JANUARY 2015

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ENVIRONMENT

FORTESCUE METALS GROUP
WESTERN HUB PROJECT - ELIWANA AND FLYING FISH
TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT

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Document Status						
Rev.	**Author**	**Reviewer**	**Date**	**Approved for Issue**		
				Name	**Distribute To**	**Date**
1	A. Heidrich J. Graff	D. Cancilla	31/8/12	L Roque-Albelo	M. d'Auvergne S. Grein	3/09/12
2	A. Heidrich J. Graff	M. d'Auvergne	28/8/12	D. Cancilla	T. Edwards S. Grein	28/8/12
3	A. Heidrich J. Graff A. Nowicki	M. d'Auvergne	24/10/12	D. Cancilla	T. Edwards S. Grein	24/10/12
4	A. Heidrich	D. Cancilla	12/06/13	K. Bauer-Simpson	T. Edwards S. Grein	14/06/13
5	A. Heidrich	D. Cancilla	19/01/15	D. Cancilla	T. Edwards S. Grein	19/01/15

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ACRONYMS

ANOSIM	Analysis of Similarity
BoM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
DEC	Department of Environment and Conservation
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EP Act	*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

EXECUTIVE SUMMARY

Fortescue Metals Group commisioned *ecologia* Environment to undertake a two-phase Level 2 vertebrate fauna and targeted conservation significant fauna assessment of the Eliwana and Flying Fish study area (study area). The study area is located on the southern edge of the western side of the Hamersley Range and covers a total of 48,644 ha.

The survey methods were consistent with the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment; Guidance Statement No. 56; Position Statement No. 3; the EPBC Act 1999 referral guidelines for the endangered Northern Quolls; 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.

A two phase Level 2 vertebrate fauna survey was conducted in autumn with two eleven day surveys (13-23 April 2012 and 19-29 April 2013). A targeted survey was undertaken in winter (3-11 July 2012). During the current survey, a total of 12 trapping sites were established across four habitat types, and five land systems. Opportunistic searches were also undertaken at 49 additional sites located in habitat not suitable for trapping due to access limitations or difficulties in trap setup. In addition, potential habitat for three EPBC listed conservation significant species was recorded from the study area: Northern Quoll (*Dasyurus hallucatus*; EPBC Act Endangered, WC Act Schedule 1), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*; EPBC Act Vulnerable, WC Act Schedule 1) and Pilbara Olive Python (*Liasis olivaceus barroni*; EPBC Act Vulnerable, WC Act Schedule 1). These species were targeted during the winter (targeted)survey. A further 15 targeted Northern Quoll trapping sites were established during the targeted conservation significant fauna survey component of the assessment.

Total survey effort expended within the study area during the Level 2 vertebrate fauna and targeted conservation siginificant fauna assessment conformed with relevant survey guidelines and comprised the following:

- Systematic trapping grids (pit traps, funnels, Elliott traps and cage traps) were open for 7,056 trap nights (Level 2 vertebrate fauna survey).
- Targeted cage trap sites were open for 749 trap nights (targeted conservation significant fauna survey).
- Approximately 59 hours were spent surveying for birds (during the Level 2 vertebrate fauna assessment).
- 70 hours were spent on opportunistic diurnal searching (63 hrs during Level 2 vertebrate fauna assessment and seven hours during targeted conservation significant fauna assessment).
- 52 hours were spent on opportunistic nocturnal searching (Level 2 vertebrate fauna assessment).
- 16 motion cameras were deployed at 23 locations for a total of 1,822 hours (864 hours during Level 2 vertebrate fauna and 958 hours during targeted conservation significant fauna assessment).
- 700 hours of SM2BAT accoustic recordings were analysed to determine bat assemblage and distribution (483.6 hours during Level 2 vertebrate fauna and 216 hours during targeted conservation sigificant fauna assessment).

The main conclusions of the Level 2 vertebrate fauna and targeted conservation significant fauna assessment of the Eliwana and Flying Fish study area are as follows:

- Species accumulation curves showed that the survey effort from the current survey was adequate.

- The fauna habitats in the study area support a diverse group of fauna, including conservation significant fauna, but these are not restricted to the study area.
- Five habitat types were identified within the study area; hilltops, hillslopes, ridges and cliffs; footslopes and plains; major creeklines; gorges and gullies; and mixed acacia woodlands (mulga and snakewood). Of these, the gorge/gully habitat type is the most significant habitat within the study area due to the ability to harbour three EPBC listed conservation significant species: Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python). However, all habitat types are widespread in the surrounding region.
- Statistical analyses of the terrestrial fauna data indicated that while the habitat types were different from each other, these were not significant differences (the habitat types were not discrete).
- A total of 22 species of native mammals, six species of introduced mammal, 80 species of bird, 70 species of reptile, three species of amphibian, and one species of fish were recorded during this survey.
- Eight vertebrate species of conservation significance (EPBC, WC Act or DPaW listed) were recorded within the study area, namely Pilbara Leaf-nosed Bat, Ghost Bat, Western Pebble-mound Mouse (active mound), Rainbow Bee-eater, Australian Bustard, Bush Stone-curlew, Pilbara Olive Python, and the skink *Notoscincus butleri*. A further eight conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the study area.
- Results of the targeted conservation significant fauna assessment did not identify any significant roost sites for Pilbara Leaf-nosed Bat, however based on the timing and the call pattern of one of the recorded calls a roost cave was located within 15 km of the SM2Bat site.
- No Northern Quoll individuals or conclusive secondary evidence of the species was recorded during the Level 2 survey or targeted conservation significant fauna assessment, indicating that significant populations are not expected to occur in the area surveyed. A single unidentifiable potential Northern Quoll scat was recorded and sent to an expert for identification; however the scat identification was inconclusive.
- Some limitations were experienced, including restricted access to the northern edge of the study area. However, synonymous habitat was surveyed elsewhere in more accessible areas of the study area and, based on statistical analysis of the data recorded; the majority of the predicted and expected fauna species likely to occur in the study area 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 a targeted conservation significant fauna assessment of the Eliwana and Flying Fish study area (study area).

The study area is located on the southern edge of the western side of the Hamersley Range and covers a total of 48,644 ha (Figure 1.1). A Level 1 fauna assessment was previously undertaken by Ecoscape (2012b, c) to identify the location and extent of habitat types and areas that support conservation significant species. This information was reviewed and utilised to establish a survey design for the two-phase Level 2 vertebrate fauna assessment and the targeted conservation significant fauna assessment, the results of which are detailed 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 2004c);
- Principles outlined in EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA 2002b); and
- The Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010).

The current survey was also undertaken in consistency with following guidelines:

- Survey guidelines for Australia's Threatened Mammals (DSEWPaC 2011d);
- Survey guidelines for Australia's Threatened Bats (DSEWPaC 2011b);
- Survey guidelines for Australia's Threatened Birds (DSEWPaC 2010);

- Survey guidelines for Australia's Threatened Reptiles (DSEWPaC 2011e);
- Survey guidelines for Australia's Threatened Fish (DSEWPaC 2011c); and
- EPBC Act 1999 Referral guidelines for the endangered Northern Quoll (DSEWPaC 2011a).

Native flora and fauna in Western Australia that are formally recognised as rare, threatened with extinction, or as having high conservation value are protected at a federal level under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and at a state level under the Western Australian *Wildlife Conservation Act 1950* (WC Act).

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

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

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

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

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

1.3 SURVEY OBJECTIVES

Fortescue commissioned *ecologia* to undertake a comprehensive biological survey of the terrestrial vertebrate fauna of the study area.

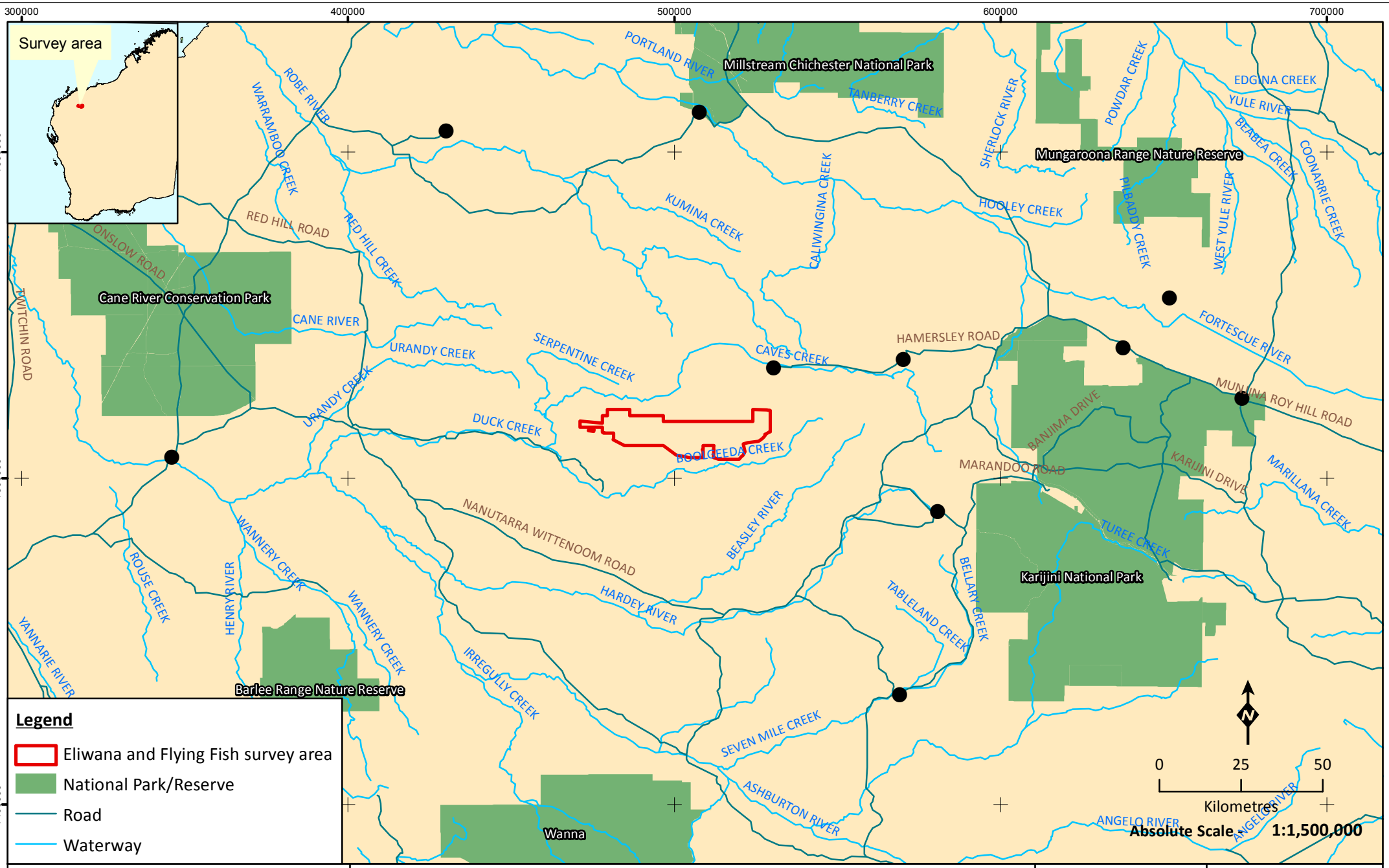
The EPA's objectives with regards to fauna management are to:

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

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

This report satisfies the objectives outlined in Fortescue's Scope of Works and satisfies the requirements documented in the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010), EPA Guidance Statement No. 56 and Position Statement No. 3 (EPA 2002b, 2004c), Guidelines for threatened mammals, bats, birds, reptiles (DSEWPaC 2010, 2011b, d, e) and the *EPBC referral guidelines for endangered northern quoll* (DSEWPaC 2011a), by providing a:

- Desktop a review of background information (including literature and database searches);
- Inventory of vertebrate fauna species potentially occurring in the study area , incorporating recent published and unpublished records;
- Review of regional and biogeographical significance, including the conservation status and significance of species recorded in the study area.
- Discussion related to the species of biological and conservation significance recorded or likely to occur within the study area and the surrounding region;
- 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;
- Detailed fauna habitat assessment of the study area ;
- Detailed Level 2 vertebrate fauna assessment, including systematic trapping, observations, acoustic bat recording and overall assessment of the faunal assemblage recorded within the study area ; and
- 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 the study area

Figure: 1.1 **Project ID: 1512**	**Drawn: AH** **Date: 09/05/12**

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

Unique Map ID: AH427

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2 EXISTING ENVIRONMENT

2.1 CLIMATE

The study 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 (BoM 2013). 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 (BoM 2013).

The closest Bureau of Meteorology (BoM) weather station that is representative of the study area and documents a full set of meteorological records (including current and historical rainfall and temperatures) is at Paraburdoo (station number 007185; 23°12' S, 117°40' E), approximately 133 km from the southern border of the study area. The Paraburdoo station provides climatic records closest to that experienced within the study area. Rainfall data preceding the survey and mean rainfall recorded between 1950 and 2013 are listed in Table 2.1 and displayed in Figure 2.1 and Figure 2.2 (BoM 2013).

The amount of rainfall at the Paraburdoo Aero weather station in January 2012 (205.2 mm) was more than four times the mean for that month (52.1 mm). Following the heavy rainfall in January, precipitation was close to average for the three months preceding the survey.

An average amount of rainfall was recorded prior the second phase of the Level 2 survey in 2013 with 77.0 mm recorded in March and 17.4 mm recorded in April 2013. Rainfall was observed on site only during the second phase of the fauna survey with a total of 4.2 mm on 27 April 2013 (Appendix B).

The weather conditions experienced during the fauna survey, as recorded by the Paraburdoo Aero weather station (BoM 2013) are listed in Appendix B. The survey was conducted over three periods, with a two phased Level2 survey and a targeted conservation significant fauna survey. Following temperatures were recorded during the surveys:

- Phase 1 (13-23 April 2012): minimum temperatures ranged between 13.5 °C and 20.9 °C and maximum temperatures ranging from 28.7 °C and 35.9 °C.
- Phase 2 (19-29 April 2013): minimum temperatures ranged between 16.4 to 23.7 °C, and maximum temperatures between 33.1 °C and 36.2 °C.
- Targeted survey (3-11 July 2012): highly varied temperatures and significantly cooler, with minimum temperatures ranging between 1.8 °C and 11.0 °C and maximum temperatures ranging between 21.4 °C and 27.4 °C.

Based on the mean climatic data (Figure 2.2), these temperatures were within the normal range for the time the surveys were conducted and were adequate for surveying for all vertebrate fauna groups (mammals, birds, reptiles and amphibians).

Table 2.1 – Mean rainfall (1950-2013) and preceding the surveys (BoM 2014)

Month	Paraburdoo	
	Mean rainfall in preceding months (mm)	Mean rainfall 1950–2013 (mm)
2012		
January	205.2	52.1
February	73.6	76.6
March	77.0	46.0
April (Phase 1)	17.4	26.2
May	0.0	17.5
June	10.4	23.1
July (Targeted)	1.0	13.9
August	0.0	11.0
September	0.4	3.3
October	32.8	4.2
November	1.6	8.4
December	33.6	29.0
2013		
January	2.6	52.1
February	-	76.6
March	-	46.0
April (Phase 2)	-	26.2

Source: (BoM 2013)

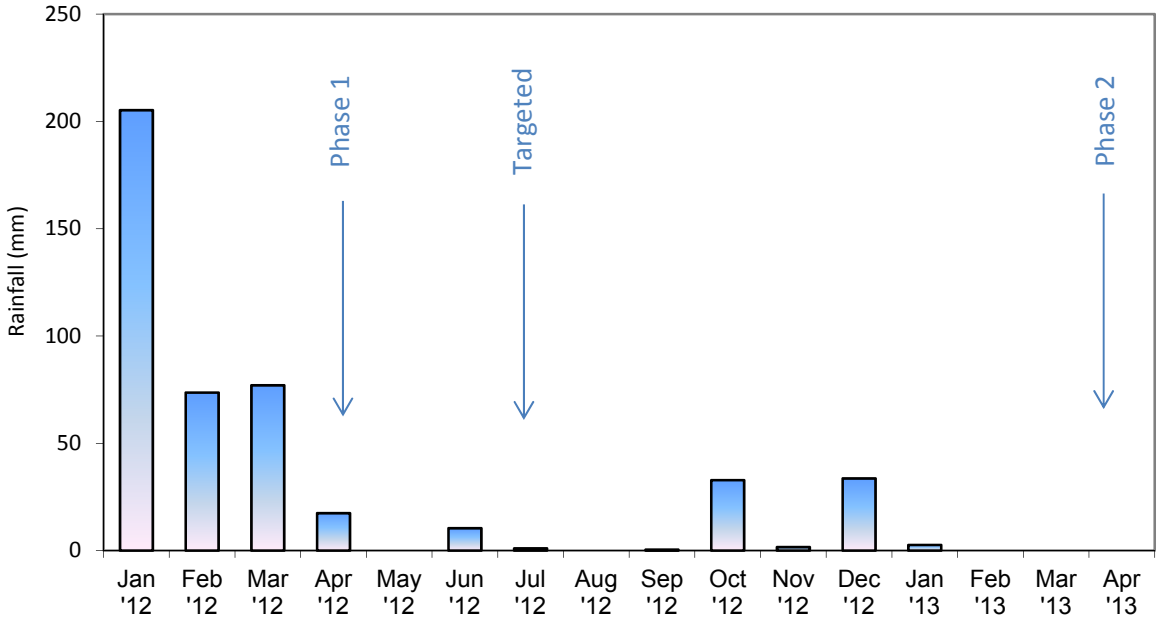


Figure 2.1 – Rainfall recorded preceding the surveys (BoM 2013)

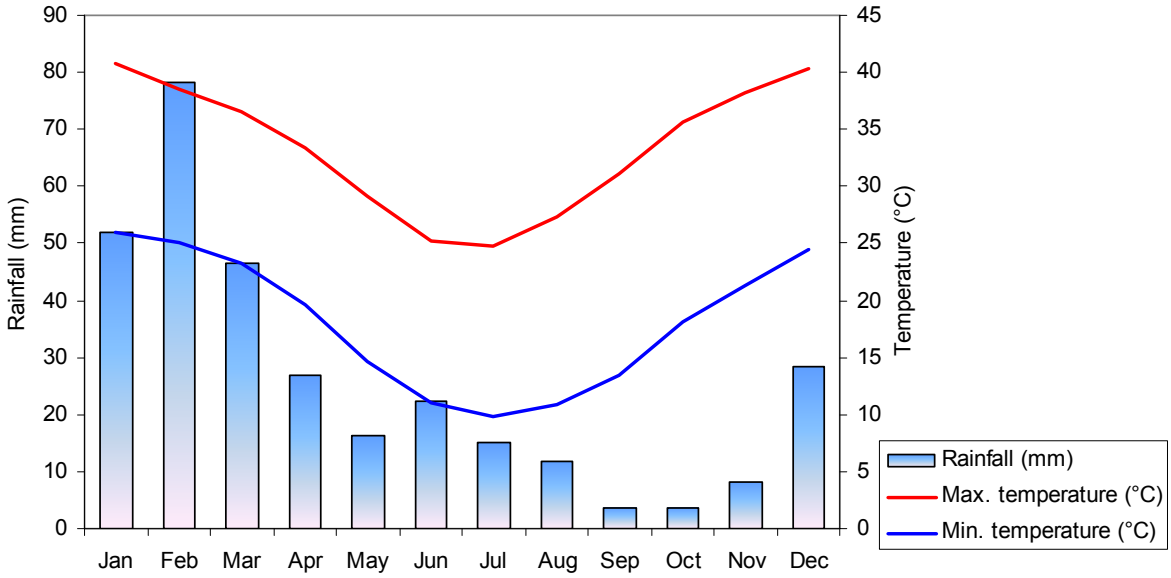


Figure 2.2 – Rainfall and temperature for Paraburdoo weather station (1974-2012)

2.2 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 7.1), the study 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, introduced 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 by 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 study area is located within a single subregion; the Hamersley. 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; low mulga 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).

2.3 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 study area contains five land systems mapped by Van Vreeswyk *et al.* (2004). The land systems with the largest proportion of area within the study area are Rocklea (51.1 %), Newman (31.7 %) and Boolgeeda (10.5 %) (Table 2.2).

The Rocklea land system is characterised by Basalt hills, lower slope and plains and occupies the majority of the north of the study area. It supports hard spinifex grasslands. The Newman land system comprises plateaus, ridges and mountains with hard spinifex grasslands. This land system was found adjacent to the Rocklea land systems occupying the south of the study area. The third largest land system recorded was the Boolgeeda land system. It is described as comprising stony lower slopes and plains below hill systems, and is dominated by soft spinifex grasslands or mulga shrublands (van Vreeswyk *et al.* 2004).

The Robe and Platform land systems occur in smaller areas throughout the southern half of the study area. The Robe land system comprises low plateaus, mesas and buttes of limonites, and is described as supporting soft and hard spinifex grasslands (van Vreeswyk *et al.* 2004). Dissected slopes and raised plains are characteristic of the Platform land system, which also supports hard spinifex grasslands. Both land systems occupy less than 6.7 % of the study area (Table 2.2).

All five land systems recorded within the study area are common in the region and less than 0.8% of their total distribution is located within the Eliwana and Flying Fish study area (Table 2.2).

Table 2.2 – Land systems of the study area

Land System	Description	Total Area in WA (ha)	Area in study area (ha)	Percent of study area (%)	Percent of Total Land System (%)
Land system Type 1					
Rocklea	Basalt hills, plateaus, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	2,893,880.1	25,429.3	51.1	0.8
Newman	Rugged jaspilite plateaus, ridges and mountains supporting hard spinifex grasslands.	1,999,771.4	15,759.5	31.7	0.7
Land system Type 3					
Robe	Low plateaus, mesas and buttes of limonites supporting soft spinifex (and occasionally hard spinifex) grasslands.	130,704.4	1,328.4	2.7	0.01
Land system Type 5					
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands.	237,112.0	2,020.7	4.0	0.8
Land system Type 18					
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	999,608.6	5,228.2	10.5	0.5

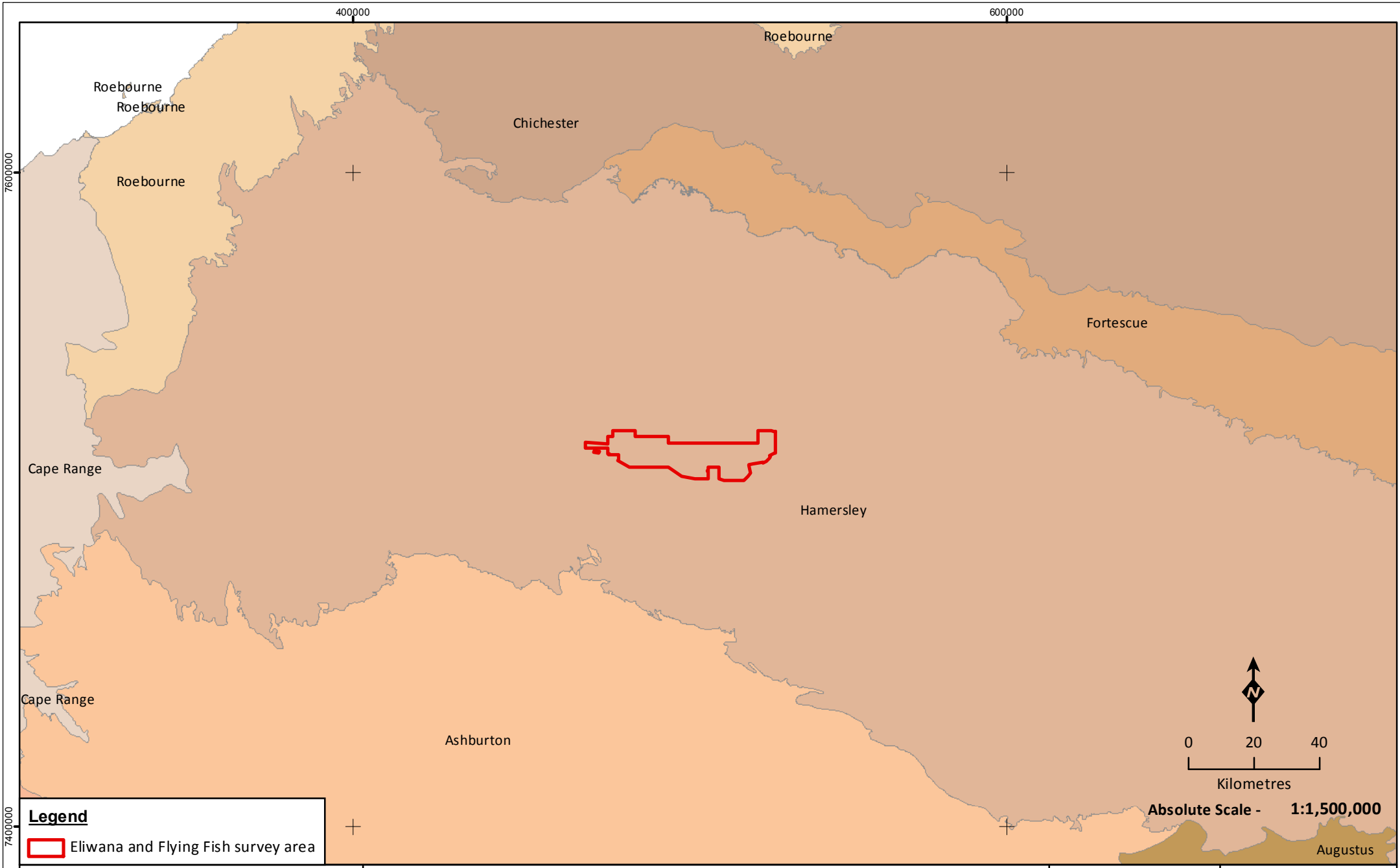
2.4 VEGETATION

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 study area lies in the Fortescue Botanical District within the larger Pilbara Botanical Province (Beard 1975). Four vegetation associations occur in the study area (Shepherd *et al.* 2001), and these are described in Table 2.3 and presented in Figure 2.5.

The study area lies predominantly in Beard's Hamersley Plateau of the Fortescue Botanical District. The most common vegetation type (52 %) in the Eliwana and Flying Fish study area is vegetation unit 567, which is found along the lower slopes and plains in the north of the study area (Table 2.3, Figure 2.5). It occupies 52 % of the area and is described as comprising hummock grassland, shrub steppe with mulga and kanji (*Acacia inaequilatera*) over soft spinifex and *Triodia basedowii* (Beard 1975). The plateaux and hills in the south of the study area are dominated by hummock grasslands (*Triodia wiseana*) with a low tree steppe of snappy gum (*Eucalyptus leucophloia*). This vegetation type occupies 39.8 % of the study area. The remaining 8.2 % of the study area is dominated by a grass plain of short bunch grassland and low woodlands of mulga (*Acacia aneura*).

Table 2.3 – Vegetation associations of the Eliwana and Flying Fish study area

Shepherd Unit	Vegetation Description	Total Area in WA (ha)	Area in the study area (ha)	Percent of study area (%)	Percent of Total Vegetation Unit (%)
82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	2,565,571.7	19,810.73	39.8	0.77
567	Hummock grasslands, shrub steppe; mulga and kanji over soft spinifex and *Triodia basedowii*	776,997.6	25,894.57	52.0	3.33
175	Short bunch grassland - savanna/grass plain (Pilbara)	526,377.0	3,016.31	6.1	0.57
18	Low woodland; mulga (*Acacia aneura*)	19,984,083.9	1,044.44	2.1	0.01



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Biogeographic regions of the study area

Figure: 2.0
Project ID: 1512

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Date: 11/06/13

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Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: AH431

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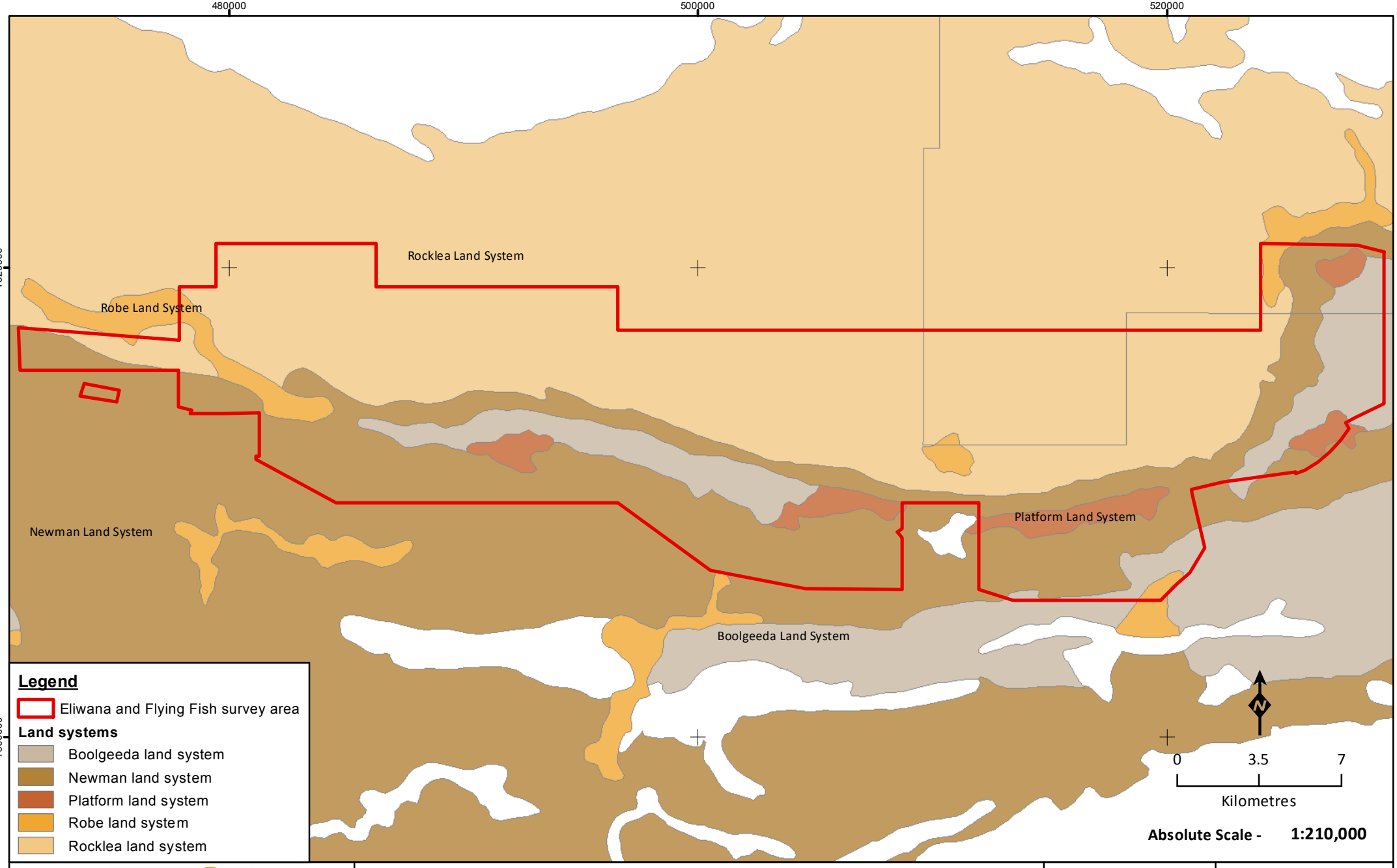

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Land systems of the study area

Figure: 2.п
Project ID: 1512

Drawn: AH
Date: 11/06/13

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Projection: Transverse Mercator
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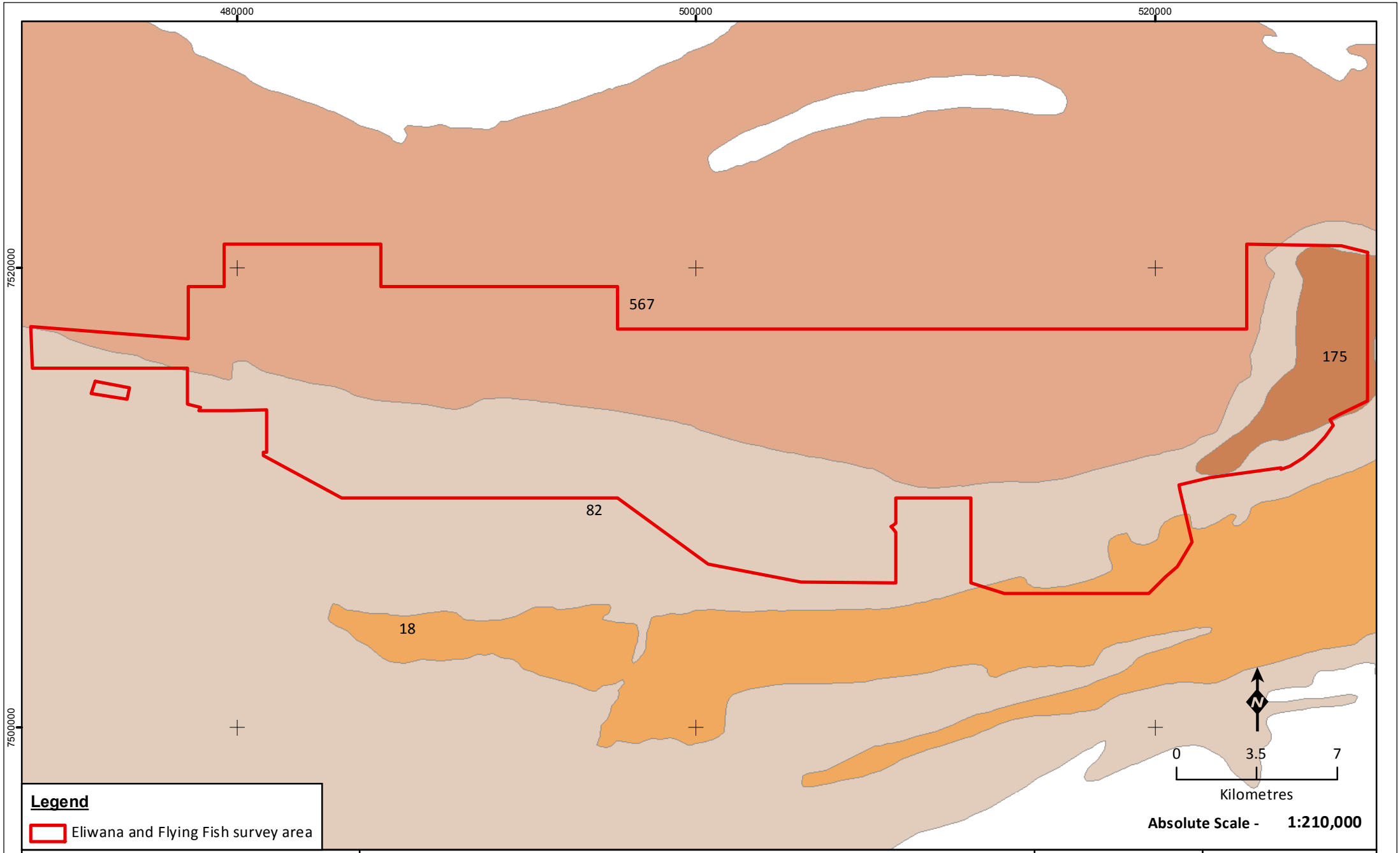

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Vegetation associations of the study area (Shepperd 2002)

Figure: 2.p
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: AH430

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2.5 PREVIOUS SURVEYS AND LAND USE

Several databases were consulted in the preparation of potential fauna (and conservation significant fauna) species lists (Table 2.4). In addition, 18 publications reporting on vertebrate fauna surveys conducted within 100 km of the study area were reviewed (Table 2.5). 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.

Table 2.4 – Fauna databases searched to determine the potential vertebrate fauna assemblage

Database	Custodian	Search Details
NatureMap	DPaW, WA Museum	40-km radius around the centre of the study area. Coordinate: 452102 E 7534262 N Date accessed: 15/8/12
Species Profile and Threats (SPRAT) Database	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)	Square around Western Hub area with a 40-km buffer
Birdata	BirdLife Australia	Records within one square decimal degree (100 km^2) Latitude: -22˚ to -23˚ Longitude: 117˚ to 118˚
Threatened and Priority Fauna Database	DPaW	Rectangle around study area with a 40-km buffer

Table 2.5 – Previous biological survey reports within 100 km of the study area

Survey Location and Author(s)	Distance to study area (km)	Comments
Eliwana and Flying Fish (Ecoscape 2012b, c)	0	Level 1 fauna and targeted conservation significant fauna assessment
ecologia internal database	4 – 46	Two Level 1 fauna assessments, one two-phase Level 2 vertebrate fauna assessment
Delphine (Ecoscape 2012a)	5	Level 1 fauna and targeted conservation significant fauna assessment
Delphine (*ecologia* 2013)	5	Level 2 vertebrate fauna and targeted conservation significant fauna assessment
Brockman 2 Detritals (Mattiske and Ninox 1990)	7	Level 1 fauna assessment
Brockman Syncline (Biota 2005b)	9	Level 2 vertebrate fauna assessment
Mt Farquhar (Ecoscape 2012d)	9	Level 1 fauna and targeted conservation significant fauna assessment
Mt Farquhar (*ecologia* 2012)	9	Single-phase Level 2 vertebrate fauna and targeted conservation significant fauna assessment
Raven (Ecoscape 2012e)	16	Level 1 fauna assessment and targeted conservation significant fauna assessment
Central Pilbara Project (*ecologia* 2011b)	40	Level 2 vertebrate fauna assessment
West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	46	Level 2 vertebrate fauna assessment
West Turner Section 10 (Biota 2009b)	49	Level 2 vertebrate fauna assessment
Solomon Hub (ecologia 2014)	55	Single-phase Level 2 survey
Solomon Mine Project Area (Coffey 2008)	65	Single-phase Level 2 vertebrate fauna assessment

Survey Location and Author(s)	Distance to study area (km)	Comments
Solomon Mine Project (*ecologia* 2010)	66	Single-phase Level 2 vertebrate fauna assessment
Firetail mining area (Ecoscape 2010)	73	Single-phase Level 2 vertebrate fauna assessment
Marandoo to Great Northern Hwy (Kendrick 1995)	92	Single-phase Level 2 vertebrate fauna assessment
Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	93	Single-phase Level 2 vertebrate fauna assessment
Mesa A transport corridor (Biota 2006)	93	Single-phase Level 2 vertebrate fauna assessment

2.5.1 Results of literature review

The review of previous reports and database searches as described in Section 2.5 resulted in a total of 38 native mammals species, eight introduced mammals species, 150 bird species (includes one introduced species), 111 reptile species, seven amphibian species and six fish species recorded from the region and potentially occurring in the study area (Table 2.6, Appendix C). Of these, 24 species are of conservation significance (seven species of mammal, 13 species of bird, three species of reptile and one species of fish). Previous records of conservation significant fauna are mapped in Figure 2.6, Figure 2.7 and Figure 2.8 and discussed in greater detail in Section 5.3.

Table 2.6 – Number of species recorded during previous surveys and database searches

Source/Report	Mammals (Native/Introduced)	Birds	Reptiles	Amphibians	Fish
NatureMap	17/4	63	60	2	0
SPRAT Database	2/3	6	1	0	0
DPaW Rare fauna database	5/0	3	2	0	0
Birdata	-	122	-	-	-
Eliwana and Flying Fish (Ecoscape 2012b, c)	4/4	38	1	0	0
Previous *ecologia* surveys	18/5	76	63	0	0
Delphine (Ecoscape 2012a)	3/4	44	5	1	2
Delphine (*ecologia* 2013)	22/5	104*	66	3	6
Brockman 2 Detritals (Mattiske and Ninox 1990)	4/4	64	15	0	0
Brockman Syncline (Biota 2005b)	15/4	82	54	2	0
Mt Farquhar (Ecoscape 2012d)	3/2	36	9	0	0
Mt Farquhar (*ecologia* 2012)	16/4	56	34	0	2
Raven (Ecoscape 2012e)	3/0	36	7	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
Solomon Hub (ecologia 2014)	20/3	80	68	3	4

Source/Report	Mammals (Native/Introduced)	Birds	Reptiles	Amphibians	Fish
Solomon Project Area (Coffey 2008)	19/4	63	73	4	0
Solomon Project (*ecologia* 2010)	20/4	75	55	3	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
West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	22/4	78	59	3	0
Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	10/1	52	31	0	0
Mesa A transport corridor (Biota 2006)	17/2	93	60	3	0
Total	**38/8**	**150***	**111**	**7**	**6**

*Includes one introduced species

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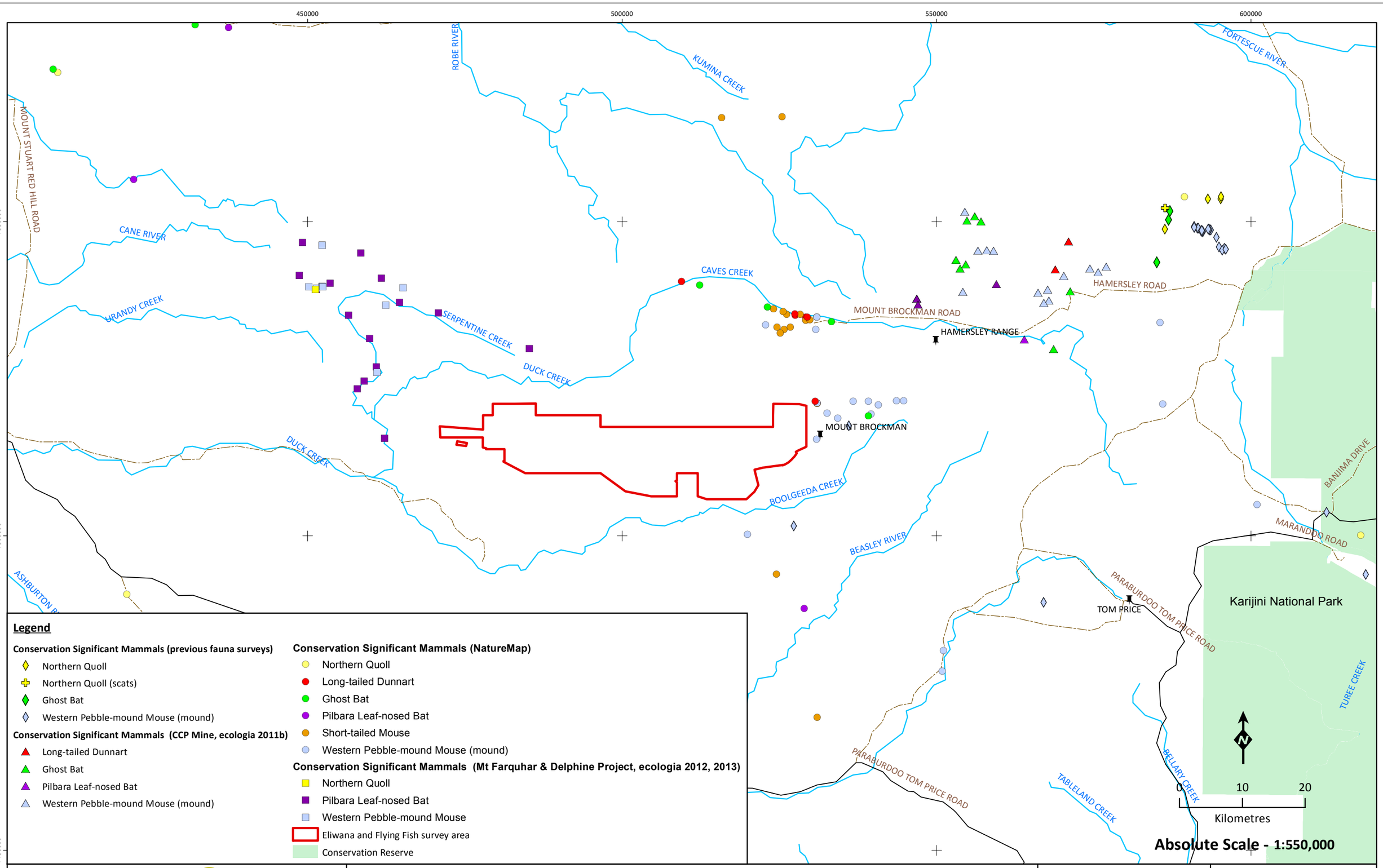

Legend

Conservation Significant Mammals (previous fauna surveys)

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

Conservation Significant Mammals (CCP Mine, ecologia 2011b)

- 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)

Conservation Significant Mammals (Mt Farquhar & Delphine Project, ecologia 2012, 2013)

- Northern Quoll
- Pilbara Leaf-nosed Bat
- Western Pebble-mound Mouse
- Eliwana and Flying Fish survey area
- Conservation Reserve

ecologia ENVIRONMENT

Regional records of conservation significant mammals

Figure: 2.6
Project ID: 1512

Drawn: AH
Date: 06/01/15

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

Unique Map ID: AH470

A3

400000 450000 500000 550000 600000

7550000 7500000 7450000

KUMINA CREEK
ROBE RIVER
RED HILL CREEK
MOUNT STUART RED HILL ROAD
CANE RIVER
BRANDY CREEK
SERPENTINE CREEK
CAVES CREEK
DUCK CREEK
MOUNT BROCKMAN ROAD
HAMERSLEY ROAD
HAMERSLEY RANGE
MOUNT BROCKMAN
BOOLGEEDA CREEK
BEASLEY RIVER
MARANDOO ROAD
PARABURDOO TOM PRICE ROAD
TOM PRICE
Karijini National Park
TABLELAND CREEK
BELLARY CREEK
ASHBURTON

Legend

Conservation Significant Birds (Previous fauna surveys)
- Australian Bustard
- Fork-tailed Swift
- Grey Falcon
- Peregrine Falcon
- Rainbow Bee-eater
- Star Finch

Conservation Significant Birds (NatureMap)
- Australian Bustard
- Bush Stone-curlew
- Eastern Great Egret
- Grey Falcon
- Peregrine Falcon
- Rainbow Bee-eater
- Star Finch

Conservation Significant Birds (CCP Mine, ecologia 2011b)
- Australian Bustard
- Bush Stone-curlew
- Fork-tailed Swift
- Peregrine Falcon
- Rainbow Bee-eater

Conservation Significant Birds (Mt Farquhar & Delphine Project, ecologia 2012, 2013)
- Australian Bustard
- Bush Stone-curlew
- Eastern Great Egret
- Eastern Osprey
- Grey Falcon
- Peregrine Falcon
- Rainbow Bee-eater
- Eliwana and Flying Fish survey area
- Conservation Reserve

N

0 10 20
Kilometres

Absolute Scale - 1:550,000

ecologia ENVIRONMENT

Regional records of conservation significant birds

Figure: 2.7
Project ID: 1512

Drawn: AH
Date: 06/01/15

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

Unique Map ID: AH471

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ROBE RIVER
KUMINA CREEK
HOOLEY CREEK
FORTESCUE RIVER
CANE RIVER
BRANDY CREEK
SERPENTINE CREEK
CAVES CREEK
DUCK CREEK
MOUNT BROCKMAN ROAD
HAMERSLEY ROAD
HAMERSLEY RANGE
MOUNT BROCKMAN
BOOLGEEDA CREEK
BEASLEY RIVER
BANJIMA DRIVE
KARIJINI DRIVE
MARANDOO ROAD
Karijini National Park
PARABURDOO TOM PRICE ROAD
TOM PRICE
HARDEY RIVER
TUREE CREEK
WITTENOOM ROAD
BELLARY CREEK
TABLELAND CREEK

Legend

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

Conservation Significant Reptiles (CCP Mine, ecologia 2011b)
- Pilbara Olive Python
- *Notoscincus butleri*
- *Ramphotyphlops ganei*

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

Conservation Significant Reptiles and Fish (Mt Farquhar & Delphine Project, ecologia 2012, 2013)
- *Notoscincus butleri*
- *Fortescue Grunter*
- Eliwana and Flying Fish survey area
- Conservation Reserve

N

0 10 20
Kilometres

Absolute Scale - 1:550,000

ecologia ENVIRONMENT

Regional records of conservation significant reptiles and fish

Figure: 2.8
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: AH472

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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 a two-phased Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment to be conducted within the study area.

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

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, however until recently the study area surrounding region was poorly studied.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The landforms associated with the study area are typical for the region and do not present any rare or special characteristics.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present.	The best survey time for birds and amphibians is following seasonal rain events. Best survey timing for reptiles is from September to April. Survey timing for mammals is not constrained.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	Twenty previous terrestrial vertebrate fauna assessments have been carried out within 100 km of the study area. Regional and local knowledge for the area is available.
Number of different habitats or degree of similarity between habitats within a study area.	Five fauna habitat types were identified based on on-site observations, and mapped land systems and vegetation units. These were: hilltops, hillslopes, ridges and cliffs; footslopes and plains; major creeklines, gorges and gullies, and mixed acacia woodlands.
Climatic restrictions (e.g. temperature or rainfall that preclude certain sampling methods).	The Pilbara region experiences hot summers with occasional cyclonic rain events, followed by mild winters with light rains. Rainfall is highly unpredictable.
Sensitivity of the environment to the proposed activities.	The study area contains habitat types which are well represented in the surrounding region.
Size, shape and location of the proposed activities.	The study area incorporates the Eliwana and Flying Fish mining tenements, and is located in the Pilbara region of Western Australia. The total size of the study area is approximately 49,766.1ha.
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. Current access tracks indicate potential site of impact, thus impact areas are expected to be suitably surveyed.

3.2 SURVEY TIMING

Both phases of the Level 2 vertebrate fauna assessment were conducted in autumn (13-23 April 2012 and 19-29 April 2013). This represents the most suitable survey timing with the rain season prior to surveying which conforms with that indicated in the respective guidelines (DEWHA 2010; DSEWPaC 2011b, d, e; EPA 2004a; EPA and DEC 2010; FMG 2011). The targeted conservation significant fauna assessment was conducted in winter (3-11 July 2012). A high proportion of expected species were recorded, indicating that the surveys were adequate.

Table 3.2 – Summary of survey timing and duration

Survey	Dates	Duration (days)	Person Days
Phase 1 Level 2 vertebrate fauna assessment	13-23 April 2012	11	74
Targeted conservation significant fauna assessment	3-11 July 2012	9	36
Phase 2 Level 2 vertebrate fauna assessment	19-29 April 2013	11	74
Total	-	**31**	**184**

3.3 SITE SELECTION

Habitat types previously mapped by Ecoscape (2012b, c) were reviewed and interpreted for survey site selection, with location of access tracks, land systems and the abundance of habitat types taken into consideration. Common habitat types (footslopes and plains; and hilltops, hillslopes, ridges and cliffs) were sampled by a larger number of systematic trapping sites than less common habitat types to assess their fauna assemblage adequately. The less common habitats (gorged and gullies and major creeklines) and those less represented by systematic trapping (mixed shrubland) were targeted with greater opportunistic survey effort (diurnal and nocturnal searches and transects) and camera trapping to ensure adequate sampling of all habitat types across the study area.

Trap site 1 was divided into two trap locations (each with five trap lines) due to extensive areas throughout the represented habitat type having been recently burnt prior to the first phase of surveying in 2013. This was to ensure that the habitat type represented by this trap site sampled unburnt vegetation within the same habitat type and land system. Their locations were approximately 3.7 km apart, but for the purpose of data analysis, these two divided trap locations were combined and referred to as a single trap site represented by the name “EFF S1a” and “EFF S1b” within the Robe land system and the footslopes and plains habitat type.

In addition to trapping, opportunistic searches were undertaken, habitat suitable to support conservation significant species. Locations and details of all survey sites are listed in Table 3.3 and mapped in Figure 3.1.

Detailed descriptions, including photographs of each of the systematic trapping sites are listed in Appendix D.

Table 3.3 – Survey site information (Level 2 survey)

Site Name	Survey Site (Survey type)	Dates	Coordinates		Land system
			Easting	Northing	
Level 2 survey					
EFF S1a	Trap site	15-22/04/12, 20-27/04/13	481944	7514627	Robe
EFF S1b	Trap site	15-22/04/12, 20-27/04/13	479122	7516842	Robe
EFF S2	Trap site	15-22/04/12, 20-27/04/13	483158	7513708	Robe
EFF S3	Trap site	14-21/04/12, 21-28/04/13	486086	7512716	Newman
EFF S4	Trap site	14-21/04/12, 21-28/04/13	492610	7512208	Platform
EFF S5	Trap site	14-21/04/12, 21-28/04/13	504086	7510890	Boolgeeda
EFF S6	Trap site	14-21/04/12, 21-28/04/13	503820	7513303	Rocklea
EFF S7	Trap site	14-21/04/12, 21-28/04/13	502989	7516151	Rocklea
EFF S8	Trap site	15-22/04/12, 22-29/04/13	507393	7510104	Platform
EFF S9	Trap site	15-22/04/12, 22-29/04/13	512475	7508750	Newman
EFF S10	Trap site	15-22/04/12, 22-29/04/13	522001	7510967	Newman
EFF S11	Trap site	15-22/04/12, 22-29/04/13	527338	7515435	Boolgeeda
EFF S12	Trap site	15-22/04/12, 22-29/04/13	524700	7513484	Boolgeeda/Newman
EFF OS1	Opportunistic	18/04/12	510017	7508811	Rocklea
EFF OS2	Opportunistic	18/04/12	500670	7515935	Newman
EFF OS3	Opportunistic	18/04/12	503472	7511704	Newman
EFF OS4	Targeted/opportunistic	18/04/12	495397	7511771	Robe
EFF OS5	Opportunistic	18/04/12	482077	7514556	Rocklea
EFF OS6	Opportunistic	18/04/12	517777	7512533	Rocklea
EFF OS7	Opportunistic	18/04/12	488594	7515783	Rocklea
EFF OS8	Targeted/opportunistic	18/04/12	506276	7516411	Newman
EFF OS9	Targeted/opportunistic	18/04/12	480110	7514102	Newman
EFF OS10	Opportunistic	19/04/12	478384	7514631	Rocklea
EFF OS11	Opportunistic	19/04/12	503662	7512214	Newman
EFF OS12	Targeted/opportunistic	19/04/12	508401	7508944	Newman
EFF OS13	Opportunistic	19/04/12	479724	7514338	Newman

Site Name	Survey Site (Survey type)	Dates	Coordinates		Land system
			Easting	Northing	
EFF OS14	Targeted/opportunistic	19/04/12	516069	7508239	Robe
EFF OS15	Targeted/opportunistic	19/04/12	479409	7516227	Newman
EFF OS16	Targeted/opportunistic	19/04/12	497630	7511226	Newman
EFF OS17	Targeted/opportunistic	19/04/12	491495	7511421	Newman
EFF OS18	Opportunistic	19/04/12	512522	7509594	Newman
EFF OS19	Opportunistic	19/04/12	479352	7513994	Newman
EFF OS20	Opportunistic	19/04/12	481648	7513441	Rocklea
EFF OS21	Targeted/opportunistic	20/04/12	503282	7516187	Robe
EFF OS22	Targeted/opportunistic	20/04/12	476220	7514921	Robe
EFF OS23	Opportunistic	20/04/12	481655	7513824	Newman
EFF OS24	Targeted/opportunistic	20/04/12	483461	7514210	Newman
EFF OS25	Opportunistic	21/04/12	486091	7512546	Newman
EFF OS26	Opportunistic	21/04/12	488612	7513966	Rocklea
EFF OS27	Opportunistic	25/04/13	479852	7515051	Newman
EFF OS28	Opportunistic	25/04/13	504299	7516094	Newman
EFF OS29	Opportunistic	25/04/13	498045	7513066	Robe
EFF OS30	Opportunistic	25/04/13	504224	7511067	Rocklea
EFF OS31	Opportunistic	25/04/13	482161	7514610	Rocklea
EFF OS32	Opportunistic	25/04/13	504258	7513330	Platform
EFF OS33	Opportunistic	26/04/13	503459	7516077	Rocklea
EFF OS34	Opportunistic	26/04/13	493012	7511880	Robe
EFF OS35	Opportunistic	26/04/13	475856	7514974	Newman
EFF OS36	Opportunistic	26/04/13	504381	7516158	Newman
EFF OS37	Opportunistic	26/04/13	483077	7513712	Newman
EFF OS38	Opportunistic	26/04/13	524551	7513639	Newman
EFF OS39	Opportunistic	26/04/13	521938	7511069	Newman
EFF OS40	Opportunistic	26/04/13	495599	7513500	Newman
EFF OS41	Opportunistic	26/04/13	512713	7508512	Newman
EFF OS42	Opportunistic	26/04/13	518403	7510546	Newman
EFF OS43	Opportunistic	26/04/13	524964	7514676	Newman
EFF OS44	Opportunistic	26/04/13	499924	7510050	Newman
EFF OS45	Opportunistic	25/04/13	525025	7514401	Newman
EFF OS46	Opportunistic	25/04/13	480446	7513865	Newman
EFF OS47	Opportunistic	25/04/13	476194	7514901	Newman
EFF OS48	Opportunistic	25/04/13	525504	7516046	Newman
EFF OS49	Opportunistic	25/04/13	512358	7508823	Newman
Bat rec 1 (EFF S3)	SM2BAT site	15/04/12	486086	7512716	Newman
Bat rec 2 (EFF S2)	SM2BAT site	16/04/12	483158	7513708	Robe
Bat rec 3 (EFF S1b)	SM2BAT site	17/04/12	479122	7516842	Robe

Site Name	Survey Site (Survey type)	Dates	Coordinates		Land system
			Easting	Northing	
Bat rec 4	SM2BAT site	18/04/12	482077	7514556	Robe
Bat rec 5 (EFF S6)	SM2BAT site	20/04/12	503820	7513303	Rocklea
Bat rec 6	SM2BAT site	21/04/12	479269	7513740	Newman
Bat rec 7(EFF S5)	SM2BAT site	22/04/12	504086	7510890	Boolgeeda
Bat rec 8 (EFF S12)	SM2BAT site	16/04/12	524700	7513484	Boolgeeda/Newman
Bat rec 9 (EFF S11)	SM2BAT site	17/04/12	527338	7515435	Boolgeeda
Bat rec 10 (EFF S9)	SM2BAT site	18/04/12	512475	7508750	Newman
Bat rec 11 (EFF S10)	SM2BAT site	19/04/12	522001	7510967	Newman
Bat rec 12 (EFF S7)	SM2BAT site	20/04/12	502989	7516151	Rocklea
Bat rec 13	SM2BAT site	21/04/12	480537	7513848	Newman
Bat rec 14 (EFF S4)	SM2BAT site	15/04/12	492610	7512208	Platform
Bat rec 15	SM2BAT site	16/04/12	483454	7514199	Robe
Bat rec 16 (EFF S4)	SM2BAT site	18/04/12	492610	7512208	Platform
Bat rec 17	SM2BAT site	19/04/12	496645	7511897	Boolgeeda
Bat rec 18 (EFF S8)	SM2BAT site	21/04/12	507393	7510104	Platform
Bat rec 19 (EFF S5)	SM2BAT site	24/04/13	504086	7510890	Boolgeeda
Bat rec 20 (EFF S7)	SM2BAT site	25/04/13	502989	7516151	Rocklea
Bat rec 21	SM2BAT site	26/04/13	475566	7516719	Rocklea
Bat rec 22	SM2BAT site	27 & 28/04/13	518064	7510408	Newman
Bat rec 23	SM2BAT site	29/04/13	503383	7511601	Newman
Bat rec 24 (EFF S1a)	SM2BAT site	21/04/13	481944	7514627	Robe
Bat rec 25 (EFF S3)	SM2BAT site	22/04/13	486086	7512716	Newman
Bat rec 26 (EFF S2)	SM2BAT site	23/04/13	483158	7513708	Robe
Bat rec 27 (EFF S4)	SM2BAT site	24/04/13	492610	7512208	Platform
Bat rec 28 (EFF S6)	SM2BAT site	25/04/13	503820	7513303	Rocklea
Bat rec 29	SM2BAT site	26/04/13	490376	7513717	Newman
Bat rec 30	SM2BAT site	28/04/13	507991	7509687	Platform
Bat rec 31	SM2BAT site	29/04/13	500991	7511609	Boolgeeda
Bat rec 32 (EFF S11)	SM2BAT site	21/04/13	527338	7515435	Boolgeeda
Bat rec 33 (EFF S12)	SM2BAT site	22/04/13	524700	7513484	Boolgeeda/Newman
Bat rec 34 (EFF S10)	SM2BAT site	23/04/13	522001	7510967	Newman
Bat rec 35 (EFF S9)	SM2BAT site	24/04/13	512475	7508750	Newman
Bat rec 36 (EFF S8)	SM2BAT site	25/04/13	507393	7510104	Platform
Bat rec 37	SM2BAT site	26/04/13	480317	7515063	Robe
Bat rec 38	SM2BAT site	28/04/13	525202	7514477	Newman
EFF MC 1	Motion Camera	16-19/04/12	483426	7514133	Robe
EFF MC 2	Motion Camera	16-19/04/12	483461	7514210	Robe
EFF MC 3	Motion Camera	16-21/04/12	497646	7511182	Newman
EFF MC 4	Motion Camera	17-21/04/12	479405	7516281	Robe

Site Name	Survey Site (Survey type)	Dates	Coordinates		Land system
			Easting	Northing	
EFF MC 5	Motion Camera	24-25/04/13	479572	7515029	Newman
EFF MC 6	Motion Camera	25-27/04/13	485998	7512636	Newman
EFF MC 7	Motion Camera	23-26/04/13	500243	7510251	Newman
EFF MC 8	Motion Camera	26-28/04/13	505979	7509564	Platform
EFF MC 9	Motion Camera	23-26/04/13	480562	7513873	Newman
EFF MC 10	Motion Camera	26-28/04/13	503588	7512051	Rocklea
EFF MC 11	Motion Camera	23-26/08/13	526889	7514796	Boolgeeda
Targeted survey					
NQ S1	Northern Quoll trap site	3-10/07/12	496624	7511920	Boolgeeda
NQ S2	Northern Quoll trap site	3-10/07/12	496167	7511986	Boolgeeda
NQ S3	Northern Quoll trap site	3-10/07/12	486089	7512583	Newman
NQ S4	Northern Quoll trap site	3-10/07/12	481740	7514162	Robe
NQ S5	Northern Quoll trap site	4-11/07/12	479453	7516138	Robe
NQ S6	Northern Quoll trap site	4-11/07/12	480471	7513841	Newman
NQ S7	Northern Quoll trap site	4-11/07/12	479288	7513897	Newman
NQ S8	Northern Quoll trap site	4-11/07/12	512525	7509625	Newman
NQ S9	Northern Quoll trap site	4-11/07/12	522947	7511423	Boolgeeda
NQ S10	Northern Quoll trap site	4-11/07/12	525022	7514530	Newman
NQ S11	Northern Quoll trap site	4-11/07/12	518350	7510963	Newman
NQ S12	Northern Quoll trap site	4-11/07/12	498886	7510886	Newman
NQ S13	Northern Quoll trap site	4-11/07/12	493323	7512212	Platform
NQ S14	Northern Quoll trap site	4-11/07/12	512395	7508757	Newman
NQ S15	Northern Quoll trap site	4-11/07/12	482955	7512727	Newman
Bat rec 39	SM2BAT site	4-11/07/12	479342	7513913	Newman
Bat rec 40	SM2BAT site	4-11/07/12	481692	7513146	Newman
Bat rec 41	SM2BAT site	4-11/07/12	498674	7511030	Newman
Bat rec 42	SM2BAT site	4-11/07/12	481647	7513841	Robe
Bat rec 43	SM2BAT site	4-11/07/12	489194	7513573	Newman
Bat rec 44	SM2BAT site	4-11/07/12	503472	7511704	Newman
Bat rec 45	SM2BAT site	4-11/07/12	496667	7511931	Boolgeeda
Bat rec 46	SM2BAT site	4-11/07/12	512521	7509594	Newman
Bat rec 47	SM2BAT site	4-11/07/12	524978	7514588	Newman
Bat rec 48	SM2BAT site	4-11/07/12	494165	7512323	Newman
Bat rec 49	SM2BAT site	4-11/07/12	480554	7513854	Newman
Bat rec 50	SM2BAT site	4-11/07/12	483454	7514177	Robe
Bat rec 51	SM2BAT site	4-11/07/12	495350	7511602	Newman
Bat rec 52	SM2BAT site	4-11/07/12	499415	7510947	Boolgeeda
EFF MC NQ1	Motion Camera	5-10/07/12	497038	7511318	Newman
EFF MC NQ2	Motion Camera	5-8/7/12	506843	7510625	Newman

Site Name	Survey Site (Survey type)	Dates	Coordinates		Land system
			Easting	Northing	
EFF MC NQ3	Motion Camera	5-8/7/12	514239	7509740	Newman
EFF MC NQ4	Motion Camera	5-8/7/12	521018	7511230	Newman
EFF MC NQ5	Motion Camera	8-10/7/12	486247	7512924	Boolgeeda
EFF MC NQ6	Motion Camera	5-8/7/12	483447	7514211	Robe
EFF MC NQ7	Motion Camera	8-10/7/12	495329	7511607	Newman
EFF MC NQ8	Motion Camera	8-10/7/12	481693	7513146	Newman
EFF MC NQ9	Motion Camera	6-9/7/12	489209	7513618	Newman
EFF MC NQ10	Motion Camera	5-9/7/12	512562	7508447	Newman
EFF MC NQ11	Motion Camera	5-9/7/12	481645	7513838	Robe
EFF MC NQ12	Motion Camera	5-10/7/12	481644	7513837	Robe
EFF MC NQ13	Motion Camera	7-9/7/12	485959	7513090	Newman

Datum: GDA 1994 MGA Zone 50

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470000 480000 490000 500000 510000 520000 530000

7530000 7520000 7510000 7500000

SERPENTINE CREEK
DUCK CREEK
CAVES CREEK

Figure 3.2

EFF S1b
EFF S1a
EFF S2
EFF S3
EFF S4
EFF S5
EFF S6
EFF S7
EFF S8
EFF S9
EFF S10
EFF S11
EFF S12

Figure 3.3

Figure 3.4

BOOLGEEDA CREEK

BOSLEY RIVER

Legend

- Level 2 trap site
- Opportunistic site
- SM2BAT opportunistic site
- Motion camera
- Northern Quoll trap site
- River
- Eliwana and Flying Fish survey area

Land systems

- Boolgeeda land system
- Newman land system
- Platform land system
- Robe land system
- Rocklea land system

N

0 4 8

Kilometres

Absolute Scale - 1:175,000

ecologia ENVIRONMENT

Survey Sites at Eliwana and Flying Fish survey area (overview)

Figure: 3.1
Project ID: 1512

Drawn: AH
Date: 08/01/15

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

Unique Map ID: AH454

A3

475000 480000 485000 490000 495000

7525000 7520000 7515000 7510000

Legend

- Trap site
- Opportunistic
- Nocturnal
- Northern Quoll trap site
- SM2BAT site
- Motion Camera
- River
- Tracks
- Eliwana and Flying Fish survey area

Land systems

- Boolgeeda land system
- Newman land system
- Platform land system
- Robe land system
- Rocklea land system

EFF S1b
NQ S5
EFF S1a
NQ S4
NQ S7
NQ S6
EFF S2
NQ S15
EFF S3
NQ S3
EFF S4
NQ S13
NQ S2

N

0 1 2

Kilometres

Absolute Scale - 1:65,000

ecologia ENVIRONMENT

Survey Sites at Eliwana and Flying Fish survey area (west)

Figure: 3.2
Project ID: 1512

Drawn: AH
Date: 09/01/15

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

Unique Map ID: AH455

A3

495000 500000 505000 510000 515000

7520000 7515000 7510000

Legend

- Trap site
- Opportunistic
- Nocturnal
- Northern Quoll trap site
- SM2BAT site
- Motion Camera
- Tracks
- Eliwana and Flying Fish study area

Land systems

- Boolgeeda land system
- Newman land system
- Platform land system
- Robe land system
- Rocklea land system

EFF S7
EFF S6
EFF S5
EFF S8
EFF S9
NQ S1
NQ S2
NQ S11
NQ S12
NQ S13
NQ S14
NQ S8

N

0 1 2
Kilometres

Absolute Scale - 1:65,000

ecologia ENVIRONMENT

Survey Sites at Eliwana and Flying Fish study area (centre)

Figure: 3.3
Project ID: 1512

Drawn: AH
Date: 09/01/15

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

Unique Map ID: AH456

A3

515000 520000 525000 530000 535000

7520000 7515000 7510000

EFF S11
NQ S10
EFF S12
NQ S9
NQ S11
EFF S10
EFF OS13

N

0 1 2
Kilometres

Absolute Scale - 1:65,000

Legend

- Trap site
- Opportunistic
- Nocturnal
- Northern Quoll trap site
- SM2BAT site
- Motion Camera
- River
- Tracks
- Eliwana and Flying Fish study area

Land systems

- Boolgeeda land system
- Newman land system
- Platform land system
- Robe land system
- Rocklea land system

ecologia ENVIRONMENT

Survey Sites at Eliwana and Flying Fish study area (east)

Figure: 3.4
Project ID: 1512

Drawn: AH
Date: 09/01/15

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

Unique Map ID: AH457

A3

3.4 CONSERVATION SIGNIFICANT FAUNA

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

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

- Fauna habitats and their general condition known to exist within the study area;
- Distance of previously recorded conservation significant species from the study area;
- Frequency of occurrence of conservation significant species records in the region; and
- Time since conservation significant species were recorded within, or nearby the study area.

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

Table 3.4 – Likelihood of occurrence categories

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

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

3.5 SAMPLING METHODS

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

- EPA's Guidance Statement No. 56 (EPA 2004b);
- Position Statement No. 3 (EPA 2002b);
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010);
- Referral Guidelines for the endangered Northern Quoll, *Dasyurus hallucatus* (DSEWPaC 2011a);
- Survey Guidelines for Australia's Threatened Mammals, Reptiles Bats and Birds (DEWHA 2010; DSEWPaC 2011b, d, e); and
- Fortescue's Terrestrial Vertebrate Fauna Assessment Guidelines (FMG 2011).

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

3.5.1 Systematic Sampling

Terrestrial Mammals and Herpetofauna

Trapping for terrestrial mammals and herpetofauna was undertaken using a standardised trapping format which comprised a combination of pit-fall traps, Elliott box traps, funnel traps and cage traps (Figure 3.5).

Each trapping site consisted of the following:

- 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 a custom made shade cloth.
- 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.

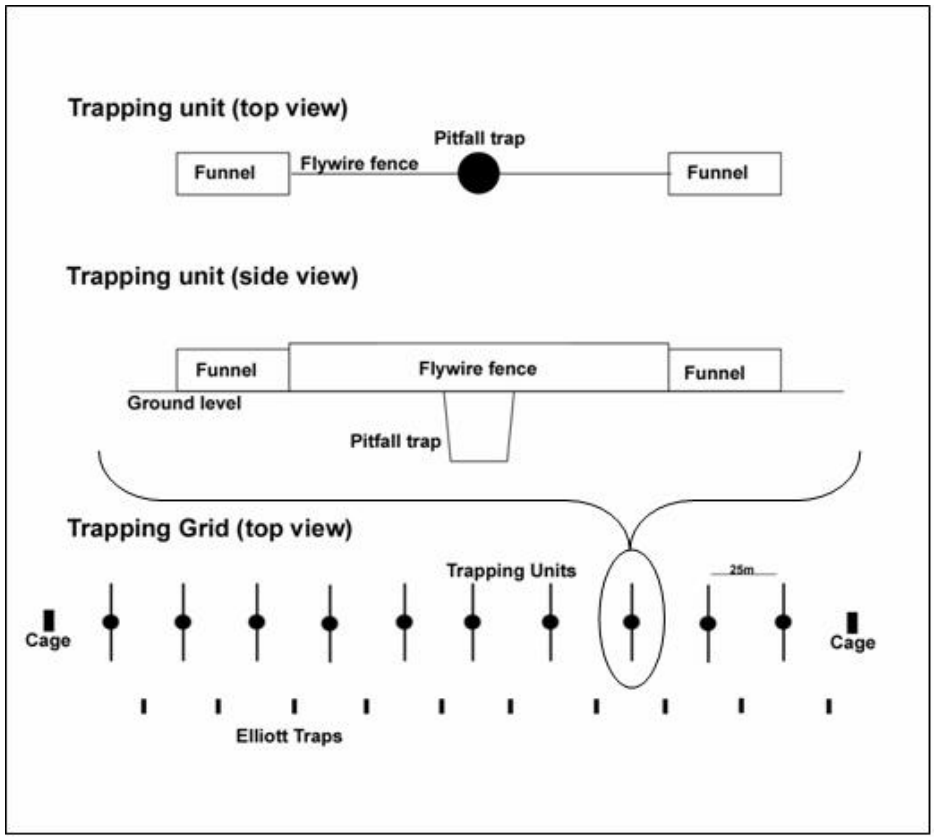

Figure 3.5 – Diagram of systematic sampling trap arrangement

Figure 3.6 – Image of single *ecologia* trap point

Avifauna

Thirty-minute set-time surveys were used to document the avifauna present at each of the systematic fauna trapping sites. 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 2010), as well as for the ongoing Birds Australia *Atlas of Australian Birds* project (Barrett *et al.* 2003; BirdLife Australia 2014).

Survey effort was concentrated at survey sites within three hours of dawn, as this time is deemed to be the optimal times 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.

All Level 2 vertebrate fauna assessment trapping sites were surveyed for birds during optimal times of bird activity. A total of 59 hours were spent surveying for bird within all habitat types identified from the study area.

Bats

Bat echolocation calls were recorded using SM2BAT 384 kHz long term passive recorder. The SM2BAT has a high sampling frequency, enabling the full spectrum of the calls to be recorded without being transformed allowing greater accuracy and sensitivity. The SM2BAT was programmed to record from dusk to dawn for each night that was surveyed.

Bat recorders were set up at a total of 38 locations during the Level 2 survey (25 locations at trap sites and 13 locations at opportunistic sites) of which 18 locations were sampled during phase 1 and the remaining 20 sites were sampled during phase 2 of the survey to determine the bat assemblage within the Eliwana and Flying Fish study area. In addition, SM2BAT recorders were set-up at 14 locations within gullies, gorges and other flyways during the targeted conservation significant fauna assessment to determine the absence or presence of Pilbara Leaf-nosed Bats and Ghost Bats.

3.5.2 Opportunistic Data

Nocturnal Searching

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

Nocturnal road spotting was conducted along the main access road for a total of 13 person hours (nine person hours during phase 1 and four person hours during phase 2). Additional nocturnal searches were conducted at trapping and opportunistic sites for a total of 39 person hours.

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. Sites were selected on the basis of fauna habitat (targeting uncommon habitats or 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 study area during the day and night. Tracks, diggings, scats, burrows and nests were recorded where possible.

A total of 69 hours of searching was conducted during the current survey of which 36 hours were searched during the first phase and the remaining 33 hours were spent on searched during phase 2 of the

survey. These searches targeted conservation significant fauna or were conducted to assess habitat present in inaccessible areas.

Camera Trapping

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).

A total of 16 motion sensor cameras were set up at 24 locations along cliff faces, in gorges and gullies and surrounding waterholes during the Level 2 vertebrate fauna (four locations during phase 1 and seven locations during phase 2) and targeted conservation significant fauna assessment (13 locations). A total of 1,844 hours of recordings were analysed to determine the absence or presence of Northern Quoll and other conservation significant fauna within the study area.

3.6 TARGETED SEARCHES ON FOOT

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

On the basis habitats observed during surveying, and the results of the desktop assessment identifying the likelihood of conservation significant species to occur in the area, specific searches were undertaken to determine the presence of following species: Northern Quoll, Western Pebble-mound Mouse, Ghost Bat, Pilbara Leaf-nosed Bat, Bush Stone-curlew and Pilbara Olive Python. Following methodology was used:

- In addition to trapping, targeted searches for secondary evidence of the Northern Quoll were conducted along rocky cliff faces and sheltered gorges. Motion cameras were established within suitable habitat with semipermanent waterholes.
- Targeted searches for secondary evidence of the Western Pebble-mound Mouse were conducted along gentle hillslopes.
- SM2BAT recorders, capturing calls from sunset to sunrise, were set up along gorges, rocky cliff faces and creeklines to target the Ghost Bat and Pilbara Leaf-nosed Bat.
- Calls of the Bush Stone-curlew were played during nocturnal searches along creeklines to determine the presence of absence of the species (call playback and response).
- Nocturnal and diurnal searches were conducted along sheltered rocky gorges and creeklines with and without semipermanent water pools.

All searches were condcuted during the recommended season for each species as per relevant guidelines (DSEWPaC 2010, 2011a, b, d, e).

3.7 SURVEY EFFORT

Total survey effort expended within the study area during the Level 2 vertebrate fauna and targeted conservation siginificant fauna assessment conformed with relevant survey guidelines (DSEWPaC 2010, 2011a, b, d, e; EPA 2002a, 2004b; EPA and DEC 2010) and comprised the following:

- Systematic trapping grids (pit traps, funnels, Elliott traps and cage traps) were open for 7,056 trap nights (Level 2 vertebrate fauna survey).
- Targeted cage trap sites were open for 749 trap nights (targeted conservation significant fauna survey).

- Approximately 59 hours were spent surveying for birds (during the Level 2 vertebrate fauna assessment).
- 70 hours were spent on opportunistic diurnal searching (63 hrs during Level 2 vertebrate fauna assessment and seven hours during targeted conservation significant fauna assessment).
- 52 hours were spent on opportunistic nocturnal searching (Level 2 vertebrate fauna assessment).
- 16 motion cameras were deployed at 23 locations for a total of 1,822 hours (864 hours during Level 2 vertebrate fauna and 958 hours during targeted conservation significant fauna assessment).
- 700 hours of SM2BAT accoustic recordings were analysed to determine bat assemblage and distribution (483.6 hours during Level 2 vertebrate fauna and 216 hours during targeted conservation sigificant fauna assessment).

Total survey effort per site is presented in Table 3.5.

Table 3.5 – Survey effort during Level 2 survey

Site	Pit Traps (trap nights)		Funnels (trap nights)		Elliotts (trap nights)		Cages (trap nights)		Bird Survey (min)		Diurnal Opp. Search (min)		Bat Recording (hours)		Nocturnal Opp. Search (min)		Camera Trapping (hours)	
	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Level 2 fauna survey																		
EFF S1	70	70	140	140	70	70	14	14	120	120	20	60	12	13	0	60	0	0
EFF S2	70	70	140	140	70	70	14	14	120	120	40	60	12	13	0	60	0	0
EFF S3	70	70	140	140	70	70	14	14	120	120	60	0	12	13	60	0	0	0
EFF S4	70	70	140	140	70	70	14	14	120	120	60	50	24	13	60	60	0	0
EFF S5	70	70	140	140	70	70	14	14	120	120	180	0	12	13	60	0	0	0
EFF S6	70	70	140	140	70	70	14	14	120	120	0	0	12	13	60	0	0	0
EFF S7	70	70	140	140	70	70	14	14	120	120	0	0	2.1	13	60	0	0	0
EFF S8	70	70	140	140	70	70	14	14	120	120	0	90	12	13	60	0	0	0
EFF S9	70	70	140	140	70	70	14	14	120	120	0	60	12	13	0	240	0	0
EFF S10	70	70	140	140	70	70	14	14	120	120	0	0	12	13	0	60	0	0
EFF S11	70	70	140	140	70	70	14	14	120	120	0	30	12	13	50	75	0	0
EFF S12	70	70	140	140	70	70	14	14	120	120	0	0	12	13	40	60	0	0
Opportunistic	0	0	0	0	0	0	0	0	545	120	2,180	900	38.5	143	850	1,265	480	384
Total	**1,680**		**3,360**		**1,680**		**336**		**3,545**		**3,790**		**483.6**		**3,180**		**864**	

Table 3.6 – Survey effort during targeted survey

Site	Pit Traps (trap nights)	Funnels (trap nights)	Elliotts (trap nights)	Cages (trap nights)	Bird Survey (min)	Diurnal Opp. Search (min)	Bat Recording (hours)	Nocturnal Opp. Search (min)	Camera Trapping (hours)
Targeted fauna survey									
NQ S1	0	0	0	35	0	30	0	0	0
NQ S2	0	0	0	35	0	30	0	0	0
NQ S3	0	0	0	28	0	30	0	0	0
NQ S4	0	0	0	154	0	30	24	0	0
NQ S5	0	0	0	35	0	30	0	0	0
NQ S6	0	0	0	70	0	30	0	0	0
NQ S7	0	0	0	56	0	30	24	0	0
NQ S8	0	0	0	28	0	30	0	0	0
NQ S9	0	0	0	35	0	30	0	0	0
NQ S10	0	0	0	35	0	30	12	0	0
NQ S11	0	0	0	56	0	30	0	0	0
NQ S12	0	0	0	42	0	30	0	0	0
NQ S13	0	0	0	42	0	30	0	0	0
NQ S14	0	0	0	56	0	30	0	0	0
NQ S15	0	0	0	42	0	30	0	0	0
Opportunistic	0	0	0	0	0	0	156	0	958
Total	**-**	**-**	**-**	**749**	**-**	**450**	**216**	**0**	**958**

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 asymptote is reached at the level at which no new species are present. To eliminate features caused by random or periodic temporal variation, the sample order was randomised 1,000 times using EstimateS (version 8, Colwell 2009). In order to estimate the theoretical maximum for each fauna group, a Michaelis-Menten (MM) enzyme kinetic curve was calculated and used as a stopping rule technique.

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 or during the targeted conservation significant fauna assessment are not included. Separate analyses were carried out for each species group (mammal, reptile and bird). Analyses were not conducted on the amphibian or fish fauna due to the paucity of results.

3.8.2 Habitat Assessment

Analysis of the fauna survey data was undertaken to determine the similarities in faunal 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 for terrestrial fauna (mammal and reptile) and avifaunal assemblages across different habitat types.

3.9 TAXONOMY AND NOMENCLATURE

Nomenclature for mammals, reptiles and amphibians within this report is as per *Western Australian Museum Checklist of the Vertebrates of Western Australia*, birds according to Christidis and Boles (2008). References used for fauna identification are listed in Table 3.7.

Table 3.7 – References used for Identification

Fauna Group	Reference
Mammals	Menkhorst and Knight (2011), Van Dyck and Strahan (2008)
Bats	Churchill (1998), Menkhorst and Knight (2011)
Birds	Simpson and Day (2010)
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 DPaW Regulation 17 Licence SF008577.

3.11 SURVEY TEAM

Survey team members, assessment personnel and external consultants are listed in Table 3.8.

Table 3.8 – Field survey personnel

Survey Member	Expertise	Qualification	Experience
Peter Taylor	Ornithology	PhD	19 years
Kellie Bauer-Simpson	Biological Science	BSc.	14 years
Damien Cancilla	Mammalogy	BSc. (Hons)	8 years
Astrid Heidrich	Herpetology	M. Sc.	8 years
Jordan Vos	Herpetology	-	8 years
Gabriela Eiris	Mammalogy	PhD	8 years
Bruce Greatwich	Ornithology	BSc.	5 years
Farhan Bokhari	Zoology	BSc. (Hons)	5 years
John Graff	Ornithology	BSc.	5 years
Tom Parkin	Herpetology	BSc.	4 years
Anna Nowicki	Zoology	BSc. (Hons)	3 years
Jesse Forbes-Harper	Herpetology	BA, BSc. (Hons)	3 years
Leigh Smith	Herpetology	-	3 years
Chris Knuckey	Herpetology	BSc.	2 years
Adam Young	Herpetology	BSc.	2 years
External consultants			
Bob Bullen	Bat Call WA	-	15 years – bat call IDs
Georgiana Story	Scats About	-	13 years

4 RESULTS

4.1 FAUNA HABITATS

Ecoscape (2012b, c) identified four broad habitat types from within the study area during their Level 1 fauna assessment. During the current Level 2 vertebrate fauna assessment, five major fauna habitat types were identified from the study area. These correspond roughly (there are some differences in delineation of habitat types) with the habitat types identified by Ecoscape (2012d) but with the slopes and plains differentiated from creeklines (Table 4.1).

Table 4.1 – Comparison of habitat nomenclature between surveys

Habitat Types Identified during the current survey	Habitat Types Identified by Ecoscape (2012b, c)
Hilltops, hillslopes, ridges and cliffs	Exposed upper slopes, clifflines and ridges
Footslopes and plains	Lower slopes and valleys with ephemeral drainage lines and dry river channels
Major creeklines	
Gorges and gullies	Sheltered gullies with permanent or ephemeral waterholes
Mixed acacia woodlands (mulga and snakewood)	Open Shrubland or open Woodland over spinifex

Of the habitat types identified during the current survey, footslopes and plains and hilltops, hillslopes, ridges and cliffs, were found to be the most common fauna habitat types occurring in the study area. All habitat types are present within 150 km of the study area (Table 4.2) and not unique to the study area. The gorges and gullies habitat, although small in terms of area, is important due to its potential to support a number of key conservation significant species.

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

Table 4.2 – Summary of fauna habitat areas

Fauna Habitat	Area inside study area (ha)	% of Total study area	Mapped area of equivalent habitat within region (ha) (*ecologia* 2014)	Percentage of mapped area within region within survey area (%)
Footslopes and plains	40,759.2	81.9	133,312.9	44.1
Hilltops, hillslopes, ridges and cliffs	7,648.1	15.4	85,211.6	28.2
Major creeklines	1,148.2	2.3	23,405.6	7.7
Gorges and gullies	176.3	0.4	2,373.3	0.8
Mixed acacia woodlands	34.1	0.07	57,779.9	19.1

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

Table 4.3 – Survey effort per fauna habitat type

Habitat type	Pit Traps (trap nights)	Funnels (trap nights)	Elliotts (trap nights)	Cages (trap nights)	Bird Survey (min)	Diurnal Opp. Search (min)	Bat Recording (hour)	Nocturnal Opp. Search (min)	Camera Trapping (min)
Footslopes and plains	980	1960	980	196	2,600	1,010	253	1525	72
Major creeklines	560	1120	560	112	1595	460	114	405	190
Hilltops, hillslopes, ridges and cliffs	0*	0*	0*	308	120	740	112	0	650
Gorges and gullies	140	280	140	469	760	1,850	220	1190	910
Mixed acacia woodlands	0*	0*	0*	0*	30	30	0*	0*	0*
Total	1,680	3,360	1,680	1,085	1,985	4,150	699	3,120	1,822

* Systematic trapping (Level 2 trapping) was not conducted in this habitat type due to the set-up of traps being labour and time intensive. To ensure adequate survey effort was expended in this habitat type, additional diurnal searches and camera trapping were conducted. The mixed acacia woodland was small and limited to approximately 34.1 ha which represents 0.07% of the study area and, therefore, was only surveyed during a habitat assessment and a 30-minute bird survey which was considered by *ecologia* to be adequate due to the low likelihood of this habitat type harbouring conservation significant species.

480000
495000
510000
525000
7530000
7515000
7500000

SERPENTINE CREEK
CAVES CREEK
DUCK CREEK
BOOLGEEDA CREEK

Legend

- River
- Tracks
- Eliwana and Flying Fish survey area
- Footslopes and plains
- Gorges and gullies
- Hilltops, hillslopes, ridges and cliffs
- Major Creek line
- Mixed acacia woodlands

N

0 3 6

Kilometres

Absolute Scale - 1:150,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Fauna Habitats at Eliwana and Flying Fish survey area

Figure: 4.1
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: AH473

A3

450000 500000 550000 600000 650000 700000 750000

7600000 7550000 7500000 7450000

PORTLAND RIVER
MILLSTREAM HOMESTEAD VISITOR CENTRE
PANNAWONICA
SHERLOCK RIVER
YULE RIVER
WOODSTOCK
COOLAWANYAH
CALAWINGINA CREEK
HOOLEY CREEK
HOOLEY
WEST YULE RIVER
COONARRIE CREEK
SHAW RIVER
MOUNT MARGARET
ROBE RIVER
MULGA DOWNS
CANE RIVER
URANDY CREEK
MOUNT KING
WITTENOOM
CAVES CREEK
DUCK CREEK
AUSKI ROADHOUSE
FORTESCUE RIVER
DUCK CREEK
MOUNT BROCKMAN
MOUNT BRUCE
MARILLANA CREEK
MOUNT SAMSON
TOM PRICE
BEASLEY RIVER
HARDEY RIVER
JUNA DOWNS
PARABURDOO
TUREE CREEK
ASHBURTON RIVER

N

0 20 40
Kilometres

Absolute Scale - 1:900,000

Legend

- Eliwana and Flying Fish survey area

Habitats previously mapped (*ecologia* 2014)

- Drainage line/River/Creek (Major)
- Gorges/gullies
- Hilltops/ridges/plateaux
- Shrubland (open)
- Plain (stony gibber)
- Study area

ecologia ENVIRONMENT

Regional fauna habitats (within 150 km of the study area)

Figure: 4.2
Project ID: 1512

Drawn: AH
Date: 09/01/15

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

Unique Map ID: AH514b

A3

4.1.1 Footslopes and plains

Footslopes and plains were the most common and widespread habitat type, covering 81.9 % (40,759.1 ha) of the total study area and 44.1 % of the regional mapped area (Table 4.2). This habitat type consists of occasional *Eucalyptus leucophloia* subsp. *leucophloia* and *E. gamophylla* over *Acacia atkinsiana* and *A. exilis* over medium to large clumps of spinifex hummock grassland on loam-clay with a continuous mantle of pebbles and stones. Wood litter and leaf litter is usually very sparse but can be present in areas of recent fire history (Figure 4.3). The majority of rocky spinifex plains and hill slopes were identified from the northern section of the study area, but such habitat also connects the hilltops, hillslopes, ridges and cliffs in the south of the study area (Figure 4.1). The footslopes and plains also include minor drainage lines with acacia thickets and other slight variations, which in small patches do not represent a separate fauna habitat type.

Figure 4.3 – Footslopes and plains habitat type within the study area

4.1.2 Hilltops, hillslopes, ridges and cliffs

Hilltops, hillslopes, ridges and cliffs are the second most common habitat in the study area, covering 15.4 % (7,648.1 ha) of the total area and 28.2% of the regional area within 150 km of the study area (Table 4.2, Figure 4.2). The hilltops and ridges comprise the most elevated level of all habitats and are usually dominated by sparse vegetation of scattered small shrubs and spinifex clumps on a rocky surface which comprises a continuous layer of bedrock and scattered skeletal soils with pebbles and stones. The hillslopes generally comprise the sides of hills which connect the hilltop and the hill-base, and are dominated by scattered *Eucalyptus leucophloia*, *Acacia pruinocarpa* and *A. bivenosa,* over *Senna* sp. shrubs and *Eriachne mucronata* over spinifex clumps on a 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. However, vegetation is usually rare along the cliffs. Crevices and caves can be found which provide shelter for a range of fauna species (Figure 4.4).

Figure 4.4 – Hilltops, hillslopes, ridges and cliffs habitat type within study area

4.1.3 Major Creeklines

Major creeklines identified from the study area consist of drainage channels with fringing eucalypt trees over a dense shrub layer, with or without surface water. This habitat type comprised 2.3% (1,139.0 ha) of the study area and 7.7% of the regional area (Table 4.2, Figure 4.2). Major creeklines are characterised by the height and density of the vegetation layer, as well as the large variety of tree and shrub species that are present. Within the study area *Eucalyptus victrix* and *E. xerothermica* were recorded from major creeklines over *Acacia citrinoviridis, Gossypium robinsonii, Acacia tumida* subsp. *pilbarensis, A. bivenosa* and *Stylobasium spathulatum*. Grasses often comprised of *Triodia epactia, Themeda triandra, Enteropogon ramosus, Eulalia aurea* and *Eriachne tenuiculmis*. Wood litter and leaf litter can vary from sparse to moderately dense. Invasive flora species, particularly buffel grass (**Cenchrus ciliaris*), was recorded within this habitat type due to the good soil condition and the presence of water. The majority of major creeklines comprise clay soil which keeps moisture and support larger trees such as eucalypts and their root systems (Figure 4.5). Major creeklines were identified from the south of the study area and in two locations in the north, consisting of one running east-west along a valley in the south of the study area. One location within this creekline was identified to contain some surface water. The two creeklines identified from the north of the study area were found to contain larger pools of water (Figure 4.1, Figure 4.5)

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

Figure 4.5 – Major creeklines habitat type within the study area

4.1.4 Gorges and gullies

The gorges and gullies habitat type is found in small isolated locations in the south of the study area (Figure 4.1). The habitat type occupies just 0.4% (176.3 ha) of the study area and 0.8% of the regional area (Table 4.2). This habitat type was found to usually comprise a moderately dense vegetation layer consisting of *Corymbia hamersleyana* over *Acacia pruinocarpa, A. maitlandii, A. pyrifolia* var. *pyrifolia* and *Gossypium robinsonii* which produce a large amount of leaf litter, small herbs such as *Indigofera* sp. Bungaroo Creek over scattered clumps of spinifex grasses (*Triodia epactia*) (Figure 4.6). In particular, the gorges with large eucalypt trees, shrubs and leaf litter preserve the moisture and support a humid climate which attracts insects and therefore a large number of insectivorous species.

Figure 4.6 – Gorges and gullies habitat within the study area

4.1.5 Mixed acacia woodlands (mulga and snakewood)

The mixed acacia (*A. aneura* and *A. xiphophylla*) woodland is the most uncommon fauna habitat in the study area, occupying just 0.07 % (24.1 ha) of the study area, however it was previously mapped covering 19.1% of the regional area (Table 4.2). This habitat comprises mulga or snakewood shrubland (*A. aneura*, *A. xiphophylla*) and *Eremophila forrestii* subsp. *forrestii* over *Triodia epactia* grassland (Figure 4.7). This habitat type was recorded from one location within the study area (Figure 4.1). The mixed acacia woodlands of this habitat type provide a variety of flowering shrubs and herbs and therefore a good food source for bird species in particular after rainfalls.

The previous Level 1 fauna assessment (Ecoscape 2012b, c) classified areas of this habitat as open acacia shrubland. These areas comprised a very open shrub layer and therefore were assessed as plains or footslopes with scattered trees and spinifex during this survey. The vegetation structure and composition was assessed to support a similar fauna assemblage as that of the plain and footslope habitat.

Figure 4.7 – Mixed acacia woodlands habitat within the study area

4.2 FAUNA HABITAT ANALYSIS

Habitat types represented in greater proportions throughout the study area were sampled by a larger number of systematic trapping sites than those represented, to ensure that the fauna assemblages of the more dominant habitats are defined accurately.

Three of the five fauna habitats within the study area were sampled with systematic trapping sites during the Level 2 vertebrate fauna assessment (Table 4.2). Seven trapping sites were installed in the largest habitat type, footslopes and plains. Four trapping sites were installed in the major creeklines habitat type and the remaining site was installed in the gorges and gullies habitat type. Due to the labour and time intensive set-up of trap sites within the hilltop, hillslope, ridges and cliff habitat type, and access restrictions to the mixed acacia shrubland habitat type, no trap sites were installed within

the two habitats. To ensure adequate sampling of each habitat type across the study area, greater opportunistic survey effort (diurnal and nocturnal searches and transects) and camera trapping was conducted in these habitats.

A one-way ANOSIM test conducted on systematically obtained trapping and avifaunal data to test for significant differences in faunal assemblages between habitat types. The one-way ANOSIM test on terrestrial trappable fauna data produced an R-value of 0.106 (R-values typically range from 0 to 1, with 1 indicating that the groups are dissimilar and 0 indicating that the groups are identical) and a p-value of 0.0001 (p-value of <0.05 indicating a significant difference). The positive R-value, close to 0 and the very low p-value from this analysis indicates statistically significant differences between habitat types in terms of their trappable faunal assemblages ($p<0.05$), but suggests that these differences are relatively small (low R value). Pair-wise comparisons between individual habitat types indicated significant differences in terrestrial trappable faunal assemblages between the footslopes and plains and major creeklines habitat types, and the major creeklines and gorges and gullies habitat types, with the major creeklines and gorges and gullies habitat types the most distinct from each other (Table 4.5). An nMDS plot was prepared, however the stress value obtained on the plot was 0.525 which indicates that the plot is a poor representation of the dataset. Hence, it is not included here.

The one-way ANOSIM test on systematically obtained avifaunal data produced an R-value of 0.0068 (R-values typically range from 0 to 1, with 1 indicating that the groups are dissimilar and 0 indicating that the groups are identical) and a p-value of 0.392 (p-value of <0.05 indicating a significant difference), indicating that there are no significant differences between habitat types in terms of their avifaunal assemblages. An nMDS plot provides a visual representation of this data, with the stress value of 0.167 indicating a good to very good representation of the data (Figure 4.8)

Table 4.4 – Post-hoc pairwise comparisons of trappable faunal assemblages by habitat type

	Footslopes and plains	Major creeklines	Gorges and gullies
Footslopes and plains	n/a	-	-
Major creeklines	0.0847 (0.0012)*	n/a	-
Gorges and gullies	0.0722 (0.2946)	0.4768 (0.0003)	n/a

Table gives pair-wise R values, with associated Bonferroni-corrected p-values in parentheses. * indicates significant difference

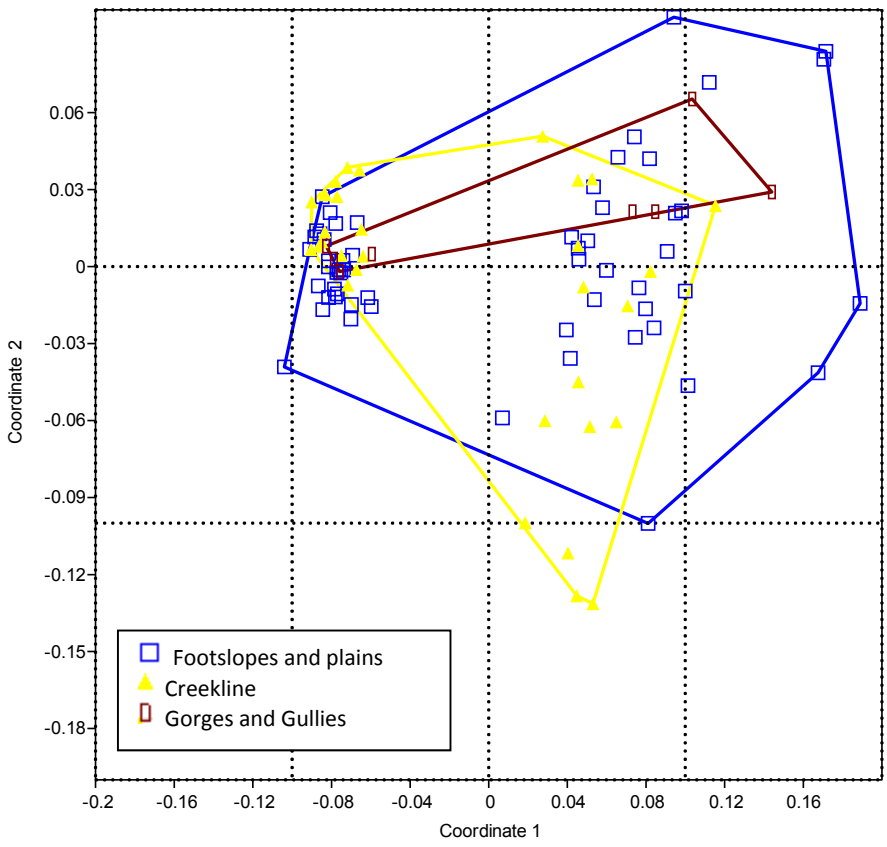

Figure 4.8 – MDS plot for avifauna

4.3 SURVEY ADEQUACY

Parametric analysis of systematically obtained survey data (opportunistic records were excluded) for birds and terrestrial faunal groups revealed that survey effort was adequate. Table 4.5 provides a summary of the theoretical maximum number of species using seven different methods of estimating richness. The Michaelis-Menton (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 4.5 – Mean estimates of total species richness of the vertebrate fauna groups

Richness Estimators	Total Richness Estimate (no species)	
	Terrestrial Vertebrates	Birds
ACE	85.3	72.0
ICE	85.9	72.5
Chao-1	84.0	70.1
Jack-1	89.9	75.9
Jack-2	91.9	78.9
Bootstrap	82.1	71.8
Michaelis-Menten	79.2	69.8
Species Observed	74	68

SACs were generated through 1,000 randomisations of the sample sequence of the data sets for avifauna (Figure 4.10) and terrestrial trapped fauna (mammals and herpetofauna, Figure 4.9). The Sobs (Mao Tau) line reflects the actual number of species observed, with the MM means (1 run) line being the predicted total number of species that could be recorded.

Analysis of the terrestrial trapped fauna dataset produced a smooth curve that although close, has not yet reached an asymptote. Visually, the shape of the curve in this SAC displays that the number of species being recorded was still increasing slightly at the cessation of survey effort. The MM estimator, used as stopping rule, indicated that the survey was 93.4 % adequate; with the species observed (Sobs Mao Tau) value of 74 with an MM means value of 79.2. These results indicate that, although the majority of species were recorded during the survey, additional trapping may detect up to an additional five species.

The SAC for the bird data is reaching an asymptote. The MM estimator, used as stopping rule, indicated that the survey was 97.4% sufficient; with the species observed (Sobs Mao Tau) value of 68 with an MM means value of 69.8. These results indicate that, although the majority of bird species were recorded during the survey, additional survey effort may record at least two additional species.

Analysis of both fauna assemblages (birds and terrestrial fauna) indicate that at the completion of this survey, survey effort was adequate to provide an indication of the majority of the fauna assemblage present in the study area. However, based on comparison with similar surveys in the Western Hub area (*ecologia* in prep-a, b) further survey effort could be expected to result in the identification of a few additional fauna species.

4.4 SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in Table 4.6 below. No significant limitations were experienced during the surveys. Limitations in the form of restricted access occurred, reducing the number of trap sites in some fauna habitats. Access within the study area was restricted mainly to

the southern edge and the western and eastern sections. However, all fauna habitats that could not be systematically trapped or reached via vehicle were investigated on foot and increased opportunistic and camera trapping effort. Given no significant limitations were encountered, an adequate level of survey has been undertaken.

Table 4.6 – 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 survey (Table 3.8).
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 (section 3.8.1).
Proportion of fauna identified, recorded and/or collected.	No	The majority of fauna species expected to occur within the study 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 study area (Table 2.5, Table 2.6 and Appendix C). Data from these surveys were used to provide regional context.
The proportion of the task achieved and further work which might be needed.	No	Analysis of faunal assemblages recorded during the survey indicates that survey effort was high and provided a comprehensive inventory of the fauna assemblage present in the study area.
Timing/weather/season/cycle.	No	The Level 2 vertebrate fauna assessment was conducted during weather and seasonal conditions that are optimal for increased fauna activity.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	Some smaller areas of habitat in the west of the study area were burnt prior to the Level 2 survey. However, similar habitat was assessed in adjacent areas. No other disturbances were recorded during this survey.
Intensity (in retrospect was the intensity adequate).	No	The survey intensity was adequate, all habitat types were surveyed systematically or opportunistically, and most of the species expected to occur were recorded.
Completeness (e.g. was relevant area fully surveyed), remoteness and/or access problems	No	All habitat types were accessible and were represented in the assessment, even though some areas along the northern edge of the study area were inaccessible.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	All zoologists were suitably qualified and experienced in identification of Pilbara fauna. There were no resources issues encountered.
Availability of contextual (e.g. biogeographic) information on the region).	No	Sufficient contextual information was available on the Pilbara region and the study 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.

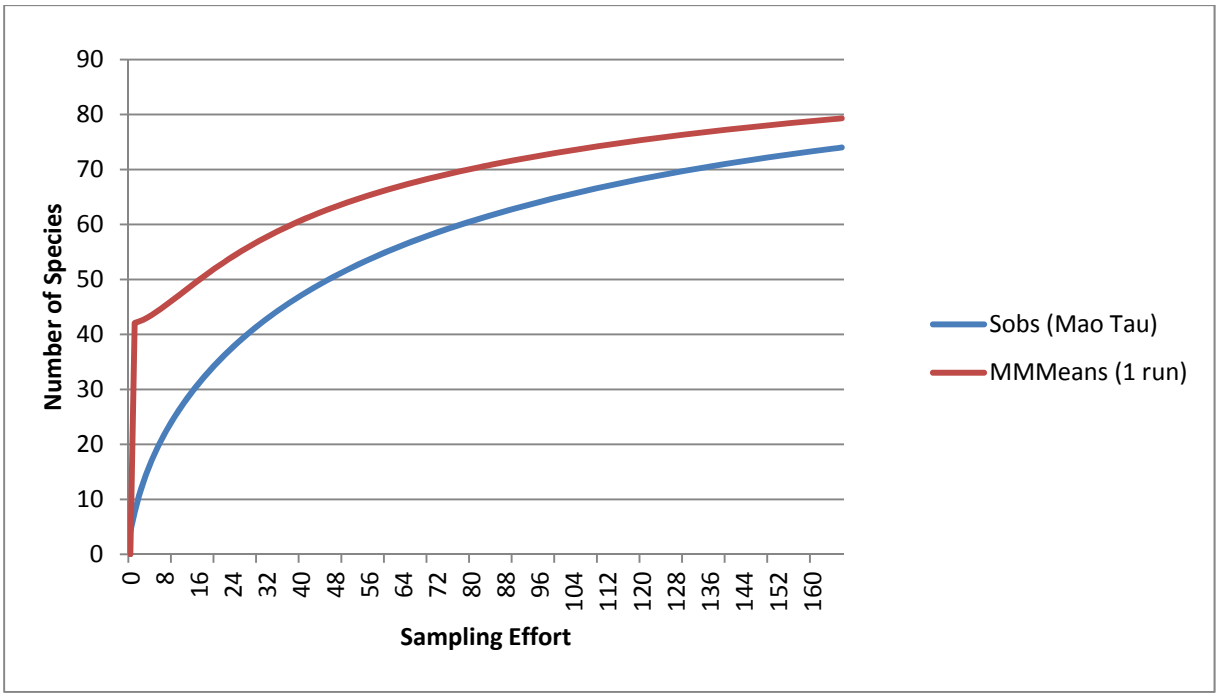

Figure 4.9 – Species accumulation curve for trappable fauna

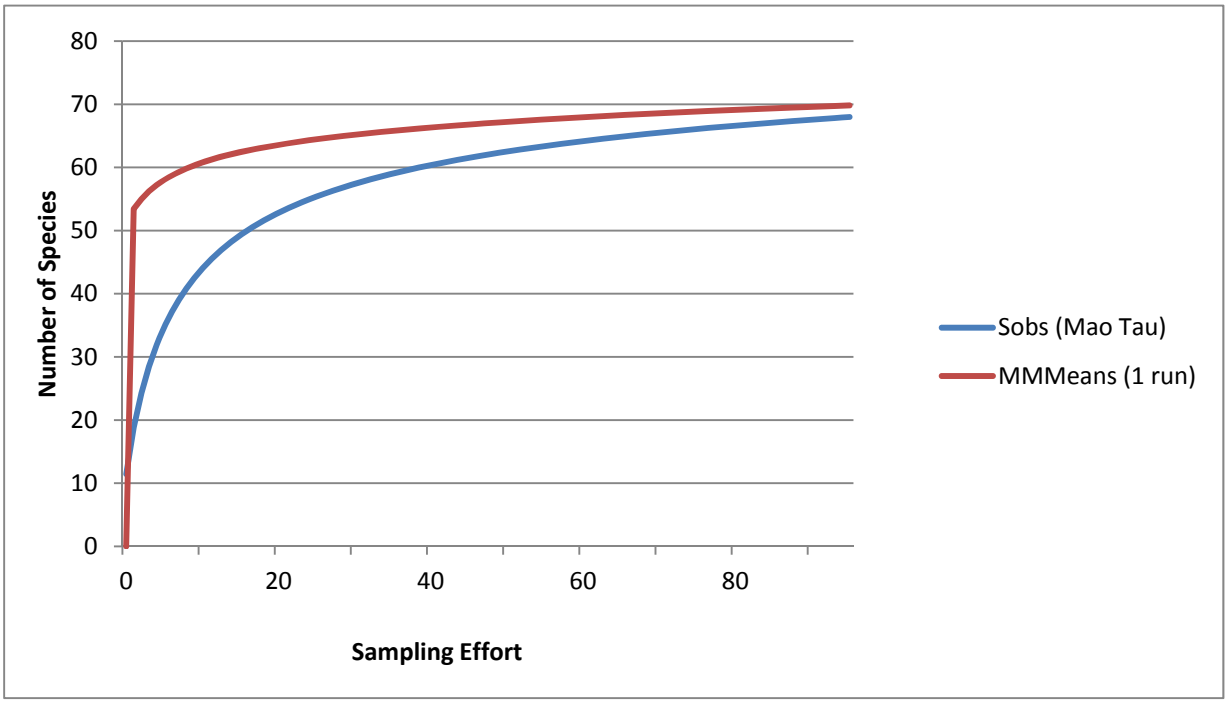

Figure 4.10 – Species accumulation curve for avifauna

4.5 FAUNA ASSEMBLAGES

24 mammal species (19 native, five introduced species), 74 bird species, 62 reptile species, two amphibian species and one species of fish were recorded during phase 1 of the survey. The second phase resulted in 22 mammal species (18 native, four introduced species), 65 bird species, 54 reptile species and two reptile species totalling 22 species of native mammals, five species of introduced mammal, 80 species of bird, 70 species of reptile, three species of amphibian and one species of fish were recorded within the Eliwana and Flying Fish study area.

Of the species recorded, eight are of conservation significance. The site by species matrix of species recorded during the Level 2 vertebrate fauna assessment can be seen in Appendix E.

4.5.1 Mammals

In comparison to previous surveys in the region and the results of database searches, the number of mammal species recorded during both phases of this survey (22 native species and six introduced species) represents a relatively large proportion of species known from the region (Table 2.6). The native mammal assemblage recorded comprised five dasyurids (small, carnivorous marsupials), two macropods (kangaroos), four murids (mice), and 11 bat species (one megadermatid, one hipposid, two emballonids, three molossids and four vespertilionids). Murids and dasyurids were captured in pitfall and Elliott traps at systematic trapping sites with the exception of Woolley's False Antechinus (*Pseudantechinus woolleyae*) which was captured in cage traps during the targeted conservation significant fauna assessment. Macropods were observed during diurnal and nocturnal opportunistic searches and nocturnal road spotting. Bats were identified from calls recorded on SM2BAT recorders.

Introduced species recorded during both phases included the House Mouse, Dingo, Cat, Donkey and Cow. The latter four species were opportunistically recorded whereas the House Mouse was trapped at sites EFF S4, S5, S9 and S11.

There were a relatively large number of individuals of some dasyurid species recorded during the Level 2 vertebrate fauna assessment, with the most frequently trapped species being the Pilbara Ningaui (*Ningaui timealeyi*) which represented by 61 records (Appendix E). Other abundant mammal species included Planigale (*Planigale* sp.; 36 records) and Sandy Inland Mouse (*Pseudomys hermannsburgensis*; 17 records). The Pilbara Ningaui and the Planigale appeared to be widely distributed throughout the study area, whereas the Sandy Inland Mouse was mainly recorded from the western and northern trapping sites. The Stripe-faced Dunnart (2 records) and Desert Mouse (7 records) were recorded from phase 2 only. The high number of captures for these species is attributed to the fairly dense spinifex understorey throughout the study area (Appendix E).

Three conservation significant mammals were recorded from the study area, the Western Pebble-mound Mouse (*Pseudomys chapmani*; DPaW Priority 4) (recorded from four active, two recently active, and one inactive mound during opportunistic searches on top of spinifex hills throughout the study area); the Ghost Bat (*Macroderma gigas;* DPaW Priority 4) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia;* EPBC Act Vulnerable, WC Act Schedule 1, DPaW Priority 4). A single potential Northern Quoll (*Dasyurus hallucatus*; EPBC Act Endangered, WC Act Schedule 1, DPaW Priority 4) scat was recorded from the study area and provided to a specialist for identification, however results were inconclusive. No further evidence of the species was recorded during the targeted conservation significant fauna assessment, indicating that significant populations are not expected to occur in the study area (Appendix E).

4.5.2 Birds

In total, 80 species of bird were recorded from the study area. Of these, two species were only recorded during the targeted conservation significant fauna assessment: Blue-winged Kookaburra,

and Ground Cuckoo-shrike (Appendix E). The family Meliphagidae was found to be the most diverse group recorded during this survey, comprising 11 species of honeyeaters. Three species were recorded during phase 2 of the Level 2 survey only: Elegant Parrot, Black Kite and Australasian Pipit. Thirteen species were not recorded during the second phase of the Level 2 fauna survey in 2013 and the targeted fauna survey but were recorded during phase 1 of the Level 2 survey. This includes: Masked Woodswallow, Horsefield's Bronze-Cuckoo, Pallid Cuckoo, Australian Bustard, Little Button-quail, Sacred Kingfisher, Spiny-cheeked Honeyeater, White-winged Triller, Grey Butcherbird, Rufous Songlark, Brown Songlark, Spinifexbird and Fairy Martin (Appendix E).

The number of bird species recorded during this survey was moderate compared to other Level 2 surveys conducted in the region and is relatively high in comparison to Level 1 survey conducted in the surrounding (Table 2.6). Ecoscape's Level 1 survey at Eliwana and Flying Fish in 2011 resulted in 38 bird species (Ecoscape 2012b, c). In addition, a Level 2 survey at Fortescue's Delphine project (within 5 km of study area) resulted in 104 bird species (*ecologia* 2013) and a Level 1 survey at Rio Tinto's Brockman 2 Detrital (within 7 km of study area) resulted in 64 bird species (Mattiske and Ninox 1990). Another Level 2 survey at Pilbara Iron's West Turner Syncline Section 10 (within 50 km of study area) recorded a total of 68 bird species over two phases of surveying.

Several species were recorded in high numbers and from many of the sites, and can be considered to represent the common bird species of the study area; Budgerigar (2,437 records), Zebra Finch (1051 records), Brown Honey-eater (325 records), Masked Woodswallow (280 records), Black Honeyeater (290 records), Weebill (275 records), Painted Finch (185 records), Cockatiel (177 records) and Singing Honeyeater (175 records). Several of these species, such as Budgerigar and Masked Woodswallow, are nomadic and appear in areas after high rainfall when food resources are high. The high abundance of these species, in particular during the first phase of the Level 2 survey, is indicative of the past two to three years that have experienced above average summer rainfall (BoM 2013).

Three bird species of conservation significance were recorded; Australian Bustard (DPaW Priority 4), Bush-stone Curlew (DPaW Priority 4) and Rainbow Bee-eater (EPBC Migratory, WC Act Schedule 3). The Rainbow Bee-eater was recorded 13 times from trap site EFF S9 in the centre of the study area. The Australian Bustard (5 records and tracks) and the Bush Stone-curlew (2 records) were only recorded from the east and centre of the study area.

4.5.3 Reptiles

In total, 70 species of reptiles were recorded during this survey which represents a relatively large number of species in comparison to surveys conducted in the region (Table 2.6). Level 2 surveys conducted at Fortescue's Delphine project (within 5 km of study area) resulted in 66 species of reptiles (*ecologia* 2013) and surveys at Hamersley Iron's Brockman Syncline (9 km of study area) resulted in 54 species of reptile (Biota 2005b). However, a Level 2 survey at Fortescue's Central Pilbara Project Mine recorded 84 reptiles species (*ecologia* 2011b). The 70 species recorded during this survey included 23 skinks, 14 geckos (eight diplodactylid species, five gekkonid species and one carphodactylid species), 11 elapids (venomous snakes), five pygopods (legless lizards), four dragon species, eight varanid (monitor lizard) species, two blind snakes and three pythons.

The most common species trapped were *Amphibolurus longirostris* (111 records), *Gehyra punctata* (108 records) *Ctenophorus caudicinctus* (104 records), *Ctenotus pantherinus* (100 records), *Ctenotus grandis* (96 records), *Carlia munda* (95 records), *Ctenotus saxatilis* (90 records), *Heteronotia binoei* (65 records), and *Ctenotus helenae* (67 records), all of which are common species throughout the Pilbara region.

In comparison to previous surveys in the region, a relatively large number of elapids (11 species) were recorded. In comparison, a total of eight elapid species were recorded from Delphine project (*ecologia* 2013), six elapids were recorded from the Brockman Syncline Project (Biota 2005b), seven elapid species were observed at Mt Farquhar project (*ecologia* 2012).

4.5.4 Amphibians

Three amphibian species were recorded during this survey. All three species of frog, the Little Red Tree Frog (*Litoria rubella*), Main's Frog (*Cyclorana maini*) and the Northwest Toadlet (*Uperoleia saxatilis*) are commonly recorded in the Pilbara region, and during periods after high rainfall, populations expand quickly resulting in high numbers recorded during some surveys (Appendix C). Four additional frog species may be present in the study area, but their potential to be recorded is limited to phases following rainfalls. The Centralian Burrowing Frog (*Platyplectrum spenceri*) has been recorded from near the study area during previous surveys (Appendix C). Recently published papers have described a new species of *Uperoleia* (*saxatilis)* in the Pilbara. Based on distribution maps (Catullo *et al.* 2011), all records of *Uperoleia russelli* that were made during previous surveys are expected be the new species, Pilbara Toadlet (*Uperoleia saxatilis*).

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

4.5.5 Fish

One species of fish, the Spangled Perch (*Leiopotherapon unicolour*) was recorded from one small pool of water in the centre of the study area. The species was recorded regularly during previous surveys (Appendix C) and is expected to be present in water pools throughout the study area after rainfall. Other fish species known from the region include the Bony Bream (*Nematalosa erebi*), Western Rainbowfish (*Melanotaenia australis*), Hyrtl's Tandan (*Neosilurus hyrtlii*), Barred Grunter (*Amniataba percoids*) and Fortescue Grunter (*Leiopotherapon aheneus*). The latter is listed as Priority 4 species (DPaW).

No fish species of conservation significance were recorded in the current survey.

4.6 CONSERVATION SIGNIFICANT FAUNA

Based on database searches and the results of previous biological surveys in the surrounding region, six species of mammal, 14 bird species, three reptiles and one fish species of conservation significance could potentially occur in the study area. Eight species of conservation significance (three mammal, three bird and two reptile species) were recorded from within the study area:

- Pilbara Leaf-nosed Bat (EPBC Act Vulnerable, WC Act Schedule 1, DPaW Vulnerable);
- Ghost Bat (DPaW Priority 4);
- Western Pebble-mound Mouse (DPaW Priority 4);
- Australian Bustard (DPaW Priority 4);
- Bush Stone-curlew (DPaW Priority 4);
- Rainbow Bee-eater (EPBC Migratory WC Act Schedule 3);
- Pilbara Olive Python (EPBC Act Vulnerable, WC Act Schedule 1, DPaW Vulnerable); and
- *Notoscincus butleri* (DPaW Priority 4).

One species, the Northern Quoll (EPBC Act Endangered, WC Act Schedule 1, DPaW Vulnerable) was recorded by secondary evidence (potential scat) only and sent to an expert for identification. However, the results were inconclusive (Appendix F).

All records of conservation significant fauna species are summarised in Table 4.7 and mapped in Figure 4.11.

When literature review results were considered, an additional eight conservation significant vertebrate species were determined to have a medium to high likelihood of occurrence, and another eight conservation significant species were determined to have a low likelihood of occurrence. Species with medium to high likelihood of occurrence are described in greater detail in Section 5.3.

Table 4.7 – Conservation significant fauna recorded during the survey

Species	Location		Site	Abundance[1]
	Easting	Northing		
Mammals				
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	482070	7514556	EFF Bat rec 2	Several calls recorded
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	479269	7513740	EFF Bat rec 1	Several calls recorded
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	479342	7513913	EFF Bat rec 6	Total of 2 calls over 2 nights
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	481647	7513841	EFF Bat rec 9	Total of 30 calls over 2 nights
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	489195	7513573	EFF Bat rec 10	1 call
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	483454	7514177	EFF rec 17	1 call
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	524700	7513484	S12	1 call
Ghost Bat (*Macroderma gigas)*	479270	7513740	Bat rec 2	Calls recorded
Ghost Bat (*Macroderma gigas)*	524699	7513483	EFF S12	Calls recorded
Ghost Bat (*Macroderma gigas)*	512475	7508750	EFF S9	Calls recorded
Ghost Bat (*Macroderma gigas)*	503427	7511533	Camp	Sighting
Ghost Bat (*Macroderma gigas)* (secondary evidence)	481907	7514383	EFF NQ S4	Remains of a potential Ghost Bat kill
Western Pebble-mound Mouse (*Pseudomys chapmani)*	480235	7514773	EFF S9	Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani)*	479795	7514950	Opportunistic	Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani)*	522002	7511010	Opportunistic	Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani)*	493448	7512917	Opportunistic	Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani)*	518507	7510883	EFF NQ S11	Recently Active mound
Western Pebble-mound Mouse	518463	7510920	EFF NQ S11	Recently Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani)*	503025	7516133	Opportunistic	Recently Active mound
Western Pebble-mound Mouse (*Pseudomys chapmani)*	503291	7516514	EFF S12	Inactive mound
Northern Quoll[2] (*Dasyurus hallucatus*)	481878	7514334	Opportunistic	Unidentifiable potential Scat
Birds				
Bush Stone-curlew (*Burhinus grallarius)*	503472	7511704	EFF OS3	Two individuals observed regularly during phase 1 and phase 2
Bush Stone-curlew (*Burhinus grallarius)*	522772	7511130	Opportunistic	1 Individual
Australian Bustard (*Ardeotis australis)*	504086	7510890	EFF S5	1 Individual
Australian Bustard (*Ardeotis australis)*	522804	7511183	Opportunistic	1 Individual

Species	Location		Site	Abundance[1]
	Easting	Northing		
Australian Bustard (*Ardeotis australis)*	527338	7515435	EFF S11	Tracks
Australian Bustard (*Ardeotis australis)*	503574	7515423	Opportunistic	2 Individuals
Australian Bustard (*Ardeotis australis)*	522702	7511012	Opportunistic	1 Individual
Rainbow Bee-eater (*Merops ornatus)*	510000	7508800	EFF OS1a	2 Records
Rainbow Bee-eater (*Merops ornatus)*	527428	7515451	EFF S11	7 Records
Rainbow Bee-eater (*Merops ornatus)*	524700	7513483	EFF S12	5 Records
Rainbow Bee-eater (*Merops ornatus)*	483133	7513661	EFF S2	7 Records
Rainbow Bee-eater (*Merops ornatus)*	503956	7510139	Opportunistic	2 records
Rainbow Bee-eater (*Merops ornatus)*	515243	7509319	Opportunistic	2 records
Rainbow Bee-eater (*Merops ornatus)*	481944	7514627	EFF S1b	5 records
Rainbow Bee-eater (*Merops ornatus)*	507394	7510104	EFF S8	1 individual
Rainbow Bee-eater (*Merops ornatus)*	512475	7508750	EFF S9	15 records
Reptiles				
Pilbara Olive Python (*Liasis olivaceus barroni*)	510017	7508811	EFF OS3	1 Individual
Pilbara Olive Python (*Liasis olivaceus barroni*)	486091	7512546	EFF OS25	1 Individual
Pilbara Olive Python (*Liasis olivaceus barroni*)	481796	7513978	EFF OS23	1 Individual
Lined Soil-crevice Skink (*Notoscincus butleri)*	479122	7516841	EFF S1b	5 Records
Lined Soil-crevice Skink (*Notoscincus butleri)*	522000	7510967	EFF S10	4 Record
Lined Soil-crevice Skink (*Notoscincus butleri)*	503821	7513303	EFF S6	1 Individual

Datum: GDA 1994 MGA Zone 50

[1] Individuals = numbers are confirmed due to animals seen at the same time. Records = individuals seen multiple times or separately, therefore number of individuals unknown.

[2] Northern Quoll = A single unidentifiable potential Northern Quoll scat was recorded and sent to an expert for identification, however results were inconclusive (Appendix F).

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480000
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SERPENTINE CREEK

BOOLGEEDA CREEK

Legend

Species

- Northern Quoll (potential scat)
- Pilbara Leaf-nosed Bat
- Western Pebble-mound Mouse mound (active)
- Western Pebble-mound Mouse mound (inactive)
- Western Pebble-mound Mouse mound (recently active)
- Ghost Bat
- Ghost Bat (secondary evidence)
- Rainbow Bee-eater
- Australian Bustard
- Australian Bustard (Tracks)
- Bush Stone-curlew
- Pilbara Olive Python
- Lined Soil-crevice Skink (*Notoscincus butleri*)

- River
- Tracks
- Eliwana and Flying Fish survey area
- Footslopes and plains
- Gorges and gullies
- Hilltops, hillslopes, ridges and cliffs
- Major Creek line
- Mixed acacia woodlands

N

0 3 6

Kilometres

Absolute Scale - 1:150,000

ecologia ENVIRONMENT

Conservation significant species recorded during this survey

Figure: 4.1M
Project ID: 1512

Drawn: AH
Date: 13/01/15

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

Unique Map ID: AH465

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5 DISCUSSION

5.1 HABITATS

Habitat types were assessed for their suitability for supporting EPBC Act listed conservation significant fauna that were recorded or that may potentially occur in the study area (Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python). Areas of potentially suitable habitat for each of these species were identified. Records of the species during this and previous surveys in the proximity of the study area were taken into consideration in the assessment of the suitability of these areas. Their location and extent is mapped in Figure 5.1 - Figure 5.3.

Detailed descriptions of the suitability of potential habitats identified for each species within the study area and extent of these within the study area are summarised in Table 5.1 below.

Table 5.1 – Summary of potential habitats for EPBC Act listed fauna within the study area

Species	Fauna Habitat	Area inside study area (ha)	Percentage of Total study area (%)
Northern Quoll	**Potential denning habitat**. Areas of rocky gorges and gullies in the study area that may contain suitable den sites, preferably near a water source. Includes rocky gorges and gully habitat.	176.3	0.4
	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 rocky gorges and gullies, hilltops/hillslopes/ridges and cliffs, and major creekline habitat.	8,972.6	18.0
Pilbara Leaf-nosed Bat	**Potential roosting habitat**. Areas of rocky gorges and gullies in the study area that may contain suitable caves for roosting. Includes rocky gorges and gully habitat.	176.3	0.4
	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 rocky gorges and gullies, and major creekline habitat.	1,324.5	2.7
Pilbara Olive Python	**Potential critical habitat**. Areas which may contain escarpments, gorges, preferably with rock crevices and outcrops near water holes, which attract prey species. Includes rocky gorges and gullies, and major creekline habitat.	1,324.5	2.7

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SERPENTINE CREEK
CAVES CREEK
DUCK CREEK
BOOLGEEDA CREEK

Legend

- Northern Quoll (potential scat)
- River
- Northern Quoll potential denning habitat (gorges and gullies)
- Northern Quoll foraging habitat (hilltops, hillslopes, ridges and cliffs)
- Northern Quoll foraging / dispersal habitat (major creeklines)
- Eliwana and Flying Fish survey area

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Kilometres

Absolute Scale - 1:150,000

ecologia ENVIRONMENT

Northern Quoll
foraging/dispersal and potential denning habitat

Figure: 5.1
Project ID: 1512

Drawn: AH
Date: 12/01/15

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

Unique Map ID: AH476

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SERPENTINE CREEK
CAVES CREEK
DUCK CREEK
BOOLGEEDA CREEK

Legend

- Pilbara Leaf-nosed Bat recorded during this survey
- River
- Pilbara Leaf-nosed Bat potential dry season roost habitat (gorges and gullies)
- Pilbara Leaf-nosed Bat foraging/wet season roost habitat (major creeklines)
- Eliwana and Flying Fish survey area

N

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Kilometres

Absolute Scale - 1:150,000

ecologia ENVIRONMENT

Pilbara Leaf-nosed Bat
foraging and potential roosting 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: AH475

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7530000 7515000 7500000

SERPENTINE CREEK

CAVES CREEK

DUCK CREEK

BOOLGEEDA CREEK

Legend

- Pilbara Olive Python
- Potential critical Pilbara Olive Python habitat (gorges and gullies)
- Potential critical Pilbara Olive Python habitat (major creeklines)
- River
- Tracks
- Eliwana and Flying Fish survey area

N

0 3 6

Kilometres

Absolute Scale - 1:150,000

ecologia ENVIRONMENT

Pilbara Olive Python potential critical habitat

Figure: 5.3
Project ID: 1512

Drawn: AH
Date: 12/01/15

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

Unique Map ID: AH474

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5.1.1 Hilltops, hillslopes, ridges and cliffs

This habitat types was recorded from large areas within the regional area (previous survey areas within 150 km of the study area) and therefore is not unique to the study area. The mammals of this habitat type typically comprise the Common Rock-rat (*Zyzomys argurus*), Woolley's False Antechinus (*Pseudantechinus woolleyae*) and Rothschild's Rock-Wallaby (*Petrogale rothschildi*). These species shelter in caves and crevices. The cliff faces of this habitat types also support cave structures which provide roosting habitat for a variety of bat species.

The avifauna of the hilltops, hillslopes, ridges and cliffs is of low variety and includes a number of generalists such as the Painted Finch and the Spinifexbird and some specialised bird species such as the Striated Grasswren and Rufous-crowned Emu-wren (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010). Cliffs can be inhabited by the Southern Boobook which will utilise overhangs and caves for nesting (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010). However, 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 cliffs habitat subtype. The habitat subtypes and the typical species inhabiting these are as followed (Wilson and Swan 2013):

- Hilltops and ridge habitat subtypes: Fat-tailed Gecko (*Diplodactylus conspicillatus*), the geckos *Lucasium wombeyi* and *Heteronotia binoei* but also specialists such as the Pilbara Barking Gecko (*Underwoodisaurus seorsus*).
- Hillslopes habitat subtype: skinks *Ctenotus rubicundus* and *C. rutilans*
- Cliff habitat subtype: Pilbara Rock Monitor (*Varanus pilbarensis*), the Western Pilbara Spiny-tailed Skink (*Egernia cygnitos*, the Pygmy Python (*Antaresia perthensis*), the Velvet gecko (*Oedura marmorata*) 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 (DPaW Priority 4) Long-tailed Dunnart and can typically be found within these habitats (DEWHA 2005; DSEWPaC 2011a, 2013a; Oakwood 2000, 2008). Cliff faces can also provide suitable breeding habitat for the EPBC migratory species, Peregrine Falcon and the Grey Falcon (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010). The DPaW Priority 4 Western Pebble-mound Mouse prefers the hilltops and hillslopes of this habitat type where spinifex clumps on rocky pebbles dominate the landscape (van Dyck and Strahan 2008).

5.1.2 Footslopes and plains

The footslopes and plains habitat type was the most common habitat type in the regional area, covering 44.1% (133,312 ha) of the previous survey areas within 150 km of the Eliwana and Flying Fish study area.

The mammal species of the footslopes and plains comprise a variety of generalists such as the Little Red Kaluta (*Dasykaluta rosamondae*), Pilbara Ningaui (*Ningaui timealeyi*), Planigale (*Planigale* sp.) and Euro (*Macropus robustus*) (van Dyck and Strahan 2008).

The avifauna of this habitat type is relatively poor 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 (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010). Footslopes and plains can also include patches of moderately dense to dense shrubs which can attract a relatively large number of bird species such Singing

Honeyeater, Masked Woodswallow, Black-faced Woodswallow and Variegated Fairy-wren. Birds of prey utilise the open vegetation for hunting and Brown Falcons, Spotted Harriers and Whistling Kite can often be seen foraging above the spinifex plains (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010).

The herpetofauna of the foothills and plains comprises a range of generalists that find shelter and shade under spinifex clumps, as the usually hard soil and rocks do not allow the construction of burrows. These include the skink *Lerista verhmens*, Rock Ctenotus (*Ctenotus saxatilis*), Leopard Ctenotus (*Ctenotus 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*) (Bush and Maryan 2011; Storr *et al.* 1999; Wilson and Swan 2013, ecologia internal database).

Footslopes and plains are preferred habitat for two other species of conservation significance: the Western Pebble-mound Mouse and the Australian Bustard, the latter of which is generally restricted to the plains and rarely occurs along the footslopes (Anstee 1997; Johnstone and Storr 1998; NPWS 1999a; Venn 2003; Ziembicki 2010).

5.1.3 Major Creeklines

Major creeklines are usually recorded from a small extent. This habitat is not unique to the study area and covered 7.7% of the regional area.

Major creeklines provide habitat for a large number of species. The mammals of this habitat include species that also occupy other habitats identified within the study area, such as Pilbara Ningaui, Planigale and Desert Mouse (van Dyck and Strahan 2008). In addition, the fauna assemblage of the major creeklines can also comprise more specialised species such as the Northern Brush-tailed Possum (*Trichosurus vulpecula arnhemensis*), Delicate Mouse (*Pseudomys delicatulus*) and Sandy Desert Inland Mouse (*P. hermannsburgensis*) (van Dyck and Strahan 2008).

Major creeklines provide suitable habitat for a variety of bird species which can be found in large numbers and variety due to the number of trees and density of the vegetation which provides food and shelter. Bird species typically only found along major creeklines include the White-plumed Honeyeater, Sacred Kingfisher, Little Corella, and Southern Boobook (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010).

The herpetofauna of major creeklines includes generalists such as the skinks *Carlia munda*, *Ctenotus pantherinus* and *C. helenae*, as well as more specialist species such as the Long-nosed Dragon (*Amphibolurus longirostris*), which is a specialist of this habitat type (Simpson and Day 2010).

Species of conservation significance that are commonly found within major creeklines include the Bush Stone-curlew and the Rainbow Bee-eater (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010). The Bush Stone-curlew hides in the vegetation and will forage along water pools and in the surrounding areas (DEH 2006; Kirkwood 2008). The Rainbow Bee-eater is an inhabitant of the trees and larger shrubs and builds breeding tunnels in the sand banks (Boland 2004; Johnstone and Storr 2004; Simpson and Day 2010).

The major creeklines habitat was assessed as comprising potentially suitable foraging/dispersal habitat for Northern Quoll (Figure 5.1), potentially suitable foraging habitat for Pilbara Leaf-nosed Bat (Figure 5.2) and potentially critical habitat for the Pilbara Olive Python (Figure 5.3). Northern Quolls may use this habitat type seasonally, during the breeding season as travel ground of males, and for dispersal of young (Braithwaite and Griffiths 1994). The Pilbara Olive Python was recorded along the major creekline habitat within 1 km of the survey area (Figure 5.3). Where suitable tree hollows occur, Northern Quolls may utilise this habitat for denning also (Armstrong 2008; Bush and Maryan 2011; Cook 2010; DEWHA 2008b; DSEWPaC 2011a, 2013b; Pearson 2003).

5.1.4 Gorges and gullies

Due to the linear nature of this habitat types, gorges and gullies were recorded from only a small percentage of the study area (0.4%) and from within the regional area (0.8%)

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*) (van Dyck and Strahan 2008).

The avifauna of the gullies and gorges is relatively poor compared to other habitat types due to the sparse shrub and grass vegetation and the low number of flowering trees and shrubs. However, Grey Shrike-thrush, Western Bowerbird, Grey-headed Honeyeater, Black-faced Cuckoo-Shrike and Painted Finch can all be observed in large trees or near waterholes along gullies and gorges when water is present. Gorges and rocky areas are also favoured habitat for Little Woodswallows (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010).

The herpetofauna of gorges and gullies includes unique species that are specialised for inhabiting this fauna habitat type. Reptile species include the Pilbara endemic skink *Egernia pilbarensis*, the skink *Egernia formosa,* Pilbara Rock Monitor (*Varanus pilbarensis*) and Russet Snake-eyed Skink (*Cryptoblepharus ustulatus*). In addition to reptiles, a few species of amphibian can be found in gorges in the Hamersley region. Microhabitats with moist soil, such as those found under logs, rocks and leaf litter in rocky gullies and gorges are suitable for the Gorge Toadlet (*Pseudophryne douglasi*) (Bush and Maryan 2011; Wilson and Swan 2013).

Gorges and gullies represent potentially suitable habitat for four mammal species of conservation significance: the Northern Quoll, the Pilbara Leaf-nosed Bat, the Pilbara Olive Python, and the Long-tailed Dunnart (*Sminthopsis longicaudata*). These species may shelter in crevices and caves, and prey on the large number of insects and smaller mammals found around waterholes and the base of trees (Armstrong 2008; Bush and Maryan 2011; Cook 2010; DEWHA 2008b; DSEWPaC 2011a, 2013b; Pearson 2003). The Pilbara Leaf-nosed Bat and the Pilbara Olive Python were recorded from the gorges and gully habitat type whereas the Northern Quoll was potentially recorded (potential scat) within a rocky gorge. The Gane's blindsnake *Ramphotyphlops ganei* is also known to occur in rocky gullies (Wilson and Swan 2013).

5.1.5 Mixed acacia woodlands (mulga and snakewood)

The mixed acacia woodland was recorded from one small area within the study area covering 0.07%; however it is relatively common in the regional area, covering 19.1% (57,779.9 ha).

The mammal species inhabiting mixed acacia woodlands include generalists and the patches of this habitat type in the Eliwana and Flying Fish study area were of small size and comprised the same species as adjacent habitats. The Pilbara Ningaui, Planigale and Euro are all common inhabitants of the mixed acacia woodlands habitat type (van Dyck and Strahan 2008).

The avifauna of the mixed acacia woodland (mulga and snakewood) habitat is usually most diverse after significant rainfall, and when acacia shrubs and trees are flowering. In particular, honeyeater species such as the Singing Honeyeater, Brown Honeyeater and, in good conditions, Black and White-fronted Honeyeater can be common, but other species also occur, including Crested Bellbird, Red-capped Robin, Grey-crowned Babbler, White-winged Triller, Chestnut-rumped Thornbill and Willie Wagtail (Johnstone and Storr 2004, ecologia internal database; Simpson and Day 2010).

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 are unique to the mulga (*Acacia aneura*) woodland section of this habitat; the two Monitor lizards *Varanus bushi* and *V*. *caudolineatus*, and the Mulga Dragon (*Caimanops amphiboluroides*) (Wilson and Swan 2013).

The acacia woodland does not specifically provide important habitat for conservation significant species, but may be utilised by the Australian Bustard (NPWS 1999a; Venn 2003).

5.2 FAUNA ASSEMBLAGES

5.2.1 Mammals

The mammals recorded in the study area represent a typical assemblage of mammal species for the Pilbara region. The number of species recorded (22 native, six introduced) is moderate in relation to previous surveys (Table 2.6, Appendix C). Surveys at the Mt Farquhar project resulted in 16 native and four introduced (*ecologia* 2012), surveys at the West Turner section resulted in 17 native and three introduced (Biota 2009b), and the Solomon Mine Project resulted in 20 native and four introduced species (*ecologia* 2010). The dasyurids are represented by the lowest proportion of all those potentially occurring. A total of five out of nine potentially occurring dasyurid species were captured during the Level 2 vertebrate fauna and targeted conservation significant fauna assessment. The lack of records of the Common Rock-rat (*Zyzomys argurus*) is somewhat unusual as this species is generally considered one of the most common species captured along gorges, gullies, cliffs and ridgetops, and was recorded on 15 of the 17 of the previous surveys in the area (Appendix C). It is likely that suboptimal conditions resulted in a low activity level of the species or natural fluctuations of the local population during the targeted conservation significant fauna survey; however the survey was conducted following the relevant guidelines and during optimal timing for the targeted conservation significant species.

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

5.2.2 Birds

The bird assemblage recorded from the study area comprises species typical of the fauna habitat types present at the study area. Water bird species were not recorded during the survey due to the lack of surface water in the study area. In addition, waterbirds of this region are largely nomadic, travelling between suitable water sources. Surveys within Fortescue's Delphine study area (20 km north-west of the study area) recorded large amounts of surface water present (*ecologia* in prep-a), as a result the majority of bird species inhabiting river systems and major creeklines are expected to utilise the surrounding areas including Duck Creek and Cave Creek to the north of the study area (Figure 2.7, Figure 4.2).

Noteworthy is the record of an individual Elegant Parrot which was observed opportunistically during phase 2 of the Level 2 fauna survey (515689mE 7508750mN, Datum 50K). This species is not commonly recorded from the Pilbara but is an occasional autumn-winter visitor in the Pilbara region (Johnstone *et al.* 2013).

Three birds of conservation significance were recorded; the Australian bustard, Bush Stone Curlew and the Rainbow Bee-eater.

5.2.3 Herpetofauna

The number of reptile species recorded represents a relatively diverse assemblage, with a large number of species recorded in comparison to previous surveys in the region (Table 2.6, Appendix C). Dragon lizards and geckos of the Diplodactylidae family appear to have been under represented during the Level 2 vertebrate fauna assessment as evidenced by the low number of species recorded; four of 10 potentially occurring species of dragon, and eight of 12 potentially occurring species of Diplodactylidae were recorded. In contrast, the majority of snake species previously recorded from the region were recorded during this survey (11 out of 13 species). It appears that this result does not relate to weather conditions, as the average number of remaining reptile species recorded was

relatively high; 23 of 39 species of skink, five of seven species of legless lizard, eight of 10 species of goanna, and three of four species of Python. It is thought that the lack of sandy and clay habitat, as well as the lack of dense shrubland is the reason for the low number of dragon lizards and geckos of the Diplodactylidae family.

Two reptile species of conservation significance were recorded; the Pilbara Olive Python and the Lined Soil-crevice Skink, *Notoscincus butleri*.

5.2.4 Fish

One species of fish, the Spangled Perch, was recorded during the Level 2 vertebrate fauna assessment during which small puddles of water were recorded from creeklines and gorges. During the targeted conservation significant fauna assessment in winter (dry season), only one waterhole was recorded from a gorge in the south-west of the study area which appears to be semi-permanent due to its depth (approximately 2.3 m) and the sheltered and shady location. However, no fish were recorded from this pool. A relatively large number of fish have been recorded from previous surveys in the region due to the presence of large water pools and springs along Cave Creek and Duck Creek to the north of the study area (Appendix C, (*ecologia* 2013)).

No conservation significant fish were recorded from the current survey. The Fortescue Grunter (P4) was recorded from the nearby Delphine study area (12 north-west of study area) from permanent to semi-permanent pools (*ecologia* 2013). Due to the Eliwana and Flying Fish study area not containing any similar pools, there is a low likelihood of the Fortescue Grunter occurring within the study area.

5.2.5 Endemic species and species of biological significance

Endemic species previously recorded from the region include the Barking Gecko (*Underwoodisaurus seorsus*), the Western Pilbara Spiny-tailed Skink (*Egernia cygnitos*) and the skink *Egernia pilbarensis*. One of the three species was recorded during this survey; *Egernia cygnitos*. This species was recently split from the taxon *E. depressa*, which was divided into four species; *E. depressa*, *E. eos, E. cygnitos* and *E. epsisolus (Doughty et al. 2011). Egernia cygnitos* is described as occurring in the Pilbara region excluding most of the Chichester IBRA subregion except for the southern Chichester Range bordering the Fortescue Marsh. The species usually inhabits rock crevices and large rock boulders of rocky outcrops.

Other endemic species to the Pilbara recorded during the survey include the Pilbara Ningaui (*Ningaui timealeyi*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*), Pilbara Olive Python (*Liasis olivaceus barroni*), Banded Knob-tailed Gecko (*Nephrurus wheeleri cinctus*), *Delma pax*, *Ctenotus rubicundus*, *C. rutilans*, Pilbara Rock Monitor (*Varanus pilbarensis*), *V. bushi* and Rufous Whipsnake (*Demansia rufescens*).

5.3 CONSERVATION SIGNIFICANT FAUNA

Based on database searches previous biological surveys in the surrounding region, six mammal, 14 bird, three reptile and one fish species and the results of conservation significance could potentially occur in the study area. Information regarding conservation significant species are summarised below in Table 5.2.

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

Table 5.2 – Conservation significant fauna occurring or potentially occurring in the study area

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPaW			
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.	Closest record from Delphine study area (*ecologia* 2013). Records from eight locations within 85 km of the study area (Coffey 2008; DEC 2012; Ecoscape 2010, ecologia internal database).	**HIGH** Unidentifiable potential Northern Quoll scats were recorded from a gorge in the south-west of the study area and nearby record from Delphine Project (Figure 2.6). Suitable denning and foraging habitat is present (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.	Calls recorded from two locations at Delphine Project and from four locations at Central Pilbara Project (*ecologia* 2011b, in prep-a). Two records from approximately 67-72 km north-west and one record from 20 km south-east of the study area (DPaW 2014).	**RECORDED** Species recorded from seven locations in the south-west and east of the study area. Suitable roosting and foraging habitat is present along gorges and gullies, and major creeklines, in particular in the south and south-west of the study area (Figure 5.2).
Long-tailed Dunnart *Sminthopsis longicaudata*			P4	Rocky, hilly areas vegetated with spinifex; occasionally open areas with a stony, rocky mantle.	Recorded from two locations within the Central Pilbara Project, approx. 46 km north-east of the study area (*ecologia* 2011b). NatureMap and DEC Threatened Fauna search list four records within 20 km, the closest record within 1 km north-east of the study area .	**HIGH** Suitable habitat present within study area within the hilltops, hillslopes, ridges and cliffs habitat type.
Ghost Bat *Macroderma gigas*			P4	Roost in caves, rockpiles and abandoned mines. Will travel 2 km from roost to hunt.	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 (DPaW 2014) states nine records within 82 km of the study area .	**RECORDED** Species recorded during this survey. Suitable habitat present was recorded from the gorge/gully and major creekline habitat type and is synonymous with habitat identified and mapped for the Pilbara Leaf-nosed Bat (Figure 5.2).

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPaW			
Short-tailed Mouse *Leggadina lakedownensis*			P4	Spinifex and tussock grassland on cracking clays. Also acacia shrubland, samphire, woodlands, and stony ranges.	Fourteen records within 48 km (majority within 14 km) of the eastern end of the study area (DPaW 2014).	**LOW** Several previous records nearby but no suitable habitat identified from the study area.
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.	Mounds recorded from 60 locations within 95 km of the study area (Biota 2005b, 2009b; Coffey 2008; *ecologia* 2010, 2011b; Kendrick 1995; Mattiske and Ninox 1990).	**RECORDED** Active and inactive mounds recorded during this survey. Suitable habitat present within the footslopes and plains habitat type.
Birds						
Fork-tailed Swift *Apus pacificus*	M	S3		Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts.	Recorded from five locations at Central Pilbara Project and Solomon Project (*ecologia* 2010, 2011a).	**MEDIUM** Likely to occur around the Project but will not land within the study area.
Eastern Great Egret *Ardea modesta*	M	S3		Wide range of wetland habitats, including floodwaters, rivers, shallows of wetlands, intertidal mudflats.	Closest record from Delphine Project (*ecologia* in prep-a). Birdata contains records within 40 km of study area. Two NatureMap records are within 67 km (DPaW 2014).	**MEDIUM** Suitable habitat present during rainy season when water is present along major creeklines.
Cattle Egret *Ardea ibis*	M	S3		Grassy habitats, shallow wetlands and waterbodies, particularly damp pastures.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** No previous records and no suitable habitat within study 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.	Recorded from Birdata only with no specific location information.	**LOW** Lack of suitable habitat within study area with one previous record.
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.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** No previous records and no suitable habitat within study area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPaW			
Oriental Plover *Charadrius veredus*	M	S3		Open plains, including samphire; bare rolling country; bare claypans; open ground near inland swamps.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** No previous records and no suitable habitat within study area.
Common Sandpiper *Actitis hypoleucos*	M	S3		Coastal and inland wetlands, with varying levels of salinity; mostly found on muddy margins or rocky shores; rarely mudflats.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** No previous records and no suitable habitat within study area.
Little Curlew *Numenius minutus*	M	S3		Short dry grasslands, including artificial grassed areas.	Recorded approximately 46 km west of study area (Biota 2009a).	**LOW** Lack of suitable habitat within study area with few previous records.
Rainbow Bee-eater *Merops ornatus*	M	S3		Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water.	Eleven NatureMap records within 70 km of the study area (DPaW 2014). In addition, 17 records from the Central Pilbara Project, 15 records from Solomon Project and 10 record from the Delphine and Mt Farquhar Project (*ecologia* 2010, 2011a, in prep-a). Species recorded during other consultancy's survey in the region.	**RECORDED** Species recorded during this survey and numerous records in the region. Suitable foraging and breeding habitat present within the major creeklines habitat type within the study area.
Peregrine Falcon *Falco peregrinus*		S4		Widespread; coastal cliffs, riverine gorges and wooded watercourses.	Two records from Mt Farquhar and Delphine study area and another from the Central Pilbara project (*ecologia* 2011a, 2012, 2013). One more record from approximately 40 km south-east of the study area and three additional NatureMap records within 50 km (DEC 2012; *ecologia* 2011b, ecologia internal database).	**HIGH** Several records nearby and suitable habitat present within hilltops, hillslopes, ridges and cliffs habitat type.
Grey Falcon *Falco hypoleucos*		S1	Vu	Lightly wooded coastal and riverine plains.	One record from Delphine study area , one from 110 km east of study area and one record 81 km south of the study area (DEC 2012; *ecologia* in prep-a; Kendrick 1995).	**HIGH** Record nearby and suitable habitat present within the hilltops, hillslopes, ridges and cliffs habitat type, and footslopes and plains can be utilised as foraging habitat.

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.	Several records in the region: 27 NatureMap records, three records from Delphine Project, six records from Central Pilbara project, one record from previous surveys conducted by other consultancies (Biota 2005b, 2009b; DEC 2012; *ecologia* in prep-a; Mattiske and Ninox 1990).	**RECORDED** Recorded during this survey and suitable habitat present within the footslopes and plains habitat type.
Bush Stone-curlew *Burhinus grallarius*			P4	Lightly wooded country next to daytime shelter of thickets or long grass.	Three NatureMap records from within 92 km of the study area , three records from Delphine Project and nine records from Central Pilbara Project (DEC 2012; *ecologia* 2011b, in prep-a). In addition Biota (2005b) and Ecoscape (2010) as well as Birdata list records of this species in the region.	**RECORDED** Three individuals sighted during this survey along suitable habitat within the study area within the footslopes and plains habitat type.
Star Finch (western) *Neochmia ruficauda subclarescens*			P4	Vegetation around watercourses, particularly thick reed beds.	Four records within 83 km of the study area , one record from Marandoo (Kendrick 1995) and Brockman 2 (Mattiske and Ninox 1990) and one record from approximately 5 km east of the study area (*ecologia* internal database).	**MEDIUM** Very little suitable habitat present within the study area. May occasionally pass through the study area to travel to adjacent creeklines.
Reptiles						
Pilbara Olive Python *Liasis olivaceus barroni*	VU	S1	VU	Watercourses and areas of permanent water in rocky gorges, escarpments and gullies.	Closest records from Solomon Project and Central Pilbara project (*ecologia* 2010, 2011a). Two records from Tom Price and one record from Karijini National Park (DEC 2012). Previously recorded by Biota (Biota 2009a, b) and Ecoscape (2010)	**RECORDED** Two individuals recorded within the study area and one individual approximately 1.3 km outside the study area during this survey. Suitable habitat present along gorge/gully and major creekline habitat (Figure 5.3).
Ramphotyphlops ganei			P1	Variety of habitats; thought to prefer moist gorges.	Closest record from Central Pilbara Project and Solomon Project (*ecologia* 2010, 2011a).	**MEDIUM** Suitable habitat present. Some previous records within 80 km of the study area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPaW			
Lined Soil-crevice Skink *Notoscincus butleri*			P4	Associated with stony/rocky, spinifex-dominated areas near creek and river margins.	Recorded from Solomon Project and Central Pilbara project (*ecologia* 2010, 2011a) and four previous surveys within 100 km (Biota 2005b, 2006, 2009b; Coffey 2008).	**RECORDED** Ten individuals from three locations. Suitable habitat present within footslopes and plains in the vicinity of major creeklines throughout the study area.
Fish						
Fortescue Grunter *Leiopotherapon aheneus*			P4	Permanent water pools or streams.	Recorded from Delphine Project (*ecologia* 2013)	**LOW** No suitable habitat present.

5.3.1 Mammals

5.3.1.1 Northern Quoll (*Dasyurus hallucatus*)

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

Distribution and Habitat: The Northern Quoll formerly occurred across northern Australia, from the Pilbara region in Western Australia to south-eastern Queensland. A 75% reduction of available habitat occurred during the 20th century, so that the species is now restricted to the Pilbara and northern Kimberley in Western Australia, and a few discrete populations across the Northern Territory and eastern Queensland (Braithwaite and Griffiths 1994). Northern Quolls are most common on dissected rocky escarpments, but are also found in eucalypt forest and woodland where they 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 Northern Quoll mortality is predation by dingoes, feral cats, snakes, owls and kites but also feeding on Cane Toads (Maxwell *et al.* 1996; Oakwood 2000, 2008). Other causes of mortality include predation by domestic dogs, motor vehicle strikes and pesticide poisoning. The level of predation is increased through the removal of groundcover by fire.

Likelihood of Occurrence: High. One individual was recently recorded from the nearby Delphine study area , approximately 30 km north-west of the study area (*ecologia* in prep-a). In April 2013, the species was also recorded from the Edge (south of the Eliwana and Flying Fish study area (Biologic 2013). Coffey and Ecoscape recorded Northern Quolls from Solomon Project, approximately 65 km north-east of the study area (Coffey 2008; Ecoscape 2010). In addition, NatureMap (DEC 2012) states two more records from within 63-85 km north-west of Eliwana and Flying Fish study area which indicates that Northern Quolls regularly occur in the region, particularly to the west of the study area .

During the Level 2 vertebrate fauna assessment, a potential Northern Quoll scat was recorded from a gorge in the south-west of the study area. The scat was analysed by a specialist (Georgianna Storey, “scats about”) but could not be clearly identified and, therefore, the presence of the species is not confirmed (Appendix F). Targeted conservation significant fauna trapping site NQ S4 was located in proximity to the location of the scat, with no individuals recorded. It is not likely that a significant populations of the species exists within the study area; however, individuals may occassionally occur within the study area when conditions are suitable. However, suitable foraging and dispersal habitat and potential denning habitat for the Northern Quoll was identified within the study area (Figure 5.1).

Figure 5.4 – Image of recorded unidentifiable potential Northern Quoll scat

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 aurantia*). While it is considered a separate form, formal reclassification has been hampered by the small sample size of the Pilbara population (Armstrong 2008).

Recent evidence suggests two main stronghold areas for the Pilbara Leaf-nosed Bat; in the western Pilbara and north of Marble Bar (Armstrong 2008). In the western Pilbara, they roost in caves formed in gorges that dissect siliceous sedimentary geology. They are most often recorded 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 as these do not provide suitable stable temperatures and the high humidity conditions required by the Pilbara Leaf-nosed Bat.

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. Pilbara Leaf-nosed Bats calls were recorded from three locations during the Level 2 vertebrate fauna assessment and from four locations during the targeted conservation significant fauna assessment (Figure 5.5), of which one location has potential to be in proximity (within 15 km) to a roost cave most likely located outside the study area. This is based on the call pattern which consists of a total of 30 calls (1st night: 13 calls, 2nd night: 17 calls) between 6:30 pm and 10:30 pm which indicates a number of Pilbara Leaf-nosed Bats leaving their roost cave after sunset (Appendix G). The majority of recorded calls were made from the gorges and gullies habitat type, along gorges with or without waterholes, or along ridges and other flyways in the hilltops, hillslopes, ridges and cliffs habitat type in the south-west of the study area (Figure 5.2). The species was also recorded from 15 locations from the Delphine study area (Figure 2.6), six locations in the Mt Farquhar study area and from four locations at the Central Pilbara Project (*ecologia* 2011b, in prep-a) (Figure 2.6). In addition, three regional records exist within 20-70 km of the study area (DEC 2012) with the closest record made in 2009. Suitable foraging in the form of major creekline habitat and potential roosting habitat in the form of gorge and gully habitat for the Pilbara Leaf-nosed Bat was identified within the study area (Figure 5.2). No roost cave was recorded from the study area; however, the species is able to utilise small, deep crevices in the vicinity of pools if these

provide suitable conditions (humidity and temperature) (Churchill 2008; Churchill 1991; Churchill *et al.* 2008).

Figure 5.5 – Gorge of recorded bats calls (site Bat Rec 9)

5.3.1.3 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).

It is not possible to identify any threatening processes at this stage as little is known about this species. Threats may 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: High. The closest record of this species was made approximately 1 km north-east of the study area (DEC 2012). There are several other records from nearby, two of which are located at the nearby Central Pilbara Project Area (DEC 2012; *ecologia* 2011b). Suitable habitat for this species exists within the hilltops, hillslopes, ridges and cliffs habitat type.

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 1998). Ghost Bats disperse widely during the non-breeding season but require warm caves with high relative humidity (80%) for rearing their young (Toop 1985). These maternity caves are uncommon with only eleven recorded in the Pilbara region (three natural caves and eight mines) (Armstrong and Anstee 2000).

Ecology: Ghost Bats are carnivorous and take 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: Recorded. The Ghost Bat was recorded from five locations during this survey, along the southern ridge of rocky breakways and gullies within the gorges and gullies habitat type (Figure 4.11). Of these, calls were recorded from three locations during the Leve 2 survey, the remains of a potential Ghost Bat kill were recorded from a cave entrance in the south-west of the study area (Figure 5.6) and one individual was observed near the camp. During previous surveys at the Central Pilbara Project, this species was recorded through sightings and calls from six different locations. Surveys conducted by Coffey (2008) and *ecologia* (2010) at Solomon revealed additional calls from three locations which indicate that this species is a regular hunter in the region. This is supported by the nine records stated by NatureMap within 82 km of the study area (DEC 2012). However, during the Level 2 vertebrate fauna and targeted conservation significant fauna assessment, no maternity caves were recorded from within the study area . Therefore, the recorded individuals are likely to be foraging visitors to the study area. Suitable potential roosting and foraging habitat for the Ghost Bat within the study area , is synonymous with Pilbara Leaf-nosed Bat potential roosting and foraging habitat and was identified within the study area (Figure 5.2).

Figure 5.6 – Remains of a potential Ghost Bat kill (wings of a Budgerigar) (at site EFF NQ S4)

5.3.2 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 Western 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. During this survey four active mounds (Figure 5.7) were recorded from the west of the study area , three recently active mounds were observed in the east and north of the study area and one inactive mound was observed in the north of the Eliwana and Flying Fish study area . Several other very old mounds were recorded thorughout the study area . Previous records in the region include several mounds from 60 locations and therefore the species appears to be widespread in the region (Coffey 2008, DEC 2013; DEC 2012; *ecologia* 2010, 2011b). Suitable habitat for the Western Pebble-mound Mouse exists within the footslopes and plains, and hilltops, hillslopes, ridges and cliffs habitat types within the surevey area.

Figure 5.7 – Active Western Pebble-mound Mouse mound recorded within the study area

5.3.3 Birds

5.3.3.1 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). It is distributed from central Siberia throughout Asia, breeding in north-east and mid-east Asia, and wintering in Australia and southern New Guinea. It is a relatively common trans-equatorial migrant from October to April throughout mainland Australia (Simpson and Day 2010). 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 2010)

Likelihood of Occurrence: Medium. Fork-tailed Swifts were not observed during this survey but previous record exist from five locations at the Central Pilbara Project and Solomon Project (*ecologia* 2010, 2011b) (Figure 2.7). The likelihood of Fork-tailed Swifts occurring within the Eliwana and Flying Fish study area is anticipated to be moderate, considering the previous records and their aerial lifestyle. Given its almost entirely aerial nature, the species is likely to overfly the study area but will not land.

5.3.3.2 Eastern Great Egret (*Ardea modesta*)

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

Distribution and Habitat: Eastern Great Egrets mainly inhabit shallow waterbodies; 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 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: Medium. The Eastern Great Egret is expected to utilise the major creeklines habitat type within study area along major creeklines when weather conditions are favourable, such as after heavy rain falls when large pools of water are present. Previous records in the region comprise two records (presumably of the same individual) from the Delphine study area (*ecologia* 2013) and one record from Beasley River, approximately 30 km south of the Eliwana and Flying Fish study area (DEC 2012) (Figure 2.7).

5.3.3.3 Rainbow Bee-eater (*Merops ornatus*)

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

Distribution and Habitat: The Rainbow Bee-eater is scarce to common throughout much of Western Australia, except for the arid interior. This species prefers 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 2010). The species eats on insects, in particular bees, but also flies, dragon flies and grasshoppers (Johnstone and Storr 1998). Eggs are laid at the end of the metre-long tunnel from August to January (Boland 2004). Rainbow Bee-eaters are most susceptible to predation during breeding, as it spends significantly more time on the ground in this period.

Likelihood of Occurrence: Recorded. A total of 46 sightings of the Rainbow Bee-eater were recorded during the Level 2 vertebrate fauna assessment from nine locations within the major creeklines habitat type in the study area and from one location approximately 1.3 km outside the study area . Suitable breeding and foraging habitat is present in the major creeklines habitat. NatureMap states additional records from 11 locations (DEC 2012). Seventeen records were made at the Central Pilbara Mine project (*ecologia* 2011a, b) (Figure 2.7).

5.3.3.4 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 its continental islands, but absent from most deserts and the Nullarbor Plain. The species is considered to be moderately common in the Stirling Range, uncommon in the Kimberley, Hamersley and Darling Ranges, and rare or scarce elsewhere (Johnstone and Storr 1998). The Peregrine Falcon occurs most commonly near cliffs along coasts, rivers and ranges, and around wooded watercourses and lakes.

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

Likelihood of Occurrence: High. The Peregrine Falcon was not recorded from the study area , although previous records include one record from the Mt Farquhar, one from the Delphine study area (*ecologia* 2012, 2013), one record from the Central Pilbara project (*ecologia* 2011b), three records from within 50 km of the study area and one additional record from 40 km south-east of the study area (*ecologia* internal database) (Figure 2.7). Potential nesting habitat exists within the hilltops, hillslopes, ridges and cliffs habitat type, which is the most important habitat for the Peregrine Falcon as it provides suitable breeding habitat. Foraging habitat can vary and the species is able to travel away from disturbed foraging habitat.

5.3.3.5 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 of the state, 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 very sparse 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 most other large 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: High. A single Grey Falcon was recorded overflying the footslopes and plains habitat in May 2012 from the Delphine study area (*ecologia* 2013). Another two records were located 110 km east and 81 km south of the study area (DEC 2012; *ecologia* in prep-a; Kendrick 1995). Suitable breeding habitat is potentially present along cliffs and ridges in the south-east of the study area and footslopes and plains can be utilised as foraging habitat.

5.3.3.6 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. A total of five individual Australian Bustards were recorded during the current survey from five locations (Figure 4.11). All locations were made from either the major creekline habitat or the footslopes and plains habitat type (Figure 4.11). A relatively large number of previous records were within 100 km: 27 NatureMap records, three records from Delphine study area, six records from the Central Pilbara Project and additional records made by Mattiske and Ninox (1990) and Biota (Biota 2005b, 2009b) (Figure 2.7). Suitable habitat exists within the footslopes and plains habitat type and they will also utilise the the mixed acacia woodlands habitat type.

5.3.3.7 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 acts as daytime shelter (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 due to predation by foxes, habitat clearance for agriculture, habitat degradations and removal of leaf litter (Garnett and Crowley 2000). 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 1999b).

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 1999b). 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 1999b).

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

Likelihood of Occurrence: Recorded. Three individuals were recorded from the study area Figure 4.11. Two individuals were regularly sighted at the Eliwana camp and the adjacent major creekline. One individual was recorded in the east of the study area along the same major creekline (Figure 4.11). Three NatureMap records exist from within 92 km of the study area , three records were made from the Delphine study area and additional individuals were recorded nine times during the survey at Central Pilbara Project (DEC 2012; *ecologia* 2011b, in prep-a). Biota (2005b), Ecoscape (2010) ,and Birdata have recorded this species in the region. Suitable habitat exists within the major creeklines habitat type.

5.3.4 Reptiles

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

Likelihood of Occurrence: Recorded. Two individuals were recorded from within the study area, one of which was found in a small pool within the gorges and gullies habitat, in the south of the study area (Figure 4.11). The second individual was found in a deep rock pool within a rocky gorge in the west of the Eliwana and Flying Fish study area (Figure 4.11). In addition to these two records, a third individual was recorded during the survey along a creekline approximately 1 km outside the study area. This creekline continues within the study area.

Suitable Pilbara Olive Python habitat was identified along major creeklines and within gorges and gullies. The Pilbara Olive Python is likely to shelter in the gorges and gullies and river systems habitat types within deep rocky crevices over the cooler winter months. Critical habitat for the Pilbara Olive Python, in particular during the summer months, includes areas where surface water collects such as deep bowls and depressions within rocky gorges (Figure 5.3).

Three small to medium-sized water pools were recorded from the gorges and gullies habitat type in the south of the study area which represent a critical location for Pilbara Olive Python to shed and hunt. Previous surveys at Central Pilbara Project and Solomon Project resulted in observations of this species in the region (*ecologia* 2010, 2011b). In addition, Ecoscape (2010) and Biota (Biota 2009a, b) recorded the species within 95 km.

Figure 5.8 – Pilbara Olive Python recorded during this survey

5.3.4.2 Gane's blindsnake *(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: Medium. The closest record of this species is from Central Pilbara Project and Solomon Project (*ecologia* 2010, 2011b). These two records were made from a rocky creek bed and from a rocky/clay plain which compliments the previously known preferred habitat. Suitable habitat in the form of rocky gullies, gorges and plains exists within the gullies and gorges habitat type, as well as the footslopes and plains habitat identified within the study area . The species has a cryptic lifestyle and can usually only be trapped after light rainfall and increased moisture in the substrate. However, the species is anticipated to have a moderate likelihood to occur in the study area.

5.3.4.3 Lined Soil-crevice Skink *(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 area of the Dampier district to Harding River dam (Storr *et al.* 1999; Wilson and

Swan 2010). Its habitat is typically spinifex dominated areas near creek and river margins (Wilson and Swan 2010).

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

Likelihood of Occurrence: Recorded. *Notoscincus butleri* was recorded at three trap sites within the Eliwana and Flying Fish study area (EFF S1, EFF S6 and EFF S10). These trap sites were located in proximity to major creeklines or minor drainage lines corresponding to the known preferred habitat of this species. However, the ecology of this species is relatively unknown and the species has potential to be present throughout different habitats in the study area. The species has also been recorded from 24 locations within 100 km of the study area (Biota 2005b, 2006, 2009b; Coffey 2008; DEC 2012; *ecologia* 2010, 2011b, in prep-a).

5.4 SURVEY ADEQUACY

Survey effort expended within the study area is summarised in Table 3.5, which shows considerable systematic and opportunistic sampling effort was undertaken. In addition, Table 3.5 shows survey effort was adequate in sampling all fauna habitat types and comparable to approved projects such as Fortescue's Solomon Mine (*ecologia* 2010). A total of 7,056 Level 2 trap nights, 749 targeted trap nights, 59 hours of bird surveys, 69 hours of diurnal searches, 53 hours of nocturnal searches were conducted within the study area. In addition, motion cameras were set-up for a total of 1,822 hours and 700 hour of SM2BAT recordings were analysed.

Analysis of the observed avifauna assemblage recorded during the Level 2 vertebrate fauna assessment suggests the survey recorded 97.4 % of the expected avifaunal assemblage, while analysis of data recorded during the Level 2 vertebrate fauna assessment of the trappable terrestrial faunal assemblage suggests the survey recorded 93.4 % of the expected terrestrial faunal assemblage. This represents a relatively high survey adequacy, in comparison to other surveys and approved projects in the region where a survey adequacy of 58% - 92.3% was recorded (*ecologia* 2010, 2011b, c). Based on the shape of SACs, it is observed a plateau profile has not been achieved. This suggests that additional surveying may reveal additional species not yet recorded. However, in summary, these results indicate that survey effort was high and provided a comprehensive inventory of the fauna assemblage present in the study area.

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6 CONCLUSION

The main conclusions of the terrestrial vertebrate fauna survey of the Eliwana and Flying Fish Level 2 vertebrate fauna and targeted conservation significant fauna assessment are as follows:

- The survey methods were consistent with the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment; Guidance Statement No. 56; Position Statement No. 3; Referral guidelines for the endangered Northern Quoll and the EPBC Act Survey Guidelines for Australia's Threatened Mammals, Reptiles, Bats and Birds, as well as Fortescue Metals Group's Terrestrial Vertebrate Fauna Assessment Guidelines.
- Species accumulation curves showed that survey adequacy from the current survey was high and provided a comprehensive inventory of the fauna assemblage present in the study area.
- The land systems, vegetation communities and habitats present recorded during this survey are not restricted to the study area.
- Five habitat types were identified within the study area; hilltops, hillslopes, ridges and cliffs; footslopes and plains; major creeklines; gorges and gullies; and mixed acacia woodlands (mulga and snakewood). The gorge/gully habitat type is the most significant habitat type as it provides potentially suitable denning habitat for the Northern Quoll, potentially suitable roosting habitat for the Pilbara Leaf-nosed Bat and critical habitat for the Pilbara Olive Python. However, all habitat types recorded during the survey are present outside the study area.
- Statistical analyses of the terrestrial fauna data indicated that there were no significant differences between fauna habitat types.
- A total of 22 species of native mammals, five species of introduced mammal, 80 species of bird, 70 species of reptile, three species of amphibian, and one species of fish were recorded during this survey. Of these, 19 native and five introduced species of mammal, 74 bird species, 62 reptile species, two amphibian species and one species of fish were recorded during phase 1 of the survey. The second phase resulted in 22 mammal species (18 native, four introduced species), 65 bird species, 54 reptile species and two reptile species.
- Eight vertebrate species of conservation significance were recorded within the study area, namely Pilbara Leaf-nosed Bat, Ghost Bat, Western Pebble-mound Mouse (active mound), Australian Bustard, Bush Stone-curlew, Rainbow Bee-eater, Pilbara Olive Python, and the skink *Notoscincus butleri*. A further eight conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the study area.
- Results of the targeted conservation significant fauna assessment did not identify any significant roost sites for Pilbara Leaf-nosed Bat, however based on the timing and the call pattern of one of the recorded calls a roost cave was located within 15 km of the SM2Bat site.
- No Northern Quoll individuals or conclusive secondary evidence of the species was recorded during the Level 2 or targeted conservation significant fauna assessment, indicating that significant populations are not expected to occur in the area surveyed. A single unidentifiable potential Northern Quoll scat was recorded and sent to an expert for identification; however the scat identification was inconclusive.
- Some limitations were experienced, including restricted access to the northern edge of the study area. However, synonymous habitat was surveyed elsewhere in more accessible areas of the study area, and based on statistical analysis of the data recorded the majority of the predicted and expected fauna species likely to occur in the study area were recorded.

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APPENDIX A EXPLANATION OF CONSERVATION CODES

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

Category	Definition
Endangered (EN)	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable (VU)	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Migratory (M)	Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • 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 DEC Threatened and Priority Fauna Codes

Threatened	**Definition**
Critically Endangered (CR)	Considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Considered to be facing a high risk of extinction in the wild.
Priority	**Definition**
Priority 1 (P1)	*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

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Date	Mean Minimum Temperature (°C)	Mean Maximum Temperature (°C)	Rainfall (mm)
Level 2 phase 1 Vertebrate Fauna Survey			
13/04/12	13.5	32.5	0
14/04/12	14.2	32.5	0
15/04/12	20.2	33.0	0
16/04/12	18.1	34.7	0
17/04/12	16.4	35.9	0
18/04/12	17.0	33.7	0
19/04/12	15.9	34.8	0
20/04/12	16.6	34.5	0
21/04/12	18.2	31.4	0
22/04/12	20.9	28.7	0
23/04/12	20.6	31.9	0
Targeted Conservation Significant Fauna Survey			
03/07/12	3.2	22.7	0
04/07/12	3.9	23.6	0
05/07/12	6.4	23.5	0
06/07/12	1.8	23.7	0
07/07/12	4.4	23.9	0
08/07/12	5.9	24.1	0
09/07/12	4.1	26.4	0
10/07/12	1.9	27.4	0
11/07/12	11.0	21.4	1.0
Level 2 phase 2 Vertebrate Fauna Survey			
19/04/13	22.6	37.1	0
20/04/13	20.2	36.2	0
21/04/13	18.3	35.1	0
22/04/13	17.8	34.4	0
23/04/13	23.1	36.0	0
24/04/13	20.4	36.2	0
25/04/13	22.4	35.1	0
26/04/13	23.7	33.6	0
27/04/13	16.4	31.7	4.2
28/04/13	18.1	33.7	0
29/04/13	18.2	35.5	0

Note: climate data recorded from Paraburdoo weather station (BoM 2014).

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APPENDIX C REGIONAL FAUNA DATA

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Appendix C1 – Mammals

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC 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				●	S (u)
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 Sheathtail Bat													●			●									
MOLOSSIDAE																										
Chaerophon jobensis	Northern Freetail Bat							●				●		●		●	●		●		●					●
Mormopterus beccarii	Beccari's Freetail Bat					●		●				●		●		●	●	●					●			●
Mormopterus loriae	Little Northern Freetail Bat									●																
Tadarida australis	White-striped Freetail Bat							●		●		●								●						
VESPERTILIONIDAE																										
Chalinolobus gouldii	Gould's Wattled Bat					●		●		●		●		●	●	●	●	●	●	●	●		●			●
Chalinolobus morio	Chocolate Wattled Bat														●											
Nyctophilus arnhemensis	Arnhem Long-eared Bat									●																
Nyctophilus bifax daedalus	Northern Long-eared Bat																					●				
Nyctophilus geoffroyi	Lesser Long-eared Bat					●								●												●
Scotorepens balstoni	Inland Broad-nosed Bat																			●						
Scotorepens greyii	Little Broad-nosed Bat					●		●		●		●		●	●	●	●	●			●					●
Vespadelus finlaysoni	Finlayson's Cave Bat					●		●		●		●		●	●	●	●	●	●	●	●	●	●			●
MURIDAE																										
Leggadina lakedownensis	Northern Short-tailed Mouse			P4		●																	●	●		
Notomys alexis	Spinifex Hopping-mouse										●											●				

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																						
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				●	●	●	●	●		●	●		●		●	●	●	●	●						●

S = Secondary evidence
S (u) = Secondary evidence (unidentifiable)
SA = Secondary evidence (active Mounds)

Appendix C2 – Birds

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC 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																											
Ephippiorhynchus asiaticus	Black-necked Stork																						●				
ARDEIDAE																											

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
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							●																				
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				●		●	●			●				●				●	●	●		●	●
RECURVIROSTRIDAE																												
Himantopus himantopus	Black-winged Stilt																										●	
CHARADRIIDAE																												
Charadrius veredus	Oriental Plover	M	S3																							●		

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																							
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																												
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					●		●		●				●	●	●	●	●		●	●	●	●			●	●

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																								
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 Sittella													●														
CAMPEPHAGIDAE																												
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																						●					

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey
		EPBC Act	WC Act	DPaW																								
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	Spinifex-bird				●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●				●	●
HIRUNDINIDAE																												
Cheramoeca leucosterna	White-backed Swallow								●																			
Hirundo neoxena	Welcome Swallow													●														
Petrochelidon ariel	Fairy Martin							●	S	●				●			●				●	●	●				●	●
Petrochelidon nigricans	Tree Martin					●		●	●	●				●		●	●			●		●					●	
NECTARINIIDAE (DICAEIDAE)																												
Dicaeum hirundinaceum	Mistletoebird							●		●		●		●	●	●	●	●		●	●	●	●				●	●
ESTRILDIDAE																												
Taeniopygia guttata	Zebra Finch					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●
Neochmia ruficauda subclarescens	Star Finch (western)			P4		●			●										●			●					●	
Emblema pictum	Painted Finch				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●
MOTACILLIDAE																												
Anthus novaeseelandiae	Australasian Pipit								●	●										●		●					●	●

Appendix C3 – Reptiles

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC 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	Pilbara Barking Gecko											●		●				●								
GEKKONIDAE																										
Gehyra pilbara						●		●				●		●		●			●			●	●			●
Gehyra punctata						●		●	●	●		●		●	●	●	●	●	●	●			●			●
Gehyra variegata	Tree Dtella					●	●	●		●		●		●	●	●	●	●	●	●		●	●			●
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					●		●		●						●		●		●	●					●
SCINCIDAE																										
Carlia munda						●		●		●	●	●		●	●	●		●	●	●	●	●	●			●

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																							
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	Western Pilbara Spiny-tailed Skink							●																			●
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																											
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																										

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																							
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													●	●	●											

S = Secondary evidence

Appendix C4 – Amphibians

Family and Species	Common name	Conservation Status			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC 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			Eliwana and Flying Fish (Ecoscape 2012b, c)	*ecologia* Internal Database	Delphine (Ecoscape 2012a)	Delphine (*ecologia* 2013)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	Mt. Farquhar (Ecoscape 2012d)	Mt Farquhar (*ecologia* 2012)	Raven (Ecoscape 2012e)	Central Pilbara Project (*ecologia* 2011a)	West Turner Section 10 (Biota 2009b)	Solomon Project Area (Coffey 2008)	Solomon Project (*ecologia* 2010)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Fauna habitats and assemblage of Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	NatureMap	DPaW Rare Fauna	DSEWPaC 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							•				•					•									•

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APPENDIX D SITE DESCRIPTIONS

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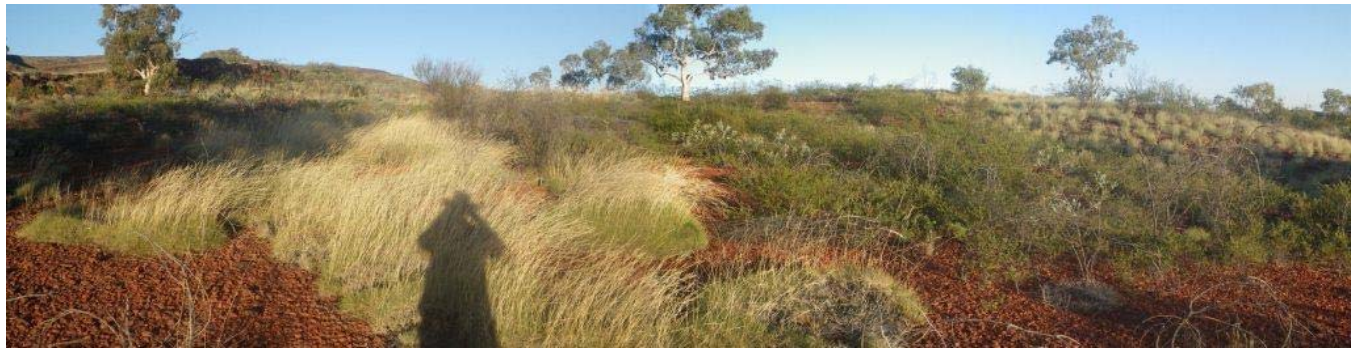
Vegetation and Fauna Habitat Description	Site Photo
EFF S1a Patch of very open shrubland with scattered eucalypt trees over very open layer of mixed acacia shrubs over moderate to dense spinifex clumps on hard red loamy-clay with pebbles. Burnt areas surrounding trap site. Little wood and leaf litter present. Habitat type: Footslopes and plains	
EFF S1b Spinifex plain adjacent to minor creekline and ridge. Few eucalypt trees over mixed shrubs over spinifex on loamy brown soil. Lower vegetation layer dense along the minor creekline. Spinifex plain consisted open vegetation. Some leaf litter and wood litter. Habitat type: Footslopes and plains	
EFF S2 Creekline with dense fringing vegetation of eucalypt trees and mixed shrubs over spinifex grasses. Gravel and clay-loam along the creekline. Leaf litter and wood litter present adjacent to creekline. Habitat type: Major creeklines	

EFF S3 Plain adjacent footslope with scattered low shrubs and large clumps of dense spinifex on rocky loam. Majority of substrate is formed of pebbles. No wood or leaf litter. Habitat type: Footslopes and plains	
EFF S4 Rocky gully with adjacent rock face. Scattered eucalypt trees and patches of dense shrubs over open layer of small spinifex clumps. Habitat type: Gorges and gullies	
EFF S5 Creekline with dense vegetation of a variety of eucalypt trees and mixed shrubs over Buffel grass and spinifex grassland on brown clay. Leaf litter and wood litter present. Habitat type: Major creeklines	

EFF S6 Open plain with adjacent gentle footslope. Sparse low shrubs over moderate spinifex clumps on rocky clay. No wood litter or leaf litter present. Habitat type: Footslopes and plains	
EFF S7 Rocky plain with scattered eucalypt trees over occasional mixed shrubs over moderate to open patches of spinifex. Rocky loam with little wood litter and no leaf litter. Habitat type: Footslopes and plains	

EFF S8 Rocky plain adjacent major creekline with few eucalypt trees and moderately dense mixed shrubs over dense spinifex clumps. Some wood litter and leaf litter present on rocky and loamy substrate. Habitat type: Major creek lines	
EFF S9 Rocky footslope with very sparse low shrubs over dense spinifex clumps. Trap site located adjacent to creekline. Some wood litter, no leaf litter. Habitat type: Footslopes and plains	

EFF S10 Rocky plain with minor drainage channel. Scattered eucalypt trees over mixed shrubs over dense large clumps of spinifex on rocky loam. Little leaf litter and wood litter. Habitat type: Footslopes and plains	
EFF S11 Major creekline with dense eucalypt trees over moderate mixed shrubs over buffel grass and adjacent spinifex grassland. Moderate wood and leaf litter. First half of trapping site in spinifex on rocks, second half in buffel grass on clay. Habitat type: Major creeklines	
EFF S12 Rocky hillslope with scattered eucalypt trees over open mixed low shrubland over moderate spinifex hummock grassland on rocky loamy soil with very sparse wood litter and leaf litter. Habitat type: Footslopes and plains	

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APPENDIX E FAUNA SPECIES RECORDED DURING THIS SURVEY

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Appendix E1 – Mammals

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
DASYURIDAE																															
Dasykaluta rosamundae	Kaluta																2	2					2	3			1	3			
Ningaui timealeyi	Pilbara Ningaui				2	2	3	1	6	4		4		1	2	3	1	2		2	2	1	8	1	1	2	8	5			
Planigale sp.	Common Planigale				2	1	4		1	2	2	2	1	1	2	2	3		4	3	1	2	2					1			
Pseudantechinus woolleyae	Woolley's False Antechinus																														2
Sminthopsis macroura	Stripe-faced Dunnart																	2													
MACROPODIDAE																															
Macropus robustus	Euro							1	1																				2	4	2
Macropus rufus	Red Kangaroo																1														
MEGADERMATIDAE																															
Macroderma gigas	Ghost Bat			P4																	R						R		R	1	
HIPPOSIDERIDAE																															
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat	VU	S1	VU																								R	R		
EMBALLONURIDAE																															
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat				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	R	
MOLOSSIDAE																															
Chaerephon jobensis	Northern Freetail Bat				R						R			R	R	R		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	
Tadarida australis	White-striped Freetail Bat																												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	
Nyctophilus geoffroyi	Lesser Long-eared Bat																						R							R	
Scotorepens greyii	Little Broad-nosed Bat				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	R	
MURIDAE																															
Pseudomys chapmani	Western Pebble-mound Mouse			P4														1											S	S	
Pseudomys delicatulus	Delicate Mouse						1																								
Pseudomys desertor	Desert Mouse													2				1									4				
Pseudomys hermannsburgensis	Sandy Inland Mouse						4						3	1			2	1		1							5				
INTRODUCED MAMMALS																															
Mus musculus	House mouse										1		1	2								1			3						
Canis lupus	Dog/dingo																												1	1	
Felis catus	Cat																												1		
Equus asinus	Donkey														1		1	1											9	6	
Bos taurus	Cow							1										1											5	1	

S = Secondary evidence
R = Recorded

Appendix E2 – Birds

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
PHASIANIDAE																															
Coturnix ypsilophora	Brown Quail					**1**								**2**												**5**				2
COLUMBIDAE																															
Phaps chalcoptera	Common Bronzewing													1														1	2	
Ocyphaps lophotes	Crested Pigeon							2				1		35	4		6	1	7	18							2	41	12	
Geophaps plumifera	Spinifex Pigeon				14						1				7				2									25	17	
Geopelia cuneata	Diamond Dove				2		1						2		7		1		18		5		3		3			41	1	
PODARGIDAE																															
Podargus strigoides	Tawny Frogmouth						2																					1	2	
EUROSTOPODIDAE																															
Eurostopodus argus	Spotted Nightjar																											6	14	
AEGOTHELIDAE																															
Aegotheles cristatus	Australian Owlet Nightjar					1					1				1									1			1		2	3	
ACCIPITRIDAE																															
Elanus axillaris	Black-shouldered Kite																								1	2			1		
Haliastur sphenurus	Whistling Kite																			2					1		2		1	1	
Milvus migrans	Black Kite																					1				1				1	
Accipiter fasciatus	Brown Goshawk						1																		8		1			2	
Circus assimilis	Spotted Harrier														1		1						1		4				3	2	
Aquila audax	Wedge-tailed Eagle																								1				2	1	
Hieraaetus morphnoides	Little Eagle							1																					2		
FALCONIDAE																															
Falco cenchroides	Nankeen Kestrel						1	1	1		3			1				1	2								1		4	1	
Falco berigora	Brown Falcon				1						1						4						1						2	2	
Falco longipennis	Australian Hobby						1										1								4				1	1	
OTIDIDAE																															
Ardeotis australis	Australian Bustard			P4									1												1				4		
BURHINIDAE																															
Burhinus grallarius	Bush-stone Curlew			P4																					1				2	2	
TURNICIDAE																															
Turnix velox	Little Button-quail				1								8						3						10		7		2		
CACATUIDAE																															
Eolophus roseicapillus	Galah						16								4	1	2	38					3							9	
Cacatua sanguinea	Little Corella																5	1	2							4		2			
Nymphicus hollandicus	Cockatiel						2		16				7				46						2		11				68	25	
PSITTACIDAE																															
Barnardius zonarius	Australian Ringneck					2	2						6		2		6	4	2		3		2		1	2		3	2	1	
Melopsittacus undulatus	Budgerigar				124	32	123	54	76		62	1	18	3	55	14	495		77	11	38	25	175	2	168	2	545	23	309	5	
Neophema elegans	Elegant Parrot																													1	
CUCULIDAE																															
Chalcites basalis	Horsfield's Bronze-cuckoo						1																1						1		
Cacomantis pallidus	Pallid Cuckoo						1																						2		
STRIGIDAE																															
Ninox novaeseelandiae	Southern Boobook												1																3	2	
HALCYONIDAE																															
Dacelo leachii	Blue-winged Kookaburra																														1
Todiramphus pyrrhopygius	Red-backed Kingfisher						2		1	1	1				1		4	1	1		1		1		1		1		1		
Todiramphus sanctus	Sacred Kingfisher												1																2		

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
MEROPIDAE																															
Merops ornatus	Rainbow Bee-eater	M	S3			5	5	2												1	13	2			7		3	2	2	4	
PTILINORHYNCHIDAE																															
Ptilonorhynchus guttatus	Western Bowerbird					2													1						1			2	1		
MALURIDAE																															
Malurus leucopterus	White-winged Fairy-wren									7	3	4	6			2	7	17										4		
Malurus lamberti	Variegated Fairy-wren					10	2	8	5	8	5	4	8			4		8	1	8	9	7		3	10			9	8	4	
Stipiturus ruficeps	Rufous-crowned Emu-wren														4	2		2													
Amytornis striatus	Striated Grasswren																												4	1	
ACANTHIZIDAE																															
Smicrornis brevirostris	Weebill				6	12	11	12		7	15	11	12	8	12	7	11	5	26	14	2	12	25	11	6	3	11	10	18	8	
Gerygone fusca	Western Gerygone						2							1					1	2	1	2									
Acanthiza uropygialis	Chestnut-rumped Thornbill							6													4	8								1	
PARDALOTIDAE																															
Pardalotus rubricatus	Red-browed Pardalote				1			1				2		1	4					5	1	7			3		4		2	2	
Pardalotus striatus	Striated Pardalote				5				1						4				1		4		4	2	2		4	2	6	4	
MELIPHAGIDAE																															
Certiomyx veriegatus	Pied Honeyeater																						1		1	4					
Lichenostomus virescens	Singing Honeyeater				1	2	1				4		19	5	1	1	4	4	15	4	1	1	15		22	58	6	2	9		
Lichenostomus keartlandi	Grey-headed Honeyeater				11	1	2		4	3	10	6			2		9	3	5	3		8	18	3	3	5	17	9	11	3	
Lichenostomus penicillatus	White-plumed Honeyeater												17	10					2							12					
Purnella albifrons	White-fronted Honeyeater																		1				2		2	1					
Manorina flavigula	Yellow-throated Miner				1					3			5			1	17		10		1	1	5	2	11	10	6	6	13	3	
Acanthagenys rufogularis	Spiny-cheeked Honeyeater						3																		1				2		
Epthianura tricolor	Crimson Chat				32						10	1					16						2	3	1				3		
Sugomel niger	Black Honeyeater				2				3		18		16				25						1		94	115	8		7	1	
Lichmera indistincta	Brown Honeyeater				7		17						88	13			16		19		4				97	20	34		10		
Melithreptus gularis	Black-chinned Honeyeater				1		2						10	3					2		1		3		8	3			1	3	
POMATOSTOMIDAE																															
Pomatostomus temporalis	Grey-crowned Babbler				3		4	3		2							7	8	2		9	4	2						1		
CAMPEPHAGIDAE																															
Coracina novaehollandiae	Black-faced Cuckoo-shrike				2		1		2	1	6		3	2	3		3		1		5		3		1		8		4		
Coracina maxima	Ground Cuckoo-shrike																														4
Lalage sueurii	White-winged Triller				14								26		3		1		3				2		19		3		1		
PACHYCEPHALIDAE																															
Pachycephala rufiventris	Rufous Whistler				5	2	3	1	1	1			6	3	1	1		1	5	3	5	3	3	1	5	1	3	1	5	1	
Colluricincla harmonica	Grey Shrike-thrush				1		1	2	3	3									4	2	5	4	1				3	5	2	5	
Oreoica gutturalis	Crested Bellbird				3	4	4	1	1	2	3	1	4	1	1	1	2	4	6		2		3	3	3	1	3	2	1	1	
ARTAMIDAE																															
Artamus personatus	Masked Woodswallow						167		7		12		5												37		5		47		
Artamus cinereus	Black-faced Woodswallow				1	3		2		5					12		2	10										5		2	
Artamus minor	Little Woodswallow					2													5		1	14							1		
Cracticus torquatus	Grey Butcherbird																												1		
Cracticus nigrogularis	Pied Butcherbird					2			1	1	1		1		6	4	1		3		1		3	3			1		7		
Cracticus tibicen	Australian Magpie				1	1					1			1	2	2	2	4						1	1		2		1		
RHIPIDURIDAE																															
Rhipidura leucophrys	Willie Wagtail				3	3	2	1	1	1		2	6	1	2	2	4	5	1	3	5	5	6	4	5	3	1		7	3	
CORVIDAE																															

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
Corvus orru	Torresian Crow					2	4	1		2	3		4	4	1	1	2	4		3	4		8	3	1	7	5	5	7		1
MONARCHIDAE																															
Grallina cyanoleuca	Magpie-lark																				3								6	3	
PETROICIDAE																															
Melanodryas cucullata	Hooded Robin				3	1	1			3		3						5	1	1	1	2	3	5					2	4	
MEGALURIDAE																															
Cincloramphus mathewsi	Rufous Songlark				1												1		3		2								1		
Cincloramphus cruralis	Brown Songlark														1														1		
Eremiornis carteri	Spinifexbird						1		3				1		5		3		3		4		5		1		4		4		
HIRUNDINIDAE																															
Petrochelidon ariel	Fairy Martin																												1		
NECTARINIIDAE																															
Dicaeum hirundinaceum	Mistletoebird							2				1																	3	1	
ESTRILDIDAE																															
Taeniopygia guttata	Zebra Finch				58	7	37	70	24	2	40	4	39	21	47	3	56	23	79	16	40	56	54	6	36	1	52	6	232	42	
Emblema pictum	Painted Finch				4	1	6	20	21		2				33		6		3		18		13				3		55		
MOTACILLIDAE																															
Anthus novaeseelandiae	Australasian Pipit																													1	

Appendix E3 – Reptiles

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
AGAMIDAE																															
Amphibolurus longirostris	Long-nosed Dragon				2	6	35	9		1			15	13				1		2		1			3	3				20	
Ctenophorus caudicinctus	Ring-tailed Dragon				3	12	2	2	10	2	7	4	1	1	4	2	7	12	2	1		3	1		1			4	16	6	1
Ctenophorus isolepis	Central Military Dragon					2		2		2		4	3	1		2		12		1		3						4		6	
Pogona minor	Bearded Dragon																	2													
DIPLODACTYLIDAE																															
Diplodactylus conspicillatus	Fat-tailed Gecko										1				3	1	3	6								1					
Diplodactylus savagei											2							1		2		1					2	1			
Lucasium stenodactylum	Sand-plain Gecko				1	1	1						1				1	1	1			1									
Lucasium wombeyi									1		2				1		1						2								
Oedura marmorata	Marbled Velvet Gecko					4		3	3																				4	19	
Rhynchoedura ornata	Beaked Gecko					1	1																								
Strophurus elderi																1														
Strophurus wellingtonae								2																2						1	
CARPHODACTYLIDAE																															
Nephrurus wheeleri	Banded Knob-tailed Gecko				2			1	1	1											1		1						1	1	
GEKKONIDAE																															
Gehyra pilbara												2										5								30	
Gehyra punctata						4			4		8	2			1							2							18	69	
Gehyra variegata								3				3	6	1				3	3	1				1					2	4	
Heteronotia binoei	Bynoe's Gecko				2	3	3	2	6	2	1	2			1	2		1		5	1	5	4	7		4	5	8		1	
Heteronotia spelea						1																2								27	
PYGOPODIDAE																															
Delma nasuta													1		2								1				4				
Delma pax														1			2		1					1	1	2	1				
Delma tincta													1				2				1										
Lialis burtonis	Burton's Snake-lizard																				1								2		
Pygopus nigriceps	Western Hooded Scaly-foot							1						1		1			1							1					
SCINCIDAE																															
Carlia munda						2	7	5	3	3	1		19	26				3	6	1	2	4		1	3	5	3	1			
Carlia triacantha																		1		1											
Cryptoblepharus ustulatus	Russet Snake-eyed Skink						1	1																						2	
Ctenotus duricola						2	1			1		3			1	3	1	1			2	3	1	2			1	7			
Ctenotus grandis							15	14		1				1	1	1			9	18	12	16			2	4	1	1			
Ctenotus helenae					1	2	2	4	1	2		1	5	12		1	1	4	6	2	6		3	1	8	1	3	1			
Ctenotus leonhardii							1																								
Ctenotus pantherinus	Leopard Ctenotus					2			4	11	2	1	5	1	4	1	13	7	2	3	6	5	4	10	6	6	5	2			
Ctenotus rubicundus										1																		1	1		
Ctenotus rutilans											3	1					1											1			
Ctenotus saxatilis	Rock Ctenotus				4	7	14	7		3	2	5		1		1	6	1	6	7	7	8	1				2		3	5	
Cyclodomorphus melanops	Spinifex Slender Blue-tongue				1	1				1				1					1					1	1	1	1				
Egernia formosa																													5	2	
Egernia cygnitos												7																	3		
Eremiascincus richardsonii	Broad-banded Sand-swimmer																												1		
Lerista muelleri																											1				

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
Menetia greyii					1														1										1		
Menetia surda										1						1			1	1											
Morethia ruficauda exquisita						1				1		1				1						2								1	
Notoscincus butleri				P4	3	2										1							1	3							
Notoscincus ornatus					1																										
Proablepharus reginae																			1												
Tiliqua multifasciata	Centralian Blue-tongue																1		1								1				
VARANIDAE																															
Varanus acanthurus	Spiny-tailed Monitor				1						3				8		1				1	4	1		2		3				
Varanus brevicauda	Short-tailed Pygmy Monitor																										1				
Varanus bushi	Pilbara Monitor					1						1	2															2			
Varanus eremius	Pygmy Desert Monitor						1												1		1		1	2		1	3		1		
Varanus giganteus	Perentie																													4	
Varanus panoptes	Yellow-spotted Monitor																							1					1		
Varanus pilbarensis	Pilbara Rock Monitor																												1		
Varanus tristis	Black-headed Monitor												1																	1	
TYPHLOPIDAE																															
Ramphotyphlops ammodytes																							1								
Ramphotyphlops grypus	Beaked Blind Snake																										1				
PYTHONIDAE																															
Antaresia perthensis	Pygmy Python										1												2							2	
Antaresia stimsoni	Stimson's Python					1	1															1							3	1	
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1	VU																									2	1	
ELAPIDAE																															
Acanthophis wellsi	Death Adder																	1									1				
Brachyurophis approximans	NW Shovel-nosed Snake																		1												
Demansia psammophis cupreiceps	Yellow-faced Whipsnake									1		2	2	2				1	3	1			1				1	1			
Demansia rufescens	Rufous Whipsnake																						1			1	1	1	1		1
Furina ornata	Moon Snake							2	1		1	1						1			1	1	1					1			
Parasuta monachus	Monk Snake						3				1				1				1			2				2					
Pseudechis australis	Mulga Snake					1	1		1					1											1				2	1	1
Pseudonaja mengdeni	Gwardar						1		1																1				2	1	
Pseudonaja modesta	Ringed Brown Snake								1		1	1																			
Suta fasciata	Rosen's Snake					1						1											1								
Suta punctata	Little Spotted Snake																	1											1		

Appendix E4 – Amphibians

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
HYLIDAE																															
Cyclorana maini	Main's Frog																	1		1										**3**	
Litoria rubella	Little Red Tree Frog																												4		
MYOBATRACHIDAE																															
Uperoleia saxatilis	Northwest Toadlet												4																	15	

Appendix E5 – Fish

Family and Species	Common Name	Conservation Status			EFF S1		EFF S 2		EFF S3		EFF S4		EFF S5		EFF S6		EFF S7		EFF S8		EFF S9		EFF S10		EFF S11		EFF S12		Opp		Targeted Survey
		EPBC Act	WC Act	DEC	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	
TERAPONTIDAE																															
Leiopotherapon unicolor	Spangled Perch																												4		

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APPENDIX F SCAT ANALYSIS REPORT FROM 'SCATS ABOUT'

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24 May 2012

Ecologia Environment
1025 Wellington St
West Perth WA 1944

To Astrid Heidrich

RE: Hamersley scat analysis #1444

The result for the scat collected in the Hamersley region of the Pilbara was not conclusive. It is felt that the scat is either from a medium sized dasyurid or a Varanid species. A description of the analysis is below.

The size and shape of this scat was consistent with a mid sized dasyurid, reptile and ghost bat. I don't think the scat is from a ghost bat because of the nature of the scat contents. Besides insect fragments and skink scales the scat contained hair from a dasyurid and was relatively undamaged. Prey hair in ghost bats (and other bats) is generally cut into small fragments. These hairs within the scat were most likely from prey rather than grooming and were from *Dasyurus hallucatus*, *Dasykaluta rosamondae* or *Sminthopsis macroura*. The scat also contained skink remains (the whiter pellet and white tip of other pellet), the composition of which made it difficult to distinguish the presence or absence of a uric plug. The fragment size of the remaining prey is consistent with a medium sized dasyurid or a goanna. Therefore, while it is possible that the scat originated from *Dasyurus hallucatus* I am unable to confirm this with certainty.

If you have any further questions regarding these results please don't hesitate to contact me.

Yours sincerely

Georgeanna Story

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APPENDIX G EXAMPLES OF PILBARA LEAF-NOSED BAT CALL PATTERNS RECORDED

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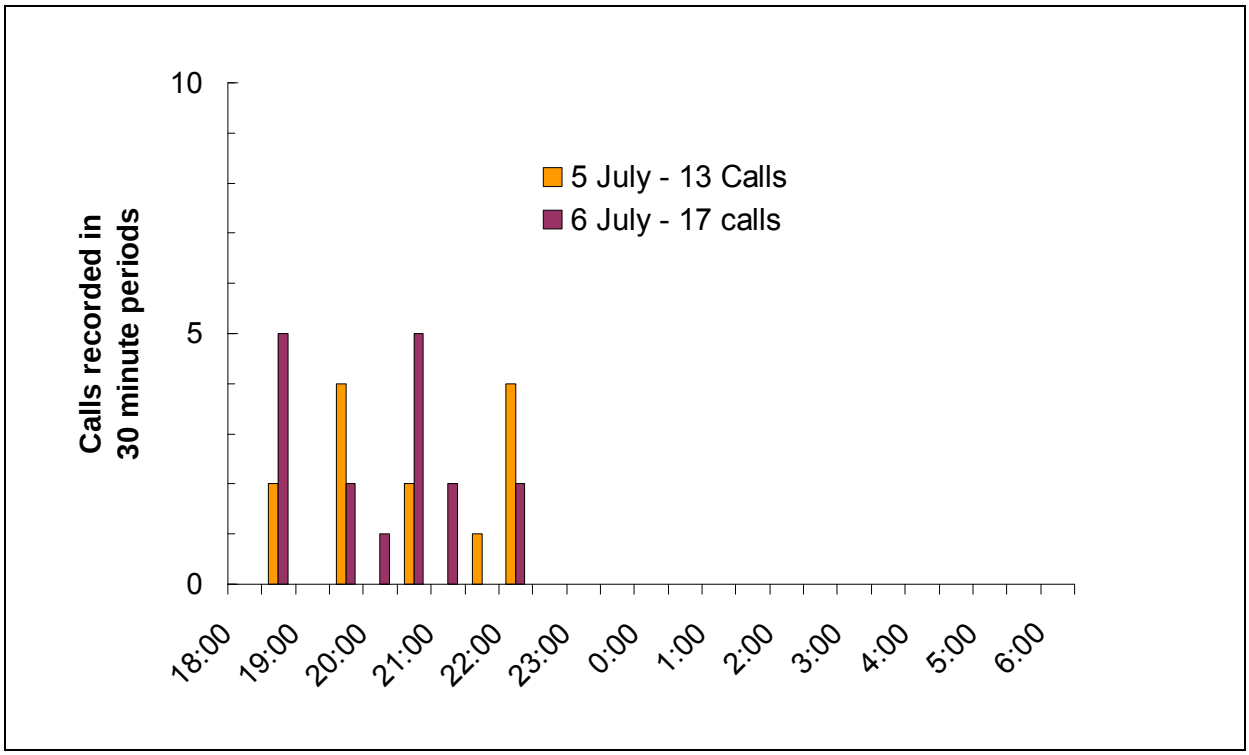
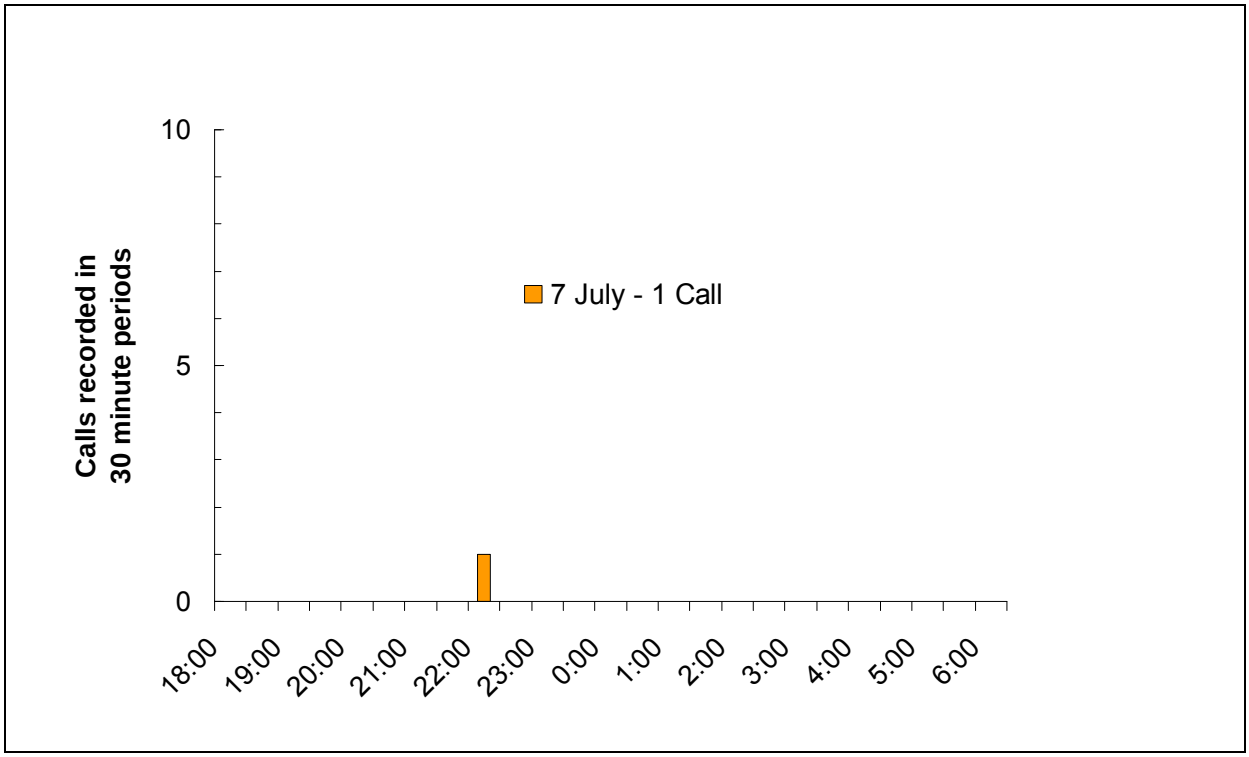
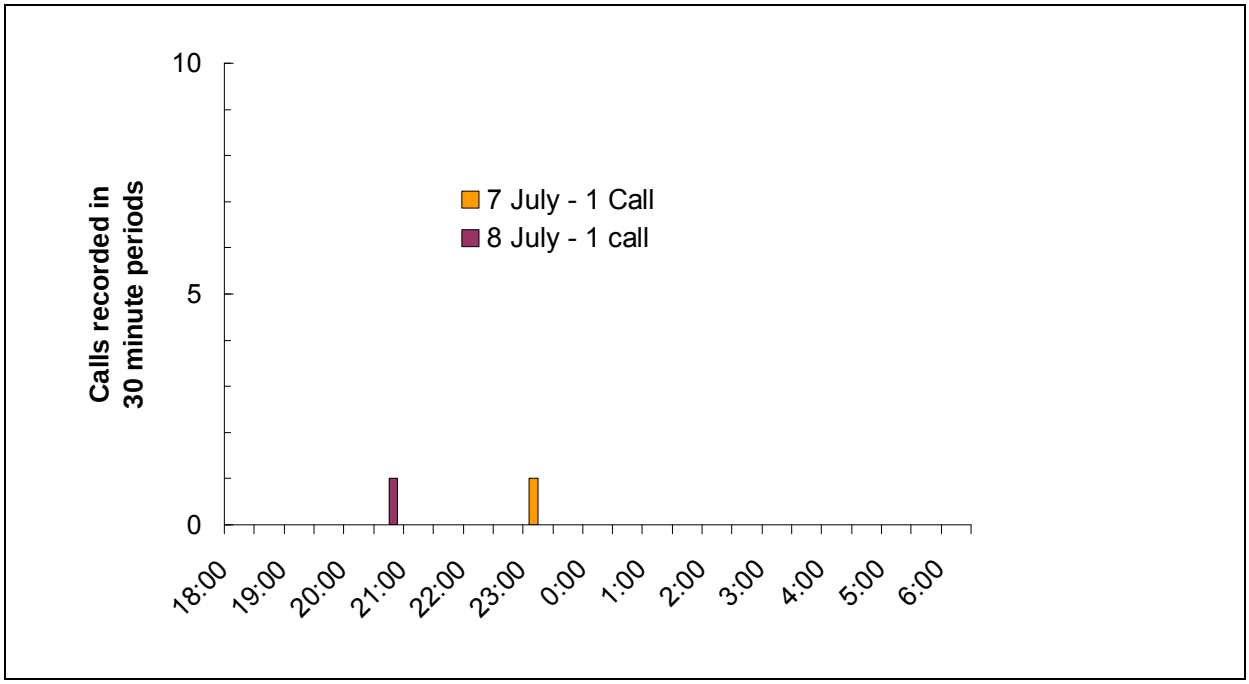
Opportunistic Site: “Bat Rec 6”



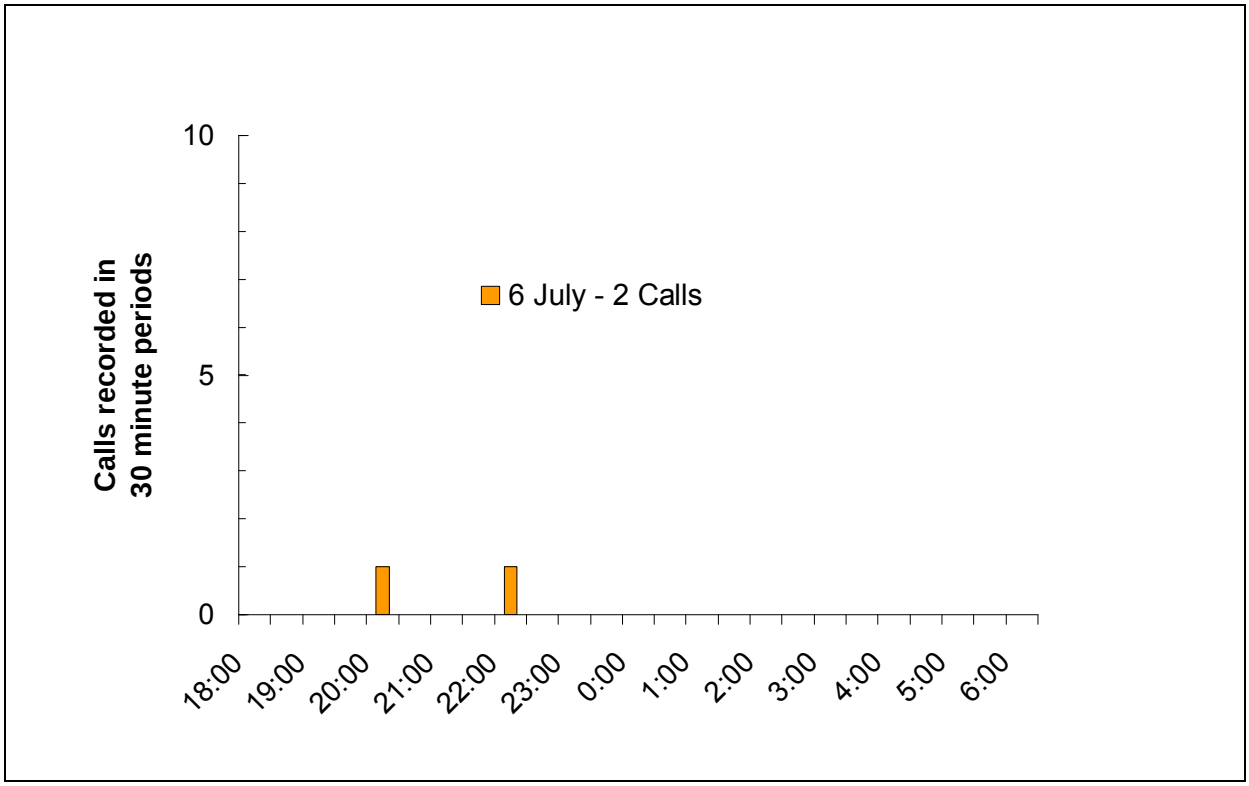
Opportunistic Site: “Bat Rec 7”

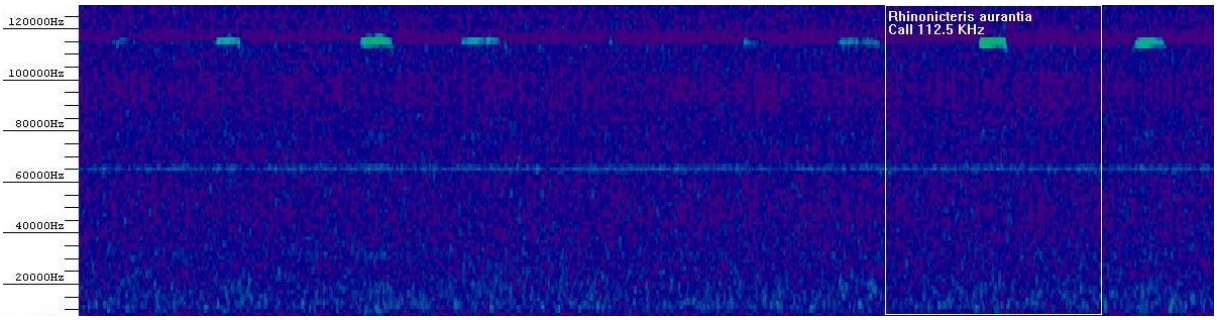


Opportunistic Site: “Bat Rec 4”



Opportunistic Site: “Bat Rec 14”





Call recorded during the phase 2 survey