetail Bat						•				•			•											•
VESPERTILIONIDAE																									
Chalinolobus gouldii	Gould's Wattled Bat				•		•		•		•			•	•		•	•	•	•	•				•
Chalinolobus morio	Chocolate Wattled Bat																	•							
Nyctophilus arnhemensis	Arnhem Long-eared Bat														•										
Nyctophilus bifax daedalus	Northern Long-eared Bat												•												
Nyctophilus geoffroyi	Lesser Long-eared Bat				•				•								•								
Scotorepens balstoni	Inland Broad-nosed Bat										•														
Scotorepens greyii	Little Broad-nosed Bat				•		•		•		•			•	•		•	•	•	•					•
Vespadelus finlaysoni	Finlayson's Cave Bat				•		•		•		•		•	•	•		•	•	•	•	•	•			•

Family and Species	Common name	Conservation Status			<i>ecologia</i> Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (<i>ecologia</i> in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (<i>ecologia</i> in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninnox 1990)	Central Pilbara Project (<i>ecologia</i> 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (<i>ecologia</i> 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DEC																					
MURIDAE																									
<i>Leggadina lakedownensis</i>	Northern Short-tailed Mouse			P4	•																	•			
<i>Notomys alexis</i>	Spinifex Hopping-mouse							•					•												
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4	•	•			S		•	•	•		•	S	S	•	S	SA	•		•		S
<i>Pseudomys delicatulus</i>	Delicate Mouse								•		•			•											
<i>Pseudomys desertor</i>	Desert Mouse				•		•				•		•		•		•	•	•			•			•
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse				•				•		•		•		•		•	•	•	•	•				•
<i>Zyzomys argurus</i>	Common Rock-rat				•		•			•	•		•	•	•	•	•	•	•	•	•				•
INTRODUCED MAMMALS																									
* <i>Mus musculus</i>	House Mouse				•		•		•						•		•	•	•		•	•			
* <i>Canis lupus</i>	Dog/Dingo				•	•	•	•	•	•	•		•	•				•	•		•	•			•
* <i>Vulpes vulpes</i>	Red Fox																							•	
* <i>Felis catus</i>	Cat				•	•	•		•	•	•		•		•	•	•	•	•	•	•			•	•
* <i>Oryctolagus cuniculus</i>	European Rabbit																							•	
* <i>Equus asinus</i>	Donkey				•				•		•				•	•									
* <i>Equus caballus</i>	Horse					•				•					•	•	•								•
* <i>Bos taurus</i>	Cow				•	•	•	•	•	•	•					•	•	•	•	•	•				•

Appendix C2 - Birds

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninnox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DEC																						
CASUARIIDAE																										
<i>Dromaius novaehollandiae</i>	Emu				•						•	•	•	•	•	•	•		•		•				•	•
PHASIANIDAE																										
<i>Coturnix pectoralis</i>	Stubble Quail																•		•							
<i>Coturnix ypsilophora</i>	Brown Quail								#		•						•		•						•	•
ANATIDAE																										
<i>Dendrocygna eytoni</i>	Plumed Whistling-duck																•								•	
<i>Cygnus atratus</i>	Black Swan																								•	
<i>Chenonetta jubata</i>	Australian Wood Duck												•			•	•								•	
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck																								•	
<i>Anas gracilis</i>	Grey Teal														•		•								•	
<i>Anas superciliosa</i>	Pacific Black Duck												•		•		•								•	#
<i>Aythya australis</i>	Hardhead																								•	
PODICIPEDIDAE																										
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe												•												•	•
<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe												•												•	
COLUMBIDAE																										
<i>*Streptopelia senegalensis</i>	Laughing Dove																									•
<i>Phaps chalcoptera</i>	Common Bronzewing				•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•			•	•
<i>Ocyphaps lophotes</i>	Crested Pigeon				•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•			•	•
<i>Geophaps plumifera</i>	Spinifex Pigeon				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•
<i>Geopelia cuneata</i>	Diamond Dove				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•
<i>Geopelia striata</i>	Peaceful Dove										•		•	•			•	•	•						•	•
PODARGIDAE																										
<i>Podargus strigoides</i>	Tawny Frogmouth				•				•								•		•	•	•				•	•
EUROSTOPODIDAE																										
<i>Eurostopodus argus</i>	Spotted Nightjar				•		•		•	•	•		•		•	•	•		•	•	•				•	•
AEGOTHELIDAE																										
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar				•	•			•	•	•		•			•	•		•	•	•				•	•
APODIDAE																										
<i>Apus pacificus</i>	Fork-tailed Swift	M	S3										•				•		•					•		
ANHINGIDAE																										
<i>Anhinga novaehollandiae</i>	Australasian Darter												•												•	•
PHALACROCORACIDAE																										
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant												•						•						•	•
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant												•												•	
PELECANIDAE																										
<i>Pelecanus conspicillatus</i>	Australian Pelican												•												•	#

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninnox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DEC																						
CICONIIDAE																										
Ephippiorhynchus asiaticus	Black-necked Stork												•													
ARDEIDAE																										
Ixobrychus flavicollis	Black Bittern			P3	•																					
Ardea pacifica	White-necked Heron										•		•		•		•		•					•	•	•
Ardea modesta	Eastern Great Egret	M	S3										•										•	•	•	
Ardea ibis	Cattle Egret	M	S3										•										•			
Ardea intermedia	Intermediate Egret																							•		
Egretta garzetta	Little Egret												•											•		
Egretta novaehollandiae	White-faced Heron					•							•	•	•		•							•	•	
Nycticorax caledonicus	Nankeen Night Heron																							•	•	
THRESKIORNITHIDAE																										
Plegadis falcinellus	Glossy Ibis	M	S3																						•	
Threskiornis spinicollis	Straw-necked Ibis										•														•	
Platalea flavipes	Yellow-billed Spoonbill												•													
ACCIPITRIDAE																										
Elanus axillaris	Black-shouldered Kite								•				•				•	•	•		•			•		
Lophoictinia isura	Square-tailed Kite																		•						•	
Haliaeetus leucogaster	White-bellied Sea-Eagle	M	S3																				•			
Haliastur sphenurus	Whistling Kite				•				•		•	•	•		•	•	•	•	•					•	•	
Milvus migrans	Black Kite						•						•											•	•	
Accipiter fasciatus	Brown Goshawk				•		•		•		•			•	•		•		•		•			•	•	
Accipiter cirrocephalus	Collared Sparrowhawk				•											•	•		•	•				•	•	
Circus assimilis	Spotted Harrier				•		•		•		•		•		•		•	•			•			•	•	
Aquila audax	Wedge-tailed Eagle				•	•			•	•	•		•		•		•	•			•	•		•	•	
Hieraaetus morphnoides	Little Eagle				•		•		•					•	•			•						•	•	
FALCONIDAE																										
Falco cenchroides	Nankeen Kestrel				•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	
Falco berigora	Brown Falcon				•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•			•	•	
Falco longipennis	Australian Hobby								•		•		•		•			•	•		•			•	•	
Falco hypoleucos	Grey Falcon			P4							•										•				•	
Falco peregrinus	Peregrine Falcon		S4		•	•	•										•					•		•		
RALLIDAE																										
Gallirallus philippensis	Buff-banded Rail																							•		
Porzana fluminea	Australian Spotted Crane																•									
Porzana pusilla	Baillon's Crane																							•		
Tribonyx ventralis	Black-tailed Native-hen																							•		
Fulica atra	Eurasian Coot												•											•		
OTIDIDAE																										
Ardeotis australis	Australian Bustard			P4	•	•			•	•	•		•		•	•	•	•	•			•	•		•	•

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninnox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DEC																						
BURHINIDAE																										
<i>Burhinus grallarius</i>	Bush Stone-curlew			P4				•	•				•		•		•		•			•			•	•
RECURVIROSTRIDAE																										
<i>Himantopus himantopus</i>	Black-winged Stilt																							•		
CHARADRIIDAE																										
<i>Charadrius veredus</i>	Oriental Plover	M	S3																				•			
<i>Elseya melanops</i>	Black-fronted Dotterel					•							•	•	•		•							•	•	
<i>Vanellus tricolor</i>	Banded Lapwing																•									
SCOLOPACIDAE																										
<i>Numenius minutus</i>	Little Curlew	M	S3								•															
SCOLOPACIDAE																										
<i>Actitis hypoleucos</i>	Common Sandpiper	M	S3																					•		
TURNICIDAE																										
<i>Turnix velox</i>	Little Button-quail				•	•	•		•	•	•	•	•		•	•	•		•	•	•	•			•	•
CACATUIDAE (PSITTACIDAE)																										
<i>Eolophus roseicapillus</i>	Galah				•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•				•	•
<i>Cacatua sanguinea</i>	Little Corella				•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•				•	•
<i>Nymphicus hollandicus</i>	Cockatiel				•		•		•		•		•	•	•	•	•	•	•	•					•	•
PSITTACIDAE																										
<i>Barnardius zonarius</i>	Australian Ringneck				•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•			•	•
<i>Melopsittacus undulatus</i>	Budgerigar				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•
<i>Neopsephotus bourkii</i>	Bourke's Parrot																•									
CUCULIDAE																										
<i>Centropus phasianinus</i>	Pheasant Coucal												•				•		•	•					•	•
<i>Chalcites basal</i>	Horsfield's Bronze-Cuckoo				•				•		•		•	•	•	•	•	•	•	•					•	•
<i>Chalcites osculans</i>	Black-eared Cuckoo									•							•								•	
<i>Cacomantis pallidus</i>	Pallid Cuckoo				•		•	•	•		•		•	•	•		•	•	•	•	•				•	•
STRIGIDAE																										
<i>Ninox connivens</i>	Barking Owl																									•
<i>Ninox novaeseelandiae</i>	Southern Boobook						•		•				•				•		•						•	•
TYTONIDAE																										
<i>Tyto javanica</i>	Eastern Barn Owl				•										•						•				•	
HALCYONIDAE																										
<i>Dacelo leachii</i>	Blue-winged Kookaburra								#		•	•	•	•	•		•		•	•					•	•
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher				•		•		•		•		•	•	•	•	•	•	•	•	•				•	•
<i>Todiramphus sanctus</i>	Sacred Kingfisher				•	•			•					•		•	•		•	•	•				•	•
MEROPIIDAE																										
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S3		•	•	•	•	•	•	•	•	•	•	•		•	•	•	•		•		•	•	•
CLIMACTERIDAE																										
<i>Climacteris melanura</i>	Black-tailed Treecreeper						•	•				•			•		•				•					•

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninnox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DEC																						
PTILINORHYNCHIDAE																										
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird				•		•	•	•		•	•	•		•	•	•	•	•						•	•
MALURIDAE																										
<i>Malurus lamberti</i>	Variegated Fairy-wren				•		•	•	•		•	•	•	•	•	•		•	•	•					•	•
<i>Malurus leucopterus</i>	White-winged Fairy-wren				•	•	•		•	•	•		•		•	•	•	•			•				•	•
<i>Stipiturus ruficeps</i>	Rufous-crowned Emu-wren				•		•		•		•		•	•			•	•			•				•	•
<i>Amytornis striatus</i>	Striated Grasswren				•				•		•		•	•	•		•	•	•		•				•	•
ACANTHIZIDAE																										
<i>Pyrholaemus brunneus</i>	Redthroat																								•	
<i>Smicronis brevirostris</i>	Weebill				•	•	•	•	•	•	•		•	•	•	•	•	•	•	•					•	•
<i>Gerygone fusca</i>	Western Gerygone				•				•		•		•	•	•	•	•	•	•	•					•	•
<i>Acanthiza robustirostris</i>	Slaty-backed Thornbill				•												•								•	
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill				•	•				•										•	•				•	
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill				•				•						•	•	•	•			•				•	
<i>Acanthiza apicalis</i>	Inland Thornbill				•										•	•	•	•			•					
<i>Aphelocephala leucopsis</i>	Southern Whiteface																		•						•	
PARDALOTIDAE																										
<i>Pardalotus rubricatus</i>	Red-browed Pardalote						•		•		•		•	•	•		•	•	•	•					•	•
<i>Pardalotus striatus</i>	Striated Pardalote				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•
MELIPHAGIDAE																										
<i>Certhionyx variegatus</i>	Pied Honeyeater				•	•			•	•						•	•	•	•		•					•
<i>Lichenostomus virescens</i>	Singing Honeyeater				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•
<i>Lichenostomus keartlandi</i>	Grey-headed Honeyeater				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater				•	•	•		•	•	•	•		•	•	•	•	•	•	•	•				•	•
<i>Purnella albifrons</i>	White-fronted Honeyeater								•		•				•	•					•					•
<i>Manorina flavigula</i>	Yellow-throated Miner				•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•			•	•
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater				•				•		•		•		•	•	•	•	•	•	•				•	•
<i>Conopophila whitei</i>	Grey Honeyeater										•							•			•				•	
<i>Epthianura tricolor</i>	Crimson Chat				•		•		•		•		•		•	•	•				•				•	•
<i>Sugomel niger</i>	Black Honeyeater				•		•		•		•		•	•			•		•		•					•
<i>Lichmera indistincta</i>	Brown Honeyeater				•		•	•	•		•		•	•	•		•	•	•	•	•				•	•
<i>Melithreptus gularis</i>	Black-chinned Honeyeater						•		•		•	•	•		•		•		•	•	•				•	•
POMATOSTOMIDAE																										
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler				•	•	•		•	•	•		•	•	•		•	•	•	•					•	•
<i>Pomatostomus superciliosus</i>	White-browed Babbler														•	S									•	
PSOPHODIDAE (CINCLOSOMATIDAE)																										
<i>Cinclosoma castaneothorax</i>	Chestnut-breasted Quail-thrush										•				•										•	
<i>Psophodes occidentalis</i>	Chiming Wedgebill							•				•														
NEOSITTIDAE																										
<i>Daphoenositta chrysoptera</i>	Varied Sittella																•									

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninnox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	Birddata	This survey
		EPBC Act	WC Act	DEC																						
CAMPEPHAGIDAE																										
<i>Coracina maxima</i>	Ground Cuckoo-shrike				•										•		•	•							•	•
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•	•
<i>Lalage sueurii</i>	White-winged Triller				•	•	•	•	•		•	•	•	•	•	•	•	•	•	•					•	•
PACHYCEPHALIDAE																										
<i>Pachycephala rufiventris</i>	Rufous Whistler				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				•	•	•	•	•	•	•		•		•	•	•	•	•	•	•				•	•
<i>Oreoica gutturalis</i>	Crested Bellbird				•	•	•		•	•	•		•	•	•	•	•	•	•	•	•				•	•
ARTAMIDAE																										
<i>Artamus leucorhynchus</i>	White-breasted Woodswallow												•													
<i>Artamus personatus</i>	Masked Woodswallow				•		•		•		•					•	•	•	•		•				•	•
<i>Artamus cinereus</i>	Black-faced Woodswallow				•		•	•	•		•	•	•	•	•	•	•	•	•	•	•				•	•
<i>Artamus minor</i>	Little Woodswallow				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•
<i>Cracticus torquatus</i>	Grey Butcherbird				•				•		•		•		•	•	•	•	•	•					•	•
<i>Cracticus nigrogularis</i>	Pied Butcherbird				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					•	•
<i>Cracticus tibicen</i>	Australian Magpie				•	•			•	•	•	•	•		•	•	•	•	•	•					•	•
RHIPIDURIDAE (DICRURIDAE)																										
<i>Rhipidura albiscapa</i>	Grey Fantail													•				•							•	•
<i>Rhipidura leucophrys</i>	Willie Wagtail				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•
CORVIDAE																										
<i>Corvus bennetti</i>	Little Crow				•						•					•	•	•	•		•				•	
<i>Corvus orru</i>	Torresian Crow				•	•	•	•	•	•	•	•	•	•	•		•	•	•		•				•	•
MONARCHIDAE (DICRURIDAE)																										
<i>Grallina cyanoleuca</i>	Magpie-lark				•	•		•	•	•	•		•	•	•	•	•	•	•	•	•				•	•
PETROICIDAE																										
<i>Petroica goodenovii</i>	Red-capped Robin				•							•			•	•	•	•			•				•	•
<i>Melanodryas cucullata</i>	Hooded Robin				•	•	•	•	•	•	•		•		•	•	•	•	•	•	•				•	•
ALAUDIDAE																										
<i>Mirafrja javanica</i>	Horsfield's Bushlark							•				•				•	•								•	•
ACROCEPHALIDAE (SYLVIIDAE)																										
<i>Acrocephalus australis</i>	Australian Reed-Warbler												•												•	•
MEGALURIDAE (SYLVIIDAE)																										
<i>Cincloramphus mathewsi</i>	Rufous Songlark				•		•		•		•		•	•	•		•		•		•				•	•
<i>Cincloramphus cruralis</i>	Brown Songlark								•		•		•		•	•	•	•	•						•	•
<i>Eremiornis carteri</i>	Spinifex-bird				•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•				•	•
HIRUNDINIDAE																										
<i>Cheramoeca leucosterna</i>	White-backed Swallow															•										
<i>Hirundo neoxena</i>	Welcome Swallow																•									
<i>Petrochelidon ariel</i>	Fairy Martin								•				•	•	•	S	•		•						•	
<i>Petrochelidon nigricans</i>	Tree Martin				•						•		•		•	•	•		•						•	•

Family and Species	Common name	Conservation Status			<i>ecologia</i> Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (<i>ecologia</i> in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (<i>ecologia</i> in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninnox 1990)	Central Pilbara Project (<i>ecologia</i> 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (<i>ecologia</i> 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DEC																						
NECTARINIIDAE (DICAIDAE)																										
<i>Dicaeum hirundinaceum</i>	Mistletoebird						•		•		•		•	•	•		•	•	•						•	•
ESTRILDIDAE																										
<i>Taeniopygia guttata</i>	Zebra Finch				•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•				•	•
<i>Neochmia ruficauda subclarescens</i>	Star Finch (western)			P4	•								•			•					•				•	
<i>Emblema pictum</i>	Painted Finch				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•
MOTACILLIDAE																										
<i>Anthus novaeseelandiae</i>	Australasian Pipit										•		•		•	•									•	

Appendix C3 - Reptiles

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DEC																					
AGAMIDAE																									
<i>Amphibolurus longirostris</i>	Long-nosed Dragon				•		•		•		•		•	•	•	•	•	•	•	•	•	•			•
<i>Caimanops amphiboluroides</i>	Mulga Dragon				•						•						•								
<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•
<i>Ctenophorus isolepis</i>	Central Military Dragon				•				•		•		•	•	•		•			•	•				
<i>Ctenophorus nuchalis</i>	Central Netted Dragon										•		•	•							•				
<i>Ctenophorus reticulatus</i>	Western Netted Dragon				•																•				
<i>Ctenophorus scutulatus</i>	Lozenge-marked Dragon																				•				
<i>Diporiphora valens</i>					•										•		•			•					
<i>Pogona minor</i>	Dwarf Bearded Dragon				•	•					•	•	•		•	•	•	•	•	•					•
<i>Tympanocryptis cephalus</i>	Pebble Dragon																•								
DIPODACTYLIDAE																									
<i>Crenadactylus ocellatus</i>	Clawless Gecko										•		•				•		•						
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko				•				•		•		•	•	•		•				•				•
<i>Diplodactylus pulcher</i>																									
<i>Diplodactylus savagei</i>					•				•		•		•		•		•	•			•				•
<i>Lucasium stenodactylum</i>	Sand-plain Gecko				•				•		•		•	•	•					•	•				•
<i>Lucasium wombeyi</i>					•				•		•		•	•	•		•	•							•
<i>Oedura marmorata</i>	Marbled Velvet Gecko				•		•	•	•		•	•	•	•		•	•	•	•						•
<i>Rhynchoedura ornata</i>	Beaked Gecko										•		•	•	•		•			•					•
<i>Strophurus elderi</i>	Jewelled Gecko										•		•		•		•	•		•	•				•
<i>Strophurus jeanae</i>																		•							
<i>Strophurus strophurus</i>	Western Spiny-tailed Gecko																•		•						
<i>Strophurus wellingtonae</i>					•			•							•		•	•	•						•
CARPHODACTYLIDAE																									
<i>Nephurus levis</i>	Smooth Knob-tailed Gecko												•	•											
<i>Nephurus wheeleri</i>	Banded Knob-tailed Gecko				•		•		•		•		•		•		•		•	•	•				•
<i>Underwoodisaurus seorsus</i>	Barking Gecko						•										•		•						
GEKKONIDAE																									
<i>Gehyra pilbara</i>					•		•						•				•		•		•				•
<i>Gehyra punctata</i>					•		•		•		•				•	•	•	•	•	•	•				•
<i>Gehyra variegata</i>					•	•	•		•		•		•		•		•	•	•	•	•				•
<i>Heteronotia binoei</i>	Bynoe's Gecko				•		•	•	•		•	•	•	•	•	•	•	•	•	•	•				•
<i>Heteronotia spelea</i>	Desert Cave Gecko										•		•				•								•
PYGOPODIDAE																									
<i>Delma butleri</i>																	•			•					
<i>Delma elegans</i>					•						•		•				•		•		•				
<i>Delma nasuta</i>					•		•		•		•		•	•	•	•	•	•	•	•	•				•
<i>Delma pax</i>					•		•		•		•		•		•		•	•	•	•	•				•
<i>Delma tincta</i>					•				•				•		•		•	•		•					
<i>Lialis burtonis</i>	Burton's Snake-lizard						•		•		•		•	•	•		•	•	•						•

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DEC																					
<i>Pygopus nigriceps</i>	Western Hooded Scaly-foot				•				•		•			•	•				•	•					•
SCINCIDAE																									
<i>Carlia munda</i>					•		•	•	•		•		•	•	•		•	•	•	•	•				•
<i>Carlia triacantha</i>																	•	•	•	•					
<i>Cryptoblepharus buchananii</i>					◊										◊	◊	•	◊							
<i>Cryptoblepharus ustulatus</i>					◊		•		•		•				◊	◊	•	◊	•		•				•
<i>Ctenotus duricola</i>					•				•		•	•	•	•	•	•	•	•	•	•	•				•
<i>Ctenotus grandis</i>					•		•	•	•		•		•	•	•		•	•		•	•				•
<i>Ctenotus hanloni</i>											•		•	•											
<i>Ctenotus helenae</i>					•		•		•		•		•	•	•	•	•	•	•						•
<i>Ctenotus leonhardii</i>					•												•								
<i>Ctenotus mimetes</i>																					•				
<i>Ctenotus pantherinus</i>	Leopard Ctenotus				•		•	•	•		•		•	•	•	•	•	•	•	•	•				•
<i>Ctenotus robustus</i>	Eastern Striped Skink																•								•
<i>Ctenotus rubicundus</i>							•		•		•						•	•	•	•	•				•
<i>Ctenotus rutilans</i>					•				•						•		•	•		•	•				
<i>Ctenotus saxatilis</i>	Rock Ctenotus				•	•	•		•		•		•	•	•		•	•	•	•	•				•
<i>Ctenotus schomburgkii</i>					•		•								•		•	•		•					•
<i>Ctenotus serventyi</i>																	•								
<i>Ctenotus severus</i>																					•				
<i>Cyclodomorphus melanops</i>	Spinifex Slender Blue-tongue				•				•		•		•		•	•	•	•	•	•	•				•
<i>Egernia cygnitos</i>									•						•		•				•				•
<i>Egernia formosa</i>							•		•				•		•		•								•
<i>Egernia pilbarensis</i>													•				•								
<i>Eremiascincus fasciolatus</i>	Narrow-banded Sand-swimmer										•			•			•	•							•
<i>Eremiascincus isolepis</i>													•												
<i>Eremiascincus richardsonii</i>	Broad-banded Sand-swimmer								•								•								
<i>Lerista bipes</i>													•	•											
<i>Lerista clara</i>	(<i>L. muelleri</i> group)										•										•				
<i>Lerista flammicauda</i>					•		•				•		•					•			•				
<i>Lerista jacksoni</i>	(<i>L. muelleri</i> group)																•	•	•						
<i>Lerista muelleri</i>					•				•		•			•	•		•		•	•	•				
<i>Lerista verhmens</i>																	•								
<i>Lerista zietzi</i>											•						•	•							
<i>Menetia greyii</i>					•	•			•		•		•	•	•	•	•	•	•	•	•				
<i>Menetia surda</i>					•				•				•		•		•	•			•				•
<i>Morethia ruficauda</i>					•		•	•			•	•	•	•	•		•	•	•	•	•				•
<i>Notoscincus butleri</i>				P4					•				•		•		•	•			•	•			•
<i>Notoscincus ornatus</i>									•		•		•												•
<i>Proablepharus reginae</i>									•									•		•					
<i>Tiliqua multifasciata</i>	Centralian Blue-tongue				•		•		•		•	•	•		•		•	•	•	•	•				•

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DEC																					
VARANIDAE																									
<i>Varanus acanthurus</i>	Spiny-tailed Monitor				•		•		•		•		•		•		•	•	•	•	•				•
<i>Varanus brevicauda</i>	Short-tailed Pygmy Monitor				•				•		•		•		•		•	•		•	•				•
<i>Varanus bushi</i>	Pilbara Monitor				•				•		•						•	•							
<i>Varanus caudolineatus</i>	Stripe-tailed Monitor																			•					
<i>Varanus eremius</i>	Pygmy Desert Monitor				•				•		•		•	•	•		•	•							•
<i>Varanus giganteus</i>	Perentie										•			•				•	•	•					•
<i>Varanus gouldii</i>	Gould's Monitor																								
<i>Varanus panoptes</i>	Yellow-spotted Monitor				•				•				•		•		•	•		•					•
<i>Varanus pilbarensis</i>	Pilbara Rock Monitor				•		•		•				•		•		•				•				•
<i>Varanus tristis</i>	Black-headed Monitor				•		•		•				•		•		•	•		•	•				•
TYPHLOPIDAE																									
<i>Ramphotyphlops ammodytes</i>					•				•		•						•	•			•				•
<i>Ramphotyphlops ganei</i>				P1	•												•	•			•	•			
<i>Ramphotyphlops grypus</i>	Beaked Blind Snake				•				•		•		•		•		•	•		•	•				
<i>Ramphotyphlops hamatus</i>																									
<i>Ramphotyphlops pilbarensis</i>	Pilbara Blind Snake				•						•				•		•	•							
<i>Ramphotyphlops waitii</i>																									
BOIDAE																									
<i>Antaresia perthensis</i>	Pygmy Python				•				•								•		•	•					•
<i>Antaresia stimsoni</i>	Stimson's Python				•				•				•				•		•	•	•				•
<i>Aspidites melanocephalus</i>	Black-headed Python				•						•			•			•		•		•				•
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S1	VU					•		•						•	•	•					•	
ELAPIDAE																									
<i>Acanthophis pyrrhus</i>	Desert Death Adder																	•							
<i>Acanthophis wellsi</i>	Pilbara Death Adder				•		•		•		•		•	•			•		•						
<i>Brachyuropsis approximans</i>	NW Shovel-nosed Snake								•		•		•		•		•	•							
<i>Demansia psammophis</i>	Yellow-faced Whipsnake				•		•		•		•		•	•	•		•		•	•	•				•
<i>Demansia rufescens</i>	Rufous Whipsnake				•		•		•				•				•	•	•	•	•				
<i>Furina ornata</i>	Moon Snake				•		•		•		•		•	•	•		•	•	•	•	•	•			•
<i>Parasuta monachus</i>	Monk Snake				•		•		•		•		•		•		•	•		•	•				•
<i>Pseudechis australis</i>	Mulga Snake				•		•	•	•		•		•		•		•		•	•	•				•
<i>Pseudonaja mengdeni</i>	Gwardar				•				•				•		•	•	•	•		•					•
<i>Pseudonaja modesta</i>	Ringed Brown Snake				•		•		•		•		•				•	•		•	•				•
<i>Suta fasciata</i>	Rosen's Snake								•								•	•		•					•
<i>Suta punctata</i>	Little Spotted Snake								•					•											
<i>Vermicella snelli</i>	Pilbara Bandy Bandy																•	•	•						

Appendix C4 - Amphibians

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DEC																					
HYLIDAE																									
<i>Cyclorana maini</i>	Main's Frog										•		•		•		•	•			•				•
<i>Cyclorana platycephala</i>	Water-Holding Frog												•				•								
<i>Litoria rubella</i>	Little Red Tree Frog					•			•		•		•		•		•			•	•				•
LIMNODYNASTIDAE																									
<i>Platypsectrum spenceri</i>	Centralian Burrowing Frog																			•					
MYOBATRACHIDAE																									
<i>Pseudophryne douglasi</i>	Gorge Toadlet																•				•				
<i>Uperoleia glandulosa</i>	Glandular Toadlet																		•						
<i>Uperoleia saxatilis</i>	Northwest Toadlet								•		•		•				•		•						•

Appendix C5 - Fish

Family and Species	Common name	Conservation Status			ecologia Internal Database	Delphine (Ecoscape 2012a)	Mt Farquhar (ecologia in prep-c)	Mt Farquhar (Ecoscape 2012d)	Eliwana and Flying Fish (ecologia in prep-b)	Eliwana and Flying Fish (Ecoscape 2012b, c)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Raven (Ecoscape 2012e)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005a)	Brockman Syncline (Biota 2005b)	Brockman 2 Detritals (Mattiske and Ninox 1990)	Central Pilbara Project (ecologia 2011b)	West Turner Section 10 (Biota 2009b)	Kings Area (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap (DEC 2012)	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DEC																					
CLUPEIDAE																									
<i>Nematalosa erebi</i>	Bony Bream																								•
MELANOTAENIIDAE																									
<i>Melanotaenia australis</i>	Western Rainbowfish					•	•												•						•
PLOTOSIDAE																									
<i>Neosilurus hyrtlii</i>	Hyrtl's Tandan					•													•						•
TERAPONTIDAE																									
<i>Amniataba percoides</i>	Barred Grunter																		•						•
<i>Leiopotherapon aheneus</i>	Fortescue Grunter			P4																					•
<i>Leiopotherapon unicolor</i>	Spangled Perch						•		•										•						•

† Species recorded just outside Survey Area

S Species recorded from secondary evidence

SA Active pebble mound

Recorded during targeted conservation significant fauna assessment

◇ Due to new taxonomic updates, records of *Cryptoblepharus plagiocephalus* and *C. carnabyi* can be either *C. buchananii* or *C. ustulatus*

APPENDIX D SITE DESCRIPTIONS

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Vegetation and Fauna Habitat Description	Site Photo
<p>Site DL S1</p> <p>Major watercourse with large permanent pools. Riparian zone consists of mature, moderately dense <i>Eucalyptus camaldulensis</i> woodland with moderately dense <i>Acacia</i> spp. and <i>Gossypium robinsonii</i> shrubs, over dense <i>Cenchrus ciliaris</i>. Soil substrate consists of weak brown sand-loam.</p> <p>Habitat type: River systems</p>	
<p>Site DL S2</p> <p><i>Triodia</i> hummock grassland with open <i>Eucalyptus leucophloia</i> and <i>Acacia inaequilatera</i> on rocky hill slope. Soil substrate consists of firm brown loam-clay with continuous quartz, granite, calcrete and BIF stones.</p> <p>Habitat type: Hilltops, hillslopes, ridges and cliffs</p>	

Site DL S3

Creek line adjacent to rocky hill slope. Mature, moderately dense *Corymbia* sp. woodland along creek line with dense *Acacia* spp. over *Triodia* sp. on outer edges. Soil substrate consists of firm brown loam-clay with loose calcrete stones.

Habitat type: Hilltops, hillslopes, ridges and cliffs

**Site DL S4**

Low undulating plain adjacent to old channel bed with scattered *Corymbia* sp. and *Acacia* sp. over very dense *Triodia* hummock grassland. Soil substrate consists of firm brown loam-clay with many loose calcrete stones.

Habitat type: Footslopes and plains



Site DL S5

Open *Acacia inaequilatera* and *A. aneura* with scattered *Eucalyptus leucophloia* and *Corymbia* sp. over *Triodia* hummock grassland. Soil substrate consists of firm reddish-brown loam-clay with continuous loose mixed (granite, quartz, BIF) stones.

Habitat type: Footslopes and plains

**Site DL S6**

Moderately dense *Eucalyptus camaldulensis* adjacent to river bed with moderately dense *Acacia* spp. over *Triodia* sp. Soil substrate consists of firm reddish-brown loam-clay with a moderate density of loose river stones and pebbles.

Habitat type: Footslopes and plains



Site DL S7

Open *Acacia aneura* over moderately dense *Cenchrus ciliaris* tussock grassland. Soil substrate consists of weak reddish-brown loam-clay without rocks.

Habitat type: Mixed acacia woodlands

**Site DL S8**

Moderately dense *Acacia* spp. shrubland with scattered *Eucalyptus* sp. over moderately dense *Triodia* hummock grassland plain. Soil substrate consists of firm reddish-brown sand-clay with continuous loose BIF pebbles.

Habitat type: Footslopes and plains



Site DL S9

Triodia hummock grassland on gentle hill slope with scattered *Eucalyptus leucophloia* and *Corymbia* sp. over open *Acacia ancistrocarpa* and *A. maitlandii* shrubs. Soil substrate consists of strong reddish-brown loam-clay with continuous mixed pebbles.

Habitat type: Footslopes and plains

**Site DL S10**

Triodia hummock grassland on small hill beside gully with scattered *Corymbia* sp., *Acacia inaequilatera* and *A. ancistrocarpa*. Soil substrate consists of firm reddish-brown clay-loam with continuous loose mixed pebbles.

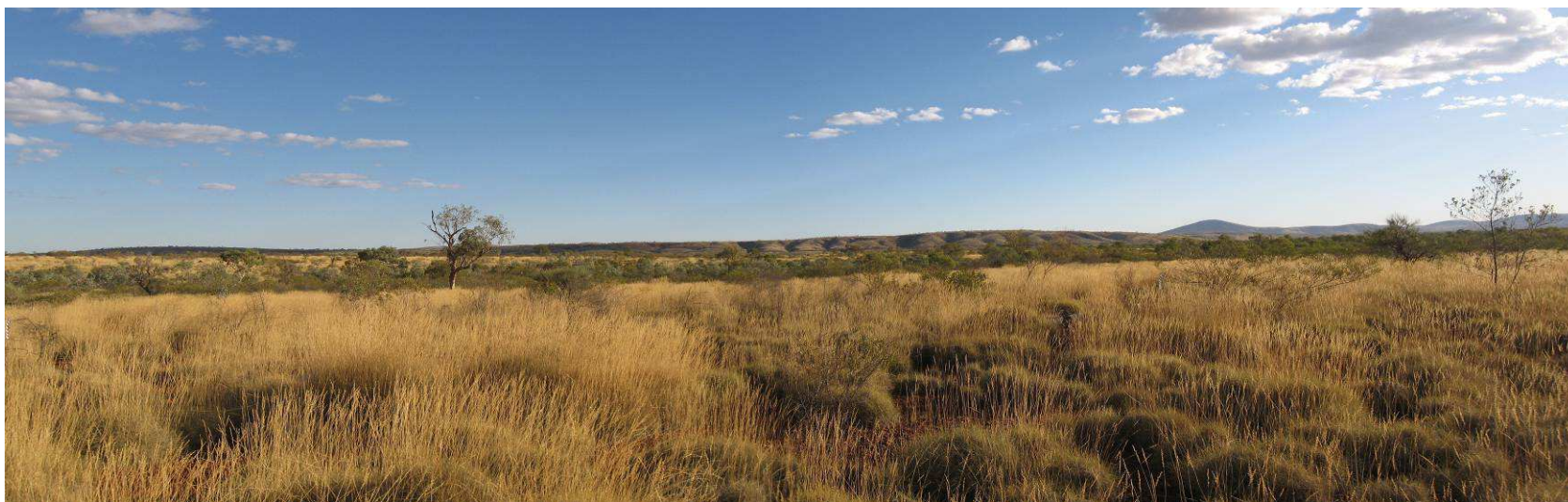
Habitat type: Footslopes and plains



Site DL S11

Triodia hummock grassland on light slope on edge of gully with scattered *Eucalyptus leucophloia*, *Acacia* spp. and *Hakea lorea*. Soil substrate consists of strong reddish-brown loam-clay with continuous loose mixed pebbles.

Habitat type: Footslopes and plains

**Site DL S12**

Open *Acacia* spp. and *Gossypium robinsonii* shrubland with scattered *Eucalyptus leucophloia* and *Corymbia* sp. over dense *Triodia* sp. Soil substrate consists of firm reddish-brown loam-clay with continuous loose mixed (granite, quartz) pebbles.

Habitat type: Footslopes and plains



Site DL S13

Triodia hummock grassland plain. Soil substrate consists of firm red sand-clay with moderate density of loose stones.

Habitat type: Footslopes and plains



Site DL S14

Dense *Acacia* shrubland over moderately dense *Triodia* hummock grassland within an alluvial fan. Soil substrate consists of weak brown coarse sand with many loose river stones.

Habitat type: Footslopes and plains



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APPENDIX E FAUNA SPECIES RECORDED DURING TRAPPING

Appendix F1 Mammals

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Targeted	Opportunistic
		EPBC Act	WC Act	DEC																
DASYURIDAE																				
<i>Dasykaluta rosamondae</i>	Kaluta							5	3			3	4	1		2	1			
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1	EN																1
<i>Ningaui timealeyi</i>	Pilbara Ningau					6	5	1	3	1			2	2	5	2	7			
<i>Planigale sp.</i>	Planigale				6	1	1			1		1		2	1		10	4		
<i>Pseudantechinus woolleyae</i>	Woolley's False Antechinus																		1	
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart							1								1	2			
MACROPODIDAE																				
<i>Macropus robustus</i>	Euro						1								1					5
<i>Macropus rufus</i>	Red Kangaroo																			4
<i>Petrogale rothschildi</i>	Rothschild's Rock-wallaby																		1	
HIPPOSIDERIDAE																				
<i>Rhinonictis aurantia</i>	Pilbara Leaf-nosed Bat	VU	S1	VU			X				X								X	
EMBALLONURIDAE																				
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat				X	X	X	X	X	X	X	X	X		X	X				
<i>Taphozous georgianus</i>	Common Sheathtail Bat					X	X		X	X	X	X	X		X			X		6
VESPERTILIONIDAE																				
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat				X	X	X	X	X	X	X	X	X	X	X	X	X			
<i>Scotorepens greyii</i>	Little Broad-nosed Bat				X	X		X	X		X	X	X		X					
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat				X	X	X	X	X	X	X	X	X	X	X		X	X		4
MOLOSSIDAE																				
<i>Chaerophon jobensis</i>	Northern Freetail Bat				X				X	X	X	X	X	X		X	X	X		
<i>Mormopterus beccarii</i>	Beccari's Freetail Bat										X			X						
<i>Tadarida australis</i>	White-striped Freetail Bat													X			X	X		

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Targeted	Opportunistic
		EPBC Act	WC Act	DEC																
MURIDAE																				
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4																S
<i>Pseudomys desertor</i>	Desert Mouse						3										4	4		
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse					9		1			1									5
<i>Zyzomys argurus</i>	Common Rock-rat																	1	2	
INTRODUCED MAMMALS																				
<i>*Canis lupus</i>	Dog/dingo													1		1				3
<i>*Equus caballus</i>	Horse																			2
<i>*Felis catus</i>	Cat																			1
<i>*Bos taurus</i>	Cow																			35

Appendix F2 Birds

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
CASUARIIDAE																			
<i>Dromaius novaehollandiae</i>	Emu																		2
PHASIANIDAE																			
<i>Coturnix ypsilophora</i>	Brown Quail								6		1								1
ANATIDAE																			
<i>Anas superciliosa</i>	Pacific Black Duck																		6
PODICIPEDIDAE																			
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe				1														1
COLUMBIDAE																			
<i>*Streptopelia senegalensis</i>	Laughing Dove																		1
<i>Phaps chalcoptera</i>	Common Bronzewing						1			1									1
<i>Ocyphaps lophotes</i>	Crested Pigeon						18		7	1		2		2			6	3	
<i>Geophaps plumifera</i>	Spinifex Pigeon						22		9										
<i>Geopelia cuneata</i>	Diamond Dove				2		1	1	3	1	10			3	1	9	1		
<i>Geopelia striata</i>	Peaceful Dove																		4
PODARGIDAE																			
<i>Podargus strigoides</i>	Tawny Frogmouth																		2
EUROSTOPODIDAE																			
<i>Eurostopodus argus</i>	Spotted Nightjar																	1	1
AEGOTHELIDAE																			
<i>Aegotheles cristatus</i>	Australian Owlet Nightjar				2												1		2
ANHINGIDAE																			
<i>Anhinga novaehollandiae</i>	Australasian Darter				3														1
PELECANIDAE																			
<i>Pelecanus conspicillatus</i>	Australian Pelican																		6

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
PHALACROCORACIDAE																			
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant				2														1
ARDEIDAE																			
<i>Ardea pacifica</i>	White-necked Heron						1					1							
<i>Ardea modesta</i>	Eastern Great Egret	M	S3																2
<i>Egretta novaehollandiae</i>	White-faced Heron				8														1
<i>Nycticorax caledonicus</i>	Nankeen Night-Heron																		3
THRESKIORNITHIDAE																			
<i>Threskiornis spinicollis</i>	Straw-necked Ibis																		1
ACCIPITRIDAE																			
<i>Lophoictinia isura</i>	Square-tailed Kite													1					
<i>Haliastur sphenurus</i>	Whistling Kite								1						1				
<i>Milvus migrans</i>	Black Kite										1								
<i>Accipiter fasciatus</i>	Brown Goshawk								1			1		2	4				
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk				2														1
<i>Circus assimilis</i>	Spotted Harrier								2	1				1	1		1		
<i>Aquila audax</i>	Wedge-tailed Eagle													1					
<i>Hieraaetus morphnoides</i>	Little Eagle														1				1
FALCONIDAE																			
<i>Falco cenchroides</i>	Nankeen Kestrel					1						1	1			1		1	
<i>Falco berigora</i>	Brown Falcon				1	1	1		1				3	2		1	1		2
<i>Falco longipennis</i>	Australian Hobby				2		1	1	1										
<i>Falco hypoleucos</i>	Grey Falcon			P4														1	
OTIDIDAE																			
<i>Ardeotis australis</i>	Australian Bustard			P4															2
BURHINIDAE																			
<i>Burhinus grallarius</i>	Bush-stone Curlew			P4															3

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
CHARADRIIDAE																			
<i>Elseyornis melanops</i>	Black-fronted Dotterel				11														3
TURNICIDAE																			
<i>Turnix velox</i>	Little Button-quail						1			2	2	1	5	6	8	1	5	2	
CACATUIDAE																			
<i>Eolophus roseicapillus</i>	Galah				30	1	10		2	5		4		24		14		21	
<i>Cacatua sanguinea</i>	Little Corella				18		2	15				35				4			12
<i>Nymphicus hollandicus</i>	Cockatiel										28	4		2	4				25
PSITTACIDAE																			
<i>Barnardius zonarius</i>	Australian Ringneck				9				4	8	4	6				8			
<i>Melopsittacus undulatus</i>	Budgerigar				220	55	98	48	203	166	124	567	1509	118	127	284	117	2	388
CUCULIDAE																			
<i>Centropus phasianinus</i>	Pheasant Coucal																		1
<i>Chalcites basal</i>	Horsfield's Bronze-cuckoo										1				1				
<i>Cacomantis pallidus</i>	Pallid Cuckoo													1					
STRIGIDAE																			
<i>Ninox connivens</i>	Barking Owl																		2
<i>Ninox novaeseelandiae</i>	Southern Boobook				2														
HALCYONIDAE																			
<i>Dacelo leachii</i>	Blue-winged Kookaburra				3	4	1	1	1	1									
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher								1		2	1	1		1	1		1	
<i>Todiramphus sanctus</i>	Sacred Kingfisher				1														1
MEROPIDAE																			
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S3		15	2	2		3			2		3					3
CLIMACTERIDAE																			
<i>Climacteris melanura</i>	Black-tailed Treecreeper				9														2

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
PTILINORHYNCHIDAE																			
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird				1		1					2							2
MALURIDAE																			
<i>Malurus leucopterus</i>	White-winged Fairy-wren										18	4		2		8			1
<i>Malurus lamberti</i>	Variegated Fairy-wren						7		2	3		4	7	8	3	3	9	17	
<i>Stipiturus ruficeps</i>	Rufous-crowned Emu-wren												6						
<i>Amytornis striatus</i>	Striated Grasswren						2												1
ACANTHIZIDAE																			
<i>Smicrornis brevirostris</i>	Weebill				15	18	18	3	4	7	2	11	16	6		4		15	6
<i>Gerygone fusca</i>	Western Gerygone						2		1	1	1			1					
PARDALOTIDAE																			
<i>Pardalotus rubricatus</i>	Red-browed Pardalote				2				2							3			2
<i>Pardalotus striatus</i>	Striated Pardalote				4	3	1	3	3	2	1	2		4	5	2		4	
MELIPHAGIDAE																			
<i>Certhionyx variegatus</i>	Pied Honeyeater												1		2	1			
<i>Lichenostomus virescens</i>	Singing Honeyeater					1			3	5	6	3	12	5	3	8	8	9	1
<i>Lichenostomus keartlandi</i>	Grey-headed Honeyeater					5	2		12			6	8	1	10		3	10	
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater				78		12		3	6		6							19
<i>Purnella albifrons</i>	White-fronted Honeyeater													1	13				
<i>Manorina flavigula</i>	Yellow-throated Miner				10	4		17	7	13		6		6		4	1	2	
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater																1		1
<i>Epthianura tricolor</i>	Crimson Chat						2	59	14	34 5		3	103	23	10	36	6		
<i>Sugomel niger</i>	Black Honeyeater							2	14	21	2	5	15	14	21	57	2		1
<i>Lichmera indistincta</i>	Brown Honeyeater					21	14		13	16	1	6	30	22	17	1	12	1	13
<i>Melithreptus gularis</i>	Black-chinned Honeyeater				1		6	1	3	1		1	36	9	12	2			6

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
POMATOSTOMIDAE																			
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler				21	5	5	7	14	11	4			3				5	
CAMPEPHAGIDAE																			
<i>Coracina maxima</i>	Ground Cuckoo-shrike										1								
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				3	2	2	2	2	1	1	3	4			3	13		4
<i>Lalage sueurii</i>	White-winged Triller						1	7	1	26		2	11	3			4	2	1
PACHYCEPHALIDAE																			
<i>Pachycephala rufiventris</i>	Rufous Whistler				2	3	7	1	5	4	4	1	2	4	1	2	2	7	6
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				4	3	1	3	3	1		2		2	1			3	
<i>Oreocia gutturalis</i>	Crested Bellbird							3	6	3	4	3	5	6	1	1		1	
ARTAMIDAE																			
<i>Artamus personatus</i>	Masked Woodswallow									980	20	8	375	252	16	80	154	2	73
<i>Artamus cinereus</i>	Black-faced Woodswallow							4	2		1		3			8	2		
<i>Artamus minor</i>	Little Woodswallow					3	1												1
<i>Cracticus torquatus</i>	Grey Butcherbird										1								1
<i>Cracticus nigrogularis</i>	Pied Butcherbird				2	3		6	3	3	2			2		1			1
<i>Cracticus tibicen</i>	Australian Magpie							2	6	2						1			3
RHIPIDURIDAE																			
<i>Rhipidura albiscapa</i>	Grey Fantail						2	1				1							1
<i>Rhipidura leucophrys</i>	Willie Wagtail				9	2	1	3	6	2	3	9	5	2	2	1	6	9	4
CORVIDAE																			
<i>Corvus orru</i>	Torresian Crow				1	2	5	6	3	5	1	5	5	6		3	2		5
PETROICIDAE																			
<i>Petroica goodenovii</i>	Red-capped Robin																	5	
<i>Melanodryas cucullata</i>	Hooded Robin																	2	
MONARCHIDAE																			

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
<i>Grallina cyanoleuca</i>	Magpie-lark				12	1		6	3	1		4				1			2
ALAUDIDAE																			
<i>Mirafrja javanica</i>	Horsfield's Bushlark																		1
ACROCEPHALIDAE																			
<i>Acrocephalus australis</i>	Australian Reed-Warbler				11														
MEGALURIDAE																			
<i>Cincloramphus mathewsi</i>	Rufous Songlark				5		1									2			
<i>Cincloramphus cruralis</i>	Brown Songlark																		1
<i>Eremiornis carteri</i>	Spinifexbird					7	1	1	3	3	3		2	1	3	3		4	
HIRUNDINIDAE																			
<i>Petrochelidon nigricans</i>	Tree Martin				6		3				5			1		2			
NECTARINIIDAE																			
<i>Dicaeum hirundinaceum</i>	Mistletoebird				4	1									1			6	1
ESTRILDIDAE																			
<i>Taeniopygia guttata</i>	Zebra Finch				10	19	71		19	20	54	22 8	19	61	16	10 3	42	36	65
<i>Emblema pictum</i>	Painted Finch				8	9	48		12	4	4	4	4		4		9	45	44

Appendix F3 Reptiles

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
AGAMIDAE																			
<i>Amphibolurus longirostris</i>	Long-nosed Dragon				2				1	8	1			1	2	4		5	1
<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon					1	6	6	3		1	3	3	3	2		2	2	3
<i>Pogona minor</i>	Dwarf Bearded Dragon														1				
DIPLODACTYLIDAE																			
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko							1	1	4	3	1		2					2
<i>Diplodactylus savagei</i>						5													
<i>Lucasium stenodactylum</i>	Sand-plain Gecko							1					2						3
<i>Lucasium wombeyi</i>										1		1	1						2
<i>Oedura marmorata</i>	Marbled Velvet Gecko															10			
<i>Rhynchoedura ornata</i>	Beaked Gecko									1		1							
<i>Strophurus elderi</i>						1													
<i>Strophurus wellingtonae</i>															1				
CARPHODACTYLIDAE																			
<i>Nephrurus wheeleri</i>	Banded Knob-tailed Gecko																		2
GEKKONIDAE																			
<i>Gehyra pilbara</i>									1							10			
<i>Gehyra punctata</i>																17			
<i>Gehyra variegata</i>					1	1		1					2	1		12		2	
<i>Heteronotia binoei</i>	Bynoe's Gecko					2		4	10	3		2	3	9	9	3		2	6
<i>Heteronotia spelea</i>																1			
PYGOPODIDAE																			
<i>Delma nasuta</i>												1	1						
<i>Delma pax</i>					2		1												
<i>Lialis burtonis</i>	Burton's Snake-lizard											1							
<i>Pygopus nigriceps</i>	Western Hooded Scaly-foot									1			1						

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
SCINCIDAE																			
<i>Carlia munda</i>					7	1	12			2		3		4	2			2	5
<i>Cryptoblepharus ustulatus</i>	Russet Snake-eyed Skink															7			
<i>Ctenotus duricola</i>					1			2	1			1	6	1	4		1		
<i>Ctenotus grandis</i>								2		4		2		1				1	5
<i>Ctenotus helenae</i>					1	4		1		3	1	1	1		4		5		4
<i>Ctenotus pantherinus</i>	Leopard Ctenotus					4		3	17	5	3	14	11	11	2		3		12
<i>Ctenotus robustus</i>	Robust Ctenotus									2	1								
<i>Ctenotus rubicundus</i>								1											
<i>Ctenotus saxatilis</i>	Rock Ctenotus				8		5	1					2			1	1	3	2
<i>Ctenotus schomburgkii</i>										1	1								
<i>Cyclodomorphus melanops</i>	Spinifex Slender Blue-tongue								1	1			1		2				
<i>Egernia cygnitos</i>	Western Pilbara Spiny-tailed Skink															1			
<i>Egernia formosa</i>																1			
<i>Eremiascincus fasciolatus</i>	Narrow-banded Sand-swimmer															1			
<i>Lerista</i> sp. (<i>muelleri</i> complex)					1														
<i>Menetia surda</i>												1							
<i>Morethia ruficauda</i>						1			1										
<i>Notoscincus butleri</i>				P4				1				1		3					
<i>Notoscincus ornatus</i>													1						
<i>Tiliqua multifasciata</i>	Centralian Blue-tongue												1						
VARANIDAE																			
<i>Varanus acanthurus</i>	Spiny-tailed Monitor					2							5			1		2	
<i>Varanus brevicauda</i>	Short-tailed Pygmy Monitor									1									
<i>Varanus eremius</i>	Pygmy Desert Monitor							1										1	2
<i>Varanus giganteus</i>	Perentie															2			
<i>Varanus panoptes</i>	Yellow-spotted Monitor															1			

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
<i>Varanus pilbarensis</i>	Pilbara Rock Monitor															2			
<i>Varanus tristis</i>	Black-headed Monitor						3												
TYPHLOPIDAE																			
<i>Ramphotyphlops ammodytes</i>									1										
PYTHONIDAE																			
<i>Antaresia perthensis</i>	Pygmy Python															1			
<i>Antaresia stimsoni</i>	Stimson's Python															4			
<i>Aspidites melanocephalus</i>	Black-headed Python																		1
ELAPIDAE																			
<i>Demansia psammophis cupreiceps</i>	Yellow-faced Whipsnake												1	1			1		
<i>Furina ornata</i>	Moon Snake							2		1		1		2					
<i>Parasuta monachus</i>	Monk Snake				1		5			2				1				3	1
<i>Pseudechis australis</i>	Mulga Snake					1		1						1		2			1
<i>Pseudonaja mengdeni</i>	Gwardar																		1
<i>Pseudonaja modesta</i>	Ringed Brown Snake																		1
<i>Suta fasciata</i>	Rosen's Snake									1							1		

Appendix F4 Amphibians

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
HYLIDAE																			
<i>Cyclorana maini</i>	Main’s Frog																		1
<i>Litoria rubella</i>	Little Red Tree Frog				15		1												4
MYOBATRACHIDAE																			
<i>Uperoleia saxatilis</i>	Northwest Toadlet				128		47												4

Appendix F5 Fish

Family and Species	Common Name	Conservation Status			DL S1	DL S2	DL S3	DL S4	DL S5	DL S6	DL S7	DL S8	DL S9	DL S10	DL S11	DL S12	DL S13	DL S14	Opportunistic
		EPBC Act	WC Act	DEC															
CLUPEIDAE																			
Nematalosa erebi	Bony Bream																		10
MELANOTAENIIDAE																			
Melanotaenia australis	Western Rainbowfish				30														20
PLOTOSIDAE																			
Neosilurus hyrtlii	Hyrtl's Tandan				1														5
TERAPONTIDAE																			
Amniataba percoides	Barred Grunter				21														
Leiopotherapon aheneus	Fortescue Grunter			P4	52														
Leiopotherapon unicolor	Spangled Perch				5														29

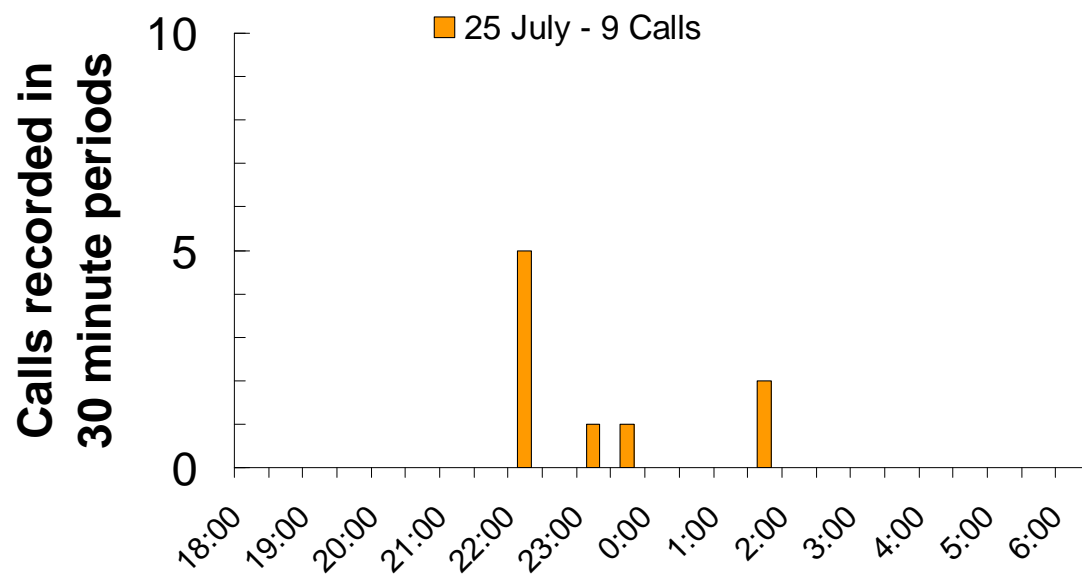
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APPENDIX F

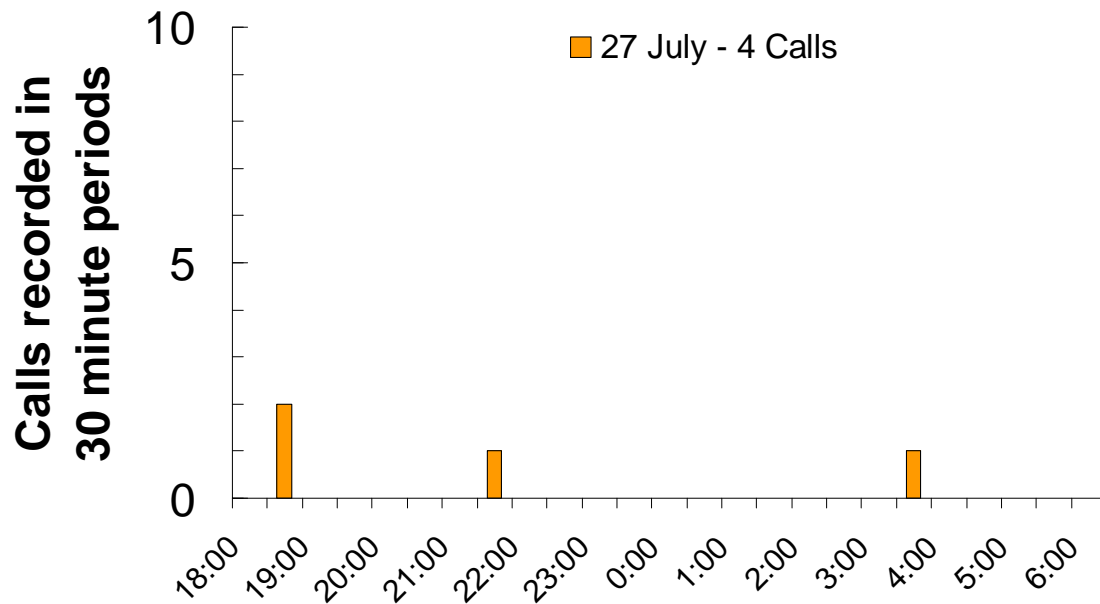
**PILBARA LEAF-NOSED BAT TEMPORAL PATTERN
RECORDS FROM TARGETED CONSERVATION
SIGNIFICANT FAUNA ASSESSMENT**

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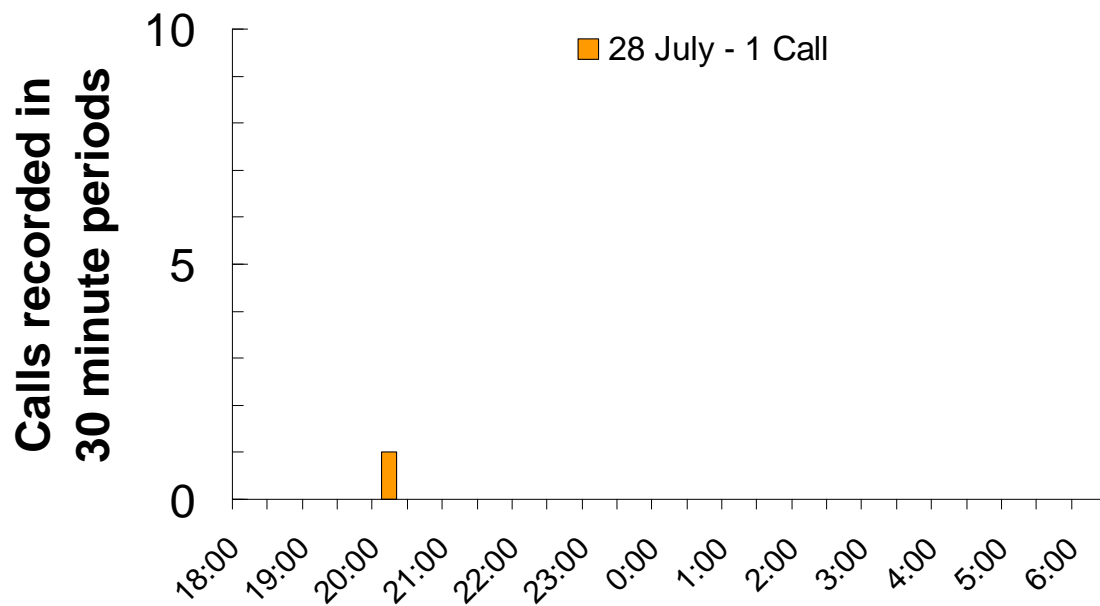
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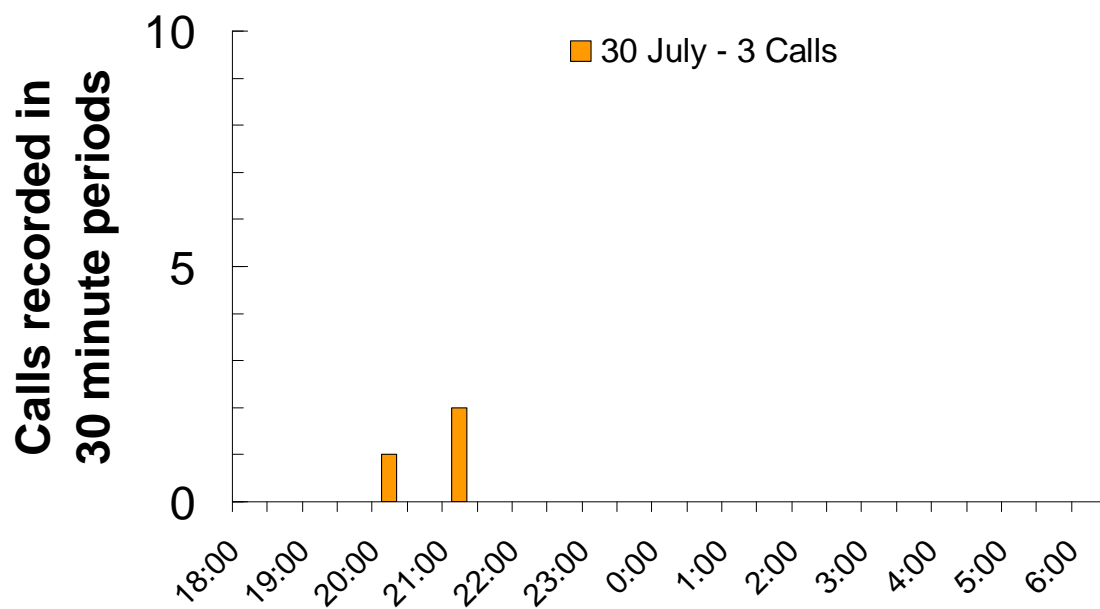
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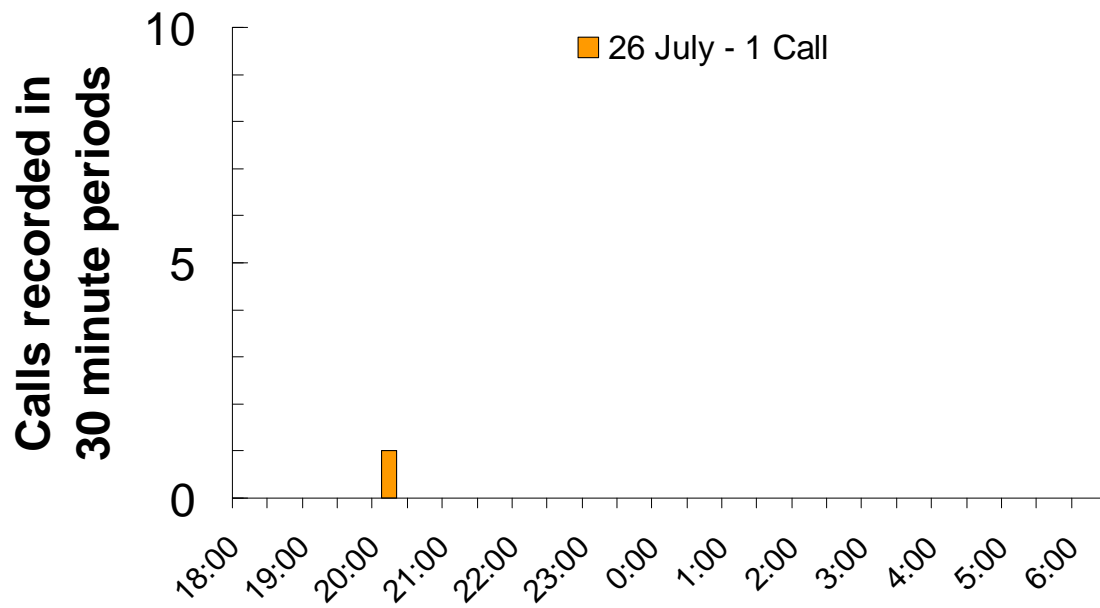
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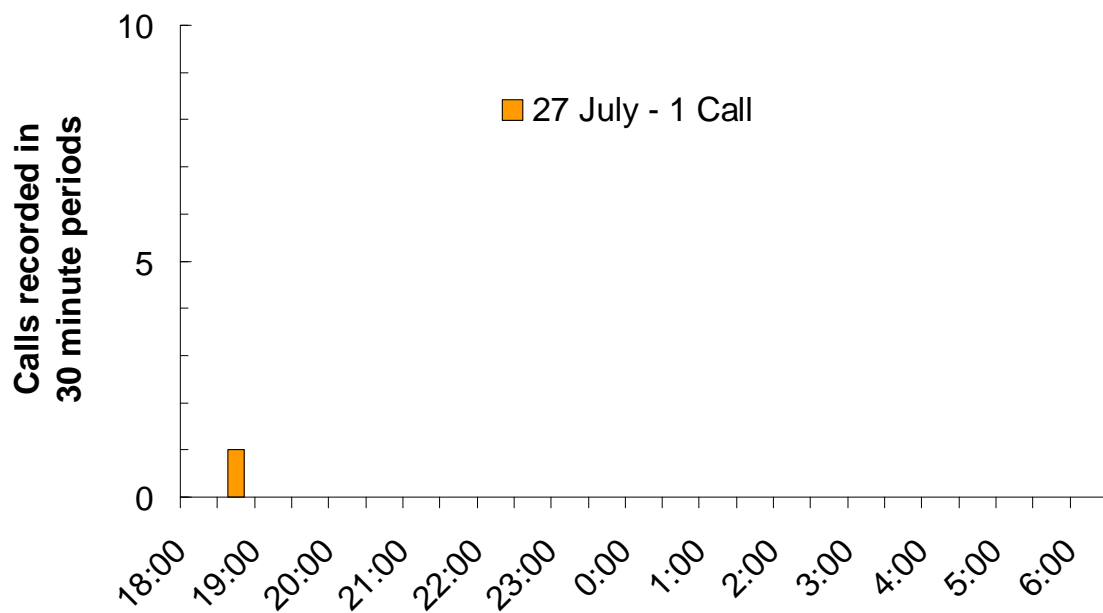
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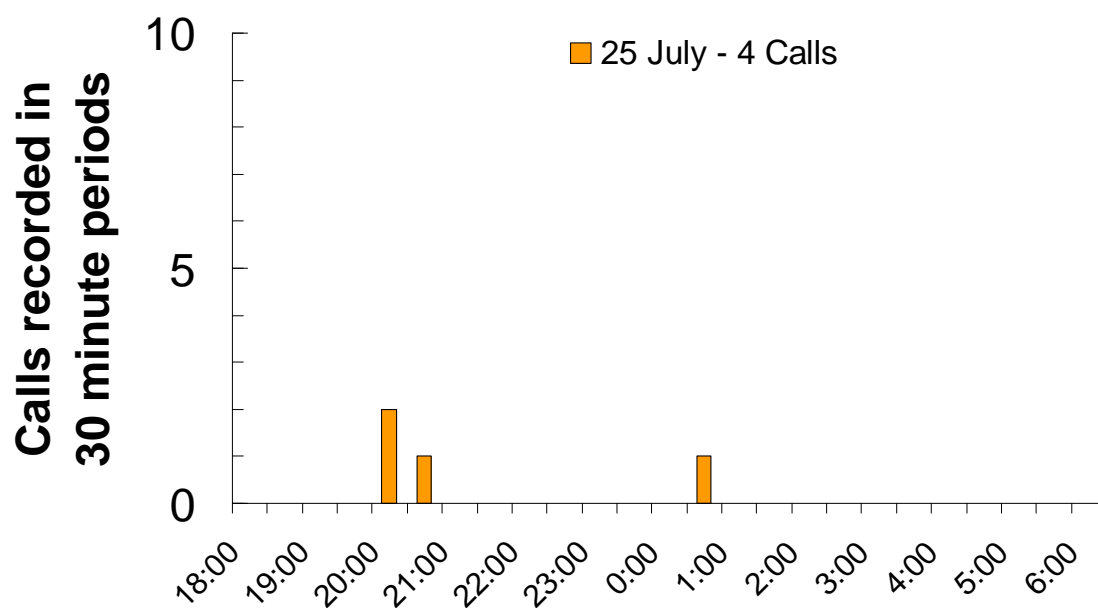
SITE: BAT 8



SITE: BAT 15



SITE: BAT 18



SITE: BAT 20

