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ecologia
ENVIRONMENT

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

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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
DPaW	Department of Parks and Wildlife (formerly DEC)
DoE	Department of Environment (formerly DSEWPaC)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EP Act	*Environmental Protection Act 1986*
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
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	*Wildlife Conservation Act 1950*

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 52,770 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 (Phase 1) and April-May 2013 (Phase 2), and the targeted conservation significant fauna survey in July 2012. During these surveys, a total of 25 trapping sites (15 during the Level 2 vertebrate fauna assessment, ten 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. Survey methods employed were consistent with *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*.

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

- Species accumulation curves showed that the current survey was very adequate overall, with an estimated 93 % of terrestrial trappable fauna species, and 98 % of avifaunal species present recorded during the survey.
- 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 systematically collected terrestrial fauna and avifaunal data indicated that most habitat types were significantly different to each other in terms of faunal assemblages.
- A total of 22 native and five introduced mammal species, 104 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.
- Twelve species of conservation significance were recorded during the current survey:
    - Northern Quoll (*Dayurus hallucatus*): EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable)

  - Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form): EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable)
  - Grey Falcon (*Falco hypoleucos*): WC Act Schedule 1 (Vulnerable)
  - Eastern Great Egret (*Ardea modesta*): EPBC Act Migratory, WC Act Schedule 3
  - Eastern Osprey (*Pandion cristatus*): EPBC Act Migratory, WC Act Schedule 3
  - Rainbow Bee-eater (*Merops ornatus*): EPBC Act Migratory, WC Act Schedule 3
  - Peregrine Falcon (*Falco peregrinus*): WC Act Schedule 4
  - Western Pebble-mound Mouse (*Pseudomys chapmani*): DPaW Priority 4
  - Australian Bustard (*Ardeotis australis*): DPaW Priority 4
  - Bush Stone-curlew (*Burhinus grallarius*): DPaW Priority 4
  - *Notoscincus butleri*: DPaW Priority 4
  - Fortescue Grunter (*Leiopotherapon aheneus*): DPaW Priority 4
- A further eight conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the Delphine survey area.
  - Pilbara Olive Python (*Liasis olivaceous barroni*): EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable)
  - Fork-tailed Swift (*Apus pacificus*): EPBC Act Migratory, WC Act Schedule 3
  - *Ramphotyphlops ganei*: DPaW Priority 1
  - Long-tailed Dunnart (*Sminthopsis longicaudata*): DPaW Priority 4
  - Ghost Bat (*Macroderma gigas*): DPaW Priority 4
  - Short-tailed Mouse (*Leggadina lakedownensis*): DPaW Priority 4
  - Black Bittern (*Ixobrychus flavicollis*): DPaW Priority 4
  - Star Finch (*Neochmia ruficauda subclarescens*): DPaW Priority 4
- No roost sites for Pilbara Leaf-nosed Bat were located within the study area during the targeted conservation significant fauna assessment. However, based on the timing of calls recorded, it is likely that at least one roost cave is present in the region.
- A single Northern Quoll was recorded on a motion camera approximately 2.5km to the south-west of Delphine camp during the Level 2 vertebrate fauna assessment; however, no evidence was recorded during the targeted conservation significant fauna assessment conducted in July. This suggests that the species is likely to occur in relatively small numbers within the study area. Based on aerial images and a short opportunistic survey conducted from a helicopter fly-over, areas of potentially suitable denning, foraging and dispersal habitat are expected to be found in the region to the west of the Delphine survey area, potentially supporting Northern Quoll populations.
- No major limitations on survey techniques were experienced, though there were some access limitations, particularly to the western parts of the survey area, and a rainfall event caused some disruption during the second phase of the Level 2 survey. However, all fauna habitats were well surveyed and statistical analysis of the data suggests that the majority of the fauna species were recorded.

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group (Fortescue) commissioned *ecologia* Environment (*ecologia*) to undertake a two-phase 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 52,770 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. The following 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
- *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 Parks and Wildlife (DPaW) 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 DPaW according to their level of threat using International Union for Conservation of Nature (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 DPaW 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.

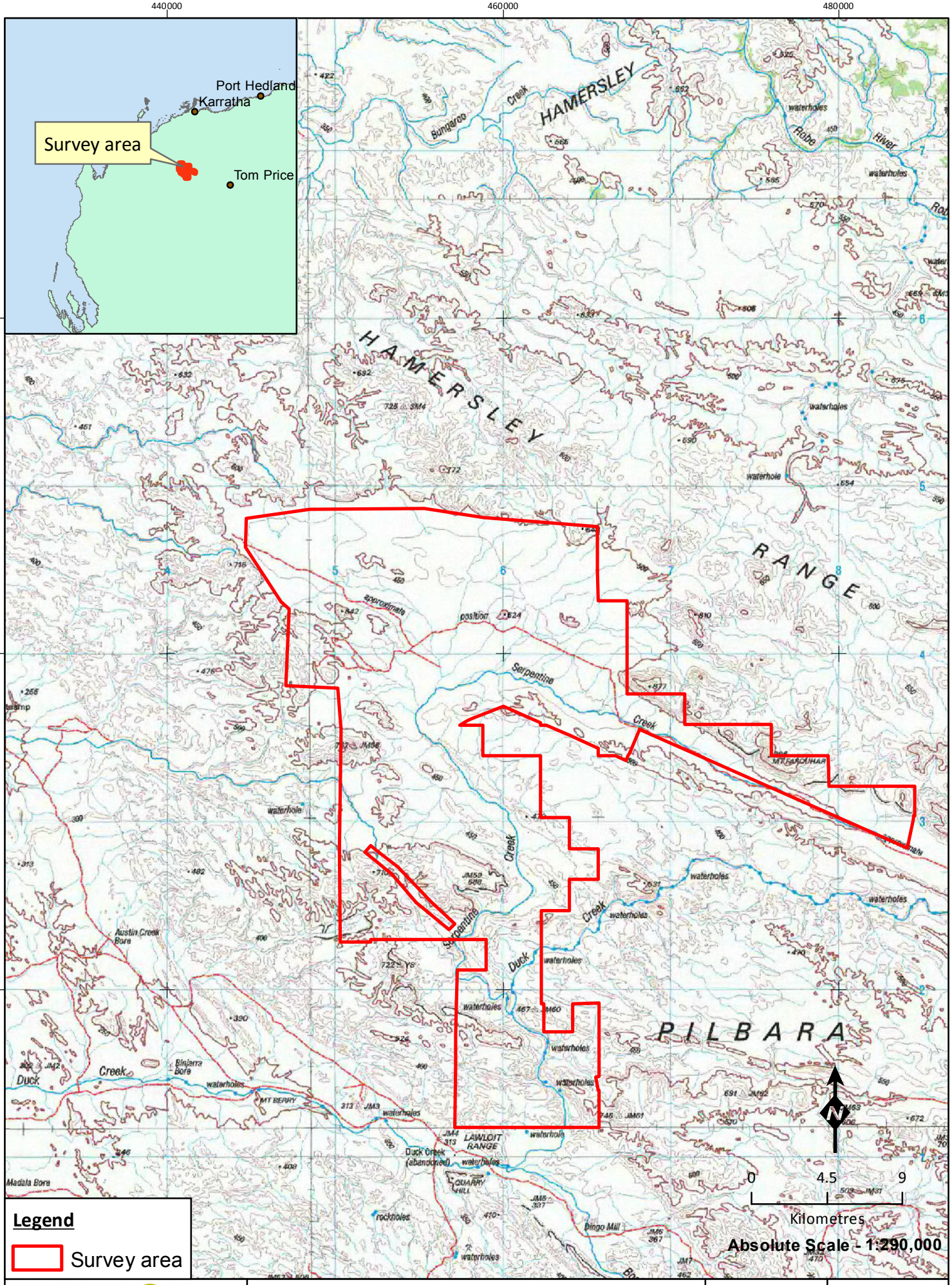
The aim of this study was to provide sufficient information to the EPA to assess the impact of the project on the vertebrate fauna populations that occur in the regional areas associated with the project, thereby ensuring that these objectives will be upheld.

The survey was undertaken using methods consistent with the following DoE guidelines:

- EPBC Act Referral Guidelines for Northern Quoll (DSEWPaC 2011a)
- Survey Guidelines for:
    - Australia's Threatened Mammals (DSEWPaC 2011c)
    - Australia's Threatened Birds (DSEWPaC 2010a)
    - Australia's Threatened Reptiles (DSEWPaC 2011d)
    - Australia's Threatened Bats (DSEWPaC 2011b)
    - Australia's Threatened Frogs (DSEWPaC 2010b)

This report satisfies the objectives outlined in Fortescue's Scope of Works and satisfies the requirements documented in *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 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 two-phase Level 2 vertebrate fauna assessment, including systematic trapping, observations, acoustic bat recording and overall assessment of the faunal assemblage recorded within the survey area
- 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.



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Location of survey area

Figure: 1.1	**Drawn: AH & JG**
Project ID: 1512	**Date: 09/01/15**

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH464

A4

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 annual 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 Aero (station number 007185, 576684 E, 7436936 N), 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).

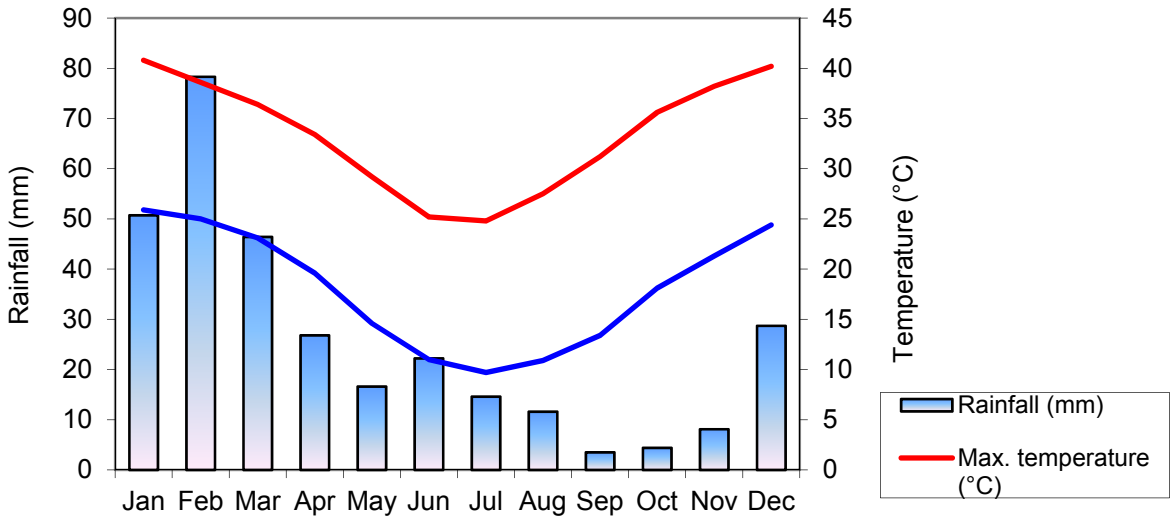


Figure 2.1 – Rainfall and temperature for the Paraburdoo Aero weather station (1974-2013).

2.2 WEATHER DURING SURVEY

The weather conditions experienced during the first phase of the fauna survey, as recorded by the Paraburdoo Aero weather station (BoM 2012), are listed in Appendix B. The first phase of the 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 first phase (1-11 May 2012) was warm, with an average daily maximum of 32.4°C and minimum of 16.6°C. The temperature during the second period of the first phase (18-28 May 2012) was mild-warm, with an average daily maximum of 27.4°C and minimum of 12.0°C. The temperature during the second phase (30 April – 10 May 2013) was warm, with an average daily maximum of 32.9°C and minimum of 17.5°C. Based on the mean climatic data (Figure 2.1), these temperatures were within the typical range for the time the surveys were conducted. On the whole, temperatures were adequate across the survey, though slightly warmer minima may have improved nocturnal reptile diversity, especially during the second part of the first phase of the survey.

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 Aero 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. During the second phase of the Level 2 fauna assessment, 80.6 mm was recorded at Wittenoom Aero (station number 005055, 637317 E, 7536736 S) situated 155 km from the study area (used due to incomplete data at Paraburdoo Aero) for the three months prior to the survey (January-March 2013), 199.1 mm below the average of 279.7 mm for the same period.

No rainfall was recorded on site during the first phase of the Level 2 vertebrate fauna assessment (May 2012) and the targeted conservation significant fauna assessment (July 2012). During the second phase of the Level 2 vertebrate fauna assessment (April-May 2013), 17.4 mm was recorded at Paraburdoo Aero. However, a rain gauge located at the Delphine camp recorded over 30 mm of rain during a heavy rainfall on the 8 May.

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 7), 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 Cresswell 1995). The Pilbara bioregion is further divided into the Chichester, Fortescue Plains, Hamersley and Roebourne subregions.

The survey area is located within 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 (49.3%), Boolgeeda (39.1%) and Rocklea (6.3%). 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 (%)
Landsystem Type 1 – Hills and ranges with spinifex grasslands					
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	1,993,745	26,011	49.3	1.30
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	2,881,897	3,323	6.3	0.12
Landsystem Type 3 – Plateaux, mesas and breakaways with spinifex grasslands					
Robe	Low plateaux, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.	128,620	57	0.1	0.04
Landsystem Type 4 - Plateaux, mesas and breakaways with acacia shrublands					
Table	Mesas, breakaways and stony plains with acacia or eucalypt woodland and halophytic shrublands.	15,959,208	1,311	2.5	0.01
Landsystem type 5 – Dissected plains with spinifex grasslands					
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands.	236,336	617	1.2	0.26
Landsystem Type 8 – Stony plains with spinifex grasslands					
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	961,637	20,649	39.1	2.15
Landsystem Type 12 – Wash plains on hardpan with groved mulga shrublands (sometimes with spinifex understorey)					
Wannamunna	Wash plains on hardpan with mulga shrublands.	6,301,339	365	0.7	0.01
Landsystem Type 14 – Alluvial plains with tussock grasslands or grassy shrublands					
Brockman	Gilgai alluvial plains with cracking clay soils supporting tussock grasslands.	74,108	331	0.6	0.45
Landsystem Type 17 – River plains with grassy woodlands and shrublands and tussock grasslands					
River	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	482,179	105	0.2	0.02

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 presented 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.

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 *Triodia wiseana*	2,565,571.7	19827.7	37.6	0.77
103	Hummock grasslands, shrub steppe; snakewood over soft spinifex and *Triodia wiseana*	614,275.3	369.9	0.7	0.06
567	Hummock grasslands, shrub steppe; mulga & kanji over soft spinifex and *Triodia basedowii*	776,997.6	4038.4	7.6	0.52
569	Hummock grasslands, low tree steppe; bloodwood over soft spinifex and *Triodia wiseana*	102,296.8	28533.5	54.1	27.89

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, DPaW threatened fauna database and DPaW 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	DPaW (DEC at time of search)	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	DoE (DSEWPaC at time of search)	Square around Western Hub area with a 40 km buffer Date accessed: 15/8/12
Birdata	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	DPaW (DEC at time of search)	Rectangle around survey area with a 40 km buffer Date accessed: 15/8/12

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

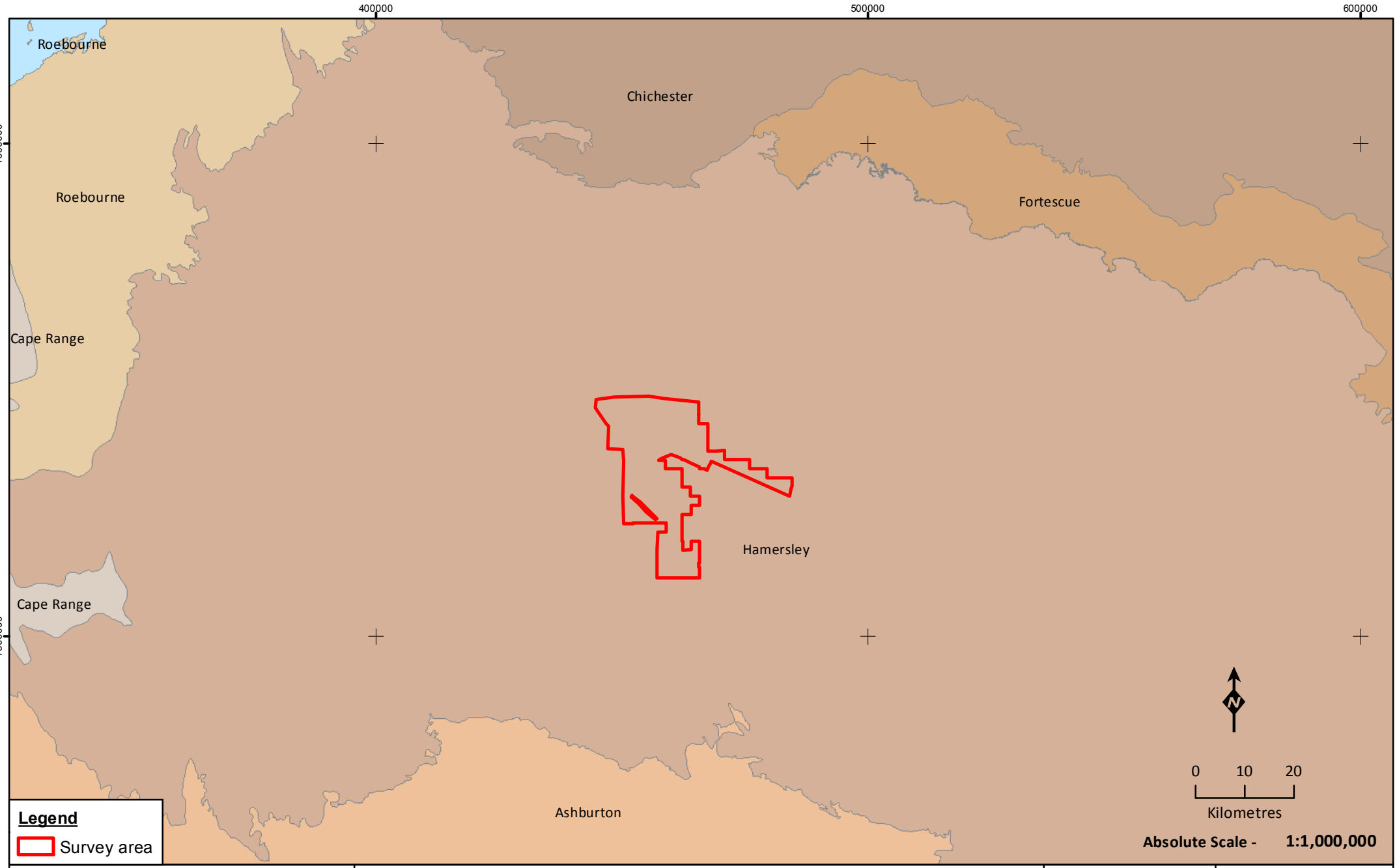
Survey Location and Author(s)	Distance to survey area (km)	Comments
ecologia internal database	4 – 46 km	Two Level 1 fauna assessments, one two-phase Level 2 vertebrate fauna assessment
Delphine (Ecoscape 2012a)	0 km	Level 1 fauna assessment and targeted conservation significant fauna assessment
Mt Farquhar (*ecologia* 2012)	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 (*ecologia* in prep-b)	5 km	Two-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 Ninox 1990)	53 km	Level 1 fauna assessment
Central Pilbara Project (*ecologia* 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 (*ecologia* 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) indicated 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 considered to be 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 Figures 2.5 and 2.6, 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
ecologia internal database	18 / 5	77	63	0	0
Delphine (Ecoscape 2012a)	3 / 4	44	5	1	2
Mt Farquhar (*ecologia* 2012)	16 / 4	56	34	0	2
Mt Farquhar (Ecoscape 2012d)	3 / 2	36	9	0	0
Eliwana and Flying Fish (*ecologia* in prep-b)	24 / 6	80	70	3	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 (*ecologia* 2011b)	24 / 4	99	84	4	0
West Turner Section 10 (Biota 2009b)	17 / 3	68	52	1	0
Kings Area Assessment (*ecologia* 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
DPaW 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**



ecologia ENVIRONMENT

Biogeographic regions of the survey area (DSEWPC 2010)

Figure: 2.2
Project ID: 1512

Drawn: AH & JG
Date: 09/01/15

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: JFH016

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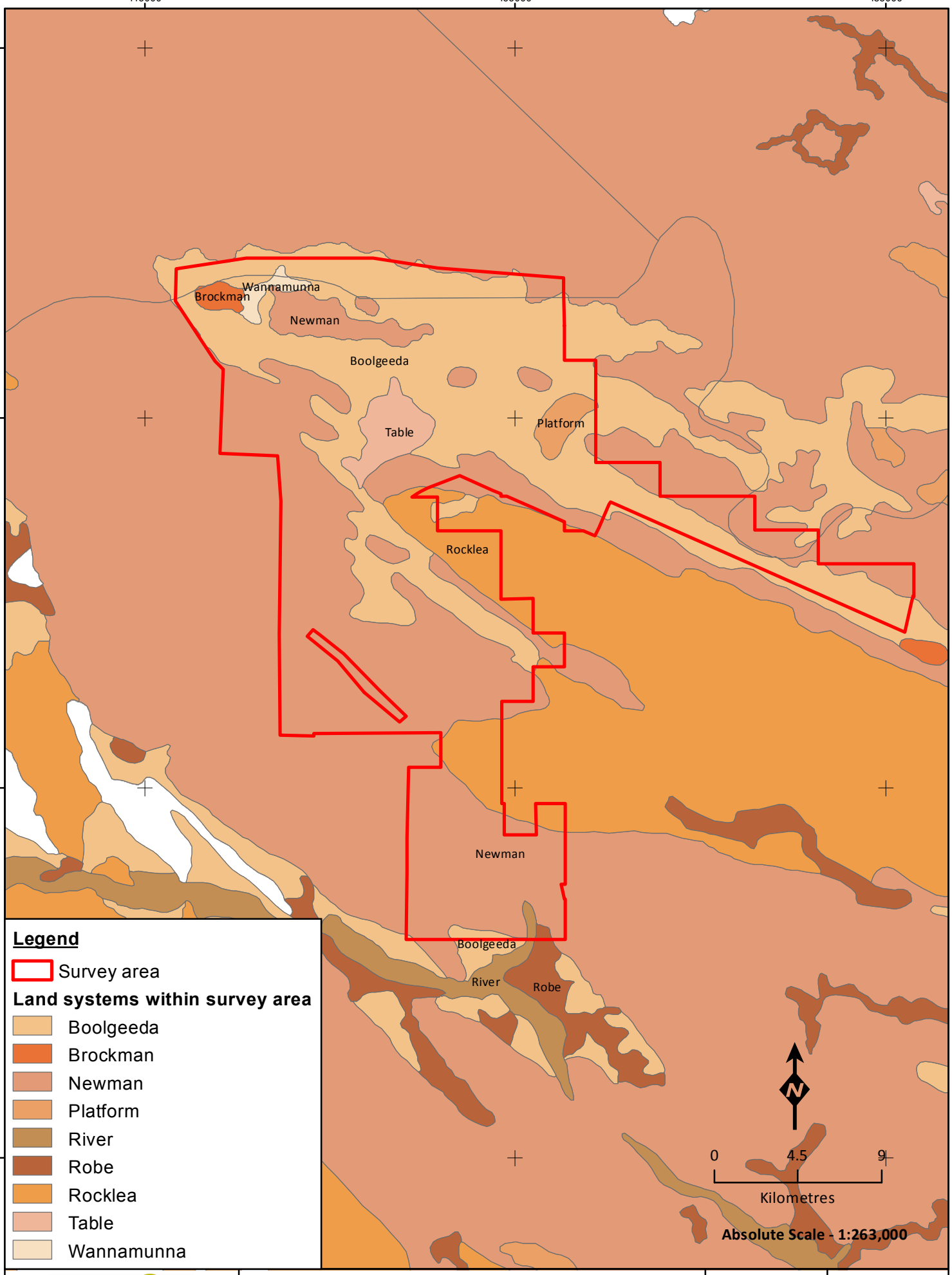

ecologia ENVIRONMENT

Land systems of the survey area (Van Vreeswyk *et al.* 2004)

Figure: 2.3
Project ID: 1512

Drawn: NJ & Ah
Date: 09/01/15

Coordinate System
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Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: NJ015

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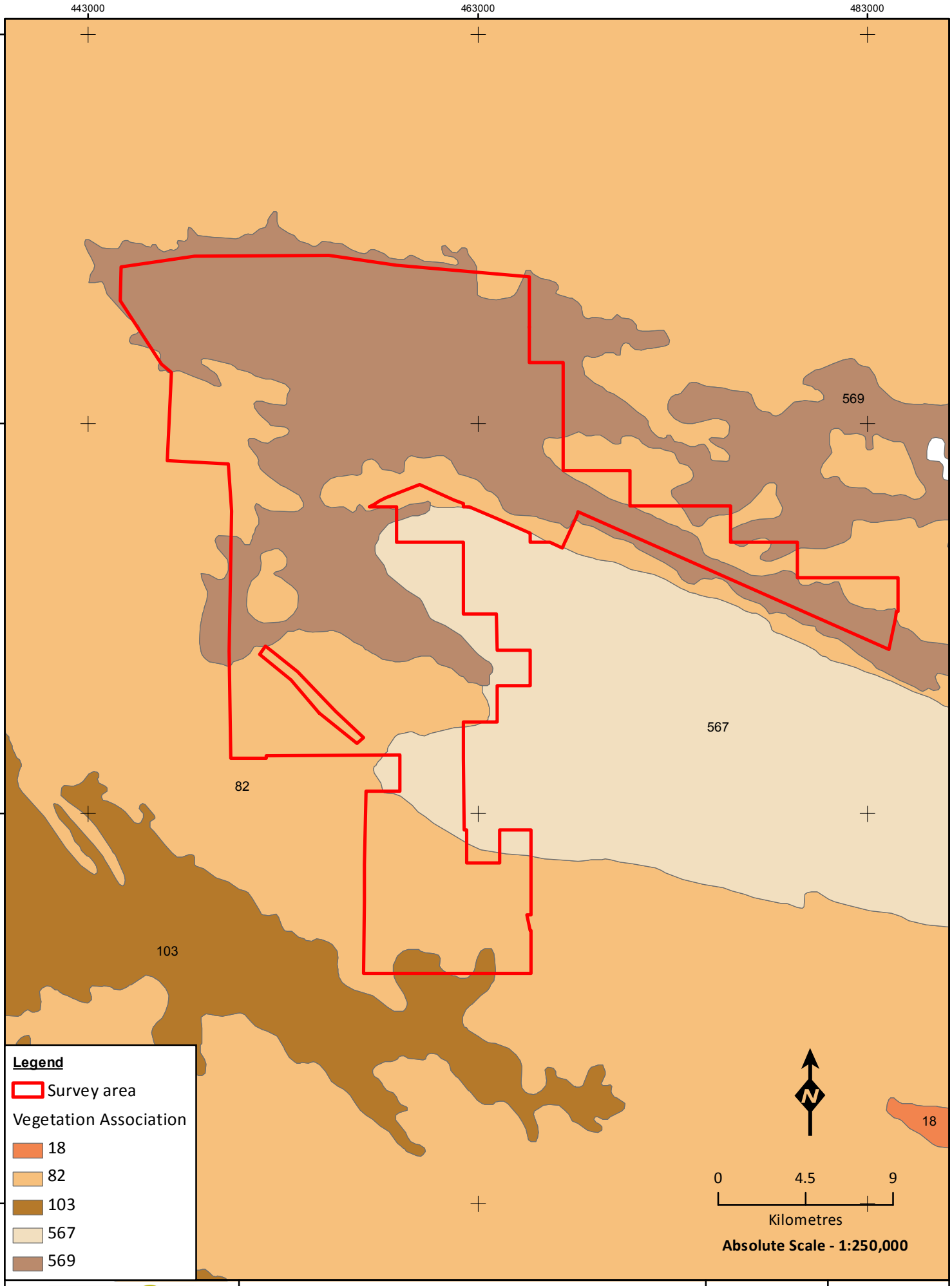

ecologia ENVIRONMENT

Vegetation associations of the survey area (Shepherd *et al.* 2002)

Figure: 2.4	**Drawn: NJ**
Project ID: 1445	**Date: 28/08/12**

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: NJ014

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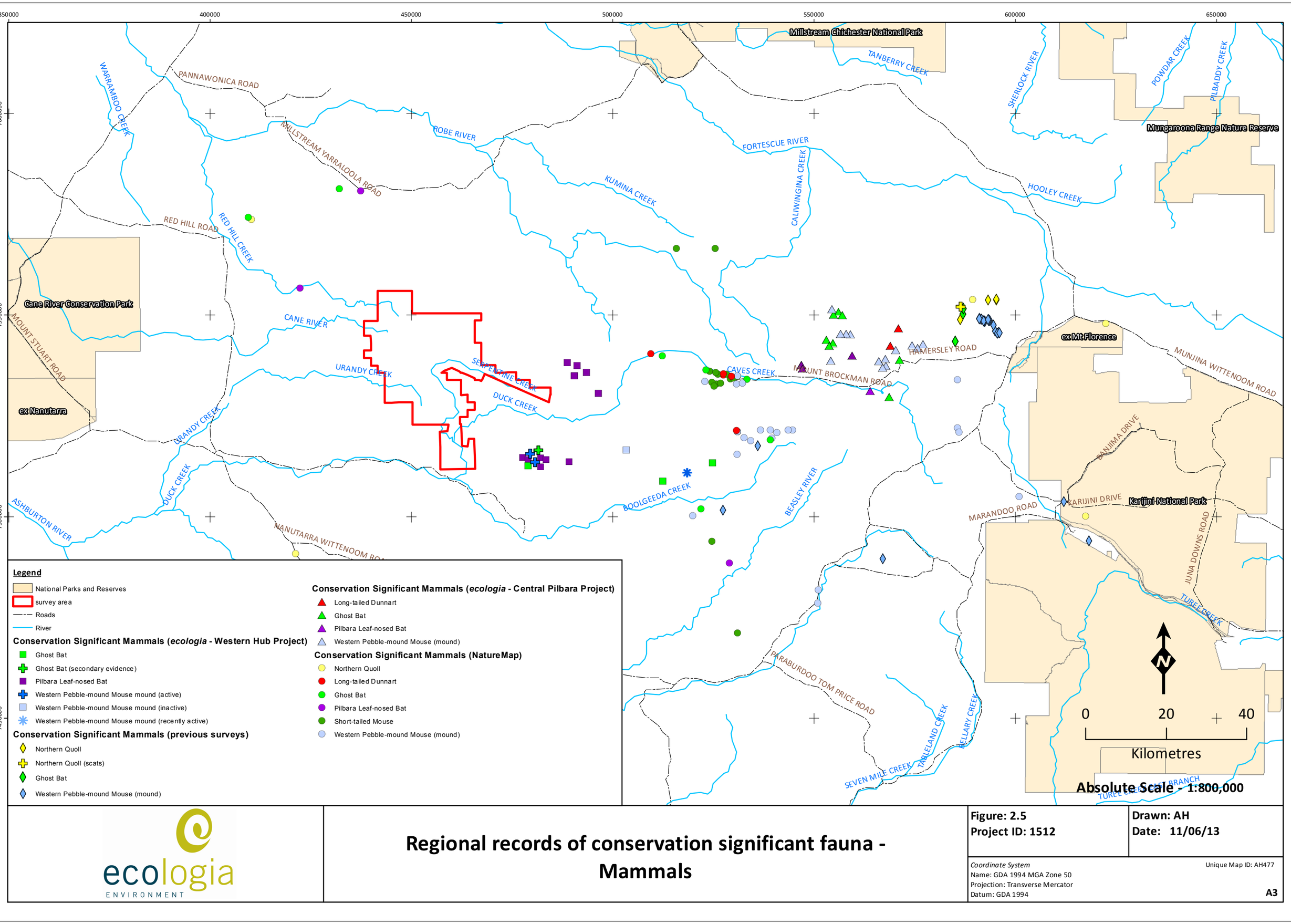

Legend

- National Parks and Reserves
- survey area
- Roads
- River

Conservation Significant Mammals (*ecologia* - Western Hub Project)

- Ghost Bat
- Ghost Bat (secondary evidence)
- Pilbara Leaf-nosed Bat
- Western Pebble-mound Mouse mound (active)
- Western Pebble-mound Mouse mound (inactive)
- Western Pebble-mound Mouse mound (recently active)

Conservation Significant Mammals (previous surveys)

- Northern Quoll
- Northern Quoll (scats)
- Ghost Bat
- Western Pebble-mound Mouse (mound)

Conservation Significant Mammals (*ecologia* - Central Pilbara Project)

- Long-tailed Dunnart
- Ghost Bat
- Pilbara Leaf-nosed Bat
- Western Pebble-mound Mouse (mound)

Conservation Significant Mammals (NatureMap)

- Northern Quoll
- Long-tailed Dunnart
- Ghost Bat
- Pilbara Leaf-nosed Bat
- Short-tailed Mouse
- Western Pebble-mound Mouse (mound)

Absolute Scale - 1:800,000

ecologia ENVIRONMENT

Regional records of conservation significant fauna - Mammals

Figure: 2.5
Project ID: 1512

Drawn: AH
Date: 11/06/13

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH477

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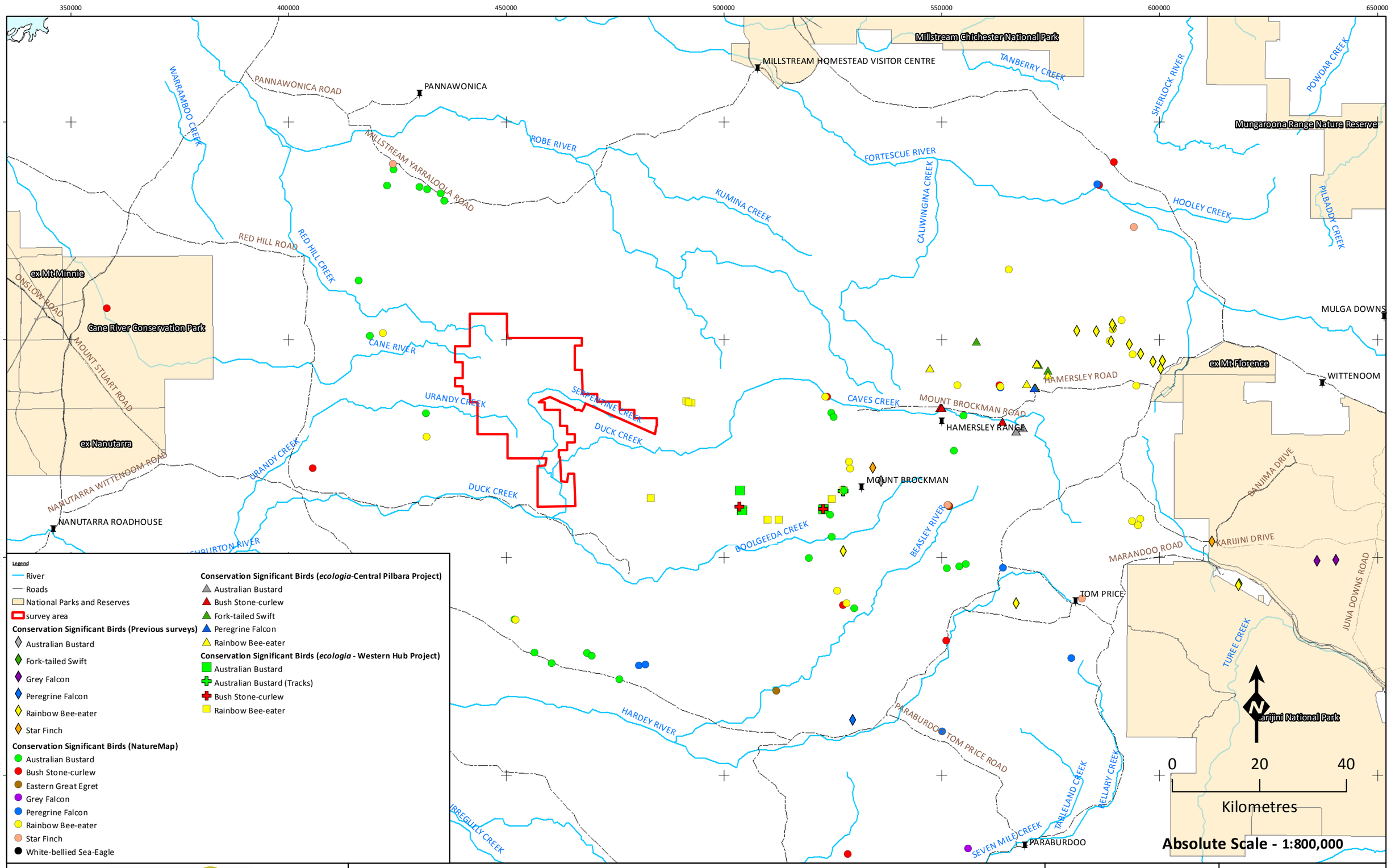

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Regional records of conservation significant fauna - Birds

Figure: 2.6
Project ID: 1512

Drawn: AH
Date: 11/06/13

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH478

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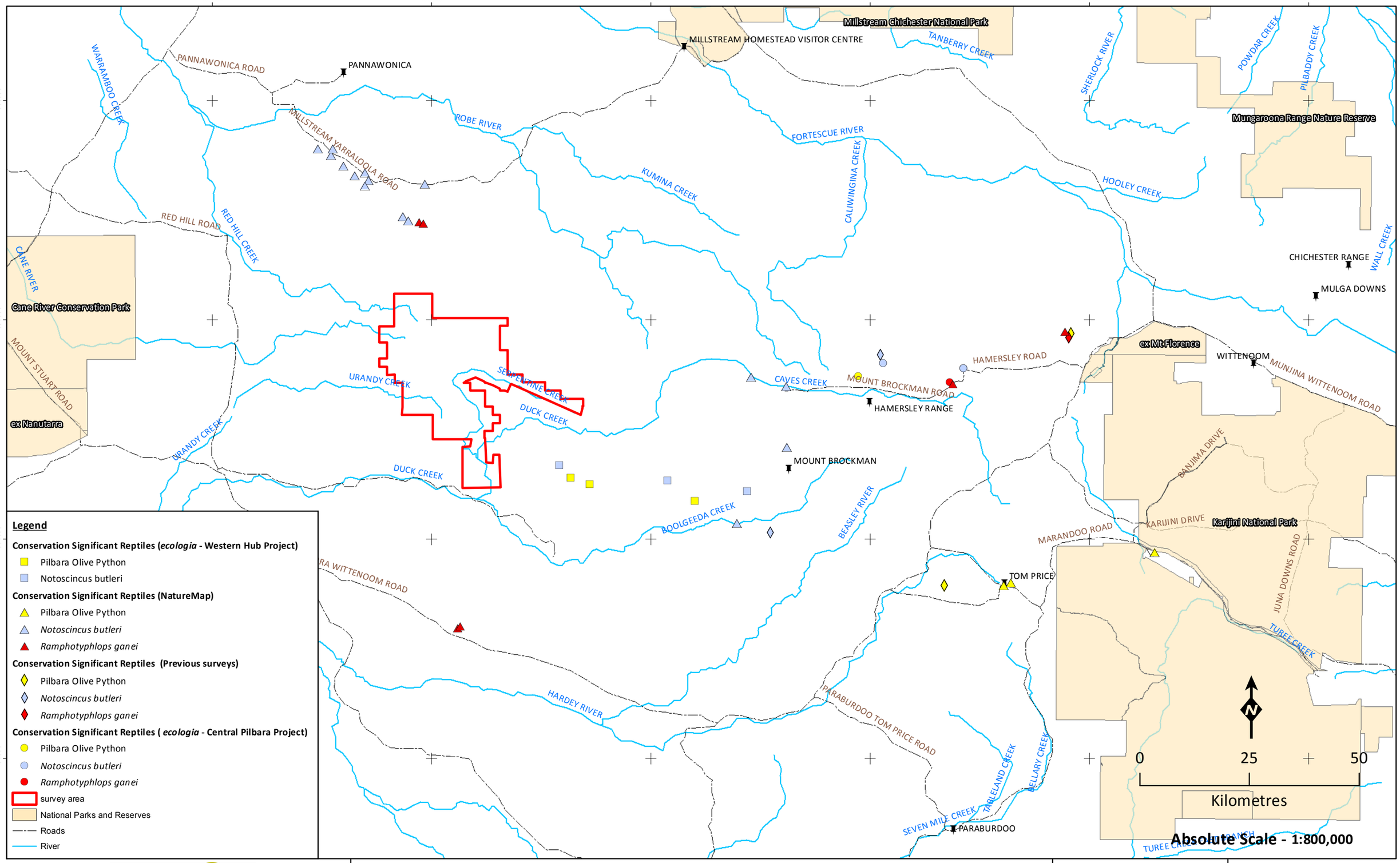

Legend

Conservation Significant Reptiles (*ecologia* - Western Hub Project)
- Pilbara Olive Python
- Notoscincus butleri

Conservation Significant Reptiles (NatureMap)
- Pilbara Olive Python
- *Notoscincus butleri*
- *Ramphotyphlops ganei*

Conservation Significant Reptiles (Previous surveys)
- Pilbara Olive Python
- *Notoscincus butleri*
- *Ramphotyphlops ganei*

Conservation Significant Reptiles (*ecologia* - Central Pilbara Project)
- Pilbara Olive Python
- *Notoscincus butleri*
- *Ramphotyphlops ganei*
- survey area
- National Parks and Reserves
- Roads
- River

Absolute Scale - 1:800,000

ecologia ENVIRONMENT

Regional records of conservation significant fauna - Reptile and fish

Figure: 2.7
Project ID: 1512

Drawn: AH
Date: 11/06/13

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH479

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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 by weather conditions, but should be timed to avoid breeding times.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	Twenty 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 observations, 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 52,770 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 first phase of 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 second phase of the Level 2 vertebrate fauna assessment was conducted the following year (30 April – 10 May 2013). 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 2011b, c, d; EPA 2004; EPA and DEC 2010; FMG 2011).

Table 3.2 – Summary of survey timing and duration

Survey	Dates	Duration (days)	Person Days
Level 2 vertebrate fauna assessment phase 1 (sites 1-12)	1 – 11 May 2012	11	74
Level 2 vertebrate fauna assessment phase 1 (sites 13-14*)	18 – 28 May 2012	11	52
Level 2 vertebrate fauna assessment phase 2 (sites 1-12)	30 April – 10 May 2013	11	74
Targeted conservation significant fauna assessment	23 – 31 July 2012	9	36
Total		**42**	**236**

*Note: These sites were surveyed during the Mt Farquhar vertebrate fauna assessment (*ecologia* 2012). Days and person days are inclusive of both survey areas (Mt Farquhar and Delphine) for that field trip.

3.3 SAMPLING METHODS

The 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 2011b, c, d); 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.

3.3.1 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 3.1):

- 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 or shadecloth.
- 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.

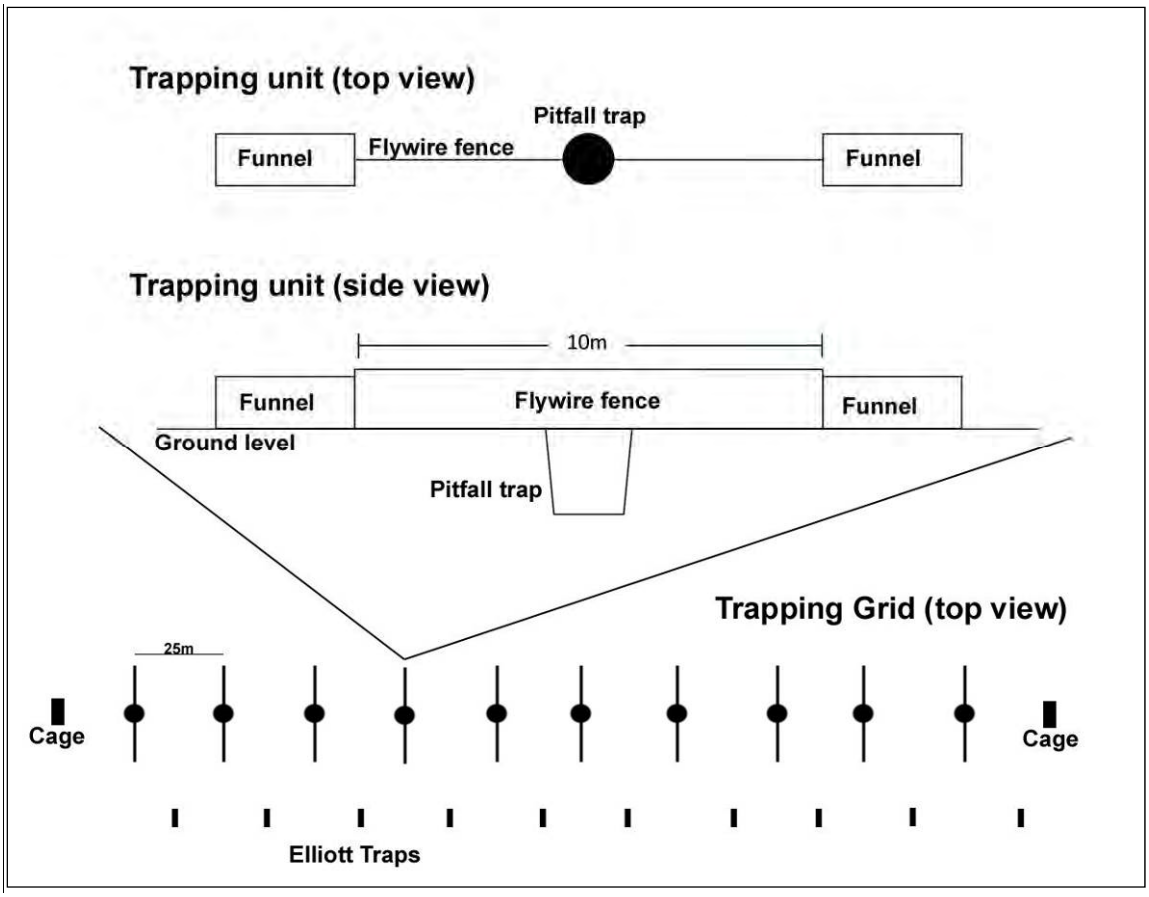

Figure 3.1 – Diagram of the systematic sampling trap arrangement

Figure 3.2 – 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 three 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.

A total of 29 hours were spent surveying for birds at trapping sites and at opportunistic sites.

Bats

Bat echolocation calls were recorded using SM2BAT 384 kHz long term passive recorders. 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 per survey phase. 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 3.6), 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.

3.3.2 Opportunistic Data

Nocturnal Searching

Locations within 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.

A total of 40.2 hours were spent on nocturnal searches at 11 locations (two trap sites, nine opportunistic sites) and six road transects during this survey.

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.

Opportunistic searches were conducted at four trapping sites and 27 opportunistic sites, totalling 78.7 hours.

Camera Trapping

A total of 18 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).

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

Helicopter Habitat Assessment

A large area of the western region of the survey area was not easily accessible by vehicle or on foot. Habitat in this area was assessed using helicopter flyovers for a four hour period during the first phase of the Level 2 survey.

Habitat Condition

A general assessment of habitat condition within the study area was also carried out, using criteria outlined in Table 3.3.

Table 3.3 – Vegetation condition scale (Trudgen 1991)

Habitat Condition*	Criteria
Excellent	Pristine or nearly so, no obvious sign of damage caused by modern humans or introduced fauna (cattle, feral cat, dog, and rabbit). No signs of recent, extensive fires.
Very good	Some relatively slight signs of damage caused by the activities of modern humans e.g. damage to tree trunks by repeated fires, no significant signs of introduced fauna or occasional vehicle tracks.
Good	More obvious signs of damage caused by the activities of modern humans, including some obvious impact to vegetation structure such as that caused by low levels of grazing or by selective logging. Some tracks or secondary evidence of introduced fauna. Some signs of recent fires.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of modern humans such as partial clearing or very frequent fires. Presence of introduced fauna.
Very poor	Severely impacted by grazing, introduced fauna, fire, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management.
Completely Degraded	Areas that are completely or almost completely without vegetation communities and are heavily impacted by extensive fires and/or introduced species e.g. cattle pasture

*Observations did not take into account any degradation as a result of exploration or other recent mining activities (e.g. drilling, clearing).

3.4 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. A targeted survey specifically focussing on conservation significant species was also conducted

On the basis of the habitats observed during surveying, specific searches were also undertaken to determine the presence of Northern Quoll, Short-tailed Mouse, Pilbara Leaf-nosed Bat, Ghost Bat, Pilbara Olive Python, 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 on habitat availability (i.e. larger areas of potential Northern Quoll habitat were sampled using a higher number of traps).

3.5 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. Where possible, sites were placed in areas of habitat that were in the best available condition. Site 2 (DL S2A) was moved to a new location (DL S2B) during the second phase of the survey, due to a fire which had destroyed most of the vegetation where the site was originally located (Figure 3.3), which would have a negative impact on fauna presence.

Figure 3.3 – Images of Site 2 before and after fire

The majority of trapping sites (11 of 15) 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, only 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 3.4 and mapped in Figure 3.4. Site photographs and descriptions are presented in Appendix D.

Table 3.4 – Survey site information

Site	Phase(s)	Survey site	Location		Land system
			Easting	Northing	
Level 2 survey: Phase 1a: 1 -11 May 2012; Phase 1b: 18 – 28 May 2012; Phase 2; 30 April – 10 May 2013					
DL S1	Phases 1a & 2	Systematic trapping & SM2BAT	460442	7518691	Newman
DL S2A	Phase 1a	Systematic trapping & SM2BAT	460639	7525260	Newman
DL S2B	Phase 2	Systematic trapping & SM2BAT	458976	7524660	Newman
DL S3	Phases 1a & 2	Systematic trapping & SM2BAT	459836	7531398	Newman
DL S4	Phases 1a & 2	Systematic trapping & SM2BAT	455591	7538562	Table
DL S5	Phases 1a & 2	Systematic trapping & SM2BAT	456499	7535096	Rocklea
DL S6	Phases 1a & 2	Systematic trapping & SM2BAT	454532	7542890	Boolgeeda
DL S7	Phases 1a & 2	Systematic trapping & SM2BAT	449198	7546668	Wannamunna
DL S8	Phases 1a & 2	Systematic trapping & SM2BAT	454070	7545841	Boolgeeda
DL S9	Phases 1a & 2	Systematic trapping & SM2BAT	458442	7545000	Newman
DL S10	Phases 1a & 2	Systematic trapping & SM2BAT	463405	7537744	Boolgeeda
DL S11	Phases 1a & 2	Systematic trapping & SM2BAT	465196	7539462	Platform
DL S12	Phases 1a & 2	Systematic trapping & SM2BAT	461724	7541018	Boolgeeda
DL S13	Phase 1b	Systematic trapping & SM2BAT	474014	7533307	Boolgeeda
DL S14	Phase 1b	Systematic trapping & SM2BAT	483603	7530190	Boolgeeda
DL OS1	Phase 1a	Opportunistic	462334	7515580	Newman
DL OS2	Phase 1a	Opportunistic	459920	7519706	Newman
DL OS3	Phase 1a	Opportunistic	459174	7519762	Newman
DL OS4	Phase 1a	Opportunistic	458613	7520759	Newman
DL OS5	Phase 1a	Opportunistic	458811	7524678	Newman
DL OS6	Phase 1a	Opportunistic	459247	7524674	Newman
DL OS7	Phase 1a	Opportunistic	459324	7524586	Newman
DL OS8	Phase 1a	Opportunistic	461541	7525406	Newman
DL OS9	Phase 1a	Opportunistic	460908	7526921	Newman
DL OS10	Phase 1a	Opportunistic	460780	7527972	Newman
DL OS11	Phase 1a	Opportunistic	451118	7539197	Newman
DL OS12	Phase 1a	Opportunistic	453562	7540022	Boolgeeda
DL OS13	Phase 1a	Opportunistic	447089	7546870	Brockman
DL OS17	Phase 2	Opportunistic	454952	7536717	Table
DL OS18	Phase 2	Opportunistic	451986	7545861	Newman
DL OS19	Phase 2	Opportunistic	450847	7539127	Newman
DL OS20	Phase 2	Opportunistic	451204	7539175	Newman
DL OS21	Phase 2	Opportunistic	459718	7542141	Newman
DL OS22	Phase 2	Opportunistic	458823	7524445	Newman
DL OS23	Phase 2	Opportunistic	458823	7524445	Newman
DL OS24	Phase 2	Opportunistic	460674	7524721	Newman
DL OS25	Phase 2	Opportunistic	476776	7531824	Boolgeeda
DL OS26	Phase 2	Opportunistic	459217	7541735	Boolgeeda
DL OS27	Phase 2	Opportunistic	461787	7538259	Boolgeeda
DL OS28	Phase 2	Opportunistic	483632	7530216	Boolgeeda

Site	Phase(s)	Survey site	Location		Land system
			Easting	Northing	
DL OS29	Phase 2	Opportunistic	457462	7544292	Newman
DL OS30	Phase 2	Opportunistic	462420	7536703	Newman
MC S1	Phase 1a	Motion camera	450879	7539168	Newman
MC S2	Phase 1a	Motion camera	450781	7539160	Newman
MC S3	Phase 1a	Motion camera	451229	7539203	Newman
MC S14	Phase 2	Motion camera	455041	7536739	Table
MC S15	Phase 2	Motion camera	451937	7545838	Newman
MC S16	Phase 2	Motion camera	451220	7539197	Newman
MC S17	Phase 2	Motion camera	447183	7546660	Brockman
MC S18	Phase 2	Motion camera	447269	7546641	Brockman
DL Bat rec 24	Phase 2	SM2BAT	453538	7540227	Boolgeeda
DL Bat rec 25	Phase 2	SM2BAT	461375	7538003	Newman
Targeted survey: 23 – 31 July 2012					
NQD S1	Targeted	Northern Quoll trapping	451323	7539197	Newman
NQD S2	Targeted	Northern Quoll trapping	462175	7515292	Newman
NQD S3	Targeted	Northern Quoll trapping	461661	7517179	Newman
NQD S4	Targeted	Northern Quoll trapping	459940	7518271	Newman
NQD S5	Targeted	Northern Quoll trapping	459192	7524708	Newman
NQD S6	Targeted	Northern Quoll trapping	448654	7541501	Newman
NQD S7	Targeted	Northern Quoll trapping	449239	7541074	Newman
NQD S8	Targeted	Northern Quoll trapping	450548	7540288	Newman
NQD S9	Targeted	Northern Quoll trapping	449860	7540134	Newman
NQD S10	Targeted	Northern Quoll trapping	449937	7540513	Newman
NQD OS1	Targeted	Opportunistic	456882	7520371	Newman
NQD OS2	Targeted	Opportunistic	450441	7538690	Newman
NQD OS3	Targeted	Opportunistic	460192	7530644	Newman
NQD OS4	Targeted	Opportunistic	452034	7545936	Newman
NQS OS5	Targeted	Opportunistic	455330	7537011	Newman
NQS OS6	Targeted	Opportunistic	462366	7517715	Newman
MC S4	Targeted	Motion camera	450401	7538650	Newman
MC S5	Targeted	Motion camera	462366	7517715	Newman
MC S6	Targeted	Motion camera	462577	7517586	Newman
MC S7	Targeted	Motion camera	462407	7517809	Newman
MC S8	Targeted	Motion camera	451976	7545942	Newman
MC S9	Targeted	Motion camera	485244	7529670	Newman
MC S10	Targeted	Motion camera	456998	7520689	Newman
MC S11	Targeted	Motion camera	457286	7520577	Newman
MC S12	Targeted	Motion camera	455352	7535983	Newman
MC S13	Targeted	Motion camera	454981	7536815	Table
DL Bat rec 1	Targeted	SM2BAT	451374	7539197	Boolgeeda
DL Bat rec 2	Targeted	SM2BAT	462286	7517530	Newman
DL Bat rec 3	Targeted	SM2BAT	485239	7529766	Newman

Site	Phase(s)	Survey site	Location		Land system
			Easting	Northing	
DL Bat rec 4	Targeted	SM2BAT	457902	7523388	Newman
DL Bat rec 5	Targeted	SM2BAT	456004	7534673	Boolgeeda
DL Bat rec 6	Targeted	SM2BAT	460915	7526901	Newman
DL Bat rec 7	Targeted	SM2BAT	453559	7540196	Boolgeeda
DL Bat rec 8	Targeted	SM2BAT	462229	7515549	Newman
DL Bat rec 9	Targeted	SM2BAT	482006	7531411	Boolgeeda
DL Bat rec 10	Targeted	SM2BAT	455103	7535893	Newman
DL Bat rec 11	Targeted	SM2BAT	454982	7536815	Table
DL Bat rec 12	Targeted	SM2BAT	460751	7528134	Newman
DL Bat rec 13	Targeted	SM2BAT	450370	7540731	Newman
DL Bat rec 14	Targeted	SM2BAT	450412	7538645	Newman
DL Bat rec 15	Targeted	SM2BAT	464610	7537199	Boolgeeda
DL Bat rec 16	Targeted	SM2BAT	456980	7520663	Newman
DL Bat rec 17	Targeted	SM2BAT	458789	7524667	Newman
DL Bat rec 18	Targeted	SM2BAT	448675	7541491	Newman
DL Bat rec 19	Targeted	SM2BAT	452034	7545936	Newman
DL Bat rec 20	Targeted	SM2BAT	470803	7535500	Boolgeeda
DL Bat rec 21	Targeted	SM2BAT	459773	7524570	Newman
DL Bat rec 22	Targeted	SM2BAT	461687	7517245	Newman
DL Bat rec 23	Targeted	SM2BAT	460590	7524783	Newman

Datum: GDA 94
Zone: 50K

435000 450000 465000 480000

7545000 7530000 7515000

NQD S1

DL S7 DL S8 DL S9 DL S6 DL S12 DL S11 DL S4 DL S10 DL S5 DL S13 DL S3 DL S14

NQD S6 NQD S7 NQD S9 NQD S1

DL S2A DL S2B NQD S5 DL S1 NQD S4 NQD S3 NQD S2

Legend

- Systematic trapping (Level 2) & SM2BAT
- Northern Quoll trapping
- Opportunistic
- Motion camera
- SM2BAT
- Survey area

Land System

- Boolgeeda
- Brockman
- Newman
- Platform
- River
- Robe
- Rocklea
- Table
- Wannamunna

N

0 2.5 5

Kilometres

Absolute Scale - 1:160,000

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Survey sites at Delphine survey area

Figure: 3.2
Project ID: 1512

Drawn: AH & JG
Date: 9/01/15

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH469

A3

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3.6 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 DPaW 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 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 in Table 3.5. 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.

Table 3.5 – 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.

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 3.6 and included the following:

- Systematic trapping grids (pit traps, funnels, Elliott traps and cage traps) were open for 8,341 trap-nights.
- Approximately 54 hours were spent surveying for birds.
- 75.7 hours were spent on opportunistic diurnal searching.
- 40.2 hours were spent on opportunistic nocturnal searching.
- 18 motion-sensing cameras were deployed for a total of 997 hours.
- 622 hours of SM2BAT recordings were analysed to determine bat assemblage and distribution.

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

- 40.7 hours of targeted searches for secondary evidence of the Northern Quoll, conducted primarily within the gorges and gullies habitat type. Cage traps targeting this species were also open for 711 trap nights. Sixteen motion cameras were set up in areas of identified suitable habitat for Northern Quoll (totalling 899 hours).
- 23.2 hours conducting targeted searches for Pilbara Olive Python individuals and secondary evidence, primarily within the gorges and gullies habitat type.
- Nine hours of targeted searches for the Short-tailed Mouse, and two motion cameras deployed for 98 hours.
- Four hours of opportunistic bird surveys for the Star Finch at water pools.
- 42.7 hours of searching for potential roost caves for the Pilbara Leaf-nosed Bat and Ghost Bat, and 648 hours of bat recordings were analysed to determine the presence of these species.
- 1.9 hours of call playback for Bush-stone Curlew conducted during nocturnal searches.
- 6.3 hours of fish trapping and searching for Fortescue Grunter at water pools. Additionally, three funnels traps were baited and positioned in a large pool to capture individuals.

Table 3.6 – Survey effort

Site	Pit traps (trap nights)	Funnels (trap nights)	Elliotts (trap nights)	Cages (trap nights)	Bird survey (min)	Diurnal opp search (min)	Bat Recording (hrs)	Nocturnal opp search (min)	Camera trapping (hrs)
Level 2 vertebrate fauna assessment (Phase 1 – May 2012)Phase 2 – April-May 2013)									
DL S1	70	140	70	14	120	0	12	0	0
DL S2A	70	140	70	14	120	60	12	0	0
DL S3	70	140	70	14	120	120	12	0	0
DL S4	70	140	70	14	120	0	12	0	0
DL S5	70	140	70	14	120	0	12	0	0
DL S6	70	140	70	14	120	0	12	0	0
DL S7	70	140	70	14	120	0	12	0	0
DL S8	70	140	70	14	120	0	12	0	0
DL S9	70	140	70	14	120	0	12	0	0
DL S10	70	140	70	14	120	60	12	0	0
DL S11	70	140	70	14	120	0	12	0	0
DL S12	70	140	70	14	120	0	12	0	0
DL S13	70	140	70	14	150	0	12	60	0
DL S14	70	140	70	14	150	0	12	60	0
Opportunistic	0	0	0	0	60	1,520	0	1,540	144
Sub-total	**980**	**1,960**	**980**	**196**	**1,740**	**1,760**	**168**	**1,540**	**144**
Level 2 vertebrate fauna assessment (Phase 2 – April-May 2013)									
DL S1	70	280	70	14	120	0	12.5	0	0
DL S2B	70	140	70	14	120	0	12.5	0	0
DL S3	70	280	70	14	120	0	12.5	0	0
DL S4	70	280	70	14	120	0	12.5	0	0
DL S5	70	280	70	14	120	0	12.5	0	0
DL S6	70	280	70	14	120	0	12.5	0	0
DL S7	70	280	70	14	120	0	12.5	0	0
DL S8	70	280	70	14	120	0	12.5	0	0

Site	Pit traps (trap nights)	Funnels (trap nights)	Elliotts (trap nights)	Cages (trap nights)	Bird survey (min)	Diurnal opp search (min)	Bat Recording (hrs)	Nocturnal opp search (min)	Camera trapping (hrs)
DL S9	70	280	70	14	120	0	12.5	0	0
DL S10	70	280	70	14	120	0	12.5	0	0
DL S11	70	280	70	14	120	0	12.5	0	0
DL S12	70	280	70	14	120	0	12.5	0	0
Opportunistic	0	0	0	0	0	1,660	0	870	315
Sub-total	**840**	**1,680**	**840**	**168**	**1,500**	**1,660**	**150**	**870**	**315**
Targeted conservation significant fauna assessment (July 2012)									
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
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	304	0	538
Sub-total	**0**	**0**	**0**	**711**	**0**	**1,120**	**304**	**0**	**538**
Total	**1,820**	**3,640**	**1,820**	**1,061**	**3,240**	**4,540**	**622**	**2,410**	**997**

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 terrestrial vertebrates (mammals and reptiles) and birds. 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 follows the *Western Australian Museum Checklist of the Vertebrates of Western Australia*. Taxonomy of birds in this report follows Christidis and Boles (2008). References used for fauna identification are listed in Table 3.7.

Table 3.7 – 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 *et al*. (1990), Wilson and Swan (2010)
Skinks	Storr *et al*. (1999), Wilson and Swan (2010)
Dragons	Storr *et al*. (1983), Wilson and Swan (2010)
Varanids	Storr *et al*. (1983), Wilson and Swan (2010)
Legless Lizards	Storr *et al*. (1990), Wilson and Swan (2010)
Snakes	Storr *et al*. (2002), Wilson and Swan (2010)
Amphibians	Tyler and Doughty (2009), Cogger (2000)
Fish	Allen *et al.* (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 and external consultants are listed in Table 3.8.

Table 3.8 – Survey personnel

Survey Member	Expertise	Relevant Qualification	Experience (years)
Kellie Bauer-Simpson	Biological Science	BSc.	14
Damien Cancilla	Mammalogy	BSc. (Hons)	8
Nigel Jackett	Ornithology	BSc. (Hons)	7
Jordan Vos	Herpetology	-	7
Dr Johara Bourke	Herpetology	PhD	6
John Graff	Ornithology	BSc.	5
Louisa Robertson	Zoology	MSc.	5
Bruce Greatwich	Ornithology	BSc.	4
Sean White	Invertebrates	BSc.	4
Dr Margot Oorebeek	Ornithology	PhD	4
Jesse Forbes-Harper	Zoology	BA, BSc. (Hons)	3
Anna Nowicki	Zoology	BSc. (Hons)	3
Leigh Smith	Herpetology	Cert. Vet Nursing	3
Adam Young	Herpetology	BSc.	2
External Consultant	**Institution**	**Relevant Experience**	
Bob Bullen	Bat Call WA	16 years – bat call IDs	

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 4.1).

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 between vertebrate fauna assessments

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 types identified, encompassing 96.9% of the total survey area. All habitat types are present in the surrounding region and not unique to the survey area (Table 4.2). The gorges and gullies habitat, although small in terms of area, is important due to its potential to support a number of conservation significant species. The high quality riverine habitat in some areas of the survey area is also important as it supports a diverse range of species (including several species of conservation significance), and the faunal assemblage is distinct from other habitat types. All habitats were assessed to be in good condition (refer to Table 3.3), although there was significant cattle activity evident in some areas within the river systems habitat type.

The area of occupation of each habitat is shown in Table 4.2 and mapped in Figure 4.1.

Table 4.2 – Summary of fauna habitat types

Fauna habitat	Area inside survey area (ha)	Percentage of total survey area (%)	Mapped area of equivalent habitat within region (ha) (*ecologia* 2014)	Percentage of mapped area within region within survey area (%)
Hilltops, hillslopes, ridges and cliffs	25 568.94	48.5	152 689	16.75
Footslopes and plains	25 509.46	48.4	881 297	2.89
River systems	842.74	1.6	37 574	2.24
Gorges and gullies	130.14	0.2	9 221	1.41
Mixed acacia woodlands	588.99	1.1	77 481	0.76
Cracking clays	85.94	0.2	88 978	0.10

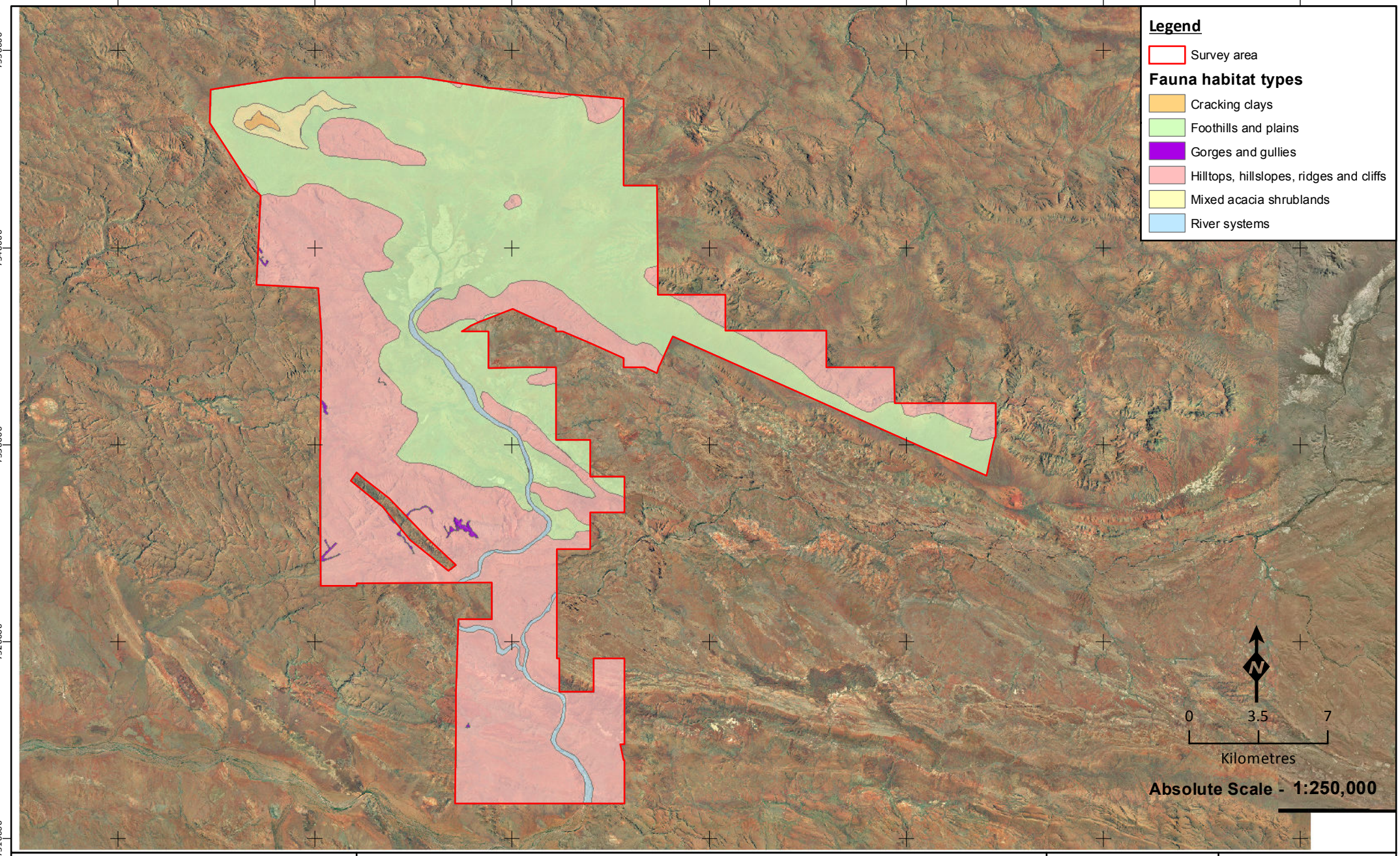
When survey effort is assessed against the habitats within the survey area (Table 4.3), it is evident that all fauna habitats within the survey area were adequately surveyed, considering their proportionate area and the potential to harbour conservation significant fauna, including the gorges and gullies habitat.

Table 4.3 – Summary of survey effort by habitat type

Habitat type	Pit trap (trap nights)	Funnel (trap nights)	Elliott (trap nights)	Cage (trap nights)	Bird survey (min)	Diurnal opp. search (min)	Bat recording (hours)	Nocturnal opp. Search (min)	Camera trapping (hours)
Hilltops, hillslopes, ridges and cliffs	210	420	210	553	360	1,710	151.5	320	419
Footslopes and plains	1,260	2,520	1,260	238	2,220	1,100	270.3	870	0
River systems	210	420	210	242	420	870	201.7	250	336
Gorges and gullies[1]	0	0	0	0	0	980	0	430	144
Mixed acacia woodlands	140	280	140	28	240	0	24.5	0	0
Cracking clays[2]	0	0	0	0	0	60	0	540	98
Total	1,820	3,640	1,820	1,061	3,240	4,720	648	2,410	997

[1]Systematic 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.

[2]A lack of vehicle access (>1 km from nearest track) prevented systematic sampling in the cracking clays habitat type for animal welfare reasons. To ensure adequate survey effort was expended in this habitat type, additional nocturnal searches and camera trapping were conducted.



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Fauna habitats of the survey area

Figure: 4.1
Project ID: 1512

Drawn: AH
Date: 11/06/2013

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH463

A4

4.1.1 Hilltops, hillslopes, ridges and cliffs

Hilltops, hillslopes, ridges and cliffs is the dominant habitat within the survey area, comprising 48.5 % (25,569 ha) of the total area (Table 4.2, Figure 4.1). The hilltops and ridges comprise the most elevated of 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 (Figure 4.2). The crevices and caves which occur in cliff faces can also provide shelter for a range of fauna species.

Figure 4.2 – Hilltops, hillslopes, ridges and cliffs habitat type

4.1.2 Footslopes and plains

Footslopes and plains are the second most common habitat type, covering 48.4 % (25,509 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 (Figure 4.3). 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 4.1).

Figure 4.3 – Footslopes and plains habitat type

4.1.3 River systems

Although the river system habitat only comprises 1.6 % (843 ha) of the survey area, river systems are an important geographical feature in the landscape. 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 (*Cenchrus ciliaris*), 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 high species diversity and abundance. Minor creeklines which comprise acacia shrubland were not included in this habitat type, because the minor drainage channels usually do not cover areas large enough to support a distinct faunal assemblage. The river systems 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 of larger water courses than those identified in the other survey areas (Figure 4.4). These larger systems typically hold a somewhat different faunal assemblage, in particular a greater variety and number of waterbirds.

Figure 4.4 – 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 0.2% (130 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 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 (Figure 4.5). 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 species of conservation significance such as Northern Quoll and Pilbara Olive Python. Some pooled water was observed in this habitat type during the surveys.

Figure 4.5 – 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 1.1 % (589 ha). 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 (Figure 4.6). This habitat type was recorded in the north-western region of the survey area (Figure 4.1).

Figure 4.6 – 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 86 ha (0.2 %) 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 medium to dense tussock grasses and occasional acacia shrubs over cracked clay soil, mainly bordered by open Mulga (*Acacia aneura*) woodland (Figure 4.7).

Figure 4.7 – 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. No systematic trapping sites were installed within the gorges and gullies or cracking clays habitat types due to limited access. However, these habitat types were 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 was conducted using data collected systematically for both birds and terrestrial trapped fauna, grouped by habitat type, to test for differences in faunal assemblages between habitat types. Non-metric MDS plots were alo prepared from the data, and are shown in Figure 4.8.

The one-way ANOSIM test comparing terrestrial trappable faunal assemblages between different habitat types produced an overall R value of 0.2587 (R values typically range from 0 to 1, with 1 indicating that the groups are dissimilar and 0 indicating that the groups are similar) and a p-value of 0.0001 (p-value of <0.05 indicating statistical difference). This indicates that there are significant differences in terrestrial faunal assemblages between habitat types. Post-hoc pairwise comparisons between habitat types indicated most habitat types were significantly different to each other in terms of terrestrial trappable faunal assemblages (Table 4.4), though the footslopes and plains habitat type and mixed acacia shrubland habitat type did not differ significantly. The river systems habitat type was the most distinct of the four habitat types tested in terms of terrestrial faunal assemblage (Table 4.4). The MDS plot for terrestrial trapped data provided a stress value of 0.5358, indicating that the plot is a poor representation of the data; hence it is not included here.

Statistical analysis of the avifauna recorded also shows some significant difference in avifaunal assemblages between different habitat types. The one-way ANOSIM test produced an R value of 0.1343 and a p-value of 0.0167. This indicates that although some significant differences in avifaunal assemblages between habitats exist, overall they are relatively similar to each other. Post-hoc pairwise comparisons indicated most habitat types were statistically significantly different to each other in terms of avifaunal assemblages (Table 4.5). The river systems habitat type was again the most distinct habitat type in terms of avifauna. The MDS plot provides a visual illustration of the data. A stress value of 0.2185 indicates that the plot provides a good representation of the data.

Table 4.4 – Pairwise comparisons between terrestrial faunal assemblages.

R values (indicating degree of difference between sites) are shown, with Bonferroni-corrected p values (indicating significance) shown in parentheses. * indicates significant difference

	Footslopes and plains	Hilltops, hillslopes, ridges and cliffs	Mixed acacia shrubland	River systems
Footslopes and plains	-			
Hilltops, hillslopes, ridges and cliffs	0.1760 (0.0036)*	-		
Mixed acacia shrubland	0.1592 (0.0798)	0.3152 (0.0012)*	-	
River systems	0.3567 (0.0006)*	0.3180 (0.0006)*	0.7040 (0.0006)*	-

Table 4.5 – Pairwise comparisons between avian faunal assemblages.

R values (indicating degree of difference between sites) are shown, with Bonferroni-corrected p values (indicating significance) shown in parentheses. * indicates significant difference

	Footslopes and plains	Hilltops, hillslopes, ridges and cliffs	Mixed acacia shrubland	River systems
Footslopes and plains	-			
Hilltops, hillslopes, ridges and cliffs	-0.0001 (1.0000)	-		
Mixed acacia shrubland	0.0698 (1.0000)	0.4763 (0.0006)*	-	
River systems	0.2731 (0.0060)*	0.4043 (0.0012)*	0.7241 (0.0006)*	-

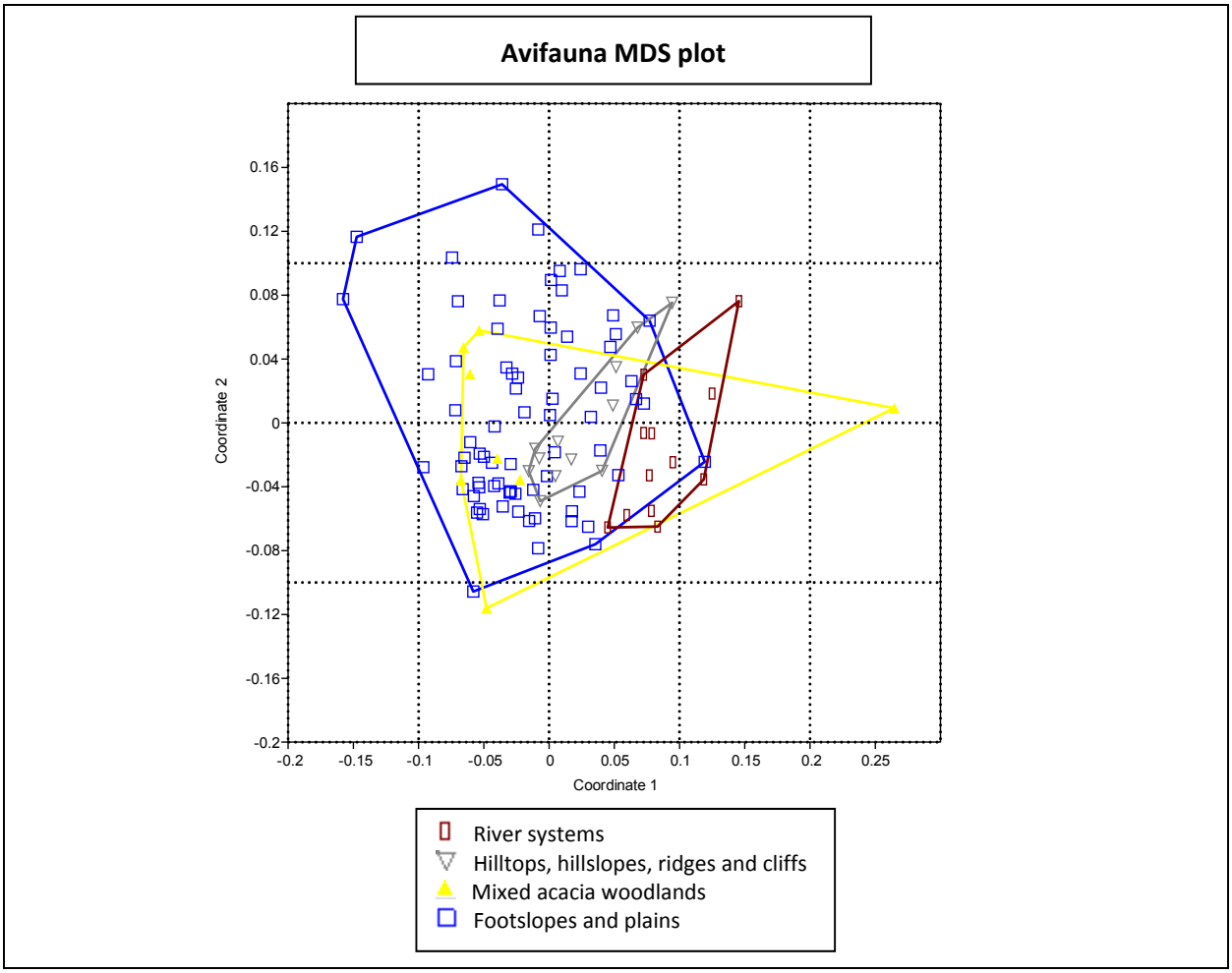

Figure 4.8 – Avifauna MDS plot

4.3 FAUNA ASSEMBLAGE

A total of 22 native and five introduced mammal, 104 bird (including one introduced), 66 reptile, three amphibian and six fish species were recorded within the survey area during the current surveys. Of the species recorded, 12 were of conservation significance. A site by species matrix of species recorded during the Level 2 vertebrate fauna assessment is included in Appendix E.

4.3.1 Mammals

In total, 22 native and five 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 *Ningaui timealeyi* (52), *Planigale* sp. (40), *Dasykaluta rosamondae* (36) and *Pseudomys hermannsburgensis* (22). Of the nine bat species recorded during the survey, two species (*Chalinolobus gouldii* and *Vespadelus finlaysoni*) were abundant, both of which were recorded at nearly all SM2BAT locations.

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

4.3.2 Birds

In total, 104 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 11,304 individuals were recorded. Several species were recorded in high numbers across most sites, and represented primarily nomadic species, for example; Budgerigars (4,047 records), Masked Woodswallow (1,987), Zebra Finch (877) and Crimson Chat (632). 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). The observation of the Eastern Osprey during the second phase survey is also of interest as they are rarely recorded inland.

Seven species of conservation significance were recorded: Eastern Great Egret (EPBC Act Migratory, WC Act Schedule 3), Eastern Osprey (EPBC Act Migratory), Peregrine Falcon (WC Act Schedule 4, DPaW Specially Protected Fauna), Rainbow Bee-eater (EPBC Act Migratory, WC Act Schedule 3), Australian Bustard (DPaW Priority 4), Bush Stone-curlew (DPaW Priority 4) and Grey Falcon (DPaW Priority 4).

4.3.3 Herpetofauna

Sixty-six 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 23 skinks, 14 geckos, eight elapids (front-fanged venomous snakes), seven varanids (monitors), five pygopods, five 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* (119), *Heteronotia binoei* (67), *Diplodactylus* conspicillatus (33), *Carlia munda* (83), *Ctenotus saxatilis* (40), *Ctenotus grandis* (42), *Ctenophorus caudicinctus* (93), and *Lophognathus longirostris* (67) and *Parasuta monachus* (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* (4) and *Ctenotus schomburgkii* (4).

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

4.3.4 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 southern region of the survey area.

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 3.4).

4.4 CONSERVATION SIGNIFICANT FAUNA

Based on database searches and the results of previous biological surveys in the surrounding region, 25 species (six mammal, 15 bird, three reptile, and one fish) of conservation significance have been identified with the potential to occur in the survey area. Twelve species of conservation significance (three mammal, seven bird, one reptile and one fish species) were recorded from within the survey area and these records are summarised in Table 4.6 and mapped in Figure 4.9. One of these species, the Western Pebble-mound Mouse, was recorded based on secondary signs (including active and possibly active mounds). An additional eight conservation significant species are assessed as having a medium to high likelihood of occurrence, with the remaining five species assessed as having a low likelihood. Conservation significant species that were recorded or have a medium to high likelihood of occurrence are described in greater detail in Section 5.3.

Table 4.6 – Conservation significant fauna recorded during the survey

Species	Location			Comments
	Easting	Northing	Site	
Mammals				
Northern Quoll (*Dasyurus hallucatus*)	451229	7539203	Opportunistic	Video footage of an individual captured on a motion-sensing camera
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	458976	7524660	DL S2B	4 calls recorded during phase 2
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	459836	7531398	DL S3	1 call recorded during phase 1
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	456499	7535096	DL S5	2 calls recorded during phase 2
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	449198	7546668	DL S7	1 call recorded during phase 1
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	458442	7545000	DL S9	1 call recorded during phase 2
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	461724	7541018	DL S12	2 calls recorded during phase 2
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	451374	7539197	Bat 1	1-5 calls recorded during targeted survey
Pilbara Leaf-nosed Bat* (*Rhinonicteris aurantia*)	485239	7529766	Bat 3	1-2 calls recorded during targeted survey
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	457902	7523388	Bat 4	1 call recorded during targeted survey
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	460915	7526901	Bat 6	1-2 calls recorded during targeted survey
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	462229	7515549	Bat 8	1 call recorded during targeted survey
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	464610	7537199	Bat 15	1 call recorded during targeted survey
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	448675	7541491	Bat 18	1-2 calls recorded during targeted survey
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	470803	7535500	Bat 20	2 calls recorded during targeted survey
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	453538	7540227	Delphine Camp	3 calls recorded during phase 2
Western Pebble-mound Mouse (*Pseudomys chapmani*)	465167	7539455	DL S11	Inactive mound
Western Pebble-mound Mouse (*Pseudomys chapmani*)	461020	7526042	Opportunistic	Inactive mound
Western Pebble-mound Mouse (*Pseudomys chapmani*)	450137	7539676	Opportunistic	Inactive mound
Western Pebble-mound Mouse (*Pseudomys chapmani*)	452289	7546255	Opportunistic	Inactive mound
Western Pebble-mound Mouse (*Pseudomys chapmani*)	452291	7546282	Opportunistic	2 inactive mounds
Western Pebble-mound Mouse (*Pseudomys chapmani*)	452315	7539718	Opportunistic	Inactive mound

Species	Location			Comments
	Easting	Northing	Site	
Western Pebble-mound Mouse (*Pseudomys chapmani*)	451401	7539417	Opportunistic	Possibly active mound
Western Pebble-mound Mouse (*Pseudomys chapmani*)	462420	7536703	Opportunistic	5 possibly active mounds
Western Pebble-mound Mouse (*Pseudomys chapmani*)	452257	7539675	Opportunistic	Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani*)	452371	7539601	Opportunistic	Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani*)	452414	7539593	Opportunistic	Active mound
Birds				
Eastern Great Egret (*Ardea modesta*)	457921	7520799	Opportunistic	Flushed from major watercourse
Eastern Great Egret (*Ardea modesta*)	460442	7518691	DL S1	One individual
Eastern Osprey (*Pandion cristatus*)	460442	7518691	DL S1	One individual
Grey Falcon (*Falco hypoleucos*)	483603	7530190	DL S14	One individual
Peregrine Falcon (*Falco peregrinus*)	458976	7524660	DL S2B	One individual
Australian Bustard (*Ardeotis australis*)	449198	7546668	DL S7	Tracks only
Australian Bustard (*Ardeotis australis*)	460742	7538797	Opportunistic	One individual
Australian Bustard (*Ardeotis australis*)	469635	7535083	Opportunistic	One individual
Bush Stone-curlew* (*Burhinus grallarius*)	457492	7522522	Opportunistic	Tracks only
Bush Stone-curlew (*Burhinus grallarius*)	455675	7538832	Opportunistic	Flushed from road north of DL S4
Bush Stone-curlew (*Burhinus grallarius*)	460908	7526921	Opportunistic	Responded to call playback and observed along watercourse
Rainbow Bee-eater (*Merops ornatus*)	460442	7518691	DL S1	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	460639	7525260	DL S2A	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	458976	7524660	DL S2B	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	459836	7531398	DL S3	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	455591	7538562	DL S4	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	456499	7535096	DL S5	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	454532	7542890	DL S6	Numerous individuals and calls

Species	Location			Comments
	Easting	Northing	Site	
Rainbow Bee-eater (*Merops ornatus*)	454070	7545841	DL S8	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	458442	7545000	DL S9	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	463405	7537744	DL S10	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	465196	7539462	DL S11	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	461724	7541018	DL S12	Numerous individuals and calls
Rainbow Bee-eater (*Merops ornatus*)	460719	7518584	Opportunistic	Numerous individuals and calls
Reptiles				
Notoscincus butleri	455591	7538562	DL S4	Captured both phase 1 and 2
Notoscincus butleri	454070	7545841	DL S8	Captured both phase 1 and 2
Notoscincus butleri	458442	7545000	DL S9	Captured phase 2
Notoscincus butleri	463405	7537744	DL S10	Captured both phase 1 and 2
Notoscincus butleri	461724	7541018	DL S12	Captured phase 2
Fish				
Fortescue Grunter (*Leiopotherapon aheneus*)	460442	7518691	DL S1	Recorded from permanent pools within Duck Creek

Zone 50 K
Datum GDA 94

* Recorded just outside survey area

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440000 450000 460000 470000 480000 490000

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CANE RIVER

SERPENTINE CREEK

DUCK CREEK

Legend

Survey area

Species

- Northern Quoll
- Western Pebble-mound Mouse
- Pilbara Leaf-nosed Bat
- Eastern Great Egret
- Eastern Osprey
- Rainbow Bee-eater
- Peregrine Falcon
- Grey Falcon
- Australian Bustard
- Bush Stone-curlew
- *Notoscincus butleri*
- Fortescue Grunter

Habitat

- Cracking clays
- Foothills and plains
- Gorges and gullies
- Hilltops, hillslopes, ridges and cliffs
- Mixed acacia shrublands
- River systems
- River

N

0 3.5 7

Kilometres

Absolute Scale - 1:160,000

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Conservation significant fauna recorded during the survey

Figure: 4.9
Project ID: 1512

Drawn: AH
Date: 11/06/13

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map IDAH465

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4.5 SURVEY ADEQUACY

Systematically obtained data (trapping results for terrestrial fauna and set-time surveys for birds, excluding opportunistic data) were analysed for survey adequacy. Mammal and reptile 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 steady SAC, nearing the asymptotic plateau (Figure 4.10). Extrapolation of the Michaelis-Menten (MM) curve suggests that 93.57% of the theoretical total number of terrestrial trappable fauna had been captured at the completion of the 182 trap nights of the Level 2 vertebrate fauna survey (Table 4.7). These results indicate that the majority of species were recorded during the survey, but additional trapping would likely detect at least five additional species.

Species accumulation curves from the avifauna set-time survey dataset also produced a typical SAC, almost reaching the asymptotic plateau (Figure 4.11). Used as a stopping rule, the MM estimator indicated that the survey was 98.39% adequate at the completion of 106 set-time surveys. The MM estimator generated a theoretical maximum of 91 species, whilst other richness estimates were as high as 109 (Table 4.7).

Parametric analysis of systematically obtained survey data for birds and terrestrial faunal groups revealed that overall survey effort was adequate. Table 4.7 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 4.7 – Mean estimates of total species richness of systematically sampled vertebrate fauna

Richness estimators	Total richness estimate	
	Terrestrial vertebrates	Birds
ACE	71	96
ICE	70	98
Chao-1	68	93
Jack-1	74	103
Jack-2	73	109
Bootstrap	70	96
Michaelis-Menten	69	91
Species Observed	**65**	**88**

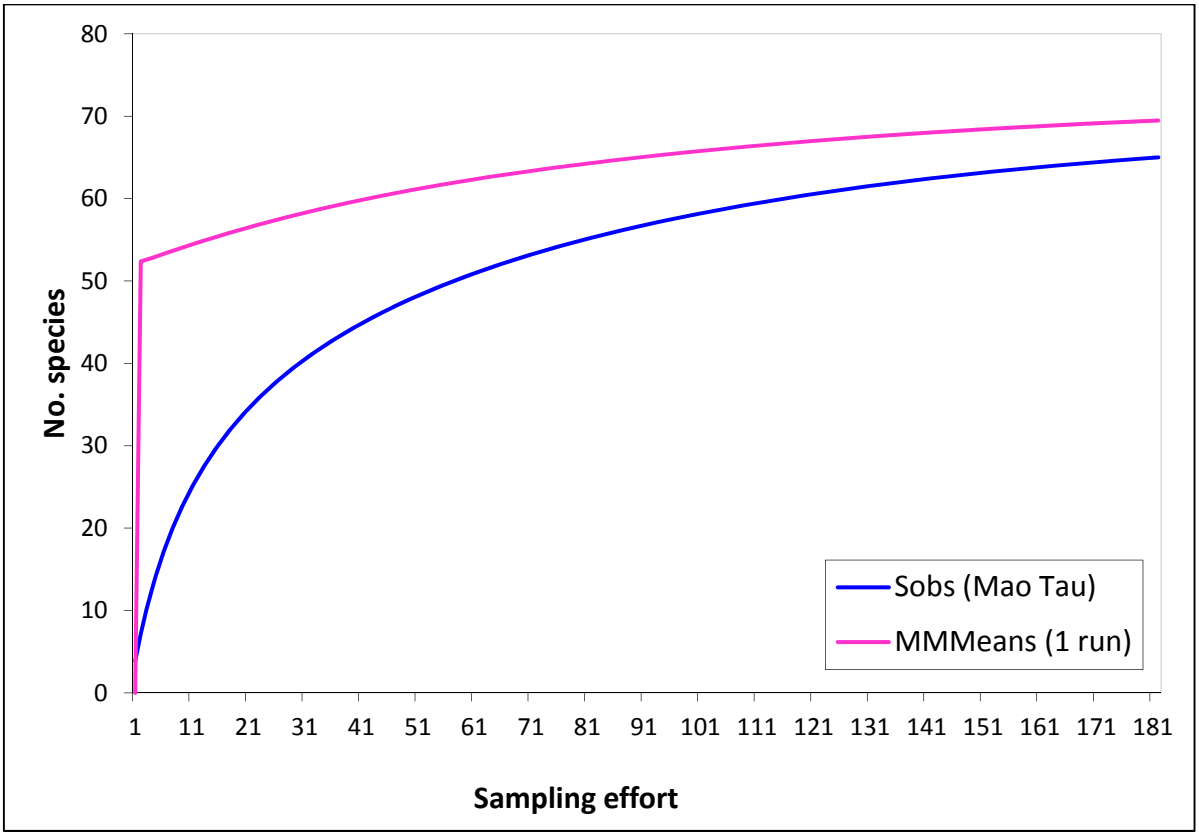


Figure 4.10 – Species accumulation curve for trapped terrestrial vertebrates

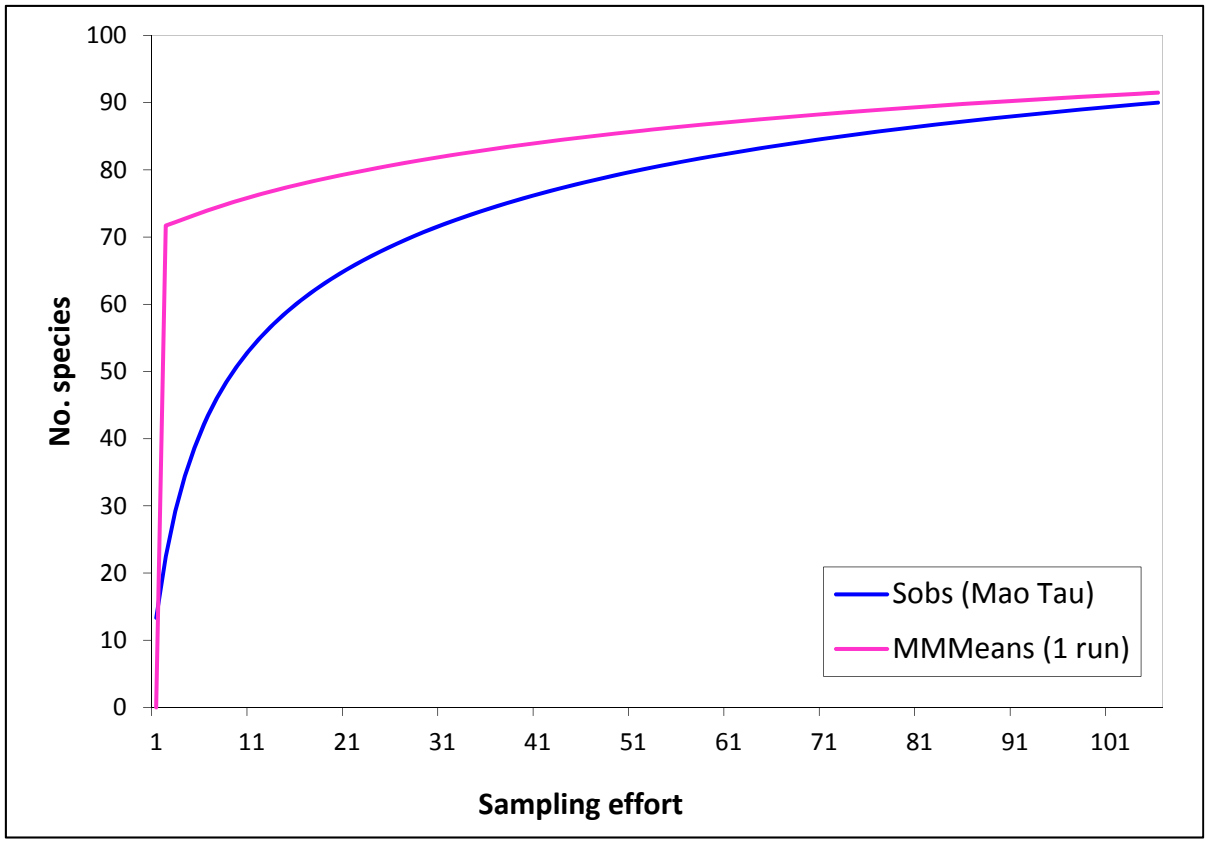


Figure 4.11 – Species accumulation curve for avifauna

4.6 SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in Table 4.8 below. No significant limitations were experienced during the surveys. Limitations in the form of limited access occurred, minimising the amount of search effort in two fauna habitats. Access within the survey area was severely restricted throughout much of the western section of the area, due to rugged terrain and a lack of vehicle tracks. However, most fauna habitats that could not be reached via vehicle were investigated on foot. As no significant limitations were encountered, an adequate level of survey has been undertaken.

Table 4.8 – Summary of survey limitations

Limitation	Constraint (yes/no)	Comment
Competency/experience of the consultant carrying out the survey.	No	All key 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	Twenty 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.	No	A two-phase Level 2 vertebrate fauna assessment was completed, as well as a targeted conservation significant fauna survey.
Timing/weather/season/cycle.	Minor	Both phases of the Level 2 vertebrate fauna assessment were mostly conducted during weather and seasonal conditions that are suitable for fauna activity. During the second phase, a heavy rain event occurred on 8 May and resulted in access restrictions for a 24 hour period.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	Minor	Fire impacted sites 2 and 13 between the first and second phase. Site 2 was relocated and increased opportunistic surveys conducted in habitat similar to Site 13
Intensity (in retrospect was the intensity adequate).	No	The survey intensity was adequate, all habitat types were surveyed systematically or opportunistically, and statistical analysis suggests the majority of species were detected.
Completeness (e.g. was relevant area fully surveyed).	No	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 resource issues encountered.
Remoteness and/or access problems.	Minor	All areas were reasonably accessible except for the hilltops, hillslopes, ridges and cliffs in the central western region of the survey area, as well as the northeastern foothills and plains. These areas comprise one landsystem and habitat type each, both of which were well surveyed elsewhere. Lack of vehicular access prevented systematic trapping in cracking clay habitat type; increased opportunistic surveying was conducted within this habitat type to compensate for this

Limitation	Constraint (yes/no)	Comment
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.

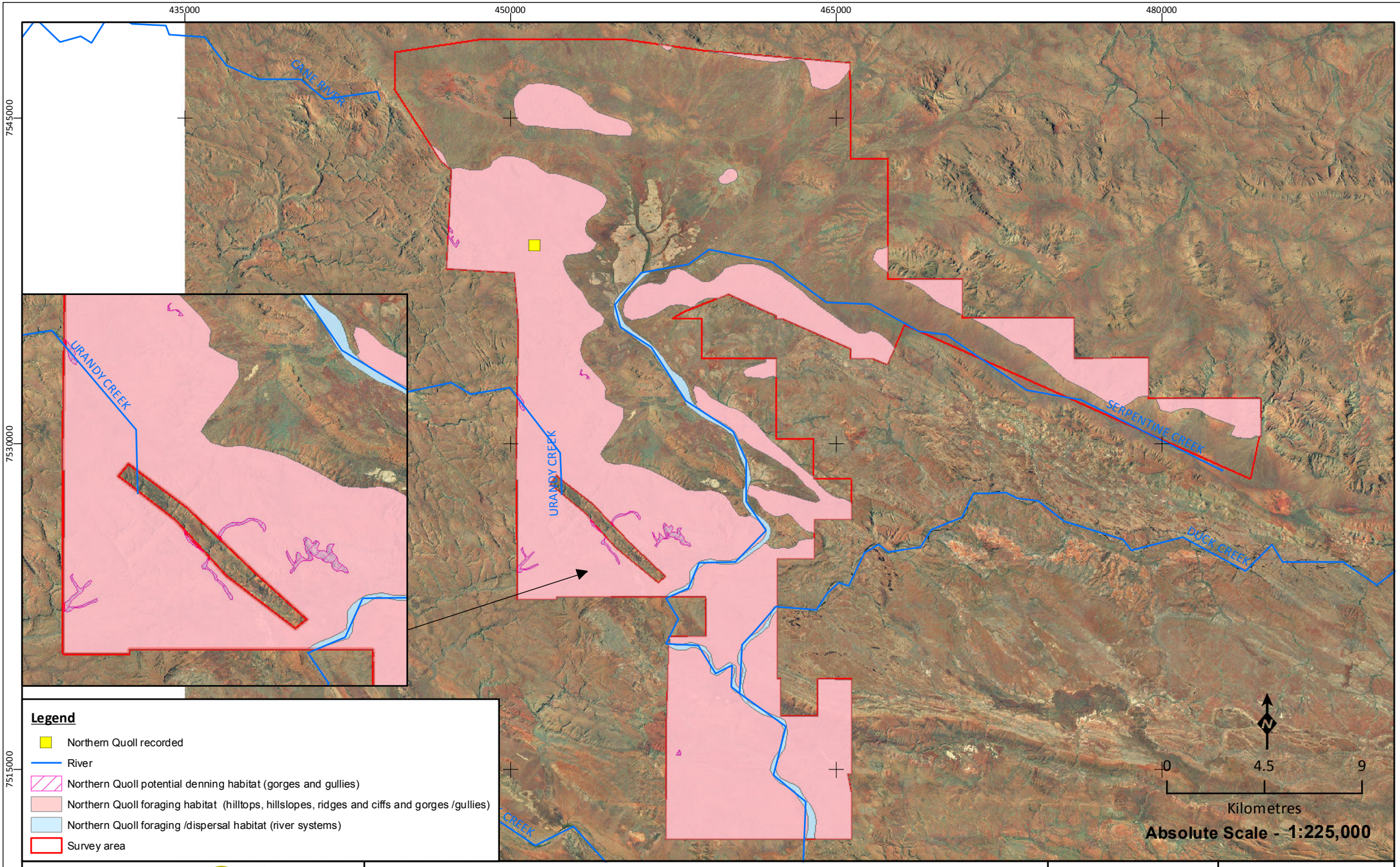
5 DISCUSSION

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 summarized in 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. Includes gorges and gullies.	130.1	0.5
	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 hilltop,hillslopes, ridges and cliff, gorges/gullies & riversystems.	26,541.8	50.3
Pilbara Leaf-nosed Bat	**Potential roosting habitat**. Areas of rocky gorges and gullies in the survey area that may contain suitable caves for roosting. Includes gorges and gullies.	130.1	0.5
	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. Includes footslopes and plains, gorges/gullies & riversystems.	26,482.3	50.2
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. Includes gorges/gullies & riversystems.	972.9	1.8



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Northern Quoll potential denning and foraging/dispersal habitat

Figure: 5.1
Project ID: 1512

Drawn: AH
Date: 11/06/13

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH466

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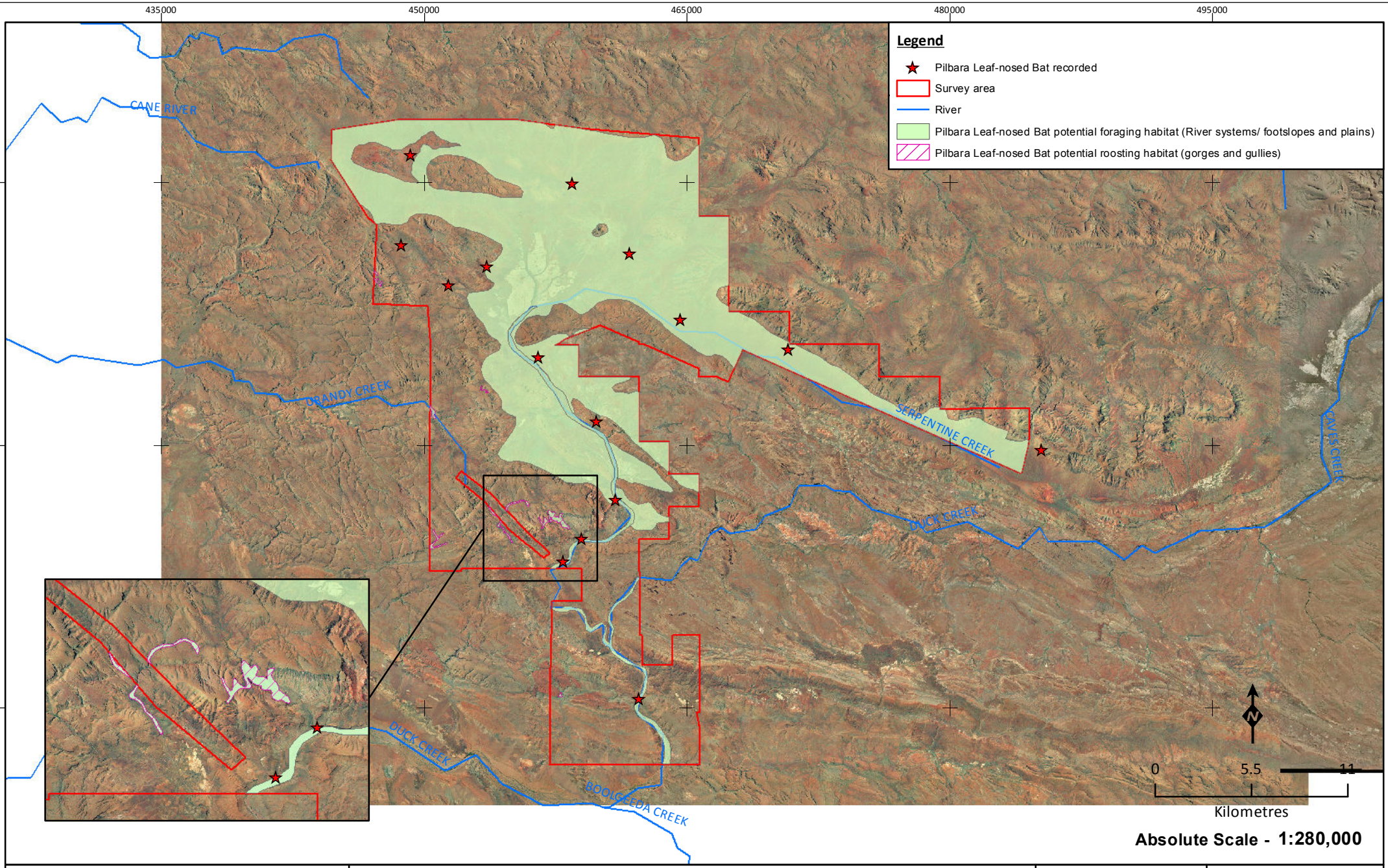

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Pilbara Leaf-nosed Bat potential roosting and foraging habitat

Figure: 5.2
Project ID: 1512

Drawn: AH
Date: 11/06/13

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH468

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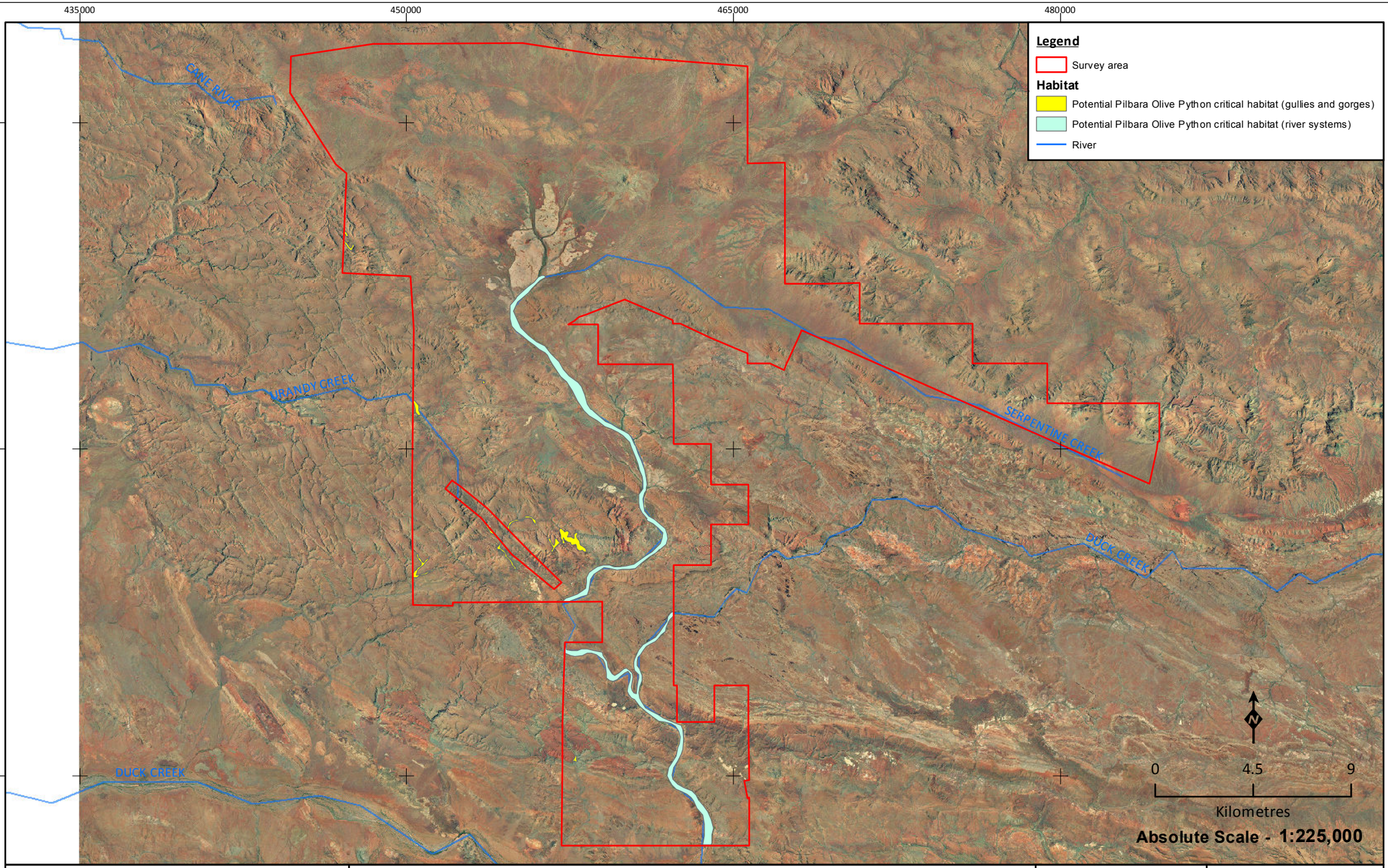

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Potential Pilbara Olive Python critical habitat

Figure: 5.3
Project ID: 1512

Drawn: AH
Date: 11/06/13

Coordinate System
Name: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH467

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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 (*Zyzomys 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 (*Rhinonicteris 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 most diverse range 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 include the Common Rock-rat (*Zyzomys 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 typically 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. 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 inhabits the hilltops and, particularly, 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 Ningaui (*Ningaui 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 wellsi*), 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 former preferring footslopes and the latter generally restricted to the plains.

5.1.4 River systems

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

A high diversity of avifauna is found in this habitat, which 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 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 hyrtili*), Barred Grunter (*Amniataba percoides*) and Spangled Perch (*Leiopotherapon unicolor*).

Several conservation significant species were 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 also assessed as comprising potential critical habitat for EPBC Act listed Pilbara Olive Python (Figure 5.3), foraging/dispersal habitat for Northern Quoll during the breeding season (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 Delphine survey area were of small size and comprised the same species as adjacent habitats (primarily the footslopes and plains habitat type). The Pilbara Ningaui, 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, Pied and White-fronted Honeyeater can be common. Other species that may occur include Crested Bellbird, Red-capped Robin, Grey-crowned Babbler, White-winged Triller, Chestnut-rumped Thornbill and Willie Wagtail. The presence of mre sedentary species such as Crested Bellbird, Grey-crowned Babbler, and Chestnut-rumped Thornbill, is less dependent on rainfall and flowering events.

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 amphiboluroides*).

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

5.1.6 Cracking clays

The faunal assemblage of the cracking clays is limited to a relatively small number of species which specialise in this less common and relatively homogenous habitat, including bird species such as 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 was not recorded during this survey but has been previously recorded from areas to the east of the survey area (Table 5.2).

5.2 FAUNA ASSEMBLAGES

5.2.1 Mammals

The relatively high diversity of mammals recorded (22 native, 4 introduced; compare with (Table 2.5) 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 Ningaui (38 records) and Planigale (27 records) were the most frequently recorded mammal species (excluding bat species). The Pilbara Ningaui is a generalist, opportunistic species, and was recorded at ten of the fourteen trapping sites within the survey area. Similarly, the Planigale is a widespread species in 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, particularly in the vicinity of 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.

Three conservation significant mammal species were recorded, the Northern Quoll, Pilbara Leaf-nosed Bat and Western Pebble-mound Mouse.

5.2.2 Birds

A very high diversity of bird species were recorded from the survey area (see Table 2.5). As with mammals, this is likely to be due to a number of contributing factors, such as the large size of the survey area, a diversity of habitats, good climatic conditions for sampling, and the presence of relatively large watercourse areas with relatively large water pools suitable for a range of waterbird species. Of the 104 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. This almost certainly contributed to the high diversity and abundance of honeyeater species recorded. Eleven of the 12 potentially occurring species were recorded, with Brown Honeyeaters, Black Honeyeaters and Crimson Chats being recorded in high numbers throughout the survey area.

Seven birds of conservation significance were recorded, the Australian Bustard, Bush Stone-curlew, Grey Falcon, Peregrine Falcon, Rainbow Bee-eater, Eastern Great Egret and Eastern Osprey. The Eastern Osprey was not identified during the literature review, as it has not been previously recorded in the surrounding region.

5.2.3 Herpetofauna

The reptile diversity and abundance recorded during the Level 2 vertebrate fauna assessment was considered 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, specialised habits (occurring almost entirely within rock crevices).

One reptile species of conservation significance was recorded, the skink *Notoscincus butleri.* High quality habitat for the Pilbara Olive Python was also identified from the survey area (Figure 5.3).

5.2.4 Fish

All six fish species identified as potentially occurring were recorded from within the survey area. All fish 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 semi-permanent and permanent pools during dry conditions.

One fish species of conservation significance was recorded during the survey, the Fortescue Grunter (Priority 4).

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 Ningaui (*Ningaui timealeyi*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*), Black-tailed Treecreeper (race *wellsi*), Striated Grasswren (race *whitei*), *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 5.2. 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 three mammal, seven bird, one reptile and one fish species of conservation significance. Of these, one bird (Eastern Osprey) was not expected to occur within the region of the survey area; however, the presence of favourable habitat (large water pools) likely contributed to the presence of a single individual during phase two of the Level 2 survey.

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 3.5). 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 – Conservation significant fauna occurring or potentially occurring in the survey area

Species	Conservation significance			Habitat	Previous records	Likelihood of occurrence
	EPBC Act	WC Act	DPaW			
Mammals						
Northern Quoll *Dasyurus hallucatus*	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 (Holmes and Miller 2005; Oakwood 2008).	Records from six locations within 115 km of the survey area (Coffey 2008; ecologia 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 (*ecologia* in prep-b). Suitable habitat exists within survey area (Figure 5.1)
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*	VU	S1	VU	Roost in caves with high humidity (95%) and temperature (32 °C). Forage along waterbodies with fringing vegetation (Armstrong 2008).	Calls recorded from four locations at Central Pilbara Project (*ecologia* 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 15 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 within the study area, with potentially suitable roosting habitat present within or close to the survey area (Figure 5.2), which is supported by calling patterns recorded during the targeted survey which indicate a likely roost in the region.
Long-tailed Dunnart *Sminthopsis longicaudata*			P4	Rocky, hilly areas vegetated with spinifex; occasionally open areas with a stony, rocky mantle (Burbidge *et al.* 2008).	Recorded from two locations within the Central Pilbara Project, approx. 78 km north-east of the survey area (*ecologia* 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	DPaW			
Ghost Bat *Macroderma gigas*			P4	Roost in caves, rockpiles and abandoned mines. Will travel 2 km from roost to hunt (Armstrong and Anstee 2000a; Richards *et al.* 2008).	Calls recorded at Eliwana and Flying Fish (*ecologia* in prep-b), with the nearest of these records c. 15 km from the survey area. Calls recorded from six locations within the Central Pilbara Project (*ecologia* 2011b) and records from three locations at Solomon Project (Coffey 2008; *ecologia* 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 habitat for the Pilbara Leaf-nosed Bat (Figure 5.2).
Short-tailed Mouse *Leggadina lakedownensis*			P4	Spinifex and tussock grassland on cracking clays. Also acacia shrubland, samphire, woodlands, and stony ranges (Moro and Kutt 2008).	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 cracking clays habitat type.
Western Pebble-mound Mouse *Pseudomys chapmani*			P4	Footslopes of rocky ranges and rocky hills where the ground has continuous small pebbles and vegetated by spinifex (Start 2008).	Mounds recorded from 60 locations within 100 km of the survey area (Biota 2005b, 2009b; Coffey 2008; *ecologia* 2010, 2011b; Kendrick 1995; Mattiske and Ninox 1990), including active mounds during the Delphine Level 1 fauna assessment (Ecoscape 2012a)	**RECORDED** 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. Possibly-active and active mounds recorded during Level 2 vertebrate fauna and targeted conservation significant fauna assessments.
Birds						
Fork-tailed Swift *Apus pacificus*	M	S3		Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts (Johnstone and Storr 1998; Simpson and Day 2010).	Recorded from five locations at Central Pilbara Project and Solomon Project (*ecologia* 2010, 2011a), 70-100 km east of the survey area.	**HIGH** Likely to occur as an irregular summer migrant.

Species	Conservation significance			Habitat	Previous records	Likelihood of occurrence
	EPBC Act	WC Act	DPaW			
Eastern Great Egret *Ardea modesta*	M	S3		Wide range of wetland habitats, including floodwaters, rivers, shallows of wetlands, intertidal mudflats (Morcombe 2000; Simpson and Day 2010).	Recorded 60 km south-east of the survey area along the Beasley River (DEC 2012).	**RECORDED** Recorded during survey. Suitable habitat is present in the river systems habitat type after substantial rainfall when water is present along major creek lines.
Eastern Osprey *Pandion cristatus*	M			Mangroves, rivers, estuaries, inland seas, coastal islands (Morcombe 2000; Simpson and Day 2010).	The species has not been recorded previously in the local region due to its general distribution along the coastline of Western Australia	**RECORDED** The species was recorded in the south end of the survey area (trap site DL S1)
Cattle Egret *Ardea ibis*	M	S3		Grassy habitats, shallow wetlands and waterbodies, particularly damp pastures (Morcombe 2000; Simpson and Day 2010).	DoE 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 *Plegadis falcinellus*	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 (Morcombe 2000; Simpson and Day 2010).	Recorded by Birdata, but no records from previous surveys.	**LOW** Very little suitable habitat present within the survey area (river systems habitat type).
White-bellied Sea-Eagle *Haliaeetus leucogaster*	M	S3		Coastal and near coastal water bodies, along river systems. Inhabits most types of habitats except closed forest (Morcombe 2000; Simpson and Day 2010).	DoE 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 *Charadrius veredus*	M	S3		Open plains, including samphire; bare rolling country; bare claypans; open ground near inland swamps (Morcombe 2000; Simpson and Day 2010).	DoE 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).

Species	Conservation significance			Habitat	Previous records	Likelihood of occurrence
	EPBC Act	WC Act	DPaW			
Oriental Pratincole *Glareola maldivarum*	M	S3		Plains, shallow wet and dry edges in open bare wetlands, tidal mudflats, beaches (Morcombe 2000; Simpson and Day 2010).	DoE 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 *Merops ornatus*	M	S3		Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water (Johnstone and Storr 2004; Simpson and Day 2010).	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 (*ecologia* 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.
Peregrine Falcon *Falco peregrinus*		S4	Other	Widespread; coastal cliffs, riverine gorges and wooded watercourses (Johnstone and Storr 1998; Simpson and Day 2010).	One record from the Central Pilbara project (DEC 2012; *ecologia* 2011b; ecologia internal database). Species sighted within the Mt Farquhar Project (*ecologia* 2012) and during Ecoscape's Level 1 fauna assessment (2012a).	**RECORDED** Recorded during this survey. Suitable habitat present throughout.
Grey Falcon *Falco hypoleucos*		S1	VU	Lightly wooded coastal and riverine plains (Johnstone and Storr 1998), typically nesting in tall trees along watercourses (Garnett and Crowley 2000)	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 foraging habitat present throughout the survey area, with suitable nesting habitat existing along the river systems.
Black Bittern *Ixobrychus flavicollis*			P3	Freshwater pools, swamps and lagoons with dense surrounding vegetation (Johnstone and Storr 1998)	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.

Species	Conservation significance			Habitat	Previous records	Likelihood of occurrence
	EPBC Act	WC Act	DPaW			
Australian Bustard *Ardeotis australis*			P4	Open grasslands, chenopod flats and low heathland (Johnstone and Storr 1998; Simpson and Day 2010).	Recorded during Level 1 fauna assessment of the survey area (Ecoscape 2012a) Additionally, recorded during concurrent Eliwana and Flying Fish survey (*ecologia* in prep-b), six records from Central Pilbara project, one record from previous surveys conducted by other consultancies (Biota 2005b, 2009b; Mattiske and Ninox 1990).	**RECORDED** Recorded during this assessment and suitable habitat present in the footslopes and plains habitat type.
Bush Stone-curlew *Burhinus grallarius*			P4	Lightly wooded country next to daytime shelter of thickets or long grass (Johnstone and Storr 1998; Simpson and Day 2010).	Six records from within 100 km of the survey area, and nine records from Central Pilbara Project (DEC 2012; *ecologia* 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
Star Finch (Western) *Neochmia ruficauda subclarescens*			P4	Vegetation around watercourses, particularly thick reed beds (Johnstone and Storr 2004; Simpson and Day 2010)	Previously recorded 3 km south-west, 43 km north-west and 68 km east of survey area (DEC 2012).	**HIGH** Areas of suitable habitat occur along major watercourses within survey area, particularly along Duck Creek and Serpentine Creek.
Reptiles						
Pilbara Olive Python *Liasis olivaceus barroni*	VU	S1	VU	Watercourses and areas of permanent water in rocky gorges, escarpments and gullies (Bush and Maryan 2011; Pearson 2003; Wilson and Swan 2013).	Recorded during the Level 2 vertebrate fauna assessment of nearby Eliwana and Flying Fish (*ecologia* in prep-b), as well as during the Central Pilbara project (*ecologia* 2011b).	**HIGH** Suitable habitat occurs throughout, particularly along Duck and Serpentine Creeks, as well as in the rugged gorges and gullies in the western parts of the survey area (Figure 5.3).
Ramphotyphlops ganei			P1	Variety of habitats; thought to prefer moist gorges (Wilson and Swan 2013).	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 gorges and gullies in the western parts of the survey area.

Species	Conservation significance			Habitat	Previous records	Likelihood of occurrence
	EPBC Act	WC Act	DPaW			
Notoscincus butleri			P4	Associated with stony/rocky, spinifex-dominated areas near creek and river margins, but also found on plains (Wilson and Swan 2013).	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 *Leiopotherapon aheneus*			P4	Slow to fast flowing watercourses or pools over sand or rock substrate (Allen *et al.* 2002)	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. Other 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 in available habitat has 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). Where present, Cane Toads have also caused the local of many Northern Quoll populations (Oakwood 2008), though this is not yet an issue in the Pilbara as Cane Toads have not yet reached the region. The level of predation is increased through the removal of groundcover by fire (Oakwood 2008).

Likelihood of Occurrence: Recorded. This species was recorded within the survey area during the first phase of the Level 2 vertebrate fauna assessment. A single individual Northern Quoll was detected twice on the 8th May 2012, on a motion-sensing camera at the entrance to a rocky gorge, approximately 2.5 km south-west of the Delphine camp (Figure 5.4). The first detection occurred between 0630 and 0710, the second approximately 1830. No quolls were captured from this location, or elsewhere within the survey area during the targeted conservation significant fauna assessment. Suitable denning and foraging/dispersal habitat is present within the survey area (Figure 5.1).

Figure 5.4 – Northern Quoll recorded on a motion-sensing camera

Areas of suitable Northern Quoll potential denning and foraging habitat occur within the gorges in the western region of the survey area, which was partly inaccessible by vehicle or foot during the current survey (Figure 5.1). The single Northern Quoll individual recorded on the motion camera during the Level 2 vertebrate fauna assessment (Figure 5.4) is thought to have been foraging on the fringe of the large area of suitable habitat to the west of the survey area, which was identified based on aerial images and a short opportunistic survey conducted by helicopter fly-over.

5.3.1.2 Pilbara Leaf-nosed Bat (*Rhinonicteris 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 (*Rhinonicteris 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 there are 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 Bat were recorded from 15 locations within the survey area, during the Level 2 vertebrate fauna and targeted conservation significant fauna assessments (Figure 4.9, Table 4.6). 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 roost may be present in the vicinity. 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 (between the eastern arm of the Delphine survey area and the western end of the Eliwana survey area).

5.3.1.3 Short-tailed Mouse (*Leggadina lakedownensis*)

Conservation Status: DPaW 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 sedgelands, 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 of the survey area to east. However, it was not recorded within the study area during the current survey and due to the relatively disconnected nature of suitable habitat to areas where this species has previously been recorded, it is considered to have only a medium likelihood of occurrence.

5.3.1.4 Ghost Bat (*Macroderma gigas*)

Conservation Status: DPaW 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 2000b).

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 intensive 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: DPaW 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 m^2, 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: Recorded. 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). Six possibly active and three active mounds were recorded during the survey, with several other inactive mounds also recorded.

Figure 5.5 – Possibly active Western Pebble-mound Mouse mound

5.3.1.6 Long-tailed Dunnart (*Sminthopsis longicaudata*)

Conservation Status: DPaW 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 habiat. 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. Single Eastern Great Egrets were recorded opportunisitically on two occasions within the survey area; along Serpentine Creek and at site 1. 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 when water is available within the Serpentine and Duck Creeks.

Figure 5.6 – Eastern Great Egret recorded from Serpentine Creek

5.3.2.1 Eastern Osprey (*Pandion cristatus*)

Conservation Status: EPBC Act Migratory.

Distribution and Habitat: The Eastern Osprey is a large (50-60 cm), highly visible and water-dependent bird of prey (Henny 1986; Wink *et al.* 2004). It occurs around most of the Australian coastline, inhabiting coastal areas and favouring mangroves, rivers and estuaries, inshore seas as well as coastal islands (Simpson and Day 2004). The species is uncommon to rare or absent from closely settled parts of south-eastern Australia and is largely absent from Victoria and Tasmania.

Ecology: The Eastern Osprey feeds mostly on fish, but also on sea snakes, seabirds, turtles, amphibians and large lizards as well as invertebrates such as crustaceans, sea snails and beetles (Henny 1986; Johnstone and Storr 1998). Breeding takes place from autumn to spring, eggs being laid in April in the north and as late as October in the south of Australia. Eastern Osprey nests are large and usually placed at the tops of trees, prominent headlands or communication towers (Henny 1986; Simpson and Day 2004). Some nests are re-used for decades (Morcombe 2000).

Degradation and removal of habitat, and disturbance to nesting sites have been identified as threats to the Eastern Osprey's survival (Henny 1986).

Likelihood of Occurrence: Recorded. One individual Eastern Osprey was sighted during this survey from trap site DL S1 (along Duck Creek) in the south of the survey area. The species has not been recorded previously from the local region and is largely a coastal species. However, the Eastern Osprey is a nomadic species and may occasionally follow river systems inland. Its foraging habitat within the survey area is restricted to the large permanent pools located in the south.

5.3.2.2 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 they spend significantly more time on the ground in this period.

Likelihood of Occurrence: Recorded. The Rainbow Bee-eater was recorded at 12 of the 15 bird census sites during the Level 2 vertebrate fauna assessment (Table 4.6; 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

5.3.2.3 Peregrine Falcon (*Falco peregrinus*)

Conservation Status: WC Act Schedule 4, DPaW 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: Recorded. This species has been recorded previously within the Delphine survey area (Ecoscape 2012a), and a single individual was recorded during the second phase of the Level 2 survey. Additionally, a single individual of this species was recorded during the nearby Mt Farquhar targeted conservation significant fauna assessment (*ecologia* 2012), 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.

5.3.2.4 Grey Falcon (*Falco hypoleucos*)

Conservation Status: WC Act Schedule 1, DPaW Vulnerable.

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 4.9). 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 habitat for this species, while suitable nesting habitat occurs along the river systems.

5.3.2.5 Black Bittern (*Ixobrychus flavicollis australis*)

Conservation Status: DPaW 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 Australian Bustard (*Ardeotis australis*)

Conservation Status: DPaW 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 three occasions during the current survey (Table 4.6), twice from the foothills and plains habitat type, and once from the mixed acacia shrubland habitat type. It was also observed duing the Level 1 fauna assessment of Delphine (Ecoscape 2012a). This widespread species is expected to occur throughout the footslopes and plains habitat type.

5.3.2.7 Bush Stone-curlew (*Burhinus grallarius*)

Conservation Status: DPaW 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. 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). 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).

Likelihood of Occurrence: Recorded. The Bush-stone Curlew was recorded twice within the survey area during the current survey (Table 4.6; Figure 4.9), within the river systems and footslopes and plains habitats. A third record was obtained just outside the survey area, also from along a watercourse. 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.

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

Conservation Status: DPaW 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: High. The Star Finch was recently recorded nearby in the Edge survey area (Biologic 2013). Within the survey area, its habitat is restricted to areas of well-vegetated pools, such as those found within the river systems habitat along the Duck and Serpentine Creeks.

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 the Pilbara 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 three times during the Eliwana and Flying Fish Level 2 vertebrate fauna assessment (*ecologia* in prep-b), located approximately 30 km south-east of the survey area. No individuals were recorded within the survey area. Both phase of the Level 2 survey were conducted almost entirely in May (by which time temperatures are relatively mild), and it is likely that by this time the species had largely retreated to rock crevices to avoid the cooler weather. For similar reasons, the species is unlikely to have been detectable during the targeted survey. 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 ganei*

Conservation Status: DPaW 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. ganei* probably burrow into social insect colonies to feed on termites and ants, as well as their eggs and pupae (Wilson and Swan 2010). *R. ganei* has been found within the Pilbara region between Newman and Pannawonica (Wilson and Swan 2010).

Ecology: It has been suggested that *R. ganei* 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. The species was not recorded on the current survey, but the cryptic, burrowing habits of the species mean they are difficult to detect. Due to the close proximity of several records, this species has a high likelihood of occurrence.

5.3.3.3 Notoscincus butleri

Conservation Status: DPaW 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. Theses 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 five 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 4.1).

5.3.4 Fish

5.3.4.1 Fortescue Grunter (*Leiopotherapon aheneus*)

Conservation Status: DPaW 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. Over 50 Fortescue Grunter were at recorded during the current survey in large pools at site 1 (Table 4.6, Figure 4.9), 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

Considerable systematic and opportunistic sampling effort was undertaken within the survey area (Table 3.6), and all fauna habitat types within the survey area were adequately sampled (Table 4.3). Systematic trapping effort was lacking in two habitat types; the gorges and gullies, and cracking clays, as a result of inaccessibility, and in the case of gorges and gullies, impracticality of installing traps. 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 systematically obtained survey data recorded during the Level 2 vertebrate fauna assessment indicates that the survey recorded the majority of terrestrial vertebrate (93.6 %) and avian species (98.4 %) present within the study area (Table 4.7). The shape of the SACs generated (Figures 4.9, 4.10), indicate that a plateau has nearly been reached for both groups. This suggests additional surveying would likely reveal only a few more species. In summary, these results indicate that survey effort was adequate to provide an indication of the fauna assemblage present in the survey area.

6 CONCLUSION

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

- The survey methods were consistent with *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 indicated that the current assessment was adequate overall, with an estimated 93.6 % of terrestrial vertebrate and 98.4 % of avian fauna detected.
- The land systems, vegetation communities and habitats in the area support a moderately diverse group of fauna, including conservation significant fauna, but are not restricted to the survey area. All habitat types within the study area were assessed to be in good condition.
- Six habitat types were identified within the survey area, all of which occur widely within the region:
    - gorges and gullies;
    - hilltops, hillslopes, ridges and cliffs;
    - footslopes and plains;
    - river systems;
    - mixed acacia woodlands; and
    - cracking clays.
- Statistical analyses of systematically obtained terrestrial fauna and avifauna data indicated that while most habitat types were significantly different from each other in terms of the assemblages of both groups. The most distinct habitat type was the river systems habitat type. However, the gorges and gullies habitat type is also expected to show a distinct terrestrial faunal assemblage but could not be included in statistical analyses due to a lack of systematic sampling
- The most important habitat types in terms of fauna are likely to be the gorges and gullies, and river systems habitat types, due to their relatively distinct faunal assemblages, their importance as habitat for a number of conservation significant fauna. They are also the two most regionally-restricted habitats occurring within the study area.
- A total of 22 native and five introduced mammal species, 104 bird species, 66 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.
- Twelve species of conservation significance were recorded during the current survey:
    - Northern Quoll (*Dayurus hallucatus*): EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable)
    - Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form): EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable)
    - Grey Falcon (*Falco hypoleucos*): WC Act Schedule 1 (Vulnerable)
    - Eastern Great Egret (*Ardea modesta*): EPBC Act Migratory, WC Act Schedule 3
    - Eastern Osprey (*Pandion cristatus*): EPBC Act Migratory, WC Act Schedule 3
    - Rainbow Bee-eater (*Merops ornatus*): EPBC Act Migratory, WC Act Schedule 3
    - Peregrine Falcon (*Falco peregrinus*): WC Act Schedule 4

    - Western Pebble-mound Mouse (*Pseudomys chapmani*): DPaW Priority 4
    - Australian Bustard (*Ardeotis australis*): DPaW Priority 4
    - Bush Stone-curlew (*Burhinus grallarius*): DPaW Priority 4
    - *Notoscincus butleri*: DPaW Priority 4
    - Fortescue Grunter (*Leiopotherapon aheneus*): DPaW Priority 4
- A further eight conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the Delphine survey area.
    - Pilbara Olive Python (*Liasis olivaceous barroni*): EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable)
    - *Ramphotyphlops ganei*: DPaW Priority 1
    - Fork-tailed Swift (*Apus pacificus*): EPBC Act Migratory, WC Act Schedule 3
    - Long-tailed Dunnart (*Sminthopsis longicaudata*): DPaW Priority 4
    - Ghost Bat (*Macroderma gigas*): DPaW Priority 4
    - Short-tailed Mouse (*Leggadina lakedownensis*): DPaW Priority 4
    - Black Bittern (*Ixobrychus flavicollis*): DPaW Priority 4
    - Star Finch (*Neochmia ruficauda subclarescens*): DPaW Priority 4
- 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 at least one roost cave is likely to be present in the region (within 15 km of the survey area).
- 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, suggesting this individual may have been on a foraging visit from more extensive habitat extending west from the survey area. The lack of records during the targeted survey suggests that the species is likely to be present only in relatively low numbers within the study area.
- Based on aerial images and a short opportunistic survey conducted from a helicopter fly-over, areas of potentially suitable denning, foraging and dispersal habitat are expected to be found in the region to the west of the Delphine survey area, potentially supporting Northern Quoll populations.
- No major limitations on survey techniques were experienced, though some access limitations and an adverse weather event were experienced. However, all 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

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: • 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 of 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 DPaW 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)	*Taxa with few, poorly known populations on threatened lands.* 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)	*Taxa with few, poorly known populations on conservation lands.* Taxa which are known from few specimens or sight records from one or a few localities, on lands not under immediate threat of habitat destruction or degradation, 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)	*Taxa with several, poorly known populations, some on conservation lands.* Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4 (P4)	*Taxa in need of monitoring.* Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could if present circumstances change. These taxa are usually represented on conservation lands.
Priority 5 (P5)	*Taxa in need of monitoring.* Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

APPENDIX B DAILY WEATHER DATA DURING SURVEY

Appendix B1 Level 2 Vertebrate Fauna Assessment

Survey	Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
DL S1 – DL S12 Phase 1	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
DL S1 – DL S12 Phase 2	30/04/2013	21.5	36.2	0
	01/05/2013	21.6	37.0	0
	02/05/2013	17.6	36.3	0
	03/05/2013	16.5	35.7	0
	04/05/2013	15.5	34.7	0
	05/05/2013	17.3	36.0	0
	06/05/2013	17.6	35.8	0
	07/05/2013	18.1	36.1	0
	08/05/2013	25.0	25.1	0
	09/05/2013	11.5	23.8	17.4
	10/05/2013	10.5	25.7	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

Appendix C1 – Mammals

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (*ecologia* 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																						
TACHYGLOSSIDAE																										
Tachyglossus aculeatus	Short-beaked Echidna												●							●	●	●				
DASYURIDAE																										
Dasykaluta rosamondae	Kaluta				●				●		●		●		●		●	●	●		●	●				●
Dasyurus hallucatus	Northern Quoll	EN	S1	EN					S (u)		●			S					●	●	●				●	●
Ningaui timealeyi	Pilbara Ningaui				●		●		●		●		●	●	●		●	●	●	●	●	●	●			●
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																										
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1	VU			●		●		●						●						●	●	●	●
EMBALLONURIDAE																										
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat				●		●		●		●						●	●	●	●	●					●
Taphozous georgianus	Common Sheathtail Bat				●		●		●		●	●	●		●		●	●	●	●	●		●			●
Taphozous hilli	Hill's Sheathail 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				●		●		●		●		●	●	●		●	●	●	●	●	●	●			●
MURIDAE																										

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (*ecologia* 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																						
Leggadina lakedownensis	Northern Short-tailed Mouse			P4	●																			●		
Notomys alexis	Spinifex Hopping-mouse							●					●													
Pseudomys chapmani	Western Pebble-mound Mouse			P4	●	●			S		●	●	●		●	S	S	●	S	S	SA	●		●		S
Pseudomys delicatulus	Delicate Mouse								●		●			●												
Pseudomys desertor	Desert Mouse				●		●		●		●		●		●		●	●	●	●	●		●			●
Pseudomys hermannsburgensis	Sandy Inland Mouse				●				●		●		●		●		●	●			●	●	●			●
Zyzomys argurus	Common Rock-rat				●		●			●	●		●	●	●	●	●	●	●	●	●	●	●			●
INTRODUCED MAMMALS																										
**Mus musculus*	House Mouse				●		●		●						●		●	●	●	●		●	●			●
**Rattus sp.*	Black/Brown Rat								●																	
**Canis lupus*	Dog/Dingo				●	●	●	●	●	●	●		●	●				●	●	●		●	●			●
**Vulpes vulpes*	Red Fox																								●	
**Felis catus*	Cat				●	●	●		●	●	●		●		●	●	●	●	●	●	●	●			●	●
**Oryctolagus cuniculus*	European Rabbit																								●	
**Equus asinus*	Donkey				●				●		●				●	●										
**Equus caballus*	Horse					●				●					●	●	●									●
**Bos taurus*	Cow				●	●	●	●	●	●	●					●	●		●	●	●	●	●			●

† = Species recorded just outside project area
S(u) = Secondary evidence (unidentifiable)
SA = Active Pebble-mound
# = Recorded during targeted survey

Appendix C2 - Birds

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
CASUARIIDAE																											
Dromaius novaehollandiae	Emu				●						●	●	●	●	●	●	●			●		●	●			●	●
PHASIANIDAE																											
Coturnix pectoralis	Stubble Quail																●				●						
Coturnix ypsilophora	Brown Quail								●		●						●		●	●	●					●	●
ANATIDAE																											
Dendrocygna eytoni	Plumed Whistling-duck																●									●	
Cygnus atratus	Black Swan																									●	
Chenonetta jubata	Australian Wood Duck												●			●	●									●	
Malacorhynchus membranaceus	Pink-eared Duck																									●	
Anas gracilis	Grey Teal														●		●									●	
Anas superciliosa	Pacific Black Duck												●		●		●									●	#
Aythya australis	Hardhead																									●	
PODICIPEDIDAE																											
Tachybaptus novaehollandiae	Australasian Grebe												●													●	●
Poliocephalus poliocephalus	Hoary-headed Grebe												●													●	
COLUMBIDAE																											
**Streptopelia senegalensis*	Laughing Dove																										●
Phaps chalcoptera	Common Bronzewing				●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●			●	●
Ocyphaps lophotes	Crested Pigeon				●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●			●	●
Geophaps plumifera	Spinifex Pigeon				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Geopelia cuneata	Diamond Dove				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Geopelia striata	Peaceful Dove										●		●	●			●	●	●	●	●					●	●
PODARGIDAE																											
Podargus strigoides	Tawny Frogmouth				●				●								●		●	●	●	●				●	●
EUROSTOPODIDAE																											
Eurostopodus argus	Spotted Nightjar				●		●		●	●	●		●		●	●	●		●	●	●	●				●	●
AEGOTHELIDAE																											
Aegotheles cristatus	Australian Owlet-nightjar				●	●			●	●	●		●			●	●			●	●	●				●	●
APODIDAE																											
Apus pacificus	Fork-tailed Swift	M	S3										●				●			●					●		
ANHINGIDAE																											
Anhinga novaehollandiae	Australasian Darter												●													●	●
PHALACROCORACIDAE																											
Microcarbo melanoleucos	Little Pied Cormorant												●								●					●	●
Phalacrocorax sulcirostris	Little Black Cormorant												●													●	
PELECANIDAE																											
Pelecanus conspicillatus	Australian Pelican												●													●	#
CICONIIDAE																											

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
Ephippiorhynchus asiaticus	Black-necked Stork												●														
ARDEIDAE																											
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																											
Pandion cristatus	Eastern Osprey	M																									●
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		S1	VU							●											●					●
Falco peregrinus	Peregrine Falcon		S4		●	●	●										●							●		●	●
RALLIDAE																											
Gallirallus philippensis	Buff-banded Rail																									●	
Porzana fluminea	Australian Spotted Crake																●										
Porzana pusilla	Baillon's Crake																									●	
Tribonyx ventralis	Black-tailed Native-hen																									●	
Fulica atra	Eurasian Coot												●													●	
OTIDIDAE																											
Ardeotis australis	Australian Bustard			P4	●	●			●	●	●		●		●	●	●	●	●	●			●	●		●	●
BURHINIDAE																											
Burhinus grallarius	Bush Stone-curlew			P4				●	●				●		●		●				●			●		●	●

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
RECURVIROSTRIDAE																											
Himantopus himantopus	Black-winged Stilt																									●	
CHARADRIIDAE																											
Charadrius veredus	Oriental Plover	M	S3																						●		
Elseyornis melanops	Black-fronted Dotterel					●							●	●	●		●			●						●	●
Vanellus tricolor	Banded Lapwing																●										
SCOLOPACIDAE																											
Numenius minutus	Little Curlew	M	S3								●																
SCOLOPACIDAE																											
Actitis hypoleucos	Common Sandpiper	M	S3																							●	
TURNICIDAE																											
Turnix velox	Little Button-quail				●	●	●		●	●	●	●	●		●	●	●		●	●	●	●	●			●	●
CACATUIDAE (PSITTACIDAE)																											
Eolophus roseicapillus	Galah				●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●				●	●
Cacatua sanguinea	Little Corella				●	●	●	●	●		●	●	●	●	●		●	●	●	●	●	●				●	●
Nymphicus hollandicus	Cockatiel				●		●		●		●		●	●	●	●	●	●		●	●					●	●
PSITTACIDAE																											
Barnardius zonarius	Australian Ringneck				●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●				●	●
Melopsittacus undulatus	Budgerigar				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●
Neopsephotus bourkii	Bourke's Parrot																●										
Neophema elegans	Elegant Parrot								●																		
CUCULIDAE																											
Centropus phasianinus	Pheasant Coucal												●				●		●	●	●					●	●
Chalcites basalis	Horsfield's Bronze-Cuckoo				●				●		●		●	●	●	●	●	●	●	●	●	●				●	●
Chalcites osculans	Black-eared Cuckoo									●								●								●	
Cacomantis pallidus	Pallid Cuckoo				●		●	●	●		●		●	●	●		●	●	●	●	●	●				●	●
STRIGIDAE																											
Ninox connivens	Barking Owl																										●
Ninox novaeseelandiae	Southern Boobook						●		●				●				●		●	●	●					●	●
TYTONIDAE																											
Tyto javanica	Eastern Barn Owl				●										●						●					●	
HALCYONIDAE																											
Dacelo leachii	Blue-winged Kookaburra								●		●	●	●	●	●		●		●	●	●					●	●
Todiramphus pyrrhopygius	Red-backed Kingfisher				●		●		●		●		●	●	●	●	●	●	●	●	●	●	●			●	●
Todiramphus sanctus	Sacred Kingfisher				●	●			●					●		●	●		●	●	●	●					●	●
MEROPIDAE																											
Merops ornatus	Rainbow Bee-eater	M	S3		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●		●	●	●
CLIMACTERIDAE																											
Climacteris melanura	Black-tailed Treecreeper						●	●				●			●		●					●					●
PTILINORHYNCHIDAE																											

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
Ptilonorhynchus guttatus	Western Bowerbird				●		●	●	●		●	●	●		●	●	●	●	●	●	●					●	●
MALURIDAE																											
Malurus lamberti	Variegated Fairy-wren				●		●	●	●		●	●	●	●	●	●		●	●	●	●	●				●	●
Malurus leucopterus	White-winged Fairy-wren				●	●	●		●	●	●		●		●	●	●	●	●	●		●	●			●	●
Stipiturus ruficeps	Rufous-crowned Emu-wren				●		●		●		●		●	●	●		●	●				●	●			●	●
Amytornis striatus	Striated Grasswren				●				●		●		●	●	●		●	●	●	●	●		●			●	●
ACANTHIZIDAE																											
Pyrrholaemus brunneus	Redthroat																									●	
Smicrornis brevirostris	Weebill				●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●			●	●
Gerygone fusca	Western Gerygone				●				●		●		●	●	●	●	●	●		●	●	●				●	●
Acanthiza robustirostris	Slaty-backed Thornbill				●												●									●	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				●	●				●												●	●			●	
Acanthiza uropygialis	Chestnut-rumped Thornbill				●				●						●	●	●	●				●				●	
Acanthiza apicalis	Inland Thornbill				●										●	●	●	●				●					
Aphelocephala leucopsis	Southern Whiteface																					●				●	
PARDALOTIDAE																											
Pardalotus rubricatus	Red-browed Pardalote						●		●		●		●	●	●		●	●	●	●	●					●	●
Pardalotus striatus	Striated Pardalote				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●
MELIPHAGIDAE																											
Certhionyx variegatus	Pied Honeyeater				●	●			●	●						●	●	●		●		●					●
Lichenostomus virescens	Singing Honeyeater				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Lichenostomus keartlandi	Grey-headed Honeyeater				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Lichenostomus penicillatus	White-plumed Honeyeater				●	●	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●			●	●
Purnella albifrons	White-fronted Honeyeater								●		●				●	●							●				●
Manorina flavigula	Yellow-throated Miner				●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●			●	●
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				●				●		●		●		●	●	●	●	●	●	●	●	●			●	●
Conopophila whitei	Grey Honeyeater										●							●				●				●	
Epthianura tricolor	Crimson Chat				●		●		●		●		●		●	●	●					●				●	●
Sugomel niger	Black Honeyeater				●		●		●		●		●	●			●			●			●				●
Lichmera indistincta	Brown Honeyeater				●		●	●	●		●		●	●	●		●	●	●	●	●	●	●			●	●
Melithreptus gularis	Black-chinned Honeyeater						●		●		●	●	●		●		●		●	●	●	●				●	●
POMATOSTOMIDAE																											
Pomatostomus temporalis	Grey-crowned Babbler				●	●	●		●	●	●		●	●	●		●	●	●		●	●				●	●
Pomatostomus superciliosus	White-browed Babbler														●	S										●	
PSOPHODIDAE (CINCLOSOMATIDAE)																											
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush										●				●											●	
Psophodes occidentalis	Chiming Wedgebill							●				●															
NEOSITTIDAE																											
Daphoenositta chrysoptera	Varied Sitella																●										
CAMPEPHAGIDAE																											

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
Coracina maxima	Ground Cuckoo-shrike				●				●						●		●			●							●
Coracina novaehollandiae	Black-faced Cuckoo-shrike				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●
Lalage sueurii	White-winged Triller				●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●				●	●
PACHYCEPHALIDAE																											
Pachycephala rufiventris	Rufous Whistler				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Colluricincla harmonica	Grey Shrike-thrush				●	●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●		●	●
Oreoica gutturalis	Crested Bellbird				●	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●		●	●
ARTAMIDAE																											
Artamus leucorynchus	White-breasted Woodswallow												●														
Artamus personatus	Masked Woodswallow				●		●		●		●					●	●	●		●		●	●			●	●
Artamus cinereus	Black-faced Woodswallow				●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Artamus minor	Little Woodswallow				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
Cracticus torquatus	Grey Butcherbird				●				●		●		●		●	●	●	●	●		●	●				●	●
Cracticus nigrogularis	Pied Butcherbird				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Cracticus tibicen	Australian Magpie				●	●			●	●	●	●	●		●	●	●	●	●	●	●		●			●	●
RHIPIDURIDAE (DICRURIDAE)																											
Rhipidura albiscapa	Grey Fantail														●				●							●	●
Rhipidura leucophrys	Willie Wagtail				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
CORVIDAE																											
Corvus bennetti	Little Crow				●						●					●	●	●		●		●				●	
Corvus orru	Torresian Crow				●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●			●			●	●
MONARCHIDAE (DICRURIDAE)																											
Grallina cyanoleuca	Magpie-lark				●	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●			●	●
PETROICIDAE																											
Petroica goodenovii	Red-capped Robin				●							●				●	●	●	●				●				●	●
Melanodryas cucullata	Hooded Robin				●	●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●				●	●
ALAUDIDAE																											
Mirafra javanica	Horsfield's Bushlark							●				●				●	●										●	●
ACROCEPHALIDAE (SYLVIIDAE)																											
Acrocephalus australis	Australian Reed-Warbler												●														●	●
MEGALURIDAE (SYLVIIDAE)																											
Cincloramphus mathewsi	Rufous Songlark				●		●		●		●		●	●	●		●		●		●		●	●			●	●
Cincloramphus cruralis	Brown Songlark								●		●		●		●	●	●	●	●								●	●
Eremiornis carteri	Spinifexbird				●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
HIRUNDINIDAE																											
Cheramoeca leucosterna	White-backed Swallow															●											
Hirundo neoxena	Welcome Swallow																●										
Petrochelidon ariel	Fairy Martin								●				●	●	●	S	●			●							●	●
Petrochelidon nigricans	Tree Martin				●						●		●		●	●	●		●	●							●	●
NECTARINIIDAE (DICAEIDAE)																											

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
Dicaeum hirundinaceum	Mistletoebird						●		●		●		●	●	●		●	●	●	●	●					●	●
ESTRILDIDAE																											
Taeniopygia guttata	Zebra Finch				●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Neochmia ruficauda subclarescens	Star Finch (western)			P4	●								●			●							●				●	
Emblema pictum	Painted Finch				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
MOTACILLIDAE																											
Anthus novaeseelandiae	Australasian Pipit								●		●		●		●	●										●	

† = Species recorded just outside project area

= Recorded during targeted survey

Appendix C3 – Reptiles

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																						
AGAMIDAE																										
Amphibolurus longirostris	Long-nosed Dragon				●		●		●		●		●	●	●	●	●	●	●	●	●	●				●
Caimanops amphiboluroides	Mulga Dragon				●						●						●									
Ctenophorus caudicinctus	Ring-tailed Dragon				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●
Ctenophorus isolepis	Central Military Dragon				●				●		●		●	●	●		●	●	●	●		●				
Ctenophorus nuchalis	Central Netted Dragon										●		●	●												
Ctenophorus reticulatus	Western Netted Dragon				●																					
Ctenophorus scutulatus	Lozenge-marked Dragon																									
Diporiphora valens					●										●		●	●		●		●				
Pogona minor	Dwarf Bearded Dragon				●	●			●		●	●	●		●	●	●	●	●	●	●	●				●
Tympanocryptis cephalus	Pebble Dragon																●									
DIPLODACTYLIDAE																										
Crenadactylus ocellatus	Clawless Gecko										●		●				●			●						
Diplodactylus conspicillatus	Fat-tailed Gecko				●				●		●		●	●	●		●	●	●	●				●		●
Diplodactylus pulcher																										
Diplodactylus savagei					●				●		●		●		●		●	●	●		●			●		●
Lucasium stenodactylum	Sand-plain Gecko				●				●		●		●	●	●				●			●	●			●
Lucasium wombeyi					●				●		●		●		●		●		●	●	●					●
Oedura marmorata	Marbled Velvet Gecko				●		●	●	●		●	●	●	●		●	●	●	●	●	●					●
Rhynchoedura ornata	Beaked Gecko								●		●		●	●	●		●	●				●				●
Strophurus elderi	Jewelled Gecko								●		●		●		●		●	●		●		●	●			●
Strophurus jeanae																			●							
Strophurus strophurus	Western Spiny-tailed Gecko																●		●							
Strophurus wellingtonae					●			●	●						●		●	●	●	●	●					●
CARPHODACTYLIDAE																										
Nephrurus levis	Smooth Knob-tailed Gecko												●	●												
Nephrurus wheeleri	Banded Knob-tailed Gecko				●		●		●		●		●		●		●		●	●	●	●	●			●
Underwoodisaurus seorsus	Barking Gecko						●										●				●					
GEKKONIDAE																										
Gehyra pilbara					●		●		●				●				●		●			●				●
Gehyra punctata					●		●		●		●				●	●	●	●	●	●	●	●	●			●
Gehyra variegata					●	●	●		●		●		●		●		●	●	●	●	●	●	●			●
Heteronotia binoei	Bynoe's Gecko				●		●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●			●
Heteronotia spelea	Desert Cave Gecko								●		●		●				●		●	●						●
PYGOPODIDAE																										
Delma butleri																	●					●				
Delma elegans					●						●		●				●		●	●			●			
Delma nasuta					●		●		●		●		●	●	●	●	●	●	●	●	●	●	●			●
Delma pax					●		●		●		●		●		●		●	●	●	●	●	●	●			●
Delma tincta					●				●				●		●		●	●	●			●				
Lialis burtonis	Burton's Snake-lizard						●		●		●		●	●	●		●	●	●	●	●					●
Pygopus nigriceps	Western Hooded Scaly-foot				●				●		●			●	●				●		●					●

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																						
SCINCIDAE																										
Carlia munda					●		●	●	●		●		●	●	●		●	●	●		●	●	●			●
Carlia triacantha									●								●		●	●	●	●				
Cryptoblepharus buchananii					◊										◊	◊	●	◊	◊							
Cryptoblepharus ustulatus					◊		●		●		●				◊	◊	●	◊	◊		●		●			●
Ctenotus duricola					●				●		●	●	●	●	●	●	●	●	●	●	●	●	●			●
Ctenotus grandis					●		●	●	●		●		●	●	●		●	●	●	●		●	●			●
Ctenotus hanloni											●		●	●												
Ctenotus helenae					●		●		●		●		●	●	●	●	●	●	●	●	●					●
Ctenotus leonhardii					●				●								●		●							
Ctenotus mimetes																							●			
Ctenotus pantherinus	Leopard Ctenotus				●		●	●	●		●		●	●	●	●	●	●	●	●	●	●				●
Ctenotus robustus	Eastern Striped Skink																●		●							●
Ctenotus rubicundus							●		●		●						●	●	●		●	●	●			●
Ctenotus rutilans					●				●						●		●		●	●		●	●			
Ctenotus saxatilis	Rock Ctenotus				●	●	●		●		●		●	●	●		●	●	●	●	●	●	●			●
Ctenotus schomburgkii					●		●								●		●	●	●			●				●
Ctenotus serventyi																	●									
Ctenotus severus																							●			
Cyclodomorphus melanops	Spinifex Slender Blue-tongue				●				●		●		●		●	●	●	●	●	●	●	●	●			●
Egernia cygnitos									●														●			●
Egernia formosa							●		●				●		●		●			●						●
Egernia pilbarensis													●				●		●							
Eremiascincus fasciolatus	Narrow-banded Sand-swimmer										●			●			●			●						●
Eremiascincus isolepis													●													
Eremiascincus richardsonii	Broad-banded Sand-swimmer								●								●									
Lerista bipes													●	●												
Lerista clara	(L.muelleri group)										●												●			
Lerista flammicauda					●		●				●		●					●					●			
Lerista jacksoni	(L.muelleri group)																●	●			●					
Lerista muelleri					●				●		●			●	●		●		●	●		●	●			
Lerista verhmens																	●		●							
Lerista zietzi											●						●		●		●					
Menetia greyii					●	●			●		●		●	●	●	●	●	●	●	●	●	●	●			
Menetia surda					●				●				●		●		●	●	●				●			●
Morethia ruficauda					●		●	●	●		●	●	●	●	●		●	●	●	●	●	●	●			●
Notoscincus butleri				P4					●				●		●		●	●	●				●	●		●
Notoscincus ornatus									●		●		●													●
Proablepharus reginae									●										●			●				
Tiliqua multifasciata	Centralian Blue-tongue				●		●		●		●	●	●		●		●	●	●	●	●	●				●
VARANIDAE																										

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Delphine (Ecoscape 2012)	Mt Farquhar (*ecologia* 2012)	Mt. Farquhar (Ecoscape 2012)	Eliwana and Flying Fish (*ecologia*, in press-b)	Eliwana and Flying Fish (ecoscape 2012)	West Pilbara Iron Ore Project Mine Areas (Biota 2009)	Raven (Ecoscape 2012)	Mesa A Transport Corridor (Biota 2006)	Mesa A and G (Biota 2005)	Brockman Syncline (Biota 2005)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Central Pilbara Project (ecologia 2011)	West Turner Section 10 (Biota 2009)	Solomon Project Area (Coffey 2008)	Solomon Project (ecologia 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy Rd (Kendrick 1995)	NatureMap	DPaW Rare Fauna	DoE Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																						
Varanus acanthurus	Spiny-tailed Monitor				●		●		●		●		●		●		●	●	●	●	●	●				●
Varanus brevicauda	Short-tailed Pygmy Monitor				●				●		●		●		●		●	●	●	●		●	●			●
Varanus bushi	Pilbara Monitor				●				●		●						●	●	●	●	●					
Varanus caudolineatus	Stripe-tailed Monitor																					●				
Varanus eremius	Pygmy Desert Monitor				●				●		●		●	●	●		●		●	●	●					●
Varanus giganteus	Perentie								●		●				●				●	●	●	●				●
Varanus gouldii	Gould's Monitor																									
Varanus panoptes	Yellow-spotted Monitor				●				●				●		●		●		●	●	●	●				●
Varanus pilbarensis	Pilbara Rock Monitor				●		●		●				●		●		●		●	●			●			●
Varanus tristis	Black-headed Monitor				●		●		●				●		●		●	●	●	●	●	●	●			●
TYPHLOPIDAE																										
Ramphotyphlops ammodytes					●				●		●						●	●	●				●			●
Ramphotyphlops ganei				P1	●												●			●			●	●		
Ramphotyphlops grypus	Beaked Blind Snake				●				●		●		●		●		●	●	●		●	●	●			
Ramphotyphlops hamatus																										
Ramphotyphlops pilbarensis	Pilbara Blind Snake				●						●				●		●		●		●					
Ramphotyphlops waitii																										
BOIDAE																										
Antaresia perthensis	Pygmy Python				●				●								●		●		●					●
Antaresia stimsoni	Stimson's Python				●				●				●				●		●	●	●	●				●
Aspidites melanocephalus	Black-headed Python				●									●			●		●	●		●				●
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1	VU					●		●						●	●		●	●				●	
ELAPIDAE																										
Acanthophis pyrrhus	Desert Death Adder																	●								
Acanthophis wellsi	Pilbara Death Adder				●		●		●		●		●	●			●			●	●					
Brachyurophis approximans	NW Shovel-nosed Snake								●		●		●		●		●	●	●	●	●					
Demansia psammophis	Yellow-faced Whipsnake				●		●		●		●		●	●	●		●		●	●	●	●				●
Demansia rufescens	Rufous Whipsnake				●		●		●				●				●	●	●	●	●	●				
Furina ornata	Moon Snake				●		●		●		●		●	●	●		●	●	●	●	●	●	●			●
Parasuta monachus	Monk Snake				●		●		●		●		●		●		●	●	●	●		●	●			●
Pseudechis australis	Mulga Snake				●		●	●	●		●		●		●		●		●	●	●	●				●
Pseudonaja mengdeni	Gwardar				●				●				●		●	●	●	●	●	●	●	●				●
Pseudonaja modesta	Ringed Brown Snake				●		●		●		●		●				●	●	●	●		●	●			●
Suta fasciata	Rosen's Snake								●								●	●	●			●				●
Suta punctata	Little Spotted Snake								●					●												
Vermicella snelli	Pilbara Bandy Bandy																●	●	●							

† Species recorded just outside project area

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

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 Rare Fauna	DoE Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																					
HYLIDAE																									
Cyclorana maini	Main's Frog								●		●		●		●		●	●	●		●				●
Cyclorana platycephala	Water-Holding Frog																								
Litoria rubella	Little Red Tree Frog					●			●		●		●		●		●		●		●	●			●
LIMNODYNASTIDAE																									
Platyplectrum spenceri	Centralian Burrowing Frog																				●				
MYOBATRACHIDAE																									
Pseudophryne douglasi	Gorge Toadlet																●					●			
Uperoleia glandulosa	Glandular Toadlet																		●						
Uperoleia saxatilis	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 Rare Fauna	DoE Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																					
CLUPEIDAE																									
Nematalosa erebi	Bony Bream																								●
MELANOTAENIIDAE																									
Melanotaenia australis	Western Rainbowfish					●	●												●						●
PLOTOSIDAE																									
Neosilurus hyrtlii	Hyrtl's Tandan					●													●						●
TERAPONTIDAE																									
Amniataba percoides	Barred Grunter																		●						●
Leiopotherapon aheneus	Fortescue Grunter			P4																					●
Leiopotherapon unicolor	Spangled Perch						●		●										●						●

APPENDIX D SITE DESCRIPTIONS

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Vegetation and Fauna Habitat Description	Site Photograph
Site DL S1 Major watercourse with large permanent pools. Riparian zone consists of mature, moderately dense *Eucalyptus camaldulensis* woodland with moderately dense *Acacia* spp. and *Gossypium robinsonii* shrubs, over dense *Cenchrus ciliaris*. Soil substrate consists of weak brown sand-loam. **Habitat type:** River systems	
Site DL S2A *Triodia* hummock grassland with open *Eucalyptus leucophloia* and *Acacia inaequilatera* on rocky hill slope. Soil substrate consists of firm brown loam-clay with continuous quartz, granite, calcrete and BIF stones. **Habitat type:** Hilltops, hillslopes, ridges and cliffs	

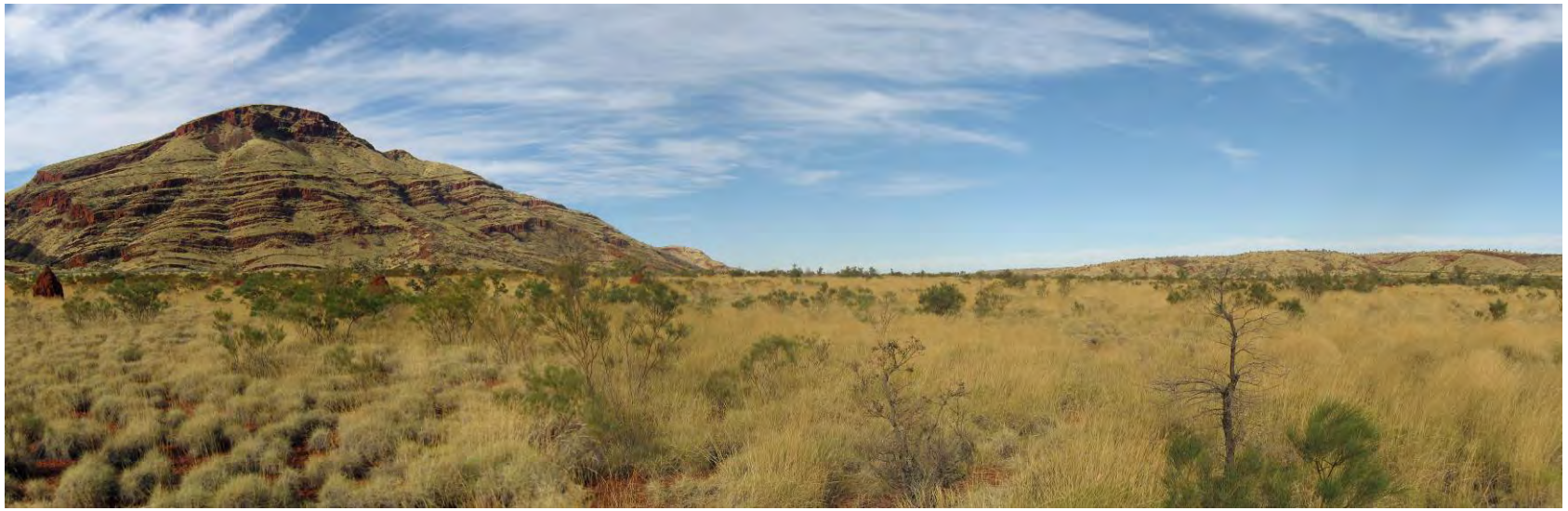
Site DL S2B Major watercourse with large permanent pools nearby. Riparian zone consists of mature, moderately dense *Eucalyptus camaldulensis* woodland with moderately dense *Acacia* spp. and *Gossypium robinsonii* shrubs, over dense *Cenchrus ciliaris*. Soil substrate consists of weak coarse brown sand and river stones. **Habitat type:** River systems	
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 course sand with many loose river stones. **Habitat type:** Footslopes and plains	

APPENDIX E SITE BY SPECIES MATRIX

Appendix F1 Mammals

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	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	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1		Ph 1	Ph 2
DASYURIDAE																																	
Dasykaluta rosamondae	Kaluta										5	5	3	1					3		4	3	1	4		3	2	1	1				
Dasyurus hallucatus	Northern Quoll	EN	S1	EN																												1	
Ningaui timealeyi	Pilbara Ningaui						6	4	5	1	1		3	3	1	2		1		3	2	1	2	2	5	1	2		7				
Planigale sp.	Planigale				6	1	1	5	1	3				1	1	1			1	1			2	1	1				10	4			
Pseudantechinus woolleyae	Woolley's False Antechinus																														1		
Sminthopsis macroura	Stripe-faced Dunnart										1	3				1		1									1		2				1
MACROPODIDAE																																	
Macropus robustus	Euro								1																1							5	4
Macropus rufus	Red Kangaroo																															4	4
Petrogale rothschildi	Rothschild's Rock-wallaby																														1		
HIPPOSIDERIDAE																																	
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1	VU				R	R					R			R					R						R			R		R
EMBALLONURIDAE																																	
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat				R		R		R		R	R	R		R	R	R		R		R				R	R	R						R
Taphozous georgianus	Common Sheathtail Bat						R	R	R	R		R	R	R	R	R	R	R	R	R	R			R	R	R				R		6	R
MOLOSSIDAE																																	
Chaerophon jobensis	Northern Freetail Bat				R							R	R		R		R		R		R		R				R		R	R			R
Mormopterus beccarii	Beccari's Freetail Bat							R		R		R				R	R			R			R					R					R
Tadarida australis	White-striped Freetail Bat																						R						R	R			R
VESPERTILIONIDAE																																	
Chalinolobus gouldii	Gould's Wattled Bat				R	R	R	R	R	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R				R
Scotorepens greyii	Little Broad-nosed Bat				R	R	R	R		R	R	R	R	R		R	R	R	R		R			R	R			R					
Vespadelus finlaysoni	Finlayson's Cave Bat				R	R	R	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R		R	R	R		4	R
MURIDAE																																	
Pseudomys chapmani	Western Pebble-mound Mouse			P4																												S	S
Pseudomys desertor	Desert Mouse								3	1								1											4	4			
Pseudomys hermannsburgensis	Sandy Inland Mouse					4	9	1			1						1											1				5	
Zyzomys argurus	Common Rock-rat							2																					1	2		1	
INTRODUCED MAMMALS																																	
Mus musculus						1				1																							
Canis lupus	Dog/dingo																						1				1					3	2
Equus caballus	Horse																															2	

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	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	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1		Ph 1	Ph 2
Felis catus	Cat																															1	1
Bos taurus	Cow																															35	

R = Recorded

Appendix F2 Birds

Family and Species	Common Name	Conservation Status			DLS1		DLS2A	DLS2B	DLS3		DLS4		DLS5		DLS		DLS7		DLS8		DLS9		DLS10		DLS11		DLS12		DLS13	DLS14	Opportunistic	
		EPBC Act	WC Act	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
CASUARIIDAE																																
Dromaius novaehollandiae	Emu																														2	
PHASIANIDAE																																
Coturnix ypsilophora	Brown Quail									1			6				1														1	
ANATIDAE																																
Anas superciliosa	Pacific Black Duck					2																									6	
PODICIPEDIDAE																																
Tachybaptus novaehollandiae	Australasian Grebe				1	1																									1	
COLUMBIDAE																																
**Streptopelia senegalensis*	Laughing Dove																														1	
Phaps chalcoptera	Common Bronzewing								1						1					1						1					1	1
Ocyphaps lophotes	Crested Pigeon								18	1			7		1	6		1	2			1	2	11				13	6	3		7
Geophaps plumifera	Spinifex Pigeon								22				9	16		1												6				10
Geopelia cuneata	Diamond Dove				2				1	3	1		3		1		10						3		1		9		1			1
Geopelia striata	Peaceful Dove											1																			4	
PODARGIDAE																																
Podargus strigoides	Tawny Frogmouth																														2	2
EUROSTOPODIDAE																																
Eurostopodus argus	Spotted Nightjar																													1	1	8
AEGOTHELIDAE																																
Aegotheles cristatus	Australian Owlet Nightjar				2													1											1		2	1
ANHINGIDAE																																
Anhinga novaehollandiae	Australasian Darter				3	1																									1	
PHALACROCORACIDAE																																
Microcarbo melanoleucos	Little Pied Cormorant				2	4																									1	
PELECANIDAE																																
Pelecanus conspicillatus	Australian Pelican - SWAP																														6	
ARDEIDAE																																
Ardea pacifica	White-necked Heron					1			1										1													1
Ardea modesta	Eastern Great Egret	M	S3			1																									2	
Egretta novaehollandiae	White-faced Heron				8	4								1																	1	
Nycticorax caledonicus	Nankeen Night-Heron																														3	
THRESKIORNITHIDAE																																

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	DL S3		DL S4		DL S5		DL S		DL S7		DL S8		DL S9		DL S10		DL S11		DL S12		DL S13	DL S14	Opportunistic	
		EPBC Act	WC Act	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
Threskiornis spinicollis	Straw-necked Ibis																														1	
ACCIPITRIDAE																																
Pandion cristatus	Eastern Osprey	M				1																										
Elanus axillaris	Black-shouldered Kite														1		1															2
Lophoictinia isura	Square-tailed Kite																						1									
Haliastur sphenurus	Whistling Kite					7							1												1							
Milvus migrans	Black Kite																1															15
Accipiter fasciatus	Brown Goshawk									2			1						1				2		4							
Accipiter cirrocephalus	Collared Sparrowhawk				2																										1	
Circus assimilis	Spotted Harrier												2		1			1					1		1	1		1	1			
Aquila audax	Wedge-tailed Eagle																						1									
Hieraaetus morphnoides	Little Eagle																								1			1			1	1
FALCONIDAE																																
Falco cenchroides	Nankeen Kestrel						1												1	1	1					1	1			1		
Falco berigora	Brown Falcon				1		1		1	1			1			1				1	3	1	2	1		1	1	3	1		2	1
Falco longipennis	Australian Hobby				2				1		1		1																			1
Falco hypoleucos	Grey Falcon		S1	VU																										1		
Falco peregrinus	Peregrine Falcon		S4	Other				1																								
OTIDIDAE																																
Ardeotis australis	Australian Bustard			P4																											2	
BURHINIDAE																																
Burhinus grallarius	Bush-stone Curlew			P4																											3	
CHARADRIIDAE																																
Elseyornis melanops	Black-fronted Dotterel				11	4																									3	2
TURNICIDAE																																
Turnix velox	Little Button-quail								1						2		2		1		5		6		8		1		5	2		
CACATUIDAE																																
Eolophus roseicapillus	Galah				30	72	1	9	10			2	2	1	5	13		1	4				24				14	25		21		4
Cacatua sanguinea	Little Corella				18	81		1	2	33	15			15					35								4	2			12	
Nymphicus hollandicus	Cockatiel																28		4				2	1	4						25	
PSITTACIDAE																																
Barnardius zonarius	Australian Ringneck				9	13		24					4	1	8	3	4		6					2			8	1				
Melopsittacus undulatus	Budgerigar				220	1	55		98		48		203	2	166		124	2	567		1509	1	118		127	4	284	5	117	2	388	6
CUCULIDAE																																
Centropus phasianinus	Pheasant Coucal																														1	

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	DL S3		DL S4		DL S5		DL S		DL S7		DL S8		DL S9		DL S10		DL S11		DL S12		DL S13	DL S14	Opportunistic	
		EPBC Act	WC Act	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
Chalcites basalis	Horsfield's Bronze-cuckoo																1								1							
Cacomantis pallidus	Pallid Cuckoo															1							1									
STRIGIDAE																																
Ninox connivens	Barking Owl																														2	
Ninox novaeseelandiae	Southern Boobook				2																											
HALCYONIDAE																																
Dacelo leachii	Blue-winged Kookaburra				3	1	4	9	1		1		1		1	2																4
Todiramphus pyrrhopygius	Red-backed Kingfisher												1				2		1		1			1	1		1			1		2
Todiramphus sanctus	Sacred Kingfisher				1	1																									1	
MEROPIDAE																																
Merops ornatus	Rainbow Bee-eater	M	S3		15	19	2	2	2	5		1	3	2		4			2			2	3	4		1		2			3	4
CLIMACTERIDAE																																
Climacteris melanura	Black-tailed Treecreeper				9	2																									2	2
PTILINORHYNCHIDAE																																
Ptilonorhynchus guttatus	Western Bowerbird				1			11	1							2			2												2	
MALURIDAE																																
Malurus lamberti	Variegated Fairy-wren					7		2	7	6		2	2	3	3	6		6	4	2	7	7	8	4	3	8	3		9	17		2
Malurus leucopterus	White-winged Fairy-wren																18	2	4				2			1	8	8			1	
Stipiturus ruficeps	Rufous-crowned Emu-wren																				6	2										1
Amytornis striatus	Striated Grasswren								2																						1	
ACANTHIZIDAE																																
Smicrornis brevirostris	Weebill				15	7	18	31	18	10	3	6	4	7	7	17	2	2	11		16	16	6	9			4	14		15	6	15
Gerygone fusca	Western Gerygone					1		2	2				1	1	1	4	1						1				2				1
PARDALOTIDAE																																
Pardalotus rubricatus	Red-browed Pardalote				2								2	1		7						3		1		1	3	5			2	1
Pardalotus striatus	Striated Pardalote				4	1	3	6	1		3		3	2	2	1	1		2			2	4		5		2			4		3
MELIPHAGIDAE																																
Certhionyx variegatus	Pied Honeyeater																				1				2		1					
Lichenostomus virescens	Singing Honeyeater						1						3	2	5	3	6	4	3	3	12	4	5	6	3	3	8	7	8	9	1	
Lichenostomus keartlandi	Grey-headed Honeyeater						5		2				12	2					6	4	8		1	2	10	13			3	10		
Lichenostomus penicillatus	White-plumed Honeyeater				78	43		21	12	25		3	3	7	6	13			6									3			19	
Purnella albifrons	White-fronted Honeyeater																						1		13							
Manorina flavigula	Yellow-throated Miner				10	4	4				17	5	7		13	2			6	15			6				4	8	1	2		3
Acanthagenys rufogularis	Spiny-cheeked Honeyeater																	1						1				1		1	1
Epthianura tricolor	Crimson Chat								2		59		14		345				3	2	103		23		10		36	29	6			

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	DL S3		DL S4		DL S5		DL S		DL S7		DL S8		DL S9		DL S10		DL S11		DL S12		DL S13	DL S14	Opportunistic	
		EPBC Act	WC Act	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
Sugomel niger	Black Honeyeater									2	2		14		21		2		5		15		14		21		57		2		1	
Lichmera indistincta	Brown Honeyeater					1	21		14				13		16		1		6		30		22		17	1	1		12	1	13	2
Melithreptus gularis	Black-chinned Honeyeater				1	6			6		1	2	3		1				1		36		9		12		2				6	2
POMATOSTOMIDAE																																
Pomatostomus temporalis	Grey-crowned Babbler				21	29	5	2	5	4	7		14	4	11	4	4						3	4						5		
CAMPEPHAGIDAE																																
Coracina maxima	Ground Cuckoo-shrike													1			1	1														
Coracina novaehollandiae	Black-faced Cuckoo-shrike				3	1	2		2	1	2		2	1	1		1		3		4	1					3		13		4	
Lalage sueurii	White-winged Triller								1		7		1		26				2		11		3					1	4	2	1	
PACHYCEPHALIDAE																																
Pachycephala rufiventris	Rufous Whistler				2	5	3	3	7	5	1	4	5	3	4	5	4	1	1	1	2		4	1	1		2		2	7	6	
Colluricincla harmonica	Grey Shrike-thrush				4		3		1		3	1	3	1	1				2				2		1	1				3		1
Oreoica gutturalis	Crested Bellbird										3	2	6	7	3	2	4	5	3		5	2	6	7	1	4	1	2		1		5
ARTAMIDAE																																
Artamus personatus	Masked Woodswallow														980		20		8		375		252		16		80		154	2	73	27
Artamus cinereus	Black-faced Woodswallow										4		2				1	8		1	3					2	8	5	2			4
Artamus minor	Little Woodswallow					1	3	3	1																						1	
Cracticus torquatus	Grey Butcherbird																1														1	
Cracticus nigrogularis	Pied Butcherbird				2	2	3	1			6	2	3	2	3		2	2					2				1				1	
Cracticus tibicen	Australian Magpie										2	4	6	1	2			2									1				3	1
RHIPIDURIDAE																																
Rhipidura albiscapa	Grey Fantail					2			2		1	2							1												1	1
Rhipidura leucophrys	Willie Wagtail				9	9	2	3	1		3	3	6	3	2	5	3		9	1	5	2	2	4	2		1	2	6	9	4	1
CORVIDAE																																
Corvus orru	Torresian Crow				1	1	2	4	5		6	8	3	4	5	3	1	2	5	1	5	1	6			1	3	4	2		5	3
MONARCHIDAE																																
Grallina cyanoleuca	Magpie-lark				12	6	1	4			6	5	3		1	1			4								1				2	
PETROICIDAE																																
Petroica goodenovii	Red-capped Robin															1														5		1
Melanodryas cucullata	Hooded Robin																													2		
ALAUDIDAE																																
Mirafra javanica	Horsfield's Bushlark																	1													1	
ACROCEPHALIDAE																																

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	DL S3		DL S4		DL S5		DL S		DL S7		DL S8		DL S9		DL S10		DL S11		DL S12		DL S13	DL S14	Opportunistic	
		EPBC Act	WC Act	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
Acrocephalus australis	Australian Reed-Warbler				11	15																										
MEGALURIDAE																																
Cincloramphus mathewsi	Rufous Songlark				5				1																		2					
Cincloramphus cruralis	Brown Songlark																														1	
Eremiornis carteri	Spinifexbird						7		1		1		3	3	3	4	3			3	2	2	1	2	3	7	3	3		4		
HIRUNDINIDAE																																
Petrochelidon ariel	Fairy Martin																															3
Petrochelidon nigricans	Tree Martin				6	1			3								5						1			3	2	4				2
NECTARINIIDAE																																
Dicaeum hirundinaceum	Mistletoebird				4	1	1																		1					6	1	
ESTRILDIDAE																																
Taeniopygia guttata	Zebra Finch				10	9	19	4	71	9			19	3	20	1	54	43	228	13	19	12	61	3	16		103	14	42	36	65	3
Emblema pictum	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 S2A	DL S2B	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	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
AGAMIDAE																																
Lophognathus longirostris	*Long-nosed Dragon*				2	1		11		3			1		8	7	1						1		2		4			5	1	20
Ctenophorus caudicinctus	*Ring-tailed Dragon*						1		6	1	6	9	3	2		1	1		3	6	3		3	1	2	1		2	2	2	3	35
Ctenophorus isolepis	*Central Military Dragon*																	1													2
Ctenophorus nuchalis	*Central Netted Dragon*																	1													
Pogona minor	*Dwarf Bearded Dragon*																							1	1						1
DIPLODACTYLIDAE																																
Diplodactylus conspicillatus	*Fat-tailed Gecko*										1	2	1	2	4	3	3		1	1			2	6				5			2	
Diplodactylus savagei							5							2		1								1								
Lucasium stenodactylum	*Sand-plain Gecko*										1							2		3	2			1							3	
Lucasium wombeyi															1				1		1	1									2	
Oedura marmorata	*Marbled Velvet Gecko*																										10					3
Rhynchoedura ornata	*Beaked Gecko*											1			1				1	1												
Strophurus elderi							1					3																				
Strophurus wellingtonae																1		1							1							
CARPHODACTYLIDAE																																
Nephrurus wheeleri	*Banded Knob-tailed Gecko*							2						1												1		1			2	
GEKKONIDAE																																
Gehyra pilbara													1														10				2	
Gehyra punctata								1																1			17				2	
Gehyra variegata					1	1	1	4			1	3		2							2		1				12			2		2
Heteronotia binoei	*Bynoe's Gecko*						2	1			4		10	1	3	3		3	2		3	1	9	2	9	1	3	2		2	6	
Heteronotia spelea																											1					
PYGOPODIDAE																																
Delma nasuta								2				1		3					1		1			1		3						
Delma pax					2				1	1																						
Delma tincta														1								1										
Lialis burtonis	*Burton's Snake-lizard*									2						1		1	1							1						
Pygopus nigriceps	*Western Hooded Scaly-foot*														1					1	1											
SCINCIDAE																																
Carlia munda					7	5	1	3	12	3					2	5			3	1			4	1	2	2				2	5	25
Carlia triacantha						7		2		4						2		1		2		1				1		1				3

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	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	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
Cryptoblepharus ustulatus	*Russet Snake-eyed Skink*																										7					6
Ctenotus duricola					1						2		1	2					1	2	6	2	1		4	1		1	1			
Ctenotus grandis								4		3	2	3		4	4	5			2				1	3		2		3		1	5	
Ctenotus hanloni								2		1						2		7		4		5										
Ctenotus helenae					1		4				1				3		1		1		1				4				5		4	
Ctenotus pantherinus	*Leopard Ctenotus*						4			2	3	1	17	9	5	2	3	5	14	2	11	3	11	1	2	2		6	3		12	1
Ctenotus robustus	*Robust Ctenotus*														2		1	1														
Ctenotus rubicundus											1																					1
Ctenotus saxatilis	*Rock Ctenotus*				8	1		10	5		1	2				1				1	2					1	1		1	3	2	1
Ctenotus schomburgkii															1		1	2														
Cyclodomorphus melanops	*Spinifex Slender Blue-tongue*											1	1	2	1	1					1				2	1						
Egernia cygnitos	*Western Pilbara Spiny-tailed Skink*																										1					
Egernia formosa																											1					
Eremiascincus fasciolatus	*Narrow-banded Sand-swimmer*																										1					
Lerista jacksoni					1																											2
Menetia greyii														1														1				1
Menetia surda																			1													
Morethia ruficauda						1	1	1				2	1	2																		
Notoscincus butleri				P4							1	4							1	2		2	3	2				1				
Notoscincus ornatus												2									1											
Tiliqua multifasciata	*Centralian Blue-tongue*											1									1											1
VARANIDAE																																
Varanus acanthurus	*Spiny-tailed Monitor*						2									1		1		1	5	1					1			2		
Varanus brevicauda	*Short-tailed Pygmy Monitor*														1																	
Varanus eremius	*Pygmy Desert Monitor*										1			1		1														1	2	
Varanus giganteus	*Perentie*																										2					
Varanus panoptes	*Yellow-spotted Monitor*																										1					1
Varanus pilbarensis	*Pilbara Rock Monitor*																										2					
Varanus tristis	*Black-headed Monitor*							1	3																							
TYPHLOPIDAE																																
Ramphotyphlops ammodytes													1	1																		
PYTHONIDAE																																
Antaresia perthensis	*Pygmy Python*																							1			1					
Antaresia stimsoni	*Stimson's Python*					1		1														1					4					1

Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	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	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
Aspidites melanocephalus	*Black-headed Python*																														1	
ELAPIDAE																																
Demansia psammophis cupreiceps	*Yellow-faced Whipsnake*					2										1				1	1		1						1			
Demansia rufescens						1								1																		
Furina ornata	*Moon Snake*					1		1			2				1				1	1			2									
Parasuta monachus	*Monk Snake*				1			2	5					1	2	2				2			1	1						3	1	
Pseudechis australis	*Mulga Snake*						1				1			1								1	1				2				1	1
Pseudonaja mengdeni	*Gwardar*											1																			1	
Pseudonaja modesta	*Ringed Brown Snake*																														1	
Suta fasciata	*Rosen's Snake*														1														1			

Appendix F4 Amphibians

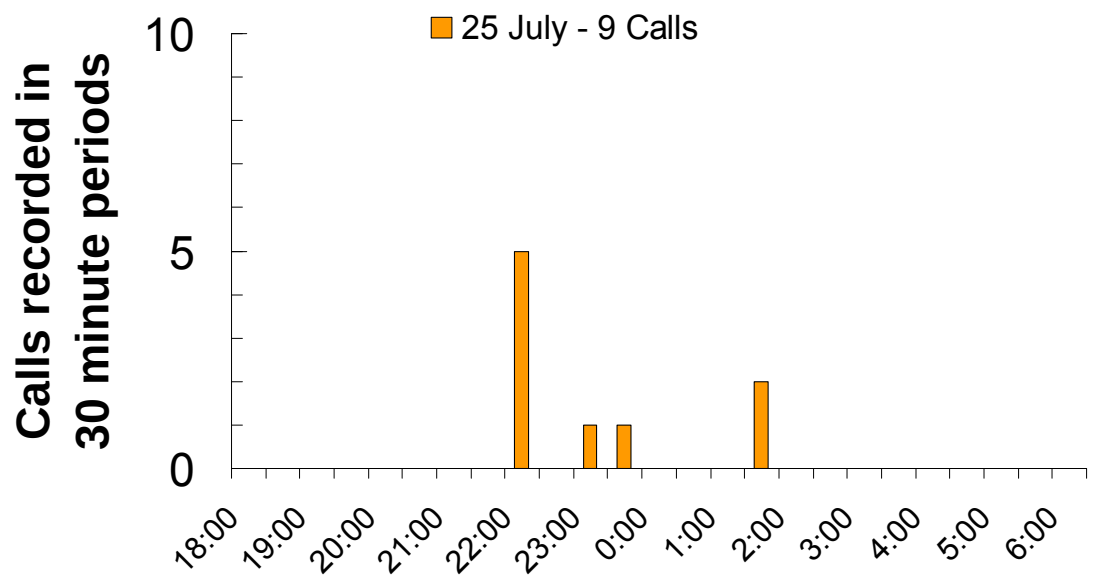
Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	DL S3		DL S4		DL S5		DL S6		DL S7		DL S8		DL S9		DL S10		DL S11		DL S12		DL S13	DL S14	Opportunistic	
		EPBC Act	WC Act	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
HYLIDAE																																
Cyclorana maini	Main's Frog									1																					1	
Litoria rubella	Little Red Tree Frog				15	26		7	1							1															4	31
MYOBATRACHIDAE																																
Uperoleia saxatilis	Northwest Toadlet				128	82		99	47	2																					4	2

Appendix F5 Fish

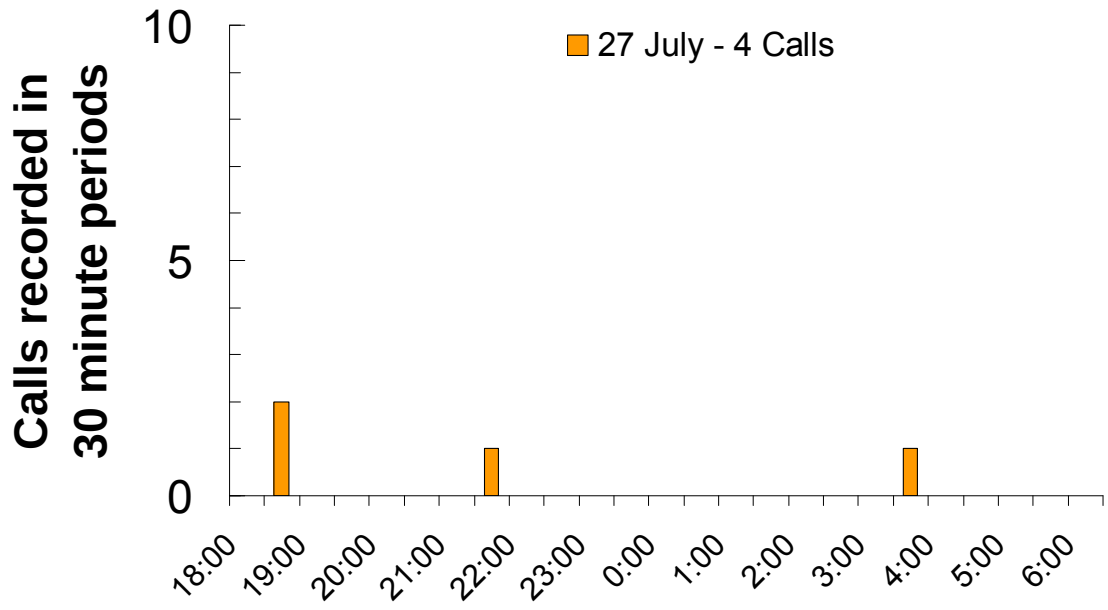
Family and Species	Common Name	Conservation Status			DL S1		DL S2A	DL S2B	DL S3		DL S4		DL S5		DL S6		DL S7		DL S8		DL S9		DL S10		DL S11		DL S12		DL S13	DL S14	Opportunistic	
		EPBC Act	WC Act	DPaW	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 1	Ph 1	Ph 2
CLUPEIDAE																																
Nematalosa erebi	Bony Bream																														10	
MELANOTAENIIDAE																																
Melanotaenia australis	Western Rainbowfish				30																										20	
PLOTOSIDAE																																
Neosilurus hyrtili	Hyrtl's Tandan				1																										5	
TERAPONTIDAE																																
Amniataba percoides	Barred Grunter				21																											
Leiopotherapon aheneus	Fortescue Grunter			P4	52																											
Leiopotherapon unicolor	Spangled Perch				5																										29	

APPENDIX F PILBARA LEAF-NOSED BAT TEMPORAL CALL PATTERNS FROM TARGETED SURVEY

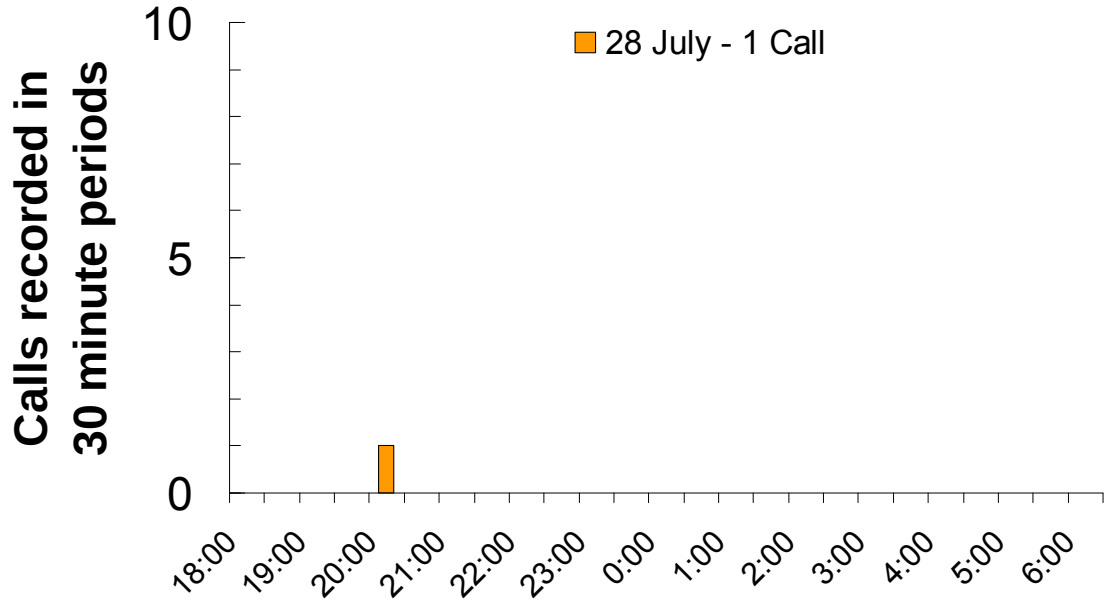
SITE: BAT 1



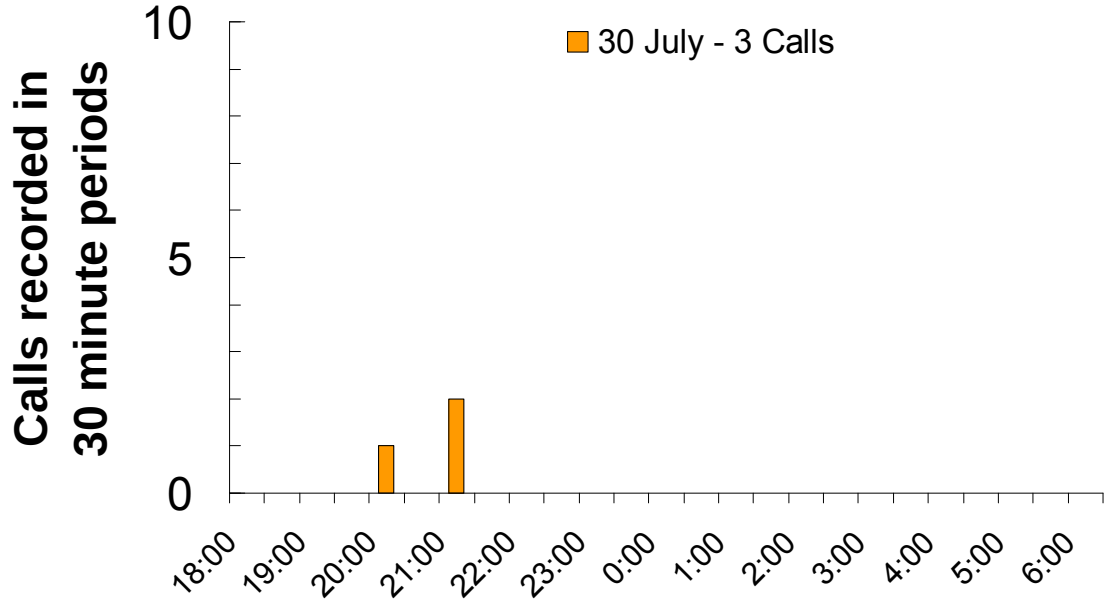
SITE: BAT 3



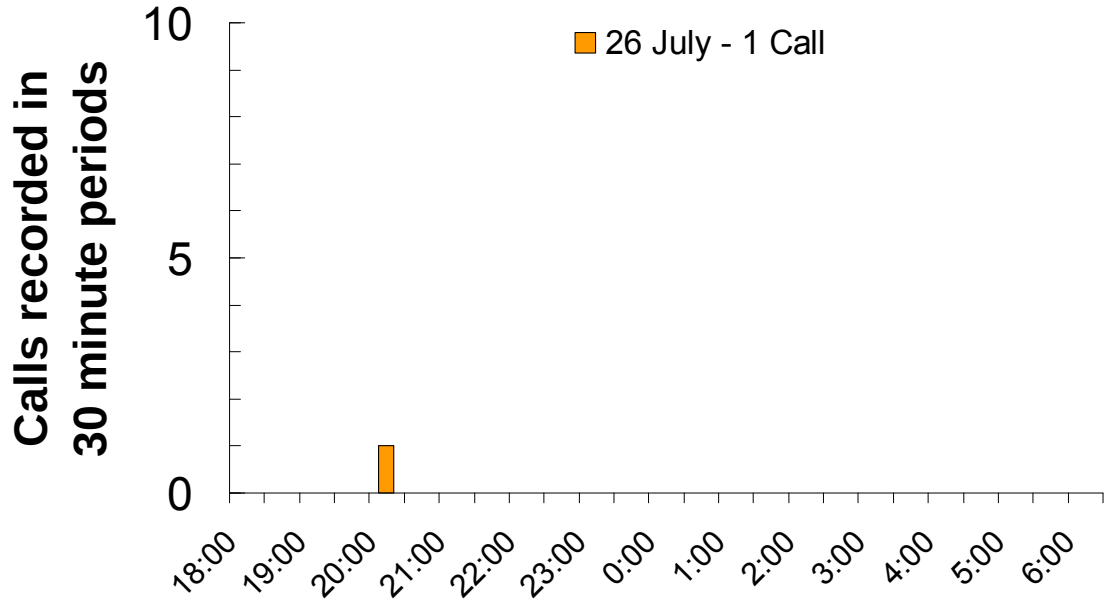
SITE: BAT 4



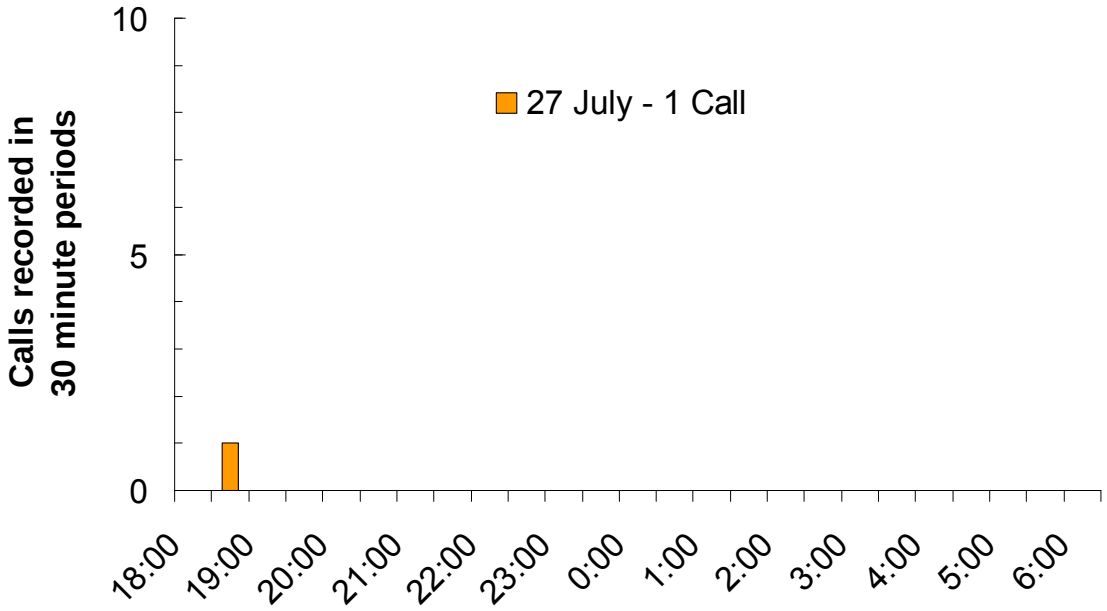
SITE: BAT 6



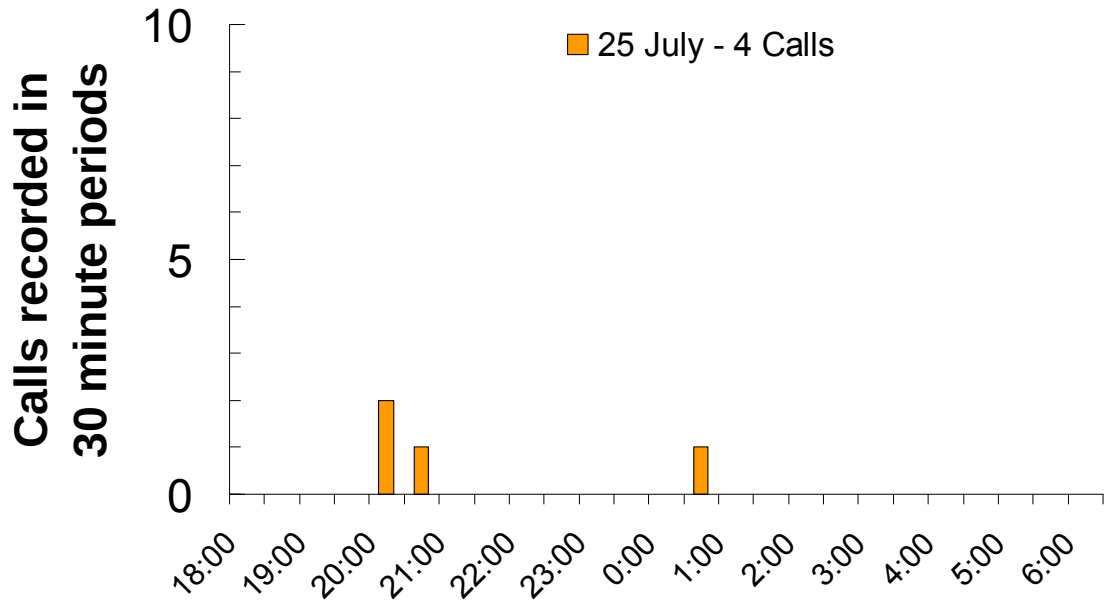
SITE: BAT 8



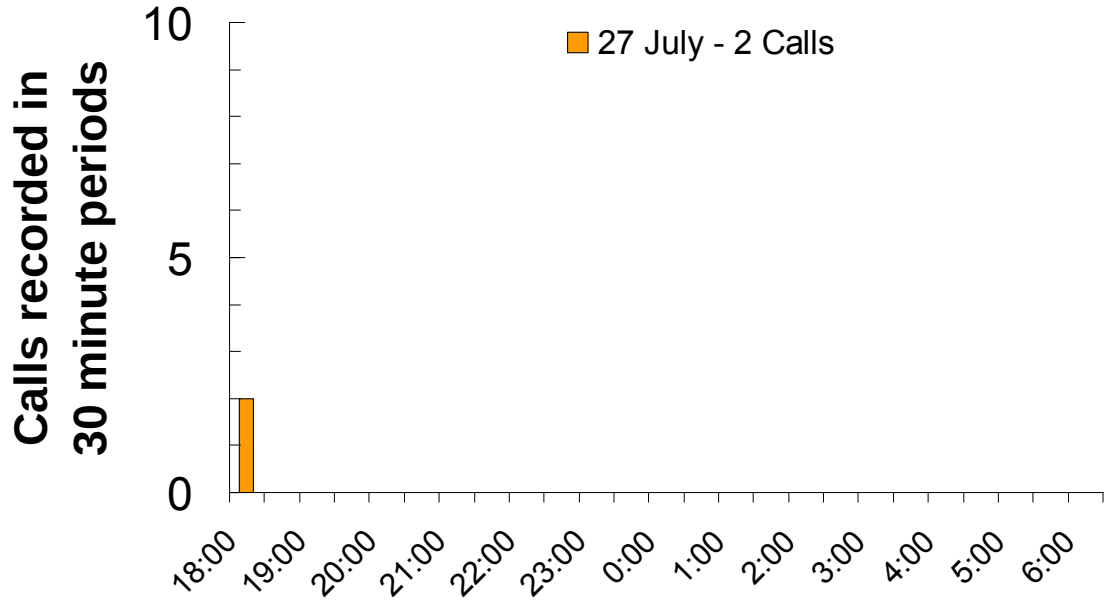
SITE: BAT 15



SITE: BAT 18


Calls recorded in 30 minute periods
10
5
0
25 July - 4 Calls
18:00
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00

SITE: BAT 20


Calls recorded in 30 minute periods
10
5
0
27 July - 2 Calls
18:00
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00