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**FORTESCUE METALS GROUP LTD
STINGRAY PROJECT
TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT**

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ACRONYMS

ANOSIM	Analysis of Similiarity
BoM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
CPP	Central Pilbara Project
DEC	Department of Environment and Conservation (now DPaW)
DEWHA	Department of Environment, Water, Heritage and the Arts
DPaW	Department of Parks and Wildlife (formerly DEC)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FMG	Fortescue Metals Group Limited
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australian Migratory Bird Agreement
MDS	Multidimensional Scaling
NHMRC	National Health and Medical Research Centre
PEC	Priority Ecological Community
PRI	Pilbara Regional Inventory
SAC	Species Accumulation Curve
SPRAT	Species Profile and Threats Database
TEC	Threatened Ecological Community
WA	Western Australia
WAM	Western Australian Museum
WC Act	<i>Wildlife Conservation Act 1950</i>

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EXECUTIVE SUMMARY

Fortescue Metals Group commissioned *ecologia* Environment to undertake a Level 2 vertebrate fauna assessment of the Stingray study area. The study area is located immediately south of Fortescue's Solomon hub (Kings and Firetail mines), and approximately 40 km north of Tom Price. The study area comprises a total area of 8,932 ha. Previous regional surveys in close proximity to the study area were reviewed and utilised to establish a survey design for the Level 2 vertebrate fauna assessment, the results of which are summarised in this document.

Several databases were consulted in the preparation of potential fauna (and conservation significant fauna) lists. In addition, 30 publications reporting on vertebrate fauna surveys conducted within 100 km of the study area were consulted. The database searches and review of publications reporting on 30 vertebrate fauna surveys resulted in a total of 41 native and 11 introduced mammal, 165 bird, 111 reptile, nine amphibian and six fish species potentially occurring in the study area. Of these, 34 species are of conservation significance (nine species of mammal, 20 species of bird, four species of reptile and one species of fish).

The Level 2 vertebrate fauna survey was conducted in May 2013. During the survey, a total of four trapping sites were established in three habitat types: plain (cracking clay), hummock grassland and rocky hillslope. Data from three sites surveyed in March and August 2011 (*ecologia* 2011a) was also used to provide additional trapping information, resulting in a total of seven trapping sites over four habitat types. These three trap sites were established across three habitat types: Hummock grassland, plain (cracking clay) & drainage line/river/creek. In addition to trapping, 13 opportunistic survey sites were located in areas not suitable for trapping due to access limitations or difficulties in the establishment of pit-fall traps. Targeted surveys were conducted in July 2013 with suitable habitat for identified conservation significant fauna species searched.

Survey effort expended during the three surveys undertaken in the study area included the following:

- Systematic trapping grids (pit traps, funnels, Elliott traps and cage traps) were open for 3,672 trap-nights;
- 18 hours were spent surveying for birds;
- 25.6 hours were spent on opportunistic diurnal searching;
- 8.8 hours were spent on opportunistic nocturnal searching and
- 108 hours of SM2BAT recordings were analysed to determine bat assemblage and distribution.

This survey effort includes following conservation significant fauna which are listed under the EPBC Act as Vulnerable or Endangered and have the potential to occur within the study area:

- Six hours assessing potential habitat and conducting targeted searches for signs of Northern Quoll in drainage line/river/creek habitat;
- A total of 108 hours of bat recordings were analysed to determine the presence of Pilbara Leaf-nosed Bat; and
- A total of 11.5 hours were spent on diurnal and nocturnal searches targeting the Pilbara Olive Python.

The vertebrate fauna assessment identified five broad scale fauna habitats from the study area:

- Woodland (open);
- Hummock grassland;
- Plain (stony gibber);
- Plain (cracking clay); and
- Drainage line/river/creek.

Four of the five fauna habitats within the study area were sampled with systematic trapping sites during the current and previous assessment (*ecologia* 2011a). A one-way ANOSIM test and MDS plot of the trapping sites within the different habitat types was completed for data collected systematically for both birds and terrestrial trapped fauna. The results from these statistical analyses indicate that the avifauna and trappable terrestrial fauna assemblages are relatively discrete in each fauna habitat, with some species occurring in multiple habitats. The avifauna forms more discrete assemblages between the different habitat types.

Survey effort was adequate in sampling all fauna habitat types within the study area. Analysis of the observed avifauna assemblage recorded during the Level 2 vertebrate fauna assessment suggests the survey recorded a high percentage of the expected avifaunal (91.3%) and trappable terrestrial fauna (80.8%) assemblages, based on SACs.

During the survey a total of 19 native and two introduced mammal, 79 bird, 48 reptile and two amphibian species were recorded. A further one species of mammal was recorded by secondary evidence only.

Sixteen conservation significant species were assessed as having a medium to high likelihood of occurrence, with the remaining 18 species assessed as having a low likelihood. Six species of conservation significance were recorded; the Pilbara Leaf-nosed Bat, Ghost Bat, Short-tailed Mouse, Australian Bustard, Rainbow Bee-eater and Star Finch (western). Additionally, the Western Pebble-mound Mouse was recorded by secondary evidence (potentially active mounds).

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group Limited (Fortescue) is developing the Pilbara Iron Ore and Infrastructure Project, which includes a series of iron ore mines and associated rail and infrastructure in the Pilbara region of Western Australia. Fortescue is investigating options to expand its Pilbara mining operations to include a tenement in the western Pilbara known as Stingray. The Stingray tenement is located immediately south-west of Fortescue's Solomon hub (Kings and Firetail mines), and approximately 40 km north of Tom Price (Figure 1.1), and comprises a total area of 8,932 ha.

As part of these investigations, Fortescue commissioned *ecologia* Environment (*ecologia*) to undertake a single-phase Level 2 terrestrial vertebrate fauna and habitat assessment of the Stingray tenements P47/1407 – 1409, E47/1763, P47/1469, P47/1470 and P47/1257 (study area, Figure 1.1). This survey will assist with environmental approvals for proposed exploration and development in the study area.

1.2 LEGISLATIVE FRAMEWORK

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

The Precautionary Principle

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

The Principle of Intergenerational Equity

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

The Principle of the Conservation of Biological Diversity and Ecological Integrity

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

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

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

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

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

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

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

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

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

1.3 SURVEY OBJECTIVES

Fortescue commissioned *ecologia* to undertake a comprehensive biological survey of the terrestrial vertebrate fauna of the study area, to contribute to the environmental approval process for the project.

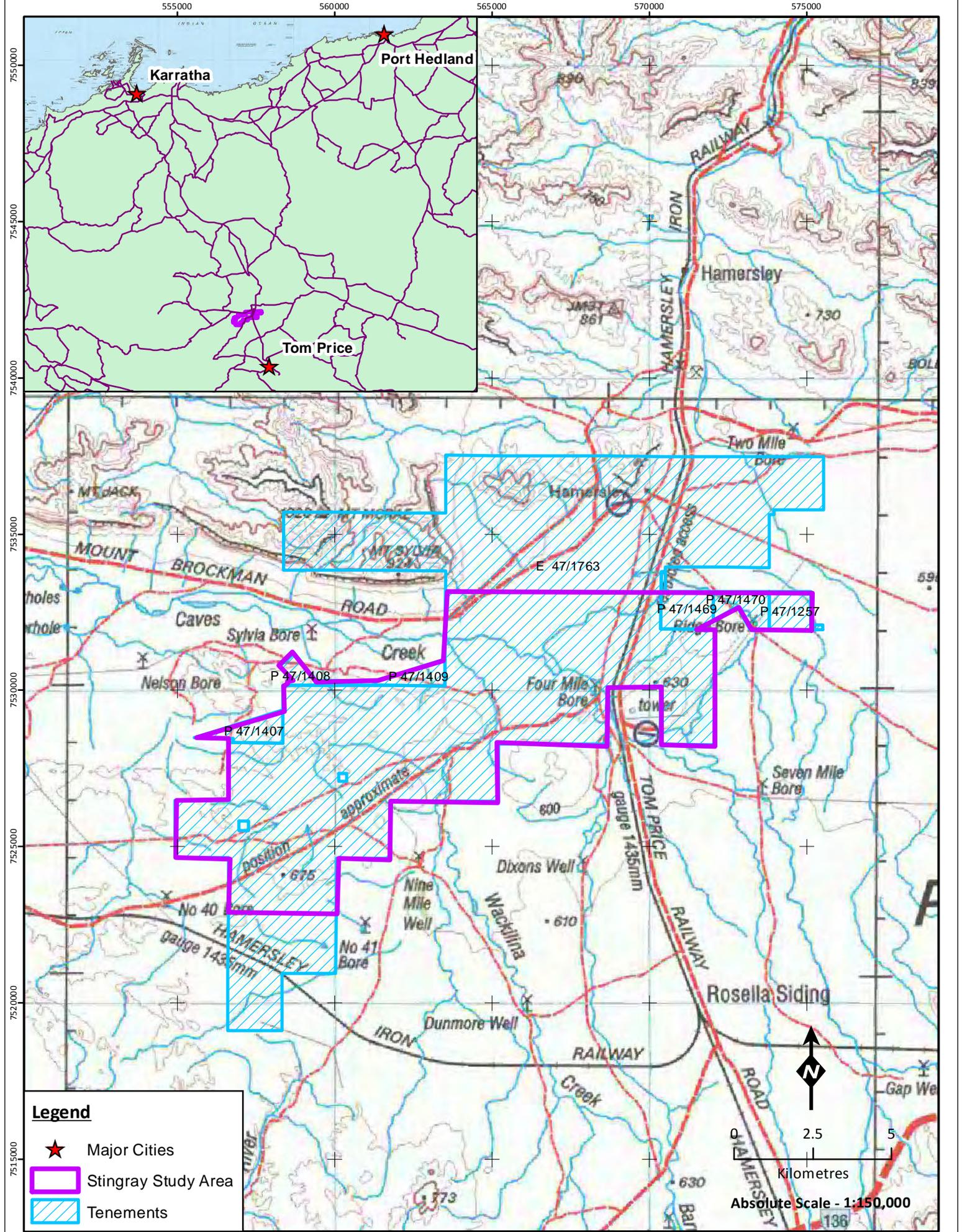
The EPA's objectives with regard to fauna management are to:

- 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.

Hence, the aim of this study was to provide sufficient information for the EPA to assess the impact of the project on the vertebrate fauna populations that occur in the areas associated with the project, thereby informing assessment against the relevant EPA objectives.

Specifically, the objectives were to undertake a survey that satisfies the requirements documented in *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*, EPA Guidance Statement No. 56 and Position Statement No. 3, thus providing:

- a review of background information (including literature and database searches);
- an inventory of vertebrate fauna species occurring in the study area, incorporating recent published and unpublished records;
- a discussion of the species of biological and conservation significance recorded or likely to occur within the study area and surrounds;
- a description of fauna habitats occurring in the study area;
- a description of the characteristics of the faunal assemblage;
- an appraisal of the current knowledge-base for the area, including a review of previous surveys conducted in the area that are relevant to the current study; and
- a review of regional and biogeographical significance, including the conservation status of species recorded or likely to occur in the study area.



Locations of the Stingray study area

Figure: 1.1
 Project ID: 1514

Drawn: NJ & AH
 Date: 5/12/14

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

Unique Map ID: NJ041

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2 EXISTING ENVIRONMENT

2.1 CLIMATE

The study area is located in the Pilbara region of Western Australia, where the climate is arid-tropical, with two distinct seasons: a hot summer from October to April and a mild winter from May to September. Temperatures are generally high, with summer temperatures frequently exceeding 40°C. Light frosts occasionally occur inland during July and August (BoM 2014).

Rainfall is generally localised and unpredictable (some years have recorded zero rainfall), and temperatures are high, resulting in annual evaporation exceeding rainfall by as much as 500 mm per year (BoM 2014). Most of the Pilbara has a bimodal rainfall distribution. Nearly 75% of the yearly rainfall is associated with thunderstorms and cyclonic activity between the months of December and March (Beard 1975; BoM 2014). Cold fronts continue to bring somewhat less rain to the region until June. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses generally flow intermittently due to the short wet season (Beard 1975).

Average rainfall and temperature data for the study area were obtained from the nearest Bureau of Meteorology (BoM) station Hamersley (Site No. 005005) located 3 km north of the study area. This location has a typical Pilbara climate of hot summers with sporadic summer storms and warm, dry winters (Figure 2.1) Hamersley has an average annual rainfall of 384.0 mm based on data from 1912 to 2013 (BoM 2014). Hamersley's rainfall data, although incomplete, depicts higher (92.4 mm) than average rainfall for the month of April, which preceded the survey (Table 2.1).

The nearest BoM station to the study area with complete rainfall data is Wittenoom (Site No. 005026), approximately 60 km east of the study area. Wittenoom has an average annual rainfall of 461.7 mm based on data from 1912 to 2013 (BoM 2014). Data from the Wittenoom station show that rainfall in the vicinity of the study area in the three months prior to the Level 2 survey (February to April) was below average (Figure 2.1). Conversely, above-average rainfall of 316.9 mm was recorded for the month of January. Rainfall dramatically influences the population dynamics of fauna through the increase or decrease in vegetation cover (Dickman *et al.* 1999a) and availability of resources (Dickman *et al.* 1999b; Masters 1993)

Table 2.1 – Rainfall for the 12 months preceding the survey (BoM 2014)

Month	Wittenoom		Hamersley	
	Mean rainfall in preceding 12 months (mm)	Mean rainfall 1950–2013 (mm)	Mean rainfall in preceding 12 months (mm)	Mean rainfall 1912–2013 (mm)
May	0	27.2	182.3	24.3
June	13	27.8	6.4	25.2
July	0	13.9	85.2	10.5
August	0	8.5	25.6	7.1
September	0	3.2	-	2.2
October	24.2	3.9	6.8	5.1
November	0	9.4	-	11.7
December	64.4	49.6	-	36.1
January	430.6	113.7	-	84.2
February	20.6	109	-	83.8
March	23.4	69	-	68
April	11.2	28	119.2	26.8

Source: BoM (2014)

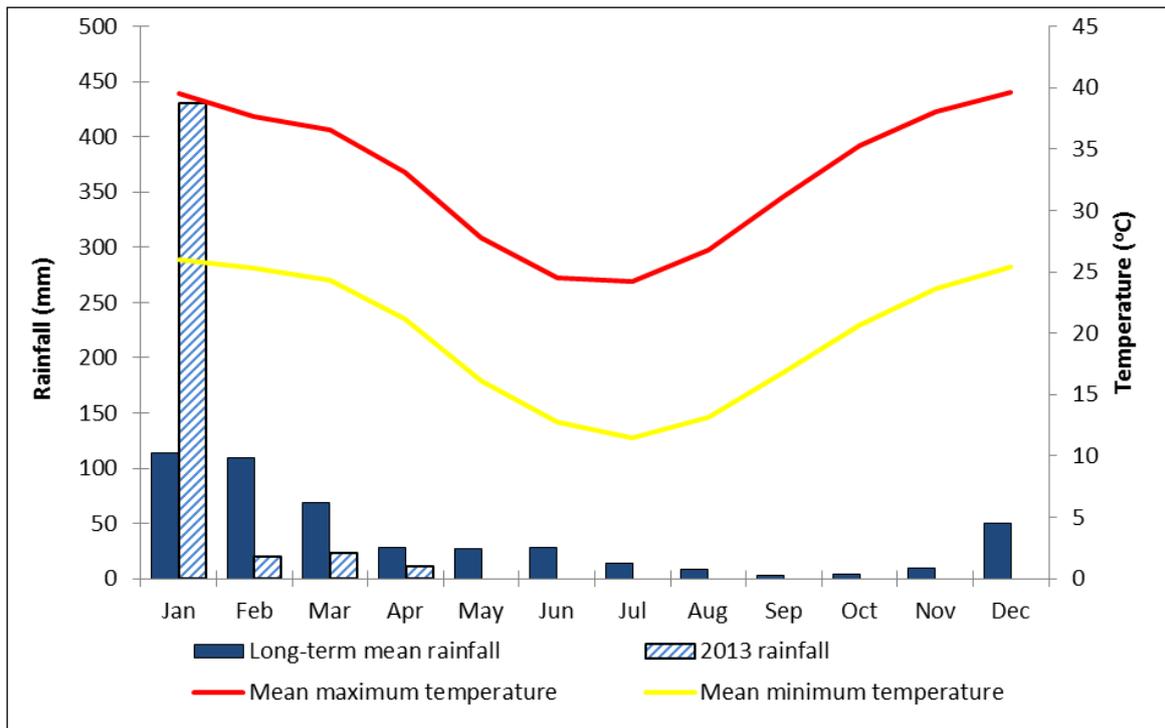


Figure 2.1 – Climatic averages for the Wittenoom weather station (1950-2013, BoM 2014)

2.2 WEATHER DURING THE SURVEY

The weather conditions experienced during the fauna survey, as recorded by the Wittenoom weather station (BoM 2014), are listed in Appendix B. The Level 2 assessment conducted at the Central Pilbara Project Mine in 2011 (a selection of this data is utilised in this assessment) was undertaken over two phases consisting of a 13 day period each with the first one conducted in March 2011 and the second one in September 2011 (Appendix B). Some rainfall was experienced during the first phase with a total of 19.2 mm recorded from Wittenoom weather station. The conditions were also warm with the maximum temperature of 38.5°C and a minimum temperature of 20.4°C during the first phase of surveying and a temperature range between 10.1°C and 35.9°C during the second phase. The Level 2 vertebrate fauna assessment of the study area was conducted over an 11-day period in May 2013 (3-13 May). The weather during this Level 2 survey was warm, with an average daily maximum of 31.4°C and minimum of 18.1 °C. Based on the mean climatic data (Figure 2.1), these temperatures were within the normal range for the time the surveys were conducted.

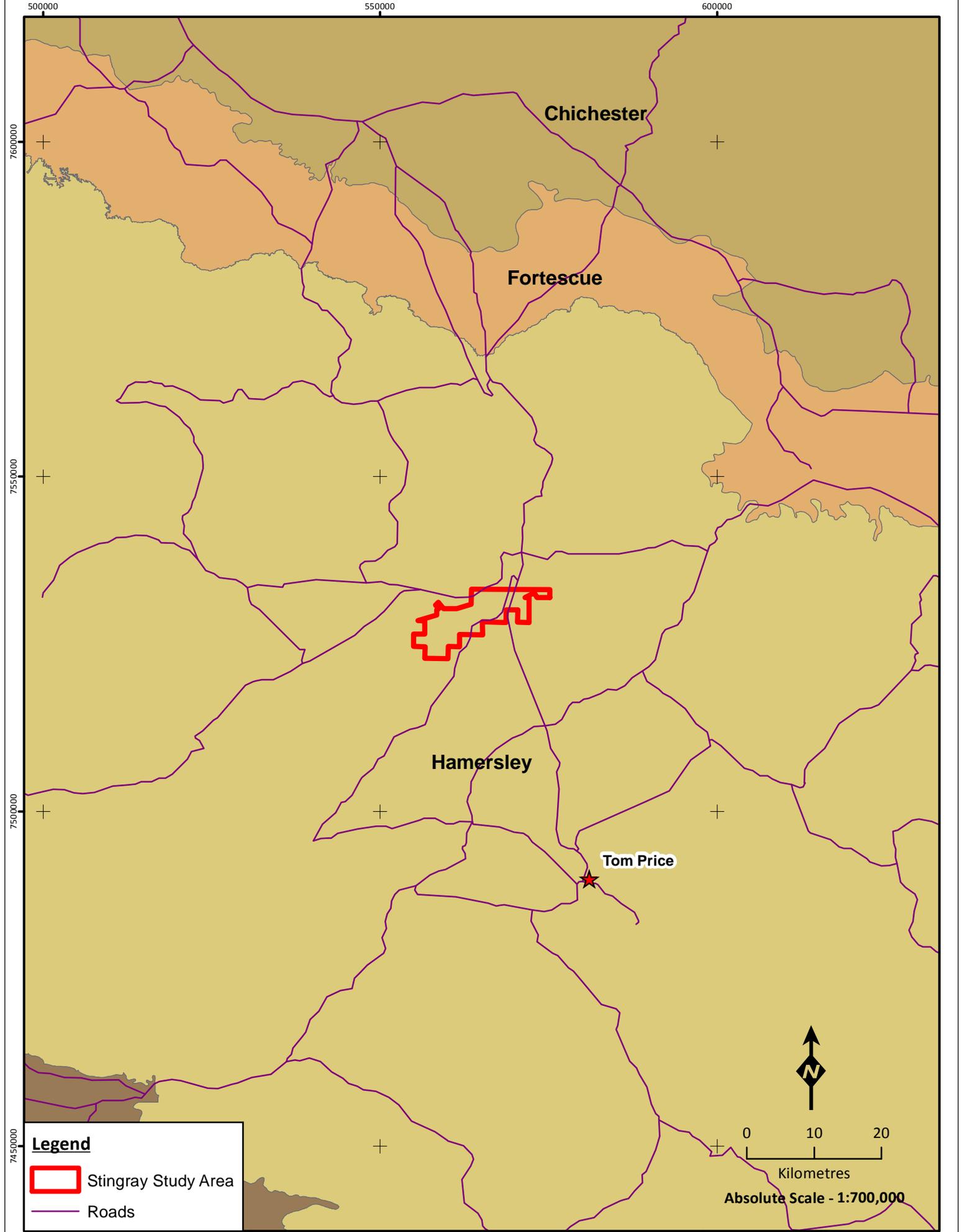
The amount of rainfall recorded at the Wittenoom weather station in January 2013 was more than four times the mean for January. Following the heavy rainfall in January, precipitation was close to average for the three months preceding the survey. A single day of rain (0.2mm) was recorded on site during the Level 2 vertebrate fauna assessment during May 2013.

2.3 BIOGEOGRAPHY

The Stingray study area is situated within the Pilbara region of the Interim Biogeographic Regionalisation of Australia (IBRA), (DSEWPaC 2013). The Pilbara biogeographic region comprises four subregions: Hamersley, Fortescue Plains, Chichester and Roebourne. The Stingray study area is situated entirely in the Hamersley (PIL3) subregion (Figure 2.2).

The Hamersley subregion of the Pilbara is generally characterised by mountain ranges and plateaux of Proterozoic sedimentary rock, dissected by gorges (Kendrick 2001). This structure is noticeable in areas surrounding the study area, with significant hilltops, hillslopes and gorges, especially given the proximity of the study area to Karijini National Park. However, the entire study area is situated on a flat to slightly undulating sedimentary plain at the base of the rocky ranges and plateaux.

The typical vegetation of the Hamersley subregion is low mulga woodland over tussock grasses on the fine soils in valley floors, combined with snappy gum (*Eucalyptus leucophloia*) over spinifex (*Triodia brizoides*) on the skeletal soils of the ranges (Kendrick 2001).



Legend

- Stingray Study Area
- Roads


 0 10 20
 Kilometres
Absolute Scale - 1:700,000



Biogeographic regions of the study area

Figure: 2.2
Project ID: 1514

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

Drawn: NJ
Date: 12/09/13

Unique Map ID: NJ042

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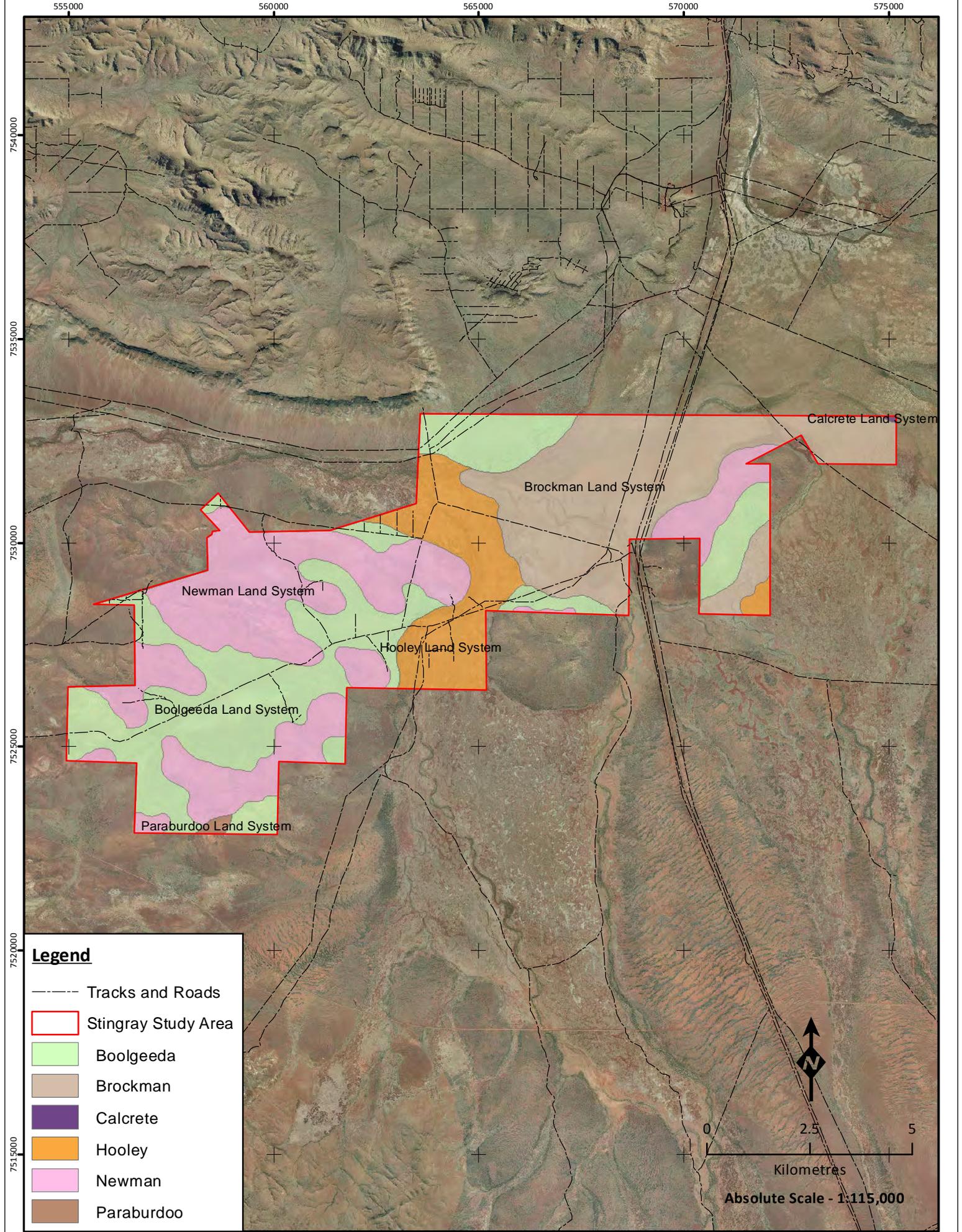
2.4 LAND SYSTEMS

Land systems are described using the biophysical characteristics of geology, landforms, vegetation and soils (van Vreeswyk *et al.* 2004a). Van Vreeswyk *et al.* (2004b) undertook a regional inventory of the Pilbara rangelands to document the land systems present and their condition. The Pilbara Regional Inventory (PIR) 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 intersects six of the land systems mapped by van Vreeswyk *et al.* (2004a) (Table 2.2). The largest land system within the study area is the Boolgeeda land system, occupying 32% of the study area. This land system typically consists of stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands. Other land systems of the study area include Newman (30%), Brockman (26%), Hooley (12%), Paraburdoo (0.3%) and Calcrete (0.04%), all of which typically consist of acacia shrublands and/or tussock and spinifex grasslands (Table 2.2). All land systems are well represented outside of the study area, with less than 0.5% of the total of each land system in Western Australia contained within the study area (Table 2.2).

Table 2.2 – Land systems of the study area

Land system	Description	Trap sites	Total area in WA (ha)	Area within Stingray (ha)	Proportion of Stingray study area (%)	Proportion of total land system (%)
<i>Land type 18 - Stony plains with spinifex grasslands</i>						
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	ST S1, ST S5	99,960,861	2,818.4	31.56	0.003
<i>Land type 2 - Hills and ranges with spinifex grasslands</i>						
Newman	Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands.	ST S2	199,977,138	2,697.1	30.20	0.001
<i>Land type 39 - Alluvial plains with tussock grasslands</i>						
Brockman	Gilgai alluvial plains with cracking clay soils supporting tussock grasslands.	ST S6, ST S7	7,410,806	2,340.9	26.20	0.03
<i>Land type 34 - Alluvial plains with acacia shrublands</i>						
Hooley	Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses.	ST S3, ST S4	5,908,110	1,046.8	11.72	0.02
<i>Land type 16 – Stony plains with acacia shrublands</i>						
Paraburdoo	Basalt derived stony gilgai plains and stony plains supporting snakewood and mulga shrublands with spinifex, chenopods and tussock grasses.	-	14,475,675	25.2	0.28	0.0002
<i>Land type 41 – Calcrete plains with spinifex grasslands</i>						
Calcrete	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands.	-	16,704,186	4	0.04	0.00002



Legend

- Tracks and Roads
- Stingray Study Area
- Boolgeeda
- Brockman
- Calcrete
- Hooley
- Newman
- Paraburdoo

Figure: 2.3
Project ID: 1514
Drawn: NJ & AH
Date: 08/12/14

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

Unique Map ID: NJ043

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Land systems of the study area



2.5 VEGETATION

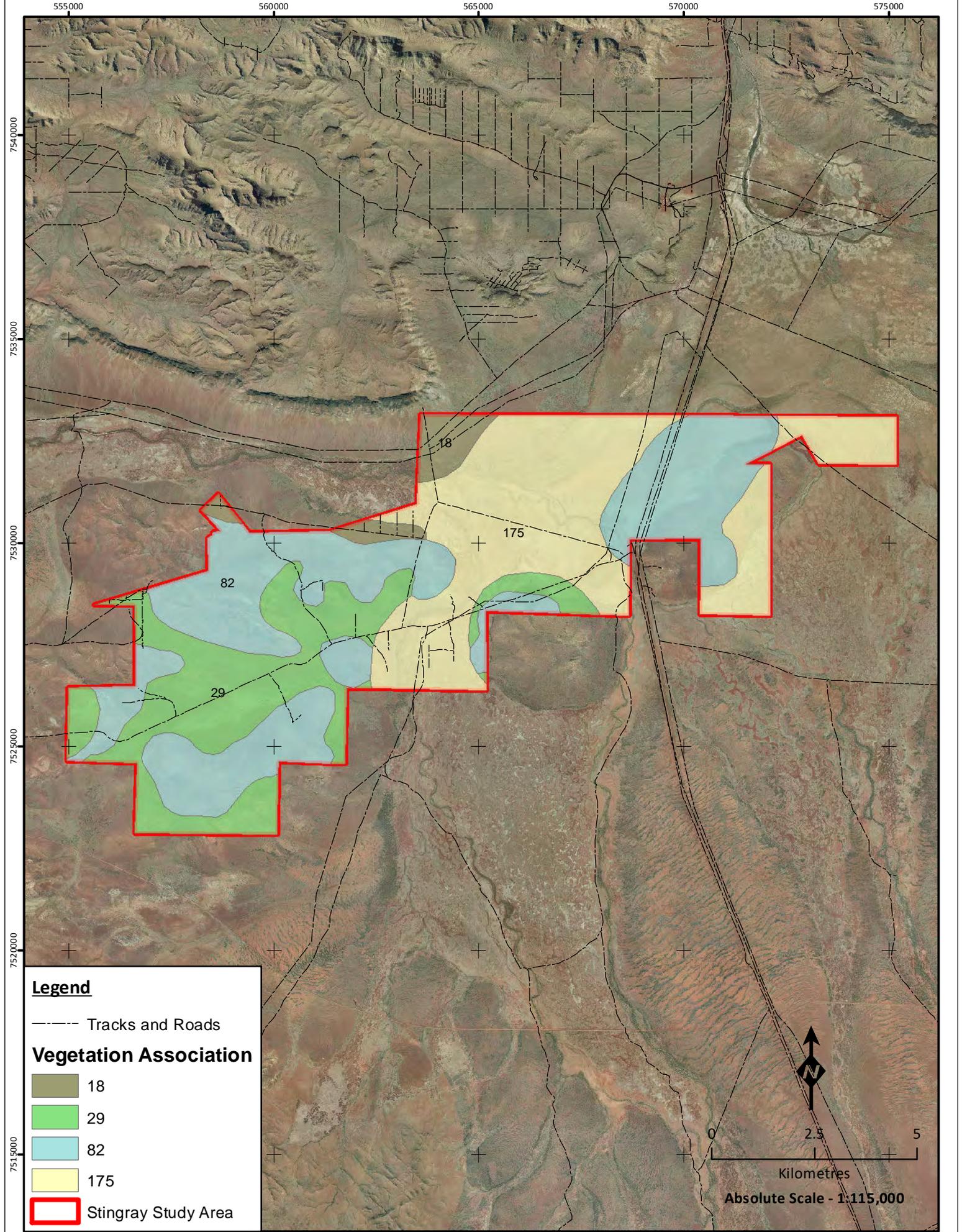
The vegetation of Western Australia was originally mapped at a 1:1,000,000 scale by Beard (1979), and was subsequently reinterpreted and updated to reflect the National Vegetation Information System standards (Shepherd *et al.* 2002). The study area lies within the Eremaean Botanical Province of the Pilbara (Beard 1975). Four vegetation associations (Beard's units 18, 29, 82 and 175) occur in the study area (Shepherd *et al.* 2001), described in Table 2.3 and displayed in Figure 2.4.

Snappy gums over spinifex hummock grasslands of *Triodia wiseana* is the most abundant vegetation unit (82), accounting for 38.3% of the study area. There is also a similar amount of savannah or grass plain (vegetation unit 175; 34.7%). The rest of the area comprises two similar vegetation units with low mulga woodland mostly in scattered stands. Broadly, all vegetation units are well represented outside the study area.

Table 2.3 – Vegetation associations of the study area

Vegetation unit	Vegetation description	Systematic survey sites	Total area in WA (ha)	Area within Stingray (ha)	Proportion of Stingray study area (%)	Proportion of total vegetation unit (%)
82	Hummock grasslands, low tree steppe; snappy gum over <i>Triodia wiseana</i>	ST S2 ST S5 ST S6	2,565,571	3425	38.3	0.001
175	Short bunch grassland – savanna/grass plain	ST S3 ST S4 ST S7	685,785	3100	34.7	0.5
29	Sparse low woodland; mulga, discontinuous in scattered groups	ST S1	7,914,567	2074	23.2	0.03
18	Low woodland; mulga (<i>Acacia aneura</i>)	-	24,751,239	335	3.8	0.001

(Shepherd *et al.* 2002)



Legend

----- Tracks and Roads

Vegetation Association

18

29

82

175

Stingray Study Area

Figure: 2.4
Project ID: 1514

Drawn: NJ & Ah
Date: 08/12/14

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

Unique Map ID: NJ043

A4



Vegetation associations of the study area

2.6 PREVIOUS SURVEYS AND LAND USE

Several databases were consulted in the preparation of potential fauna (and conservation significant fauna) lists (Table 2.4). In addition, 30 publications reporting on vertebrate fauna surveys conducted within 100 km of the study area were consulted (Table 2.5). The results of all database searches and previous surveys are presented in Appendix C. The online NatureMap database encompasses several datasets, including the WA Museum (WAM), DPaW Threatened and Priority Fauna database and DPaW Survey Returns database. The Stingray study area is located within the Hamersley pastoral lease which is an active pastoral lease. Karijini National Park is situated approximately 23 km east (DPaW 2014).

Table 2.4 – Fauna databases

Database	Custodian	Search Details
NatureMap	DPaW	40 km radius around the centre of the study area. Coordinates: 563867 E 7527993 N Date accessed: 28/03/2013
Species Profile and Threats (SPRAT) Database	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)	Records within 100 km of the study area Date accessed: 28/03/2013
Birdata	BirdLife Australia	Records within one degree of the study area Date accessed: 28/03/2013
Threatened and Priority Fauna Database	DPaW	Rectangle around the study area with a 40 km buffer Date accessed: 28/03/2013

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
Internal <i>ecologia</i> database	15 – 100	Two level 1 and eight level 2 vertebrate fauna surveys. Two conservation significant fauna surveys.
Central Pilbara Project Mine (<i>ecologia</i> 2011a)	0	Two-phase Level 2 survey. One targeted conservation significant fauna survey.
Mt Macleod West (Ecoscape 2013)	0	Level 1 survey
Solomon Hub (<i>ecologia</i> 2014)	0	Single-phase Level 2 survey
Mt Macleod (Rapallo 2011)	9	Single-phase Level 2 survey
Mt Macleod (<i>ecologia</i> 2013b)	9	Single-phase Level 2 survey
Central Pilbara Project Rail (south) (<i>ecologia</i> 2012a)	15	Two-phase Level 2 survey.
Brockman 2 Detritals (Matiske and Ninnox 1990)	20	Level 1 survey
Hamersley Range National Park (Muir 1983)	25	Single-phase Level 2 survey
Firetail (Ecoscape 2010c)	28	Level 1 survey
West Turner Syncline Section 10 Development (Biota 2009)	34	Two-phase Level 2 survey
Brockman Syncline 4 (Biota 2005)	35	Single-phase Level 2 survey

Survey location and author(s)	Distance to study area (km)	Comments
Solomon Project –rail-realignment (Ecoscape 2010b)	43	Level 1 survey
Solomon Project –rail camps (Ecoscape 2010a)	43	Level 1 survey
Solomon Mine Project (Coffey 2010a)	43	Single-phase Level 2 survey
Marandoo to Great Northern Highway Road (Kendrick 1995)	47	Single-phase Level 2 survey
Raven (Ecoscape 2012c)	54	Level 1 survey
Marandoo Mine (Biota 2008)	57	Two-phase Level 2 survey
Flying Fish (Ecoscape 2012b)	64	Level 1 survey
Eliwana (Ecoscape 2012a)	64	Level 1 survey
Western Range (Biota 2011)	87	Two-phase Level 2 survey
Northern Transport Corridor Option (Ninox 1995)	100	Level 1 survey

2.6.1 Results of literature review

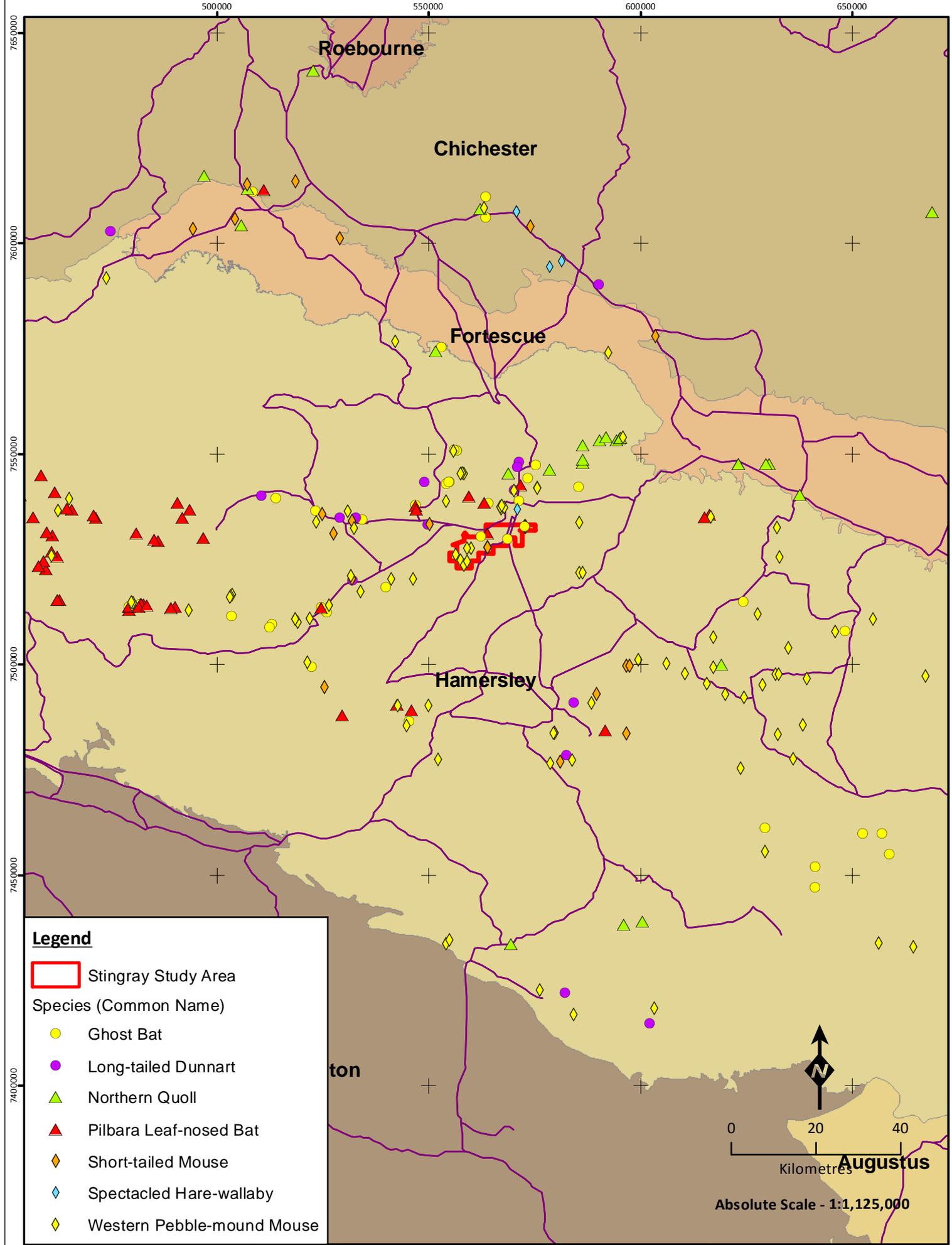
The database searches and review of publications reporting on 29 vertebrate fauna surveys (Table 2.5) resulted in a total of 42 native and 11 introduced mammal, 163 bird, 109 reptile, eight amphibian and six fish species potentially occurring in the study area (Table 2.6). Of these, 34 species are of conservation significance (10 species of mammal, 20 species of bird, three species of reptile and one species of fish).

The Fortescue Grunter (*Leiopotherapon aheneus*) is known to occur along major rivers and large creeklines in the wider region but based on observations and habitat mapping completed during previous surveys within the study area (*ecologia* 2011a; Ecoscape 2013), no suitable habitat is present within the study area. Therefore this species will not be included in this assessment. In addition, potential habitat of the Northern Marsupial Mole (*Notoryctes caurinus*) consisting of longitudinal sand dunes and interdunal flats is listed as likely to occur in the wider region (DSEWPaC 2013). However, observations and habitat mapping completed during previous surveys within the study area (*ecologia* 2011a; Ecoscape 2013) have shown that no suitable habitat is present within and surrounding the study area. This result and the lack of records within 300 km of the study area indicate that the species is not likely to occur within the Stingray study area and therefore will not be discussed in this assessment.

Previous records of conservation significant fauna are mapped in Figure 2.5 and Figure 2.6, and discussed in greater detail in Section 5.2.

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

Source/Report	Mammals (Native/introduced)	Birds	Reptiles	Amphibians	Fish
Internal <i>ecologia</i> database	28/5	114	93	3	0
Central Pilbara Project Mine (<i>ecologia</i> 2011a)	24/4	98	85	4	0
Mt Macleod West (Ecoscape 2013)	4/2	34	12	1	0
Solomon Hub (<i>ecologia</i> 2014)	20/3	80	68	3	4
Mt Macleod (Rapallo 2011)	14/1	82	52	0	0
Mt Macleod (<i>ecologia</i> 2013b)	18/1	62	28	2	0
Central Pilbara Project Rail (south) (<i>ecologia</i> 2012a)	23/4	103	78	4	0
Brockman 2 Detritals (Mattiske and Ninnox 1990)	4/4	64	15	0	0
Hamersley Range National Park (Muir 1983)	21/1	128	70	6	0
Firetail (Ecoscape 2010c)	18/2	63	48	1	0
West Turner Syncline Section 10 Development (Biota 2009)	18/2	68	52	1	0
Brockman Syncline 4 (Biota 2005)	15/4	82	54	2	0
Solomon Project –rail- realignment (Ecoscape 2010b)	1/1	17	2	0	0
Solomon Project –rail camps (Ecoscape 2010a)	2/2	14	6	0	0
Solomon Mine Project (Coffey 2010a)	21/3	63	73	4	0
Marandoo to Great Northern Highway Road (Kendrick 1995)	15/3	67	49	3	0
Raven (Ecoscape 2012c)	3/0	37	7	0	0
Marandoo Mine (Biota 2008)	9/2	55	44	3	0
Flying Fish (Ecoscape 2012b)	5/3	38	1	0	0
Eliwana (Ecoscape 2012a)					
Western Range (Biota 2011)	8/1	51	34	1	0
Northern Transport Corridor Option (Ninox 1995)	4/2	46	5	1	0
NatureMap (DPaW 2014)	32/5	138	98	7	3
DPaW Threatened Fauna Database	7/0	14	3	0	0
SPRAT Database	3/9	12	1	9	0
Birdata	N/A	122	N/A	N/A	N/A
Total	41/11	165	111	9	6



Legend

 Stingray Study Area

Species (Common Name)

-  Ghost Bat
-  Long-tailed Dunnart
-  Northern Quoll
-  Pilbara Leaf-nosed Bat
-  Short-tailed Mouse
-  Spectacled Hare-wallaby
-  Western Pebble-mound Mouse

Figure: 2.5
Project ID: 1514

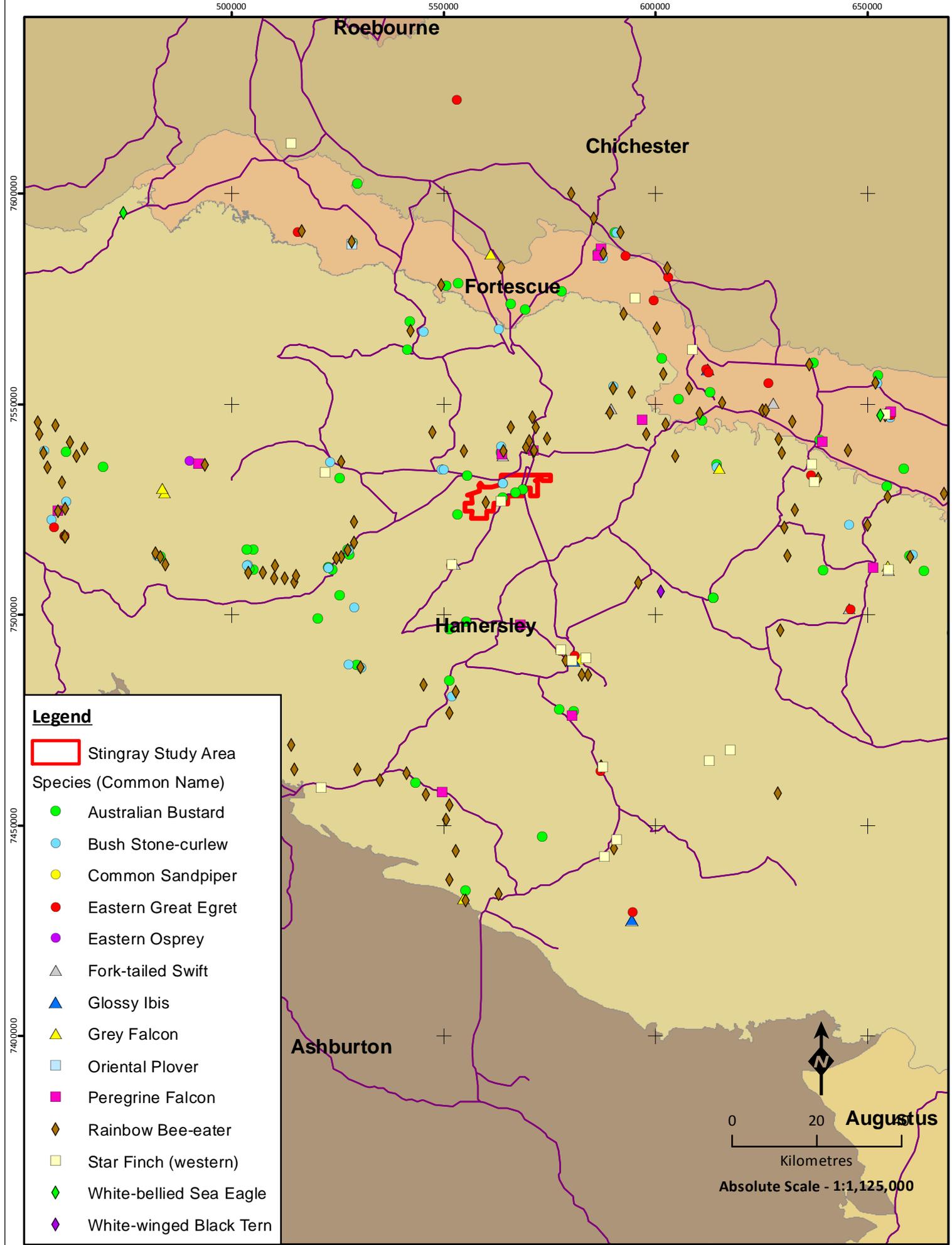
Drawn: NJ
Date: 12/09/13

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

Unique Map ID: NJ045



**Regional records
of conservation significant mammals**



Legend

Stingray Study Area

Species (Common Name)

- Australian Bustard
- Bush Stone-curlew
- Common Sandpiper
- Eastern Great Egret
- Eastern Osprey
- Fork-tailed Swift
- Glossy Ibis
- Grey Falcon
- Oriental Plover
- Peregrine Falcon
- Rainbow Bee-eater
- Star Finch (western)
- White-bellied Sea Eagle
- White-winged Black Tern

Figure: 2.6
Project ID: 1514

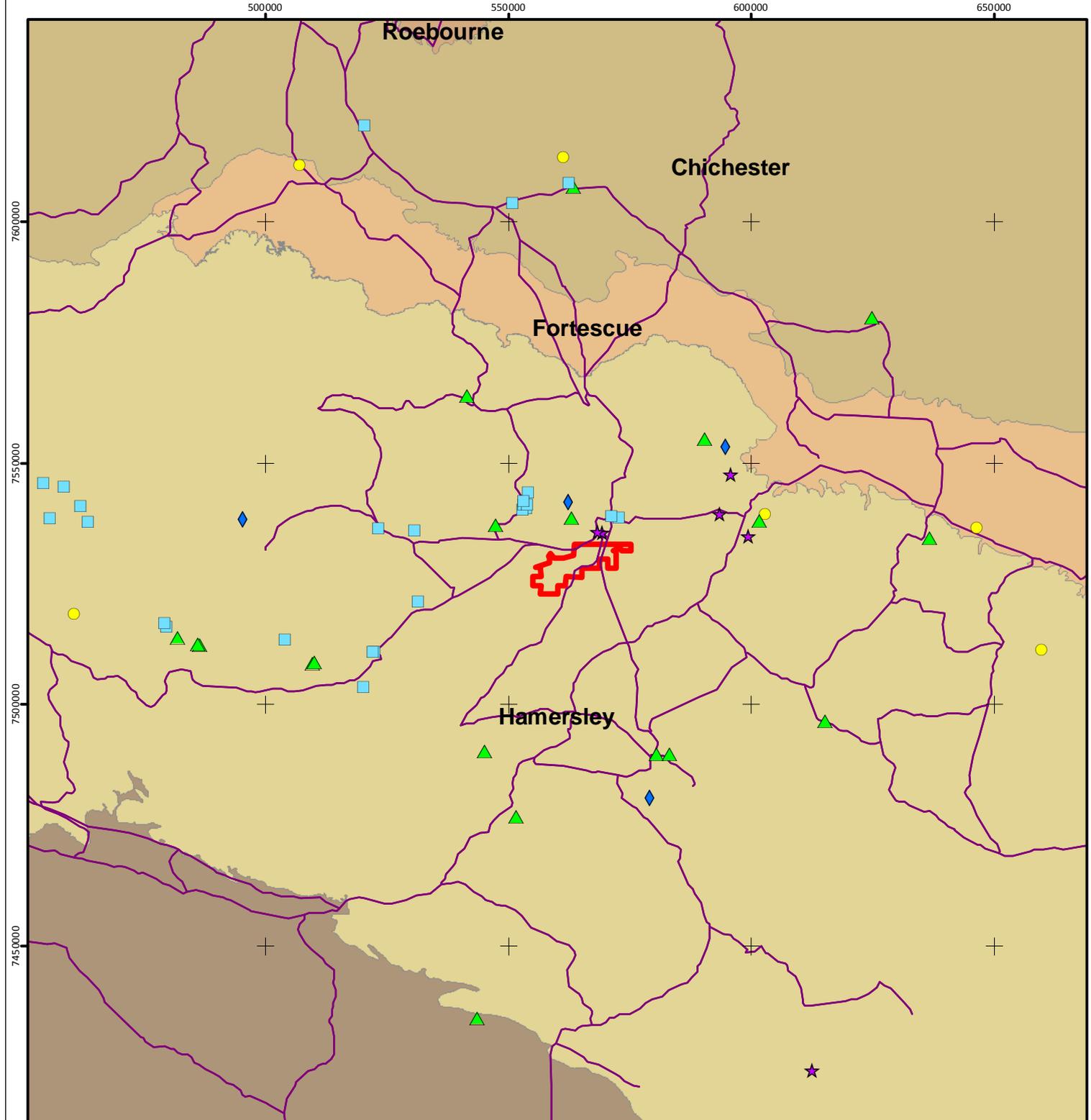
Drawn: NJ & AH
Date: 05/12/14

**Regional records
of conservation significant birds**

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

Unique Map ID: NJ045





Legend

 Stingray Study Area

Species

-  Pilbara Olive Python (*Liasis olivaceus barroni*)
-  Lined Soil-crevice Skink *Notoscincus butleri*
-  Gane's Blindsnake *Ramphotyphlops ganei*
-  Pilbara Barking Gecko (*Underwoodisaurus seorsus*)
-  Fortescue Grunter (*Leiopotherapon aheneus*)



0 20 **Augustus**
Kilometres

Absolute Scale - 1:1,125,000



Regional records of conservation significant herpetofauna and fish

Figure: 2.7
Project ID: 1514

Drawn: NJ & AH
Date: 05/12/14

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

Unique Map ID: NJ046

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 Level 2 terrestrial vertebrate fauna assessment to be conducted within the study area. Due to the small size of the study area, it was determined that seven trapping sites should provide sufficient survey adequacy. Previous surveys conducted within the study area were considered when developing the survey design and previous surveys were incorporated into the dataset. Data was utilised from three trapping sites (CPP S15, S16, S17) previously surveyed for the Central Pilbara Project Mine (*ecologia* 2011a). Because these sites are located within the study area they were renamed to match the current Stingray sites: ST S4, ST S5 and ST S6. The three trap sites were complimented with four additional sites to result in a total of seven trap sites within the study area.

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

Factor	Relevance
Bioregion – level of existing survey-knowledge of the region and associated ability to predict accurately.	The Pilbara bioregion (including the Hamersley subregion) has been well studied, and information was readily available.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The landforms associated with the 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. Rainfall was above average in the some of the months preceding the survey. The best survey timing for reptiles is from September to April (due to warm conditions), but surveying in early May is still effective if conditions are suitable. 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).	29 previous terrestrial vertebrate fauna surveys 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 observation, and mapped land systems and vegetation units. These were: creekline, hillslope, hummock grassland, cracking clay and woodland over grassy plain
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods).	The Pilbara region experiences hot summers with occasional cyclonic rain events, followed by warm winters with little rain. Rainfall is highly unpredictable.
Sensitivity of the environment to the proposed activities.	The study area contains habitat types which are well represented in the surrounding region.
Size, shape and location of the proposed activities.	The study area comprises the Stingray exploration tenement and covers an area of 8,932 ha.
Scale and impact of the proposal.	The scale and impact of the proposal was not known and did not influence the design of this survey.

3.2 SURVEY TIMING

The Stingray Level 2 terrestrial vertebrate fauna assessment was conducted in autumn from 3 to 13 May 2013. The Central Pilbara Project Mine phase 1 autumn survey was conducted in March 2011, and the phase 2 spring survey between August and October 2011 (*ecologia* 2011a). Some supplementary survey work was also undertaken during a targeted survey of both the Stingray study area and the nearby Mt Macleod study area (*ecologia* 2013b) conducted from 16 to 24 July 2013. The timing for all surveys was determined as per guidelines (DEWHA 2010a, b; DSEWPaC 2011a, b, c; EPA 2004; EPA and DEC 2010; FMG 2011).

Table 3.2 – Summary of survey timing and duration

Survey	Dates	Duration (days)	Person Days
Central Pilbara Project Mine Level 2 Phase 1	3 – 15 Mar 2011	13	26
Central Pilbara Project Mine Targeted survey	3 – 11 Aug 2011	9	18
Central Pilbara Project Mine Level 2 Phase 2	23 Sep – 5 Oct 2011	13	26
Mt Macleod West (Ecoscape 2013)	12 – 15 Aug 2011 (targeted) July 2011 (fauna/flora)	n/a	n/a
Stingray Level 2 (this survey)	3 – 13 May 2013	11	22
Total		46	92

3.3 SITE SELECTION

Habitat types previously described and mapped by and Ecoscape (2013) were reviewed and interpreted for survey site selection, with locations of access tracks, land systems and the abundance of habitat types taken into consideration. Survey site locations were selected to provide a good geographic spread over the study area, and to be representative of the habitat types in the study area.

Trapping sites were installed in the four main land systems in the study area; Boolgeeda, Newman, Brockman and Hooley.

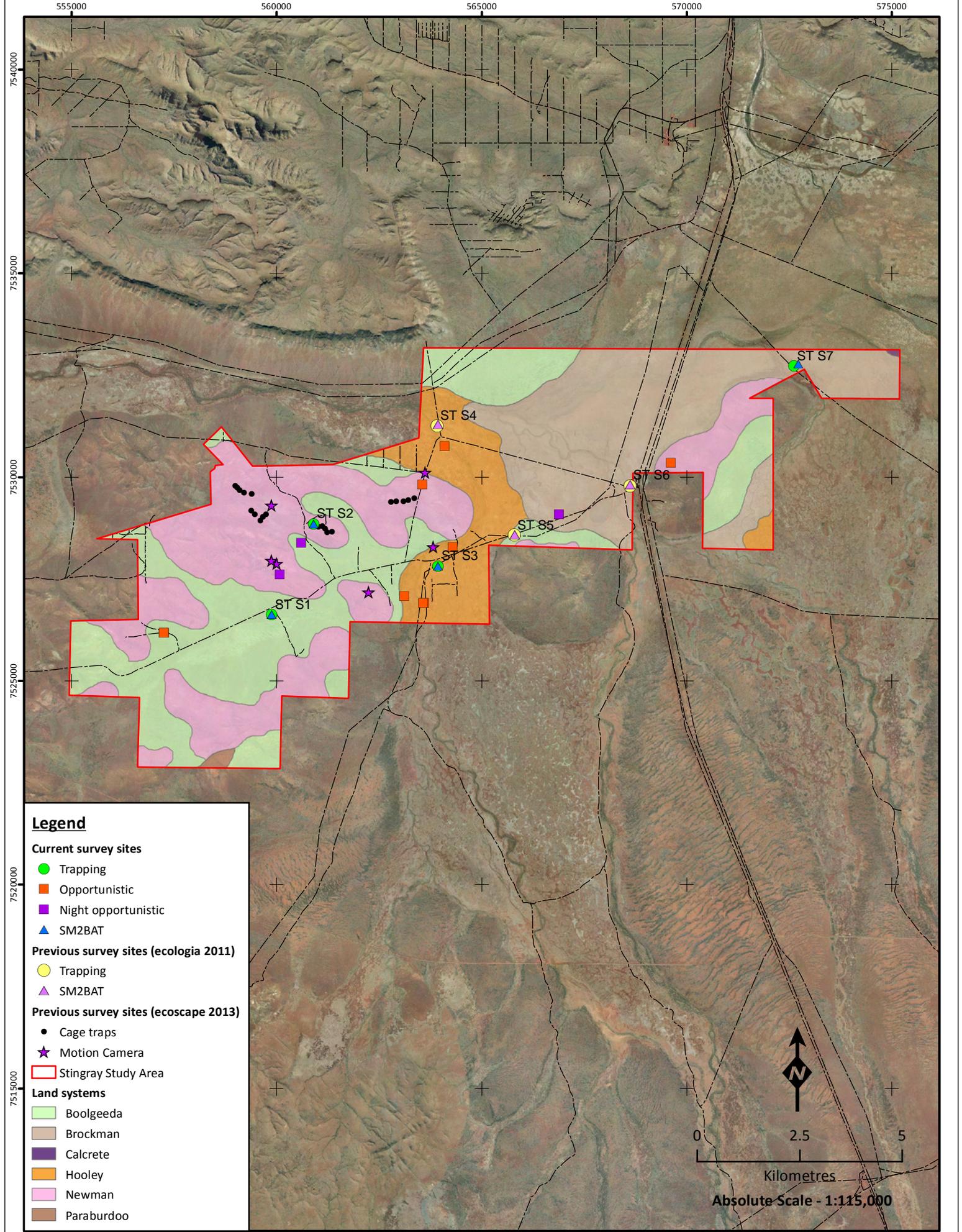
In addition to trapping, opportunistic searches were undertaken, targeting potentially sensitive habitats and habitat supporting conservation significant species. Locations and details of all survey sites sampled during the Level 2 survey are listed in Table 3.3 and mapped in Figure 3.1. Site photographs and descriptions are presented in Appendix D.

Table 3.3 – Level 2 survey site information

Site	Location		Land system	Vegetation association
	Easting	Northing		
Current survey				
Trapping				
ST S1	559875	7526629	Boolgeeda	29
ST S2	560899	7528850	Newman	82
ST S3	563933	7527815	Hooley	175
ST S7	572604	7532725	Brockman	175
Opportunistic				
ST OS4	569603	7530352	Newman	82
ST OS5	563552	7529819	Newman	82

Site	Location		Land system	Vegetation association
	Easting	Northing		
ST OS6	557259	7526194	Boolgeeda	29
ST OS7	563602	7526906	Hooley	175
ST OS8	557254	7526182	Boolgeeda	29
ST OS9	563400	7526900	Hooley	175
ST OS10	564099	7530770	Hooley	175
ST OS11	563573	7526917	Hooley	175
ST OS12	564286	7528287	Hooley	175
Nocturnal Opportunistic				
ST OS1	566877	7529084	Brockman	29
ST OS2	560077	7527614	Newman	82
ST OS3	560602	7528393	Boolgeeda	29
SM2BAT				
ST Bat 1	560899	7528850	Newman	82
ST Bat 2	559875	7526629	Boolgeeda	29
ST Bat 3	572711	7532769	Brockman	175
ST Bat 4	563933	7527815	Hooley	175
Central Pilbara Project Mine (2011)				
Trapping				
ST S4 (CPP17)	563909	7531260	Hooley	175
ST S5 (CPP16)	565787	7528575	Boolgeeda	82
ST S6 (CPP15)	568615	7529787	Brockman	82
SM2BAT				
ST Bat 5 (CPP17)	563909	7531260	Newman	82
ST Bat 6 (CPP16)	565787	7528575	Boolgeeda	29
ST Bat 7 (CPP15)	568615	7529787	Brockman	175
Ecoscape (2013)				
Targeted trap sites				
Cage site 1	559118	7529659	Newman	82
Cage site 2	559581	7529076	Newman	82
Cage site 3	561189	7528701	Newman	82/29
Cage site 4	563095	7529450	Newman	82
Motion Cameras				
MCAM1	563620	7530117	Hooley	18
MCAM2	559866	7529317	Newman	82
MCAM3	562234	7527195	Newman	82
MCAM4	563817	7528292	Hooley	175
MCAM5	559994	7527880	Newman	82
MCAM6	559872	7527961	Newman	82

Datum: GDA 94
 Zone: 50 K



Legend

Current survey sites

- Trapping
- Opportunistic
- Night opportunistic
- ▲ SM2BAT

Previous survey sites (ecologia 2011)

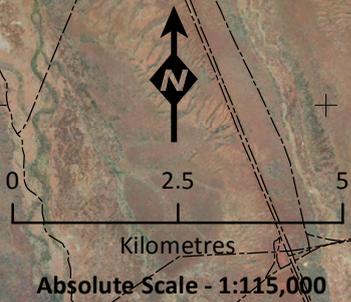
- Trapping
- ▲ SM2BAT

Previous survey sites (ecoscape 2013)

- Cage traps
- ★ Motion Camera
- Stingray Study Area

Land systems

- Boolgeeda
- Brockman
- Calcrete
- Hooley
- Newman
- Paraburdoo



Locations of survey sites

Figure: 3.1
Project ID: 1514

Drawn: JFH & AH
Date: 08/12/14

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

Unique Map ID: JFH028

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 DPaW priority list).

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

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

A fauna habitat type broadly describes an area of habitat that is distinguishable in its vegetation and land features from its surroundings, and is likely to support a different fauna assemblage to that found in other fauna habitats. Particular attention is also paid to the likelihood that certain species are present which tend to be found only in that specific habitat. Fauna habitat types were identified, described and mapped partly using the following existing information:

- Aerial photography
- Vegetation associations (Beard 1975; Shepherd *et al.* 2002)
- Land systems (van Vreeswyk *et al.* 2004a)

During the survey, other information was also collected, including:

- Landform
- Vegetation type and structure

- Soil characteristics (soil structure and substrate)
- Composition of terrestrial fauna species
- Habitat condition (Table 3.5)

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

Table 3.5 – Habitat condition assessment

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

Note: Based on vegetation condition scale from Trudgen (1991, cited in Department of Environmental Protection 2000).

3.6 SAMPLING METHODS

The following 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:

- Guidance Statement No. 56 “Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia” (EPA 2004);
- Position Statement No. 3 “Terrestrial Biological Surveys as an Element of Biodiversity Protection” (EPA 2002);
- *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010);
- Survey Guidelines for Australia’s Threatened Mammals, Reptiles Bats and Birds (DEWHA 2010b; DSEWPac 2011a, b, c); and
- Fortescue’s *Terrestrial Vertebrate Fauna Assessment Guidelines* (FMG 2011).

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

3.6.1 Systematic Sampling

Terrestrial Mammals and Herpetofauna

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

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

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

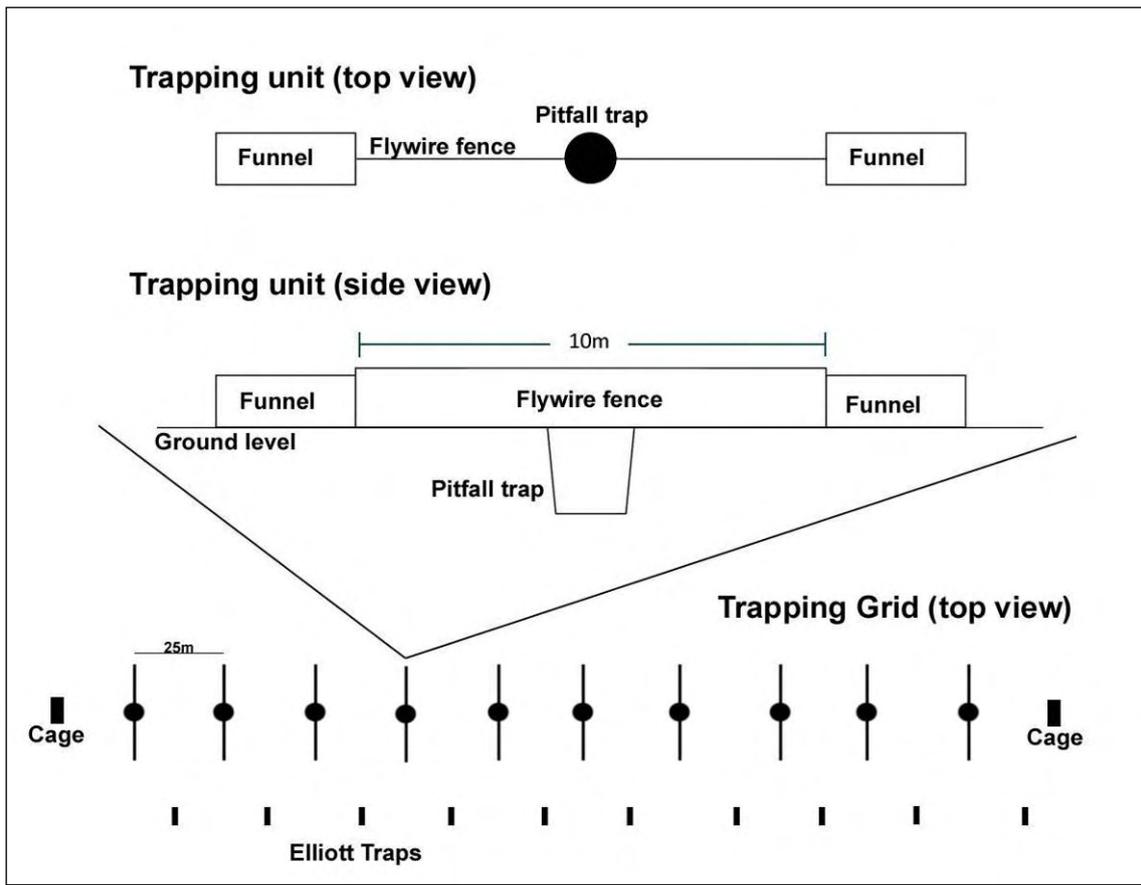


Figure 3.2 – Diagram of the systematic sampling trap arrangement



Figure 3.3 – Image of single *ecologia* trap point

Avifauna

Thirty minute set-time surveys were used to document the avifauna present at each of the fauna sites. During each set-time survey an ornithologist recorded the number of individuals of each species positively identified while actively searching similar habitat within 500 m of the survey site. This is aligned with survey methodology for the ongoing Birds Australia *Atlas of Australian Birds* project.

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

Bats

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

SM2BAT bat recorders were set up at four locations within the study area during the current survey and three locations during the Central Pilbara Project Mine (*ecologia* 2011a).

3.6.2 Opportunistic Data

Nocturnal Searching

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

Diurnal Searching

Both trapping and opportunistic sites were searched by hand for cryptic species, which comprised searching beneath the bark of dead trees, breaking open old logs, stumps and dead free-standing trees, investigating burrows and over-turning logs and stones. 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. Tracks, diggings, scats, burrows, mounds and nests were recorded where possible.

3.7 TARGETED CONSERVATION SIGNIFICANT FAUNA SURVEYING

Prior to the commencement of survey activity, the preferred habitat of the conservation significant species that potentially occur in the study area was determined. Ecoscape conducted a targeted survey of the study area in 2013. The survey included cage traps and motion camera within identified potential Northern Quoll habitats. These and other areas identified as potential habitats for species of conservation significance were targeted during survey activities using both systematic survey sites and opportunistic surveys.

3.8 SURVEY EFFORT

Survey effort expended during the four surveys undertaken in the study area is presented in Table 3.6, and included the following:

- Systematic trapping grids (pit traps, funnels, Elliott traps and cage traps) were open for 3,672 trap-nights;
- 18 hours were spent surveying for birds;
- 25.6 hours were spent on opportunistic diurnal searching;
- 8.8 hours were spent on opportunistic nocturnal searching; and
- 108 hours of SM2BAT recordings were analysed to determine bat assemblage and distribution.

This survey effort includes following conservation significant fauna which are listed under the EPBC Act as Vulnerable or Endangered and have the potential to occur within the study area:

- Six hours assessing potential habitat and conducting targeted searches for signs of Northern Quoll in creekline habitat;
- A total of 108 hours of bat recordings were analysed to determine the presence of Pilbara Leaf-nosed Bat; and
- A total of 11.5 hours were spent on diurnal and nocturnal searches targeting the Pilbara Olive Python.

Table 3.6 – Survey effort

Site	Pit traps (trap nights)	Funnels (trap nights)	Elliotts (trap nights)	Cages (trap nights)	Bird survey (min)	Diurnal opp. search (min)	Bat recording (min)	Nocturnal opp. search (min)
ST S1	70	140	70	14	120	-	720	-
ST S2	70	140	70	14	120	-	720	-
ST S3	70	140	70	14	120	-	720	-
ST S4	160	320	320	32	180	160	720	-
ST S5	160	320	320	32	200	60	720	60
ST S6	160	320	320	32	220	60	1440	-
ST S7	70	140	70	14	120	-	720	-
ST OS1	N/A	N/A	N/A	N/A	-	-	-	80
ST OS2	N/A	N/A	N/A	N/A	-	-	-	208
ST OS3	N/A	N/A	N/A	N/A	-	-	-	180
ST OS4	N/A	N/A	N/A	N/A	-	60	-	-
ST OS5	N/A	N/A	N/A	N/A	-	60	-	-
ST OS6	N/A	N/A	N/A	N/A	-	60	-	-
ST OS7	N/A	N/A	N/A	N/A	-	60	-	-
ST OS8	N/A	N/A	N/A	N/A	-	60	-	-
ST OS9	N/A	N/A	N/A	N/A	-	60	-	-
ST OS10	N/A	N/A	N/A	N/A	-	120	-	-
ST OS11	N/A	N/A	N/A	N/A	-	120	-	-
ST OS12	N/A	N/A	N/A	N/A	-	120	-	-
Opportunistic	N/A	N/A	N/A	N/A	-	540	-	-
Total	760	1520	1240	152	1080	1540	5760	528

3.9 DATA ANALYSIS

3.9.1 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 enzyme kinetic curve was calculated and used as a stopping rule technique.

Only the results of trapping are included in SAC analysis, as this form of analysis assumes a standard sampling effort. Therefore, species recorded through opportunistic methods are not included. Separate analyses were carried out for avifauna and terrestrial trappable fauna (mammals and reptiles). Analysis was not conducted on the amphibian fauna due to the paucity of results.

3.9.2 Habitat Assessment

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

To analyse differences in species diversity between habitats, the data was subjected to log+1 transformation. To test whether the differences in species diversity between habitat types were significant, analyses 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 multidimensional 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 avifauna.

3.10 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 (2004)
Reptiles	Cogger (2000), Wilson and Swan (2010)
Geckos	Storr <i>et al.</i> (1990), Wilson and Swan (2010)
Skinks	Storr <i>et al.</i> (1999), Wilson and Swan (2010)
Dragons	Storr <i>et al.</i> (1983), Wilson and Swan (2010)
Varanids	Storr <i>et al.</i> (1983), Wilson and Swan (2010)
Legless Lizards	Storr <i>et al.</i> (1990), Wilson and Swan (2010)
Snakes	Storr <i>et al.</i> (2002), Wilson and Swan (2010)
Amphibians	Tyler and Doughty (2009), Cogger (2000)

3.11 ANIMAL ETHICS

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 most cases, fauna were identified in the field and released at the point of capture. Where the taxonomy of specimens was not clearly discernible, or when species were collected that are known to exhibit significant morphological variation or are not yet fully described, vouchered specimens were lodged with the W.A. Museum (Appendix F). Voucher specimens were maintained according to WA Museum guidelines to ensure minimum stress to captured animals.

3.12 SURVEY TEAM AND LICENCES

Field survey team members are listed in Table 3.8 and external consultants listed in Table 3.9. The survey was conducted under DEC (now DPaW) Regulation 17 Licences SF007849 and SF009218. Names and qualifications of field personnel during Ecoscape's survey in 2013 are not known.

Table 3.8 – Field survey personnel

Survey Member	Expertise	Qualification	Experience
Current survey			
Jordan Vos	Herpetology/Ornithology	-	8 years
MC Leng	Zoology	BSc (Hons)	8 years
Dr Gabriella Eiris	Mammalogy	PhD	8 years
Sean White	Zoology	-	7 years
Farhan Bokhari	Invertebrates	MSc (Hons)	5 years
Mimi d'Auvergne	Mammalogy	BSc (Hons)	5 years
Jordan de Jong	Herpetology	BSc (Hons)	5 years
Chris Knuckey	Herpetology	BSc	3 years
Central Pilbara Project Mine (ecologia 2011)			
George Swann	Ornithology	-	41 years
David Algaba	Herpetology	-	11 years
Damien Cancilla	Mammalogy	BSc (Hons)	9 years
Leigh Smith	Herpetology	Certificate for vet nursing	9 years
Nigel Jackett	Ornithology	BSc (Hons)	7 years
Astrid Heidrich	Herpetology	MSc	7 years
Bret Stewart	Herpetology	BSc (Hons)	7 years
Bruce Greatwich	Ornithology	BSc	5 years
John Graff	Ornithology	-	5 years
Laura Quinn	Zoology	MSc.	5 years
Catherine Hall	Zoology	BSc	3 years

Table 3.9 – External consultant

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

4 RESULTS

4.1 FAUNA HABITATS

Habitat mapping within the Stingray study area is based partly upon that mapped in the region of overlap with the prior Central Pilbara Project Mine survey (*ecologia* 2011a). In addition, a subsequent survey was conducted at the Solomon Hub Project which also overlaps with the study area (*ecologia* 2014). The terminology used is also consistent with that for the nearby Mt Macleod study area report (*ecologia* 2013b). During the current Level 2 vertebrate fauna assessment, broad habitat types were assessed and classified (Table 4.1) into five main fauna habitat types based on vegetation assemblages, land systems, geographical features, on-ground observations and prior survey data (Table 4.1, Figure 4.1). In addition, habitats mapped during the fauna assessment at the Solomon Hub project were taken into consideration to determine the extent of each habitat type outside the study area (*ecologia* 2014). The extent is listed in Table 4.1 and shown in Figure 4.2.

The five fauna habitats identified from the study area during the current Level 2 vertebrate fauna assessment were:

- Hummock grassland;
- Plain (cracking clay);
- Plain (stony gibber) – includes rocky hillslope;
- Woodland (open); and
- Drainage line/river/creek

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

Table 4.1 – Summary of fauna habitat areas

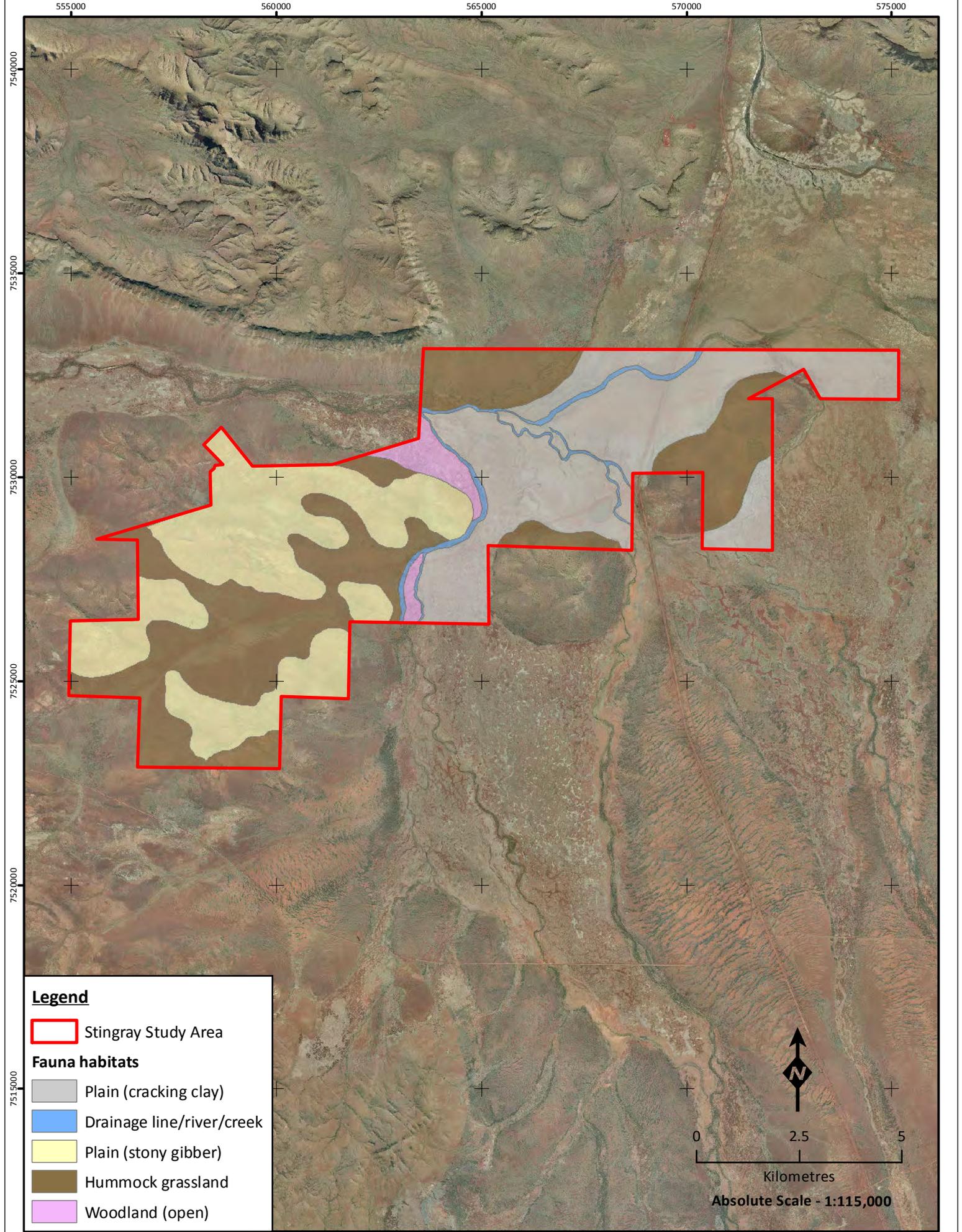
Fauna habitat	Area inside study area (ha)	Percentage of study area (%)	Area within 20km of study area (ha)	Percentage within 20km of study area (%)
Hummock grassland	3,107.5	35.5	934.1	0.4
Plain (cracking clay)	2,862.8	32.7	21,490.9	9.6
Plain (stony gibber)	2,525.8	28.9	143,044.8	63.7
Woodland (open)	239.5	2.7	6,608.6	2.9
Drainage line/river/creek	19.5	0.2	2,324.3	1.0

Of the five habitat types identified during the current survey, three make up the great majority of the study area. The hummock grassland; plain (cracking clay); and stony gibber plain (which includes rocky hillslope) habitat types occupy 34.8%, 32% and 28.3% of the study area, respectively. Table 4.1 and Figure 4.2 show that all five of the habitat types are present in the surrounding area, and are not unique to the Stingray study area. The most common habitat type in the region is the stony gibber plain with 63.7 % of the regional area, followed by cracking clay which occupies 9.6% of the area within 20 km of the study area. The remaining three habitat types (hummock grassland, woodland and drainage line/river/creek) when combined make up 4.3 % of the regional area.

When total survey effort is assessed against the habitats within the study area (Table 4.2), it can be seen that all of the major fauna habitats within the study area were adequately surveyed. Minimal survey effort (including opportunistic diurnal searches and motion cameras) was expended in the open woodland habitat, since this comprises a small percentage of the study area (2.7%), and is not expected to harbour a significantly different fauna assemblage. Systematic trapping and bird surveys were also conducted adjacent to this habitat type at sites ST 03 and ST 04.

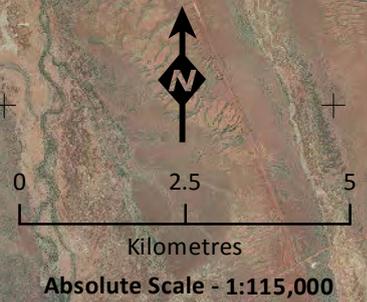
Table 4.2 – Combined survey effort per fauna habitat type

Habitat type	Pit traps (trap nights)	Funnels (trap nights)	Elliotts (trap nights)	Cages (trap nights)	Bird survey (min)	Diurnal opp. search (min)	Bat recording (min)	Nocturnal opp. search (min)
Hummock grassland	230	460	390	46	320	240	1440	240
Plain (cracking clay)	300	600	460	60	420	700	2,880	80
Plain (stony gibber)	70	140	70	14	120	60	720	208
Woodland (open)	-	-	-	-	-	60	-	-
Drainage line/river/creek	160	320	320	32	220	480	1,440	-
Total	760	1,520	1,240	152	1,080	1,540	6,480	528



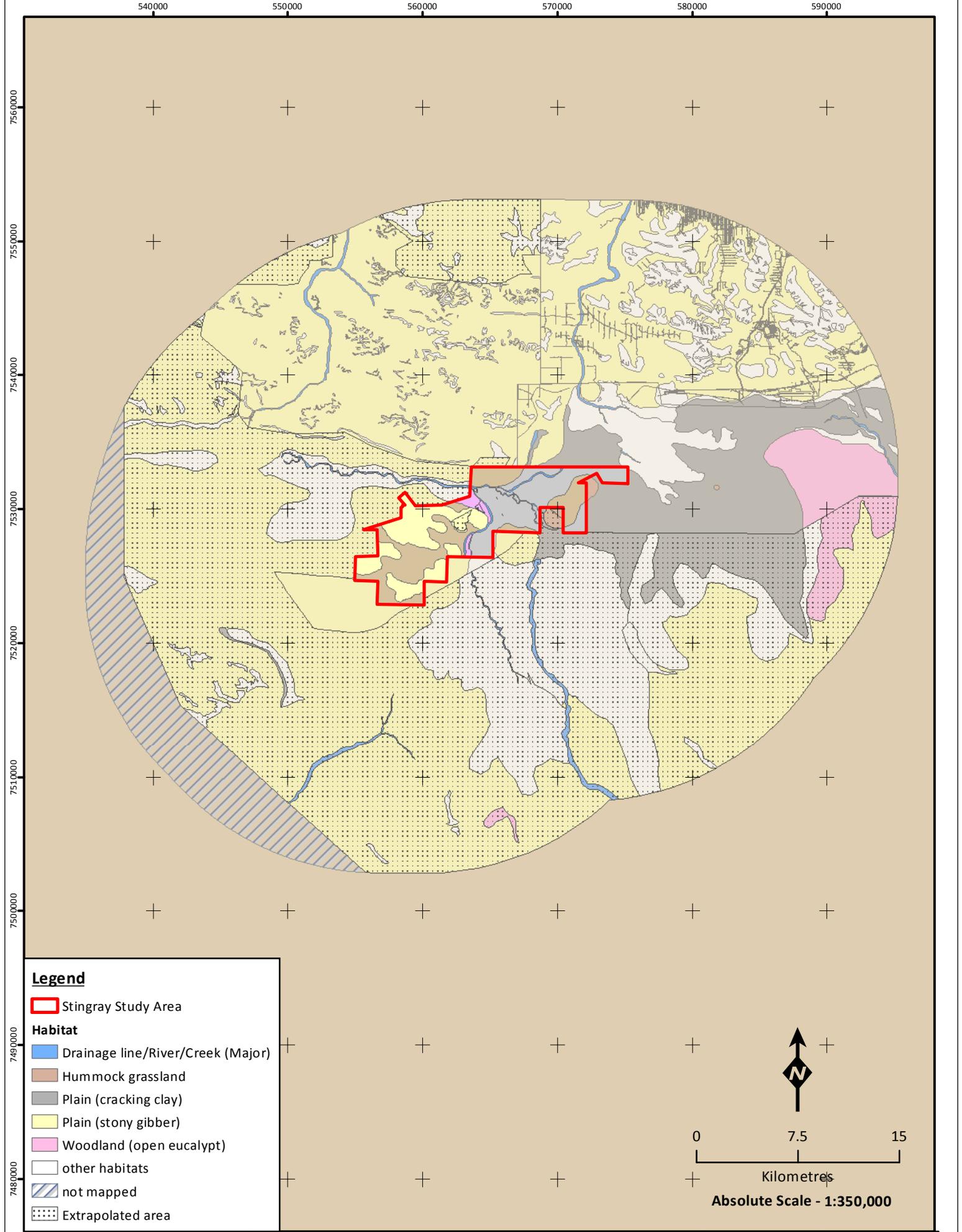
Legend

- Stingray Study Area
- Fauna habitats**
- Plain (cracking clay)
- Drainage line/river/creek
- Plain (stony gibber)
- Hummock grassland
- Woodland (open)



Fauna habitat mapping

Figure: 4.1 Project ID: 1514	Drawn: AH Date: 04/12/14
Coordinate System Name: GDA 1994 MGA Zone 50 Projection: Transverse Mercator Datum: GDA 1994	Unique Map ID: MD004 A4



Legend

Stingray Study Area

Habitat

Drainage line/River/Creek (Major)

Hummock grassland

Plain (cracking clay)

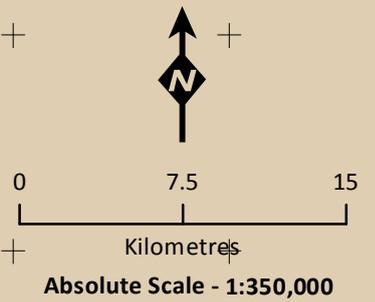
Plain (stony gibber)

Woodland (open eucalypt)

other habitats

not mapped

Extrapolated area



**Regional Fauna Habitat
Mapping (ecologia 2014)**

Figure: 4.2
Project ID: 1514

Drawn: AH
Date: 04/12/14

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

Unique Map ID: MD004

4.1.1 Hummock grassland

The hummock grasslands habitat is the largest habitat type of the study area, a total of 3,107.5 ha (35.5%) (Table 4.1, Figure 4.1). The vegetation is characterised by isolated trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia aneura* over sparse to medium dense *Acacia/Senna* spp. shrubs over *Triodia wiseana* hummock grassland (Figure 4.3). These often undulating plains consist of firm red fine clay-sands with numerous loose rocks. The amount of leaf litter and woody debris is usually low within these habitats. Hummock grasslands are located throughout the Stingray study area and extent into a small area to the east of the study area (Figure 4.2). Small areas of this habitat type may also be contained in the plain (stony gibber) in addition to the extent already mapped due to the similarity of the landform and vegetation composition between those two habitat types (Figure 4.2). The condition of the hummock grassland was very good to excellent based on the criteria listed in Table 3.5.



Figure 4.3 – Hummock grassland habitat recorded from the study area

4.1.2 Plain (cracking clay)

The plain (cracking clay) occupy approximately 2,862.4 ha (32.7%) of the study area (Table 4.1). This habitat type is the second largest, and occurs in the eastern half of the study area (Figure 4.1). The cracking clay habitat is a unique habitat type that contains little to no overstorey and often dominated by one or two tussock grass species. This habitat type is associated with the Themeda grasslands (Vu) Threatened Ecological Community (TEC) and the Brockman Iron cracking clay communities of the Hamersley Range (P1) Priority Ecological Community (PEC). The vegetation is described as isolated shrubs of *Sida spinosa* and/or *Vachellia farnesiana* located amongst dense tussock grassland dominated by *Chrysopogon fallax*, *Themeda* sp. Hamersley Station and/or *Astrelba pectinata* grass species (Figure 4.4). The soils are often firm cracking clays that contain many cracks and crevices. Rocks/stones/pebbles, leaf litter and woody debris are almost entirely lacking from this habitat type. This habitat type extends to the east of the study area (Table 4.2). During the current survey, the cracking clay was of moderate to good condition based on the criteria listed in Table 3.5. Slight grazing of cattle and some clearance in form of tracks was noted.



Figure 4.4 – Plain (cracking clay) recorded from the study area

4.1.3 Plain (stony gibber) – includes rocky hillslopes

The stony gibber plain is a large habitat within the study area, comprising 28.9 % (2,525.8 ha) of the total area and includes rocky hillslopes (Table 4.1). This habitat is the most elevated of the five habitat types within areas of hillslopes, and is mainly found in the western half of the study area (Figure 4.1). This habitat type consists of an open shrubland of *Acacia aneura*, *A. pruinocarpa*, *A. binevosa* and *Senna glutinosa* over *Triodia wiseana* hummock grassland on a continuous layer of bedrock and scattered pebbles and stones (Figure 4.5). Wood litter and leaf litter is generally sparse in this habitat. The stony gibber plain occupies the large majority of the region with 143,044.8 ha (63.7 %) covering the area within 20 km of the study area (Figure 4.2). The stony gibber plain was in very good to excellent condition during the current survey (Table 3.5).



Figure 4.5 – Plain (stony gibber) recorded from the study area

4.1.4 Woodland (open)

Open woodland is a minor habitat type within the study area, covering 2.7 % (239.5 ha) of the total study area (Table 4.1, Figure 4.1). This habitat type consists of moderately dense *Eucalyptus* and *Acacia aneura* trees over *Acacia* spp. shrubs and tussock grasslands on loam or clay soils with pebbles present (Figure 4.6). Wood litter is usually sparse to moderately dense. Leaf litter can build up over time in denser areas which have not been subject to fire, such as the acacia thickets. The open woodland habitat occurs in the central part of the Stingray study area. The open woodland habitat type was recorded within 20 km of the study area and is not unique for the Stingray study area (Figure 4.2). Small areas of this habitat type may be found within the plain (stony gibber) in addition to the extent already mapped due to the similarity of the landform and vegetation composition between those two habitat types. This habitat type was in a moderate to good condition during the current survey (Table 3.5).



Figure 4.6 – Woodland (open) habitat recorded from study area

4.1.5 Drainage line/river/creek

The drainage line/river/creek habitat type comprises 0.2 % (19.5 ha) of the study area and is the smallest habitat represented within the Stingray study area (Table 4.1, Figure 4.1). The drainage line/river/creek habitat is unique and consists of features that are distinct from other habitats. This habitat type is represented by several tributaries that flow in a westerly direction in the lower elevated habitats of the study area. The banks of the creekline are defined as an open woodland of *Acacia citronviridis* and *Eucalyptus victrix* over a dense tussock grassland which is dominated by *Cenchrus ciliaris* in many areas (Figure 4.7). The bed of the drainage line/river/creek consists of river stones and gravel with sections and banks consisting of moist clay-loam topsoil and built up debris. During the survey there were sections of water which support a large number of fauna species. These areas contain a moderate amount of leaf litter and woody debris. Drainage line/river/creek which may comprise acacia shrubland were not included in this habitat type, because these small drainage channels usually do not provide areas large enough to support a different faunal assemblage. This habitat type was in a poor to moderate condition during the current survey due to grazing by cattle (Table 3.5).



Figure 4.7 – Drainage line/river/creek habitat recorded from the study area

4.2 FAUNA HABITAT ANALYSIS

Four fauna habitats within the study area were sampled with systematic trapping sites during the current survey. A one-way ANOSIM test and MDS plot of the trapping sites within the different habitat types was completed for data collected systematically for both birds and terrestrial trapped fauna. The results from these statistical analyses indicate there are some differences between the faunal assemblages in the different habitat types for the birds or terrestrial trapped fauna. MDS plots for the analyses are shown in Figure 4.8.

The one-way ANOSIM test when comparing trapped terrestrial fauna against the different habitat types determined an R-value of 0.1912 (R-value ranges from -1 to 1, with 1 indicating that the groups are dissimilar and -1 indicating that the groups are similar) and a p-value of 0.0001 (p-value of <0.05 indicating a significant difference). The R-value above 0 and a relatively low p-value from this analysis suggest that some differences between habitat types exist, and that the data collected are sufficient to make this analysis. However, the MDS plot for trapped terrestrial fauna data provides a visual illustration of the habitat data and shows that the four fauna habitats are relatively similar (Figure 4.8). The stress value of 0.5425 for this test indicates a reasonable fit of the scaling to the matrix, confirming differences in some habitat types when comparing trapped terrestrial fauna data.

Statistical analysis of the avifauna recorded showed a greater difference between habitat types and avifauna recorded than the terrestrial trapped fauna. The one-way ANOSIM test determined an R-value of 0.3402 and a p-value of 0.0001. This indicates that differences between the avifauna habitats exist. The p-value of 0.0001 suggests sufficient data was obtained to complete the analysis. The MDS plot reflects the results from the ANOSIM. Visually, it appears bird species recorded from the stony gibber habitat type are distinct from the remaining three habitat types, while the drainage line/river/creek and Hummock grassland are also dissimilar (Figure 4.8). A stress value of 0.2515 for this test indicates reasonable fit of the scaling to the matrix.

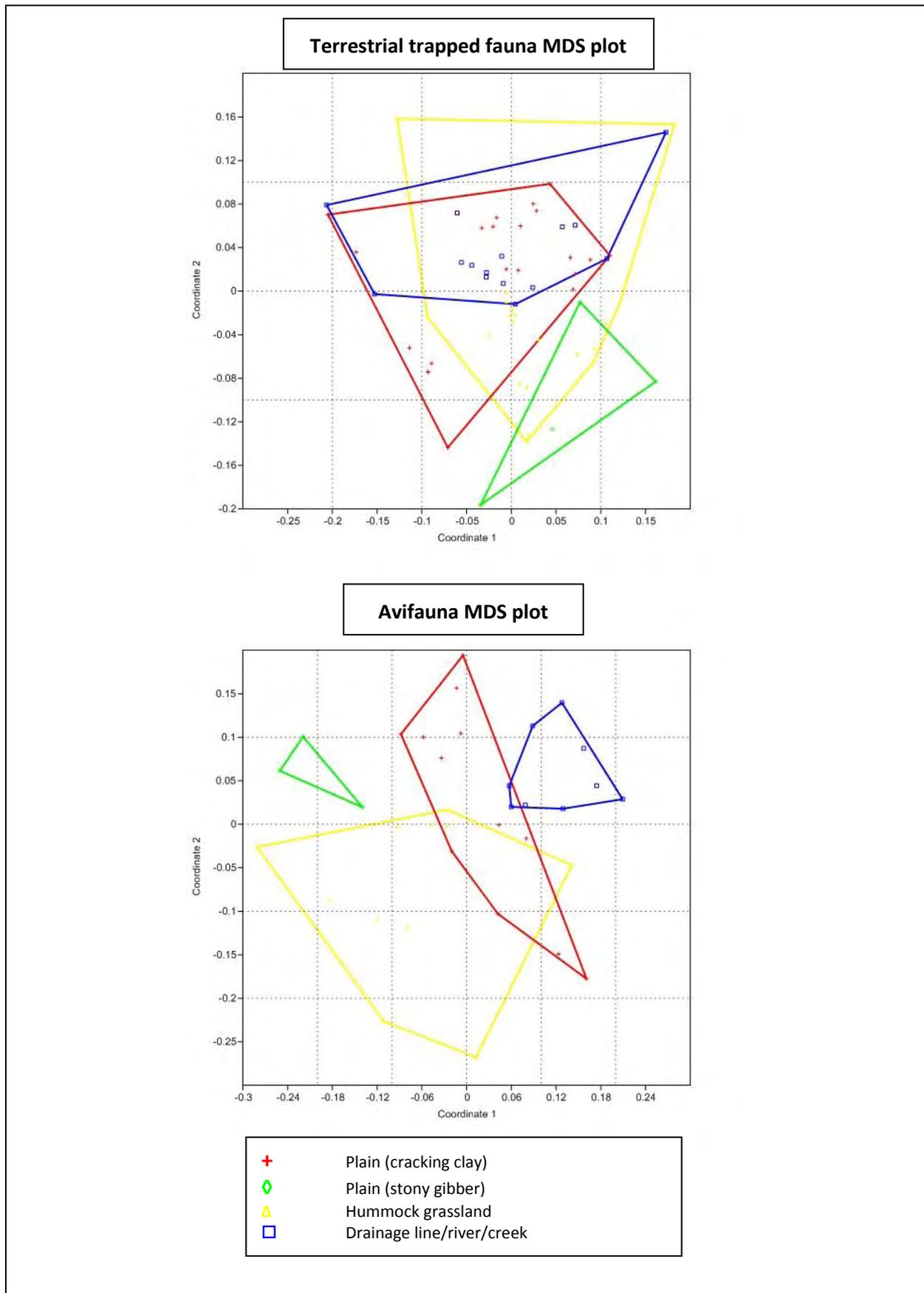


Figure 4.8 – Terrestrial trapped fauna and avifauna MDS plots

4.3 FAUNA ASSEMBLAGE

During the survey a total of 19 native and two introduced mammal, 79 bird, 48 reptile and two amphibian species were recorded. One further species of mammal (Western Pebble-mound Mouse) was recorded by secondary evidence only. Seven of these species are of conservation significance. A site-by-species matrix of the results of the survey is provided in Appendix E.

4.3.1 Mammals

The 19 native mammal species recorded consist of four dasyurids (small, carnivorous marsupials), three rodents, one macropod (kangaroos and wallabies) and 11 microbats. The smaller mammals were captured in pitfall and funnel traps at systematic trapping sites, whilst the macropod was observed during opportunistic searches. Bat species were identified from calls recorded on SM2BAT systems.

The most abundant mammal species recorded during the Level 2 survey was the Striped-faced Dunnart (*Sminthopsis macroura*), which was captured on 11 occasions at five trapping sites. The bats *Chaerephon jobensis* and *Chalinolobus gouldii* were the most widespread bat species recorded, both at six sites. The introduced House Mouse (*Mus musculus*) was trapped at two sites.

Three species of conservation significant mammals were observed during the Level 2 survey, including the Pilbara Leaf-nosed Bat (*Rhinoicteris aurantia* (Pilbara form); EPBC Act Vulnerable), Ghost Bat (*Macroderma gigas*; DPaW Priority 4) and the Short-tailed Mouse (*Leggadina lakedownensis*; DPaW Priority 4). Additionally, the presence of the Western Pebble-mound Mouse (*Pseudomys chapmani*; DPaW Priority 4) was recorded through secondary evidence.

4.3.2 Birds

In total, 79 native bird species were recorded during systematic and opportunistic searches. The more abundant species included the Budgerigar (381), Little Corella (320), Zebra Finch (221), Rufous Songlark (87), Cockatiel (80) and Weebill (80).

Three species of conservation significant birds were recorded within the study area: the Rainbow Bee-eater (EPBC Act Migratory, WC Act Schedule 3), Australian Bustard (DPaW Priority 4) and Star Finch (DPaW Priority 4).

4.3.3 Herpetofauna

A total of 48 reptile species and two amphibian species were recorded during the survey. The reptile assemblage comprised six agamids (dragons), nine geckos, three pygopods (legless-lizards) 16 skinks, four varanids (goannas), two blind snakes, three pythons and five elapids (front-fanged venomous snakes). The remains of *Delma* sp. (legless lizard) were also recorded. The most common species were *Ctenotus helenae* (44), *Ctenotus robustus* (36), *Carlia munda* (27), *Ctenotus pantherinus* (24) and *Gehyra variegata* (23). The two species of amphibians trapped included *Litoria rubella* and *Cyclorana maini*.

No conservation significant reptile species were recorded during the survey.

4.3.4 Fish

No species of fish were recorded during the survey.

4.4 CONSERVATION SIGNIFICANT FAUNA

Based on database searches and the results of previous biological surveys in the surrounding region, nine mammals, 20 birds, four reptiles and one fish species of conservation significance could potentially occur in the study area. Six species of conservation significance (three mammals and three birds) were recorded during the survey, and these records are summarised in Table 4.3 and presented in Figure 4.9. Additionally, secondary evidence (active and inactive mounds) of the Western Pebble-mound Mouse was recorded.

Sixteen species were assessed as having a medium to high likelihood of occurrence, with the remaining 18 species assessed as having a low likelihood. Species with medium to high likelihood of occurrence are described in greater detail in Section 5.2.

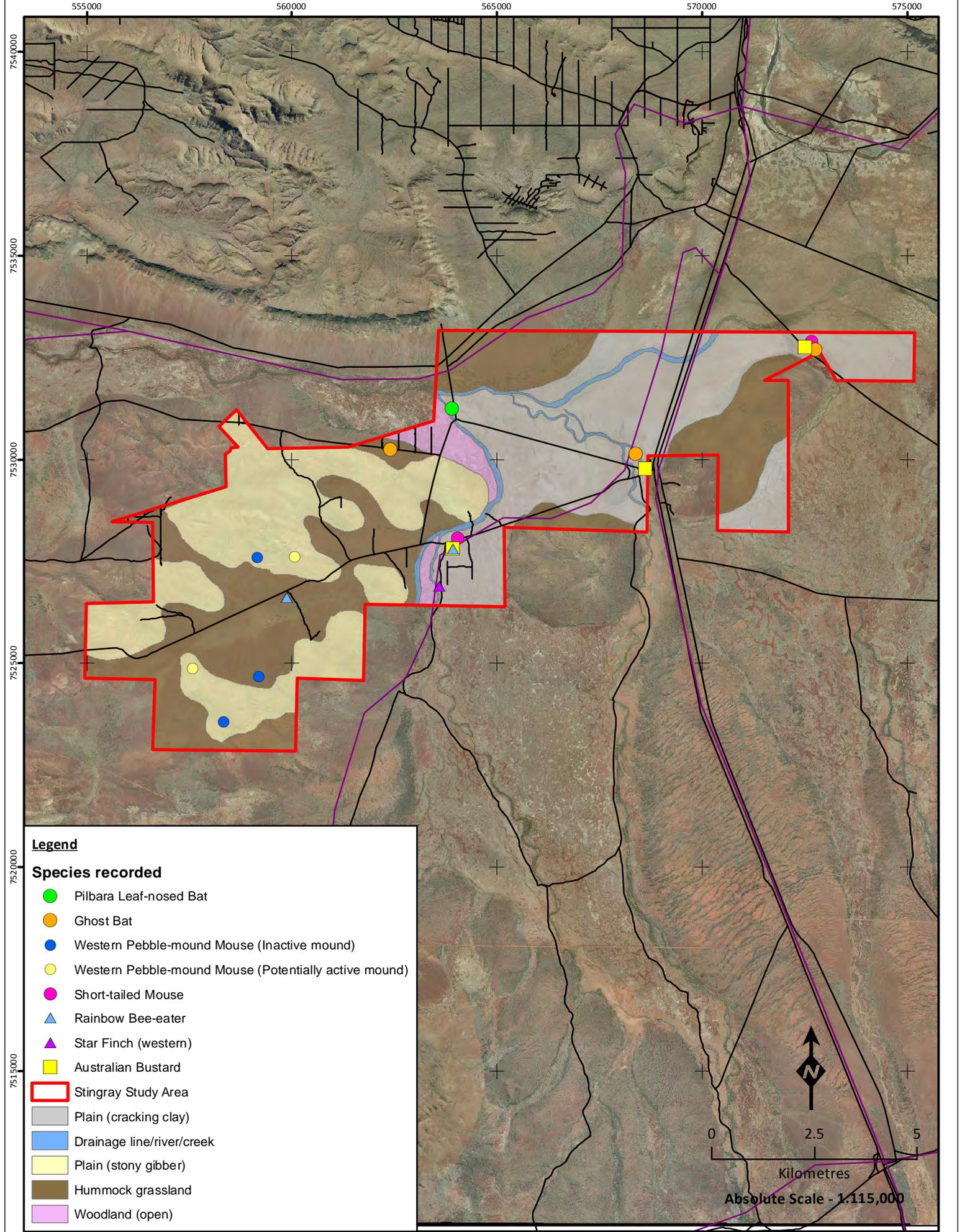
Table 4.3 – Conservation significant fauna recorded during the survey

Species	Location			Comments ¹
	Easting	Northing	Site	
Mammals				
Pilbara Leaf-nosed Bat <i>Rhinioncteris aurantia</i> (Pilbara form)	563909	7531260	ST S4	Call recorded
Short-tailed Mouse <i>Leggadina lakedownensis</i>	563933	7527815	ST S3	Two records
	572604	7532725	ST S7	Eight records
Western Pebble-mound Mouse <i>Pseudomys chapmani</i>	560077	7527614	Opportunistic	Active or recently active mound
	557566	7524881	Opportunistic	Active or recently active mound
	558328	7523578	Opportunistic	Recently active mound recorded
	559194	7524682	Opportunistic	Inactive mound recorded
	559146	7527611	Opportunistic	Inactive mound recorded
Ghost Bat <i>Macroderma gigas</i>	572711	7532769	ST Bat 3	Call recorded
	568615	7529787	ST S6	Call recorded
	562406	7530256	Opportunistic	Body found on barbed wire, WAMTS230
Birds				
Australian Bustard <i>Ardeotis australis</i>	563933	7527815	ST S3	Four records including three individuals flying over trap site
	568615	7529787	ST S6	Three records
	572604	7532725	ST S7	One record
Rainbow Bee-eater <i>Merops ornatus</i>	559875	7526629	ST S1	One record
	563933	7527815	ST S3	One record
Star Finch (western) <i>Neochmia ruficauda subclarescens</i>	563600	7526907	Opportunistic	21 individuals; males and females feeding amongst Zebra Finch next to pool in drainage line.

Zone 50K; Datum GDA 94

¹ Individuals = animals seen at the same time and, therefore, numbers are confirmed.

Records = some individuals may have been observed multiple times.



Legend

Species recorded

- Pilbara Leaf-nosed Bat
- Ghost Bat
- Western Pebble-mound Mouse (Inactive mound)
- Western Pebble-mound Mouse (Potentially active mound)
- Short-tailed Mouse
- ▲ Rainbow Bee-eater
- ▲ Star Finch (western)
- Australian Bustard
- Stingray Study Area
- Plain (cracking clay)
- Drainage line/river/creek
- Plain (stony gibber)
- Hummock grassland
- Woodland (open)

Figure: 4.8
Project ID: 1514

Drawn: NJ & AH
Date: 10/12/14

Conservation significant fauna recorded during survey



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

Unique Map ID: NJ049

4.5 SURVEY ADEQUACY

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

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

Analysis of the terrestrial vertebrate trapping data produced a reasonably smooth SAC, nearing the asymptotic plateau (Appendix F). Extrapolation of the Michaelis-Menten (MM) curve suggests that 80.8% of the theoretical total number of terrestrial fauna able to be trapped had been captured at the completion of the 68 trap nights of the Level 2 vertebrate fauna survey (Table 4.4). These results indicate that additional trapping could potentially detect 12 additional species with other estimators suggesting that between seven and 17 additional species may occur.

Species accumulation curve (SAC) analysis of the avifauna set-time survey dataset also produced a typical SAC, almost reaching the asymptotic plateau (Appendix F). Used as a stopping rule, the MM estimator indicated that the survey was 91.3% adequate at the completion of 36 set-time surveys. The MM estimator generated a theoretical maximum of 82 species (Table 4.4), suggesting further survey effort may have identified an additional seven species. Other estimators indicated that between three and 22 additional species may occur.

Table 4.4 – Mean estimates of total species richness

Richness Estimators	Total Richness Estimate	
	Terrestrial Vertebrates	Birds
ACE	66.52	80.83
ICE	68.14	89.18
Chao-1	73.67	78
Jack-1	68.74	91.53
Jack-2	78.56	97.49
Bootstrap	58.93	82.88
Michaelis-Menten	63.16	82.11
Species Observed	51	75

4.6 SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in Table 4.5. No significant limitations were experienced during the surveys and over 80% of the expected terrestrial fauna assemblage was recorded during systematic trapping. Given the few limitations encountered, it can be confirmed that an adequate level of survey has been undertaken.

Table 4.5 – Summary of survey limitations

Constraint	Relevant (yes/no)	Comment
Competency/experience of the consultant carrying out the survey.	No	All key members of the survey team are experienced in Pilbara fauna identification and fauna surveys.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	All faunal groups were adequately sampled
Proportion of fauna identified, recorded and/or collected.	No	The majority of fauna species expected to occur within the study area were recorded, as indicated by SACs. All captured species were identified in the field.
Sources of information (previously available information as distinct from new data).	No	Thirty-one fauna surveys have been conducted within 100 km of the study area. Data from these surveys was included to provide a regional context.
The proportion of the task achieved and further work which might be needed.	No	The Level 2 vertebrate fauna assessment incorporated data from three phases of surveying over two seasons. The large number of previous surveys in the region also provides additional data allowing an accurate assessment of the fauna assemblages of the study area.
Timing/weather/season/cycle.	No	The Level 2 fauna assessment was conducted over three phases. Over 80% of the expected terrestrial trappable fauna and 90% of expected avifauna were recorded.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	No major disturbances were experienced during the 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).	No	The study area was comprehensively surveyed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	All zoologists are suitably qualified and experienced in identification of Pilbara fauna and Pilbara fauna habitats. There were no resource issues encountered.
Remoteness and/or access problems.	No	All fauna habitats within the study area were accessible by vehicle or on foot.
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 distributed in the study area.

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5 DISCUSSION

5.1 HABITATS

Habitat types potentially suitable for EPBC Act listed conservation significant fauna (Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) were identified within the study area and areas for each species mapped in Figure 5.1. 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.

Potential denning habitat for Northern Quolls and Pilbara Leaf-nosed Bats was not recorded. Potential foraging and dispersal habitat for Northern Quolls in the form of drainage lines/river/creeks was recorded from 193 ha (2.2%) within the study area and potential foraging habitat for the Pilbara Leaf-nosed Bat occupied 433 ha (4.8%) of the study area. The Pilbara Leaf-nosed Bat foraging habitat comprises of drainage line/river/creek habitat and the adjacent open woodland. Potential habitat for Pilbara Olive Pythons was recorded from the drainage line/river/creek habitat which occupies 192 ha (2.2%) of the study area. However, not the entire extent of this habitat type is considered to be critical for the species and only patches along the drainage line may be critical for the species.

Table 5.1 – Summary of potential habitats for EPBC Act listed threatened fauna

Species	Fauna Habitat	Area inside study area (ha)	Percentage of Total study area (%)
Northern Quoll	Potential denning habitat. Areas of rocky habitat in the study area that may contain suitable den sites, preferably near a water source.	0	0
	Foraging/dispersal habitat. Well-vegetated and/or rocky areas used for foraging/hunting, often associated with a creekline or river system, as well as habitat traversed by the species when moving from potential denning areas to suitable foraging areas and when seeking mates during the breeding season (includes footslopes and plains).	192	2.2
Pilbara Leaf-nosed Bat	Potential roosting habitat. Areas of rocky gorges and gullies in the study area that may contain suitable caves for roosting.	0	0
	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.	430	4.8
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.	192	2.2

5.1.1 Hummock grassland

The very good to excellent condition of the hummock grassland was due to very little impact by feral species, only few tracks and no recent fire history was recorded. As stated in section 4.1.1, the hummock grassland was recorded and mapped within the region (Table 4.1, Figure 4.2) and previous surveys (*ecologia* 2014) and is not unique to the study area. In addition to mapped areas, this habitat type may also occur within the plain (stony gibber) habitat type as composition of flora and landforms can overlap between these two habitat types and small areas, in particular when extrapolated, cannot be determined.

The mammal species of the hummock grassland comprise a variety of generalists such as the Little Red Kaluta (*Dasykaluta rosamondae*), Pilbara Ningai (*Ningai timealeyi*) and Desert Mouse (*Pseudomys desertor*) (van Dyck and Strahan 2008). All mammal species caught within this habitat type were caught in other habitats of the study area.

The avifauna of this habitat type is of relatively low diversity due to the low density of trees and shrubs. Bird species that can be found in this habitat include generalists such as Zebra Finch, Black-faced Woodswallow, Variegated Fairy-wren, and Crested Pigeon (Morcombe 2000; Simpson and Day 2010, *ecologia* internal database). The widespread, but generally uncommon, Ground Cuckoo-shrike was recorded from this habitat. Birds of prey utilise the open vegetation for hunting and Whistling Kite and Wedge-tailed Eagle were recorded foraging above the hummock grasslands.

The herpetofauna of the hummock grassland comprises a list of generalists that shelter within spinifex clumps, including the skinks *Carlia munda*, *Ctenotus pantherinus*, *Ctenotus helenae*, *Cyclodomorphus melanops*, the Ring-tailed Dragon (*Ctenophorus caudicinctus*), Spiny-tailed Monitor (*Varanus acanthurus*), and Monk Snake (*Parasuta monachus*) (Bush and Maryan 2011; Storr *et al.* 1999; Wilson and Swan 2013, *ecologia* internal database).

Hummock grasslands are also preferred habitat for the Australian Bustard (Johnstone and Storr 1998; Simpson and Day 2010).

5.1.2 Plain (cracking clay)

The cracking clay habitat is a widespread habitat type in the surroundings of the study area (Table 4.1, Figure 4.2), dominating the east of the local region (20 km within the study area) and is well recorded in the vicinity of the Fortescue Marsh (*ecologia* 2014).

The cracking clay plain was of moderate to good condition due to grazing by cattle and some cleared tracks. No signs of recent fires were observed; however it is not known if the habitat condition and the impacts upon it impacted the fauna assemblage on a significant level.

The mammal diversity within this habitat is generally low. Mammal species captured from this habitat include the Short-tailed Mouse and Striped-face Dunnart. Small mammals inhabiting this habitat, shelter within the cracks of the substrate and at the bases of the tussock grasses (van Dyck and Strahan 2008).

Avifauna diversity within plain (cracking clay)s is limited to a relatively small number which specialise in this less common and relatively homogenous habitat. Specialist avifauna that can be found in this habitat includes the Rufous Songlark and Horsfield's Bushlark in addition to the Australasian Pipit and Brown Songlark which are expected to occur (Morcombe 2000; Simpson and Day 2010, *ecologia* internal database). Other more common species which were observed to utilise this habitat as part of a greater home range include the Crested Pigeon, Cockatiel, Budgerigar and raptors such as the Spotted Harrier and Black-shouldered Kite.

Herpetofauna diversity within this habitat is somewhat limited in comparison to other habitat within the study area. This is largely due to homogeneity of the habitat and the lack of microhabitats which

it supports. Species which generally occur within this habitat include the skink *Ctenotus robustus*, the Fat-tailed Gecko (*Diplodactylus conspicillatus*), Gwadar (*Pseudonaja mengdeni*) and Ringed Brown Snake (*Pseudonaja modesta*) (Bush and Maryan 2011; Storr *et al.* 1999; Wilson and Swan 2013, ecologia internal database).

The plain (cracking clay) habitat type is part of the Vulnerable *Themeda* grasslands on cracking clays (Hamersley Station, Pilbara) TEC and the Priority 1 Brockman Iron cracking clay communities of the Hamersley Range PEC. The cracking clay habitat is known to be the preferred habitat for the conservation significant Priority 4 Short-tailed Mouse (ecologia internal database, ecologia 2012a, 2013e; van Dyck and Strahan 2008) and is likely to provide supporting habitat for the Australian Bustard and Flock Bronzewing.

5.1.3 Plain (stony gibber) – includes rocky hillslopes

The plain (stony gibber) habitat type is the most widespread habitat type in the Pilbara Bioregion (ecologia 2011a, b, 2012a, c, d, 2013a, f, 2014) and also covers 63.7% of the local region (within 20 km of the study area) (Table 4.1).

The stony gibber plains were in very good to excellent condition due to no signs of recent fires during the survey and very low impact by introduced herbivores (cattle, camel, donkey and horse). The mammals of this habitat typically comprise the Common Rock-rat (*Zygomys argurus*), Striped-face Dunnart and Sandy Inland Mouse. The Common Rock-rat shelters in particular in rock cracks and crevices of the rocky hillslopes. The small rock shelters and cracks of this habitat type also support cave structures which provide roosting habitat for a variety of bat species such as the Finlayson's Cave Bat (van Dyck and Strahan 2008).

The avifauna of the hillslopes is of low variety and includes a number of generalists, such as the Zebra Finch, Crested Pigeon and the Spinifexbird. The areas containing sparse trees and shrubs support bird species such as the Grey-headed Honeyeater, Weebill and Red-browed Pardalote. Most birds inhabiting this habitat type are foraging and living within or between spinifex clumps. Raptors such as the Wedge-tailed Eagle and Brown Falcon are commonly recorded flying over and foraging within these habitats (Morcombe 2000; Simpson and Day 2010).

The herpetofauna of this habitat includes common species that are found amongst the spinifex hummocks and in rock cracks and crevices. Species which commonly inhabit this habitat type include Fat-tailed Gecko (*Diplodactylus conspicillatus*), *Heteronotia binoei*, *Ctenotus rubicundus* and *C. rutilans*, Pilbara Rock Monitor (*Varanus pilbarensis*), Pygmy Python (*Antaresia perthensis*) and the Desert Cave Gecko (*Heteronotia spelea*) (Bush and Maryan 2011; Storr *et al.* 1999; Wilson and Swan 2013, ecologia internal database).

The Hillslope within the gibber stony plain habitat has the potential features to support the EPBC Act listed Northern Quoll (foraging/dispersal habitat) and the conservation significant Long-tailed Dunnart (*Sminthopsis longicaudata*). However, it does not provide denning habitat and evidence of these species was not recorded during the targeted survey in 2013 and this survey (Ecoscape 2013). This habitat is the preferred habitat for the Western Pebble-mound Mouse, which was recorded by secondary evidence during the survey.

5.1.4 Woodland (open)

The woodland (open) habitat type occupies a relatively small area within and outside the study area (2.7% and 2.9%, respectively) (Table 4.1). However, it is a widespread habitat throughout much of the Pilbara bioregion and arid zone (Bamford 2005; Coffey 2008, 2010b, 2013; Shepherd *et al.* 2002); as such, the fauna assemblage of this habitat consists of many common and widespread species.

This habitat type was in a good condition during the current survey. Some grazing and previous fires were recorded in addition to tracks. The mammal species inhabiting the woodland over grassland habitat are generalist species that occur throughout the majority of the Pilbara. Common species recorded within this habitat type include the Stripe-faced Dunnart, Desert Mouse (*Pseudomys desertor*) and Sandy Inland Mouse (*Pseudomys hermannsburgensis*) which forage and shelter within the large amounts of woody debris and grass (van Dyck and Strahan 2008).

The avifauna of the woodland is usually most diverse after significant rainfall when acacia shrubs and trees are flowering, increasing feeding resources for birds. In particular, honeyeater species such as the Singing Honeyeater, Brown Honeyeater and in good conditions, Black Honeyeater and White-fronted Honeyeater can be commonly found in this habitat. Other species such as the Crested Bellbird, Grey-crowned Babbler, Chestnut-rumped Thornbill and Willie Wagtail are less reliant on rainfall events and occupy such habitat year-round (Morcombe 2000; Simpson and Day 2010, ecologia internal database).

The herpetofauna of the woodland habitat comprises species such as the Mulga Snake (*Pseudechis australis*) and *Ctenotus robustus* and the Western Netted Dragon (*Ctenophorus reticulatus*). The open woodland habitat has the potential to inhabit species that are unique to mulga woodlands such as the monitor lizard *Varanus caudolineatus*, and the Mulga Dragon *Caimanops amphiboluroides* (Bush and Maryan 2011; Storr *et al.* 1999; Wilson and Swan 2013, ecologia internal database).

5.1.5 Drainage line/river/creek

Drainage lines/river/creek habitats is a widespread habitat type across the Pilbara Bioregion (Bamford 2005; Coffey 2008, 2010b, 2013; Shepherd *et al.* 2002); however its extend is usually limited to a small area due the stream lined nature of the habitat.

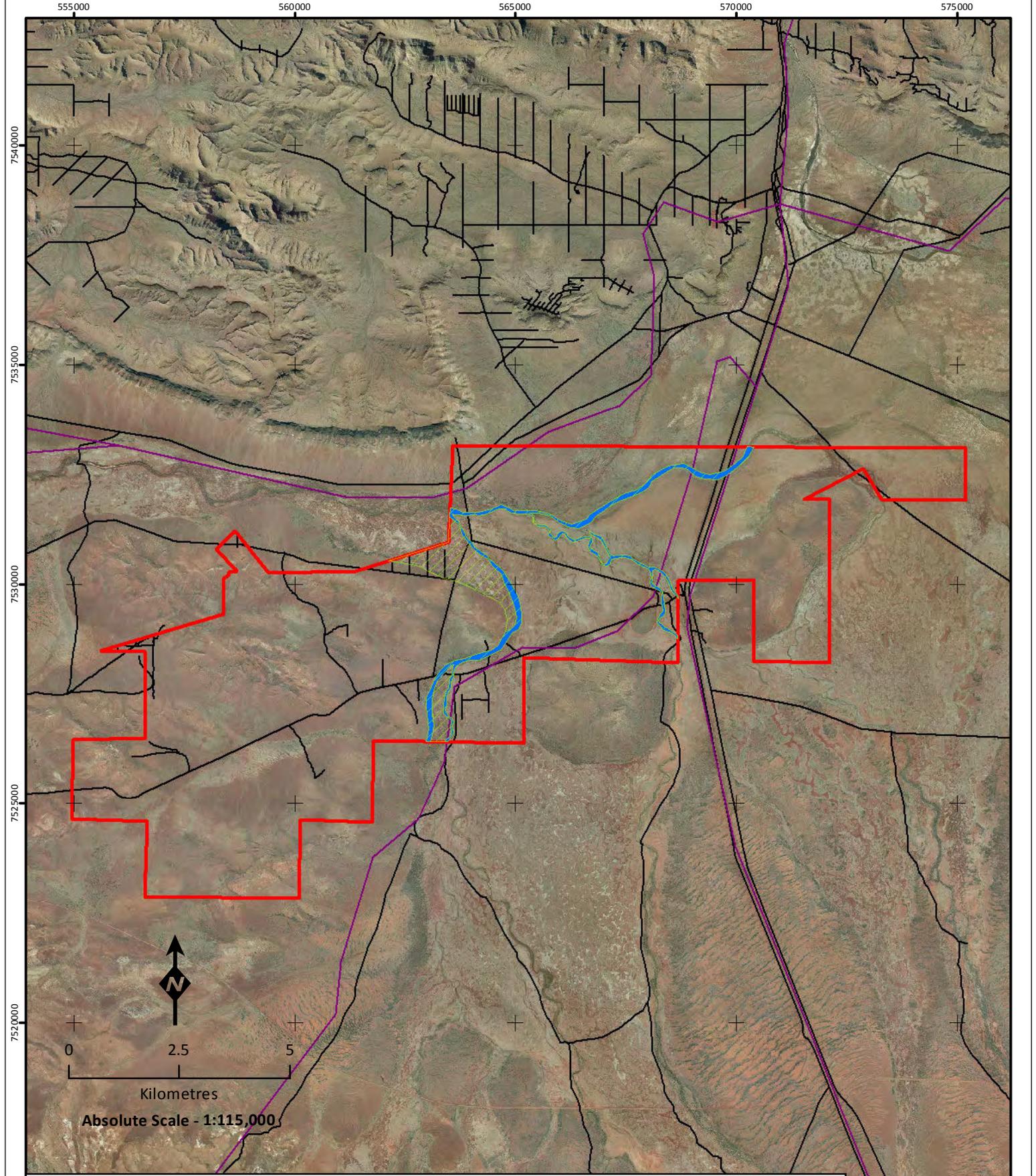
The drainage line/river/creek habitat is the smallest habitat type within the study area. Drainage lines are often well-vegetated and may contain small puddles of water and for this reason are used as corridors by many species (which may usually occupy other habitats) moving through the landscape. This habitat type was in a poor to moderate condition during the current survey due to grazing by cattle and the accumulation of cattle tracks and ground disturbance around water holes.

Mammal species commonly recorded from this habitat include the Red Kangaroo and the Stripe-faced Dunnart. The large number of tree hollows, abundance of insect and presence of water make this habitat type ideal habitat for many microbat species such as the Little Broad-nosed Bat (*Scotorepens greyii*), Yellow-bellied Sheathtail Bat (*Saccolaimus falviventris*) and Gould's Wattled Bat (Churchill 2008; van Dyck and Strahan 2008).

The high diversity of avifauna found in this habitat reflects the preference of many species for trees and/or remnant water. Several pigeon and honeyeater species such as the White-plumed Honeyeaters, Brown Honeyeater, Crested Pigeon and Singing Honeyeater are commonly found in this habitat (Morcombe 2000; Simpson and Day 2010, ecologia internal database).

The herpetofauna of the drainage line/river/creek habitat consists of species that prefer dense vegetation and associated leaf litter. These include skinks such as *Carlia munda*, and *Ctenotus robustus* and other species such as the Long-nosed Dragon (*Amphibolurus longirostris*), Rosen's Snake (*Suta fasciata*) and legless lizards (Bush and Maryan 2011; Storr *et al.* 1999; Wilson and Swan 2013, ecologia internal database).

The drainage line/river/creek habitat may provide suitable nesting habitat for the Bush-stone Curlew and Rainbow Bee-eater, however no breeding evidence was recorded from the study area (Morcombe 2000; Simpson and Day 2010). This habitat type also provides potential foraging habitat for the Pilbara Leaf-nosed Bat, potential dispersal habitat for the Northern Quoll and may provide small areas of critical habitat for the Pilbara Olive Python.



Legend

- Potential foraging habitat for Pilbara Leaf-nosed Bat
- Potential foraging/dispersal habitat for Northern Quoll, critical habitat for Pilbara Olive Python
- Stingray Study Area



**Habitats suitable for
EPBC Act listed threatened fauna**

Figure: 5.1
Project ID: 1514

Drawn: NJ & AH
Date: 10/12/14

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

Unique Map ID: NJ050

5.1.6 Endemic species and species of biological significance

One species endemic to the Pilbara IBRA region was recorded during the survey, the skink *Lerista jacksoni*. Additionally, five near-endemic species were recorded, including the Little Red Kaluta (*Dasykaluta rosamondae*), Pilbara Ningai (*Ningai timealeyi*), the geckos *Diplodactylus savagei* and *Lucasium wombeyi*, and the blind snake *Ramphotyphlops ammodytes*. Only a small percentage of the distributional areas of the near-endemic species extend beyond the Pilbara IBRA region boundary.

5.2 CONSERVATION SIGNIFICANT FAUNA

Based on database searches and the results of previous biological surveys in the surrounding region, nine mammal, 20 bird, four reptile and one fish species of conservation significance could potentially occur in the study area. Information regarding conservation significant species are summarised below in Table 5.2. Based on location of previous records and the habitat type composition within the study area, the Fortescue Grunter and Northern Marsupial Mole have been excluded from this table due to the very low likelihood to occur within the study area. Species of conservation significance with a high to medium likelihood of occurrence are reviewed in greater detail below.

Table 5.2 – Conservation significant fauna likelihood of occurrence

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPAW			
Mammals						
Northern Quoll <i>Dasyurus hallucatus</i>	EN	S1	EN	In the Pilbara, most common on dissected rocky escarpments, but also found in eucalypt forest and woodland. Typically rocky areas with suitable denning sites and access to surface water (Holmes and Miller 2005; Oakwood 2008).	Species not recorded within study area. Scats and individual Northern Quolls have been recorded 14 km and 18 km north of the study area (DPaW 2014).	LOW The Northern Quoll has been recorded within 20 km of the study area, based on regional records. However, records are localised within the Solomon Project and there is very limited potential habitat for this species within the study area. Despite a single phase Level 2 survey and a targeted survey (Ecoscape 2013) within the study area, no evidence was recorded has been recorded.
Greater Bilby <i>Macrotis lagotis</i>	VU	S1	VU	Variety of habitats on soft soil including spinifex hummock grassland, acacia shrubland, open woodland and cracking clays (Johnson 2008).	Listed in table as DEWPaC states 'potential habitat'. The species occurs within the Pilbara region but not recorded within 100 km of the study area (DPaW 2014).	LOW Not known from the Hamersley Range despite widespread fauna surveys. Limited habitat (soft soils) present within the study area.
Pilbara Leaf-nosed Bat <i>Rhinonicteris aurantia</i> (Pilbara form)	VU	S1	VU	Roost in caves with high humidity (95%) and temperature (32 °C). Forage along waterbodies with fringing vegetation (Armstrong 2008).	There are four NatureMap records taken since 2011, located ~15 km northwest of the study area (DPaW 2014).	RECORDED The Pilbara Leaf-nosed Bat was recorded during the survey. However, based on the call pattern recorded during this and previous surveys, this species is only likely to be present during foraging activities. In addition, no cave structures suitable for roosting were recorded.
Spectacled Hare-wallaby <i>Lagorchestes conspicillatus leichardti</i>			P3	Grasslands, open forests, open woodlands and tall shrublands; shelter during the day under tussocks of <i>Triodia</i> spp (Burbidge and Johnson 2008).	Species not recorded within the study area. Several records between 1966 and 1979 within 100 km of the study area (DPaW 2014).	LOW Not recorded within 100 km of the study area since 1979. Limited suitable habitat occurs.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPAW			
Long-tailed Dunnart <i>Sminthopsis longicaudata</i>			P4	Rocky, hilly areas vegetated with spinifex; occasionally open areas with a stony, rocky mantle (Burbidge <i>et al.</i> 2008).	Species not recorded within the study area. Ten records within 100 km of the study area, including two records within 20 km to the study area (DPaW 2014).	LOW The hillslope habitat is potentially suitable for this species. However, due to a general lack of rocky habitats, this species has a low likelihood of occurrence.
Ghost Bat <i>Macroderma gigas</i>			P4	Roost in caves, rockpiles and abandoned mines. Will travel 2 km from roost to hunt (Armstrong and Anstee 2000a; Richards <i>et al.</i> 2008).	Species not recorded within the study area. Nineteen records within 100 km of the study area, including a record from 2013 within 10 km to the study area (DPaW 2014; <i>ecologia</i> 2013e).	RECORDED The Ghost Bat was recorded at three sites within the study area. The study area is expected to be only used for foraging activities, as no caves suitable for roosting are present.
Short-tailed Mouse <i>Leggadina lakedownensis</i>			P4	Spinifex and tussock grassland on cracking clays. Also acacia shrubland, samphire, woodlands, and stony ranges (Moro and Kutt 2008).	Recorded at two sites during the survey. Previously recorded within the study area (Rapallo 2011). More than 20 records within 100 km of the study area, including a record approximately 20 km south-west (DPaW 2014).	RECORDED This species was recorded at two sites within the Stingray study area. Based on literature and previous records, it is likely widespread in the plain (cracking clay) habitats
Western Pebble-mound Mouse <i>Pseudomys chapmani</i>			P4	Footslopes of rocky ranges and rocky hills where the ground has continuous small pebbles and vegetated by spinifex (Start 2008)	Recorded in the study area via secondary evidence. Previously recorded in the study area via secondary evidence (Rapallo 2011). Numerous records within 100 km of the study area (DPaW 2014).	RECORDED Active to recently active mounds were recorded during the survey. Suitable habitat occurs in the stony gibber plain habitat.
Birds						
Night Parrot <i>Pezoporus occidentalis</i>	EN	S1	CR	Mostly ground-dwelling; spinifex grasslands or samphire and chenopod shrublands near waterbodies (Johnstone and Storr 1998; Simpson and Day 2010).	Species not recorded within the study area. Not previously recorded within 100 km of study area (DPaW 2014). The nearest confirmed record is located ~140 km to the east of the study area at Minga Well, Fortescue Marsh (Davis and Metcalf 2008).	LOW Only one recent record located within Western Australia Marsh (Davis and Metcalf 2008). No records within 100 km of the study area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPAW			
Fork-tailed Swift <i>Apus pacificus</i>	M	S3		Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts (Johnstone and Storr 1998; Simpson and Day 2010).	Species not recorded within the study area. The nearest record is located ~ 15 km north of the study area (DPaW 2014). Recorded at three locations in 2011 during Fortescue's Central Pilbara project (<i>ecologia</i> 2011a).	MEDIUM The species has recently been recorded during nearby surveys. The species may occur within the study area as an irregular summer migrant.
Rainbow Bee-eater <i>Merops ornatus</i>	M	S3		Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water (Johnstone and Storr 2004; Simpson and Day 2010).	Recorded in the study area from two locations. Numerous records within 100 km of the study area (DPaW 2014).	RECORDED The Rainbow Bee-eater was recorded at two locations within the study area. The creekline habitat provides suitable foraging and breeding habitat for the species.
Barn Swallow <i>Hirundo rustica</i>	M	S3		Open agricultural areas and urban areas; wetlands, including sewage and saltwork ponds, river pools and tidal creeks (Morcombe 2000; Simpson and Day 2010).	Listed in table as DEWPaC states 'potential habitat'. Species rarely recorded within the region. There are no records within 200 km of the study area.	LOW There are no records of the species within 200 km of the study area. The species is rarely recorded within the Pilbara region.
Eastern Great Egret <i>Ardea modesta</i>	M	S3		Wide range of wetland habitats, including floodwaters, rivers, shallows of wetlands, intertidal mudflats (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. Nearest record located ~30 km to the north of the study area in the Kangeenarina creek (Solomon Mine) in 2013 (<i>ecologia</i> 2013c). There are six DPaW (2014) records located within 50 km of the study area.	MEDIUM Some suitable habitat is present along the major creekline habitat. Numerous records from the surrounding region.
Cattle Egret <i>Ardea ibis</i>	M	S3		Grassy habitats, shallow wetlands and waterbodies, particularly damp pastures (Morcombe 2000; Simpson and Day 2010).	No previous record within 200 km of the study area.	LOW No records within 200 km of the study area. No suitable habitat is present within the study area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPAW			
Glossy Ibis <i>Plegadis falcinellus</i>	M	S3		Shallows and adjacent flats of freshwater lakes and swamps; river pool; flooded samphire; sewage ponds. Nest in freshwater/brackish wetlands with tall, dense stands of emergent vegetation and low trees or bushes (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. Nearest record located ~30 km northeast of the study area from 2000 in the Fortescue River. Species also recorded near Tom Price in 2008. Two records of the species are located within 50 km of the study area (DPaW 2013).	LOW Few recent records of the species are located within the vicinity of the study area. No suitable habitat is present within the study area.
Eastern Osprey <i>Pandion cristatus</i>	M	-		Mangroves, rivers, estuaries, inland seas, coastal islands (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. The nearest record is located ~100 km to the west of the study area from Fortescue's Delphine study area (<i>ecologia</i> 2012b). Also recorded ~100 km to the east of the study area (DPaW 2014).	LOW Very few records of the species within the inland Pilbara particularly the Hamersley Range. The study area does not provide quality habitat for the species.
White-bellied Sea-Eagle <i>Haliaeetus leucogaster</i>	M	S3		Coastal and near coastal water bodies, along river systems. Inhabits most types of habitats except closed forest (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. Nearest record located ~30 km northeast of the study area from 2000 in the Fortescue River (DPaW 2014).	MEDIUM Some suitable habitat is present along the drainage line/river/creek habitat post rainfall events. Species has been recorded occasionally in the local region and due to the large size of the species and the ability to travel long distances result in a medium likelihood for the species to occur when conditions are suitable.
Oriental Plover <i>Charadrius veredus</i>	M	S3		Open plains, including samphire; bare rolling country; bare claypans; open ground near inland swamps (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. Nearest record located ~85 km northwest of the study area. The record was recorded in 2011.	LOW Very few records of the species within the inland Pilbara particularly the Hamersley Range. The study area does not provide quality habitat for the species.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPAW			
Swinhoes's Snipe <i>Gallinago megala</i>	M	S3		Shallow freshwater wetlands of various kinds including paddy fields and sewage farms, with bare mud or shallow water for feeding, with nearby vegetation cover (Morcombe 2000; Simpson and Day 2010).	Recorded from area near Rocklea in 1981 (DPaW 2013). No NatureMap records located within 200 km of the study area (DPaW 2014).	LOW No recent records of the species located within 200 km of the study area. The study area does not provide suitable habitat for the species.
Common Sandpiper <i>Actitis hypoleucos</i>	M	S3		Coastal and inland wetlands, with varying levels of salinity; mostly found on muddy margins or rocky shores; rarely mudflats (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. The nearest NatureMap record is located ~40 km to the south of the study area from Tom Price from 1999 and 2002 (DPaW 2013).	LOW There are very few records from within the region. The study area does not provide suitable habitat for the species.
Oriental Pratincole <i>Glareola maldivarum</i>	M	S3		Plains, shallow wet and dry edges in open bare wetlands, tidal mudflats, beaches (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. The nearest NatureMap record is located >150 km to the north of the study area.	LOW There are no records of the species within 150 km of the study area. The study area provides limited suitable habitat for the species.
White-winged Black Tern <i>Chlidonias leucopterus</i>	M	S3		Mainly estuaries and sheltered seas in north, freshwater lakes and swamps in south (Morcombe 2000; Simpson and Day 2010).	Species not recorded within the study area. The nearest NatureMap record is located ~40 km the south of the study area from 2011 (DPaW 2014).	LOW There are very few records from within the region and limited suitable habitat within the study area exists.
Grey Falcon <i>Falco hypoleucos</i>		S1	VU	Lightly wooded coastal and riverine plains (Johnstone and Storr 1998; Simpson and Day 2010)	Species not recorded within the study area. Recorded three times within 100 km of the study area, including a record 35 km east of the study area (DPaW 2013).	MEDIUM The species has been recorded recently east of the study area and due to the species' ability to travel long distances result in a medium likelihood for the species to occur within the study area. Foraging habitat occurs in the drainage line and open woodland habitats.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPAW			
Peregrine Falcon <i>Falco peregrinus</i>		S4	Other	Widespread; coastal cliffs, riverine gorges and wooded watercourses (Johnstone and Storr 1998; Simpson and Day 2010).	Species not recorded within the study area. The nearest records are located ~11 km to the north of the study area from Fortescue's Central Pilbara project (<i>ecologia</i> 2011a).	MEDIUM Species recently recorded outside the study area. Suitable foraging habitat exists within the stony gibber plain and drainage line habitat of the study area.
Flock Bronzewing <i>Phaps histrionica</i>			P4	Sparsely wooded plains near water. Nomadic visitor to areas of suitable habitat (Johnstone and Storr 2004; Simpson and Day 2010)	The species has previously been recorded at Mt Macleod (Rapallo 2011), ~15 km east of the study area. The nearest NatureMap record is located ~115 km to the northeast of the study area (DPaW 2014).	MEDIUM The species has previously been recorded adjacent to the study area at Mt Macleod. The plain (cracking clay)s of the study area provide suitable foraging habitat and potential breeding habitat for the species. However, based on literature and previous records, the species is not a regular occurring species of the Hamersley Ranges.
Australian Bustard <i>Ardeotis australis</i>			P4	Open grasslands, chenopod flats and low heathland (Johnstone and Storr 1998; Simpson and Day 2010).	The species was recorded at four locations within the Stingray study area. There are numerous NatureMap records within the surrounding area (DPaW 2014) and 20 DPaW (2013) records within 50 km of the study area.	RECORDED The species was recorded at four locations within the study area. The plain (cracking clay), hummock grassland and woodland habitat within the study area provide suitable habitat for the species.
Bush Stone-curlew <i>Burhinus grallarius</i>			P4	Lightly wooded country next to daytime shelter of thickets or long grass (Johnstone and Storr 1998; Simpson and Day 2010)	Species not recorded within the study area. The nearest NatureMap record is located ~30 km to the east of the study area from 2012 (DPaW 2014). There are four records of the species within 50 km of the study area (DPaW 2013).	MEDIUM Suitable habitat exists throughout the drainage line and open woodland habitat of the study area. The species has been recorded recently within 50 km of the study area.
Star Finch (western) <i>Neochmia ruficauda subclarescens</i>			P4	Vegetation around watercourses, particularly thick reed beds (Johnstone and Storr 2004; Simpson and Day 2010).	Species recorded within the study area. The nearest record is located ~35 km east of the study area (DPaW 2014).	RECORDED A flock of 21 individuals of this species was recorded at a pool.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DPAW			
Reptiles						
Pilbara Olive Python <i>Liasis olivaceus barroni</i>	VU	S1	VU	Watercourses and areas of permanent water in rocky gorges, escarpments and gullies (Bush and Maryan 2011; Pearson 2003; Wilson and Swan 2013).	Species not recorded within the study area. The nearest NatureMap record is located ~6 km to the northwest of the study area from 2013 at Hamersley Gorge (DPaW 2014) (<i>ecologia</i> 2013d). There are seven DPaW (2013) records within 50 km of the study area.	MEDIUM The drainage habitat within the study area may provide suitable habitat for this species, in particular around water pools. However, there is a lack of rock structures suitable for dry season hibernacula.
Pilbara Barking Gecko <i>Underwoodisaurus seorsus</i>			P1	Rocky areas of the Hamersley Ranges, both tops of ranges and bottom of gorges (Doughty and Oliver 2011).	Species not recorded within the study area. Nearest NatureMap record located ~15 km to the northwest of the study from Fortescue's Central Pilbara Project and Firetail Mining Area (<i>ecologia</i> 2011a; Ecoscape 2010c).	LOW The stony gibber plain habitat type provides limited suitable habitat for this species, due to the small area of hillslopes and rocky outcrops within this habitat type. Local records of this species tend to be in areas with significant ranges.
Gane's blindsnake <i>Ramphotyphlops ganei</i>			P1	Variety of habitats; thought to prefer moist gorges (Wilson and Swan 2013).	Species previously recorded within the Mt Macleod north study area, ~15 km east of the study area (Rapallo 2011). Five records located within 20 km of the study area (DPaW 2014). Recorded from Fortescue's Central Pilbara Project, 5 km northwest of the study area (<i>ecologia</i> 2011a).	HIGH Recorded within very close proximity to the study area. Suitable habitat for this species is likely to occur within the stony gibber plain and/or drainage line habitats.
Lined Soil-crevice Skink <i>Notoscincus butleri</i>			P4	Associated with stony/rocky, spinifex-dominated areas near creek and river margins, but also found on plains (Wilson and Swan 2013).	Species not recorded within the study area. The species was recorded at multiple locations during surveys at Fortescue's Central Pilbara Project, with the closest record located 5 km to the north of the study area (<i>ecologia</i> 2011a).	MEDIUM The species has recently been recorded within close proximity to the study area. Habitat is located in the gibber stony plains and hummock grassland areas adjacent to drainage lines/river/creeks of the study area.

5.2.1 Mammals

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 (Oakwood 2008). 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 (Oakwood 2008). They are both arboreal and terrestrial and use a variety of den sites, including rock crevices, tree hollows, logs, termite mounds and goanna burrows (Oakwood 2008).

Ecology: Northern Quolls are the smallest of the Australian quolls. Northern Quolls 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 (Oakwood 2008).

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

Likelihood of Occurrence: Low. The Northern Quoll has been documented within 20 km of the study area (*ecologia* 2013c). The stony gibber plain provides some suitable habitat for the species, although no evidence of the species was recorded during the fauna assessment and the previous targeted survey. Therefore the likelihood of occurrence is assessed to be low.

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

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

Distribution and Habitat: The Pilbara Leaf-nosed Bat is the Pilbara form of the Orange Leaf-nosed Bat (*Rhinonictis 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 (Armstrong 2008). They are most often observed in flight over waterholes in gorges, although they are rare even in the Hamersley Ranges where this habitat is common (Armstrong 2008). The Pilbara Leaf-nosed Bat roosts in disused mines and areas of high relief with gorges and watercourses (Armstrong 2001). They are unlikely to occur in the shallow 'breakaway' caves that occur along mesas and strike ridges.

Ecology: At dusk, Pilbara Leaf-nosed Bats emerge from their roosting sites to forage in gorges, small gullies and large watercourses for insects (van Dyck and Strahan 2008). They are susceptible to disturbance and will abandon roost caves if disturbed (Churchill 2008). 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. The Pilbara Leaf-nosed Bat was recorded within the study area during the current survey (site ST S4). It is likely to forage along drainage lines and adjacent areas within the study area. However, due to a lack of suitable roosting habitat and the recorded call

pattern indicating a foraging individual (Figure 5.2), the Pilbara Leaf-nosed Bat is unlikely to be heavily reliant on the study area.

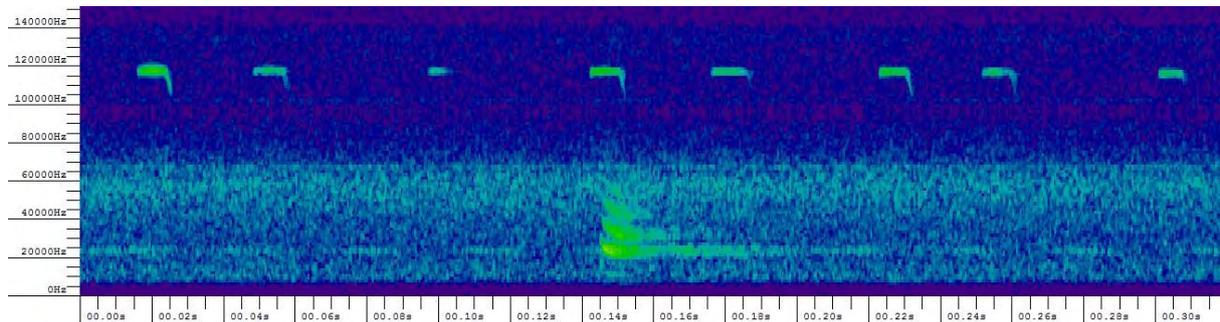


Figure 5.2 – Echolocation (foraging) calls (F_{peak} 121.2 kHz) of Pilbara Leaf-nosed Bat

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 (Armstrong and Anstee 2000a; Richards *et al.* 2008). 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 2000b).

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

Likelihood of Occurrence: Recorded. The Ghost Bat was recorded during the current fauna assessment. Due to a lack of cave structures suitable for roosting, the Ghost Bat is only likely to occur as a foraging species.

Short-tailed Mouse (*Leggadina lakedownensis*)

Conservation Status: DPaW Priority 4.

Distribution and Habitat: Populations of this small, elusive rodent are distributed across northern Australia, but records have been sporadic (Moro and Kutt 2008). They occupy a diverse range of habitats from the monsoon tropical coast to semi-arid climates, including spinifex and tussock grasslands, samphire and sedgeland, *Acacia* shrublands, tropical eucalypt and *Melaleuca* woodlands and stony ranges (Kutt and Kemp 2005; Moro and Kutt 2008). However, Short-tailed Mice are usually found in seasonally inundated habitats on red or white sandy-clay soils (Moro and Kutt 2008).

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

Likelihood of Occurrence: Recorded. During the current survey, this species was recorded regularly from two sites within the plain (cracking clay) habitat. The species has been well documented within

the region with more than ten records within 50 km of the study area. The plain (cracking clay) habitat is likely to provide suitable habitat for the species within the study area.

Western Pebble-mound Mouse (*Pseudomys chapmani*)

Conservation Status: DPaW Priority 4.

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

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

Likelihood of Occurrence: Recorded. This species is widespread throughout the region, with captures and active mounds recorded at over 71 locations within 50 km of the study area (DPaW 2013). Two potentially active and three inactive Western Pebble-mound Mouse mounds were recorded during the current survey. The stony gibber plain habitat provides suitable habitat for the species.

5.2.2 Birds

Fork-tailed Swift (*Apus pacificus*)

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

Distribution and Habitat: The Fork-tailed Swift is a small, insectivorous species with a white throat and rump, and a deeply forked tail (Morcombe 2000). Its distribution spans from central Siberia and throughout Asia, breeding in north-east and mid-east Asia, and wintering in Australia and south New Guinea (Morcombe 2000; Pizzey and Knight 2003) It is a relatively common trans-equatorial migrant from October to April throughout mainland Australia (Simpson and Day 2004). In Western Australia the species begins to arrive in the Kimberley in late September, the Pilbara in November and the South-west by mid-December (Johnstone and Storr 1998). In Western Australia the Fork-tailed Swift is considered uncommon to moderately common near the north-west, west and south-east coasts, common in the Kimberley and rare or scarce elsewhere (Johnstone and Storr 1998).

Ecology: Fork-tailed swifts are nomadic in response to broad-scale weather pattern changes. They are attracted to thunderstorms where they can be seen in flocks, occasionally of up to 2,000 birds (Johnstone and Storr 1998). They rarely land, living almost exclusively in the air and feeding entirely on aerial insects, especially nuptial swarms of beetles, ants, termites and native bees (Simpson and Day 2004).

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

Rainbow Bee-eater (*Merops ornatus*)

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

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

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

Likelihood of Occurrence: Recorded. The species was recorded from two locations within the study area. The species is regularly recorded from throughout the region and there are 37 DPaW (2013) records located within 50 km of the study area. Within the study area the species was recorded from the hummock grassland and plain (cracking clay) habitats near drainage lines/rivers/creeks. The study provides additional suitable breeding and foraging habitat within the drainage line/river/creek habitat.

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 Eastern Great Egret is common to very common in the well-watered Kimberley flatlands, and scarce to moderately common elsewhere within its range (Johnstone and Storr 1998).

Ecology: This species' diet consists predominantly of small fish and crustaceans (Johnstone and Storr 1998). 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. Some suitable habitat exists within the study area (along the drainage line/river/creek habitat) and the species was recorded from the Solomon Mine (approximately 15 km north of the study area) during a previous survey (*ecologia* 2013c). Six additional records from within 50 km of the study area (DPaW 2014).

White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

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

Distribution and Habitat: The White-bellied Sea-Eagle is considered moderately common in the Houtman Abrolhos Islands off Geraldton (Garnett and Crowley 2000; Morcombe 2000; Simpson and Day 2010). White-bellied Sea-eagles occur in coastal and near coastal areas across Australia inhabiting most types of habitats except closed forest. Outside Australia, the species is found in New Guinea, Indonesia, China, south-east Asia and India (Garnett and Crowley 2000).

Ecology: The White-bellied Sea-Eagle feeds mainly on aquatic animals such as fish, turtles and sea snakes, but it takes birds and mammals as well (Johnstone and Storr 1998).. It breeds almost wholly on islands, building a large stick nest, which is used for many seasons in succession (Johnstone and

Storr 1998; RPS 2008). The breeding season ranges from May to September in the north, and in winter and spring in Australia's south (Morcombe 2000).

Likelihood of Occurrence: Medium. The species was recorded in 2000 from approximately 30 km northeast of the study area (DPaW 2014). Some potential habitat exists within the study area in the form of the drainage line/river/creek which represents suitable foraging habitat after heavy rainfall events. However, breeding is not expected to take place within the study area.

Grey Falcon (*Falco hypoleucos*)

Conservation Status: WC Act Schedule 1 (Vulnerable).

Distribution and Habitat: Grey Falcons are a rare, nomadic species sparsely distributed across much of arid and semi-arid Australia. In Western Australia, they are restricted to the northern half, occurring in a variety of habitats ranging from wooded drainage systems through to open spinifex plains (Johnstone and Storr 1998; Morcombe 2000; Simpson and Day 2010). The distribution of the Grey Falcons is thought to be restricted to north of 26 °S (Johnstone and Storr 1998). Because the distribution of this species is scarce over an extremely large area, sightings of this species are very uncommon.

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

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

Likelihood of Occurrence: Medium. The species has recently been recorded ~35 km to the east of the Stingray study area and due to the species' ability to travel long distances result in a medium likelihood for the species to occur within the study area. Within the Pilbara the species is commonly associated with riparian and other productive oases (Sutton 2010). Although unlikely to nest due to a lack of suitable nesting structures, this species may occasionally occur during hunting activities.

Peregrine Falcon (*Falco peregrinus*)

Conservation Status: WC Act Schedule 4 (Specially Protected Fauna).

Distribution and Habitat: This nomadic or sedentary falcon is widespread in many parts of Australia and some of Australia's continental islands, but absent from most deserts and the Nullarbor Plain (Johnstone and Storr 1998). 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 (Johnstone and Storr 1998; Morcombe 2000; Simpson and Day 2010).

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 (Johnstone and Storr 1998). Eggs are predominantly laid in September (Johnstone and Storr 1998; Olsen *et al.* 2006).

Likelihood of Occurrence: Medium. The Peregrine Falcon has been recorded from Fortescue's Central Pilbara Project and within the Solomon Project Area (*ecologia* 2011a, 2013c). While the study area does not provide suitable breeding habitat, the number of nearby records suggests that the

species commonly occurs in nearby areas and may utilise the study area, particularly the drainage line/river/creek habitat, as part of its foraging range.

Flock Bronzewing (*Phaps histrionica*)

Conservation Status: DPaW Priority 4.

Distribution and Habitat: Also known as the Flock Pigeon, the Flock Bronzewing is most common on the black-soil plains of the south-east Kimberley, but is also found in the adjacent north-eastern interior and the coastal and riverine plains between Port Hedland and Carnarvon (Johnstone and Storr 1998). Its preferred habitat is treeless or sparsely wooded plains near water. It is not a frequent visitor to the state, but was recorded in flocks of up to 100,000 individuals in the 1980s and 1990s (Garnett and Crowley 2000)

Ecology: The Flock Bronzewing is gregarious, often feeding and drinking in groups, but is very wary of predators. During the day, the species has been seen resting on the ground in tussock grassland (Ayers *et al.* 1996). Nesting occurs on the ground in the cover of a bush, lower branch, grass tussock or in the dusty, bare ground around bores (Higgins and Davies 1996). It feeds on seeds of grasses and herbaceous plants (NPWS 1999b).

Likelihood of Occurrence: Medium. The Flock Bronzewing is not commonly recorded within the Hamersely Range. However, the species was recently recorded adjacent to the Stingray study area at Mt Macleod (Rapallo (2011)). The plain (cracking clay)s provides suitable habitat for the species, but due to the scarcity of records in the region, the Flock Bronzewing has a medium likelihood of occurrence within the Stingray study area.

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 (Johnstone and Storr 1998). The Australian Bustard has an omnivorous diet, feeding on grasses, seeds, fruit, insects and small vertebrates (Garnett and Crowley 2000).

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

Likelihood of Occurrence: Recorded. The Australian Bustard has been recorded during most surveys within the region (Biota 2009; Coffey 2008; *ecologia* 2010, 2011a, 2012c; Ecoscape 2010b, 2012b, 2013; Rapallo 2011). The species was recorded from four locations within the Stingray study area. The species is widespread throughout the region and is expected to occur in the woodlands over grassland plain, hummock grassland and plain (cracking clay) habitats.

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. 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 1999a).

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; NSW National Parks and Wildlife Service 1999). They are usually seen in pairs, although may occasionally flock together during the breeding season (August to January) and are generally nocturnal, being especially active on moonlit nights (NPWS 1999a).

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: Medium. The species has been recorded during many surveys undertaken within the region (Biota 2005; *ecologia* 2011a, 2012c, 2013f; Ecoscape 2010c). It is expected that the Bush Stone-curlew may occur in the open woodland and creekline habitats within the study area.

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

Conservation Status: DPaW Priority 4.

Distribution and Habitat: The western subspecies of the Star Finch is found across northern Australia, including the Pilbara region where it is patchily distributed, with occasional concentrations at Exmouth and Millstream (DPaW 2014; Johnstone and Storr 2004). Typical Star Finch habitat consists of long grass or rushes around swamps and lagoons or permanent pools. It is also found in irrigated crops and pastures (Johnstone and Storr 2004).

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

Likelihood of Occurrence: Recorded. A flock of 21 individuals was observed amongst a flock of Zebra Finch beside a pool (50K 563600E 7526907N) next to the drainage line/river/creek habitat within the study area. This species is likely to occur within vegetated parts of drainage line/river/creeks habitat when water is present.

5.2.3 Reptiles

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 Pilbara Olive Python is an adept swimmer, often hunting in water, feeding on a variety of vertebrates such as rock wallabies, fruit bats, ducks and pigeons (Wilson and Swan 2013). 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 (Pearson 2003).

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

Likelihood of Occurrence: Medium. Seven DPaW (2013) records for the Pilbara Olive Python are located within 50 km of the study area and the species has been recorded from many surveys within the region, particularly within Fortescue's Solomon Mine Project area (Biota 2009, 2011; *ecologia* 2011a, 2012c, 2013c; Ecoscape 2010c). The species often occupies highly specialised habitat that are not represented within the Mt Macleod study area. Based on the number and locality of nearby records the Pilbara Olive Python has a medium likelihood of occurring in the drainage line/river/creek habitat and stony gibber plain of the study area.

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 (NatureMap). This species is most likely threatened by removal of suitable habitat, and by drilling and/or any other mining activities impacting the subterranean environment.

Likelihood of Occurrence: High. *Ramphotyphlops ganei* has previously been recorded within 5 km of the study area (*ecologia* 2010, 2011a; Rapallo 2011). Suitable habitat for this species exists within the drainage line/river/creek and stony gibber plain of the study area. Due to the close proximity of records and the species having been recorded within the study area previously, this species has a high likelihood of occurrence.

Notoscincus butleri

Conservation Status: DPaW Priority 4.

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

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

Likelihood of Occurrence: Medium. *Notoscincus butleri* has been recorded in many surveys to the west of the study area, these records make up the most southeast extend of the species distribution (Biota 2005, 2009; Coffey 2008; *ecologia* 2011a, 2012c). The known ecology and habitat requirements of the species are relatively vague however based on existing information it seems the species has a preference for rocky hills and plains dominated by spinifex. The stony gibber plain and hummock grassland may therefore provide suitable habitat for this species.

5.3 SURVEY ADEQUACY

Survey effort expended within the study area is summarised in Table 3.6, showing considerable systematic and opportunistic sampling effort was undertaken. In addition, Table 4.2 shows survey effort was adequate in sampling all fauna habitat types within the study area except for Open woodland. However, this habitat makes up 2.7% of the study area, and is not expected to harbour additional species that could not be sampled from the other, larger habitat units.

Analysis of the observed avifauna assemblage recorded during the fauna assessment suggests the survey recorded a high percentage (91.3%) of the expected avifaunal assemblages (Table 4.4). Based on the shape of the SACs generated (Appendix F), a plateau has nearly been reached for the systematic avifauna data.

Analysis of the observed terrestrial assemblage recorded during the fauna assessment suggests the survey recorded a relatively high percentage (80.8%) off the expected terrestrial fauna assemblage, with an additional 12 species potentially occurring (Table 4.4).

6 CONCLUSION

The main conclusions of the vertebrate fauna assessment of the Stingray study area are as follows:

- The vertebrate fauna assessment survey methods were consistent with *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*; Guidance Statement No. 56; Position Statement No. 3; and the EPBC Act Survey Guidelines for Australia's Threatened Mammals, Reptiles, Bats and Birds, as well as Fortescue Metals Group's *Terrestrial Vertebrate Fauna Assessment Guidelines*.
- The literature review included several databases and 29 publications were consulted in the preparation of potential fauna (and conservation significant fauna) lists. The database searches and review resulted in a total of 41 native and 11 introduced mammal, 165 bird, 111 reptile, nine amphibian and six fish species potentially occurring in the study area. Of these, 34 species are of conservation significance (nine species of mammal, 20 species of bird, four species of reptile and one species of fish).
- During the current and previous vertebrate fauna assessment (*ecologia* 2011a), five main fauna habitat types based on vegetation assemblages, land systems and geographical features were identified; woodland (open), hummock grassland, plain (stony gibber), plain (cracking clay) and drainage line/river/creek.
- Four of the five fauna habitats within the study area were sampled with systematic trapping sites during the current survey. The remaining habitat type (open woodland) was targeted during opportunistic searches and is adjacent to two trapping sites. Due to the similarity in landform, vegetation composition and structure of this habitat type with the stony gibber plain, the fauna assemblage is expected to overlap greatly with that of the stony gibber plain. A one-way ANOSIM test and MDS plot of the trapping sites within the different habitat types was completed for data collected systematically for both birds and terrestrial trapped fauna. The results from these statistical analyses indicate that the avifauna and trappable terrestrial fauna assemblages are relatively discrete in each fauna habitat, with some species occurring in multiple habitats. The avifauna forms more discrete assemblages between the different habitat types.
- Survey effort was adequate in sampling all fauna habitat types within the study area. Analysis of the observed avifauna assemblage recorded during the Level 2 vertebrate fauna assessment suggests the survey recorded a high percentage of the expected avifaunal (91.3%) and terrestrial trappable fauna (80.8%) assemblages, based on SACs.
- During the survey a total of 19 native and two introduced mammal, 79 bird, 48 reptile and two amphibian species were recorded. A further one species of mammal was recorded by secondary evidence.
- Of the species recorded, six are of conservation significance, the Pilbara Leaf-nosed Bat (EPBC Act Vulnerable, WC Act Schedule 1), Short-tailed Mouse (DPaW Priority 4), Ghost Bat (DPaW Priority 4), Australian Bustard (DPaW Priority 4), Rainbow Bee-eater (EPBC Migratory, WC Act Schedule 3) and Star Finch (DPaW Priority 4). Additionally, the Western Pebble-mound Mouse (DPaW Priority 4) was recorded occurring through secondary evidence.
- No significant limitations were experienced during the surveys.

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7 REFERENCES

- Anstee, S. D. 1996. Use of external mound structures as indicators of the presence of the Pebble-mound Mouse, *Pseudomys chapmani*, in mound systems. *Wildlife Research* 23: 429-434.
- Anstee, S. D., Roberts, J. D., and O'Shea, J. E. 1997. Social structure and patterns of movement of the Western Pebble-mouse, *Pseudomys chapmani*, at Marandoo, Western Australia. *Wildlife Research* 24: 295-305.
- Armstrong, K. and Anstee, S. D. 2000a. The Ghost Bat in the Pilbara: 100 years on. *Australian Mammalogy*(22): 93-101.
- Armstrong, K. N. 2001. The distribution and roost habitat of the orange leaf-nosed bat, *Rhinoicteris aurantius*, in the Pilbara region of Western Australia. *Wildlife Research* 28: 95-104.
- Armstrong, K. N. 2008. Pilbara Leaf-nosed Bat, *Rhinoicteris aurantia*. pp. 470-471 in Van Dyck, S., and Strahan, R., eds. *The Mammals of Australia*. 3rd edition. Reed New Holland, Sydney.
- Armstrong, K. N. and Anstee, S. D. 2000b. The ghost bat in the pilbara: 100 years on. *Australian Mammalogy* 22: 93-101.
- Ayers, D., Nash, S., and Bagget, K., 1996. *Threatened Species of Western NSW*. National Parks and Wildlife Service.
- Bamford Consulting Ecologists, 2005. Fauna survey of the proposed iron ore mine: Cloudbreak. Unpublished report for Fortescue Metals Group Ltd.
- Beard, J. S. 1975. The vegetation of the Pilbara region. Explanatory notes to map sheet 5 of vegetation survey of Western Australia: Pilbara. University of Western Australia Press, Nedlands.
- Beard, J. S. 1979. Kimberley: The vegetation of the Kimberley area. Vegetation Survey of Western Australia 1:1,000,000 series, explanatory notes and map. University of Western Australia Press, Nedlands, WA.
- Biota Environmental Sciences, 2005. Fauna habitats and fauna assemblage of the Brockman Syncline 4 project, near Tom Price. Unpublished report for Hamersley Iron Pty Ltd.
- Biota Environmental Services, 2008. Marandoo Mine Phase 2 Seasonal Fauna Survey. Unpublished report for Rio Tinto Iron Ore Pty Ltd.
- Biota Environmental Sciences, 2009. West Turner Syncline Section 10 Development Two-Phase Fauna Survey. Unpublished report for Pilbara Iron Company.
- Biota Environmental Sciences, 2011. Western Range Two-Phase Fauna Survey. Unpublished report for Rio Tinto Iron Ore Pty Ltd. Unpublished report for Rio Tinto Iron Ore Pty Ltd.
- Boland, C. R. J. 2004. Breeding biology of Rainbow Bee-eaters (*Merops ornatus*): a migratory, colonial, cooperative bird. *The Auk* 121(3): 811-823.
- BoM. 2012. Climate Data Online. Accessed <http://www.bom.gov.au/climate/data/>.
- Bureau of Meteorology, 2014. Climate Data Online.
- Braithwaite, R. W. and Griffiths, A. 1994. Demographic variation and range contraction in the northern quoll *Dasyurus hallucatus* (Marsupialia: Dasyuridae). *Wildlife Research* 21: 203-217.
- Bunge, J. and Fitzpatrick, M. 1993. Estimating the number of species: A review. *Journal of the American Statistical Association* 88: 364-373.

- Burbidge, A. A. and Johnson, P. M. 2008. Spectacled Hare-wallaby, *Lagorchestes conspicillatus*. pp. 314-316 in van Dyck, S., and Strahan, R., eds. The Mammals of Australia. 3rd edition. Reed New Holland, Sydney.
- Burbidge, A. A., McKenzie, N. L., and Fuller, P. J. 2008. Long-tailed Dunnart, *Sminthopsis longicaudata*. pp. 148-150 in Van Dyck, S., and Strahan, R., eds. The Mammals of Australia. 3rd edition. Reed New Holland, Sydney.
- Bush, B. and Maryan, B. 2011. Field Guide to Snakes of the Pilbara. Western Australian Museum.
- Christidis, L. and Boles, W. E. 2008. Systematics and Taxonomy of Australian Birds. CSIRO Publishing, Collingwood.
- Churchill, S. 1998. Australian Bats. Reed New Holland, Sydney.
- Churchill, S. 2008. Australian Bats. Jacana Books, Crows Nest NSW.
- Clarke, K. R. 1993. Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18: 117-143.
- Coffey Environments, 2008. Level 2 Terrestrial Vertebrate Fauna Assessment for the Solomon Project. Prepared for Fortescue Metals Group Ltd.
- Coffey Environments, 2010a. Fauna Risk Assessment - Solomon Rail Corridor: Stage 1. Prepared for Fortescue Metals Group.
- Coffey environments, 2010b. Level 1 Vertebrate Fauna Assessment - Solomon Rail Project. Unpublished Report for Fortescue Metals Group Ltd.
- Coffey Environments, 2013. Level 2 Vertebrate Fauna Assessment of the Turee Exploration Tenements.
- Cogger, H. G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.
- Colwell, R. K. 2009. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.
- Colwell, R. K. and Coddington, J. A. 1994. Estimating terrestrial biodiversity through extrapolation. Philosophical Transactions of the Royal Society of London, B Biological Sciences 345(1311): 101-118.
- Davis, R. A. and Metcalf, B. M. 2008. The Night Parrot (*Pezoporus occidentalis*) in northern Western Australia: a recent sighting from the Pilbara region. Emu 108(3): 233-236.
- Department of Environmental Protection. 2000. Bush Forever Volume 2: Directory of Bush Forever Sites. Western Australia, Department of Environment Protection, Perth.
- Department of Environment, Water, Heritage and the Arts, 2008a. Approved Conservation Advice for *Liasis olivaceus barroni* (Olive Python-Pilbara subspecies).
- Department of Environment, Water, Heritage and the Arts, 2008b. Approved Conservation Advice for *Rhinoicteris aurantius* (Pilbara form) (Pilbara Leaf-nosed Bat).
- Department of Environment, Water, Heritage and the Arts, 2010a. Survey Guidelines for Australia's Threatened Bats.
- Department of Environment, Water, Heritage and the Arts, 2010b. Survey Guidelines for Australia's Threatened Birds.
- Dickman, C. R., Letnic, M., and Mahon, P. S. 1999a. Population dynamics of two species of dragon lizards in arid Australia: the effects of rainfall. Oecologia 119: 357-366.

- Dickman, C. R., Mahon, P. S., Masters, P., and Gibson, D. F. 1999b. Long-term dynamics of rodent populations in arid Australia: the influence of rainfall. *Wildlife Research* 26(4): 389-403.
- Doughty, P. and Oliver, P. M. 2011. A new species of *Underwoodisaurus* (Squamata: Gekkota: Carphodactylidae) from the Pilbara region of Western Australia. *Zootaxa* 3010: 20-30.
- DPaW. 2013. Threatened and Priority Fauna Database search results #4492. Department of Environment and Conservation. Kensington, Western Australia.
- Department of Parks and Wildlife, 2014. NatureMap: Mapping Western Australia's Biodiversity.
- Department of Sustainability, Environment, Water, Population and Communities, 2011a. Survey Guidelines for Australia's Threatened Bats.
- Department of Sustainability, Environment, Water, Population and Communities, 2011b. Survey guidelines for Australia's threatened mammals.
- Department of Sustainability, Environment, Water, Population and Communities, 2011c. Survey Guidelines for Australia's Threatened Reptiles.
- Department of Sustainability, Environment, Water, Population and Communities, 2013. Australia's Bioregions (IBRA).
- ecologia* Environment, 2010. Vertebrate fauna assessment: Solomon project: Kings area. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2011a. Central Pilbara Project: Mine. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group. Unpublished report for Fortescue Metals Group Ltd.
- ecologia* Environment, 2011b. North Star Project. Level 2 vertebrate fauna assessment. Report for Fortescue Metals Group.
- ecologia* Environment, 2012a. Central Pilbara Project: Rail. Level 2 vertebrate fauna assessment. Unpublished report for Fortescue Metals Group Ltd.
- ecologia* Environment, 2012b. Western Hub project - Delphine. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2012c. Western Hub project - Eliwana and Flying Fish. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2012d. Western Hub project - Mt Farquhar. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2013a. Kutayi, Level 2 Vertebrate Fauna Assessment, Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2013b. Mt Macleod Vertebrate Fauna Survey 2013. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2013c. Solomon Mine Annual Monitoring. Conservation Significant Fauna Monitoring Report 2012. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2013d. Solomon Rail Annual Monitoring. Conservation Significant Fauna Monitoring Report 2012/2013. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2013e. Stingray Vertebrate Fauna Survey 2013. Unpublished report for Fortescue Metals Group.

- ecologia* Environment, 2013f. Western Hub project - Delphine. Level 2. Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.
- ecologia* Environment, 2014. Solomon Hub Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.
- Ecoscape, 2010a. Solomon Project – Rail Camp Sites 1, 2 and 3: Fauna Assessment. Prepared by Ecoscape (Australia) Pty Ltd for Fortescue Metals Group Ltd.
- Ecoscape, 2010b. Solomon Project – Rail Re-alignment: Fauna Assessment. Prepared by Ecoscape (Australia) Pty Ltd for Fortescue Metals Group Ltd.
- Ecoscape, 2010c. Vertebrate Fauna and Fauna Habitat Assessment for the Firetail Project. Prepared for Fortescue Metals Group Ltd by Ecoscape (Australia) Pty Ltd.
- Ecoscape, 2012a. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Eliwana. Unpublished report for Fortescue Metals Group.
- Ecoscape, 2012b. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Flying Fish. Unpublished report for Fortescue Metals Group.
- Ecoscape, 2012c. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Raven. Unpublished report for Fortescue Metals Group.
- Ecoscape, 2013. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Mt Macleod West. Unpublished report for Fortescue Metals Group.
- Ehmann, H. and Watson, M., 2008. Grey Falcon, *Falco hypoleuca*. South Australian Arid Lands Natural Resources Management Board.
- Environmental Protection Authority. 2002. Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection. Environmental Protection Authority, Perth.
- Environmental Protection Authority. 2004. Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Environmental Protection Authority, Perth.
- Environmental Protection Authority and Department of Environment and Conservation, 2010. Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment. Technical report for the Environmental Protection Authority and the Department of Environment and Conservation.
- Fortescue Metals Group, 2011. Terrestrial Vertebrate Fauna Assessment Guidelines.
- Frith, A. J. 1976. Reader's Digest Complete Birds of Australia. Reader's Digest, Sydney.
- Garnett, S. T. and Crowley, G. M. 2000. The Action Plan for Australian Birds. Environment Australia, Canberra.
- Gaston, K. J. 1996. Species richness: measure and measurement. Biodiversity, a biology of number and difference. Blackwell Science, Cambridge.
- Hammer, Ø., Harper, D. A. T., and Ryan, P. D. 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica* 4(1).
- Higgins, P. J. and Davies, S. J. J. F. 1996. Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons. Oxford University Press, Melbourne.

- Holmes, J. and Miller, K. 2005. Australian Threatened Species. Northern Quoll *Dasyurus hallucatus*. Infosheet. WWF-Australia, Threatened Species Network and Australian Government,.
- Johnson, K. A. 2008. Bilby, *Macrotis lagotis*. pp. 191-193 in van Dyck, S., and Strahan, R., eds. The Mammals of Australia. Reed New Holland, Sydney.
- Johnstone, R. E. and Storr, G. M. 1998. Handbook of Western Australian Birds, Volume I - Non-Passerines (Emu to Dollarbird). Western Australian Museum, Perth.
- Johnstone, R. E. and Storr, G. M. 2004. Handbook of Western Australian Birds, Volume II - Passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth.
- Kendrick, P., 1995. Vertebrate Fauna of the Marandoo to Great Northern Highway Road. Unpublished report for Main Roads Western Australia and CALM.
- Kendrick, P. 2001. Pilbara 3 (PIL3 - Hamersley subregion). A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. DEC.
- Kutt, A. S. and Kemp, J. E. 2005. Distribution, habitat and conservation status of *Leggadina lakedownensis* (Rodentia: Muridae) in Queensland. Australian Zoologist 33(2): 258-264.
- Marchant, S. and Higgins, P. J. 1993. Handbook of Australian, New Zealand and Antarctic Birds. Oxford University Press, Melbourne.
- Masters, P. 1993. The effects of fire-driven succession and rainfall on small mammals in spinifex grassland at Uluru National Park, Northern Territory. Wildlife Research 20: 803-813.
- Mattiske and Associates and Ninox Wildlife Consulting, 1990. Brockman 2 Detritals Survey Area and Proposed Transport Corridor. Unpublished report for Hamersley Iron Pty Ltd.
- Maxwell, S., Burbidge, A. A., and Morris, K. D., eds. 1996. The 1996 Action Plan for Australian Marsupials and Monotremes. Wildlife Australia, Canberra.
- Menkhorst, P. and Knight, F. 2011. *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.
- Morcombe, M. 2000. Field Guide to Australian Birds. Steve Parish Publishing Pty Ltd, Archerfield, Australia.
- Moro, D. and Kutt, A. S. 2008. Northern Short-tailed Mouse, *Leggadina lakedownensis*. pp. 583-584 in van Dyck, S., and Strahan, R., eds. The Mammals of Australia. Reed New Holland, Sydney.
- Muir, B. G., ed. 1983. A Fauna Survey of the Hamersley Range National Park Western Australia. Bulletin No. 1. National Parks Authority of Western Australia.
- National Health and Medical Research Council, 2004. Australian code of practice for the care and use of animals for scientific purposes.
- Ninox Wildlife Consulting, 1995. Vertebrate fauna of the northern transport corridor option. Unpublished report for Hamersley Iron Pty Ltd.
- National Parks and Wildlife Service, 1999a. Threatened Species Information: Bush Stone-curlew *Burhinus grallarius* (Latham, 1801). NSW National Parks and Wildlife Service.
- National Parks and Wildlife Service, 1999b. Threatened Species Information: Flock Bronzewing *Phaps histrionica*. NSW National Parks and Wildlife Service.
1999. Threatened Species Information: Bush Stone-curlew *Burhinus grallarius* (Latham, 1801). Hurstville, NSW www.npws.nsw.gov.au.

- Oakwood, M. 2008. Northern Quoll, *Dasyurus hallucatus*. pp. 57-59 in van Dyck, S., and Strahan, R., eds. The Mammals of Australia. 3rd edition. Reed New Holland, Sydney.
- Olsen, J., Fuentes, E., Dykstra, R., and Rose, A. B. 2006. Male Peregrine Falcon *Falco peregrinus* fledged from a cliff-nest found breeding in a stick-nest. Australian Field Ornithology 23: 8-14.
- Pearson, D. 2003. Giant pythons of the Pilbara. Landscape 19(1): 32-39.
- Pearson, D. J. 2006. Giant pythons of the pilbara. Landscape 19: 32-39.
- Pizzey, G. and Knight, F. 2003. A Field Guide to the Birds of Australia. Harper Collins Publishers, Sydney.
- Rapallo Environment, 2011. Terrestrial Vertebrate Fauna Survey of the Mt Macleod Project Area. Unpublished report for Fortescue Metals Group Limited.
- Richards, G. C., Hand, S., and Armstrong, K. N. 2008. Ghost Bat, *Macroderma gigas*. pp. 449-450 in van Dyck, S., and Strahan, R., eds. The Mammals of Australia. Reed New Holland, Sydney.
- RPS. 2008. Migratory Birds in Bridgewater North ODP, ed. EBPC Referral,.
- Shepherd, D. P., Beeston, G. R., and Hopkins, A. J. M. 2001. Native vegetation in Western Australia: Extent, type and status. Technical Report 249. Department of Agriculture, South Perth.
- Shepherd, *et al.*, 2002. Native Vegetation in Western Australia. Technical Report 249. Department of Agriculture.
- Simpson, K. and Day, N. 2004. Field Guide to the Birds of Australia. Penguin Group, Camberwell.
- Simpson, K. and Day, N. 2010. Field Guide to the Birds of Australia. Penguin Group, Camberwell.
- Start, A. N. 2008. Western Pebble-mouse, *Pseudomys chapmani*. pp. 621-622 in van Dyck, S., and Strahan, R., eds. The Mammals of Australia. Reed New Holland, Sydney.
- Storr, G. M., Smith, L. A., and Johnstone, R. E. 1983. Lizards of Western Australia II: Dragons and Monitors. Western Australian Museum, Perth.
- Storr, G. M., Smith, L. A., and Johnstone, R. E. 1990. Lizards of Western Australia III: Geckos and Pygopods. Western Australian Museum, Perth.
- Storr, G. M., Smith, L. A., and Johnstone, R. E. 1999. Lizards of Western Australia I: Skinks. Western Australian Museum, Perth.
- Storr, G. M., Smith, L. A., and Johnstone, R. E. 2002. Snakes of Western Australia. Western Australian Museum, Perth.
- Sutton, A. J. G. 2010. Aspects of the biology of the Grey Falcon *Falco hypoleucos* in the Pilbara region of Western Australia. Corella 35(1).
- Tidemann, C. R., Priddel, D. M., Nelson, J. E., and Pettigrew, J. D. 1985. Foraging behaviour of the Australian Ghost Bat, *Macroderma gigas* (Microchiroptera: Megadermatidae). Australian Journal of Zoology 33: 705-713.
- Toop, J. 1985. Habitat requirements, survival strategies and ecology of the ghost bat, *Macroderma gigas* Dobson (Microchiroptera, Megadermatidae) in central coastal Queensland. Macroderma 1(2): 37-41.
- Tyler, M. J. and Doughty, P. 2009. Field Guide to Frogs of Western Australia. Western Australian Museum, Perth.
- van Dyck, S. and Strahan, R. 2008. *The Mammals of Australia*. Reed New Holland, Sydney.

- van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A., and Hennig, P. 2004a. An inventory and condition survey of the Pilbara region, Western Australia. Department of Agriculture Technical Bulletin No. 92.
- Van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A., and Hennig, P. 2004b. An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No. 92. Department of Agriculture, Western Australia.
- Wilson, S. and Swan, G. 2010. *A Complete Guide to Reptiles of Australia*. New Holland Publishers, Sydney.
- Wilson, S. and Swan, G. 2013. *A Complete Guide to Reptiles of Australia*. New Holland Publishers, Sydney.

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APPENDIX A EXPLANATION OF CONSERVATION CODES

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

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

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

Schedule	Definition
Schedule 1 (S1)	Fauna which are rare or likely to become extinct, are declared to be fauna that is in need of special protection.
Schedule 2 (S2)	Fauna which are presumed to be extinct, are declared to be fauna that is in need of species protection.
Schedule 3 (S3)	Birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of species protection.
Schedule 4 (S4)	Declared to be fauna that is in need of species protection, otherwise than for the reasons mentioned above.

Appendix A3 Definition of DPaW Threatened and Priority Fauna Codes

Threatened	Definition
Critically Endangered (CR)	Considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Considered to be facing a high risk of extinction in the wild.
Priority	Definition
Priority 1 (P1)	<i>Taxa with few, poorly known populations on threatened lands.</i> Taxa which are known from few specimens or sight records from one or a few localities, on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2 (P2)	<i>Taxa with few, poorly known populations on conservation lands.</i> Taxa which are known from few specimens or sight records from one or a few localities, on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3 (P3)	<i>Taxa with several, poorly known populations, some on conservation lands.</i> Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4 (P4)	<i>Taxa in need of monitoring.</i> Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could if present circumstances change. These taxa are usually represented on conservation lands.
Priority 5 (P5)	<i>Taxa in need of monitoring.</i> Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

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APPENDIX B DAILY WEATHER DATA DURING SURVEY

Appendix B1 Level 2 Vertebrate Fauna Assessment

Date	Mean Minimum Temperature (°C)	Mean Maximum Temperature (°C)	Rainfall (mm)
CPP survey (ecologia 2011)			
Phase 1			
03/03/11	20.4	31.4	0.0
04/03/11	20.4	32.1	0.0
05/03/11	21.5	34.5	0.0
06/03/11	24.1	37.2	0.0
07/03/11	26.4	36.6	0.0
08/03/11	24.5	35.6	19.2
09/03/11	25.3	36.2	0.0
10/03/11	21.9	36.3	0.0
11/03/11	22.6	37.5	0.0
12/03/11	21.1	38.5	0.0
13/03/11	22.6	37.9	0.0
14/03/11	26.4	37.2	0.0
15/03/11	25.4	36.3	0.0
Phase 2			
23/09/11	13.8	33.0	0.0
24/09/11	17.3	35.9	0.0
25/09/11	12.8	32.9	0.0
26/09/11	10.1	31.2	0.0
27/09/11	16.0	28.7	0.0
28/09/11	15.1	30.9	0.0
29/09/11	11.5	33.7	0.0
30/09/11	14.7	34.7	0.0
01/10/11	16.0	30.3	0.0
02/10/11	16.6	30.0	0.0
03/10/11	14.6	25.4	0.0
04/10/11	14.3	28.0	0.0
05/10/11	18.1	33.7	0.0
This survey			
03/05/2012	17.2	34.7	0
04/05/2012	18.5	34.5	0
05/05/2012	18.5	34.9	0
06/05/2012	18.1	35.0	0
07/05/2012	19.5	35.9	0
08/05/2012	22.4	29.2	0
09/05/2012	16.2	29.9	0.2
10/05/2012	14.5	31.4	0
11/05/2012	20.8	27.9	0
12/05/2012	18.8	28.6	0
13/05/2012	14.5	24.0	0

Note: climate data recorded from Wittenoom Aero weather station (005026) (BoM 2012).

APPENDIX C REGIONAL FAUNA DATA

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Appendix C1 Mammals

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2013)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hammersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	West Turner Section 10 (Biota 2009)	Brockman Syncline 4 (Biota 2005)	Solomon Project – rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (Ecoscape 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninnox 1995)	NatureMap	DPaW Rare Fauna	DSEWPac Protected Matters Search	This survey	
		EPBC Act	WC Act	DPaW																										
TACHYGLOSSIDAE																														
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna																													
DASYURIDAE																														
<i>Dasykaluta rosamondae</i>	Little Red Kaluta				•	•	•	•	•	•		•	•	•	•			•	•							•			•	
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	S1	EN	•								•					•								•	•	•		
<i>Ningui timealeyi</i>	Pilbara Ningui				•	•	•	•	•	•		•	•	•	•			•	•							•		•		
<i>Planigale sp. (prev. maculata)</i>	Common Planigale				•	•	•	•	•	•		•	•	•	•			•	•							•				
<i>Pseudantechinus woolleyae</i>	Woolley's False Antechinus				•	•								•				•				•				•				
<i>Sminthopsis longicaudata</i>	Long-tailed Dunnart			P4	•	•												•								•	•			
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart				•	•	•	•	•	•		•	•	•				•	•							•			•	
<i>Sminthopsis ooldea</i>	Ooldea Dunnart											•							•											
THYLACOMYIDAE																														
<i>Macrotis lagotis</i>	Bilby	VU	S1	VU																					•			•		
NOTORYCTIDAE																														
<i>Notoryctes caurinus</i>	Northern Marsupial Mole	EN	S1	EN																									•	
MACROPODIDAE																														
<i>Lagorchestes conspicillatus leichardti</i>	Spectacled Hare-wallaby			P3													•									•	•			
<i>Macropus robustus</i>	Euro				•	•	•	•	•	•	•		•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	
<i>Macropus rufus</i>	Red Kangaroo				•	•	•	•	•	•	S			•	•			•	•	•	•	•	•	•	•	•	•	•	•	
<i>Petrogale rothschildi</i>	Rothschild's Rock Wallaby				•																					•	•			
PHALANGERIDAE																														
<i>Trichosurus vulpecula arnhemensis</i>	Northern Brushtail Possum									•			•										•			•				
PTEROPODIDAE																														
<i>Pteropus scapulatus</i>	Little Red Flying-fox							•																		•				
<i>Pteropus alecto</i>	Black Flying Fox						•																							
HIPPOSIDERIDAE																														
<i>Rhinonictes aurantia</i>	Pilbara Leaf-nosed Bat	VU	S1	VU	•	•																				•	•	•		
MEGADERMATIDAE																														
<i>Macroderma gigas</i>	Ghost Bat			P4	•	•						•						•								•	•			
EMBALLONURIDAE																														
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat				•	•	•	•	•	•		•	•	•				•								•				
<i>Taphozous georgianus</i>	Common Sheathtail Bat				•	•	•	•	•	•		•	•	•	•			•			•					•				
<i>Taphozous hilli</i>	Hill's Sheathtail Bat				•	•						•														•				
VESPERTILIONIDAE																														
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat				•	•	•	•	•	•		•	•	•	•			•	•							•				
<i>Chalinolobus morio</i>	Chocolate Wattled Bat									•				•																
<i>Nyctophilus arnhemensis</i>	Arnhem Long-eared Bat														•															
<i>Nyctophilus bifax daedalus</i>	Northern Long-eared Bat				•							•																		

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2013)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hamersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	West Turner Section 10 (Biota 2009)	Brockman Syncline 4 (Biota 2005)	Solomon Project – rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (Ecoscape 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninnox 1995)	NatureMap	DPaW Rare Fauna	DSEWPac Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																									
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat				•	•				•		•													•				
<i>Scotorepens greyii</i>	Little Broad-nosed Bat				•	•	•	•	•	•		•	•	•	•			•							•				
<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat				•	•	•	•	•	•		•	•	•	•			•	•						•				
MOLOSSIDAE																													
<i>Chaerophon jobensis</i>	Northern Freetail Bat				•	•	•		•	•		•						•	•						•				
<i>Mormopterus beccarii</i>	Beccari's Freetail Bat				•	•	•			•		•	•					•							•				
<i>Mormopterus loriae</i>	Little Northern Freetail Bat														•														
<i>Tadarida australis</i>	White-striped Freetail Bat				•		•			•		•			•										•				
MURIDAE																													
<i>Leggadina lakedownensis</i>	Short-tailed Mouse			P4	•		•		•	•															•	•		•	
<i>Notomys alexis</i>	Spinifex Hopping-mouse					S						•																	
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4	•	S	S	•	S	S	S	•	SA	•	•			S	•	•	•		•		•	•		SIA	
<i>Pseudomys delicatulus</i>	Delicate Mouse						•	•	•	•													•						
<i>Pseudomys desertor</i>	Desert Mouse				•	•	•	•	•	•			•	•	•			•							•			•	
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse				•	•	•	•	•	•		•	•	•	•				•						•			•	
<i>Zyzomys argurus</i>	Common Rock-rat				•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•			
CANIDAE																													
<i>Canis lupus dingo</i>	Dingo				•	•	•	S	•	•				•			•	•	•	•	•	•	•	•	•	•	•	•	
INTRODUCED MAMMALS																													
* <i>Mus musculus</i>	House Mouse				•	•	•	•	•	•		•		•	•			•	•							•		•	
* <i>Rattus rattus</i>	Black Rat																											•	
* <i>Vulpes vulpes</i>	Red Fox																											•	
* <i>Felis catus</i>	Cat				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
* <i>Oryctolagus cuniculus</i>	European Rabbit																											•	
* <i>Equus asinus</i>	Donkey										•				•								•		•		•	•	
* <i>Equus caballus</i>	Horse				•	•				•	•				•							•			•		•	•	
* <i>Camelus dromedarius</i>	Camel																								•		•	•	
* <i>Bos taurus</i>	Cow				•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•		•	•	
* <i>Capra hircus</i>	Goat																										•	•	

Abbreviations:
S Recorded by secondary evidence (e.g. scat, burrow, mound, feather, track)
SA Active mound of Western Pebble-mound Mouse
SIA Inactive mound of Western Pebble-mound Mouse

Appendix C2 Birds

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2013)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hammersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	West Turner Section 10 (Biota 2009)	Brockman Syncline 4 (Biota 2005)	Solomon Project - rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (ecoscope 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninox 1995)	NatureMap	DEC Rare Fauna	DSEWPaC Protected Matters Search	Birdata	This survey	
		EPBC Act	WC Act	DPaW																											
CASUARIIDAE																															
<i>Dromaius novaehollandiae</i>	Emu				•	•	•	•	•		•	•			•	•			•	•				•	•					•	
PHASIANIDAE																															
<i>Coturnix pectoralis</i>	Stubble Quail				•	•		•					•						•						•						
<i>Coturnix ypsilophora</i>	Brown Quail				•	•				•			•						•						•						
ANATIDAE																															
<i>Dendrocygna eytoni</i>	Plumed Whistling-duck				•	•		•		•															•						
<i>Cygnus atratus</i>	Black Swan									•		•																			
<i>Chenonetta jubata</i>	Australian Wood Duck				•	•				•	•	•										•			•						
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck								•			•													•						
<i>Anas gracilis</i>	Grey Teal				•	•		•		•		•			•										•						
<i>Anas superciliosa</i>	Pacific Black Duck				•	•		•		•		•			•										•						
<i>Aythya australis</i>	Hardhead											•													•						
PODICIPEDIDAE																															
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe									•		•													•						
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe											•													•						
COLUMBIDAE																															
* <i>Columba livia</i>	Rock Dove																														
<i>Phaps chalcoptera</i>	Common Bronzewing				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Phaps histrionica</i>	Flock Bronzewing											•																			
<i>Ocyphaps lophotes</i>	Crested Pigeon				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Geophaps plumifera</i>	Spinifex Pigeon				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Geopelia cuneata</i>	Diamond Dove				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Geopelia striata</i>	Peaceful Dove				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
PODARGIDAE																															
<i>Podargus strigoides</i>	Tawny Frogmouth				•	•						•	•						•	•					•						
EUROSTOPODIDAE																															
<i>Eurostopodus argus</i>	Spotted Nightjar				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
AEGOTHELIDAE																															
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar				•	•	•	•	•	•	•	•	•						•						•						
APODIDAE																															
<i>Apus pacificus</i>	Fork-tailed Swift	M	S3		•	•						•													•	•	•				
ANHINGIDAE																															
<i>Anhinga novaehollandiae</i>	Australasian Darter											•																			
PHALACROCORACIDAE																															
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant											•	•								•				•						
<i>Phalacrocorax carbo</i>	Great Cormorant											•																			
<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant									•															•						

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2013)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hammersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	West Turner Section 10 (Biota 2009)	Brockman Syncline 4 (Biota 2005)	Solomon Project – rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (ecologia 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninox 1995)	NatureMap	DEC Rare Fauna	DSEWPoC Protected Matters Search	Birdata	This survey	
		EPBC Act	WC Act	DPaW																											
<i>Ninox novaeseelandiae</i>	Southern Boobook				•	•			•	•		•	•					•					•					•			
TYTONIDAE																															
<i>Tyto javanica</i>	Eastern Barn Owl				•							•			•				•							•			•		
HALCYONIDAE																															
<i>Dacelo leachii</i>	Blue-winged Kookaburra				•	•	•	•		•		•	•		•			•		•			•		•			•			
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher				•	•	•	•	•	•	•	•	•	•	•			•		•		•		•		•		•			
<i>Todiramphus sanctus</i>	Sacred Kingfisher				•	•				•	•	•	•					•		•			•	•	•			•			
MEROPIIDAE																															
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S3		•	•	•	•	•	•		•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	
CLIMACTERIDAE																															
<i>Climacteris melanura</i>	Black-tailed Treecreeper				•	•	•			•		•			•				•	•					•	•					
PTILINORHYNCHIDAE																															
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird				•	•	•	•		•	•	•	•	•	•			•		•	•				•			•	•		
MALURIDAE																															
<i>Malurus leucopterus</i>	White-winged Fairy-wren				•	•	•	•		•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Malurus lamberti</i>	Variagated Fairy-wren				•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Stipiturus ruficeps</i>	Rufous-crowned Emu-wren				•	•				•		•	•	•	•				•					•		•		•			
<i>Amytornis striatus</i>	Striated Grasswren				•	•	•	•		•	•	•	•	•	•			•				•		•	•	•		•			
ACANTHIZIDAE																															
<i>Pyrrholaemus brunneus</i>	Redthroat						•					•														•			•		
<i>Smicronis brevirostris</i>	Weebill				•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Gerygone fusca</i>	Western Gerygone				•	•	•	•	•	•	•	•	•	•	•				•		•		•	•	•	•	•	•	•	•	
<i>Acanthiza robustirostris</i>	Slaty-backed Thornbill				•	•		•	•			•													•			•			
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill				•							•	•			•	•		•						•			•			
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill				•	•	•	•	•		•	•	•	•	•				•					•		•		•			
<i>Acanthiza apicalis</i>	Inland Thornbill				•	•	•	•			•	•	•	•	•				•					•		•		•			
<i>Aphelocephala leucopsis</i>	Southern Whiteface												•												•			•			
PARDALOTIDAE																															
<i>Pardalotus rubricatus</i>	Red-browed Pardalote				•	•	•	•	•	•	•	•	•	•	•			•		•	•	•	•	•	•	•	•	•	•	•	
<i>Pardalotus striatus</i>	Striated Pardalote				•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	
MELIPHAGIDAE																															
<i>Certhionyx variegatus</i>	Pied Honeyeater				•	•	•	•		•	•	•	•	•					•			•		•		•		•			
<i>Lichenostomus virescens</i>	Singing Honeyeater				•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Lichenostomus keartlandi</i>	Grey-headed Honeyeater				•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Lichenostomus plumulus</i>	Grey-fronted Honeyeater																					•				•					
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater				•	•	•	•		•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Purnella albifrons</i>	White-fronted Honeyeater				•				•			•			•										•		•				
<i>Manorina flavigula</i>	Yellow-throated Miner				•	•	•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater				•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	
<i>Conopophila whitei</i>	Grey Honeyeater				•		•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2013)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hammersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	West Turner Section 10 (Biota 2009)	Brockman Syncline 4 (Biota 2005)	Solomon Project – rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (ecoscope 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninox 1995)	NatureMap	DEC Rare Fauna	DSEWPac Protected Matters Search	Birdata	This survey		
		EPBC Act	WC Act	DPaW																												
<i>Epthianura tricolor</i>	Crimson Chat				•	•		•	•	•	•	•			•				•						•			•				
<i>Sugomel niger</i>	Black Honeyeater				•	•		•	•	•	•	•														•						
<i>Lichmera indistincta</i>	Brown Honeyeater				•	•		•	•	•	•	•							•	•		•	•			•			•	•		
<i>Meliphreptus gularis</i>	Black-chinned Honeyeater				•	•		•	•	•	•	•							•	•	•					•			•			
POMATOSTOMIDAE																																
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler				•	•		•	•	•	•	•							•	•		•	•						•	•		
<i>Pomatostomus superciliosus</i>	White-browed Babbler				•																									•		
PSOPHODIDAE																																
<i>Cinclosoma castaneothorax</i>	Chestnut-breasted Quail-thrush				•																									•		
<i>Psophodes occidentalis</i>	Chiming Wedgebill																															
NEOSITTIDAE																																
<i>Daphoenositta chrysoptera</i>	Varied Sitella				•	•																										
CAMPEPHAGIDAE																																
<i>Coracina maxima</i>	Ground Cuckoo-shrike				•	•		•							•	•														•	•	
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Lalage sueurii</i>	White-winged Triller				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
PACHYCEPHALIDAE																																
<i>Pachycephala rufiventris</i>	Rufous Whistler				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Oreoica gutturalis</i>	Crested Bellbird				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
ARTAMIDAE																																
<i>Artamus personatus</i>	Masked Woodswallow				•	•		•	•	•	•	•	•																	•	•	
<i>Artamus cinereus</i>	Black-faced Woodswallow				•	•	•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Artamus minor</i>	Little Woodswallow				•	•		•	•	•	•	•	•						•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Cracticus torquatus</i>	Grey Butcherbird				•	•	•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Cracticus nigrogularis</i>	Pied Butcherbird				•	•	•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Cracticus tibicen</i>	Australian Magpie				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
RHIPIDURIDAE																																
<i>Rhipidura albiscapa</i>	Grey Fantail				•																											
<i>Rhipidura leucophrys</i>	Willie Wagtail				•	•	•	•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•
CORVIDAE																																
<i>Corvus bennetti</i>	Little Crow				•			•	•	•	•	•																				
<i>Corvus orru</i>	Torresian Crow				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
MONARCHIDAE																																
<i>Grallina cyanoleuca</i>	Magpie-lark				•	•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
PETROICIDAE																																
<i>Microeca fascians</i>	Jacky Winter																															
<i>Petroica goodenovii</i>	Red-capped Robin				•	•		•	•	•	•	•	•	•	•					•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Melanodryas cucullata</i>	Hooded Robin				•	•		•	•	•	•	•	•	•	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•
ALAUDIDAE																																
<i>Mirafrja javanica</i>	Horsfield's Bushlark				•	•		•	•	•	•	•	•	•	•																	

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		EPBC Act	WC Act	DPaW																											
ACROCEPHALIDAE																															
<i>Acrocephalus australis</i>	Australian Reed-Warbler				•					•		•																			
MEGALURIDAE																															
<i>Cincloramphus mathewsi</i>	Rufous Songlark				•	•	•	•		•		•			•			•	•							•				•	•
<i>Cincloramphus cruralis</i>	Brown Songlark				•	•		•		•	•	•		•	•			•	•							•				•	•
<i>Eremiornis carteri</i>	Spinifexbird				•	•	•	•	•	•	•	•	•	•	•			•	•	•	•	•	•	•	•					•	•
HIRUNDINIDAE																															
<i>Cheramoeca leucosterna</i>	White-backed Swallow						•				•																				
<i>Hirundo rustica</i>	Barn Swallow	M	S3																											•	
<i>Hirundo neoxena</i>	Welcome Swallow				•	•																				•					
<i>Petrochelidon ariel</i>	Fairy Martin				•	•		•		•	S	•			•											•				•	
<i>Petrochelidon nigricans</i>	Tree Martin				•	•	•	•		•	•	•			•			•								•				•	•
NECTARINIIDAE																															
<i>Dicaeum hirundinaceum</i>	Mistletoebird				•	•	•	•	•	•		•	•	•	•			•							•	•				•	•
ESTRILDIDAE																															
<i>Taeniopygia guttata</i>	Zebra Finch				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Neochmia ruficauda subclarescens</i>	Star Finch (western)				•					•	•	•							•							•	•			•	
<i>Emblema pictum</i>	Painted Finch				•	•	•	•		•	•	•	•	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•
PASSERIDAE																															
<i>*Passer montanus</i>	Eurasian Tree Sparrow																													•	
MOTACILLIDAE																															
<i>Anthus novaeseelandiae</i>	Australasian Pipit				•		•	•		•	•	•			•											•				•	

Appendix C3 Reptiles

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2013)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hammersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	West Turner Section 10 (Biota 2009)	Brockman Syncline 4 (Biota 2005)	Solomon Project – rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (Ecoscape 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninnox 1995)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																									
CHELUIDAE																													
<i>Chelodina steindachneri</i>	Flat-shelled Turtle									•																			
AGAMIDAE																													
<i>Amphibolurus longirostris</i>	Long-nosed Dragon				•	•	•	•	•	•	•	•	•	•	•	•			•	•		•	•	•	•	•		•	
<i>Caimanops amphiboluroides</i>	Mulga Dragon				•	•		•									•					•							
<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon				•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•		•	•	•	•		•	
<i>Ctenophorus isolepis</i>	Central Military Dragon				•	•		•	•	•	•	•	•	•	•	•		•	•	•	•		•	•	•	•		•	
<i>Ctenophorus nuchalis</i>	Central Netted Dragon									•	•													•					
<i>Ctenophorus reticulatus</i>	Western Netted Dragon				•			•	•	•	•														•				
<i>Diporiphora valens</i>					•	•		•	•	•	•	•	•	•	•	•					•		•						
<i>Diporiphora winneckeii</i>	Blue-lined Dragon							•																					
<i>Pogona minor</i>	Dwarf Bearded Dragon				•	•		•	•	•	•	•	•	•	•	•			•	•	•	•		•	•	•		•	
<i>Tympanocryptis cephalus</i>	Pebble Dragon				•	•		•	•	•	•													•					
DIPLODACTYLIDAE																													
<i>Crenadactylus ocellatus</i>	Clawless Gecko				•	•																						•	
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko				•	•		•		•									•			•						•	
<i>Diplodactylus galaxias</i>								•		•																			
<i>Diplodactylus pulcher</i>								•																				•	
<i>Diplodactylus savagei</i>					•	•		•	•	•	•	•	•	•	•	•			•					•				•	
<i>Lucasium stenodactylum</i>	Sand-plain Gecko				•	•		•		•	•	•	•	•	•	•			•	•	•	•		•	•	•		•	
<i>Lucasium wombeyi</i>					•	•		•	•	•	•	•	•	•	•	•			•					•				•	
<i>Oedura marmorata</i>	Marbled Velvet Gecko				•	•		•	•	•	•	•	•	•	•	•			•		•	•		•	•	•		•	
<i>Rhynchoedura ornata</i>	Beaked Gecko				•	•		•		•											•							•	
<i>Strophurus elderi</i>	Jewelled Gecko				•	•		•		•	•	•	•	•	•	•			•		•	•		•	•	•		•	
<i>Strophurus jeanae</i>								•																					
<i>Strophurus strophurus</i>	Western Spiny-tailed Gecko				•	•																							
<i>Strophurus wellingtonae</i>					•	•	S	•		•	•	•	•	•	•	•			•									•	
CARPHODACTYLIDAE																													
<i>Nephurus wheeleri</i>	Banded Knob-tailed Gecko				•	•	S	•	•	•	•	•	•	•	•	•			•	•	•							•	
<i>Underwoodisaurus seorsus</i>	Barking Gecko							•																				•	
GEKKONIDAE																													
<i>Gehyra pilbara</i>					•	•				•	•	•	•	•	•	•			•	•	•				•			•	
<i>Gehyra punctata</i>					•	•		•	•	•	•	•	•	•	•	•			•	•	•			•				•	
<i>Gehyra variegata</i>	Tree Dtella				•	•		•	•	•	•	•	•	•	•	•			•	•	•			•				•	
<i>Heteronotia binoei</i>	Bynoe's Gecko				•	•		•	•	•	•	•	•	•	•	•			•	•	•			•				•	
<i>Heteronotia spelea</i>	Desert Cave Gecko				•	•				•	•	•	•	•	•	•			•					•				•	
PYGOPODIDAE																													
<i>Delma butleri</i>					•	•			•																			•	
<i>Delma elegans</i>					•	•		•		•	•	•	•	•	•	•			•					•				•	
<i>Delma haroldi</i>										•																		•	
<i>Delma nasuta</i>					•	•		•	•	•	•	•	•	•	•	•			•	•	•			•				•	
<i>Delma pax</i>					•	•		•		•	•	•	•	•	•	•			•	•	•			•				•	

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		EPBC Act	WC Act	DPaW																									
<i>Delma tinctoria</i>					•	•		•	•	•		•	•	•	•			•	•						•				
<i>Lialis burtonis</i>	Burton's Snake-lizard				•	•	S	•	•	•		•	•	•	•			•	•				•						
<i>Pygopus nigriceps</i>	Western Hooded Scaly-foot				•	•		•				•	•		•			•								•			
SCINCIDAE																													
<i>Carlia munda</i>					•	•	•	•	•	•			•	•	•			•	•							•			•
<i>Carlia triacantha</i>					•	•		•	•	•			•	•				•	•							•			•
<i>Cryptoblepharus buchananii</i>					•	•		•	◊			◊	◊		◊			◊				•				•			
<i>Cryptoblepharus ustulatus</i>					•	•			◊			◊	◊		◊			◊				•				•			
<i>Ctenotus duricola</i>					•	•		•	•	•		•	•	•	•			•	•	•						•			
<i>Ctenotus grandis</i>					•	•			•	•				•	•			•	•	•						•			
<i>Ctenotus hanloni</i>								•																		•			
<i>Ctenotus helenae</i>					•	•		•	•	•		•	•	•	•		•	•								•			
<i>Ctenotus leonhardii</i>					•	•												•	•							•			
<i>Ctenotus pantherinus</i>	Leopard Ctenotus				•	•		•	•	•		•	•	•	•			•	•	•						•			•
<i>Ctenotus robustus</i>	Eastern Striped Skink				•	•			•	•								•	•							•			•
<i>Ctenotus rubicundus</i>					•	•	•		•					•	•			•	•							•			
<i>Ctenotus rutilans</i>					•	•		•							•			•	•							•			
<i>Ctenotus saxatilis</i>	Rock Ctenotus				•	•	•	•	•	•		•	•	•	•			•	•					•		•			•
<i>Ctenotus schomburgkii</i>					•	•		•				•	•	•	•			•	•							•			
<i>Ctenotus serventyi</i>					•	•						•	•					•	•							•			
<i>Ctenotus severus</i>												†														•			
<i>Ctenotus uber</i>								•																		•			•
<i>Cyclodomorphus melanops</i>	Spinifex Slender Blue-tongue				•	•		•	•	•		•	•	•	•			•	•							•			•
<i>Egernia cygnitos</i>					•			•	•										•							•			
<i>Egernia formosa</i>					•	•		•																		•			
<i>Egernia pilbarensis</i>					•													•								•			
<i>Eremiascincus fasciolatus</i>	Narrow-banded Sand-swimmer				•	•																				•			
<i>Eremiascincus isolepis</i>																													
<i>Eremiascincus richardsonii</i>	Broad-banded Sand-swimmer				•	•																				•			
<i>Lerista flammicauda</i>					•			•						•												•			
<i>Lerista jacksoni</i>	(<i>L. muelleri</i> group)				•	•							•	•												•			
<i>Lerista muelleri</i>					•	•		•				•	•		•				•	•						•			
<i>Lerista timida</i>								•																					
<i>Lerista verhmens</i>					•														•										
<i>Lerista zietzi</i>					•	•							•						•	•						•			
<i>Menetia greyii</i>					•	•		•			•	•	•	•	•				•	•						•			
<i>Menetia surda</i>					•	•		•				•	•	•	•				•	•						•			
<i>Morethia ruficauda</i>					•	•	•	•	•	•		•	•	•	•				•	•	•					•			•

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		EPBC Act	WC Act	DPaW																									
<i>Notoscincus butleri</i>				P4	•	•				•				•	•			•							•	•			
<i>Notoscincus ornatus</i>					•			•											•						•	•			
<i>Prooblepharus reginae</i>					•			•		•									•	•					•	•			
<i>Tiliqua multifasciata</i>	Centralian Blue-tongue				•	•		•	•	•			•	•	•		•	•	•	•					•	•			
VARANIDAE																													
<i>Varanus acanthurus</i>	Spiny-tailed Monitor				•	•		•	•	•			•	•	•			•	•					•	•				•
<i>Varanus breviceauda</i>	Short-tailed Pygmy Monitor				•	•		•	•	•			•	•	•			•	•					•	•				
<i>Varanus bushi</i>	Pilbara Monitor				•	•		•	•	•			•	•	•			•	•					•	•				
<i>Varanus caudolineatus</i>	Stripe-tailed Monitor				•			•		•			•					•	•					•	•				
<i>Varanus eremius</i>	Pygmy Desert Monitor				•	•		•	•	•			•		•			•	•					•	•				
<i>Varanus giganteus</i>	Perentie				•		S	•		•			•	•	•		•	•	•	•									
<i>Varanus gilleni</i>	Pygmy Mulga Monitor				•					•			•					•	•						•	•			
<i>Varanus gouldii</i>	Gould's Monitor				•					•			•					•	•					•	•				
<i>Varanus panoptes</i>	Yellow-spotted Monitor				•	•		•	•	•			•	•	•			•	•					•	•				
<i>Varanus pilbarensis</i>	Pilbara Rock Monitor				•	•		•		•			•	•	•			•	•					•	•				
<i>Varanus tristis</i>	Black-headed Monitor				•	•		•		•			•	•	•			•	•					•	•				
TYPHLOPIDAE																													
<i>Ramphotyphlops ammodytes</i>					•	•				•				•				•	•					•	•				
<i>Ramphotyphlops ganei</i>				P1	•	•		•	•									•	•					•	•				
<i>Ramphotyphlops grypus</i>	Beaked Blind Snake				•	•		•	•	•			•	•	•			•	•					•	•				
<i>Ramphotyphlops hamatus</i>													•						•					•	•				
<i>Ramphotyphlops pilbarensis</i>	Pilbara Blind Snake				•	•		•		•			•		•			•	•					•	•				
<i>Ramphotyphlops waitii</i>													•						•					•	•				
BOIDAE																													
<i>Antaresia perthensis</i>	Pygmy Python				•	•				•			•	•				•	•					•	•				•
<i>Antaresia stimsoni</i>	Stimson's Python				•	•	•	•	•	•			•	•				•	•					•	•				•
<i>Aspidites melanocephalus</i>	Black-headed Python				•	•				•			•					•	•					•	•				•
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S1	VU	•	•	S			•			•	•				•	•				•	•			•	•	•
ELAPIDAE																													
<i>Acanthophis pyrrhus</i>	Desert Death Adder												•	•															
<i>Acanthophis wellsi</i>	Pilbara Death Adder				•	•		•					•						•					•	•				
<i>Brachyuropsis approximans</i>	NW Shovel-nosed Snake				•	•		•		•			•	•	•			•	•					•	•				
<i>Demansia psammophis</i>	Yellow-faced Whipsnake				•	•		•	•	•			•	•	•			•	•					•	•				•
<i>Demansia rufescens</i>	Rufous Whipsnake				•	•		•	•	•			•	•	•			•	•					•	•				
<i>Furina ornata</i>	Moon Snake				•	•		•		•			•	•	•			•	•					•	•				
<i>Parasuta monachus</i>	Monk Snake				•	•		•		•			•	•	•			•	•					•	•				
<i>Pseudechis australis</i>	Mulga Snake				•	•	S	•		•			•	•	•			•	•					•	•				

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2013)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hamersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	West Turner Section 10 (Biota 2009)	Brockman Syncline 4 (Biota 2005)	Solomon Project – rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (Ecoscape 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninox 1995)	NatureMap	DPaW Rare Fauna	DSEWPaC Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																									
<i>Pseudonaja mengdeni</i>	Gwardar				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Pseudonaja modesta</i>	Ringed Brown Snake				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Suta fasciata</i>	Rosen's Snake				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Suta punctata</i>	Little Spotted Snake				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
<i>Vermicella snelli</i>	Pilbara Bandy Bandy				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Abbreviations:

S Recorded by secondary evidence (e.g. scat, burrow, mound, feather, track)

† Species recorded just outside project area

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

Appendix C4 Amphibians

Family and Species	Common name	Conservation Status			ecologia Internal Database	Central Pilbara Project: Mine (ecologia 2011)	Mt Macleod West Level 1 (Ecoscape 2011)	Solomon Hub (ecologia 2014)	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod Level 2 (ecologia 2013)	Central Pilbara Project: Rail (south) (ecologia 2011)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Hammersley Range (Muir 1983)	Firetail mining area (Ecoscape 2010)	Solomon Project – rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Brockman Syncline 4 (Biota 2005)	West Turner Section 10 (Biota 2009)	Marandoo to Great Northern Hwy (Kendrick 1995)	Raven (Ecoscape 2012)	Marandoo Mine (Biota 2008)	Eliwana and Flying Fish (Ecoscape 2012)	Western Range (Biota 2011)	Northern Transport Corridor (Ninox 1995)	NatureMap	DPaW Rare Fauna	DSEWPac Protected Matters Search	This survey
		EPBC Act	WC Act	DPaW																									
HYLIDAE																													
<i>Cyclorana maini</i>	Sheep Frog				•	•	•	•	•	•		•				•	•	•	•		•				•				
<i>Cyclorana platycephala</i>	Water-Holding Frog											•														•			
<i>Litoria rubella</i>	Little Red Tree Frog				•	•	•	•	•	•		•	•			•	•		•		•		•	•	•				•
LIMNODYNASTIDAE																													
<i>Notaden nicholli</i>	Desert Spadefoot										•																		
<i>Platyplectrum spenceri</i>	Centralian Burrowing Frog											•							•		•					•			
MYOBATRACHIDAE																													
<i>Pseudophryne douglasi</i>	Gorge Toadlet					•						•														•			
<i>Uperoleia sglandulosa</i>	Glandular Toadlet															•										•			
<i>Uperoleia saxatilis</i>	Northwest Toadlet				•	•	•			•		•				•										•			
BUFONIDAE																													
<i>Bufo marinus</i>	Cane Toad																									•			

Appendix C5 Fish

Family and Species	Common name	Conservation Status			ecologia Internal Database	Mt Macleod Level 2 (Rapallo 2011)	Mt Macleod West Level 1 (Ecoscape 2011)	Marandoo to Great Northern Hwy (Kendrick 1995)	Firetail mining area (Ecoscape 2010)	Solomon Project - rail re-alignment (Ecoscape 2010)	Solomon Project - rail camps (Ecoscape 2010)	Solomon Project Area (Coffey 2008)	Hammersley Range (Muir 1983)	Marandoo Mine (Biota 2008)	West Turner Section 10 (Biota 2009)	Brockman 2 Detritals Transport Corridor (Mattiske and Ninnox 1990)	Brockman Syncline 4 (Biota 2005)	Northern Transport Corridor (Ninox 1995)	Raven (Ecoscape 2012)	Western Range (Biota 2011)	Eliwana and Flying Fish (Ecoscape 2012)	NatureMap	DPaWRare Fauna	DSEWPac Protected Matters Search	Mt Macleod (ecologia in prep)	This survey
		EPBC Act	WC Act	DPaW																						
CLUPEIDAE																										
<i>Nematalosa erebi</i>	Bony Bream																									
MELANOENIIDAE																										
<i>Melanotaenia australis</i>	Western Rainbowfish				•																					
PLOTOSIDAE																										
<i>Neosilurus hyrtli</i>	Hyrtil's Tandan				•																					
TERAPONTIDAE																										
<i>Amniataba percoides</i>	Barred Grunter				•																					
<i>Leiopotherapon aheneus</i>	Fortescue Grunter			P4																						
<i>Leiopotherapon unicolor</i>	Spangled Perch				•																					

APPENDIX D SITE DESCRIPTIONS

Vegetation and Fauna Habitat Description	Site Photo
<p>Site ST S1 Moderately dense <i>Triodia</i> hummock grassland with open <i>Acacia</i> spp. Soil substrate consists of firm reddish-brown sand-clay with numerous loose rocks. Habitat type: Hummock grassland</p>	
<p>Site ST S2 Open <i>Acacia pruinocarpa</i> and <i>A. binevosa</i> with <i>Senna glutinosa</i> shrubland over <i>Triodia wiseana</i> hummock grassland. Soil substrate consists of strong reddish-brown sand-clay with continuous loose pebbles and stones. Habitat type: Plain (stony gibber)</p>	

Site ST S3

Open *Themeda* grassland on cracking clays. Soil substrate consists of loose reddish-brown clay with few rocks.

Habitat type: Plain (cracking clay)



Site ST S4

Creek bed with large pools. Open *Eucalyptus camaldulensis* woodland over scattered mixed *Acacia* over grazed moderately dense *Cenchrus ciliaris* on soft clay. Sparse wood litter and sparse leaf litter.

Habitat type: Drainage line/river/creek



Site ST S5

Rocky spinifex hill with open *Acacia inaequilatera* and *A. aneura* over moderately dense spinifex on rocky loam. Sparse wood litter and sparse leaf litter.

Habitat type: Hummock grassland



Site ST S6

Creek bed with large pools and adjacent *Acacia* shrubland. *Eucalypt victrix* over moderately dense *Cenchrus ciliaris* and dense *Acacia xiphophylla* over open spinifex on loamy clay with pebbles. Sparse wood litter and sparse leaf litter.

Habitat type: Drainage line/river/creek



Site ST S7

Open *Themeda* grassland on cracking clays. Soil substrate consists of loose reddish-brown clay with few rocks.

Habitat type: Plain (cracking clay)



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APPENDIX E SPECIES RECORDED DURING SAMPLING

Appendix E1 Mammals

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
DASYURIDAE															
<i>Dasykaluta rosamundae</i>	Kaluta				2				1			1	1		
<i>Ningau timealeyi</i>	Pilbara Ningau				1				2	1	2	1			
<i>Planigale sp.</i>									3			1	3		1
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart						1	1		1		5		3	
MACROPODIDAE															
<i>Macropus rufus</i>	Red Kangaroo														1
MEGADERMATIDAE															
<i>Macroderma gigas</i>	Ghost Bat			P4								A		A	
HIPPOSIDERIDAE															
<i>Rhinonictis aurantia</i> (Pilbara form)	Pilbara Leaf-nosed Bat	VU	S1	VU				A							
EMBALLONURIDAE															
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat									A					
<i>Taphozous georgianus</i>	Common Sheathtail Bat						A	A						A	
<i>Taphozous hilli</i>	Hill's Sheathtail Bat							A							
MOLOSSIDAE															
<i>Chaerephon jobensis</i>	Northern Freetail Bat				A	A		A		A		A	A	A	
<i>Mormopterus beccarii</i>	Beccari's Freetail Bat							A		A		A			
VESPERTILIONIDAE															
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat				A	A		A		A		A	A		A
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat									A		A			
<i>Scotorepens greyii</i>	Little Broad-nosed Bat							A		A		A		A	A

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
<i>Vespardelus finlaysoni</i>	Finlayson's Cave Bat					A		A		A		A		A	
MURIDAE															
<i>Leggadina lakedownensis</i>	Short-tailed Mouse			P4				2						8	
<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse			P4											S
<i>Pseudomys desertor</i>	Desert Mouse				2								2		
<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse									1		1			
INTRODUCED MAMMALS															
* <i>Mus musculus</i>	House mouse							2				1	1		1
* <i>Felis catus</i>	Cat														1

Abbreviations:

S - secondary evidence recorded (i.e. scat, burrow, mound, feather, carcass)

A - species recorded based on echolocation call characteristics

Appendix E2 Birds

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
PHASIANIDAE															
<i>Coturnix pectoralis</i>	Stubble Quail							1		2					
<i>Coturnix ypsilophora</i>	Brown Quail									1					
ANATIDAE															
<i>Dendrocygna eytoni</i>	Plumed Whistling-Duck												2		
<i>Chenonetta jubata</i>	Australian Wood Duck											2			
<i>Anas gracilis</i>	Grey Teal							2							
<i>Anas superciliosa</i>	Pacific Black Duck							2				1			
COLUMBIDAE															
<i>Ocyphaps lophotes</i>	Crested Pigeon				6		13	4	6	3	6	4	6	8	
<i>Geophaps plumifera</i>	Spinifex Pigeon				6								2		
<i>Geopelia cuneata</i>	Diamond Dove							9		32	3	23	5		
<i>Geopelia striata</i>	Peaceful Dove								1	3					
PODARGIDAE															
<i>Podargus strigoides</i>	Tawny Frogmouth								1						
EUROSTOPODIDAE															
<i>Eurostopodus argus</i>	Spotted Nightjar													1	1
ARDEIDAE															
<i>Ardea pacifica</i>	White-necked Heron						1								
<i>Egretta novaehollandiae</i>	White-faced Heron						2					5			
ACCIPITRIDAE															
<i>Elanus axillaris</i>	Black-shouldered Kite						2								

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
<i>Haliastur sphenurus</i>	Whistling Kite						5			1	1	9	5	1	
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk							4	3						
<i>Circus assimilis</i>	Spotted Harrier											1			
<i>Aquila audax</i>	Wedge-tailed Eagle					1					1				
FALCONIDAE															
<i>Falco cenchroides</i>	Nankeen Kestrel								1			3	1	4	
<i>Falco berigora</i>	Brown Falcon					1	2		1			3		3	
OTIDIDAE															
<i>Ardeotis australis</i>	Australian Bustard			P4			1					3		1	4
CHARADRIIDAE															
<i>Euseyonis melanops</i>	Black-fronted Dotterel									3		2	1		
<i>Vanellus tricolor</i>	Banded Lapwing											4			
TURNICIDAE															
<i>Turnix velox</i>	Little Button-quail						3	1		4	4	18		3	
CACATUIDAE															
<i>Eolophus roseicapillus</i>	Galah						21	8	2		2	2	3	19	
<i>Cacatua sanguinea</i>	Little Corella								2	300	1	4	6	7	
<i>Nymphicus hollandicus</i>	Cockatiel						3	5		4	6	34	6	22	
PSITTACIDAE															
<i>Barnardius zonarius</i>	Australian Ringneck				3	8	7	9	3		1	2	2	6	
<i>Melopsittacus undulatus</i>	Budgerigar						19	16	3	10	6	321	6		
CUCULIDAE															
<i>Chalcites basalus</i>	Horsfield's Bronze-cuckoo							1							

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
<i>Cacomantis pallidus</i>	Pallid Cuckoo									2		1			
HALCYONIDAE															
<i>Dacelo leachii</i>	Blue-winged Kookaburra							1				1			
<i>Todiramphus pyrrophygius</i>	Red-backed Kingfisher							2		2	4	1			
<i>Todiramphus sanctus</i>	Sacred Kingfisher							6							
MEROPIIDAE															
<i>Merops ornatus</i>	Rainbow Bee-eater	M	S3		1		1								
PTILINORHYNCHIDAE															
<i>Ptilonorhynchus guttatus</i>	Western Bowerbird									1				1	
MALURIDAE															
<i>Malurus lamberti</i>	Variiegated Fairy-wren				12	3		6			1				
<i>Malurus leucopterus</i>	White-winged Fairy-wren						13			2	1	1			
ACANTHIZIDAE															
<i>Smicrornis brevirostris</i>	Weebill				3	34	4	16	6	2	4	6	2	3	
<i>Gerygone fusca</i>	Western Gerygone					4	1	1	6		6				
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill								3		3				
<i>Acanthiza apicalis</i>	Inland Thornbill							1							
PARDALOTIDAE															
<i>Pardalotus rubricatus</i>	Red-browed Pardalote				1							8	2		
<i>Pardalotus striatus</i>	Striated Pardalote					15			2		3				
MELIPHAGIDAE															
<i>Lichenostomus virescens</i>	Singing Honeyeater				2	4	1	1	2	8	6			3	
<i>Lichenostomus keartlandi</i>	Grey-headed Honeyeater				2	9						7			

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater						4			5		3	3		1
<i>Manorina flavigula</i>	Yellow-throated Miner						2	6	2	2	2	19	6	3	
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater				1		3		1		6				
<i>Epthianura tricolor</i>	Crimson Chat									4					
<i>Lichmera indistincta</i>	Brown Honeyeater				3	2	2			3	1			2	
POMATOSTOMIDAE															
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler				3	6		16	3	2	5		3		
CAMPEPHAGIDAE															
<i>Coracina maxima</i>	Ground Cuckoo-shrike				2										
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				1		2	10	2		1	8	2		
<i>Lalage sueurii</i>	White-winged Triller						2	2		7		10			
PACHYCEPHALIDAE															
<i>Pachycephala rufiventris</i>	Rufous Whistler				3	4	5	18	6	3	6				
<i>Colluricincla harmonica</i>	Grey Shrike-thrush					8				1	1				
<i>Oreoica gutturalis</i>	Crested Bellbird				2	4		3	2	3	5				
ARTAMIDAE															
<i>Artamus personatus</i>	Masked Woodswallow				4										
<i>Artamus cinereus</i>	Black-faced Woodswallow				3		13			16		8	1		
<i>Artamus minor</i>	Little Woodswallow											4			
<i>Cracticus nigrogularis</i>	Pied Butcherbird				2		3	9	4		3	4	1	1	
<i>Cracticus tibicen</i>	Australian Magpie							12	1			7	1	1	
RHIPIDURIDAE															
<i>Rhipidura leucophrys</i>	Willie Wagtail				5	1	2	3	5	5	6	2	5	4	

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
CORVIDAE															
<i>Corvus orru</i>	Torresian Crow				3	2		3	6		3	4	3	5	
MONARCHIDAE															
<i>Gallina cyanoleuca</i>	Magpie-lark						2	20	5			35	5	4	
PETROICIDAE															
<i>Petroica goodenovii</i>	Red-capped Robin								3						
<i>Melanodryas cucullata</i>	Hooded Robin								1						1
ALAUDIDAE															
<i>Mirafrja javanica</i>	Horsfield's Bushlark						7			5		3		6	
MEGALURIDAE															
<i>Cincloramphus mathewsi</i>	Rufous Songlark						1	5		48	1	29	3		
<i>Cincloramphus cruralis</i>	Brown Songlark									6		20			
<i>Eremiornis carteri</i>	Spinifexbird				8		1				5				
HIRUNDINIDAE															
<i>Petrochelidon ariel</i>	Fairy Martin									6					
<i>Petrochelidon nigricans</i>	Tree Martin						1			1		9	5	4	
NECTARINIIDAE															
<i>Dicaeum hirundinaceum</i>	Mistletoebird						1		2						
ESTRILDIDAE															
<i>Taeniopygia guttata</i>	Zebra Finch				2	8	77	16		74	6	14	6	18	
<i>Neochmia ruficauda subclaescens</i>	Star Finch (western)			P4											21
<i>Emblema pictum</i>	Painted Finch					2				2					

Appendix E3 Reptiles

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
DIPODACTYLIDAE															
<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko					1	1				3				
<i>Diplodactylus savagei</i>								1							
<i>Lucasium stenodactylum</i>	Sand-plain Gecko									2					
<i>Lucasium wombeyi</i>										2					
<i>Strophurus wellingtonae</i>	Western Spiny-tailed Gecko														2
GEKKONIDAE															
<i>Gehyra pilbara</i>															2
<i>Gehyra variegata</i>								8	7		4	1	1		2
<i>Heteronotia binoei</i>	Bynoe's Gecko									3	3				1
CARPHODACTYLIDAE															
<i>Nephurus wheeleri</i>	Banded Knob-tailed Gecko					1					1				
PYGOPODIDAE															
<i>Delma nasuta</i>					1										
<i>Delma tincta</i>										1	1		1		
<i>Pygopus nigriceps</i>	Western Hooded Scaly-foot										2				
SCINCIDAE															
<i>Carlia munda</i>					1			1	2	14	3	1	4		1
<i>Carlia triacantha</i>								2						1	
<i>Ctenotus grandis</i>								1							
<i>Ctenotus helena</i>								1	3	27	10	3			
<i>Ctenotus pantherinus</i>	Leopard Ctenotus					2				8	13				1

Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
<i>Ctenotus robustus</i>	Eastern Striped Skink						1			9		19	6		1
<i>Ctenotus saxatilis</i>	Rock Ctenotus									4	1	2			2
<i>Ctenotus uber</i>						1									
<i>Cyclodomorphus melanops</i>	Spinifex Slender Blue-tongue									6	1	1			1
<i>Eremiascincus fasciolatus</i>	Narrow-banded Sand-swimmer									3					
<i>Eremiascincus richardsonii</i>	Broad-banded Sand-swimmer										6				
<i>Lerista jacksoni</i>													1		
<i>Lerista muelleri</i>								1							
<i>Menetia greyii</i>								4		3		1	3		1
<i>Morethia ruficauda exquisita</i>														1	
<i>Tiliqua multifasciata</i>	Centralian Blue-tongue									5					
AGAMIDAE															
<i>Amphibolurus longirostris</i>	Long-nosed Dragon									2	1				1
<i>Ctenophorus caudicinctus</i>	Ring-tailed Dragon					2		1		1	1				1
<i>Ctenophorus isolepis</i>	Central Military Dragon				1										1
<i>Ctenophorus nuchalis</i>	Central Netted Dragon														1
<i>Pogona minor</i>	Dwarf Bearded Dragon														1
<i>Tympanocryptis cephalo</i>	Pebble Dragon							3							
VARANIDAE															
<i>Varanus acanthurus</i>	Spiny-tailed Monitor									2	1				1
<i>Varanus brevicauda</i>	Short-tailed Pygmy Monitor									1					
<i>Varanus eremius</i>	Pygmy Desert Monitor				1					1					
<i>Varanus panoptes</i>	Yellow-spotted Monitor											1			

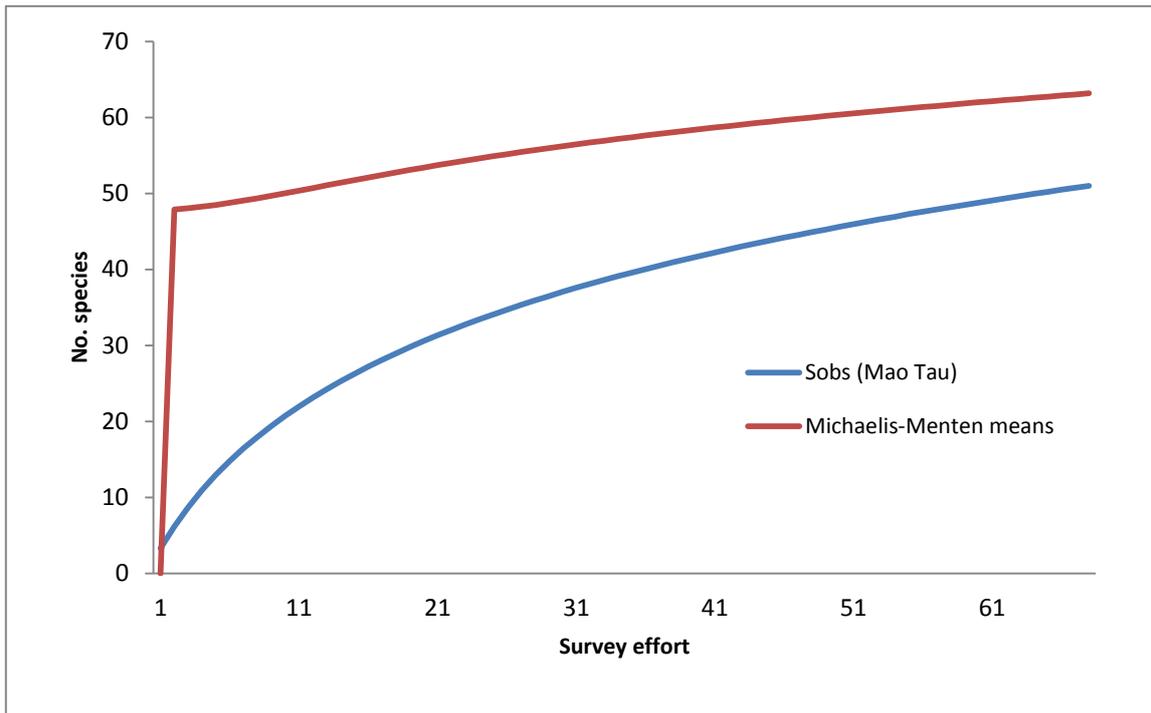
Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
TYPHLOPIDAE															
<i>Ramphotyphlops ammodytes</i>						1									
<i>Ramphotyphlops grypus</i>	Beaked Blind Snake											1			
PYTHONIDAE															
<i>Antaresia perthensis</i>	Pygmy Python														2
<i>Antaresia stimsoni</i>	Stimson's Python											1			1
<i>Aspidites melanocephalus</i>	Black-headed Python														1
ELAPIDAE															
<i>Demansia psammophis cupreiceps</i>	Yellow-faced Whipsnake					1		1	1			1	1		
<i>Parasuta monachus</i>	Monk Snake									1	1				
<i>Pseudechis australis</i>	Mulga Snake							1	1	1		2			
<i>Pseudonaja mengdeni</i>	Gwardar						1						1		
<i>Pseudonaja modesta</i>	Ringed Brown Snake						1								

Appendix E4 Amphibians

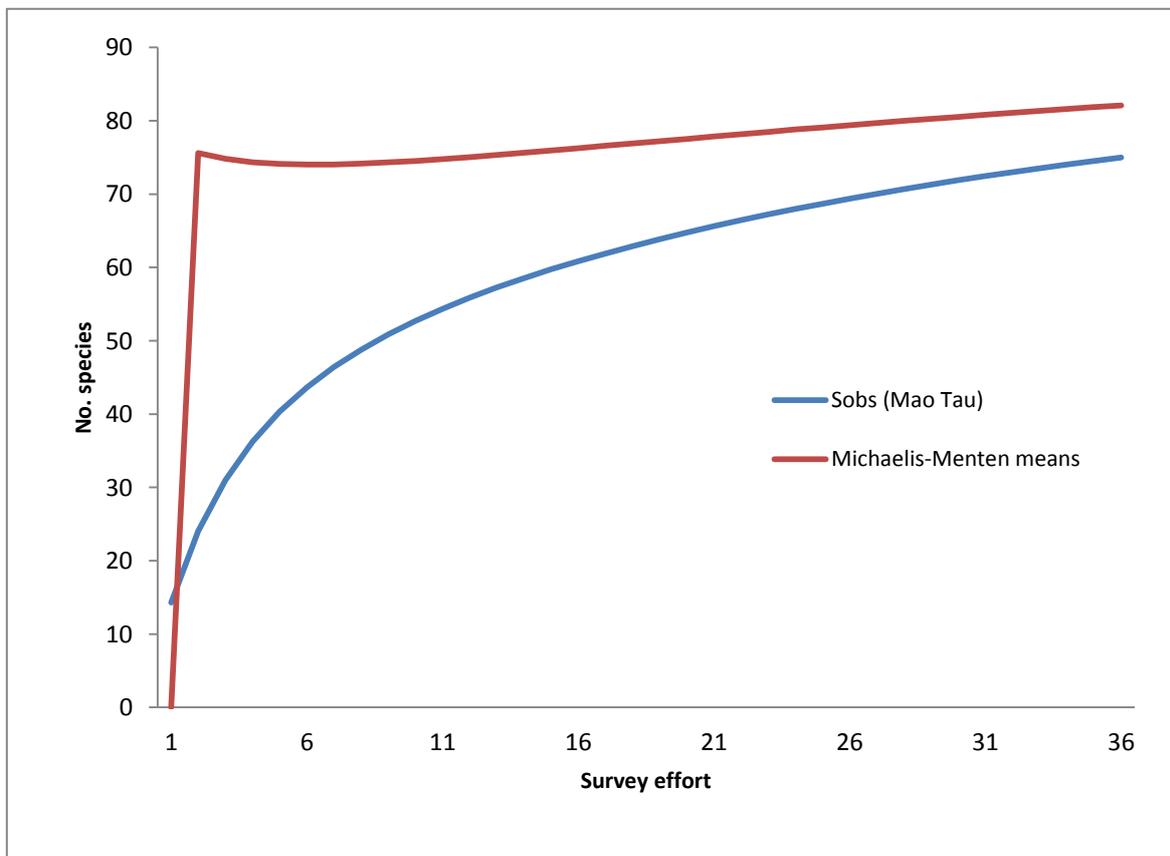
Family and Species	Common Name	Conservation Status			ST S1	ST S2	ST S3	ST S4		ST S5		ST S6		ST S7	Opportunistic
		EPBC Act	WC Act	DPaW	Ph 1	Ph 1	Ph 1	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	
HYLIDAE															
<i>Cyclorana maini</i>	Main's Frog							47		365		216			
<i>Litoria rubella</i>	Little Red Tree Frog					1		7							

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APPENDIX F SPECIES ACCUMULATION CURVES



Species accumulation curve for trapped terrestrial vertebrates



Species accumulation curve for avifauna