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FORTESCUE METALS GROUP
WESTERN HUB PROJECT - MT FARQUHAR
TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT

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FORTESCUE METALS GROUP LTD

WESTERN HUB PROJECT- MT FARQUHAR

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acronyms

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

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EXECUTIVE SUMMARY

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

The Survey Area is located on the southern edge of the western side of the Hamersley Range and covers a total of 9,562 ha (Figure 1.1). A Level 1 fauna assessment of the Survey Area was previously undertaken to identify the location and extent of fauna habitat types and areas that support conservation significant species. This information was reviewed and utilised to establish a survey design for the Level 2 vertebrate fauna assessment and targeted Northern Quoll and Pilbara Leaf-nosed Bat assessment, the results of which are summarised in this document.

During the current surveys, six fauna trapping sites were established across three habitat types and three land systems. Opportunistic searches were also undertaken at six additional sites located in habitat not suitable for trapping due to access limitations or difficulties in trap setup. A further six targeted Northern Quoll trapping sites were established during the targeted conservation significant fauna assessment.

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

- Trapping sites open for a total of 2,499 trapnights.
- Approximately 24 hours spent surveying for birds.
- 41.5 hours spent on opportunistic diurnal searching.
- Six hours spent on opportunistic nocturnal searching.
- 13 motion cameras deployed for a total of 1,008 hours.
- 300 hours of SM2BAT recordings wereanalysed to determine bat assemblage and distribution.

The main conclusions of the Mount Farquhar Level 2 vertebrate fauna and targeted conservation significant fauna assessment are:

- The survey methods were consistent with the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*; Guidance Statement No. 56; Position Statement No. 3; and the EPBC Act Survey Guidelines for Australia's Threatened Mammals, Reptiles, Bats and Birds, as well as Fortescue Metals Group's *Terrestrial Vertebrate Fauna Assessment Guidelines*. Species accumulation curves showed that the current survey was adequate overall, though with additional survey effort additional species would likely be recorded.
- The land systems, vegetation communities and habitats in the area support a moderately diverse group of fauna, including conservation significant fauna, but these are not restricted to the Survey Area.
- Four habitat types were identified within the Survey Area; hilltops, hillslopes, ridges and cliffs; footslopes and plains; major creeklines; and gorges and gullies.
- Statistical analyses of the terrestrial fauna data indicated that while the habitat types were different from each other, these were not large differences (the habitat types were not

discrete). Insufficient avifauna data were available to demonstrate statistically significant differences between the habitat types utilised by birds.

- A total of 16 native and four introduced mammal species, 56 bird species, 34 reptile species and two fish species were recorded within the Survey Area during the current surveys.
- Three vertebrate species of conservation significance were recorded within the Survey Area: Pilbara Leaf-nosed Bat, Peregrine Falcon and Rainbow Bee-eater. A further 13 conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the Survey Area.
- Several records were made of the Pilbara-endemic gecko *Underwoodisaurus seorsus*, a newly described taxon recently separated from the more southerly *U. milii*, which represent a westward extension of approximately 60 km to the species' currently known range. Whilst the species is not currently listed as conservation significant, its status has been recommended for review. Impacts on this local population could potentially result in a reduction of the species' range, representing a regional impact.
- Results from the targeted conservation significant fauna assessment did not reveal any significant roost sites for Pilbara Leaf-nosed Bat or Ghost Bat, and no Northern Quolls were trapped or observed. Inaccessible areas containing gorges and gullies that may potentially contain suitable denning and roosting habitat for Pilbara Leaf-nosed bat, Pilbara Olive Python and Northern Quoll have been mapped from aerial photography and based on the habitat assessments conducted during the Level 2 vertebrate fauna assessment.
- No major limitations on survey techniques were experienced, though access to some parts of the Survey Area was limited and mild weather conditions were experienced during the Level 2 vertebrate fauna assessment. These factors may have contributed to a reduced the capture rate of small mammals and herpetofauna.

1 INTRODUCTION

1.1 PROJECT OVERVIEW

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

The Survey Area is located on the southern edge of the western side of the Hamersley Range and covers a total of 9,562 ha (Figure 1.1). A Level 1 fauna assessment was previously undertaken by Ecoscape (2012d) to identify the location and extent of habitat types and areas that support conservation significant species. This information was reviewed and utilised to establish a survey design for the Level 2 vertebrate fauna assessment and targeted Northern Quoll and Pilbara Leaf-nosed Bat assessment, the results of which are summarised in this document.

1.2 LEGISLATIVE FRAMEWORK

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

- *The Precautionary Principle*

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

- *The Principle of Intergenerational Equity*

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

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

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

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

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

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

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

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

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

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

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

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

1.3 SURVEY OBJECTIVES

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

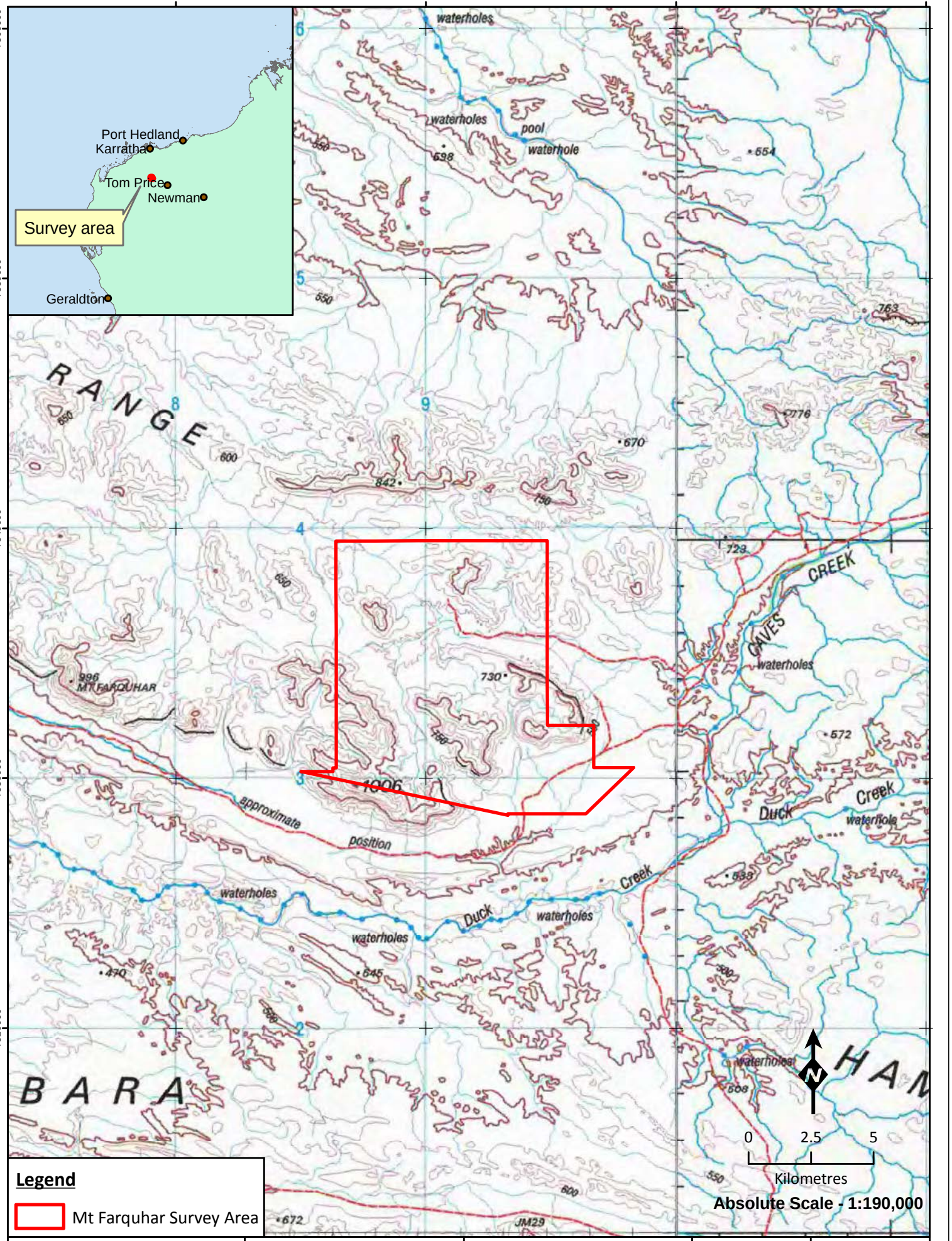
The EPA's objectives with regards to fauna management are to:

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

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

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

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



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FMG Fortescue The New Force in Iron Ore

Location of the Survey Area

Figure: 1.1	**Drawn: BG**
Project ID: 1446	**Date: 30/04/2012**

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

Unique Map ID: BG241

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2 EXISTING ENVIRONMENT

2.1 CLIMATE

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

The closest Bureau of Meteorology (BoM) weather station that is representative of the Survey Area and documents a full set of meteorological records (including current and historical rainfall and temperatures) is at Paraburdoo (station number 007185, 23°12' S, 117°40' E), approximately 125 km from the Survey Area. The Paraburdoo station provides climatic records closest to that experienced within the Survey Area, and its climate statistics are summarised in Figure 2.1 (BoM 2012).

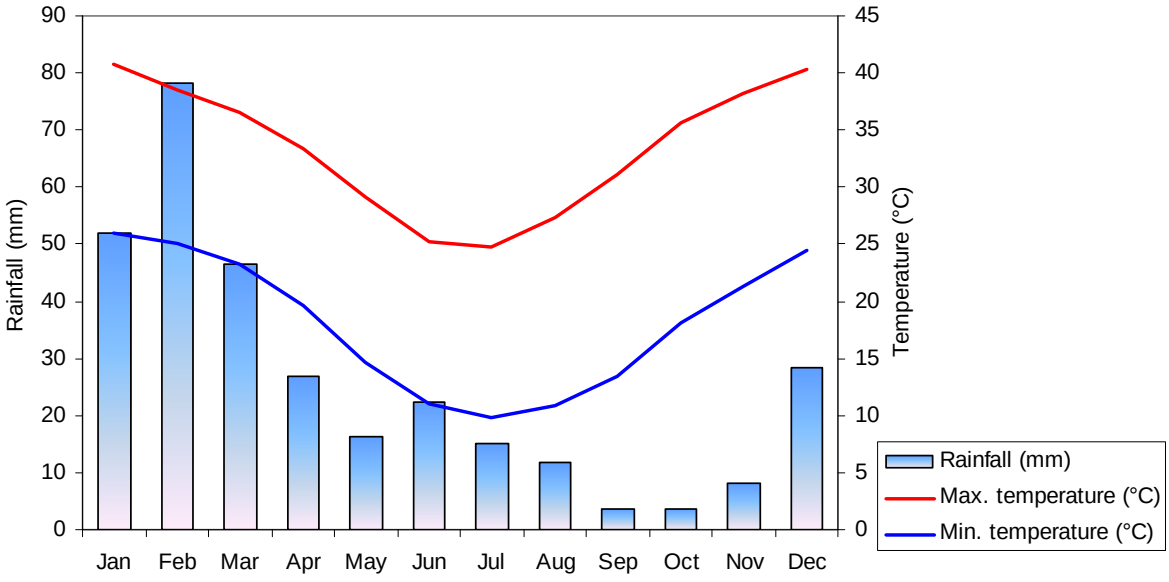


Figure 2.1 – Rainfall and temperature for the Paraburdoo weather station (BoM 2012)

2.2 WEATHER DURING SURVEY

Weather observations during the surveys were generally mild to warm during the day, with cool overnight temperatures and no rainfall. Weather data during the surveys has also been taken from the Paraburdoo weather station, providing an indication of the weather experienced during the surveys (BoM 2012). These data are shown in Appendix B.

The Level 2 vertebrate fauna assessment appears to have been completed during the transition of the autumn weather pattern to a more winter pattern. This is indicated by a steady decline in both daily maximum and minimum temperatures during the survey, with the final day of surveying (28/5/12) experiencing a daily minimum and maximum temperature of just 9.3 °C and 25.6 °C

respectively. The average minimum and maximum daily temperatures for the survey were 12 °C and 27.3 °C, respectively. The targeted conservation significant fauna assessment experienced typical winter conditions, with the average daily minimum and maximum temperatures being 10.1 °C and 24.8 °C, respectively.

2.3 BIOGEOGRAPHY

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

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

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

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

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

2.4 LAND SYSTEMS

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

The Survey Area contains three land systems mapped by van Vreeswyk *et al.* (2004). The predominant land system within the Survey Area is Newman (71.7 %). Platform and Boolgeeda land systems occupy 20.3% and 8%, respectively (Table 2.1, Figure 2.3).

The Newman land system comprises plateaus, ridges and mountains with hard spinifex grasslands. This land system occurs throughout the centre and majority of the Survey Area. Three areas of Platform land system occur within the Survey Area. The Platform land system is described as dissected slopes and raised plains supporting hard spinifex shrublands. The Boolgeeda land system occurs in the south-east and north-west corners of the Survey Area. It is described as stony lower slopes and plains below hill systems. It is dominated by soft spinifex grasslands or mulga shrublands (van Vreeswyk *et al.* 2004).

All three land systems recorded from the Survey Area are common in the region. The Platform land system has the largest percent of its total regional area within the Survey Area, at 0.82 % (Table 2.1).

Table 2.1 – Land systems of the Survey Area

Land System	Description	Total Area in WA (ha)	Area in Survey Area (ha)	Percent of Survey Area (%)	Percent of Total Land System (%)
Land system Type 2					
Newman	Rugged jaspilite plateaus, ridges and mountains supporting hard spinifex grasslands.	1,999,771.4	6,857	71.7	0.34
Land system Type 18					
Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	999,608.6	766	8.0	0.08
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands.	237,112.0	1,939	20.3	0.82

2.5 VEGETATION

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

The most common vegetation type in the Survey Area is the vegetation unit 82, which is found upon the rocky hills and ridges of the Survey Area. It occupies 5,675 ha, which equates to 59.4 % of the Survey Area. The lower slopes and valleys of the Survey Area are occupied by vegetation unit 569. This vegetation unit totals 3,887 ha, occupying the remaining 40.6% of the Survey Area.

Table 2.2 – Vegetation associations of the Survey Area

Shepherd Unit	Vegetation Description	Total Area in WA (ha)	Area in the Survey Area (ha)	Percent of Survey Area (%)	Percent of Total Vegetation Unit (%)
82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana.*	2,565,571.7	5,675	59.4	0.22
569	Hummock grasslands, low tree steppe; bloodwood over soft spinifex & *Triodia wiseana.*	102,296.8	3,887	40.6	3.80

2.6 PREVIOUS SURVEYS AND LAND USE

Several databases were consulted in the preparation of potential fauna (and conservation significant fauna) lists (Table 2.3). In addition, publications reporting on 20 vertebrate fauna assessments conducted within 120 km of the Survey Area were consulted (Table 2.4). The results of all database searches and previous surveys are presented in Appendix C. The online NatureMap database (DEC 2012) encompasses several datasets which include the Western Australian Museum, DEC threatened fauna database and DEC survey return database.

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

Database	Custodian	Search Details
NatureMap	DEC	Search co-ordinates: 22°17'55.83"S 116°54'44.99"E Distance searched (buffer): 40 km Date accessed: 17/4/2012
DEC Threatened Fauna Database	DEC	Records within 40 km of the Survey Area
Species Profile and Threats (SPRAT) Database	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)	Records within 50 km of the Survey Area
Birdata	BirdLife Australia	Records within 100 km of the Survey Area

Table 2.4 – Previous biological survey reports within 120 km of the Survey Area

Survey Location and Author(s)	Distance to Survey Area (km)	Comments
ecologia internal database	45-60	Two Level 1 fauna assessments and one two-phase Level 2 vertebrate fauna assessment
Mt Farquhar (Ecoscape 2012d)	0	Level 1 fauna assessment and targeted conservation significant fauna assessment
Delphine (*ecologia* in prep-a)	3	Single-phase Level 2 vertebrate fauna and targeted conservation significant fauna assessment
Delphine (Ecoscape 2012a)	5	Level 1 fauna and targeted conservation significant fauna assessment
Eliwana and Flying Fish (Ecoscape 2012b, c)	10	Level 1 fauna and targeted conservation significant fauna assessment
Eliwana and Flying Fish (*ecologia* in prep-b)	10	Single-phase Level 2 vertebrate fauna and targeted conservation significant fauna assessment
Raven (Ecoscape 2012e)	25	Level 1 fauna and targeted conservation significant fauna assessment
Brockman 2 Detritals (Mattiske and Ninox 1990)	40	Level 1 fauna assessment
Brockman Syncline (Biota 2005b)	40	Two-phase Level 2 vertebrate fauna assessment
West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	55-90	Two-phase Level 2 vertebrate fauna assessment
Central Pilbara Project (*ecologia* 2011b)	65	Two-phase Level 2 vertebrate fauna and targeted conservation significant fauna assessment
West Turner Section 10 (Biota 2009b)	80	Two-phase Level 2 vertebrate fauna assessment
Kings Area Assessment (*ecologia* 2010)	90	Single-phase Level 2 vertebrate fauna assessment
Mesa A and Mesa G (Biota 2005a)	95	Single-phase Level 2 vertebrate fauna assessment

Survey Location and Author(s)	Distance to Survey Area (km)	Comments
Mesa A transport corridor (Biota 2006)	80-120	Single-phase Level 2 vertebrate fauna assessment
Firetail mining area (Ecoscape 2010)	100	Single-phase Level 2 vertebrate fauna assessment
Marandoo to Great Northern Hwy (Kendrick 1995)	115	Single-phase Level 2 vertebrate fauna assessment

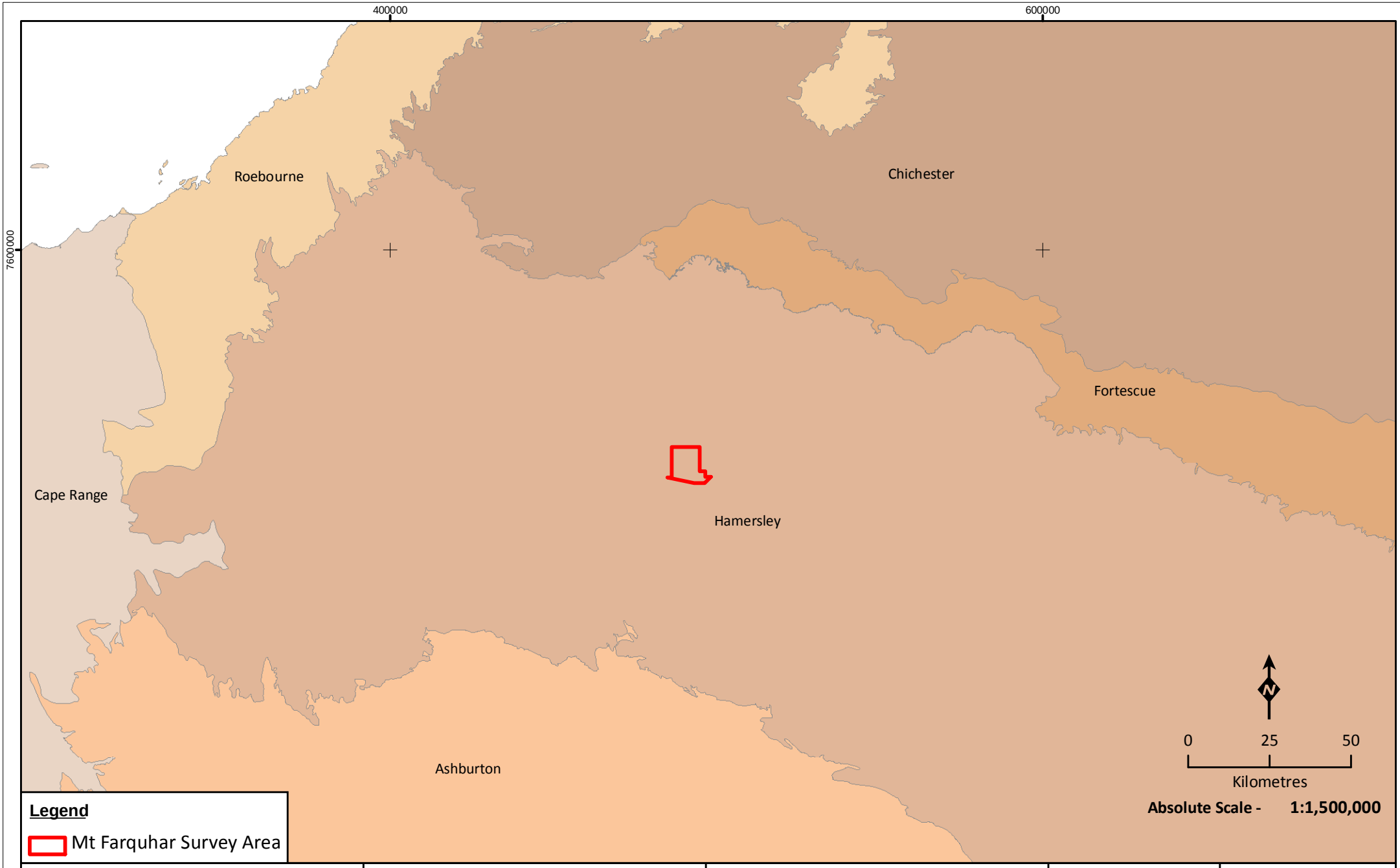
2.6.1 Results of literature review

The review of previous fauna assessments and database searches as described in Section 2.6 resulted in a total of 38 native mammal species, eight introduced mammal species, 150 bird species, 108 reptile species, seven amphibian species and six fish species potentially occurring in the Survey Area (Appendix C). Of these, 24 species are of conservation significance (six species of mammal, 14 species of bird, three species of reptile and one species of fish). Previous records of conservation significant fauna are mapped in Figure 2.5, Figure 2.6 and Figure 2.7 and discussed in greater detail in Section 5.3.

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

Source/Report	Mammals (Native/Introduced)	Birds	Reptiles	Amphibians	Fish
ecologia internal database records	18 / 5	76	63	0	0
Mt Farquhar (Ecoscape 2012d)	3 / 2	36	9	0	0
Delphine (Ecoscape 2012a)	3 / 4	44	5	1	2
Delphine (*ecologia* in prep-a)	22 / 4	100*	58	3	6
Eliwana and Flying Fish (Ecoscape 2012b, c)	4 / 4	38	1	0	0
Eliwana and Flying Fish (*ecologia* in prep-b)	19 / 5	76	60	2	1
Raven (Ecoscape 2012e)	3 / 0	36	7	0	0
Brockman 2 Detritals (Mattiske and Ninox 1990)	4 / 4	64	15	0	0
Brockman Syncline (Biota 2005b)	15 / 4	82	54	2	0
West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	22/ 4	78	59	3	0
Central Pilbara Project (*ecologia* 2011b)	24 / 4	99	84	4	0
West Turner Section 10 (Biota 2009b)	17 / 3	68	52	1	0
Kings Area Assessment (*ecologia* 2010)	21 /4	80	81	4	4
Mesa A and Mesa G (Biota 2005a)	10/ 1	52	31	0	0
Mesa A transport corridor (Biota 2006)	17 /2	93	60	3	0
Firetail mining area (Ecoscape 2010)	18 / 2	63	48	0	0
Marandoo to Great Northern Hwy (Kendrick 1995)	14 / 4	67	49	3	0
NatureMap	18 / 3	58	39	0	0
DEC Threatened Fauna Database	5 / 0	3	2	0	0
DSEWPaC Protected matters search	2 / 3	6	1	0	0
Birdata	-	122	-	-	-
Total	**38 / 8**	**150**	**108**	**7**	**6**

*Includes one introduced species



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FMG Fortescue The New Force in Iron Ore

Biogeographic regions of the Survey Area

Figure: 2.2
Project ID: 1446

Drawn: BG
Date: 17/07/12

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

Unique Map ID: BG249

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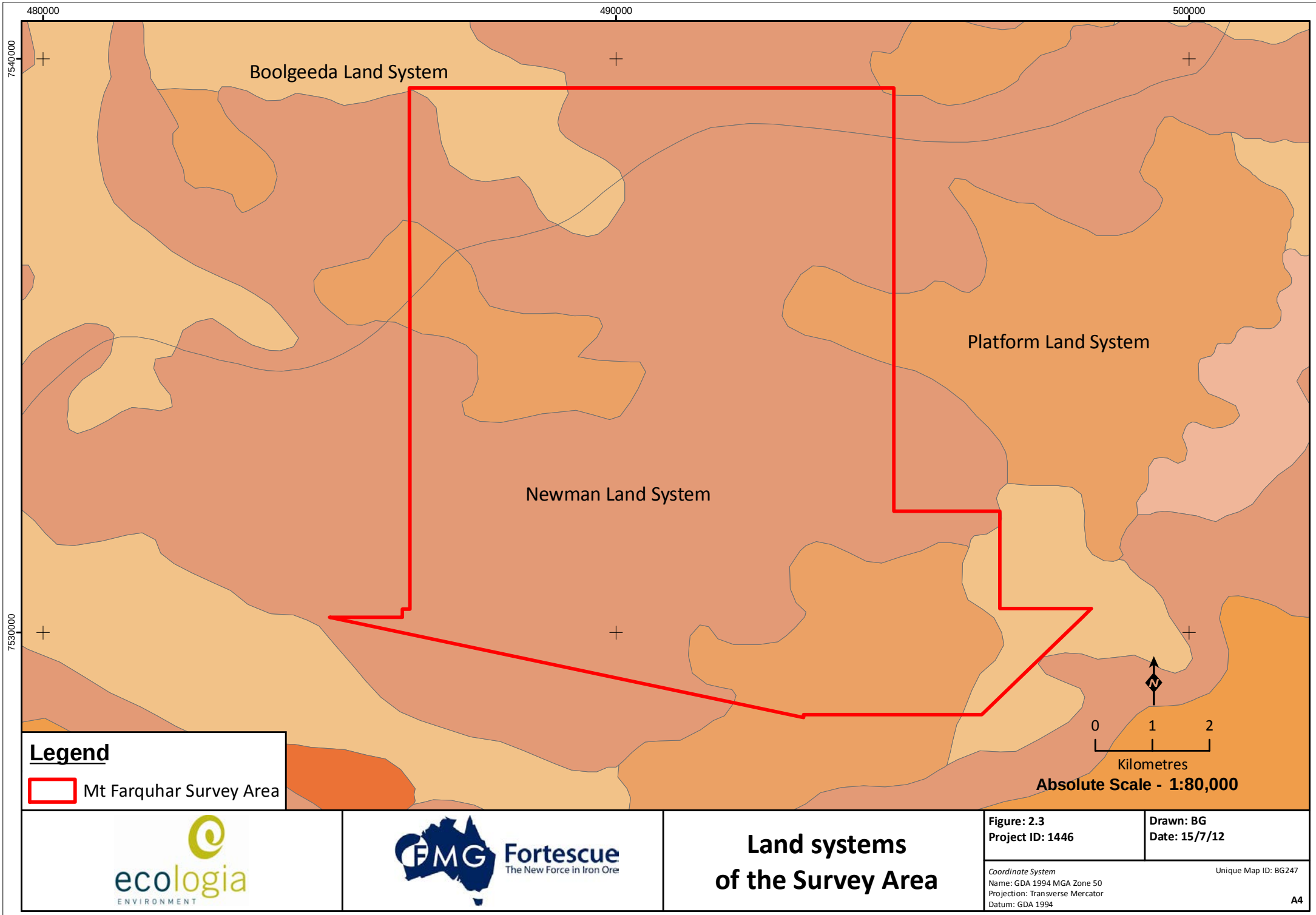

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FMG Fortescue The New Force in Iron Ore

Land systems of the Survey Area

Figure: 2.3
Project ID: 1446

Drawn: BG
Date: 15/7/12

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

Unique Map ID: BG247

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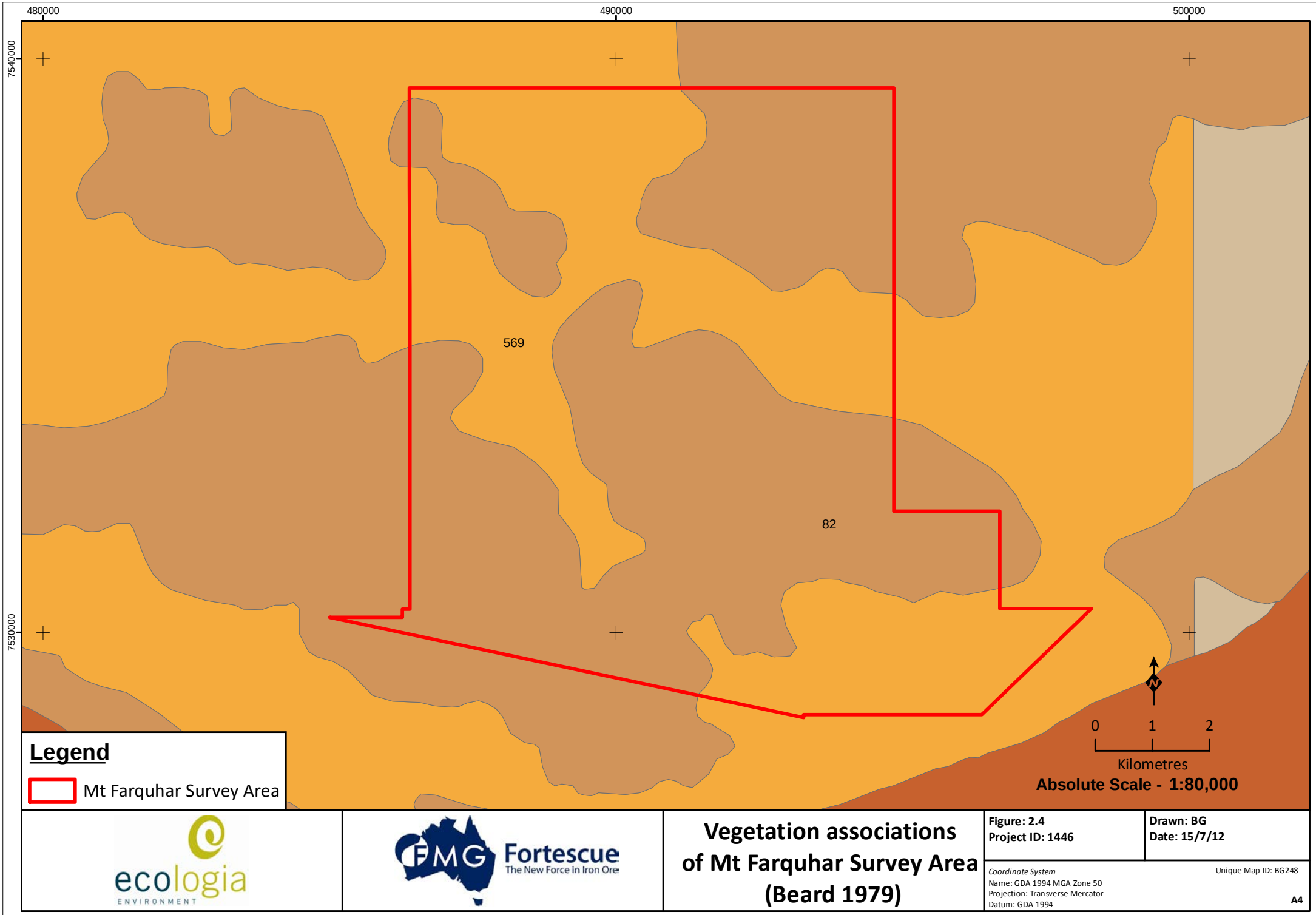

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FMG Fortescue The New Force in Iron Ore

Vegetation associations of Mt Farquhar Survey Area (Beard 1979)

Figure: 2.4
Project ID: 1446

Drawn: BG
Date: 15/7/12

Coordinate System
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Projection: Transverse Mercator
Datum: GDA 1994

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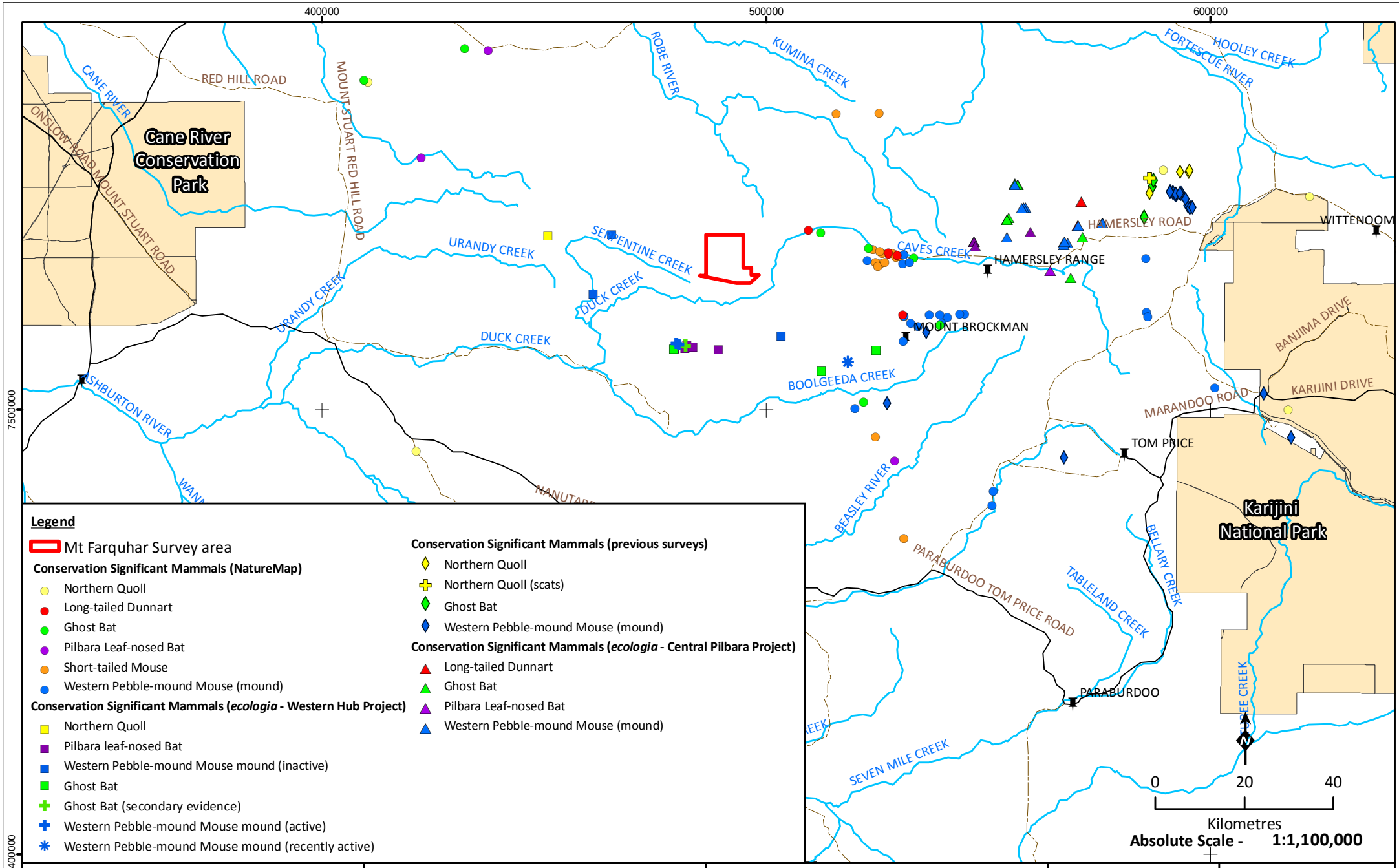

Legend

Mt Farquhar Survey area

Conservation Significant Mammals (NatureMap)

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

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

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

Conservation Significant Mammals (previous surveys)

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

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

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

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FMG Fortescue The New Force in Iron Ore

Regional records of conservation significant mammals

Figure: 2.5
Project ID: 1446

Drawn: AH
Date: 09/05/12

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

Unique Map ID: BG251

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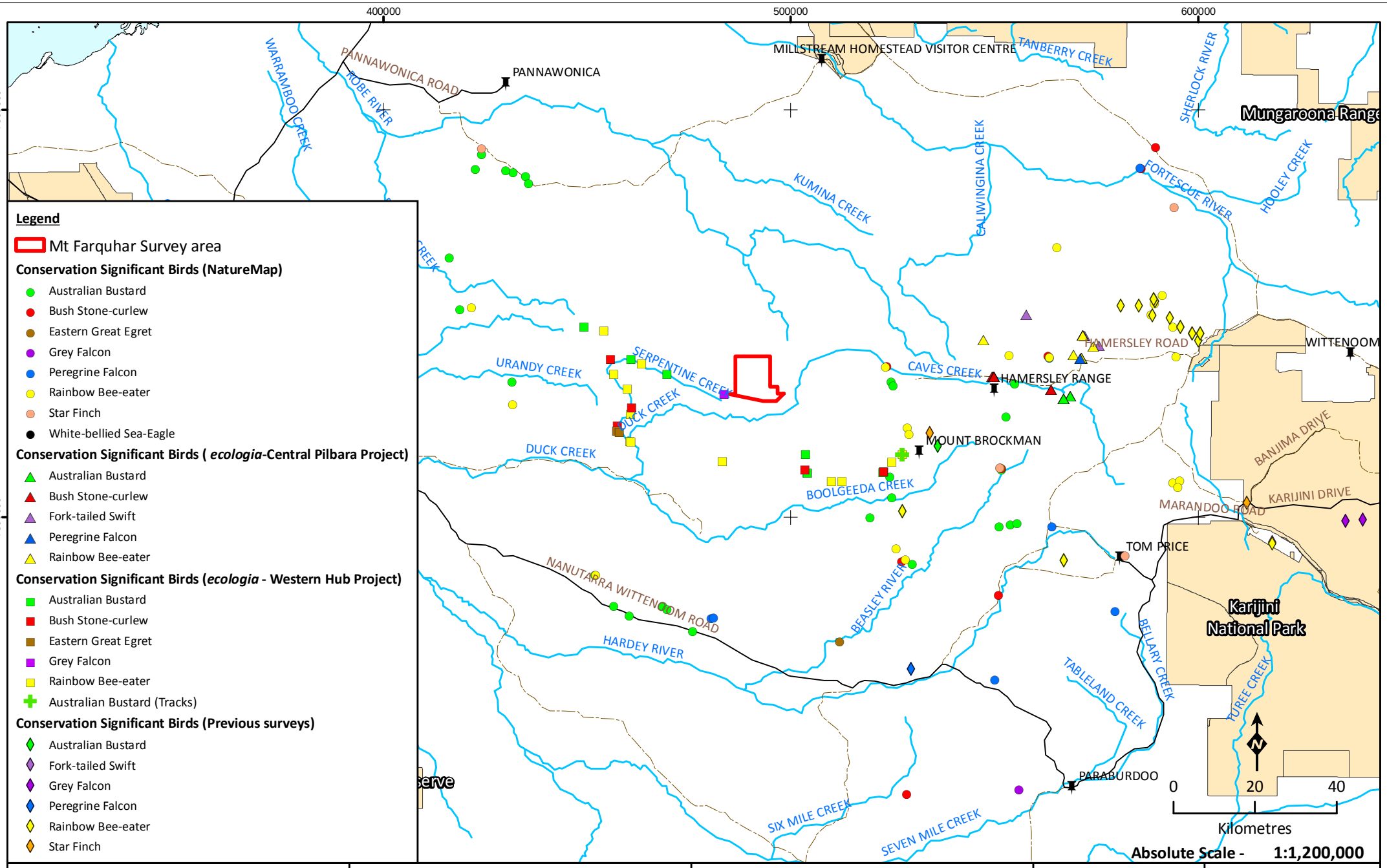

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Regional records of conservation significant fauna - birds

Figure: 2.6
Project ID: 1446

Drawn: AH
Date: 09/05/12

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

Unique Map ID: BG250

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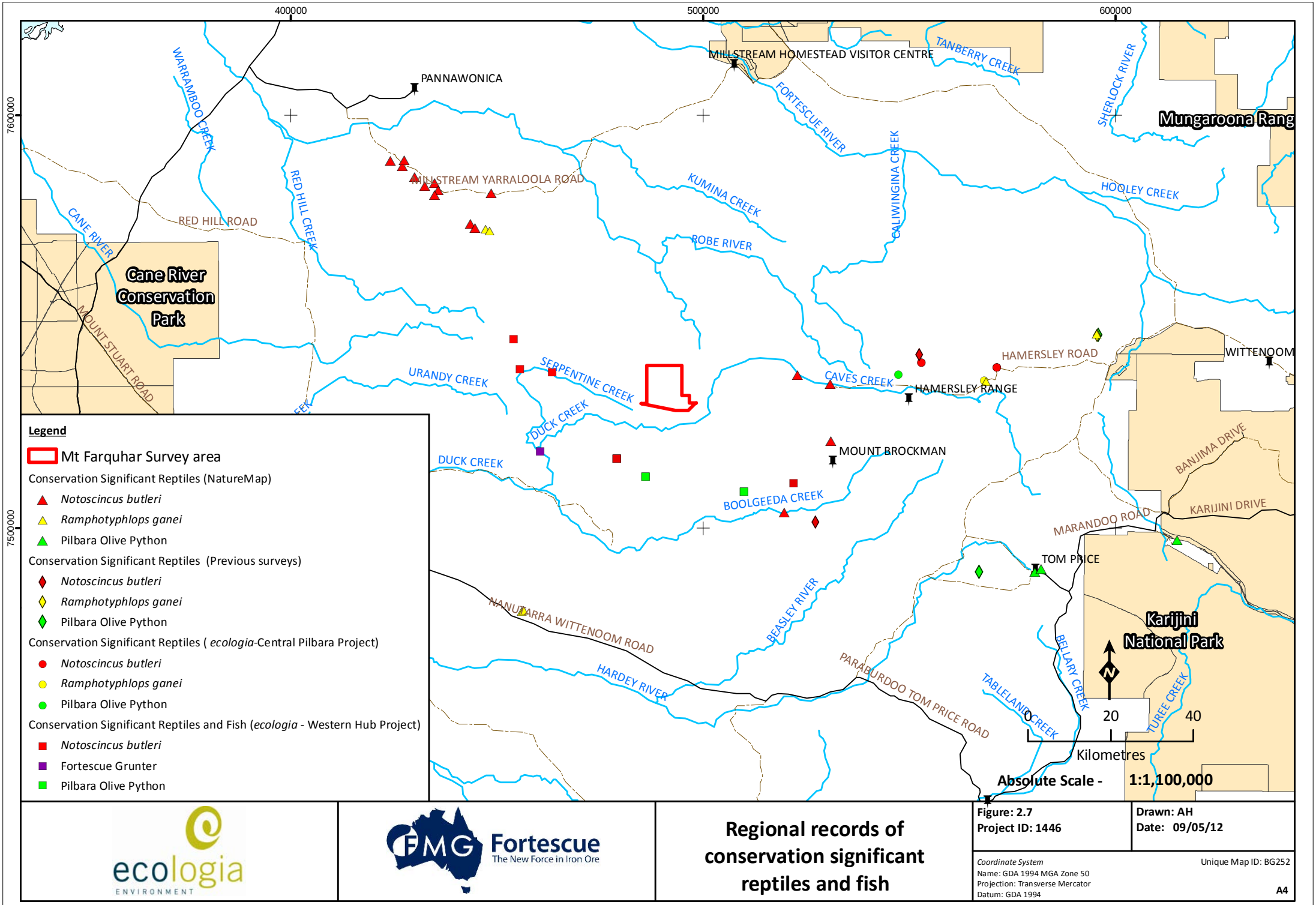

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Regional records of conservation significant reptiles and fish

Figure: 2.7
Project ID: 1446

Drawn: AH
Date: 09/05/12

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

Unique Map ID: BG252

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3 METHODS

3.1 DETERMINATION OF SURVEY SAMPLING DESIGN AND INTENSITY

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

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

Factor	Relevance
Bioregion – level of existing survey-knowledge of the region and associated ability to predict accurately.	The Pilbara bioregion (including the Hamersley subregion) has been well studied, and information was readily available.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The landforms associated with the Survey Area are typical for the region and do not present any rare or special characteristics.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present.	The best survey time for birds and amphibians is following seasonal rain events. Best survey timing for reptiles is from September to April. Survey timing for mammals is not constrained.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	20 previous terrestrial vertebrate fauna assessments have been carried out within 135 km of the Survey Area. Regional and local knowledge for the area is available.
Number of different habitats or degree of similarity between habitats within a Survey Area.	Four fauna habitat types were identified based on on-site observation, and mapped land systems and vegetation units. These were: hilltops, hillslopes, ridges and cliffs; footslopes and plains; river systems and gorges and gullies.
Climatic constraints (e.g. temperature or rainfall that preclude certain sampling methods).	The Pilbara region experiences hot summers with occasional cyclonic rain events, followed by warm winters with little rain. Rainfall is highly unpredictable.
Sensitivity of the environment to the proposed activities.	The Survey Area contains habitat types which are well represented in the surrounding region.
Size, shape and location of the proposed activities.	The Survey Area comprises the Mt Farquhar mining tenement and covers an area of 9562 ha.
Scale and impact of the proposal.	The scale and impact of the proposal was not known and did not influence the design of this survey.

3.2 SURVEY TIMING

The Level 2 vertebrate fauna assessment was conducted in autumn (18 - 28 May 2012). The targeted conservation significant fauna assessment was conducted in winter (12 - 20 July 2012). The survey timing was determined as per guidelines (DEWHA 2010a, b; DSEWPaC 2011a, b, c; EPA 2004; EPA and DEC 2010; FMG 2011).

Table 3.2 – Summary of survey timing and duration

Survey	Duration (days)	Person Days
Level 2 vertebrate fauna assessment	11	52
Targeted conservation significant fauna assessment	9	36
Total	**20**	**88**

3.3 SITE SELECTION

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

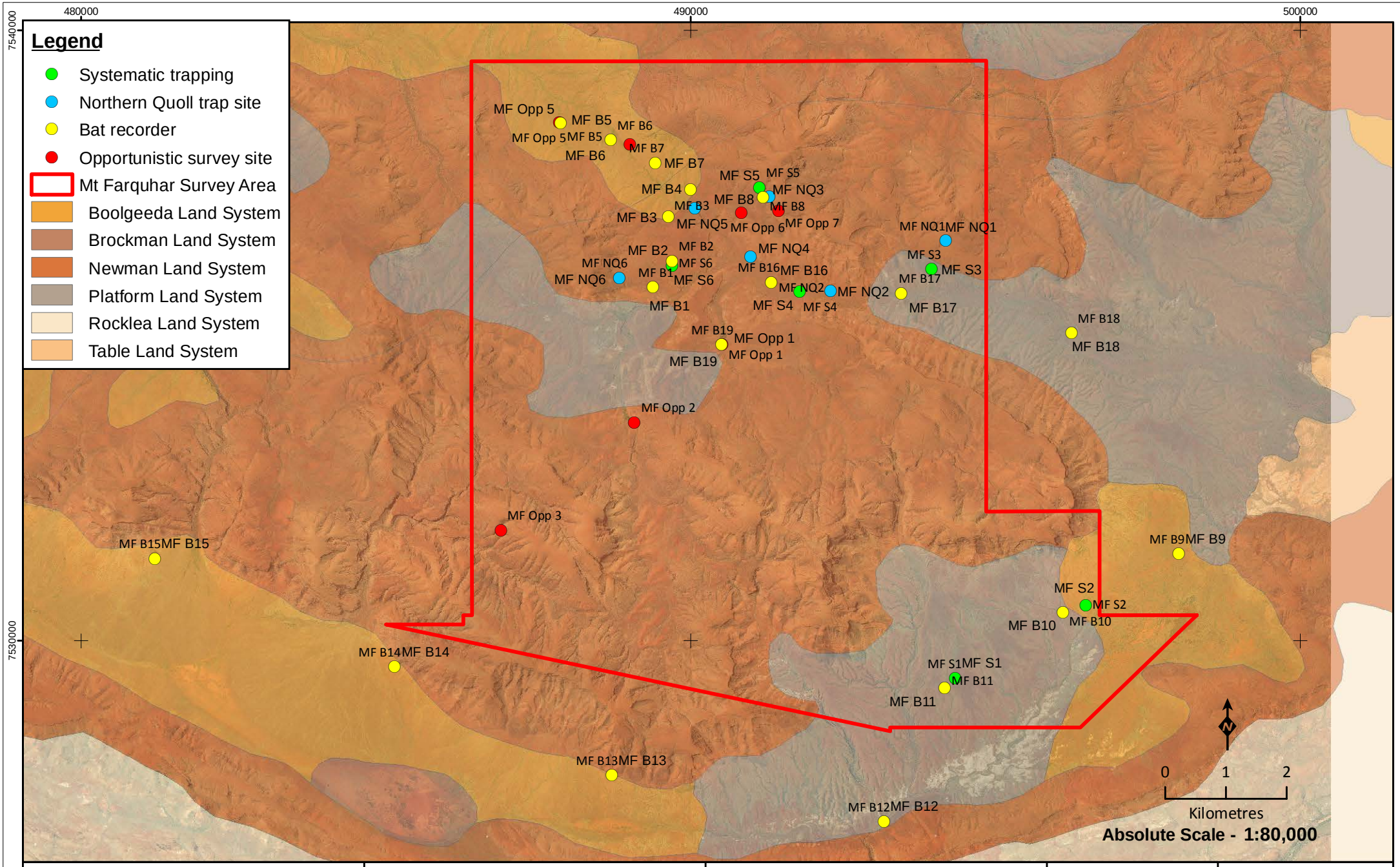
Habitat types poorly represented by systematic sampling sites were further targeted using opportunistic searches, targeting potentially sensitive habitats and habitat supporting conservation significant species. Locations and details of all survey sites are listed in Table 3.3 and mapped in Figure 3.1. Descriptions and photographs of systematically sampled sites are presented in Appendix D.

Table 3.3 – Survey site information

Site name	Survey site	Location		Land System
		Easting	Northing	
MF S1	Systematic trapping	494337	7529391	Platform
MF S2	Systematic trapping	496485	7530584	Boolgeeda
MF S3	Systematic trapping	493948	7536098	Platform
MF S4	Systematic trapping	491792	7535722	Newman
MF S5	Systematic trapping	491129	7537433	Newman
MF S6	Systematic trapping	489696	7536153	Newman
MF Opp 1	Opportunistic	490513	7534863	Newman
MF Opp 2	Opportunistic	489077	7533582	Newman
MF Opp 3	Opportunistic	486887	7531813	Newman
MF Opp 4	Opportunistic	489003	7538136	Boolgeeda
MF Opp 5	Opportunistic	487843	7538493	Boolgeeda
MF Opp 6	Opportunistic	490828	7537018	Newman
MF Opp 7	Opportunistic	491441	7537047	Newman
MF NQ1	Northern Quoll Trapping site	494181	7536557	Newman
MF NQ2	Northern Quoll Trapping site	492297	7535732	Newman
MF NQ3	Northern Quoll Trapping site	491286	7537279	Newman
MF NQ4	Northern Quoll Trapping site	490983	7536294	Newman
MF NQ5	Northern Quoll Trapping site	490071	7537087	Newman
MF NQ6	Northern Quoll Trapping site	488825	7535952	Newman
MF B1	Bat recorder	489383	7535792	Newman
MF B2	Bat recorder	489698	7536226	Newman
MF B3	Bat recorder	489628	7536956	Newman
MF B4	Bat recorder	489999	7537405	Boolgeeda
MF B5	Bat recorder	487862	7538490	Boolgeeda
MF B6	Bat recorder	488692	7538210	Boolgeeda
MF B7	Bat recorder	489423	7537831	Boolgeeda
MF B8	Bat recorder	491189	7537265	Newman
MF B9*	Bat recorder	498004	7531427	Boolgeeda

Site name	Survey site	Location		Land System
		Easting	Northing	
MF B10	Bat recorder	496106	7530470	Platform
MF B11	Bat recorder	494168	7529227	Platform
MF B12*	Bat recorder	493170	7527043	Platform
MF B13*	Bat recorder	488709	7527800	Boolgeeda
MF B14*	Bat recorder	485144	7529573	Boolgeeda
MF B15*	Bat recorder	481206	7531345	Boolgeeda
MF B16	Bat recorder	491316	7535879	Newman
MF B17	Bat recorder	493457	7535694	Platform
MF B18*	Bat recorder	496247	7535043	Platform
MF B19	Bat recorder	490504	7534855	Newman

Datum: GDA 94
Zone: 50K
* Bat recorders located outside the Survey Area (placed near Survey Area main access road at base of ridge).



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FMG Fortescue The New Force in Iron Ore

Location of fauna survey sites within the Survey Area

Figure: 3.1
Project ID: 1446

Drawn: BG
Date: 15/7/12

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

Unique Map ID: BG253

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3.4 CONSERVATION SIGNIFICANT FAUNA

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

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

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

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

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

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

3.5 SAMPLING METHODS

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

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

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

3.5.1 Systematic Sampling

Terrestrial Mammals and Herpetofauna

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

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

- Pit-trap and drift fence: Five PVC pipe (16 x 50 cm) and five 20 L plastic buckets (30 x 40 cm) were established at each site. A 10-m 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.

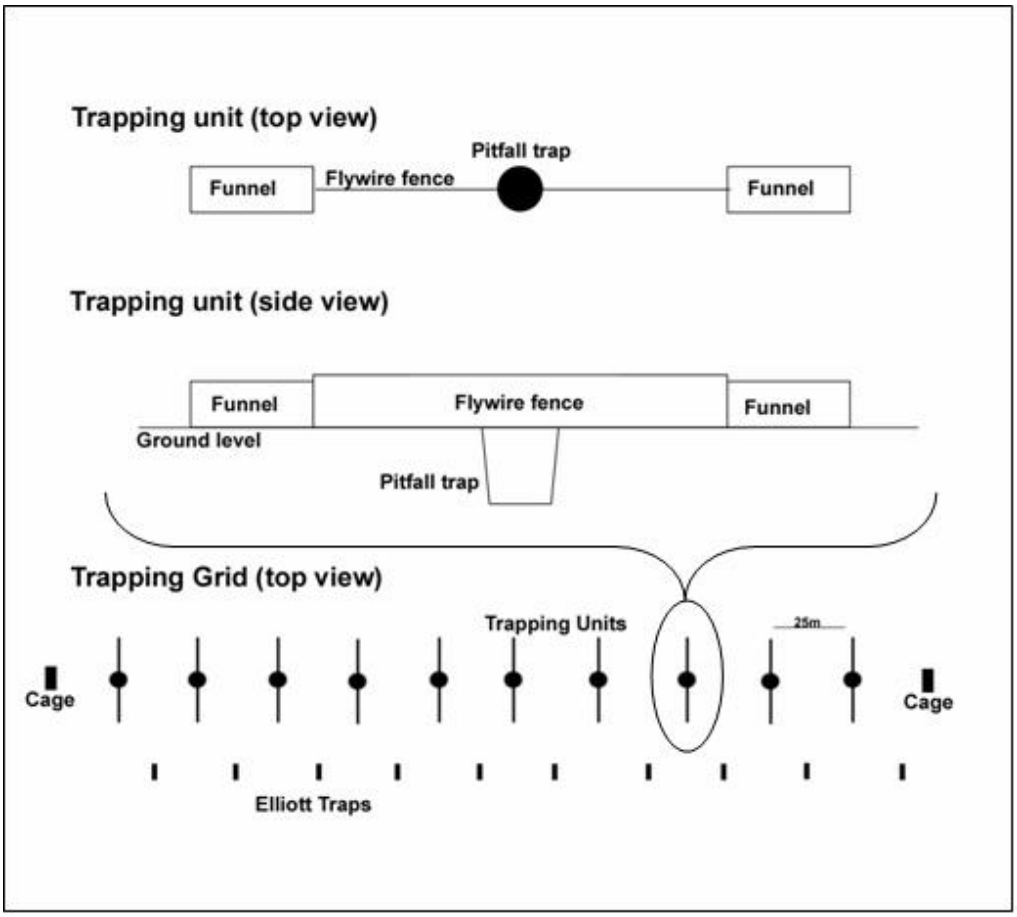

Figure 3.2 – Diagram of the systematic sampling trap arrangement

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 systematic fauna trapping sites. During each set-time survey an ornithologist recorded the number of individuals of each species observed while actively searching similar habitat within 500 m of the survey site. This is in accordance with survey methodology outlined in the Survey Guidelines for Australia's Threatened Birds (DSEWPaC 2011), as well as for the ongoing Birds Australia *Atlas of Australian Birds* project.

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

Bats

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

During the targeted Pilbara Leaf-nosed Bat survey, SM2BAT units were set up in linear transects, varying from approximately 1 to 5 km separation, some of which were set up along ridgelines presumed suitable to contain potential roost cave habitat, which bordered the Survey Area, but were situated just outside. By comparing the timing of calls recorded, an estimation of direction of flight patterns in bat species can be made. This is particularly focussed on the Pilbara Leaf-nosed Bat, where populations venture out from a roost cave location. Based on the temporal pattern of the calls, an estimation of the distance to the nearest roost cave location can be made. For example, two waves of clusters of calls recorded just following sunset and immediately before sunrise suggests a roost cave location is nearby, as bats venture out and return to their roost cave. In contrast, calls scattered over the middle of the night indicate foraging individuals.

3.5.2 Opportunistic Data

Nocturnal Searching

Areas of the Survey Area were searched at night using a combination of road transects and opportunistic ground searches using head torches to uncover nocturnal species, including geckos, snakes, frogs and birds. Each systematic trapping site was searched at night for a total of 60 minutes.

Diurnal Searching

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

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

Camera Trapping

A total of 13 motion sensor cameras (Bushnell Trophy Cam, model number 119415) were used in areas with a high likelihood of animal activity, such as water sources, to detect fauna species. The camera is triggered by movement by a highly sensitive passive infra-red motion sensor and functions day and night taking either video footage or photos (Bushnell Outdoor Products 2009).

Camera trapping was conducted in areas where systematic sampling sites were unable to be installed due to access constraints, which typically consisted of the gorges and gullies habitat, within the central areas of the Survey Area. Six cameras were deployed during the Level 2 vertebrate fauna assessment, and seven were deployed during the targeted conservation significant fauna assessment.

3.6 TARGETED CONSERVATION SIGNIFICANT FAUNA SURVEYING

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

On the basis of the habitats observed during surveying, specific searches were also undertaken to determine the presence of Northern Quoll, Pilbara Olive Python, Star Finch, Fortescue Grunter and Bush-stone Curlew.

3.7 SURVEY EFFORT

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

- Systematic trapping grids (pit traps, funnels, Elliott traps and cage traps) were open for 2,499 trap nights (during the Level 2 vertebrate fauna assessment).
- Targeted cage traps were open for 735 trap nights (targeted survey).
- Approximately 24 hours spent surveying for birds (during the Level 2 vertebrate fauna assessment).
- 41.5 hours spent on opportunistic diurnal searching (Level 2 vertebrate fauna and targeted conservation significant fauna assessments).
- Six hours spent on opportunistic nocturnal searching (Level 2 vertebrate fauna assessment).
- 13 motion-sensing cameras deployed for a total of 1,008 hours (total for both the Level 2 vertebrate fauna and targeted conservation significant fauna assessments).
- 300 hours of SM2BAT recordings were analysed to determine bat assemblage and distribution (Level 2 vertebrate fauna and targeted conservation significant fauna assessments).

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

- 29.8 hours conducting targeted searches for secondary evidence of the Northern Quoll were conducted primarily within gorges and gullies habitat type. 7 Motion cameras were set up in areas of identified suitable habitat for Northern Quoll.
- 29.8 hours conducting targeted searches for Pilbara Olive Python individuals and secondary evidence, primarily within the gorges and gullies habitat type.
- Six hours of opportunistic bird surveys for Star Finch at water pools.
- Six hours of fish trapping and searching for Fortescue Grunter at water pools.
- Two hours of call playback for Bush-stone Curlew conducted during nocturnal searches.

Table 3.4 – 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)	Camera Trapping (hours)
Level 2 Vertebrate Fauna Assessment									
MF S1	70	140	70	14	150	0	720	60	0
MF S2	70	140	70	14	150	0	720	60	0
MF S3	70	140	70	14	150	0	720	60	0
MF S4	70	140	70	14	150	0	720	60	0
MF S5	70	140	70	14	150	0	720	60	0
MF S6	70	140	70	14	150	0	720	60	0
Opportunistic	0	0	0	0	540	1,910	0	0	504
Targeted Conservation Significant Fauna Assessment									
MF NQ1	0	0	0	105	0	0	0	0	0
MF NQ2	0	0	0	140	0	0	0	0	0
MF NQ3	0	0	0	140	0	0	0	0	0
MF NQ4	0	0	0	105	0	0	0	0	0
MF NQ5	0	0	0	140	0	0	0	0	0
MF NQ6	0	0	0	105	0	0	0	0	0
Opportunistic	0	0	0	0	0	580	13,680	0	504
Total	**420**	**840**	**420**	**819**	**1,440**	**2,490**	**18,000**	**360**	**1,008**

3.8 DATA ANALYSIS

3.8.1 Survey Adequacy

There are three general methods of estimating species richness from sample data: extrapolating species-accumulation curves (SACs), fitting parametric models of relative abundance, and using non-parametric estimators (Bunge and Fitzpatrick 1993; Colwell and Coddington 1994; Gaston 1996). In this report, the level of survey adequacy was estimated using SACs, which graphically illustrate the accumulation of new species as more individuals are recorded. Ultimately, the asymptote is reached at the level at which no new species are present. To eliminate features caused by random or periodic temporal variation, the sample order was randomised 1,000 times using EstimateS (version 8, Colwell 2009). In order to estimate the theoretical maximum for each fauna group, a Michaelis-Menten (MM) enzyme kinetic curve was calculated and used as a stopping rule technique.

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

3.8.2 Habitat Assessment

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

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

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

3.9 TAXONOMY AND NOMENCLATURE

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

Table 3.5 – References used for identification

Fauna Group	Reference
Mammals	Menkhorst and Knight (2011), Van Dyck and Strahan (2008)
Bats	Churchill (1998), Menkhorst and Knight (2011)
Birds	Simpson and Day (2004)
Reptiles	Cogger (2000), Wilson and Swan (2010)
Geckos	Storr *et al*. (1990), Wilson and Swan (2010)
Skinks	Storr *et al*. (1999), Wilson and Swan (2010)
Dragons	Storr *et al*. (1983), Wilson and Swan (2010)
Varanids	Storr *et al*. (1983), Wilson and Swan (2010)
Legless Lizards	Storr *et al*. (1990), Wilson and Swan (2010)
Snakes	Storr *et al*. (2002), Wilson and Swan (2010)
Amphibians	Tyler and Doughty (2009), Cogger (2000)
Fish	Allen *et al.* (2002)

3.10 ANIMAL ETHICS AND LICENCES

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

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

3.11 SURVEY TEAM

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

Table 3.6 – Field survey personnel

Survey Member	Expertise	Qualification	Experience
Level 2 Vertebrate Fauna Assessment			
A. Heidrich	Herpetology	M. Sc.	7 years
J. Graff	Ornithology	B. Sc	5 years
B. Greatwich	Ornithology	B. Sc	4 years
S. White	Invertebrates	-	4 years
J. Forbes-Harper		B. A., B. Sc (Hons)	3 years
L. Smith	Herpetology	Certificate for vet nursing	2 years
Targeted Conservation Significant Fauna Assessment			
N. Jackett	Ornithology	B. Sc (Hons)	7 years
B. Greatwich	Ornithology	B. Sc	4 years
A. Nowicki		B. Sc (Hons)	3 years
A. Young		B. Sc	2 years

Table 3.7 – External consultants

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

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4 RESULTS

4.1 FAUNA HABITATS

Ecoscape (2012d) identified three habitat types within the Survey Area. During the current Level 2 vertebrate fauna assessment, four major fauna habitat types were identified from the Survey Area. These correspond roughly (there are some differences in delineation of habitat types) with the habitat types identified by Ecoscape (2012d) but with the slopes and plains differentiated from creeklines (Table 4.1).

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

Habitat Types Identified during the Current Assessment	Habitat Types Identified by Ecoscape (2012d)
Hilltops, hillslopes, ridges and cliffs	Exposed upper slopes, clifflines and ridges
Gorges and gullies	Sheltered gullies with permanent or ephemeral waterholes
Footslopes and plains	Lower slopes and valleys with ephemeral drainage lines and dry river channels
Major creeklines	

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

The area of occupation of each habitat is shown in Table 4.2 and mapped in Figure 4.6.

Table 4.2 – Summary of fauna habitat areas

Fauna Habitat	Area inside Survey Area (ha)	Percentage of Total Survey Area (%)
Hilltops, hillslopes, ridges and cliffs	5,303.1	55.4
Footslopes and plains	4,079.4	42.7
Major creeklines	150.4	1.6
Gorges and gullies	29.1	0.3

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

Table 4.3 – Survey effort per fauna habitat type

Habitat type	Pit Traps (trap nights)	Funnel (trap nights)	Elliot (trap nights)	Cage (trap nights)	Bird Survey (min)	Diurnal Opp search (min)	Bat Recording (min)	Nocturnal search (min)	Camera Trapping (hours)
Gorges and gullies	0*	0*	0*	490	420	2,370	72	0	1,080
Hilltops, hillslopes, ridges and cliffs	70	140	70	14	240	90	2,160	60	0
Major creeklines	70	140	70	259	150	0	2,880	60	0
Footslopes and plains	280	560	280	56	630	30	12,240	240	0
Total	**420**	**840**	**420**	**819**	**1,440**	**2,490**	**18,000**	**360**	**1,080**

* Systematic trapping was not conducted in this habitat type due to the substrate being too hard and rocky to dig in traps. For safety reasons, no nocturnal observations were conducted in this habitat type as access to this habitat type required climbing over rocks and loose substrate. To ensure adequate survey effort was expended in this habitat type, additional diurnal searches and camera trapping were conducted.

4.1.1 Hilltops, hillslopes, ridges and cliffs

The hilltops, hillslopes, ridges and cliffs habitat type is the dominant habitat within the Survey Area, covering 55.4 % (5303.1 ha) of the total area (Table 4.2). The hilltops and ridges comprise the most elevated level of all habitats and are usually dominated by sparse vegetation of scattered small shrubs and spinifex clumps on a rocky surface which comprises a continuous layer of outcropping banded iron formation rock with scattered pebbles and stones. The hillslopes generally comprise the sides of a hill which connect the hilltop and the footslope. They are dominated by scattered trees and shrubs over spinifex clumps on a rocky loamy-clay with a continuous layer of pebbles and stones. Cliffs exist along the side of ridges and hills where hillslopes open up to rock faces with very sparse vegetation of scattered trees and smaller shrubs in some sheltered spots. However, vegetation is usually rare along the cliffs. Crevices and caves can be found which provide shelter for a range of fauna species.

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

4.1.2 Footslopes and plains

Footslopes and plains were the second most common habitat type, covering 42.7 % (4,079.4 ha) of the total Survey Area (Table 4.2). This habitat type consists of occasional eucalypt trees and scattered acacia shrubs over medium to large clumps of spinifex hummock grassland on loam-clay with a continuous mantle of pebbles and stones. Wood litter and leaf litter is usually very sparse. This habitat type is found within the central and south-west areas of the Survey Area (Figure 4.6). The footslopes and plains also include minor drainage lines with acacia thickets and other slight variations which in small patches do not represent a separate fauna habitat type.

Figure 4.2 – Representative photo of footslopes and plains habitat type

4.1.3 Major creeklines

Major creeklines recorded from the Survey Area consist of major drainage channels with fringing eucalypt trees over a dense to open shrub layer, with or without surface water. During the current survey, no water was present. This habitat type comprised 1.6 % (150.4 ha) of the Survey Area (Table 4.2). Major creeklines are characterised by the height and density of the vegetation layer, as well as the large variety of tree and shrub species that are present. Wood litter and leaf litter can vary from sparse to moderately dense. Invasive flora species, in particular buffel grass (**Cenchrus ciliaris*), can be found in this habitat type due to the good soil condition and the presence of water. The majority of the major creeklines comprise clay soils which retain moisture and support larger trees, such as eucalypts, and their root systems. Major creeklines were identified from the south and centre of the Survey Area. Both of these systems drain into Duck Creek, south of the Survey Area.

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

Figure 4.3 – Representative photo of major creeklines habitat type

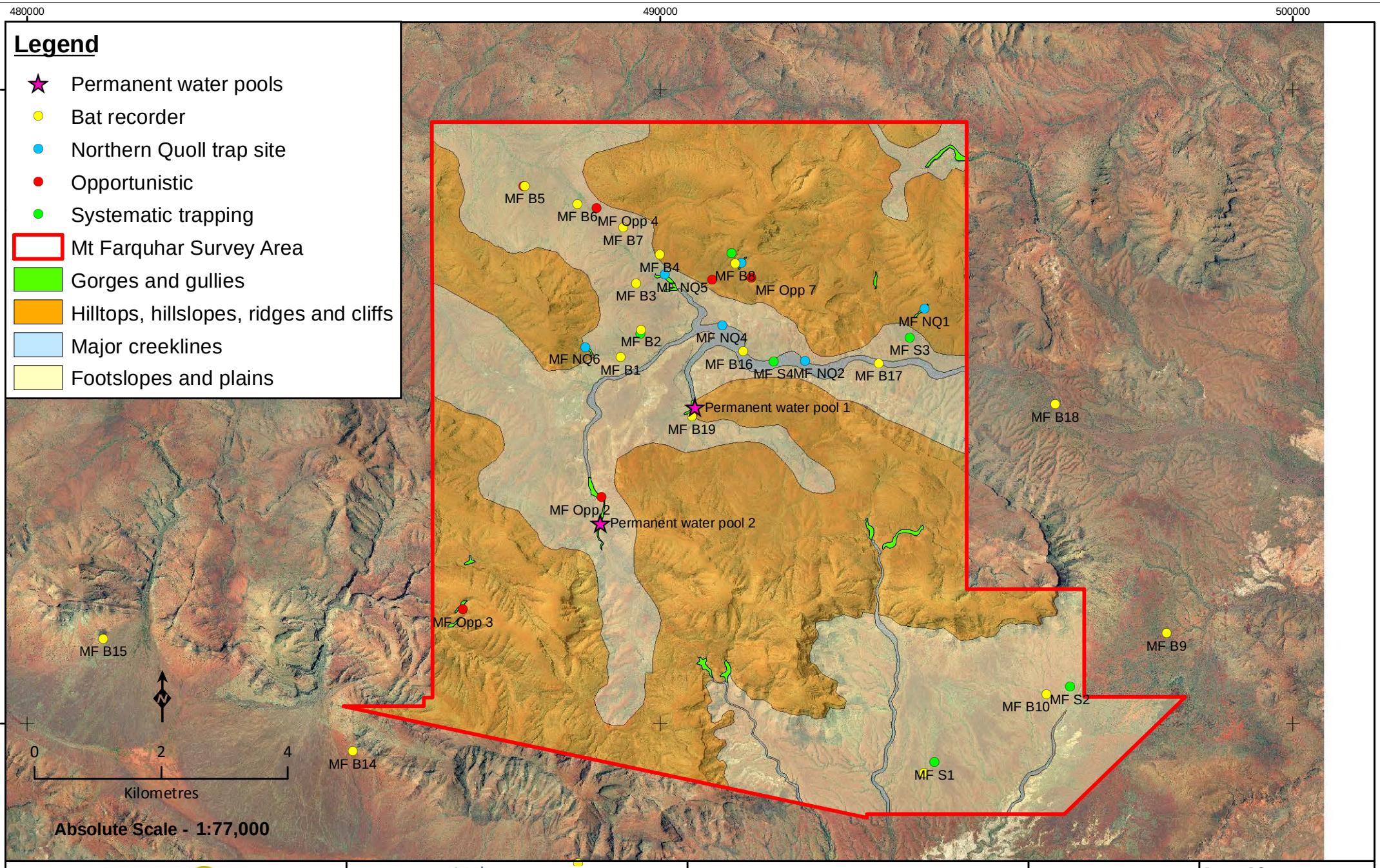
4.1.4 Gorges and gullies

The gorges and gullies habitat type is found in small isolated locations throughout the Survey Area (Figure 4.6). The habitat type occupies just 0.3% (29.1 ha) of the Survey Area (Table 4.2). This habitat type usually comprises a moderately dense vegetation layer consisting of native fig trees and eucalypt trees which produce a large amount of leaf litter, small herbs and shrubs over spinifex hummock grassland. In particular, the gorges with large eucalypt trees, shrubs and leaf litter preserve the moisture and support a humid climate which attracts insects and, therefore, a large number of insect eating species.

Two large rock pools within this habitat type were recorded from within the Survey Area. Both pools were at least 1.5 m deep, and although they appear to be surface water collection points only, the depth and size of the pools mean they would likely contain water for most of the year. The presence of these water pools is important in the surrounding landscape, and provides an important resource for many fauna species. Figure 4.5 shows a photo of water pool 1, the locations of which are shown in Figure 4.6.

Figure 4.4 – Representative photo of gorges and gullies habitat type

Figure 4.5 – Water Pool 1



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Fauna habitats of the Survey Area

Figure: 4.6
Project ID: 1446

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4.2 FAUNA HABITAT ANALYSIS

Common habitat types were sampled by a larger number of systematic trapping sites than less common habitat types due to their ease of accessibility and suitable ground conditions to install trap lines. Three of the four fauna habitats within the Survey Area were sampled with systematic trapping sites during the current Level 2 vertebrate fauna assessment. Four trapping sites (MF S1, MF S2, MF S3 and MF S6) were installed in the second most dominant habitat type, footslopes and plains. One trapping site (MF S4) was installed in the major creeklines habitat type, while the remaining site (MF S5) was installed in the hilltops, hillslopes, ridges and cliffs. No trapping sites were installed within the gorges and gullies habitat type due to access limitations; however, this habitat type was targeted with greater opportunistic survey effort (diurnal and camera trapping) to ensure adequate sampling of each habitat type across the Survey Area.

A one-way ANOSIM test and MDS plot of the trapping sites within the different habitat types was completed for data collected systematically for both birds and terrestrial trapped fauna. The results from these statistical analyses show a difference between the faunal assemblages in the different habitat types between birds and terrestrial trappable fauna. MDS plots for the analyses are shown in Figure 4.7.

The one-way ANOSIM test when comparing terrestrial trapped fauna against the different habitat types determined an R value of 0.3168 (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 0.027 (p-value of <0.05 indicating a significant difference). The R and p values from this analysis do suggest some differences between habitat types. The MDS plot for trapping data provides a visual illustration, showing some overlap between habitats, but overall a difference between faunal assemblages recorded at different habitat types. A stress value of 0.183 for this test indicates good fit of the scaling to the matrix, confirming differences in habitat types when comparing trapped fauna data.

The results of the statistical analysis of the avifauna recorded are inconclusive with regard to similarities between habitat types using the results of the recorded avifauna. The one-way ANOSIM test determined an R value of 0.082, which is very close to 0 and a p value of 0.219, which would indicate low significance. However, these results suggest there is insufficient data to determine a significant difference in species recorded between habitat types. The MDS plot reflects the results from the ANOSIM. Visually it appears bird species recorded from the creekline habitat type are distinct from the remaining two habitat types and that hilltops, hillslopes, ridges and cliffs habitat type shows strong similarity with species recorded from footslopes and plains habitat type. A stress value of 0.19 for this test indicates good fit of the scaling to the matrix, which would confirm differences in habitat types when comparing avifauna data.

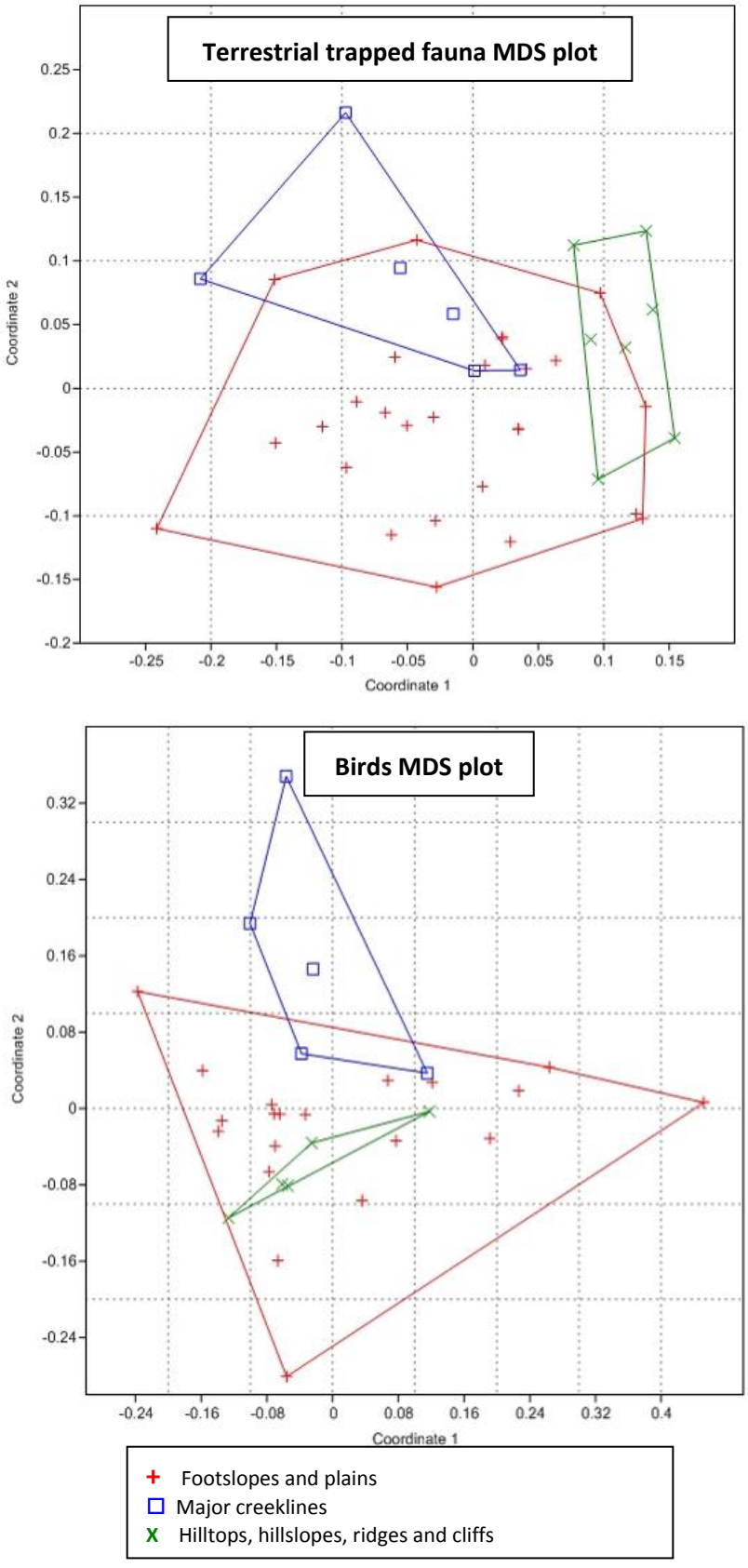


Figure 4.7 – Birds and terrestrial trapped fauna MDS plot

4.3 SURVEY ADEQUACY

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

Table 4.4 – Mean estimates of total species richness of the vertebrate fauna groups.

Richness Estimators	Total Richness Estimate	
	Terrestrial Vertebrates	Birds
ACE	41.18	48.24
ICE	41.83	50.72
Chao-1	37.86	47.60
Jack-1	40.74	53.77
Jack-2	45.64	57.60
Bootstrap	34.85	50.18
Michaelis-Menten	36.70	51.40
Species Observed	30	47

SACs were generated through 1,000 randomisations of the sample sequence of the data sets for terrestrial trapped fauna (mammals and herpetofauna; Figure 4.8) and avifauna (Figure 4.9). The Sobs (Mao Tau) line reflects the actual number of species observed, with the MM means (1 run) line being the theoretical total number of species that could be recorded.

Analysis of the terrestrial trapped fauna data set produced a smooth curve that has not yet reached an asymptote. Visually the shape of the curve in this SAC shows that the number of species being recorded was still increasing at the cessation of survey effort. The Michaelis-Menten estimator, used as stopping rule, indicated that the survey was 81.7% adequate, with the species observed (Sobs Mao Tau) value of 30 and with the MM means value of 36.7. These results indicate that, although the majority of species were recorded during the survey, additional trapping would likely detect at least seven additional species.

The SAC for the bird data set is nearing, but does not reach, an asymptote. The Michaelis-Menten estimator, used as stopping rule, indicated that the survey was 91.4% adequate, with the species observed (Sobs Mao Tau) value of 47 and with an MM means value of 51.4. These results indicate that, although the majority of bird species were recorded during the survey, additional survey effort would likely detect at least four additional species.

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

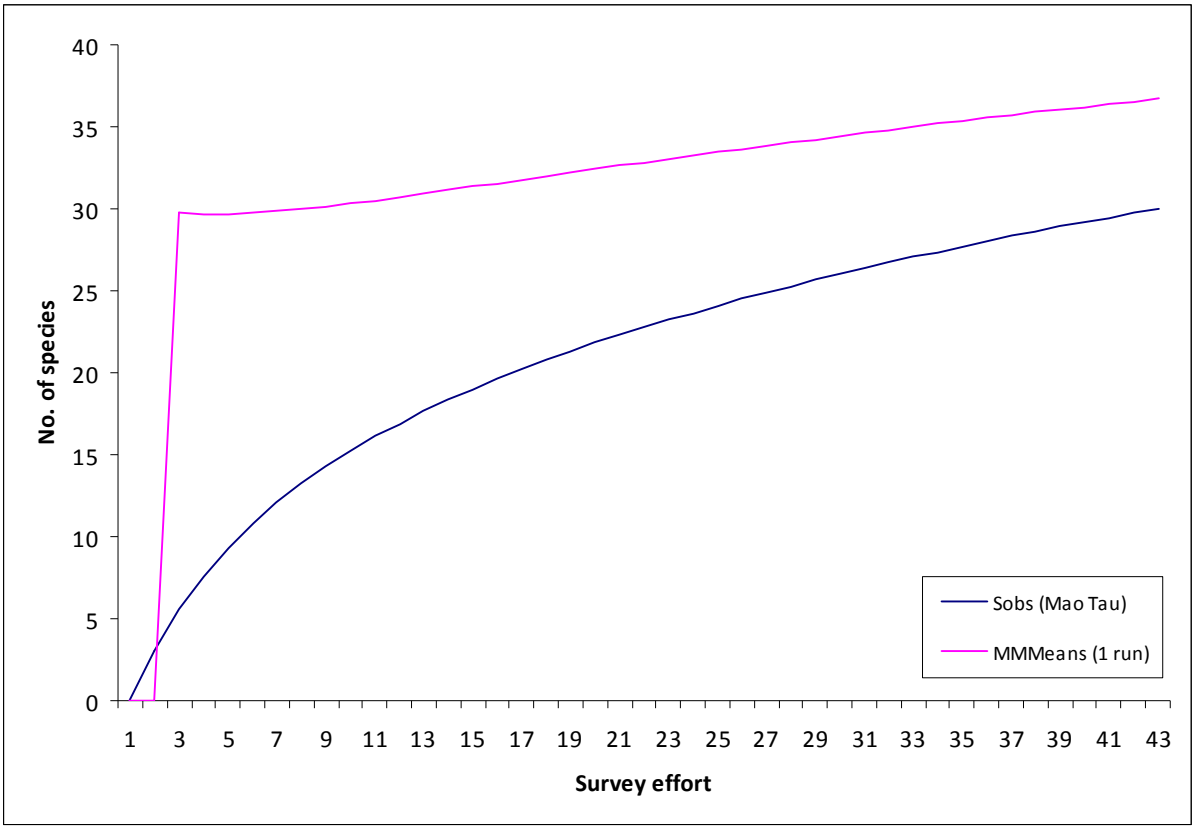


Figure 4.8 – Species Accumulation Curve for trappable terrestrial vertebrates

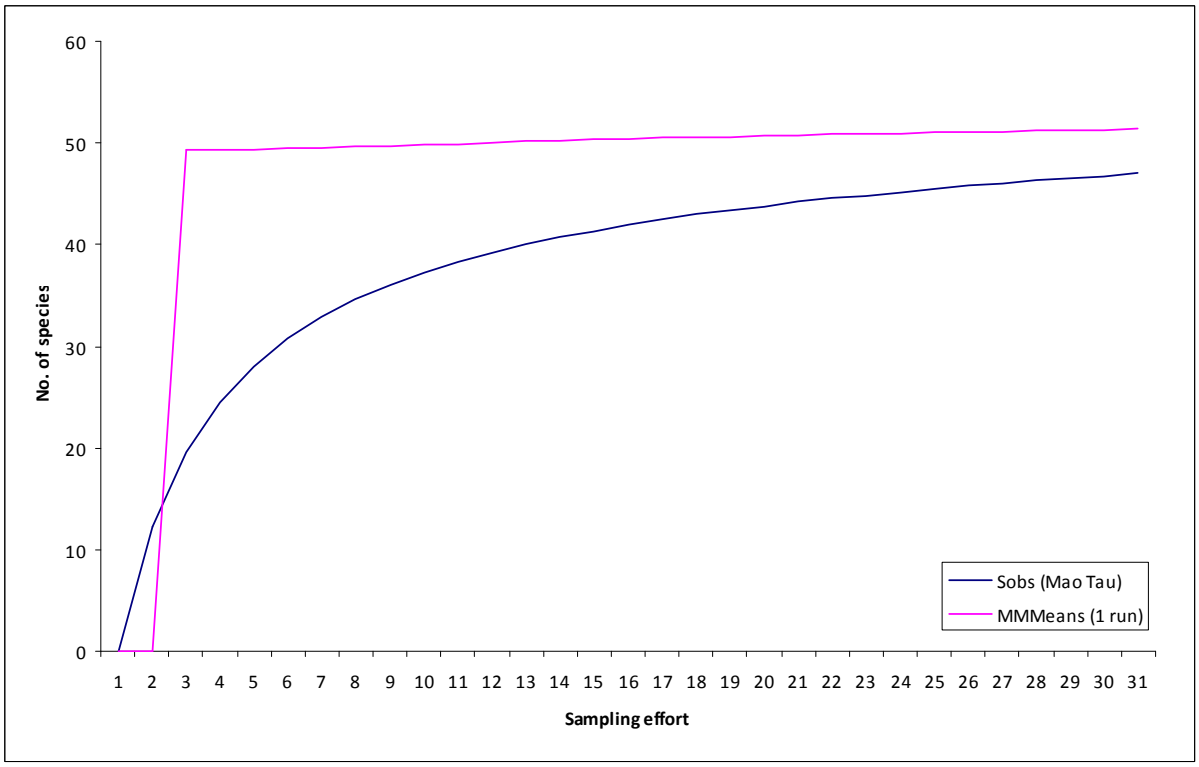


Figure 4.9 – Species Accumulation Curve for avifauna

4.4 FAUNA ASSEMBLAGES

A total of 16 native and four introduced mammal species, 56 bird species, 34 reptile species and two fish species were recorded within the Survey Area during the current surveys. No amphibians were recorded during the current survey. Of the species recorded, three species were of conservation significance. The site by species matrix of species recorded during the Level 2 vertebrate fauna assessment can be seen in Appendix E.

4.4.1 Mammals

A total of 16 native and four introduced mammal species were recorded from the Level 2 vertebrate fauna and targeted conservation significant fauna assessment. The literature review revealed a total 38 native and eight introduced mammal species could potentially occur in the Survey Area. The diversity of mammals recorded, when compared to results from previous surveys, appears to be lower than average. The mammal assemblage recorded from the Survey Area consists of three dasyurid (small carnivorous marsupials) species, two macropod species, nine volant (bat) species, two murids (rodents) and four introduced species (cat, house mouse, cow and dog).

The abundance of the mammal species recorded was relatively low. The most frequently recorded non-volant mammal species was the Common Rock-rat (*Zyzomys argurus*). This species was recorded just once during the Level 2 vertebrate fauna assessment, but an additional 25 individuals were recorded during the targeted conservation significant fauna assessment as a result of increased trapping effort within this species' preferred habitat.

A single conservation significant mammal species was recorded, the Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*). Records of this species were made both during the Level 2 vertebrate fauna and targeted conservation significant fauna assessments.

4.4.2 Birds

A total of 56 bird species were recorded from the Survey Area. When compared to previous surveys of the region, the bird diversity recorded is relatively low, with the literature review revealing the Survey Area has 150 species potentially occurring in the region. Many of these species, such as waterbirds, are unlikely to occur due to a lack of suitable habitat. The low number of species recorded is confirmed when compared with the recent concurrent Western Hub surveys (*ecologia* in prep-a, b) in the Eliwana/Flying Fish and Delphine survey areas, which recorded 76 and 100 species respectively.

Abundance of species recorded was also generally low, the most abundant species recorded being nomadic species the Masked Woodswallow (540 records) and Budgerigar (239 records). The honeyeaters (family Meliphagidae) had the most number of species recorded, with eight species from this family recorded.

Two bird species of conservation significance were recorded from the Survey Area, the Rainbow Bee-eater (*Merops ornatus*) and Peregrine Falcon (*Falco peregrinus*). The Rainbow Bee-eater was recorded regularly throughout the Survey Area on both surveys, while the Peregrine Falcon was recorded during the targeted conservation significant fauna assessment only.

4.4.3 Reptiles

A total of 34 reptile species were recorded from the current survey. This diversity is relatively low, with the literature review showing 108 reptile and seven amphibian species potentially occur within the Survey Area. The low number of species recorded is confirmed when compared with the recent concurrent Western Hub surveys (*ecologia* in prep-a, b) in the Eliwana/Flying Fish and Delphine survey areas, which recorded 61 and 58 reptile species, respectively.

The reptile assemblage recorded consists of two dragon species, seven gecko species, three legless lizard species, 12 skink species, three varanid (goanna) species and seven elapid (venomous snake) species. The most numerous species recorded were the skink *Carlia munda* (42 records), Long-nosed Dragon (*Amphibolurus longirostris*, 34 records), Leopard Ctenotus (*Ctenotus pantherinus*, 27 records) and Ring-tailed Dragon (*Ctenophorus caudicinctus*, 26 records). No reptile species of conservation significance were recorded.

4.4.4 Amphibians

No amphibians were recorded in the Survey Area, despite the literature review showing seven amphibian species potentially occur within the Survey Area. The recent concurrent Western Hub surveys (*ecologia* in prep-a, b) in the Eliwana/Flying Fish and Delphine survey areas recorded two and three species of amphibian, respectively.

4.4.5 Fish

Two species of fish were recorded within the Survey Area. A total of six species have the potential to occur within the Survey Area. No fish species of conservation significance were recorded on the current survey.

4.5 CONSERVATION SIGNIFICANT FAUNA

Based on database searches and the results of previous biological surveys in the surrounding region, six mammal, 14 bird, three reptile and one fish species of conservation significance could potentially occur in the Survey Area.

Three species of conservation significance, one mammal and two bird, were recorded from within the Survey Area:

- Pilbara Leaf-nosed Bat (EPBC Act Vulnerable, WC Act Schedule 1, DEC Vulnerable);
- Rainbow Bee-eater (EPBC Migratory WC Act Schedule 3); and
- Peregrine Falcon (WC Act Schedule 4).

These records are summarised in Table 4.5 and mapped in Figure 4.10.

When literature review results were considered, an additional 14 species were assessed as having a medium to high likelihood of occurrence, and another 10 species were assessed as having a low likelihood. Species with medium to high likelihood of occurrence are described in greater detail in Section 5.3.

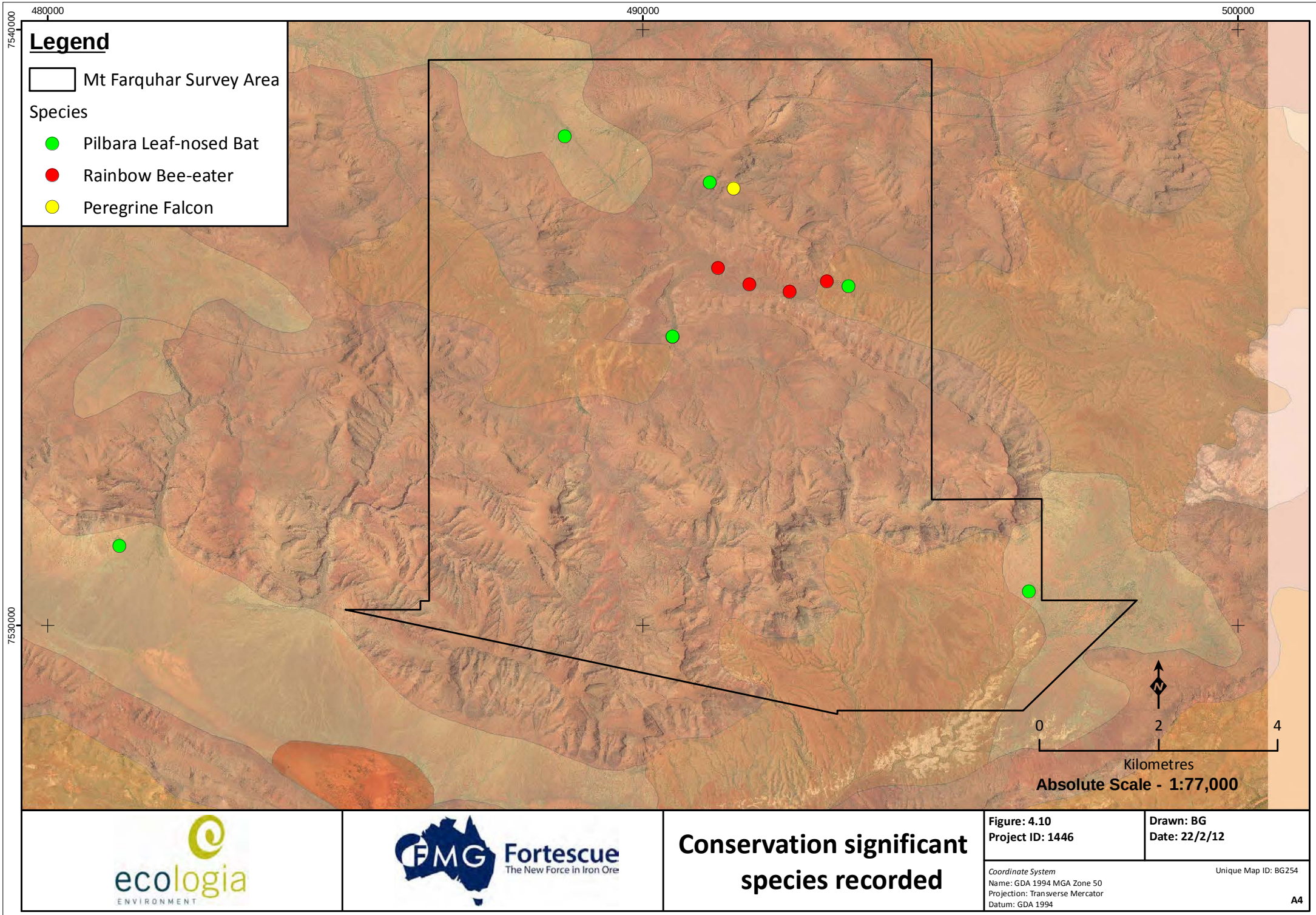
Table 4.5 – Conservation significant fauna recorded during the survey

Species	Location			Comments*
	Easting	Northing	Site	
Mammals				
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	496485	7530584	MF S2	Level 2 vertebrate fauna assessment
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	491129	7537433	MF S5	Level 2 vertebrate fauna assessment
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	488692	7538210	MF B6	One call - Targeted conservation significant fauna assessment
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	481206	7531345	MF B15	Three calls - Targeted conservation significant fauna assessment
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	490504	7534855	MF B19	Six calls - Targeted conservation significant fauna assessment
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	490504	7534855	MF B19	Two calls - Targeted conservation significant fauna assessment
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	493457	7535694	MF B17	One call - Targeted conservation significant fauna assessment
Birds				
Peregrine Falcon (*Falco peregrinus*)	491524	7537336	MF Opp	One individual - Targeted conservation significant fauna assessment
Rainbow Bee-eater (*Merops ornatus*)	491792	7535721	MF S4	One individual - Level 2 vertebrate fauna assessment
Rainbow Bee-eater (*Merops ornatus*)	492470	7535607	MF Opp	One individual - Level 2 vertebrate fauna assessment
Rainbow Bee-eater (*Merops ornatus*)	491261	7535995	MF Opp	One individual - Level 2 vertebrate fauna assessment
Rainbow Bee-eater (*Merops ornatus*)	493089	7535777	MF Opp	One individual - Targeted conservation significant fauna assessment

Datum GDA 94

Zone 50K

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



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Conservation significant species recorded

Figure: 4.10
Project ID: 1446

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

Unique Map ID: BG254

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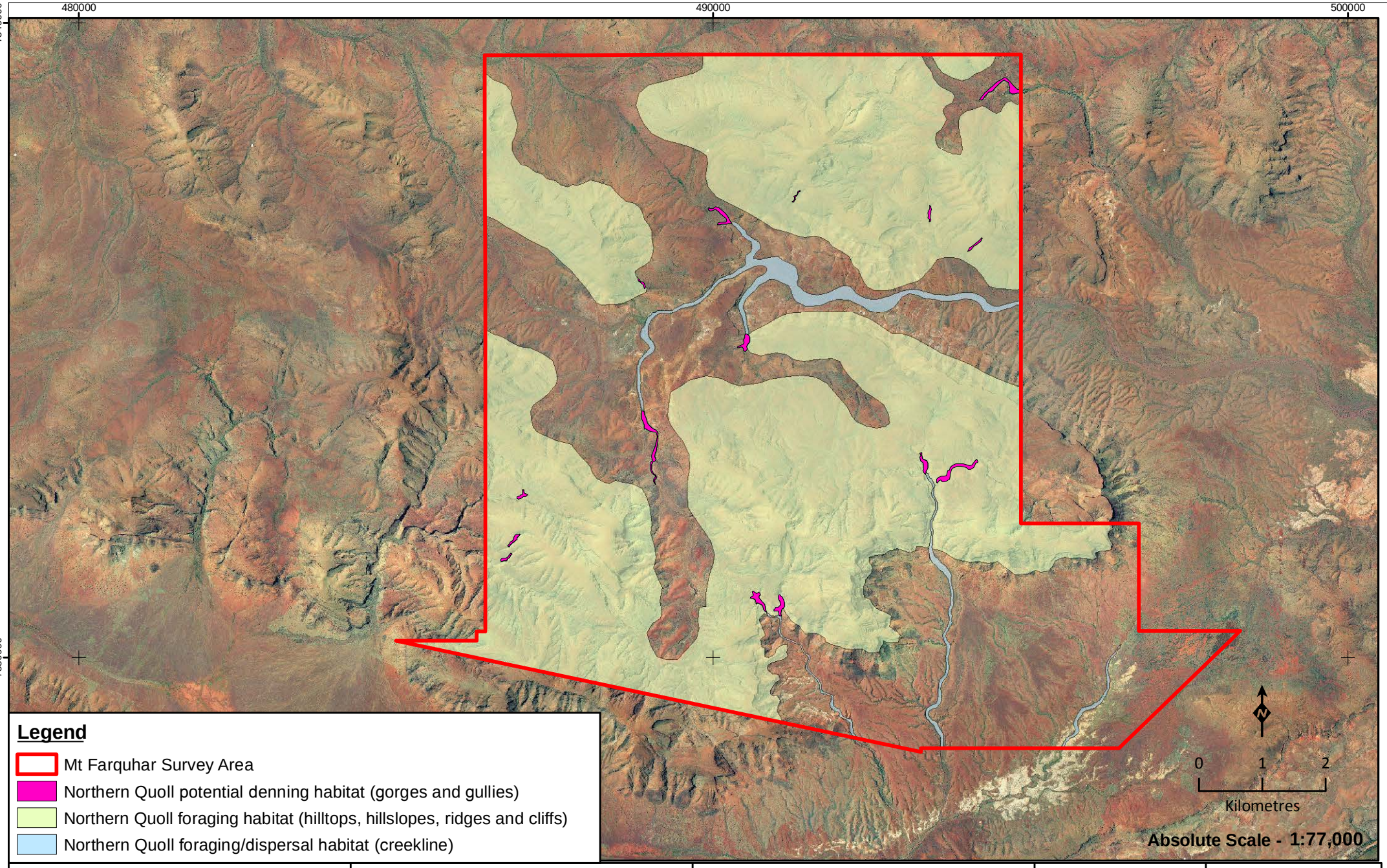
5 DISCUSSION

5.1 HABITATS

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

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

Species	Fauna Habitat	Area inside Survey Area (ha)	Percentage of Total Survey Area (%)
Northern Quoll	**Potential denning habitat**. Areas of rocky gorges and gullies in the Survey Area that may contain suitable den sites, preferably near a water source.	29.1	0.3
	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).	5,453.5	57.0
Pilbara Leaf-nosed Bat	**Potential roosting habitat**. Areas of rocky gorges and gullies in the Survey Area that may contain suitable caves for roosting.	29.1	0.3
	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.	4,229.8	44.3
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.	179.5	1.9



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Northern Quoll potential denning and foraging/dispersal habitat

Figure: 5.1
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Date: 04/10/12

Coordinate System
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Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: BG245

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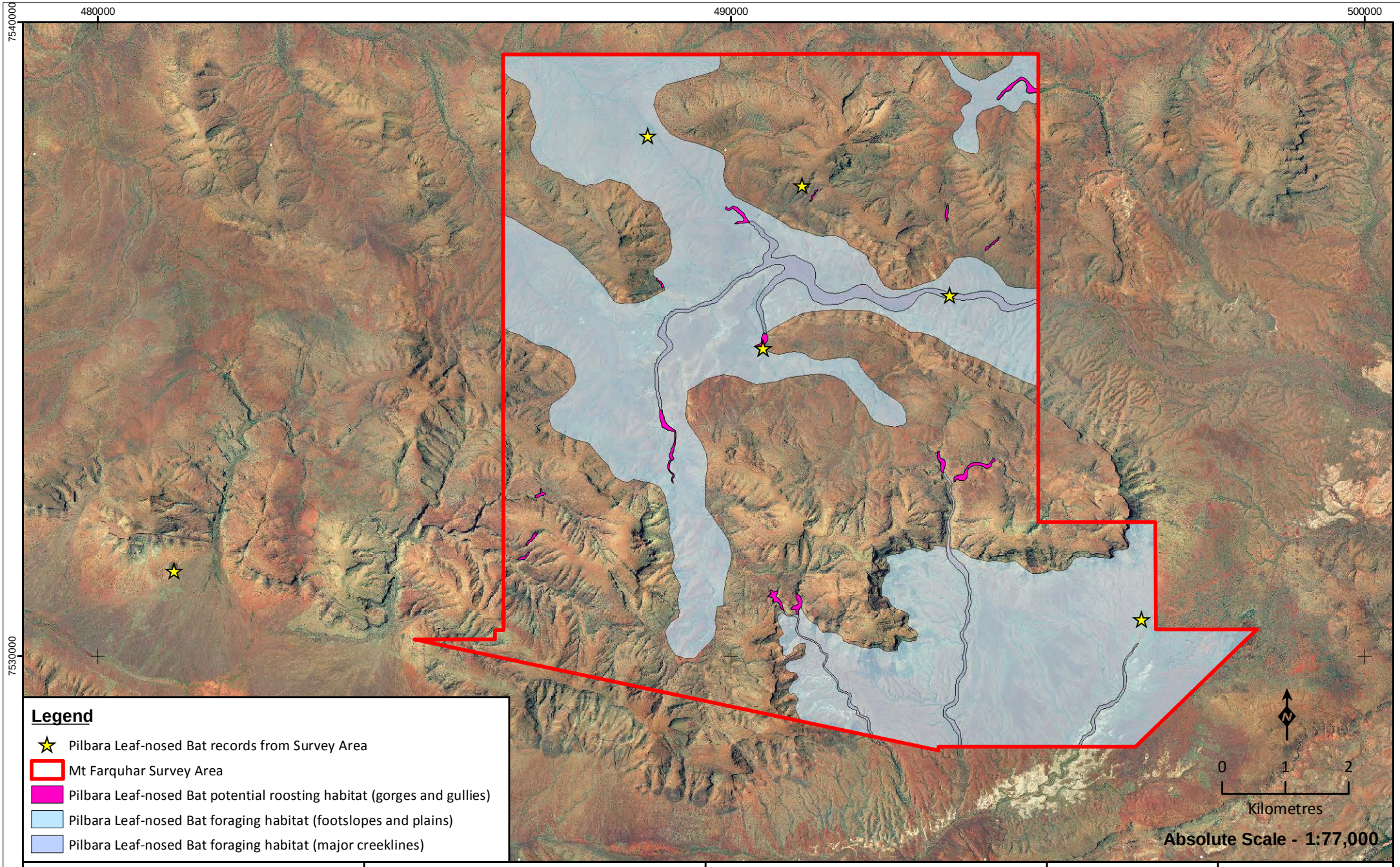

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Pilbara Leaf-nosed Bat potential roosting and foraging habitat

Figure: 5.2
Project ID: 1446

Drawn: Md'A
Date: 04/10/12

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

Unique Map ID: BG245

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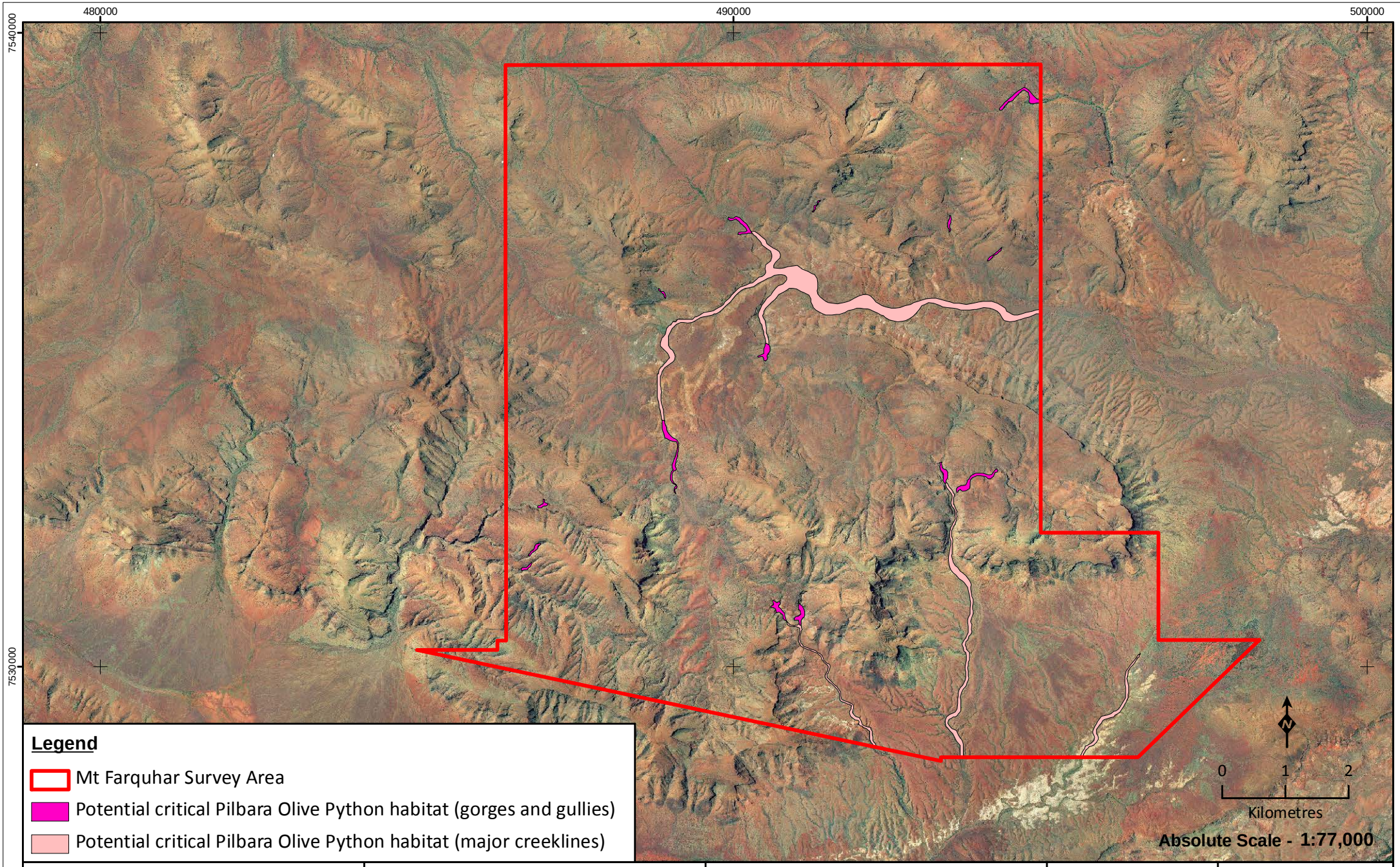

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Pilbara Olive Python potential critical habitat

Figure: 5.3
Project ID: 1446

Drawn: Md'A
Date: 04/10/12

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

Unique Map ID: BG245

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5.1.1 Hilltops, hillslopes, ridges and cliffs

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

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

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

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

5.1.2 Footslopes and plains

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

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

The herpetofauna of the foothills and plains comprises a range of generalists that find shelter and shade under spinifex clumps. Soil substrates are typically hard and rocky. Species typical of this habitat include the skink *Lerista verhmens*, Leopard Ctenotus (*Ctenotus pantherinus*), Ring-tailed Dragon (*Ctenophorus caudicinctus*), Spiny-tailed Monitor (*Varanus acanthurus*), Pilbara Death Adder

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

5.1.3 Major creeklines

Major creeklines provide habitat for a large number of species. The mammals of this habitat include generalist species which also occupy other habitats in the Survey Area, such as Pilbara Ningaui, Planigale and Desert Mouse. In addition, the fauna assemblage of the major creeklines can also comprise more specialised species such as the Northern Brush-tailed Possum (*Trichosurus vulpecula arnhemensis*), Delicate Mouse (*Pseudomys delicatulus*) and Sandy Desert Inland Mouse (*P. hermannsburgensis*). The Northern Quoll is also likely to forage, breed and disperse along creeklines during the breeding season.

The herpetofauna of major creeklines include generalist species, such as the skinks *Carlia munda*, *Ctenotus pantherinus* and *C. helenae*, as well as more specialist species such as the Long-nosed Dragon (*Amphibolurus longirostris*).

Major creeklines provide suitable habitat for a variety of bird species, which can often be found in large numbers and abundance due to the number of trees and density of the vegetation which provides food and shelter. Bird species found predominately along major creeklines include the White-plumed Honeyeater, Sacred Kingfisher, Little Corella and Southern Boobook.

Species of conservation significance that are commonly found within major creeklines include the Bush Stone-curlew and Rainbow Bee-eater. The Bush Stone-curlew hides in the vegetation and will forage along water pools and in the surrounding areas. The Rainbow Bee-eater is an inhabitant of the trees and larger shrubs and builds breeding tunnels in the sand banks.

The major creeklines habitat was assessed as comprising potential critical habitat for Pilbara Olive Python (Figure 5.3), foraging/dispersal habitat for Northern Quoll (Figure 5.1) and foraging habitat for Pilbara Leaf-nosed Bat (Figure 5.2), all *EPBC Act* listed species. Northern Quoll are expected to use this habitat type seasonally, during the breeding season, for dispersal. Where suitable tree hollows occur, Northern Quolls may utilise this habitat for nesting also.

5.1.4 Gorges and gullies

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

Due to the sparse shrub and grass vegetation and the low number of flowering trees and shrubs within this habitat type, the avifauna of the gullies and gorges can be relatively poor when compared with other habitat types. However, when water (rock pools) is present in this habitat during the wet season avifauna can be notably more abundant when compared to surrounding, drier habitats. Grey Shrike-thrush, Western Bowerbird, Grey-headed Honeyeater, Black-faced Cuckoo-Shrike and Painted Finch can all be observed in large trees or near waterholes along gullies and gorges.

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

gorges in the Hamersley region. Locations with moist soil, such as those found under logs, rocks and leaf litter of rocky gullies and gorges, are suitable for the Gorge Toadlet (*Pseudophryne douglasi*).

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

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

5.2 FAUNA ASSEMBLAGES

5.2.1 Mammals

The mammals of the Mt Farquhar Survey Area represent a typical assemblage of mammal species for the Pilbara region. The number of species recorded (16 native / 4 introduced) is moderate in relation to previous surveys (Table 2.5, Appendix C). The dasyurids have the lowest percentage of species recorded in relation to potentially occurring species. A total of three species out of nine potentially occurring dasyurids were captured during the Level 2 vertebrate fauna and targeted conservation significant fauna assessment. This is most likely due to the low temperatures during surveys resulting in species being less active.

Nine out of a possible 17 bat species were recorded from the Survey Area: Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Common Sheathtail Bat (*Taphozous georgianus*), Gould's Wattled Bat (*Chalinolobus gouldii*), Little Broad-nosed Bat (*Scotorepens greyii*), Finlayson's Cave Bat (*Vespadelus finlaysoni*), Northern Freetail Bat (*Chaerophon jobensis*), Beccari's Freetail Bat (*Mormopterus beccarii*) and White-striped Freetail Bat (*Tadarida australis*). These species are commonly recorded in this area of the Hamersley Range, whereas the remaining eight species that potentially occur in the region are only rarely recorded. The absence of Ghost Bats from this survey is notable as there are several regional records and they are expected to occur in the surrounding region.

A single conservation significant mammal species was recorded; the Pilbara Leaf-nosed Bat.

5.2.2 Birds

Bird species recorded from the Survey Area were also generally low in abundance and diversity. As with the mammals, this is likely to be due to a number of contributing factors, such as a relatively small survey area and a lack of habitat diversity. Of particular influence is a lack of typical woodland habitat, which is preferable for many bird species. Of the species recorded, the nomadic Masked Woodswallow (540 records) and Budgerigar (239 records) were most frequently recorded. Although recorded in relatively high numbers, these species appear in far greater numbers when conditions are optimal. The presence of nomadic species suggests conditions within the Survey Area over the wetter summer months were very good. By definition, nomadic species typically occur in greater

numbers during periods of high food resources, with a gradual decline as conditions decline. This appears evident as neither of these species was observed during the targeted conservation significant fauna assessment, conducted later in winter.

Many eucalypt, corymbia and acacia plant species were flowering during the Level 2 vertebrate fauna assessment. As a result, good diversity and abundance of honeyeater species were recorded. Eight of the potential twelve species were recorded, with the Brown Honeyeater being the most abundant species, recorded 113 times. In addition, the Singing Honeyeater, Grey-headed honeyeater, Yellow-throated Miner, Crimson Chat, and Black Honeyeater all had over 40 records.

Two birds of conservation significance were recorded, the Rainbow Bee-eater and Peregrine Falcon.

5.2.3 Herpetofauna

The relatively low reptile diversity and abundance recorded, as with the mammals, is likely due to a combination of factors. These include the relatively small size of the Survey Area, lack of habitat diversity, and primarily, sub-optimal survey conditions due to generally cool weather during the survey. Reptiles become increasingly inactive as temperatures drop which is highlighted in the climatic data recorded during the survey with both minimum and maximum temperatures declining during the Level 2 vertebrate fauna assessment (Appendix B). This is likely to have caused low reptile activity and consequently fewer reptile captures. The SAC based on trapping data supports this, as the SAC is yet to reach a plateau, indicating additional trapping effort would capture additional species (Figure 4.8).

The most frequently recorded species are all common, widespread species of the region. The most notable records from the survey were the five records of *Underwoodisaurus Seorsus*, from site MF S5, and the two records of *Lerista flammicauda*, opportunistically recorded from the gorges and gullies habitat type at permanent water pool 1. Both species are endemic to the Pilbara region. *U. seorsus* is a new species which has only recently been described in 2011 (Doughty and Oliver 2011), with very little known of its ecology. NatureMap shows just seven previous records of this species within the Pilbara (DEC 2012). Records from this survey represent the western-most extent in which this species has been recorded, extending this species' range by approximately 60 km.

No reptile species of conservation significance were recorded from the current survey, although high quality habitat for the Pilbara Olive Python exists (Figure 5.3).

5.2.4 Fish

Two fish species were recorded from within the Survey Area, the Spangled Perch and Western Rainbow Fish. Both species were recorded at water pools 1 and 2, within the gorges and gullies habitat type.

No conservation significant fish were recorded from the current survey; however, the Fortescue Grunter (P4) was recorded from the nearby Delphine survey area, from the junction of Duck and Serpentine creeks, which have tributaries within the Mt Farquhar Survey Area. This species may occur within the Survey Area, though due to the absence of major river systems in the Survey Area, there is only a medium likelihood of the Fortescue Grunter occurring within the Survey Area.

5.2.5 Endemic species and species of biological significance

As mentioned in Section 5.2.3, the records of *Underwoodisaurus seorsus* are particularly noteworthy. This recently described species is endemic to the Pilbara, and current records suggest it is restricted

solely to the Hamersley Range (Doughty and Oliver 2011). The records from the current survey appear to be approximately 60 km further west of any previous records. Doughty and Oliver (2011) define the habitat for *U. seorsus* as rocky areas within the Hamersley Range. This species was recorded from MF S5 only, with this site being located on the rocky upper slopes of a hill Appendix D, matching the micro-habitat of previous records. As this is a recently described species, and because there are so few regional records, it is difficult to map typical habitat for *U. seorsus*. The current records for habitats in which this species have been recorded range from hilltops, to rocky escarpments, hillslopes and footslopes. Within the Survey Area, the species has the potential to occur within the hilltops, hillslopes, ridges and cliffs habitat type as well as along footslopes of the footslopes and plains habitat type.

Interestingly, this species was the second most recorded gecko species, with five records. Only the widespread and often abundant Bynoe's Gecko (*Heteronotia binoei*) was recorded at a higher frequency, with six records. *U. seorsus* has previously been classified as *U. milii*, a species of gecko occurring across much of southern Australia. *U. milii*, being a gecko species of temperate climates, is better able to withstand and maintain activity during cool conditions. Due to their phylogenetic proximity, *U. seorsus* may share similar ecological traits to the more southerly-occurring *U. milii*. This may result in *U. seorsus* being better able to tolerate cooler conditions than other arid-inhabiting gecko species. Due to the lack of information known on this species, Doughty and Oliver (2011) recommend the conservation status of *U. seorsus* be assessed immediately and suggest a DEC priority 2 listing. However, at the time of writing this report, this species remains unlisted. An individual of *U. seorsus* recorded from the survey is shown in Figure 5.4.

Other species endemic to the Pilbara recorded during the survey include the Pilbara Ningaui (*Ningaui timealeyi*), Rothschild's Rock Wallaby (*Petrogale rothschildi*), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*), Banded Knob-tailed Gecko (*Nephrurus wheeleri cinctus*), *Delma pax*, *Cryptoblepharus ustulatus*, *Ctenotus rubicundus*, *Lerista flammicauda*, Pilbara Rock Monitor (*Varanus pilbarensis*), Pilbara Death Adder (*Acanthophis wellsi*) and Rufous Whipsnake (*Demansia rufescens*).

Figure 5.4 – *Underwoodisaurus seorsus* individual recorded from the survey

5.3 CONSERVATION SIGNIFICANT FAUNA

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

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

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

Table 5.2 – Likelihood of occurrence categories

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

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

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

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Mammals						
Northern Quoll *Dasyurus hallucatus*	EN	S1	EN	In the Pilbara, most common on dissected rocky escarpments, but also found in eucalypt forest and woodland. Typically rocky areas with suitable denning sites and access to surface water.	Closest record from Delphine survey area (*ecologia* in prep-a). Records from eight locations within 85 km of the Survey Area (Coffey 2008; DEC 2012; Ecoscape 2010, ecologia internal database).	**HIGH** Recently recorded during concurrent survey approximately 40 km west of Survey Area. High quality habitat exists within Survey Area (Figure 5.1).
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia*	VU	S1	VU	Roost in caves with high humidity (95%) and temperature (32 °C). Forage along waterbodies with fringing vegetation.	Calls recorded from ten locations at Delphine Project and from four locations at Central Pilbara Project (*ecologia* 2011b, in prep-a). Two records from approximately 67-72 km north-west and one record from 20 km south-east of the Survey Area (DEC 2012).	**RECORDED** Species recorded within Survey Area during Level 2 vertebrate fauna and targeted conservation significant fauna assessments. Suitable foraging habitat exists, with potentially suitable habitat present for roost caves within or nearby the Survey Area (Figure 5.2).
Long-tailed Dunnart *Sminthopsis longicaudata*			P4	Rocky, hilly areas vegetated with spinifex; occasionally open areas with a stony, rocky mantle.	Closest record approximately 20 km east of Survey Area, with more records further east (DEC 2012).	**HIGH** Suitable habitat within Survey Area in the hilltops, hillslopes, ridges and cliffs habitat type; one record relatively close-by.
Ghost Bat *Macroderma gigas*			P4	Roost in caves, rockpiles and abandoned mines. Will travel 2 km from roost to hunt.	Recorded during concurrent survey at Eliwana/Flying Fish approximately 20 km south of Survey Area (*ecologia* in prep-b). Many previous records to the south and east of the Survey Area (DEC 2012; *ecologia* 2011b).	**HIGH** Not recorded on current survey, however suitable foraging habitat exists in the footslopes and plains habitat type, as well as along major creeklines. Suitable habitat potentially exists within the gullies and gorges habitat. Habitat use is synonymous with that of the Pilbara Leaf-nosed Bat (Figure 5.2).

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Short-tailed Mouse *Leggadina lakedownensis*			P4	Spinifex and tussock grassland on cracking clays. Also acacia shrubland, samphire, woodlands, and stony ranges.	Fourteen records within 48 km (majority within 14 km) of the eastern end of the Survey Area (DEC 2012).	**LOW** Many records relatively close-by; however, no typical habitat within Survey Area.
Western Pebble-mound Mouse *Pseudomys chapmani*			P4	Footslopes of rocky ranges and rocky hills where the ground has continuous small pebbles and vegetated by spinifex.	Mounds recorded from 60 locations within 95 km of the Survey Area (Biota 2005b, 2009b; Coffey 2008; *ecologia* 2010, 2011b; Kendrick 1995; Mattiske and Ninox 1990).	**HIGH** Many surrounding records with suitable habitat present in the hilltops, hillslopes, ridges and cliffs; and the footslopes and plains habitat types. However, no evidence in the form of mounds recorded during surveys.
Birds						
Fork-tailed Swift *Apus pacificus*	M	S3		Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts.	Recorded from five locations at Central Pilbara Project and Solomon Project (*ecologia* 2010, 2011a).	**MEDIUM** This species irregularly appears in the Pilbara during suitable weather events. May occasionally overfly Survey Area but will not utilise habitats directly.
Eastern Great Egret *Ardea modesta*	M	S3		Wide range of wetland habitats, including floodwaters, rivers, shallows of wetlands, intertidal mudflats.	Closest record from Delphine Project (*ecologia* in prep-a). Birdata states records within 40 km of Survey Area. Two records within 67 km (DEC 2012).	**LOW** Lack of suitable habitat within Survey Area.
Cattle Egret *Ardea ibis*	M	S3		Grassy habitats, shallow wetlands and waterbodies, particularly damp pastures.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** Lack of suitable habitat within Survey Area with few previous records.
Glossy Ibis *Plegadis falcinellus*	M	S3		Shallows and adjacent flats of freshwater lakes and swamps; river pool; flooded samphire; sewage ponds. Nest in freshwater/brackish wetlands with tall, dense stands of emergent vegetation and low trees or bushes.	Recorded from Birdata only with no specific location information.	**LOW** Lack of suitable habitat within Survey Area with few previous records.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
White-bellied Sea-Eagle *Haliaeetus leucogaster*	M	S3		Coastal and near coastal water bodies, along river systems. Inhabits most types of habitats except closed forest.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** Lack of suitable habitat within Survey Area with few previous records.
Oriental Plover *Charadrius veredus*	M	S3		Open plains, including samphire; bare rolling country; bare claypans; open ground near inland swamps.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** Lack of suitable habitat within Survey Area with few previous records.
Common Sandpiper *Actitis hypoleucos*	M	S3		Coastal and inland wetlands, with varying levels of salinity; mostly found on muddy margins or rocky shores; rarely mudflats.	DSEWPaC states potential habitat in the region. No previous records.	**LOW** Lack of suitable habitat within Survey Area with few previous records.
Little Curlew *Numenius minutus*	M	S3		Short dry grasslands, including artificial grassed areas.	Recorded approximately 70 km west of Survey Area (Biota 2009a).	**LOW** Lack of suitable habitat within Survey Area with few previous records.
Rainbow Bee-eater *Merops ornatus*	M	S3		Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water.	Eleven NatureMap records within 70 km of the Survey Area, In addition, 17 records from the Central Pilbara Project, 15 records from Solomon Project and 10 records from the Delphine and Mt Farquhar Project (DEC 2012; *ecologia* 2010, 2011a, in prep-a). Species recorded during other consultancy's survey in the region.	**RECORDED** Species frequently recorded within Pilbara, recorded on four occasions from major creekline habitat during current surveys.
Peregrine Falcon *Falco peregrinus*		S4	Other	Widespread; coastal cliffs, riverine gorges and wooded watercourses.	At least eight previous records within 100 km, mainly south and east of Survey Area (DEC 2012; *ecologia* 2011b, ecologia internal database).	**RECORDED** Single individual recorded during targeted conservation significant fauna assessment in hilltops, hillslopes, ridges and cliffs habitat type.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Grey Falcon *Falco hypoleucos*			P4	Lightly wooded coastal and riverine plains.	Recorded from western arm of Delphine survey area, within 5 km of Survey Area (*ecologia* in prep-a). At least three regional records within 100 km of Survey Area (DEC 2012).	**HIGH** Recorded very close by during concurrent survey in hilltops, suitable habitat occurs within the hillslopes, ridges and cliffs habitat type.
Australian Bustard *Ardeotis australis*			P4	Open grasslands, chenopod flats and low heathland.	Numerous surrounding records, closest being within 20 km during concurrent Western Hub surveys (Biota 2005b, 2009b; *ecologia* in prep-a; Mattiske and Ninox 1990).	**HIGH** Although the Survey Area doesn't contain typical habitat, this widespread, nomadic species is likely to occur within Survey Area on occasions.
Bush Stone-curlew *Burhinus grallarius*			P4	Lightly wooded country next to daytime shelter of thickets or long grass.	Numerous surrounding records, closest being within 20 km during concurrent Western Hub surveys (Ecoscape 2010). In addition Birdata list records of this species in the region.	**HIGH** Not recorded on current survey; however, many surrounding records and suitable habitat present.
Star Finch (western) *Neochmia ruficauda subclarescens*			P4	Vegetation around watercourses, particularly thick reed beds.	Four records within 90 km of the Survey Area, closest being approximately 50 km east of Survey Area (Kendrick 1995; Mattiske and Ninox 1990) *ecologia* internal database).	**MEDIUM** High quality habitat restricted to permanent water pools, where this species may occasionally occur.
Reptiles						
Pilbara Olive Python *Liasis olivaceus barroni*	VU	S1	VU	Watercourses and areas of permanent water in rocky gorges, escarpments and gullies.	Two recent records during Eliwana/Flying Fish survey (*ecologia* in prep-b) approximately 20 km south of Survey Area. Other previous records from Solomon Project and Central Pilbara project (*ecologia* 2010, 2011a). Two records from Tom Price and one record from Karijini National Park (DEC 2012). Previously recorded by Biota (Biota 2009a, b) and Ecoscape (2010).	**HIGH** Nearby records with high quality habitat present within the gorges and gullies habitat type and along major creeklines habitat types (Figure 5.3).

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Ramphotyphlops ganei			P1	Variety of habitats; thought to prefer moist gorges.	Number of records between 60 - 100 km from Survey Area (DEC 2012; *ecologia* 2010, 2011a).	**HIGH** Infrequently recorded species with known habitat within Survey Area in the gorges and gullies, and major creeklines habitat types.
Notoscincus butleri			P4	Associated with stony/rocky, spinifex-dominated areas near creek and river margins.	Recorded close by from concurrent Western Hub surveys (*ecologia* in prep-a, b), Solomon Project and Central Pilbara project (*ecologia* 2010, 2011a) and four previous surveys within 100 km (Biota 2005b, 2006, 2009b; Coffey 2008).	**HIGH** Nearby records with habitat present throughout the Survey Area.
Fish						
Fortescue Grunter *Leiopotherapon aheneus*			P4	Permanent water pools or streams.	Recorded from Delphine (*ecologia* in prep-a) in Duck creek.	**MEDIUM** Tributaries within Survey Area connect with Duck Creek, where this species has been recorded recently.

5.3.1 Conservation significant mammal species descriptions

5.3.1.1 Northern Quoll (*Dasyurus hallucatus*)

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

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

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

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

Likelihood of Occurrence: High. No Northern Quolls or evidence of Northern Quoll were recorded from the current surveys. However, recent records have been made within the Hamersley Range, both 40 km west of the Survey Area in the Delphine survey area (*ecologia* in prep-a) and 90 km east of the Survey Area from Solomon (Coffey 2008; Ecoscape 2010) (Figure 2.5). These records, and the presence of potential suitable habitat for denning, and foraging and dispersal habitat within the Survey Area (Figure 5.1), suggest there is a high likelihood of Northern Quolls ocurring within the Survey Area. In particular, the presence of long standing pools of water within rocky gorge habitat represents high quality habitat for this species (Figure 4.5).

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

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

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

Recent evidence suggests two main stronghold areas for the Pilbara Leaf-nosed Bat; in the western Pilbara and north of Marble Bar (Armstrong 2008). In the western Pilbara, they roost in caves formed in gorges that dissect siliceous sedimentary geology. They are most often 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 shallow 'break-away' caves that occur along mesas and strike ridges as these do not provide suitable roosting habitat.

Ecology: At dusk, Pilbara Leaf-nosed Bats emerge from their roosting sites to forage in gorges, small gullies and large watercourses for insects (van Dyck and Strahan 2008). They are susceptible to

disturbance and will abandon roost caves if disturbed. Colonies in mines in the eastern Pilbara are subject to several pressures, including human visitation, and the collapse and flooding of disused mines (Armstrong 2008; DEWHA 2008b).

Likelihood of Occurrence: Recorded. The Pilbara Leaf-nosed Bat was recorded on seven occasions from the Level 2 vertebrate fauna and targeted conservation significant fauna assessment (Figure 4.10, Table 4.5). No potential roost caves were identified from within the Survey Area; however, suitable roost caves may potentially occur, particularly within the gorges and gullies habitat type (Figure 5.2). Call analysis of the records made suggest individuals of this species are currently utilising the Survey Area as foraging habitat only. Temporal pattern analyses of calls recorded during the targeted conservation significant fauna assessment are shown in Appendix F. These records show few calls were recorded, with the largest quantity of calls recorded at MF B19 on the 17 July, where six calls were recorded. This site was located at water pool 1 (Figure 3.1, Figure 4.6), which represents a high quality foraging location. Two calls were recorded the following night at the same location, potentially indiciating a small number of individuals regularly utilise this location for foraging. Based on the information gathered from this survey, and concurrent Western Hub surveys, it appears a Pilbara Leaf-nosed Bat roost cave would be located within a 15 km radius of the Survey Area (Bob Bullen pers. comms.). Suitable foraging and areas of potential roosting (if suitable caves are present) habitat for the Pilbara Leaf-nosed Bat was identified within the Survey Area (Figure 5.2).

5.3.1.3 Long-tailed Dunnart (*Sminthopsis longicaudata*)

Conservation Status: DEC Priority 4.

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

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

It is not possible to identify any threatening processes at this stage as little is known about this species. Threats may include inappropriate fire regimes and habitat modification as a result of the activities of introduced herbivores such as horses and cows, invasion by *Buffel Grass and predation by feral cats and foxes (Pavey 2006).

Likelihood of Occurrence: High. No records of this species were made during the current survey though records exist from 20 km east of Survey Area in adjoining similar habitat. Within the Survey Area suitable habitat for this species occurs within the hilltops, hillslopes, ridges and cliffs habitat type. Small mammal capture rates during the survey appeared to be reduced due to cool weather during the survey, increasing the likelihood of this species not being recorded during surveying. Suitable habitat for this species exists within the hilltops, hillslopes, ridges and cliffs habitat type.

5.3.1.4 Ghost Bat (*Macroderma gigas*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Ghost Bat has a patchy but widespread distribution across northern Australia. Preferred roosting habitats in the Pilbara include caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles. Ghost Bats have also been known to roost in large colonies within sandstone caves, under boulder piles and in abandoned mines (Churchill 1998). Ghost Bats disperse widely during the non-breeding season but require warm caves with high relative humidity (80%) for rearing their young (Toop 1985). These maternity caves are uncommon with only eleven recorded in the Pilbara region (three natural caves and eight mines) (Armstrong and Anstee 2000).

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

Likelihood of Occurrence: High. This species was not recorded during the current survey, despite relatively intense survey effort for bat species. Despite this, the Ghost Bat has a high likelihood of occurring due to nearby records approximately 20 km south and east of the Survey Area (Figure 2.5). Suitable foraging and potential roosting habitat (dependent on suitable caves being present) for the Ghost Bat within the Survey Area, is synonymous with the Pilbara Leaf-nosed Bat foraging and potential roosting habitat that was identified within the Survey Area (Figure 5.2).

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

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Western Pebble-mound Mouse occurs across the 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, 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 at the same time. The demographic structure of the groups that inhabit the mounds and their patterns of movement around the mounds is still unknown (Anstee 1996; Anstee *et al.* 1997). Mounds can cover an area of 0.5 to 9.0 m^2, and a single mound can house up to 25 mice (Start 2008). Breeding occurs throughout the year with females producing several litters of four young per year (Start 2008).

Likelihood of Occurrence: High. This species is widespread in the region, with captures and active mounds recorded at over 60 locations (Coffey 2008, DEC rare fauna; DEC 2012; *ecologia* 2010, 2011b). Despite this no individuals or evidence of mounds were recorded within the Survey Area. However due to the numerous nearby records, and suitable habitat within the hilltops, hillslopes, ridges and cliffs and footslopes and plains habitat types, this species has a high likelihood of occurrence. Suitable habitat for the Western Pebble-mound Mouse exists within the footslopes and plains, and hilltops, hillslopes, ridges and cliffs habitat types within the Survey Area.

5.3.2 Conservation significant bird species descriptions

5.3.2.1 Fork-tailed Swift (*Apus pacificus*)

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

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

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

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

5.3.2.2 Rainbow Bee-eater (*Merops ornatus*)

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

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

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

Likelihood of Occurrence: Recorded. The Rainbow Bee-eater was recorded from four locations during the current survey (Figure 4.10, Table 4.5), and is regularly recorded from the region (Figure 2.6). The major creeklines habitat type represents best quality habitat for this species.

5.3.2.3 Peregrine Falcon (*Falco peregrinus*)

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

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

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

Likelihood of Occurrence: Recorded. A single individual of this species was recorded during the targeted conservation significant fauna assessment (Figure 4.10, Table 4.5). The individual was observed foraging along a ridgeline. Potential nesting habitat exists within the hilltops, hillslopes, ridges and cliffs habitat type, which is the most important habitat for the Peregrine Falcon as it provides suitable breeding habitat. Foraging habitat can vary and the species is able to travel away from disturbed foraging habitat.

5.3.2.4 Grey Falcon (*Falco hypoleucos*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: Grey Falcons are a rare, nomadic species sparsely distributed across much of arid and semi-arid Australia. In Western Australia, they are restricted to the northern half, occurring in a variety of habitats ranging from wooded drainage systems through to open spinifex plains. Grey Falcons once occurred across much of Western Australia, with sightings as far south as York and New Norcia during colonial times. However, the current distribution is now thought to be restricted to north of 26 °S (Johnstone and Storr 1998). Because the distribution of this species is very 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 most other large falcons, this species preys primarily on birds such as parrots and pigeons, although reptiles and mammals are also taken (Ehmann and Watson 2008). Two to three eggs are laid in winter in the disused nests of other birds of prey and ravens, typically in tall eucalypt trees near water (Ehmann and Watson 2008; Garnett and Crowley 2000).

Likelihood of Occurrence: High. A single Grey Falcon was recorded just 4 km west of the Survey Area during the concurrent Delphine survey (*ecologia* in prep-a). This species is infrequently recorded, reflected by few regional records (Figure 2.6). Due to the proximity of the Delphine survey area and the similarity of suitable habitats within both survey areas, there is a high likelihood of occurrence for this species in the Mt Farquhar survey area. Suitable breeding habitat is potentially present along cliffs and ridges within the hilltops, hillslopes, ridges and cliffs habitat type, and footslopes and plains can be utilised as foraging habitat.

5.3.2.5 Australian Bustard (*Ardeotis australis*)

Conservation Status: DEC Priority 4.

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

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

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

Likelihood of Occurrence: High. The Australian Bustard was not recorded during the current survey, however numerous surrounding records exist (Figure 2.6). Although typical habitat for this species in the form of open plain habitats does not exist within the Survey Area, the generalist nature of the species suggests it still has a high likelihood of occurrence, particularly within the footslopes and plains habitat type.

5.3.2.6 Bush Stone-curlew (*Burhinus grallarius*)

Conservation Status: DEC Priority 4.

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

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

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

Likelihood of Occurrence: High. The Bush-stone Curlew was not recorded on the current survey, however many relatively close-by records exist (Figure 2.6), with suitable habitat within the major creekline habitat type, resulting in a high likelihood of this species occurring within the Survey Area.

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

Conservation Status: DEC Priority 4.

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

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

Likelihood of Occurrence: Medium. Relatively few records exist for this species nearby, with the closest record being approximately 45 km south east of the Survey Area. Within the Survey Area, habitat is restricted to areas of water congregation, such as water pools 1 and 2, which represent high quality, albeit small and isolated, habitat. The major creeklines habitat type could potentially be suitable following periods of rainfall. Due to few surrounding records, and limited potential habitat, this species has a medium likelihood of occurrence.

5.3.3 Conservation significant reptile species descriptions

5.3.3.1 Pilbara Olive Python (*Liasis olivaceus barroni*)

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

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

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

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

Likelihood of Occurrence: High. There are two recent nearby records, from the concurrent Eliwana/Flying Fish survey, approximately 20 km south of the Survey Area. Suitable habitat was present in major creeklines and gorges and gullies. The Pilbara Olive Python is likely to shelter in the gorges and gullies and major creeklines habitat types within deep rocky crevices over the cooler winter months, when this species aestivates. Potential critical habitat for the Pilbara Olive Python includes areas where surface water collects such as deep bowls and depressions within rocky gorges (Figure 5.3). Given the high quality habitat within gorges and gullies habitat type, particularly in the vicinity of water pools 1 and 2, the Pilbara Olive Python has a high likelihood of occurrence. Within the immediate vicinity of water pools 1 and 2, numerous large rocky crevices and cracks are present,

providing ideal habitat (Figure 4.5). Due to the relatively mild conditions experienced during the survey (Appendix B), reptile activity was reduced, resulting in a low likelihood of detecting this species if present.

5.3.3.2 *Ramphotyphlops ganei*

Conservation Status: DEC Priority 1.

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

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

Likelihood of Occurrence: High. This species was not recorded during the current survey; however, it has previously been recorded approximately 80 km east and north-west of the Survey Area (Figure 2.7). Suitable habitat in the form of rocky gullies, gorges and plains exists within the gullies and gorges habitat type, as well as the footslopes and plains habitat, recorded within the Survey Area Despite the few surrounding records, a combination of the existence of records either side of the Survey Area, the cryptic nature of this species, and the existence of suitable habitat suggests this species has a high likelihood of occurrence.

5.3.3.3 Notoscincus butleri

Conservation Status: DEC Priority 4.

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

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

Likelihood of Occurrence: High. *Notoscincus butleri* was not recorded during the current survey; however, it was recorded from both concurrent Western Hub surveys, in addition to numerous other regional records (Figure 2.7). The major creeklines habitat type represents suitable habitat for this species. The existence of appropriate habitat and many surrounding records indicates this species has a high likelihood of occurrence.

5.3.4 Conservation significant fish species descriptions

5.3.4.1 Fortescue Grunter (*Leiopotherapon aheneus*)

Conservation Status: DEC Priority 4.

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

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

Likelihood of Occurrence: Medium. The Fortescue Grunter was recorded during the concurrent Delphine survey (*ecologia* in prep-a), within the Duck Creek river system. The major creeklines habitat type within the Survey Area is part of the catchment which feeds in to Duck Creek. Water pools 1 and 2 were observed containing two species of fish, Spangled Perch and Western Rainbow fish. Despite trapping for Fortescue Grunter, no individuals were recorded. Due to the Survey Area not containing any major river systems, there is only a medium likelihood of the Fortescue Grunter occurring within the Survey Area.

5.4 SURVEY ADEQUACY

Survey effort expended within the Survey Area is summarised in Table 3.4, which shows considerable systematic and opportunistic sampling effort was undertaken. In addition, Table 4.3 shows survey effort was adequate in sampling all fauna habitat types within the Survey Area.

Analysis of the observed avifauna assemblage recorded during the Level 2 vertebrate fauna assessment suggests the survey recorded 91.4% of the expected avifaunal assemblage, while analysis of data recorded during the Level 2 vertebrate fauna assessment of the trappable terrestrial faunal assemblage suggests the survey recorded 81.7% of the expected terrestrial faunal assemblage. Based on the shape of SACs, it is observed a plateau profile has not been achieved, particularly with trappable fauna. This suggests additional surveying is likely to reveal additional species not yet recorded. In summary, these results indicate that survey effort was adequate to provide an indication of the majority of the fauna assemblage present in the Survey Area. However, it is expected that a second phase of surveying during warmer climatic conditions would result in an increase in the number of species recorded.

The low diversity of mammals recorded (total of 20 species recorded) within the Survey Area is likely to be due to a combination of factors, such as a relatively small survey area, lack of habitat diversity, and sub-optimal survey conditions due to generally cool weather. It is known that small mammal species which inhabit arid interior of Australia enter a state of torpor during cool conditions (van Dyck and Strahan 2008). Due to the mild conditions experienced during the Level 2 vertebrate fauna assessment (Appendix B), it is likely many small mammals became less active, reducing their likelihood of capture. The terrestrial trappable fauna SAC produced supports this, showing that the SAC is yet to reach a plateau, indicating additional survey effort would likely capture additional species (Figure 4.8).

5.5 SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in Table 5.4 below. No significant limitations were experienced during the surveys, however relatively minor limitations in the form of weather and access occurred. The Level 2 vertebrate fauna assessment experienced mild conditions, which was likely to reduce reptile and small mammal activity, thus reducing their likelihood of detection. Access within the Survey Area was restricted mainly to the northern section, and south-east corner. Areas not accessible to vehicles were investigated on foot, however much of the centre of the Survey Area was not able to be accessed. However, areas of similar habitat were surveyed elsewhere in the Survey Area. Given no significant limitations were encountered, it can be confirmed that an adequate level of survey has been undertaken.

Table 5.4 – Summary of survey limitations

Limitation	Constraint (yes/no)	Comment
Competency/experience of the consultant carrying out the survey.	No	All members of the survey team were experienced in Pilbara fauna identification and fauna surveys.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	All habitat types were surveyed and their suitability as habitat for conservation significant species was assessed. All faunal groups were able to be adequately sampled.
Proportion of fauna identified, recorded and/or collected.	Yes (partial)	The survey was conducted as a single phase Level 2 vertebrate fauna assessment with an additional targeted Northern Quoll and Pilbara Leaf-nosed Bat assessment. Further survey effort during warmer conditions may result in an increase in recorded species.
Sources of information (previously available information as distinct from new data).	No	Previous data sourced from three database searches complimented with data from 20 publications from previous surveys.
The proportion of the task achieved and further work which might be needed.	Yes	A single phase Level 2 vertebrate fauna assessment was completed. The level of assessment for the Project may require a second phase of surveying conducted during the spring season.
Timing/weather/season/cycle.	Yes (partial)	Survey was completed at end of autumn, within recommended survey timing of guidelines, however mild temperatures are thought to have resulted in reduced capture rates for small vertebrate fauna species.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	No disturbances were encountered during the survey.
Intensity (in retrospect was the intensity adequate).	No	The survey intensity was adequate, all habitat types were surveyed.
Completeness (e.g. was relevant area fully surveyed).	Yes (partial)	Due to limited vehicle access, much of the centre region of the Survey Area could not be accessed, though areas of similar habitat were surveyed elsewhere in the Survey Area.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	All zoologists were suitably qualified and experienced in identification of Pilbara fauna. There were no other resource issues.

Limitation	Constraint (yes/no)	Comment
Remoteness and/or access problems.	Yes (partial)	Due to limited vehicle access, much of the centre region of the Survey Area could not be accessed, though areas of similar habitat were surveyed elsewhere in the Survey Area.
Availability of contextual (e.g. biogeographic) information on the region).	No	Sufficient contextual information was available on the Pilbara region and the Survey Area.
Efficacy of sampling methods (i.e. any groups not sampled by survey methods).	No	Survey methods were suitable to record all terrestrial vertebrate fauna groups.

6 CONCLUSION

The main conclusions of the Mount Farquhar Level 2 vertebrate fauna and targeted conservation significant fauna assessment are:

- The survey methods were consistent with the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*; Guidance Statement No. 56; Position Statement No. 3; and the EPBC Act Survey Guidelines for Australia's Threatened Mammals, Reptiles, Bats and Birds, as well as Fortescue's *Terrestrial Vertebrate Fauna Assessment Guidelines*. Species accumulation curves showed that the current survey was adequate overall, though with additional survey effort additional species would likely be recorded.

- The land systems, vegetation communities and habitats in the area support a moderately diverse group of fauna, including conservation significant fauna, but these are not restricted to the Survey Area.

- Four habitat types were identified within the Survey Area; hilltops, hillslopes, ridges and cliffs; footslopes and plains; major creeklines; and gorges and gullies.

- Statistical analyses of the terrestrial fauna data indicated that while the habitat types were different from each other, these were not large differences (the habitat types were not discrete). Insufficient avifauna data were available to demonstrate statistically significant differences between the habitat types utilised by birds.

- A total of 16 native and four introduced mammal species, 56 bird species, 34 reptile species and two fish species were recorded within the Survey Area.

- Three vertebrate species of conservation significance were recorded within the Survey Area: Pilbara Leaf-nosed Bat, Peregrine Falcon and Rainbow Bee-eater. A further 13 conservation significant vertebrate species are considered to have a medium or high likelihood of occurring within the Survey Area.

- Several records were made of the Pilbara-endemic gecko *Underwoodisaurus seorsus*, a newly described taxon recently separated from the more southerly *U. milii*, which represent a westward extension of approximately 60 km to the species' currently known range. Whilst the species is not currently listed as conservation significant, its status has been recommended for review. Impacts on this local population could potentially result in a reduction of the species' range, representing a regional impact.

- Results from the targeted conservation significant fauna assessment did not reveal any significant roost sites for Pilbara Leaf-nosed Bat or Ghost Bat, and no Northern Quolls were trapped or observed. Inaccessible areas containing gorges and gullies that that may potentially contain suitable denning and roosting habitat for Pilbara Leaf-nosed bat, Pilbara Olive Python and Northern Quoll have been mapped from aerial photography and based on the habitat assessments conducted during the Level 2 vertebrate fauna assessment.

- No major limitations on survey techniques were experienced, though access to some parts of the Survey Area was limited and mild weather conditions were experienced during the Level 2 vertebrate fauna assessment. These factors may have contributed to a reduced the capture rate of small mammals and herpetofauna.

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APPENDIX A EXPLANATION OF CONSERVATION CODES

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

Category	Definition
Endangered (EN)	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable (VU)	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Migratory (M)	Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state; • the agreement between the Government of Australian and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their environment (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). • the agreement between the Republic of Korea and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (ROKAMBA).

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

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

Appendix A3 Definition of DEC Threatened and Priority Fauna Codes

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

APPENDIX B DAILY WEATHER DATA DURING SURVEY

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Date	Daily minimum temperature (°C)	Daily maximum temperature (°C)	Rainfall (mm)
Level 2 Vertebrate Fauna Assessment			
18/5/12	13.8	31.9	0
19/5/12	11.8	30.9	0
20/5/12	15.8	30.6	0
21/5/12	13.6	28.7	0
22/5/12	11.3	28	0
23/5/12	12.4	26.8	0
24/5/12	12.4	24.2	0
25/5/12	11.1	24.3	0
26/5/12	11	24.7	0
27/5/12	9.4	25.2	0
28/5/12	9.3	25.6	0
Average	12	27.3	0
Targeted Conservation Significant Fauna Assessment			
12/7/12	7.3	23.6	0
13/7/12	10.4	21	0
14/7/12	8	21.3	0
15/7/12	6.1	23.1	0
16/7/12	5.2	25.9	0
17/7/12	7.2	28.9	0
18/7/12	17.3	27.4	0
19/7/12	15.9	28.5	0
20/7/12	13.6	23.6	0
Average	10.1	24.8	0

Note: climate data recorded from Paraburdoo (station 7185) weather station (BoM 2012).

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APPENDIX C REGIONAL FAUNA DATA

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APPENDIX D1 – MAMMALS

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

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

* introduced species

SA recorded from secondary evidence (active pebble-mound)

S recorded from secondary evidence (inactive pebble-mound)

APPENDIX D2 - BIRDS

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

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

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

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Mt. Farquhar (Ecoscape 2012d)	Delphine (Ecoscape 2012a)	Delphine (*ecologia* in prep-a)	Eliwana and Flying Fish (Ecoscape 2012b, c)	Eliwana and Flying Fish (*ecologia* in prep-b)	Raven (Ecoscape 2012e)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Central Pilbara Project (*ecologia* 2011b)	Kings Area Assessment (*ecologia* 2010)	West Turner Section 10 (Biota 2009b)	Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey	*ecologia* Internal Database
		EPBC Act	WC Act	DEC																						
Merops ornatus	Rainbow Bee-eater	M	S3		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●		●		●	●	●
CLIMACTERIDAE																										
Climacteris melanura	Black-tailed Treecreeper					●		●			●		●		●						●					●
PTILINORHYNCHIDAE																										
Ptilonorhynchus guttatus	Western Bowerbird				●	●		●		●	●	●	●	●	●	●		●	●					●	●
MALURIDAE																										
Malurus lamberti	Variegated Fairy-wren				●	●		●		●	●	●	●	●		●	●	●	●	●	●	●		●	●
Malurus leucopterus	White-winged Fairy-wren				●		●	●	●	●		●	●	●	●	●	●		●		●	●			●	●
Stipiturus ruficeps	Rufous-crowned Emu-wren				●			●		●			●	●	●	●		●	●		●	●			●	●
Amytornis striatus	Striated Grasswren				●			●		●			●	●	●	●	●	●	●	●					●	
ACANTHIZIDAE																										
Pyrrholaemus brunneus	Redthroat																								●	
Smicrornis brevirostris	Weebill				●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●			●	●
Gerygone fusca	Western Gerygone				●			●		●		●	●	●	●	●	●	●	●	●	●	●			●	
Acanthiza robustirostris	Slaty-backed Thornbill				●										●										●	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				●		●		●											●	●				●	
Acanthiza uropygialis	Chestnut-rumped Thornbill				●					●		●	●		●	●					●				●	
Acanthiza apicalis	Inland Thornbill				●							●	●		●	●					●					
Aphelocephala leucopsis	Southern Whiteface																			●					●	
PARDALOTIDAE																										
Pardalotus rubricatus	Red-browed Pardalote							●		●			●	●	●	●	●	●	●	●		●			●	●
Pardalotus striatus	Striated Pardalote				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
MELIPHAGIDAE																										
Certhionyx variegatus	Pied Honeyeater				●		●	●	●	●		●			●	●	●				●					
Lichenostomus virescens	Singing Honeyeater				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Lichenostomus keartlandi	Grey-headed Honeyeater				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Lichenostomus penicillatus	White-plumed Honeyeater				●		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●			●	●
Purnella albifrons	White-fronted Honeyeater							●		●		●	●	●												
Manorina flavigula	Yellow-throated Miner				●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●			●	●
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				●			●		●		●	●	●	●	●	●		●	●	●				●	
Conopophila whitei	Grey Honeyeater													●		●					●				●	
Epthianura tricolor	Crimson Chat				●			●		●		●	●	●	●				●		●				●	●
Sugomel niger	Black Honeyeater				●			●		●				●	●		●	●	●							●
Lichmera indistincta	Brown Honeyeater				●	●		●		●			●	●	●	●	●	●	●	●	●	●			●	●
Melithreptus gularis	Black-chinned Honeyeater							●		●	●		●	●	●		●		●	●	●				●	●
POMATOSTOMIDAE																										
Pomatostomus temporalis	Grey-crowned Babbler				●		●	●	●	●			●	●	●	●		●	●	●	●	●			●	●
Pomatostomus superciliosus	White-browed Babbler											S	●												●	
PSOPHODIDAE (CINCLOSOMATIDAE)																										
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush												●	●											●	

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Mt. Farquhar (Ecoscape 2012d)	Delphine (Ecoscape 2012a)	Delphine (*ecologia* in prep-a)	Eliwana and Flying Fish (Ecoscape 2012b, c)	Eliwana and Flying Fish (*ecologia* in prep-b)	Raven (Ecoscape 2012e)	Brockman 2 Detritals (Mattiske & Ninox 1990)	Brockman Syncline (Biota 2005b)	West Pilbara Iron Ore Project Mine Areas (Biota 2009a)	Central Pilbara Project (*ecologia* 2011b)	Kings Area Assessment (*ecologia* 2010)	West Turner Section 10 (Biota 2009b)	Mesa A and G (Biota 2005a)	Mesa A transport corridor (Biota 2006)	Firetail mining area (Ecoscape 2010)	Marandoo to Great Northern Hwy (Kendrick 1995)	NatureMap	DEC Rare Fauna	DSEWPaC Protected Matters Search	This survey	*ecologia* Internal Database
		EPBC Act	WC Act	DEC																						
Psophodes occidentalis	Chiming Wedgebill					●					●															
NEOSITTIDAE																										
Daphoenositta chrysoptera	Varied Sittella														●											
CAMPEPHAGIDAE																										
Coracina maxima	Ground Cuckoo-shrike				●			●					●		●	●	●									
Coracina novaehollandiae	Black-faced Cuckoo-shrike				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Lalage sueurii	White-winged Triller				●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
PACHYCEPHALIDAE																										
Pachycephala rufiventris	Rufous Whistler				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Colluricincla harmonica	Grey Shrike-thrush				●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●			●	●
Oreoica gutturalis	Crested Bellbird				●		●	●	●	●		●	●	●	●	●	●	●	●	●	●	●			●	●
ARTAMIDAE																										
Artamus leucorynchus	White-breasted Woodswallow																		●							
Artamus personatus	Masked Woodswallow				●			●		●		●		●	●	●	●				●				●	●
Artamus cinereus	Black-faced Woodswallow				●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Artamus minor	Little Woodswallow				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●
Cracticus torquatus	Grey Butcherbird				●			●		●		●	●	●	●	●	●		●	●	●				●	
Cracticus nigrogularis	Pied Butcherbird				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
Cracticus tibicen	Australian Magpie				●		●	●	●	●	●	●	●	●	●	●	●		●		●	●			●	
RHIPIDURIDAE (DICRURIDAE)																										
Rhipidura albiscapa	Grey Fantail							●								●		●							●	
Rhipidura leucophrys	Willie Wagtail				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
CORVIDAE																										
Corvus bennetti	Little Crow				●							●		●	●	●	●				●				●	
Corvus orru	Torresian Crow				●	●	●	●	●	●	●		●	●	●	●	●	●	●			●			●	●
MONARCHIDAE (DICRURIDAE)																										
Grallina cyanoleuca	Magpie-lark				●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●			●	
PETROICIDAE																										
Petroica goodenovii	Red-capped Robin				●			●			●	●	●		●	●					●				●	
Melanodryas cucullata	Hooded Robin				●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●			●	●
ALAUDIDAE																										
Mirafra javanica	Horsfield's Bushlark					●		●			●	●			●							●			●	
ACROCEPHALIDAE (SYLVIIDAE)																										
Acrocephalus australis	Australian Reed-Warbler							●											●						●	
MEGALURIDAE (SYLVIIDAE)																										
Cincloramphus mathewsi	Rufous Songlark				●			●		●			●	●	●		●	●	●		●	●			●	●
Cincloramphus cruralis	Brown Songlark							●		●		●	●	●	●	●	●		●			●			●	
Eremiornis carteri	Spinifex-bird				●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●

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

* introduced species

recorded during targeted conservation significant fauna assessment

S recorded from secondary evidence

APPENDIX D3 - REPTILES

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

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

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

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

APPENDIX D4 - AMPHIBIANS

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

APPENDIX D5 - FISH

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

APPENDIX D SITE DESCRIPTIONS

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Vegetation and Fauna Habitat Description	Site Photo
MF S1 A hummock grassland plain, dominated by dense spinifex. Shrub layer is open, consisting of mixed acacia species. No tree species present in immediate vicinity of site. Soil substrate rocky with continuous surface layer of loose pebbles. Habitat type: Footslopes and plains.	
MF S2 Hummock grassland plain with dense spinifex. Scattered eucalypt and mulga (*Acacia aneura*) trees present. Mixed acacia shrub species of medium density. Soil substrate clay sand of reddish brown colour with loose rocks through the soil profile, and a continuous surface layer of pebbles. Habitat type: Footslopes and plains.	

MF S3 Hummock grassland plain on footslopes of nearby hills and ranges. Very dense and tall spinifex. Scattered eucalyptus trees, with medium density of mixed acacia shrub species, with *Acacia inaequilatera* dominant. Some rocky surface outcropping of banded iron formation, with soil substrate otherwise clay sand with lose rocky pebbles and stones. Habitat type: Footslopes and plains.	
MF S4 Open eucalypt woodland, with large mature trees within creekline, with many younger trees on the adjoining fringing plain. Dense spinifex hummock grassland with medium density of primarily mixed acacia species. Soil substrate sandy loam of brownish colour with loose pebbles throughout soil substrate. Habitat type: Major creeklines	

MF S5 Hummock grassland on upper slopes of hill. Numerous and continuous in spots of outcropping banded iron formation. Eucalyptus trees present with scattered acacia shrub species. Soil substrate rocky. Habitat type: Hilltops, hillslopes, ridges and cliffs.	
MF S6 Hummock grassland on footslopes of hill. Scattered *Corymbia* sp. Open shrub layer of mixed acacia species, with patches of denser *Acacia ancistrocarpa*. Soil substrate sand clay, reddish brown with lose pebbles through soil profile and continuous surface layer of lose pebbles. Habitat type: Footslopes and plains.	

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APPENDIX E FAUNA SPECIES RECORDED DURING TRAPPING

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APPENDIX E1 - MAMMALS

Family and Species	Common name	MF S1	MF S2	MF S3	MF S4	MF S5	MF S6	MF opp	MF NQ PLNB Targeted Survey
DASYURIDAE									
Ningaui timealeyi	Pilbara Ningaui	5	3	4		7	2		
Planigale sp.		1		1		3	1		
Pseudantechinus woolleyae	Woolley's Pseudantechinus					1			
MACROPODIDAE									
Macropus robustus	Euro					2			1
Petrogale rothschildi	Rothschild's Rock-wallaby								1
HIPPOSIDERIDAE									
Rhinonicteris aurantia	Pilbara Leaf-nosed Bat		●			●			●
EMBALLONURIDAE									
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	●			●				●
Taphozous georgianus	Common Sheathtail Bat	●	●		●	●	●		●
VESPERTILIONIDAE									
Chalinolobus gouldii	Gould's Wattled Bat	●	●	●	●		●		●
Scotorepens greyii	Little Broad-nosed Bat						●		●
Vespadelus finlaysoni	Finlayson's Cave Bat	●	●	●	●		●		●
MOLOSSIDAE									
Chaerophon jobensis	Northern Freetail Bat	●	●	●	●	●	●		●
Mormopterus beccarii	Beccari's Freetail Bat		●		●				●
Tadarida australis	White-striped Freetail Bat				●				●
MURIDAE									
Pseudomys desertor	Desert Mouse		5	3	4		1		
Zyzomys argurus	Common Rock Rat				1				25
INTRODUCED MAMMALS									
**Bos taurus*	Cow							15	25
**Canis lupus*	Dog							2	
**Felis catus*	Cat								2
**Mus musculus*	House Mouse			1	3	1			

APPENDIX E2 - BIRDS

Family and Species	Common name	MF S1	MF S2	MF S3	MF S4	MF S5	MF S6	MF Opp	MF NQ PLNB Targeted Survey
COLUMBIDAE									
Phaps chalcoptera	Common Bronzewing	1							
Ocyphaps lophotes	Crested Pigeon		1		9				1
Geophaps plumifera	Spinifex Pigeon			2				5	
Geopelia cuneata	Diamond Dove			4	5			9	
EUROSTOPODIDAE									
Eurostopodus argus	Spotted Nightjar		1						
ACCIPITRIDAE									
Milvus migrans	Black Kite						1		
Accipiter fasciatus	Brown Goshawk							3	
Circus assimilis	Spotted Harrier	1	2	3			1	1	
Hieraaetus morphnoides	Little Eagle						1	2	
FALCONIDAE									
Falco cenchroides	Nankeen Kestrel		1				1	2	
Falco berigora	Brown Falcon		3				1		
Falco peregrinus	Peregrine Falcon								1
TURNICIDAE									
Turnix velox	Little Button-quail		9	5	1	1	2	4	1
CACATUIDAE									
Eolophus roseicapillus	Galah		39					4	
Cacatua sanguinea	Little Corella							60	
Nymphicus hollandicus	Cockatiel				3	6			
PSITTACIDAE									
Barnardius zonarius	Australian Ringneck		5		2	2		2	
Melopsittacus undulatus	Budgerigar	21	10	17	139	14	30	8	
CUCULIDAE									
Cacomantis pallidus	Pallid Cuckoo				5				1

Family and Species	Common name	MF S1	MF S2	MF S3	MF S4	MF S5	MF S6	MF Opp	MF NQ PLNB Targeted Survey
STRIGIDAE									
Ninox novaeseelandiae	Southern Boobook								1
HALCYONIDAE									
Todiramphus pyrrhopygius	Red-backed Kingfisher				2	1			1
MEROPIDAE									
Merops ornatus	Rainbow Bee-eater				1			2	1
CLIMACTERIDAE									
Climacteris melanura	Black-tailed Treecreeper				8				
PTILONORHYNCHIDAE									
Ptilonorhynchus guttatus	Western Bowerbird	1	1	6			1		1
MALURIDAE									
Malurus lamberti	Variegated Fairy-wren	11	23	4	5	2	5	5	8
Malurus leucopterus	White-winged Fairy-wren	2							
Stipiturus ruficeps	Rufous-crowned Emu-wren					1			2
ACANTHIZIDAE									
Smicrornis brevirostris	Weebill	22	27	6	44	19	22	11	2
PARDALOTIDAE									
Pardalotus rubricatus	Red-browed Pardalote			1	7	3	2	2	1
Pardalotus striatus	Striated Pardalote		2	5	4	6	3	2	1
MELIPHAGIDAE									
Lichenostomus virescens	Singing Honeyeater	12	14	3	7	2	2	4	
Lichenostomus keartlandi	Grey-headed Honeyeater	36	6	5	18	16	1	11	2
Lichenostomus penicillatus	White-plumed Honeyeater							8	
Manorina flavigula	Yellow-throated Miner	3	9	16	20	4		6	2
Epthianura tricolor	Crimson Chat	1		26	15		24	7	
Sugomel niger	Black Honeyeater			23	16		1	2	
Lichmera indistincta	Brown Honeyeater	10		46	27		6	19	5
Melithreptus gularis	Black-chinned Honeyeater			3	6			4	1

Family and Species	Common name	MF S1	MF S2	MF S3	MF S4	MF S5	MF S6	MF Opp	MF NQ PLNB Targeted Survey
POMATOSTOMIDAE									
Pomatostomus temporalis	Grey-crowned Babbler		3					6	
CAMPEPHAGIDAE									
Coracina novaehollandiae	Black-faced Cuckoo-shrike		2	3		16	2	1	5
Lalage sueurii	White-winged Triller			6	4	4	27	3	2
PACHYCEPHALIDAE									
Pachycephala rufiventris	Rufous Whistler		7	2	6		1	4	
Colluricincla harmonica	Grey Shrike-thrush	1	1	3	4	4	2	6	
Oreoica gutturalis	Crested Bellbird	1	1						
ARTAMIDAE									
Artamus personatus	Masked Woodswallow	4	10	64	32	31	356	43	
Artamus cinereus	Black-faced Woodswallow			5	15		4		
Artamus minor	Little Woodswallow					2		3	5
Cracticus nigrogularis	Pied Butcherbird			5	2	2	3	3	1
RHIPIDURIDAE									
Rhipidura leucophrys	Willie Wagtail	1	2	2	5		3	2	
CORVIDAE									
Corvus orru	Torresian Crow		6	2	2	3		2	
PETROICIDAE									
Melanodryas cucullata	Hooded Robin	9	1		1	1			
MEGALURIDAE									
Cincloramphus mathewsi	Rufous Songlark				3	3			1
Eremiornis carteri	Spinifexbird	3	4	2		1		1	1
NECTARINIIDAE									
Dicaeum hirundinaceum	Mistletoebird	5	1			2		1	1
ESTRILDIDAE									
Taeniopygia guttata	Zebra Finch	15	42	35	53	6	11	32	40
Emblema pictum	Painted Finch	4	4	44	4	37	6	88	12

APPENDIX E3 - REPTILES

Family and Species	Common Name	MF S1	MF S2	MF S3	MF S4	MF S5	MF S6	MF Opp	MF NQ PLNB Targeted Survey
AGAMIDAE									
Amphibolurus longirostris	Long-nosed Dragon			3	3			28	
Ctenophorus caudicinctus	Ring-tailed Dragon	9	1			1	5	9	1
DIPLODACTYLIDAE									
Oedura marmorata	Marbled Velvet Gecko							4	
CARPHODACTYLIDAE									
Nephrurus wheeleri	Banded Knob-tailed Gecko						2		
Underwoodisaurus seorsus						5			
GEKKONIDAE									
Gehyra pilbara		1							
Gehyra punctata								1	
Gehyra variegata					2				
Heteronotia binoei	Bynoe's Gecko		1	4			1		
PYGOPODIDAE									
Delma nasuta			1		1		1		
Delma pax					1				
Liasis burtonis	Burton's Legless Lizard								1
SCINCIDAE									
Carlia munda		1		9	7	2	3	20	
Cryptoblepharus ustulatus								10	1
Ctenotus grandis		1			1				
Ctenotus helenae		1	2	1	1	1	1		
Ctenotus pantherinus	Leopard Ctenotus	4	5	9	1		8		
Ctenotus rubicundus						1			
Ctenotus saxatilis	Rock Ctenotus			1	1	3	1	2	
Ctenotus schomburgkii		1							
Egernia formosa								2	
Lerista flammicauda								2	

Family and Species	Common Name	MF S1	MF S2	MF S3	MF S4	MF S5	MF S6	MF Opp	MF NQ PLNB Targeted Survey
Morethia ruficauda						2		3	
Tiliqua multifasciata	Central Blue-tongue		1						
VARANIDAE									
Varanus acanthurus	Spiny-tailed Monitor			1		1			
Varanus pilbarensis	Pilbara Rock Monitor							1	
Varanus tristis tristis	Racehorse Monitor							3	
ELAPIDAE									
Acanthophis wellsi	Pilbara Death Adder			1				1	
Demansia psammophis	Yellow-faced Whipsnake				1			1	
Demansia rufescens	Rufous Whipsnake						1		
Furina ornata	Moon Snake					2			
Parasuta monachus	Hooded Snake				1				
Pseudechis australis	Mulga Snake						1		
Pseudonaja modesta	Ringed Brown Snake	1							

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

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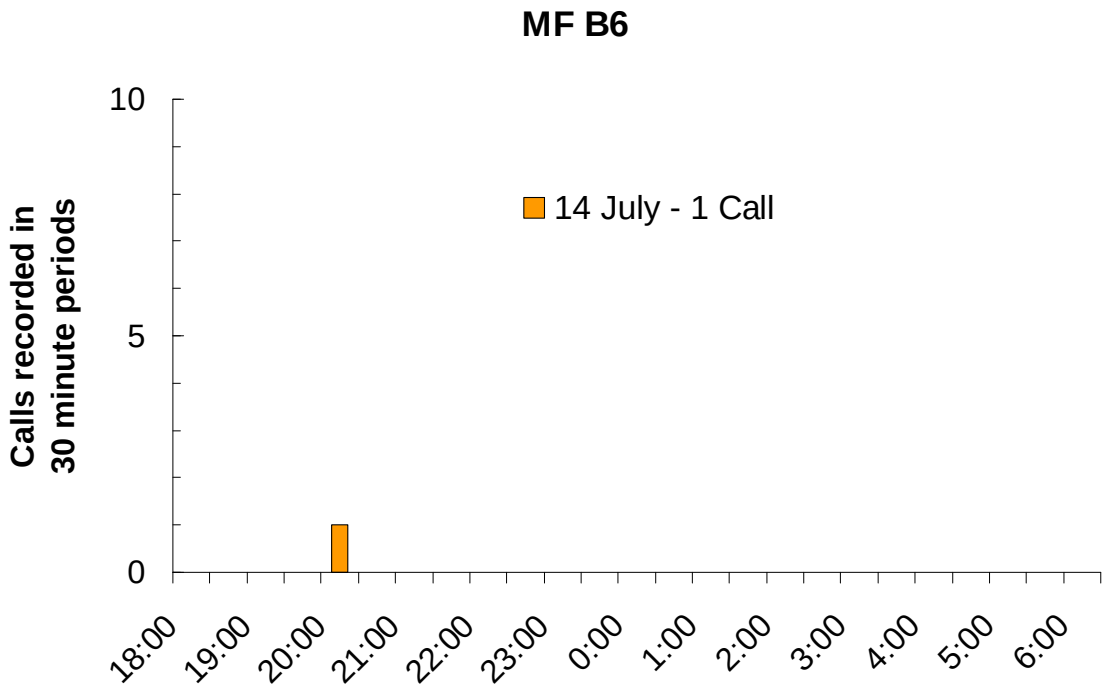
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14 July - 1 Call
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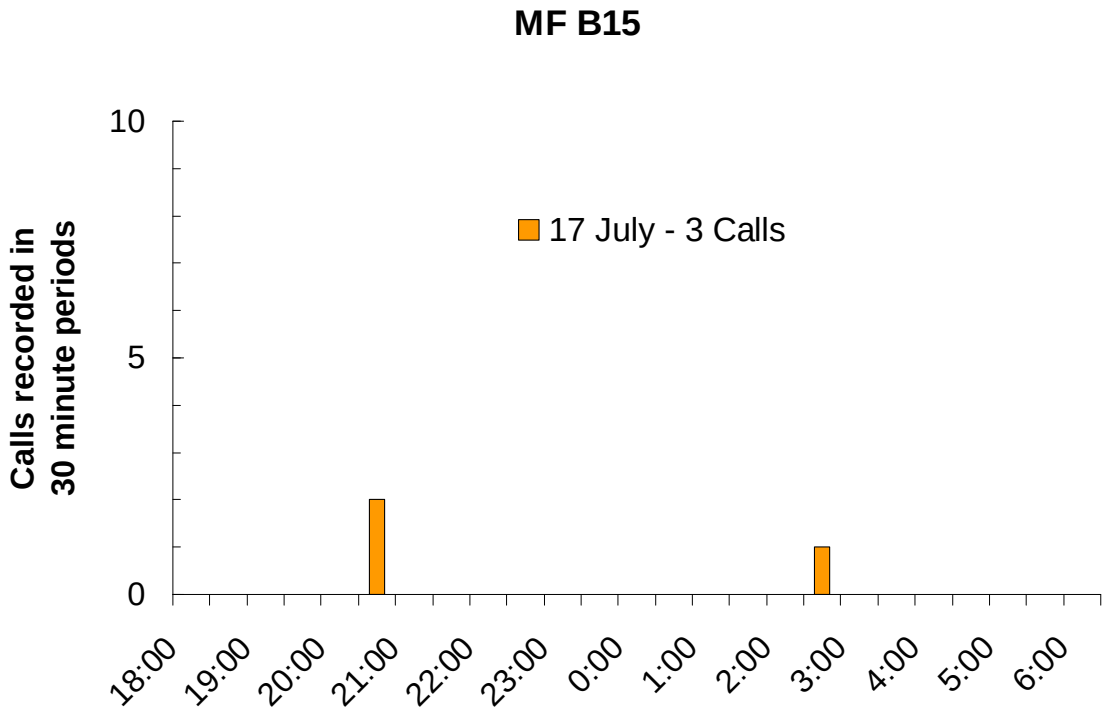
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00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17 July - 3 Calls
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20:00
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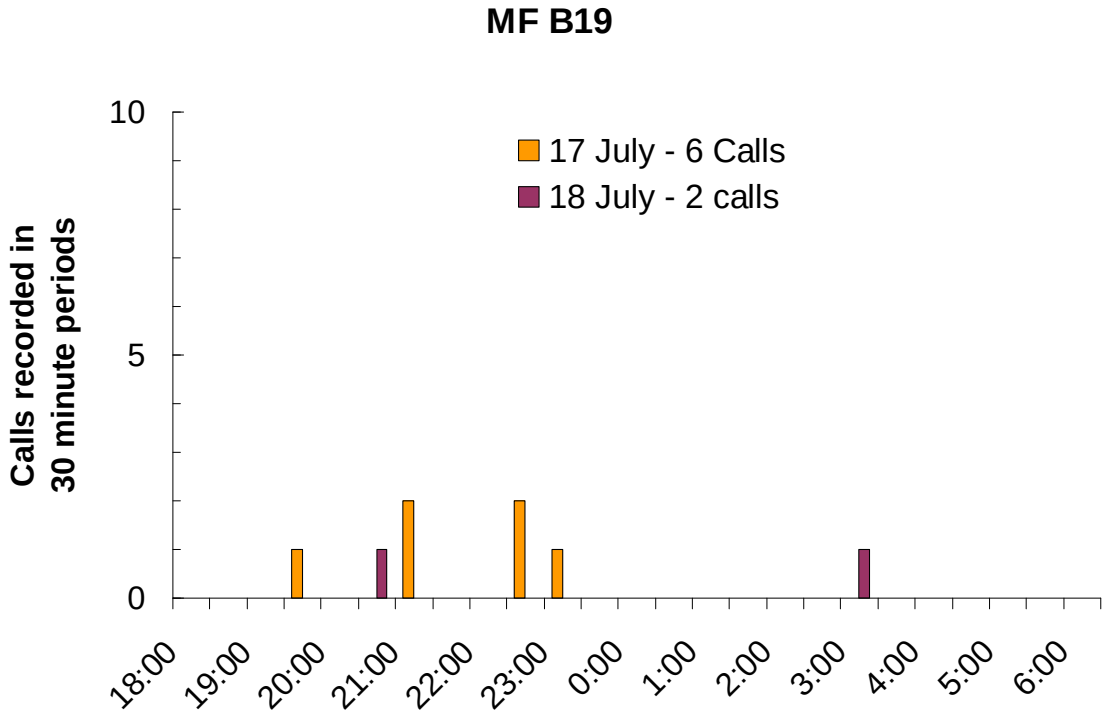
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00


MF B19
Calls recorded in 30 minute periods
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5
0
17 July - 6 Calls
18 July - 2 calls
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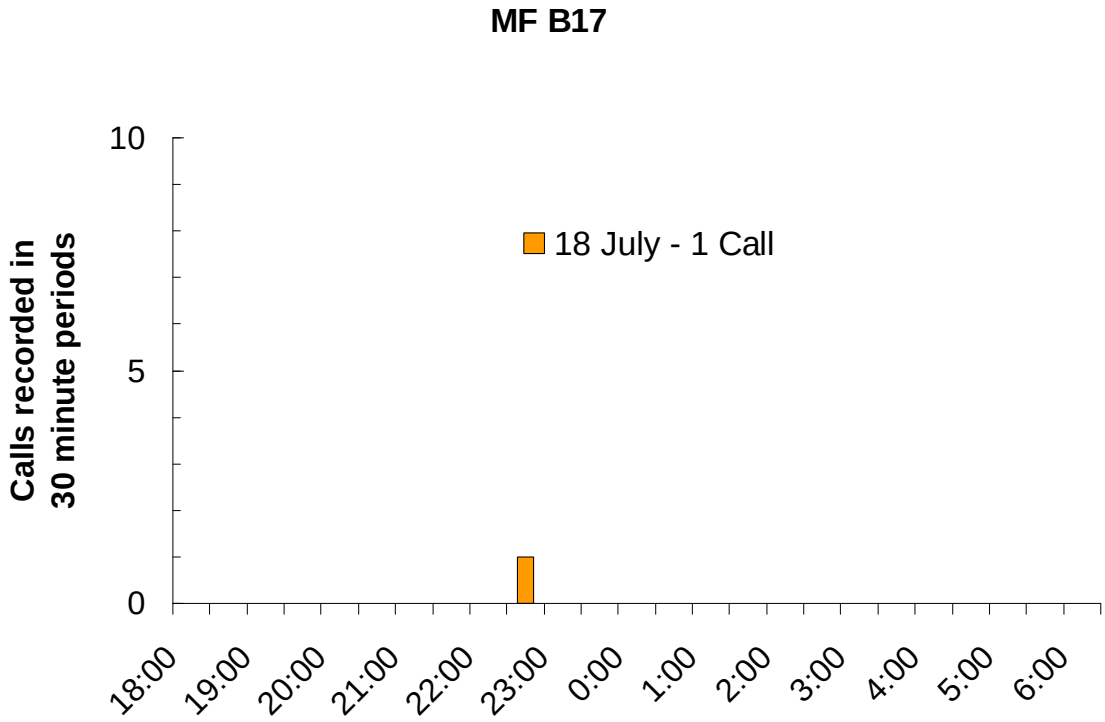
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00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Calls recorded in 30 minute periods
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5
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18 July - 1 Call
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19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00