OCTOBER 2014

Providing sustainable environmental strategies,
management and monitoring solutions
to industry and government.

ecologia
ENVIRONMENT

FORTESCUE METALS GROUP LTD
SOLOMON HUB
VERTEBRATE FAUNA ASSESSMENT

This page has been left blank intentionally

Document Status						
Rev.	**Author/s**	**Reviewer/s**	**Date**	**Approved for Issue**		
				Name	**Distribute To**	**Date**
A	D. Cancilla A. Heidrich B. Greatwich J. Graff K. McMaster	D. Cancilla	15/08/2014			
0	B. Greatwich A. Heidrich J. Graff	D. Cancilla	1/09/2014	M. Wohling	S. Grein T. Edwards	1/09/2014
1	B. Greatwich D. Cancilla N. Jackett J. Graff	D. Cancilla	1/10/2014	M. Wohling	S. Grein T. Edwards	1/10/2014
2	N. Jackett	D. Cancilla	2/10/2014	M. Wohling	S. Grein T. Edwards	2/10/2014
2a	A. Heidrich	D. Cancilla	23/10/14	M. Wohling	S. Grein T. Edwards	23/10/14
3	A. Heidrich D. Cancilla	D. Cancilla	27/10/14	M. Wohling	S. Grein T. Edwards	28/10/14
4	B. Greatwich	B. Greatwich	6/05/14	M. Macdonald	T. Edwards A. Barker	6/05/2015

Restrictions on Use

This report has been prepared specifically for Fortescue Metals Group Ltd. Neither the report nor its contents may be referred to or quoted in any statement, study, report, application, prospectus, loan, or other agreement document (with the exception of when this document is required to be publicly released as part of a statutory approval process), without the express approval of Fortescue Metals Group Ltd.

ecologia Environment

Level 8, Carillon City Office Tower
207 Murray Street
PERTH WA 6000
Phone: +61 (0) 8 6180 4450
Fax: +61 (0) 8 6180 4451
Email: admin@ecologia.com.au

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS

ANOSIM	Analysis of Similarity
BoM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
DEC	Department of Environment and Conservation (now DPaW or DER)
DPaW	Department of Parks and Wildlife
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
IBRA	Interim Biogeographic Regionalisation of Australia
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australian Migratory Bird Agreement
nMDS	Non-metric Multidimensional Scaling
NHMRC	National Health and Medical Research Centre
NP	National Park
PRI	Pilbara Regional Inventory
SAC	Species Accumulation Curve
SPRAT	Species Profile and Threats (Database)
UCL	Unallocated Crown Land
WA	Western Australia
WAM	Western Australian Museum
WC Act	*Wildlife Conservation Act 1950*

This page has been left blank intentionally

EXECUTIVE SUMMARY

Fortescue Metals Group (Fortescue) is investigating options to expand the Solomon Hub, including the expansion of the mine footprint, the development of two new borefields to the south and north east, and new resources at the Solomon Mine Hub. This project covers 183,201 ha, and is located approximately 40 km north of Tom Price in the Pilbara region of Western Australia.

As part of the environmental approvals processes for the development of the Solomon Hub, baseline vertebrate fauna assessments are required to assess potential impacts and identify appropriate management strategies. Fortescue commissioned *ecologia* Environment (*ecologia*) to combine the results of previous surveys and complete vertebrate fauna assessments (including targeted fauna surveys) in any identified field assessment gaps.

Prior to the development of field survey methods, a review was undertaken of factors likely to influence survey design and intensity. Based on this review, it was deemed necessary that a single phase Level 2 vertebrate fauna as well as a targeted conservation significant fauna assessment be conducted within the study area. The literature review showed 30 previous terrestrial vertebrate fauna surveys have been carried out within 100 km of the study area, 19 of these surveys occur within or partially overlap the current study area.

The Level 2 survey was completed in April 2014, with a total of 16 systematic trapping sites established. A targeted conservation significant fauna survey was completed 10 weeks later, with 8 sites totalling 200 cage traps targeting Northern Quoll. The survey was undertaken using a variety of sampling techniques, including systematic, opportunistic and targeted species methods. 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. Thirty minute set-time surveys were used to document the avifauna present at each of the fauna sites. Bat echolocation calls were recorded using SM2BAT long term passive recorder. Both trapping and opportunistic sites were searched by hand for cryptic species. A total of 38 long term motion cameras were established during the level 2 survey, which were then left in place for a duration of 10 weeks and collected during the targeted survey.

Survey effort expended within the study area for the current and previous surveys included the following:

- trapping grids were open for seven trap nights;
- 22,550 pitfall trap nights were completed;
- 32,645 funnel trap nights were completed;
- 26,905 elliott trap nights were completed;
- 12,614 cage trap nights were completed;
- 306 were spent surveying for birds;
- 386 hours were spent on opportunistic diurnal searching;
- 67,861 hours of camera trapping was analysed; and,
- 3,244.5hours of Bat recordings were analysed to determine bat assemblage and distribution.

Of this, the current survey effort within the study area was following; 1,120 pitfall trap nights, 2,240 funnel trap nights, 1,120 Elliot trap nights, 1,672 cage trap nights, 36 hours of bird surveys, 17.5 hours of diurnal opportunistic surveys, 636 hours of SM2Bat recordings analysed, 14 hours of nocturnal opportunistic surveys and 63,840 hours of motion camera.

A total of 11 broad-scale fauna habitats were recorded within the study area which were also recorded outside the study area. Each habitat type and the precentage of their extent within the study area are following:

- Plain (stony gibber) (includes lower slopes and midslopes) (45.4%);
- Hilltops/ridges/plateaux (12.5%);
- Plain (Alluvial) (11.3%);
- Plain (Cracking clay) (10.3%);
- Hummock grassland (6.0%);
- Shrubland (Open) (5.0%);
- Woodland (Open Eucalypt) (3.3%);
- Plain (stony calcrete) (3.0%);
- Drainage line/River/Creek (Major) (2.2%);
- Gorges and Gullies (1.0%); and
- Tussock grassland (on loam/clay) (<0.1%).

Species accumulation curves (SACs) were calculated for mammals, birds and reptiles to test the adequacy of survey effort in the study area. Systematically obtained data (trapping results for terrestrial fauna and set-time surveys for birds) from the current survey were used to prepare the SACs, along with such data from previous surveys conducted by *ecologia* in or immediately adjacent to the study area. This amounted to 833 trap nights for terrestrial fauna (terrestrial mammals and reptiles) and 690 standardised bird surveys. Analysis of systematically obtained survey data for terrestrial mammals, birds, and reptiles indicated that the overall survey effort was very adequate. SACs for mammals, birds and reptiles produced estimated species richness ranging from 68-108%, 88-106% and 87-101% respectively.

The literature review identified 30 vertebrate fauna species, listed as either conservation significant (EPBC Act, WC Act Schedule 1) or priority fauna (DPaW Priority list), that could potentially occur within the study area; nine mammal species, 17 bird species and four reptile species. An assessment of their likelihood of occurrence was completed.

A total of 16 of these listed species were recorded during the current survey, and from surveys conducted previously which overlap the study area. A further three species are assessed as having a high likelihood of occurrence and one species as having a medium likelihood of occurrence. The remaining 11 species are considered to have a low likelihood of occurrence

Three conservation significant fauna species have been recorded within the study area:

- Northern Quoll – EPBC Act Endangered, WC Act Schedule 1 (Endangered);
- Pilbara Leaf-nosed Bat – EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable) (foraging individual only); and
- Pilbara Olive Python – EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

Based on the results of the combined surveys within the study area, three habitat types are considered suitable for three EPBC Act threatened fauna known to occur within the study area:

The Gorges/Gullies habitat type covers 1.0% of the sudy area and 0.6% of the area within 30 km of study area. It is considered suitable habitat for:

- Northern Quoll (denning and foraging)
- Pilbara Leaf-nosed Bat (foraging)
- Pilbara Olive Python (winter shelter and foraging)

The Drainage line/River/Creek (Major) covers 2.1% of the sudy area and 1.1% of the area within 30 km of study area, and is considered suitable habitat for:

- Northern Quoll (dispersal and foraging)
- Pilbara Leaf-nosed Bat (foraging)
- Pilbara Olive Python (dispersal and foraging)

The Hilltops/ridges/plateaux habitat type covers 12.5% of the sudy area and 5.6% of the area within 30 km of study area. It is considered suitable habitat for:

- Northern Quoll (dispersal and foraging)
- Pilbara Olive Python (dispersal and foraging)

No significant survey limitations were encountered during the current survey. By consolidating the results of all previous surveys, survey limitations caused by survey timing, climate etc have been minimised as the surveys conducted within the study area have occurred over a 5 year period, during all seasons and using a wide variety of sampling methodology.

This page has been left blank intentionally

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group (Fortescue) is investigating options to expand the Solomon Hub, including the expansion of the mine footprint, the development of two new borefields to the south and north east, and new resources at the Solomon Mine Hub (study area). This study area covers 183,201 ha, and is located approximately 40 km north of Tom Price in the Pilbara region of Western Australia (Figure 1.1).

As part of the environmental approvals processes for the development of the Solomon Hub, baseline vertebrate fauna assessments are required to assess potential impacts and identify appropriate management strategies. These assessments will also assist with environmental approvals for proposed exploration and development.

A number of baseline and targeted vertebrate fauna surveys have been previously conducted within and surrounding the study area. Fortescue commissioned *ecologia* Environment (*ecologia*) to consolidate the results of these surveys and fill any gaps identified with field surveys. *ecologia* conducted a single phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna survey within these areas within the study area.

1.2 LEGISLATIVE FRAMEWORK

The *Environmental Protection Act 1986* 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 are required to be addressed to ensure that the objectives of the Act are met. 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*

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

In addition to these principles, projects undergoing 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 2004b), 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 *Wildlife Conservation Act 1950* (WC Act).

The EPBC Act also takes into consideration 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 EPBC 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. Definitions of categories relevant to fauna occurring or potentially occurring in the study area are provided in Appendix A.

The Western Australian *Wildlife Conservation Act 1950* (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 (Appendix A). These species are considered Threatened Fauna. The current listing was gazetted on 17 September 2013.

In addition, the Department of Parks and Wildlife (DPaW) maintains a ranked list of specially protected fauna, which includes Threatened and Priority Fauna. These rankings dictate which species should receive the highest priority for conservation management. Threatened fauna listed on Schedule 1 of the WC Act are further ranked by DPaW according to their level of threat using IUCN Red List categories and criteria. Schedule 1 species can be ranked as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU).

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, and are ranked in order of priority for survey and evaluation of conservation status, so that consideration can be given to their declaration as threatened fauna. 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. The three Threatened Fauna codes and five Priority codes are summarised in Appendix A.

1.3 SURVEY OBJECTIVES

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

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

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

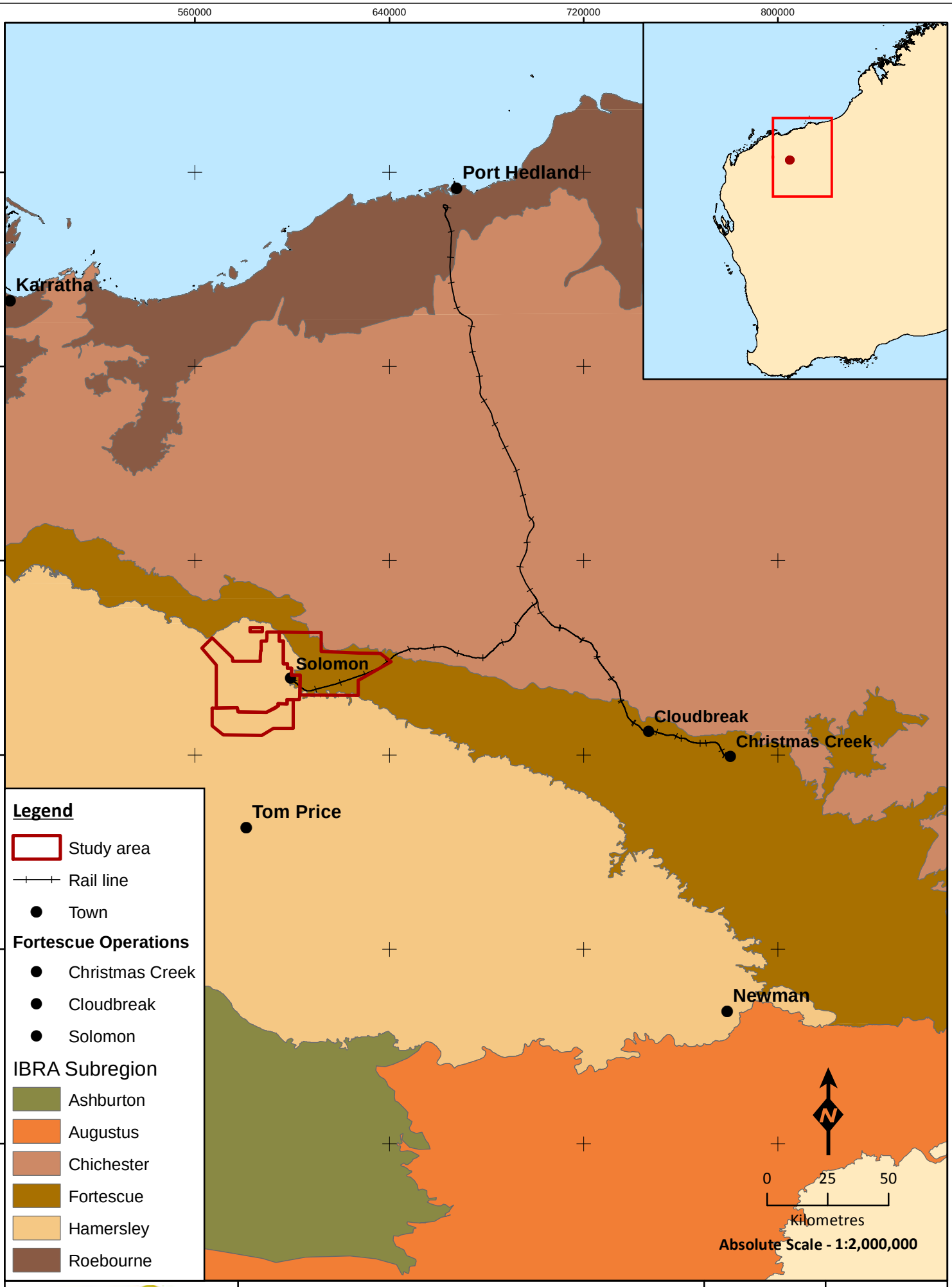
Hence, the aim of this study was to provide sufficient information to the EPA to assess the impact of the project on the vertebrate fauna populations that occur in the areas associated with the project, thereby informing assessment against the relevant EPA objectives.

This report satisfies the requirements of a Level 2 baseline and targeted conservation significant fauna survey as documented in *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*, EPA Guidance Statement No. 56 and Position Statement No. 3, by providing:

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

Due to the level of previous survey effort within the area completed, specific objectives for this study were to:

- Consolidate previous terrestrial vertebrate fauna data and fauna habitat mapping conducted within the Life of Mine survey area to compile a comprehensive fauna assessment report for the study area;
- Conduct a Level 2 terrestrial vertebrate fauna and fauna habitat assessment in areas not previously adequately surveyed within the study area;
- Conduct a targeted survey for conservation significant species recorded or likely to occur in the study area; and
- Consolidate terrestrial vertebrate fauna and fauna habitat mapping assessment data previous collected surrounding the study area to allow regional impacts to be assessed, including a regional habitat mapping and conservation significant fauna habitat mapping.



ecologia ENVIRONMENT

Location of the Solomon Hub study area

Figure: 1.1 **Project ID: 1592**	**Drawn: MH** **Date:06/08/2014**

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

Unique Map ID: MH017

A4

2 EXISTING ENVIRONMENT

2.1 CLIMATE

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

Rainfall is generally localised and unpredictable (some years have recorded zero rainfall), and temperatures are high, resulting in annual evaporation exceeding rainfall by as much as 500 mm per year. Most of the Pilbara has a bimodal rainfall distribution; from November to March rains result from tropical storms producing sporadic thunderstorms. Tropical cyclones moving south also bring heavy rains. From May to June, extensive cold fronts move eastwards across the state and occasionally reach the Pilbara and these fronts usually produce only light rains. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses generally flow intermittently due to the short wet season (Beard 1975).

The closest weather station is located within the study area at the Solomon Mine, and the nearest Bureau of Meteorology (BOM) station for which both rainfall and temperature data are available is Wittenoom (Site No. 005026), 11 km southeast of the study area. The average data from Wittenoom shows a typical Pilbara climate of hot summers with sporadic rainfall due to summer storms and warm dry winters, with an average annual rainfall of 465.1 mm (BoM 2014).

Rainfall data from the Solomon Mine and Wittenoom are shown in Figure 2.1 (BoM 2014). Significantly different monthly rainfall was observed at each site in December, January, March and May highlighting how localised rainfall events can be in the Pilbara. Rainfall dramatically influences the population dynamics of fauna through the increase or decrease in vegetation cover (Dickman *et al.* 1999a) and availability of resources (Dickman *et al.* 1999b; Masters 1993) In relation to the survey timing, it is recommended that surveys be conducted 3-6 months following significant rainfall to coincide with increased population densities:

- Level 2 vertebrate fauna survey (May 2014): In the six months prior to the survey (Nov to April), 394.4 mm (Wittenoom) and 379.2 mm (Solomon Mine) fell, which match the long term average of 378.9 mm. High rainfall over December and January provided significant rainfall to allow favourable conditions for fauna populations in the study area.
- Targeted fauna survey (July 2014): Conditions over the previous summer combined with high rainfall in March and May contributed to favourable conditions for fauna populations across the study area. Targeted EPBC Act listed species (Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) are all predators and their populations would be expected to respond to increases in prey populations caused by significant rainfall during summer and autumn.

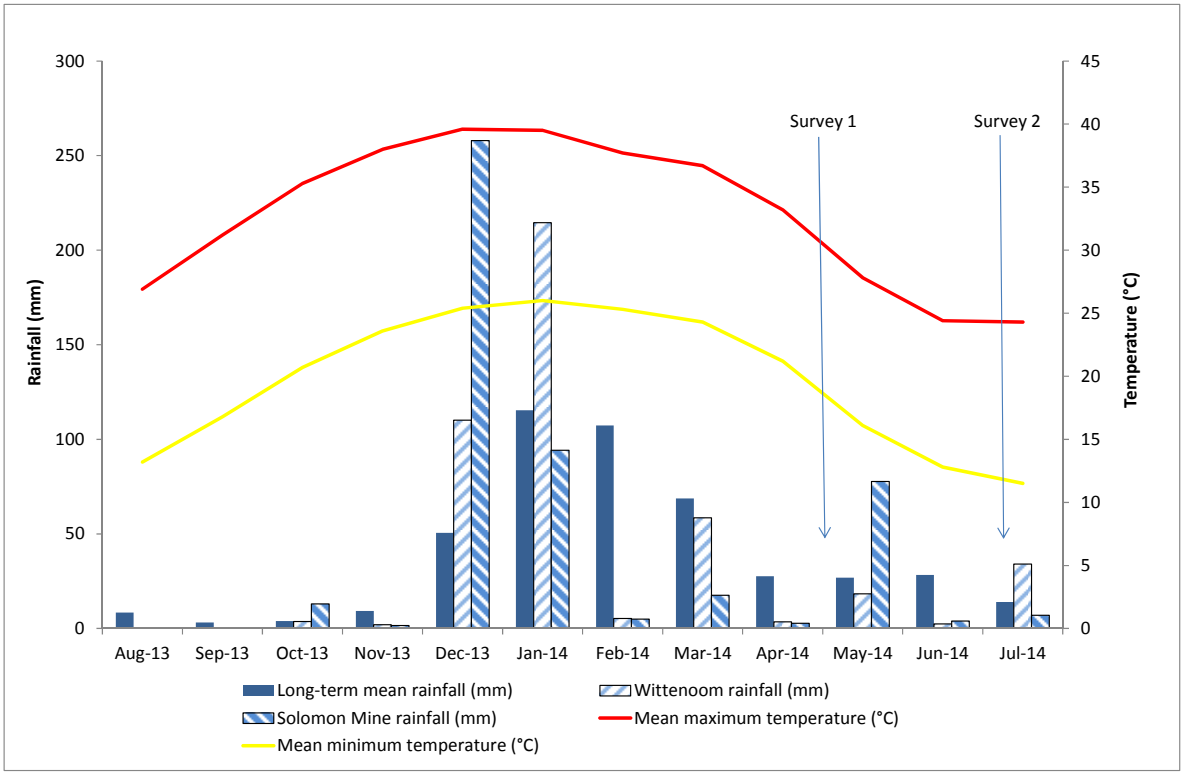


Figure 2.1 – Rainfall and temperature for the Wittenoom weather station (BoM 2014)

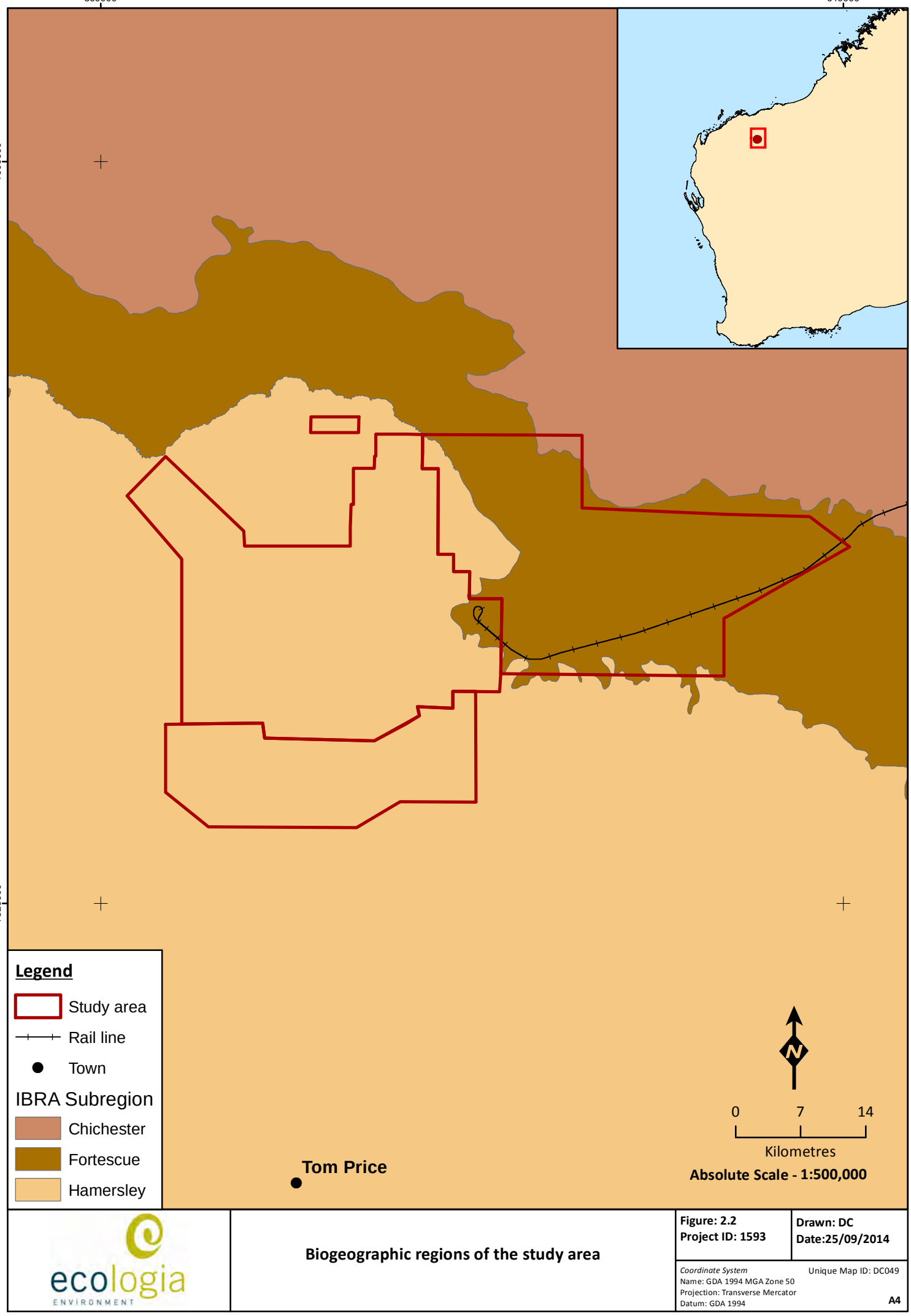
2.2 BIOGEOGRAPHY

The study area is situated within the Pilbara Region of the Interim Biogeographic Regionalisation of Australia, IBRA 7 (DSEWPaC 2012) (Figure 2.2). The Pilbara biogeographic region comprises four subregions: Hamersley, Fortescue Plains, Chichester and Roebourne. The study area is situated within the Hamersley (65.5%), Fortescue (34%) and Chichester (0.5%) subregions.

The Hamersley subregion of the Pilbara is characterised by mountain ranges and plateaux of Proterozoic sedimentary rock, dissected by gorges (Kendrick 2001b). This structure is noticeable in the study area, which comprises hilltops, hillslopes and gorges, with only a minor element of plains and undulating plains on the southern portion of the south polygon. The vegetation of the Hamersley subregion is typically mulga woodland over tussock grasses on the fine soils in valley floors, combined with snappy gum (*Eucalyptus leucophloia*) over spinifex (*Triodia brizoides*) on the skeletal soils of the ranges (Kendrick 2001b).

The Chichester Subregion is charactersied as undulating Archaean granite and basalt plains including significant areas of basaltic ranges. Typical vegetation of the area is shrub steppe on basalt plains characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on basaltic ranges (Kendrick and McKenzie 2001).

The Fortescue Plains Subregion is charactereised as alluvial plains and river frontage, with extensive salt marsh, mulga-bunch grass and short grass communities on alluvial plains in the east. River gum woodlands fringe the drainage lines. It is also the northern limit of Mulga (Kendrick 2001a).



ecologia ENVIRONMENT

Biogeographic regions of the study area

Figure: 2.2
Project ID: 1593

Drawn: DC
Date:25/09/2014

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

Unique Map ID: DC049

A4

2.3 LAND SYSTEMS

Van Vreeswyk *et al.* (2004) undertook a regional inventory of the Pilbara rangelands to document the land systems present and their condition. The Pilbara Regional Inventory (PRI) covered 181,723 km^2, 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 extent of each of the land systems vary greatly, with almost half the area comprised of just six land systems: Little Sandy, Macroy, Newman, Nita, Rocklea and Uaroo (Van Vreeswyk *et al.* 2004).

Thirteen of the land systems mapped and assessed for vegetation condition by Van Vreeswyk *et al.* (2004) within the PRI are present within the study area (Figure 2.3). Each system is further classified by landform, soil, vegetation and drainage patterns (Table 2.1).

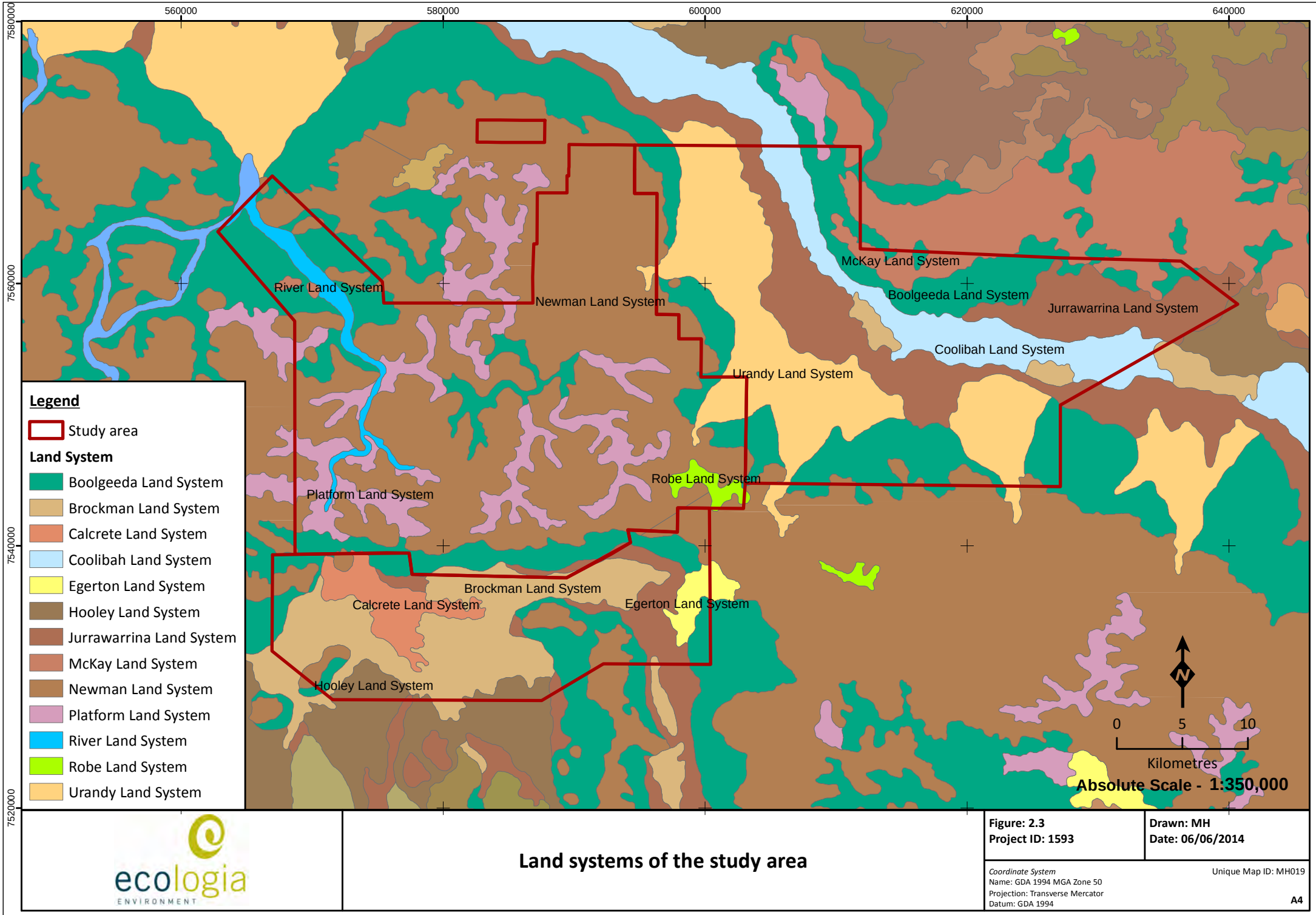
The Newman land system makes up the majority of the study area, with 57,430.1 ha (31.4%), followed by the Boolgeeda system, with 35,093.5 ha (19.2%); with smaller representation of the remaining land systems.

The land systems located in the central portion of the study area are not preferred by livestock due to poor or complete inaccessibility or unpalatable vegetation (Van Vreeswyk *et al.* 2004); whereas the southern and Northern borefields, as well as the northwest extension of the study area are mostly classified as areas of high or moderate palatability to livestock.

Table 2.1 – Land systems of the study area

Land System (PRI area, %)	Landform (and % of Land system)	Description	Extent of study area (km^2)	% of study area
Boolgeeda ($7,748\ km^2$, 4.3%)	Low hills and rises (4%) Stony slopes and upper plains (20%) Stony lower plains (65%) Groves (1%) Narrow drainage floors and channels (10%)	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands. Hard spinifex grasslands not preferred by livestock.	351	19.2%
Brockman ($735\ km^2$, 0.4%)	Hardpan plains (10%) Gilgai plains (75%) Stony plains (10%) Narrow drainage tracts and channels (3%) Groves (1%) Swamps (1%)	Alluvial plains with cracking clay soils supporting tussock grasslands. Highly preferred by livestock and other animals, susceptible to grazing and degradation. Soil erosion can occur if vegetation cover is severely depleted.	155	8.5%
Calcrete ($1,444\ km^2$, 0.8%)	Calcrete plains, platforms and low rises (80%) Drainage foci (1%) Sandy plains/sandplains (9%) Drainage tracts (8%) Channels (2%)	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands. Some shrubs and grasses are attractive to grazing animals and may be depleted if grazing levels are excessive. Low erosion risk.	36	2.0%
Coolibah ($1,014\ km^2$, 0.6%)	Flood plains (50%) Alluvial plains (14%) Gilgai back plains (16%) Stony plains (5%) Calcrete platforms (3%) Depressions and drainage foci (10%) Channel, bank and minor river terrace (2%)	Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey. Vegetation includes perennial grasses and forbs which are preferred by grazing animals and are prone to depletion under controlled grazing.	87	4.7%
Egerton ($3,868\ km^2$, 2.1%)	Hardpan plains (10%) Dissected slopes (75%) Calcreted drainage margins (6%) Drainage floors and channels (9%)	Dissected hardpan plains supporting mulga shrublands and hard spinifex hummock grasslands. Vegetation not preferred by livestock.	11	0.6%
Hooley ($590\ km^2$, 0.3%)	Stony plains (40%) Gilgai plains (50%) Drainage tracts (10%)	Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands. Tussock grasslands and snakewood shrub communities are favoured by grazing and prone to degradation. Those parts of the system not protected by a stony surface mantle are moderately susceptible to erosion.	20	1.1%

Land System (PRI area, %)	Landform (and % of Land system)	Description	Extent of study area (km^2)	% of study area
Jurrawarrina ($664\ km^2$, 0.4%)	Stony plains (20%) Hardpan plains (32%) Drainage tracts (20%) Groves and drainage foci (22%) Gilgai plains (5%)	Hardpan plains and alluvial tracts supporting mulga shrublands with tussock and spinifex grasses. Much of the vegetation on this system is highly preferred by grazing animals and is prone to degradation if overgrazed. Some areas are susceptible to erosion.	206	11.2%
McKay ($4,202\ km^2$, 2.3%)	Hills, ridges and plateaux remnants (60%) Breakaways (2%) Lower footslopes (10%) Stony plains (20%) Drainage floors (8%)	Hills, ridges, plateaux remnants and breakaways of meta sedimentary and sedimentary rocks supporting hard spinifex grasslands. Some areas are poorly accessible and the system is not prone to degradation or soil erosion.	35	1.9%
Newman ($14,580\ km^2$, 8%)	Plateaux, ridges, mountains and hills (70%) Lower slopes (20%) Stony plains (5%) Narrow drainage floors with channels (5%)	Rugged jaspilite plateaux, ridges and mountains supporting hard and soft spinifex grasslands. Inaccessible or poorly accessible area which is unsuitable for pastoral purposes.	574	31.3%
Platform ($1,570\ km^2$, 0.9%)	Stony upper plains (25%) Dissecated slopes (60%) Drainage floors (15%)	Dissected slopes and raised plains supporting hard spinifex grasslands. Vegetation not preferred by livestock and of very little use to pastoralism. The system is not susceptible to erosion.	114	6.2%
River ($4,821\ km^2$, 2.7%)	Sandy levees and sand sheets (15%) Upper terraces (5%) Flood plains and lower terraces (50%) Stony plains (10%) Minor and major channels (20%)	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands. Buffel grass and soft spinifex on this system are highly and moderately preferred respectively by livestock. The system is largely stabilised by buffel and spinifex and accelerated erosion is uncommon.	24	1.3%
Robe ($1,286\ km^2$, 0.7%)	Low plateaux, mesas and buttes (60%) Lower slopes (20%) Gravely plains (15%) Drainage floors and channels (5%)	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands. Soft spinifex vegetation is moderately preferred by grazing animals. The system is not generally susceptible to vegetation degradation or erosion.	9	0.5%
Urandy ($1,311\ km^2$, 0.7%)	Stony plains (58%) Alluvial plains (35%) Drainage zones and channels (7%)	Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands. The system supports spinifex vegetation which, except for old mature stands, is moderately preferred by grazing animals.	210	11.5%



ecologia ENVIRONMENT

Land systems of the study area

Figure: 2.3
Project ID: 1593

Drawn: MH
Date: 06/06/2014

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

Unique Map ID: MH019

A4

2.1 GEOLOGY AND SOILS

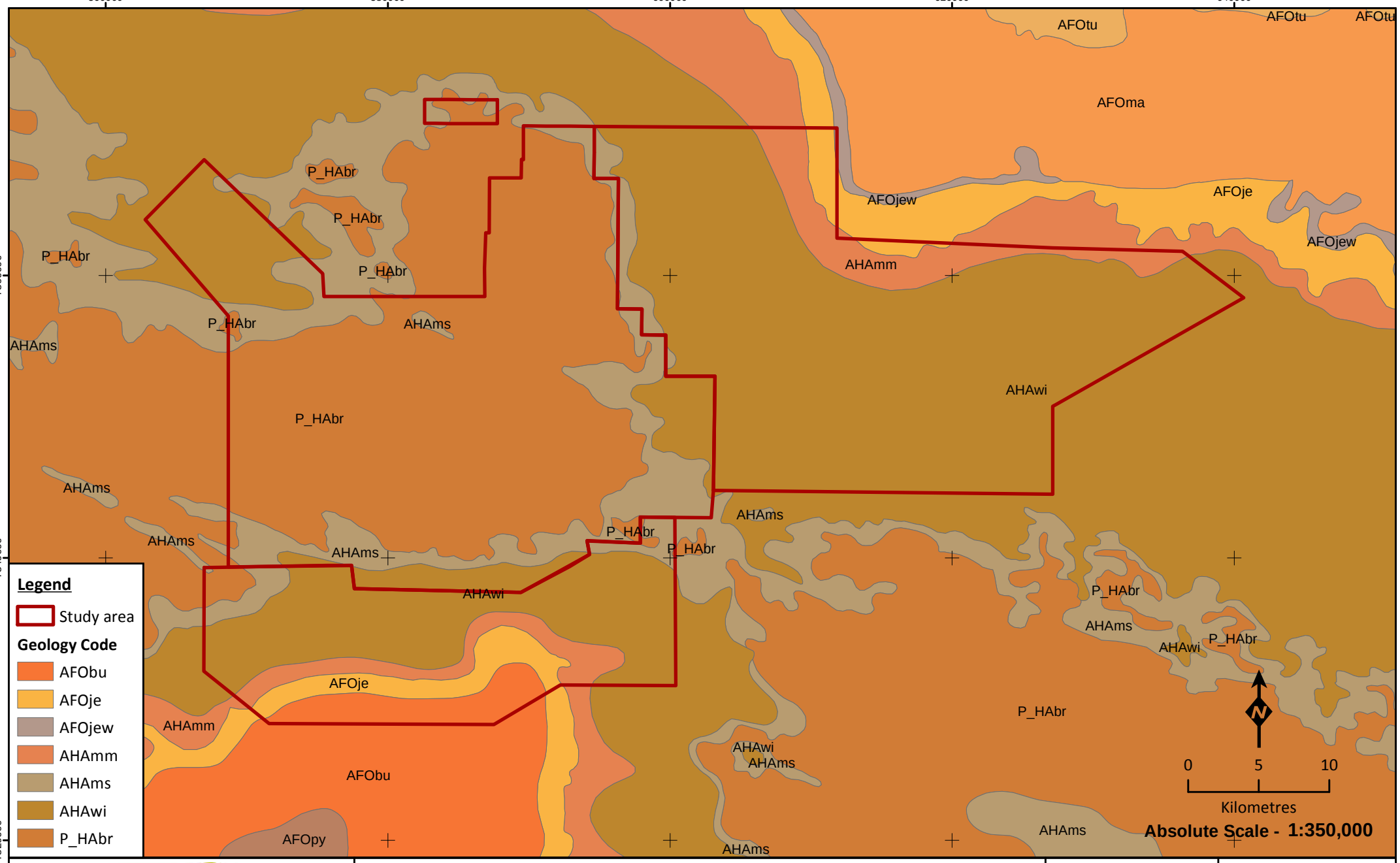
2.1.1 Geology

Most of the Pilbara is comprised of the granite terrain of the Pilbara Block in the north with the rugged sedimentary Hamersley Basin in the south and the sedimentary rocks overlain by Aeolian sands of the Canning Basin to the east. Drainage is mostly via major river catchments of the De Grey, Turner and Yule rivers in the north, and the Fortescue and Robe rivers in the south and west. All rivers are exoreic (i.e. flow into the ocean) with the exception of Savory Creek, which drains eastwards into Lake Disappointment (Van Vreeswyk *et al.* 2004). The geological stratigraphy in the Pilbara region of Western Australia is relatively continuous, with similar geological processes occurring across the region which have resulted in the enrichment of iron deposits.

The study area is comprised of seven geological units. These are described in Table 2.2 and mapped in Figure 2.4.

Table 2.2 – Geological units at the study area

Code	Description	Extent of study area (ha)	% of study area
AFObu	Pillowed and massive basaltic flows; basaltic breccia; and basaltic volcaniclastic sandstone; minor chert; amygdaloidal basalt flows occur in upper parts of formation; metamorphosed	4,133	2.3%
AFOje	Mudstone; siltstone; sandstone; chert; massive basaltic flows; basaltic pillow lava; basaltic breccia; and minor felsic volcaniclastic rock; intruded by numerous dolerite sills; metamorphosed	5,584	3.0%
AFOjew	Quartzitic sandstone; chert (locally stromatolitic); chert breccia; and argillite; metamorphosed	38	0.1%
AHAmm	Chert; banded iron-formation; mudstone; and siltstone; metamorphosed	10,271	5.6%
AHAms	Mudstone; siltstone; chert; banded iron-formation; and dolomite; metamorphosed	18,197	9.9%
AHAwi	Thin- to medium-bedded dolomite; dolomitic mudstone; chert; and felsic volcanic sandstone; metamorphosed.	89,812	49.0%
P_HAbr	Banded iron-formation; chert; mudstone; and siltstone; metamorphosed	55,136	30.1%



ecologia ENVIRONMENT

Geological units at the study area

Figure: 2.4
Project ID: 1593

Drawn: MH
Date: 06/06/2014

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

Unique Map ID: MH018

A4

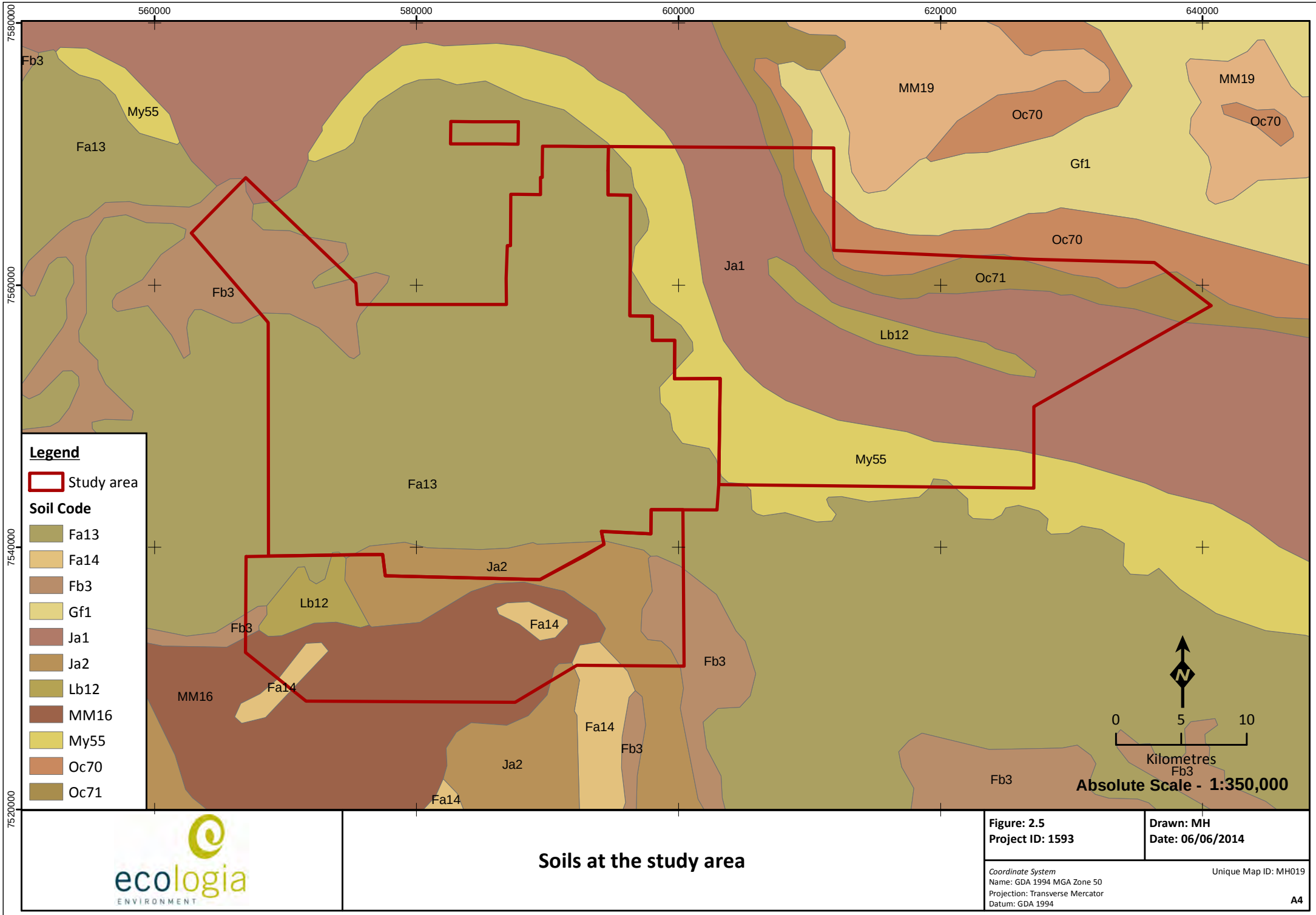
2.1.2 Soils

Twenty-one broad soil groups were identified in the Pilbara Regional Inventory (Van Vreeswyk *et al.* 2004). Soils are predominantly red and shallow with stony mantles. According to Van Vreeswick *et al.* (2004) "the most extensive soils are shallow stony soils on hills and ranges and sands on sandplains. In the south the soils are predominantly red earths overlying hardpan on level to gently inclined plains. Lower flood plains have cracking and non-cracking clay soils. Duplex (texture-contrast) soils occur in localised areas on saline alluvial plains and elsewhere. These soils support the most preferentially grazed vegetation and are highly susceptible to erosion".

Soils within the study area have been classified into 11 units (Bettenay *et al.* 1967), which are described in Table 2.3 and mapped in Figure 2.5.

Table 2.3 – Soils at the study area

Soil code	Description	Extent of study area (ha)	% of study area
Fa13	Ranges of banded jaspilite and chert along with shales, dolomites, and iron ore formations; some areas of ferruginous duricrust as well as occasional narrow winding valley plains and steeply dissected pediments. This unit is largely associated with the Hamersley and Ophthalmia Ranges. The soils are frequently stony and shallow and there are extensive areas without soil cover: chief soils are shallow stony earthy loams.	72,560	39.6%
Fa14	Steep hills and steeply dissected pediments on areas of banded jaspilite and chert along with shales, dolomite, and iron ore formations; some narrow winding valley plains: chief soils are shallow stony earthy loams.	1,969	1.1%
Fb3	High-level valley plains set in extensive areas of the Fa13 unit. There are extensive areas of pisolitic limonite deposits: the principal soils are deep earthy loams.	9,253	5.1%
Gf1	Steep ranges on basic lavas along with dolomites, tuff, banded iron formations, and dolerite dykes, with some narrow valley plains and high-level gently undulating areas of limited extent. The soils are generally shallow and stony and there are large areas without soil cover: chief soils are brown loams.	464	0.3%
Ja1	Extensive valley plains largely associated with the Fortescue River: chief soils are earthy clays.	33,956	18.5%
Ja2	This unit occupies the central position within the high-level valley plains represented by unit Fb3: chief soils are earthy clays.	11,846	6.5%
Lb12	Valley flats along major drainage lines, associated with limestone and calcareous gravels (kunkar): chief soils are highly calcareous earths.	6,554	3.6%
MM16	Alluvial plains dominated by deep cracking clays.	14,764	8.1%
My55	Gently sloping outwash plains generally flanking the northern face of the Hamersley Range; coarse surface gravels are extensive: chief soils are neutral red earths.	21,033	11.5%
Oc70	Dissected pediments and low stony hills associated with cherts, jaspilites, and iron ore formations; much coarse surface gravel: chief soils are hard alkaline red soils.	3,433	1.9%
Oc71	Outwash plains with much coarse surface gravel: chief soils are hard alkaline red soils.	7,334	4.0%



ecologia ENVIRONMENT

Soils at the study area

Figure: 2.5
Project ID: 1593

Drawn: MH
Date: 06/06/2014

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

Unique Map ID: MH019

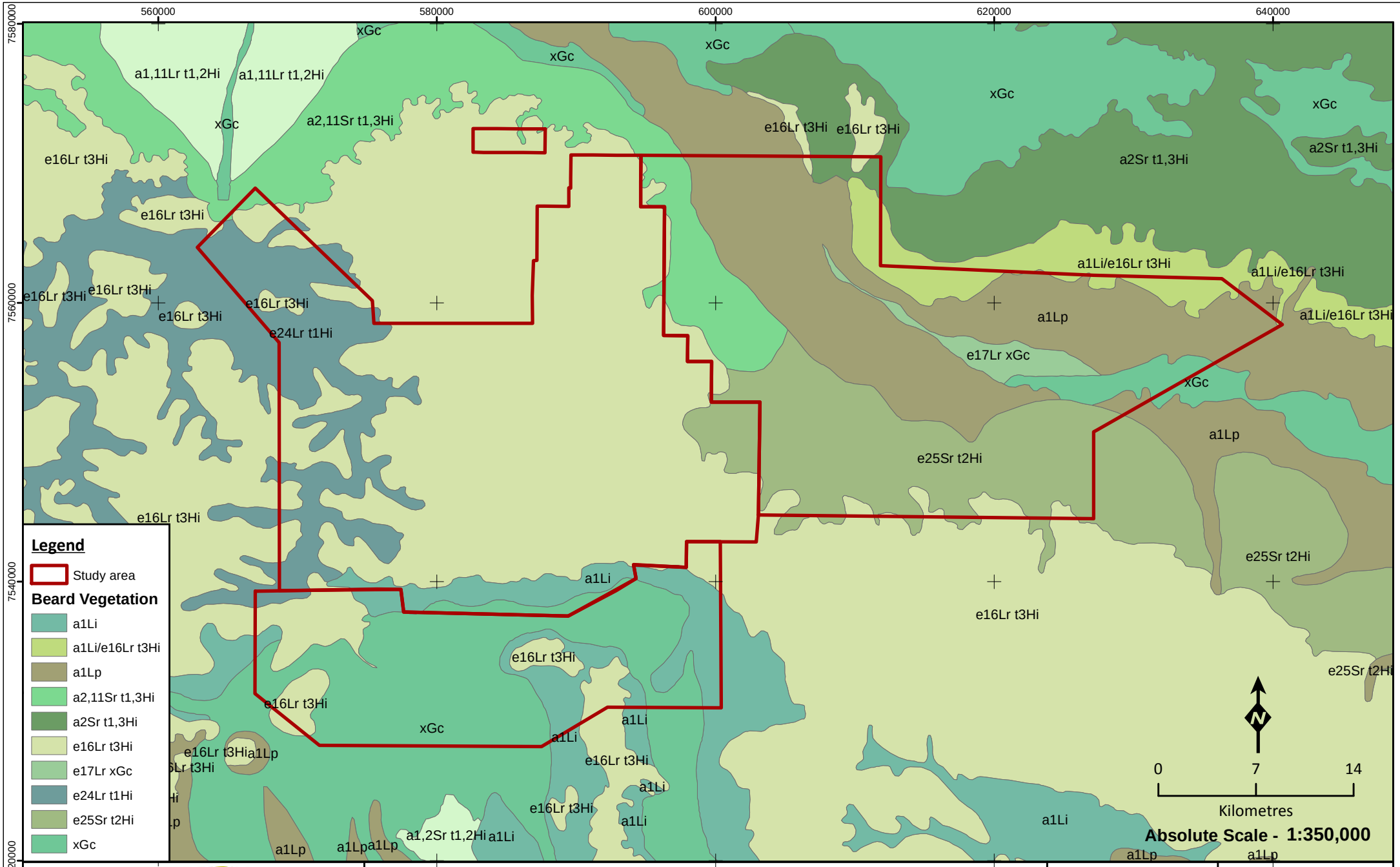
A4

2.2 VEGETATION

The study area lies within Beard's (1975) Pilbara region of the Eremaean Botanical Province, part of a series of maps completed by Beard *et al.* from 1974 to 1981 throughout Western Australia. The vegetation mapping was reinterpreted to reflect the National Vegetation Information System (ESCAVI 2003) standards, taxonomic revisions and digitised (Shepherd *et al.* 2001). Ten vegetation associations occurs within the study area (Table 2.4 and Figure 2.6).

Table 2.4 – Vegetation associations of the study area

Beard association (Shepherd Code)	Structure	Vegetation association	Extent of study area (km^2)	% of study area
a1Li (18)	Open shrubland	*Acacia* open shrubland / *Ptilotus* mixed open forbland	9,727	5.3
a1Lp (29)	Isolated clumps of shrubs	*Acacia* isolated clumps of shrubs	30,650	16.7
e16Lr t3Hi(82)	Open hummock grassland	*Eucalyptus* open woodland / *Senna* mixed sparse shrubland / *Triodia* open hummock grassland	69,371	37.9
e25Sr t2Hi (111)	Open hummock grassland	*Hakea* mixed open woodland / *Acacia* mixed sparse shrubland / *Triodia* open hummock grassland	22,049	12.1
e17Lr xGc (151)	Open tussock grassland	*Eucalyptus* open woodland / *Aristida* mixed open tussock grassland	2,445	1.3
a2Sr t1,3Hi (173)	Open hummock grassland	*Eucalyptus* open woodland / *Acacia* mixed sparse shrubland / *Triodia* open hummock grassland	801	0.4
xGc (175)	Open tussock grassland	*Aristida* mixed open tussock grassland	22,802	12.4
a1Li/e16Lr t3Hi (562)	Woodland	*Acacia* woodland	4,372	2.4
e24Lr t1Hi (565)	Open hummock grassland	*Eucalyptus* open woodland / *Triodia* open hummock grassland	14,049	7.7
a2,11Sr t1,3Hi (645)	Open hummock grassland	*Acacia* sparse shrubland / *Triodia* open hummock grassland	6,895	3.8



ecologia ENVIRONMENT

Vegetation of the study area

Figure: 2.6
Project ID: 1593

Drawn: MH
Date: 06/06/2014

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

Unique Map ID: MH019

A4

2.3 LAND USE HISTORY

2.3.1 Overview

Pastoralism is the most extensive land use in the Pilbara. Within the Pilbara bioregion there are just under a hundred different pastoral leases which collectively occupy 109,285 km^2 (61.4%) of the Pilbara. Areas set aside for conservation, including National Parks, Nature Reserves and Conservation Estates account for 14,763 km^2 (8.3%) of the Pilbara. In addition the pastoral leases of Mt Minnie and Nanutarra (adjoining the Cane River Conservation Park), a portion of Mt Florence (adjoining Karijini NP) and Meentheena have been relinquished to unallocated crown land (UCL) and destocked. These areas will be incorporated into the conservation estate, contributing a further 1.9% of the bioregion to conservation.

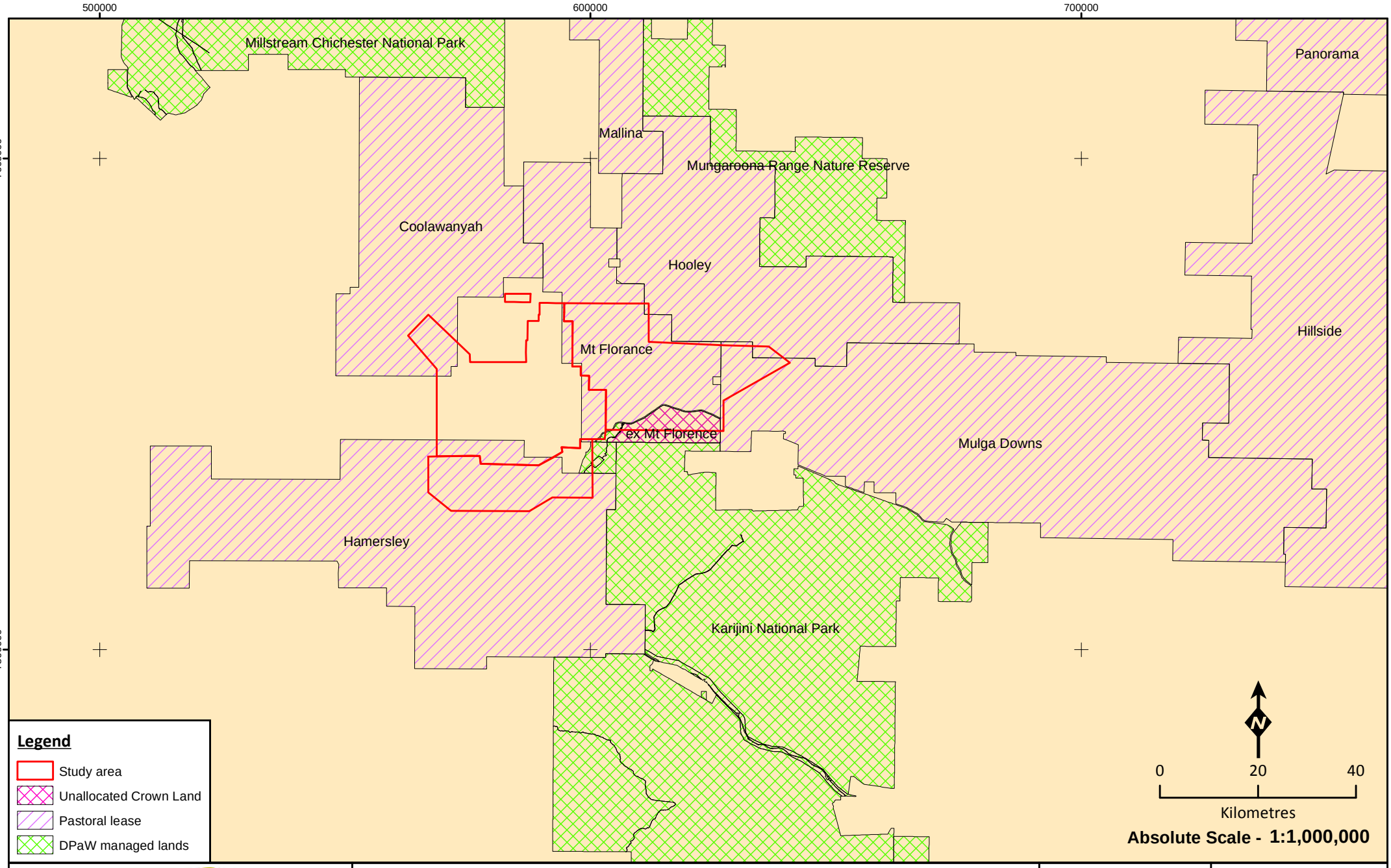
The Aboriginal reserves of Abydos, Jigalong, Woodstock and Yandeyarra, and the special lease for Aboriginal use, Callawa, occupy 10,655 km^2 (6.0%) of the bioregion. Mining is largely confined to ironstone ranges and greenstone belts throughout the bioregion. Exploration and mining leases encompass 86.0% and 4.1% of the bioregion respectively. There are also large tracts of UCL which accounts for 40,496 km^2 (22.74%) of the Pilbara Bioregion (Van Vreeswyk *et al.* 2004). The remaining 1% of the Van Vreeswyk *et al*. (2004) survey area consists of town commons, road reserves and various other reserves.

The development of the iron ore industry has resulted in activity within the Pilbara increasing from cattle and sheep stations and small coastal ports to a large mining economic base with a commensurate increase in population. Development of the iron ore rich deposits was accelerated in the 1960s after the Commonwealth lifted the 1938 export embargo on iron ore.

2.3.2 Local Land Use

The study area lies upon 131 tenements (exploration, prospecting, mining lease, mineral lease, and miscellaneous licenses), which are held by 13 different groups; predominantly Fortescue Metals Group.

The study area overlaps with five pastoral leases: Coolawanyah to the northwest; Hooley to the northeast; Mulga Downs to the east; Mt Florence in the centre-east portion (covering most of the Northern Bore Fields); and Hamersley Station in the southern portion of the study area. The study area also adjoins one conservation estate: ex. Mt Florence (7,025.0 ha of overlap) (Figure 2.7).



ecologia ENVIRONMENT

Pastoral leases and conservation reserves

Figure: 2.7
Project ID: 1593

Drawn: RY
Date: 31/08/2014

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

Unique Map ID: RY211

A4

2.4 PREVIOUS SURVEYS

A significant amount of survey effort has been completed within the study area over the past seven years, with 19 vertebrate fauna surveys completed that overlap the current study area. An additional 20 vertebrate fauna surveys have been completed within 140 km of the study area, totalling 39 publications reporting on vertebrate fauna surveys that were consulted to determine the potential fauna assemblage of the study area (Table 2.6 and Figure 2.8). Several databases were also interrogated in the preparation of potential fauna (and conservation significant fauna) lists (Table 2.5).

The results of all database searches and previous surveys are presented in Appendix D. The online NatureMap database encompasses several datasets which include the WA Museum (WAM), DPaW threatened fauna database and DPaW survey return database.

Table 2.5 – Databases searched to determine the potential vertebrate fauna assemblage

Database	Custodian	Search Details
NatureMap	DPaW	Records within 40 km of the study area
Species Profile and Threats (SPRAT) Database	Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)	Records within 100 km of the study area
DPaW Rare Fauna	Department of Parks and Wildlife	Records within 40 km of the study area
Birdata	Birdlife Australia	Records within one degree cell

Table 2.6 – Previous biological survey reports within 100 km of the study area

Survey location and author(s)	Level of assessment	Distance to study area
Solomon South Project (Outback Ecology 2014)	Level 1 vertebrate fauna assessment	0 km
Mt Macleod Project (*ecologia* 2013b)	Phase two of a Level 2 vertebrate fauna assessment including a targeted conservation significant fauna survey	0 km
Stingray Project (*ecologia* 2013e)	Single phase Level 2 vertebrate fauna assessment including a targeted conservation significant fauna survey	0 km
Investigator Project (*ecologia* 2013a)	Single phase Level 2 vertebrate fauna assessment including a targeted conservation significant fauna survey	0 km
Solomon Mine Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013c)	Annual monitoring project targeting EPBC listed vertebrate fauna species	0 km
Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)	Annual monitoring project targeting EPBC listed vertebrate fauna species	0 km
Solomon Mine Conservation Significant Fauna Monitoring (2014) (*ecologia* 2014b)	Annual monitoring project targeting EPBC listed vertebrate fauna species	0 km
Mt Macleod Project (Rapallo 2011)	Phase one of a Level 2 1 vertebrate fauna assessment	0 km
Solomon Project – Firetail (Ecoscape 2010d)	Two phase Level 2 1 vertebrate fauna assessment	0 km
Solomon Project – Kings Area (*ecologia* 2010)	Two phase Level 2 1 vertebrate fauna assessment	0 km
Solomon Project – Airstrip (Ecoscape 2010a)	Level 1 vertebrate fauna assessment	0 km
Solomon Project – Mine (Coffey 2011a)	Targeted conservation significant vertebrate fauna assessment	0 km
Solomon Project – Mine (Coffey 2008)	Single phase Level 2 vertebrate fauna assessment	0 km

Survey location and author(s)	Level of assessment	Distance to study area
Central Pilbara Project – Mine (*ecologia* 2011b)	Two phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment	0 - 25 km
Solomon Rail Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013d)	Annual monitoring project targeting EPBC listed vertebrate fauna species	0 – 75 km
Solomon Rail Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014c)	Annual monitoring project targeting EPBC listed vertebrate fauna species	0 – 75 km
Solomon Rail Conservation Significant Fauna Monitoring (2014) (*ecologia* in prep.)	Annual monitoring project targeting EPBC listed vertebrate fauna species	0 – 75 km
Solomon Project – Rail (Coffey 2011b)	Targeted conservation significant vertebrate fauna assessment	0 – 75 km
Central Pilbara Project – Rail (data from sites within 100 km) (*ecologia* 2012a)	Two phase Level 2 vertebrate fauna assessment	0 – 100 km
Mt Macleod West Project (Ecoscape 2013)	Level 1 vertebrate fauna assessment	5 km
Greater Nammuldi Irrigated Agriculture Project (*ecologia* 2011c)	Two phase Level 2 vertebrate fauna assessment	20 km
Blacksmith Project (Ecoscape 2011)	Single phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment	20 km
Solomon Project – Rail re-alignment (Ecoscape 2010c)	Level 1 vertebrate fauna assessment	30 km
Solomon Project – Rail camps (Ecoscape 2010b)	Level 1 vertebrate fauna assessment	15 – 90 km
Marandoo to Great Northern Highway (Kendrick 1995)	Single phase Level 2 vertebrate fauna assessment	35 km
Hamersley Range (Muir 1983)	Level 2 vertebrate fauna assessment	45 km
Raven Project (Ecoscape 2012d)	Level 1 vertebrate fauna assessment	50 km
West Turner Section 10 (Biota 2009)	Two phase Level 2 vertebrate fauna assessment	60 km
Marandoo Mine (Biota 2008)	Two phase Level 2 vertebrate fauna assessment	60 km
Brockman Syncline 4 (Biota 2005)	Two phase Level 2 vertebrate fauna assessment	70 km
Eliwana/Flying Fish Project (ecologia 2013g)	Two phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment	75 km
Eliwana/Flying Fish Project (Ecoscape 2012b, c)	Level 1 vertebrate fauna assessment	75 km
Mt Farquhar Project (*ecologia* 2012d)	Single phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment	80 km
Northern Transport Corridor (Ninox 1995)	Level 1 vertebrate fauna assessment	85 km
Delphine Project (*ecologia* 2013f)	Two phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment	120 km
Delphine Project (Ecoscape 2012a)	Level 1 vertebrate fauna assessment	120 km
Western Range Project (Biota 2011)	Two phase Level 2 vertebrate fauna assessment	120 km
Turee Project (Coffey 2013)	Single phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment	130 km

Survey location and author(s)	Level of assessment	Distance to study area
The Edge (Biologic 2013)	Single phase Level 2 vertebrate fauna assessment and targeted conservation significant fauna assessment	140 km

2.4.1 Results of literature review

The database searches and review of the publications reporting on 39 vertebrate fauna surveys resulted in a total of 42 native and 11 introduced mammal species, 157 bird species, 112 reptile species, eight amphibian species and seven fish species potentially occurring in the study area (Appendix D). Of these, 31 species are of conservation significance (ten species of mammal, 17 species of bird, four species of reptile).

Table 2.7 – Vertebrate fauna species recorded during previous surveys and database searches

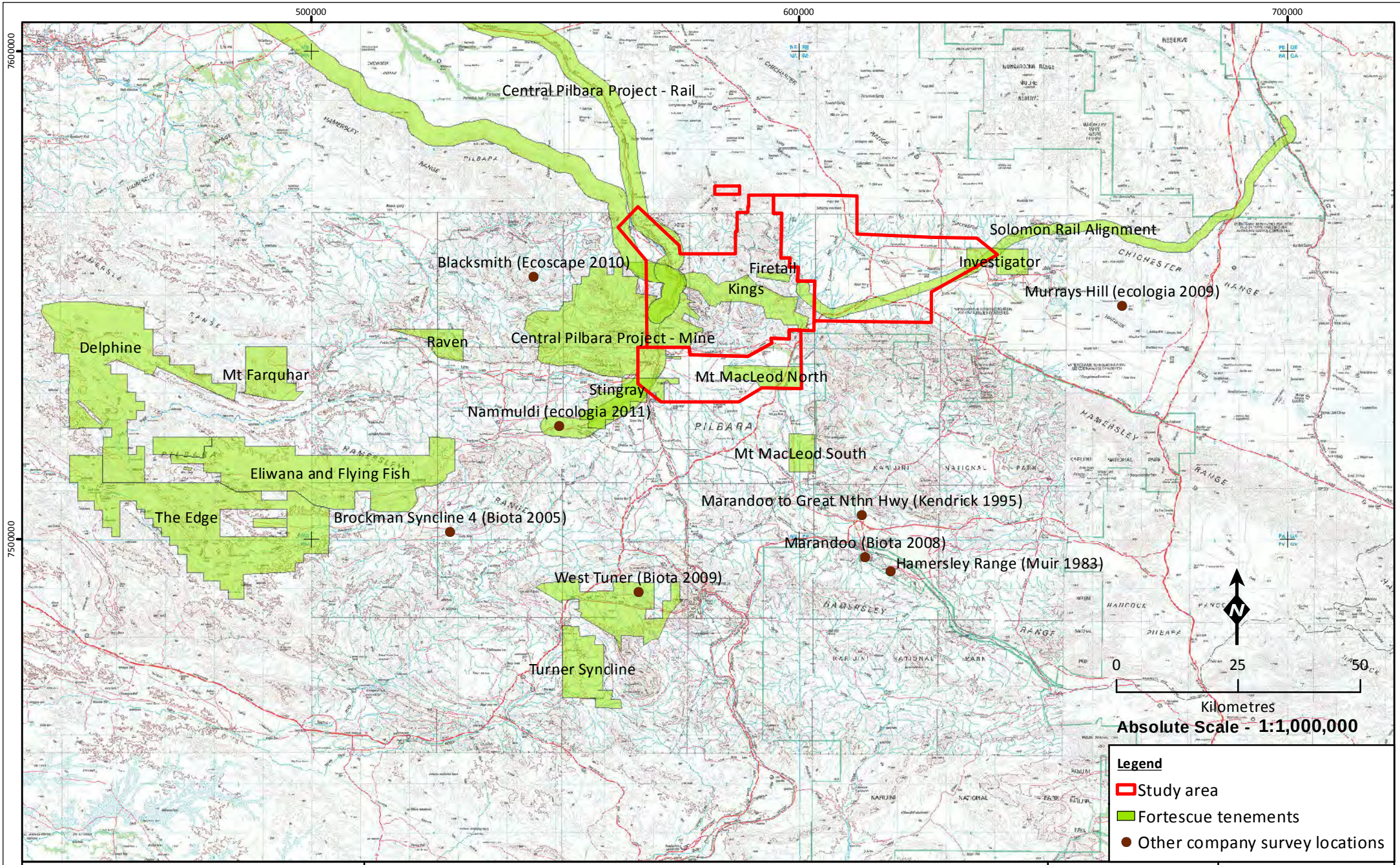
Source/Report	Survey Type	Mammals	Birds	Reptiles	Amphibians	Fish
Previous surveys						
Solomon South Project (Outback Ecology 2014)	Level 1	12	29	4	0	0
Mt Macleod Project (*ecologia* 2013b)	Level 2 / Targeted	11	57	24	2	1
Stingray Project (*ecologia* 2013e)	Level 2 / Targeted	10	50	25	1	1
Investigator Project (*ecologia* 2013a)	Level 2 / Targeted	22	66	26	1	0
Solomon Mine Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013c)	Monitoring	9	31	24	3	0
Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)	Monitoring	6	3	20	2	0
Solomon Mine Conservation Significant Fauna Monitoring (2014) (*ecologia* 2014b)	Monitoring	6	0	0	0	0
Mt Macleod Project (Rapallo 2011)	Level 2	15	82	52	0	0
Solomon Project – Firetail (Ecoscape 2010d)	Level 2	20	63	47	1	0
Solomon Project – Kings Area (*ecologia* 2010)	Level 2	25	71	73	4	4
Solomon Project – Airstrip (Ecoscape 2010a)	Level 1	4	21	6	5	0
Solomon Project – Mine (Coffey 2011a)	Targeted	11	0	0	0	0
Solomon Project – Mine (Coffey 2008)	Level 2	20	66	59	3	0
Central Pilbara Project – Mine (*ecologia* 2011b)	Level 2	28	99	83	4	0
Solomon Rail Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013d)	Monitoring	24	10	6	0	0
Solomon Rail Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014c)	Monitoring	14	0	0	0	0

Source/Report	Survey Type	Mammals	Birds	Reptiles	Amphibians	Fish
Solomon Rail Conservation Significant Fauna Monitoring (2014) (*ecologia* in prep.)	Monitoring	9	4	1	0	0
Solomon Project – Rail (Coffey 2011b)	Targeted	7	3	1	0	0
Central Pilbara Project – Rail (data from sites within 100 km) (*ecologia* 2012a)	Level 2	22	88	55	3	0
Mt Macleod West Project (Ecoscape 2013)	Level 1	6	34	12	1	0
Greater Nammuldi Irrigated Agriculture Project (*ecologia* 2011c)	Level 2	21	69	48	1	0
Blacksmith Project (Ecoscape 2011)	Level 2	17	45	47	2	0
Solomon Project – Rail re-alignment (Ecoscape 2010c)	Level 1	2	17	2	0	0
Solomon Project – Rail camps (Ecoscape 2010b)	Level 1	4	14	6	0	0
Marandoo to Great Northern Highway (Kendrick 1995)	Level 2	17	67	49	3	0
Hamersley Range (Muir 1983)	Level 2	22	128	69	5	0
Raven Project (Ecoscape 2012d)	Level 1	3	37	7	0	0
West Turner Section 10 (Biota 2009)	Level 2	20	68	52	1	0
Marandoo Mine (Biota 2008)	Level 2	11	55	44	3	0
Brockman Syncline 4 (Biota 2005)	Level 2	19	82	54	2	0
Eliwana/Flying Fish Project (ecologia 2013g)	Level 2 / Targeted	24	73	60	2	1
Eliwana/Flying Fish Project (Ecoscape 2012b, c)	Level 1	8	38	1	0	0
Mt Farquhar Project (*ecologia* 2012d)	Level 2 / Targeted	20	56	34	0	2
Northern Transport Corridor (Ninox 1995)	Level 2	6	46	5	1	0
Delphine Project (*ecologia* 2013f)	Level 2 / Targeted	26	101	58	3	6
Delphine Project (Ecoscape 2012a)	Level 1	8	44	5	1	2
Western Range Project (Biota 2011)	Level 2	9	51	34	1	0
Turee Project (Coffey 2013)	Level 2	24	80	33	1	6
The Edge (Biologic 2013)	Level 2 / Targeted	24	77	48	2	2
Databases						
NatureMap		35	130	100	5	3
DPaW Rare fauna		7	10	5	0	1
DoE Protected Matters Search		14	12	1	0	0

Source/Report	Survey Type	Mammals	Birds	Reptiles	Amphibians	Fish
Birdata		-	122	-	-	-
Total	**-**	**53**	**157**	**112**	**8**	**7**

Several fauna species have been reported in the DoE protected matters search that are not expected to occur in the study area nor in the surrounding region based on a complete absence of records from any other database or previous biological survey. These species are listed below and have been excluded from the above regional fauna assessment

Species	Type of Presence	Nearest record (NatureMap)
Northern Marsupial Mole (*Notoryctes caurinus*)	Species or species habitat likely to occur within area	385 km to the east
Eurasian Tree Sparrow (*Passer montanus*)	Species or species habitat likely to occur within area	180 km to the north (all records are coastal from ship assisted entries)
Barn Swallow (*Hirundo rustica*)	Species or species habitat may occur within area	180 km to the north (species typically restricted to coastal areas)
Oriental Pratincole (*Glareola maldivarum*)	Species or species habitat may occur within area	120 km to the north



ecologia ENVIRONMENT

Locations of previous Level 2 vertebrate fauna surveys

Figure: 2.8
Project ID: 1593

Drawn: DC
Date: 21/08/14

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

Unique Map ID: DC057

A4

This page has been left blank intentionally

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 single phase Level 2 vertebrate fauna including a targeted conservation significant fauna assessment to be conducted within the study area.

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

Factor	Relevance
Bioregion – level of existing survey/knowledge of the region and associated ability to predict accurately.	The Pilbara bioregion (including the Hamersley subregion) has been well studied, and information was readily available.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The landforms associated with the study area are typical for the region and do not present any rare or special characteristics. Areas of the Hamersley range in the study area form habitat that is suitable for EPBC listed species
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).	19 vertebrate fauna surveys have been conducted that overlap with the current study area. An additional 20 previous terrestrial vertebrate fauna surveys have been carried out within 140 km of the study area. Regional and local knowledge for the area is highly detailed, highly comparable and publically available.
Number of different habitats or degree of similarity between habitats within a study area.	11 fauna habitat types were initially identified based on staff experience with the region, previous habitat mapping, land systems and vegetation units.
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. Several previous surveys have been conducted following significant rainfall events and have detailed data on the respective fauna assemblages
Sensitivity of the environment to the proposed activities.	The study area contains habitat types which are well represented in the surrounding region. Highest impacts are associated with the restricted areas of mining.
Size, shape and location of the proposed activities.	The study area comprises the Solomon Hub study area (183,201 ha). The Solomon Hub incorporates areas of the Hamersley Range and Fortescue Plain
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. The entire Solomon Hub area was surveyed

3.2 SURVEY TIMING

Seven Level 2 vertebrate fauna surveys have previously been conducted by *ecologia* in or within the immediate vicinity the study area since 2010 (Figure 2.8). Each survey was conducted using the same trapping methodology which allows direct comparison of the collected data. Three additional Level 2 surveys were conducted using different trapping methodology, and four Level 1 surveys and three targeted survey were also conducted in the study area. The survey timing of each study is presented in Table 3.2. The survey timing conforms to current survey guidelines (EPA 2004b; EPA and DEC 2010).

Table 3.2 – Summary of previous vertebrate fauna survey timing and duration

Survey	Dates of survey	Duration (days)	Person days
Current survey			
Solomon Hub Level 2 (*ecologia*)	22nd April – 4th May 2014	11	96
Solomon Hub targeted conservation significant fauna (*ecologia*)	1st – 11th July 2014	11	44
Previous Level 2 Surveys overlapping or within study area			
Mt Macleod project (*ecologia* 2013b)	3rd – 13th May 2013	11	44
Stingray project (*ecologia* 2013e)	3rd – 13th May 2013	11	22
Investigator project (*ecologia* 2013a)	20th – 30th May 2013	11	44
Mt Macleod project (Rapallo 2011)	19th – 30th April 2011	12	48
Solomon Project – Firetail (Ecoscape 2010d)	7th – 13th April 2010 10th – 18th May 2010	7 9	28 36
Solomon Project – Kings Area (*ecologia* 2010)	15th – 27th February 2010	13	104
Solomon project – Mine (Coffey 2008)	29th February – 15th March 2008	16	144
Central Pilbara Project – Rail (data from sites within 100 km) (*ecologia* 2012a)	10th – 22nd May 2011 10th – 21st October 2011	13 13	52 52
Central Pilbara Project – Mine (*ecologia* 2011b)	3rd - 15th March 2011 25th August – 6th September 2011	13 13	130 156
Previous Level 1 Surveys overlapping or within study area			
Solomon South project (Outback Ecology 2014)	22nd – 25th April 2013	4	8
Mt Macleod West project (Ecoscape 2013)	August 2011	4	8
Solomon Project – Airstrip (Ecoscape 2010a)	15th – 16th May 2010	3	6
Previous Targeted Conservation Significant Fauna Surveys and Monitoring overlapping or within study area			
Mt Macleod project (*ecologia* 2013b)	16th – 24th July 2013	9	18
Solomon project – Rail (Coffey 2011b)	5th – 28th August 2011	4	115
Solomon project – Mine (Coffey 2011a)	18th July – 2nd August 2011	14	42
Solomon Mine Conservation Significant Fauna Monitoring (2012/13) (*ecologia* 2013c)	2nd – 10th August 2012 14th – 24th August 2012 17th – 22nd January 2013	9 9 6	36 36 24
Solomon Mine Conservation Significant Fauna Monitoring (2013/14) (*ecologia* 2014a)	7th – 15th August 2013 2nd – 10th September 2013 16th – 21st January 2014	9 9 6	36 36 24
Solomon Rail Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013d)	12th – 21st July 2012 27th August – 5th Sep 2012	9 9	36 54
Solomon Rail Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014c)	1st – 9th August 2013 21st – 29th August 2013	9 9	36 54
Solomon Rail Conservation Significant Fauna Monitoring (2014) (*ecologia* in prep.)	19th – 27th June 2014	9	90

3.3 SITE SELECTION

As part of the survey planning for the current survey, all previous vertebrate fauna studies (Coffey 2010b; Outback Ecology 2014), sampling and habitat mapping within the study area (Rapallo (2011), *ecologia* (*ecologia* 2010, 2011b, 2013b, e) and Ecoscape (2013)) were consolidated which allowed the identification of survey gaps. Previous survey information, land system mapping, pre-European vegetation mapping (Shepherd *et al.* 2002) and aerial photography information were then utilised to identify fauna habitats that are expected to occur within the study area. In addition, the number of previous survey sites located in each habitat type was determined to allow further identification of survey gaps (Table 1).

The locations of the previous vertebrate fauna systematic surveys have focused on the Hamersley range and proposed impact areas of the Solomon mine site. Limited survey effort has been expended in the alluvial floodplains associated with the Fortescue River valley and some gaps existed near the Solomon mine that were previously outside of the proposed impact areas. Previous survey site locations are shown in Figure 3.1.

Preliminary habitat mapping based on previous survey data indicated that a total of eleven broad scale habitat types occur in the study are. Substantial survey effort had previously been expended in the most common habitat type (Plain (Stony gibber) which includes hillslopes) with additional survey effort focused in common habitat types such as Cracking Clay Plains, Drainage Lines, Hummock grassland and Woodlands. The gap analysis indicated that habitats associated with the Fortescue river valley (Floodplain/alluvial plain, Shrubland and tussock grassland) had not been adequately surveyed. Geographically, several additional areas within the study area had not been systematically surveyed, even though habitat types that occur in these areas have been previously assessed. For this reason, additional trap sites were established within these areas during this survey.

The set-up of the trap sites for the current survey was spread over six Land Systems within the study area. Five of the 16 trap sites were installed within the Boolgeeda Land System, four trap sites were established within Coolibah Land System, two trap sites were located within Newman Land System, one site was set up within River Land System, two sites were installed within Hooley Land System and the remaining two trap sites were set up within the Urandy Land System.

In addition to trapping, targeted surveys were undertaken in habitats potentially supporting conservation significant species and in potentially sensitive habitats such as Weelamarra Creek, Kangeenarina Creek. The targeted conservation significant fauna survey included cage trapping at eight sites and the deployment of SM2Bat recording devices at 30 locations.

Locations and details of all current survey sites sampled and searched during the survey are presented in Table 3.3 and mapped in Figure 3.2. Site photographs and descriptions of trap sites are presented in Appendix C.

Table 3.3 – Survey site locations

Site	Survey Type	Location		Land System
		Easting	Northing	
Level 2 Assessment				
SLM S1	Systematic trap site	568867	7559252	Boolgeeda
SLM S2	Systematic trap site	572922	7556943	River
SLM S3	Systematic trap site	580596	7540709	Newman
SLM S4	Systematic trap site	587738	7539222	Boolgeeda
SLM S5	Systematic trap site	577802	7538938	Boolgeeda
SLM S6	Systematic trap site	591100	7541803	Newman
SLM S7	Systematic trap site	574465	7531208	Hooley
SLM S8	Systematic trap site	581685	7528272	Hooley
SLM S9	Systematic trap site	607563	7566615	Urandy
SLM S10	Systematic trap site	607512	7566571	Coolibah
SLM S11	Systematic trap site	608576	7561881	Coolibah
SLM S12	Systematic trap site	614304	7559688	Boolgeeda
SLM S13	Systematic trap site	618131	7560148	Boolgeeda
SLM S14	Systematic trap site	614323	7557239	Coolibah
SLM S15	Systematic trap site	622204	7555686	Coolibah
SLM S16	Systematic trap site	620922	7550522	Urandy
SLM OS1	Opportunistic site	588658	7552502	Newman
SLM OS2	Opportunistic site	588574	7552430	Newman
SLM OS3	Opportunistic site	588593	7552094	Newman
SLM OS4	Opportunistic site	588391	7551305	Newman
SLM OS5	Opportunistic site	566189	7564168	River
SLM OS6	Opportunistic site	572800	7556134	River
SLM OS7	Opportunistic site	571794	7544612	River
SLM OS8	Opportunistic site	608973	7546363	Boolgeeda
SLM OS9	Opportunistic site	606775	7560785	Jurrawarrina
SLM OS10	Opportunistic site	607518	7563783	Coolibah
SLM OS11	Opportunistic site	600910	7559941	Urandy
SLM OS12	Opportunistic site	621042	7552034	Urandy
SLM OS13	Opportunistic site	583545	7571553	Newman
SLM OS14	Opportunistic site	586715	7571482	Newman
SLM OS15	Opportunistic site	591496	7569155	Newman
SLM OS16	Opportunistic site	594317	7565745	Newman
SLM OS17	Opportunistic site	588781	7563883	Newman
SLM OS18	Opportunistic site	593100	7563231	Newman
SLM OS19	Opportunistic site	591173	7559308	Newman
SLM OS20	Opportunistic site	590469	7560956	Newman
SLM OS21	Opportunistic site	596481	7546710	Platform
SLM OS22	Opportunistic site	589618	7554129	Boolgeeda
SLM OS23	Opportunistic site	621099	7555057	Coolibah
SLM OS24	Opportunistic site	621099	7555057	Boolgeeda
SLM OS25	Opportunistic site	574204	7558601	Newman
SLM OS26	Opportunistic site	574578	7550552	Calcrete
SLM OS27	Opportunistic site	623193	7560104	Boolgeeda
SLM OS28	Opportunistic site	621032	7551737	Urandy
Bat Rec 1	SM2 Bat recorder	591496	7569155	Newman
Bat Rec 2	SM2 Bat recorder	577803	7538938	Boolgeeda
Bat Rec 3	SM2 Bat recorder	591120	7541798	Newman
Bat Rec 4 (SLM S3)	SM2 Bat recorder	580567	7540704	Newman
Bat Rec 5	SM2 Bat recorder	583486	7542205	Platform
Bat Rec 6 (SLM S12)	SM2 Bat recorder	614340	7559776	Boolgeeda
Bat Rec 7 (SLM S10)	SM2 Bat recorder	607498	7566563	Coolibah

Bat Rec 8	SM2 Bat recorder	595868	7560643	Urandy
Bat Rec 9	SM2 Bat recorder	586715	7571482	Newman
Bat Rec 10 (SLM S11)	SM2 Bat recorder	608657	7561866	Coolibah
Bat Rec 11 (SLM S9)	SM2 Bat recorder	602615	7559675	Urandy
Bat Rec 12	SM2 Bat recorder	603939	7554049	Urandy
Bat Rec 13 (SLM S4)	SM2 Bat recorder	587738	7539222	Boolgeeda
Bat Rec 14	SM2 Bat recorder	583545	7571553	Newman
Bat Rec 15 (SLM S16)	SM2 Bat recorder	620977	7550403	Urandy
Bat Rec 16	SM2 Bat recorder	614407	7557199	Coolibah
Bat Rec 17 (SLM S2)	SM2 Bat recorder	572921	7556751	River
Bat Rec 18 (SLM S1)	SM2 Bat recorder	568837	7559268	Boolgeeda
Bat Rec 19 (SLM S7)	SM2 Bat recorder	574465	7531208	Hooley
Bat Rec 20	SM2 Bat recorder	594317	7565745	Newman
Bat Rec 21 (SLM S13)	SM2 Bat recorder	618156	7560284	Boolgeeda
Bat Rec 22 (SLM S15)	SM2 Bat recorder	622255	7555616	Coolibah
Site	**Survey Type**	**Location**		**Land System**
		Easting	**Northing**	
SLM NE Mc1	Long-term Camera	583601	7571483	Newman
SLM NE Mc2	Long-term Camera	583662	7571550	Newman
SLM NE Mc3	Long-term Camera	586773	7571482	Newman
SLM NE Mc4	Long-term Camera	586864	7571516	Newman
SLM NE Mc5	Long-term Camera	586685	7571407	Newman
SLM NE Mc6	Long-term Camera	591453	7568999	Newman
SLM NE Mc7	Long-term Camera	594342	7565818	Newman
SLM NE Mc8	Long-term Camera	594308	7565810	Newman
SLM NE Mc9	Long-term Camera	594477	7565673	Newman
SLM NE Mc10	Long-term Camera	588837	7563811	Newman
SLM NE Mc11	Long-term Camera	588851	7563824	Newman
SLM NE Mc12	Long-term Camera	588769	7563928	Newman
SLM NE Mc13	Long-term Camera	588719	7563967	Newman
SLM NE Mc14	Long-term Camera	592991	7563245	Newman
SLM NE Mc15	Long-term Camera	592974	7563138	Newman
SLM NE Mc16	Long-term Camera	591099	7559313	Newman
SLM NE Mc17	Long-term Camera	591176	7559308	Newman
SLM NE Mc18	Long-term Camera	590572	7560854	Newman
SLM NE Mc19	Long-term Camera	590444	7560961	Newman
SLM NE Mc20	Long-term Camera	590457	7560965	Newman
SLM Mc1	Long-term Camera	598463	7545395	Robe
SLM Mc2	Long-term Camera	599220	7546602	Newman
SLM Mc3	Long-term Camera	599088	7545633	Robe
SLM Mc4	Long-term Camera	592187	7541620	Newman
SLM Mc5	Long-term Camera	592957	7542337	Newman
SLM Mc6	Long-term Camera	599909	7540820	Newman
SLM Mc7	Long-term Camera	597218	7544765	Platform
SLM Mc8	Long-term Camera	586926	7553283	Boolgeeda
SLM Mc9	Long-term Camera	572897	7556401	River
SLM Mc10	Long-term Camera	597163	7547444	Platform
SLM Mc11	Long-term Camera	593381	7545356	Platform
SLM Mc12	Long-term Camera	597780	7547808	Newman
SLM Mc13	Long-term Camera	572935	7556625	River
SLM Mc14	Long-term Camera	581746	7540867	Newman
SLM Mc15	Long-term Camera	572771	7556129	River
SLM Mc16	Long-term Camera	571509	7538868	Calcrete
SLM Mc17	Long-term Camera	593400	7545372	Platform
SLM Mc18	Long-term Camera	593357	7544853	Platform

Targeted Survey				
NQ A	Targeted NQ Trap site	599514	7540253	Newman
NQ B	Targeted NQ Trap site	599718	7540397	Newman
NQ C	Targeted NQ Trap site	595249	7559532	Newman
NQ D	Targeted NQ Trap site	592831	7543368	Platform
NQ E	Targeted NQ Trap site	579995	7541586	Newman
NQ F	Targeted NQ Trap site	581836	7549279	Newman
NQ G	Targeted NQ Trap site	576930	7552671	Newman
NQ H	Targeted NQ Trap site	575057	7554970	Newman
PLNB 1	Targeted SM2 Bat site	595399	7559595	Newman
PLNB 2	Targeted SM2 Bat site	595956	7560725	Urandy
PLNB 3	Targeted SM2 Bat site	591305	7559327	Newman
PLNB 4	Targeted SM2 Bat site	593249	7559166	Newman
PLNB 5	Targeted SM2 Bat site	594444	7559117	Newman
PLNB 6	Targeted SM2 Bat site	575014	7537910	Calcrete
PLNB 7	Targeted SM2 Bat site	584401	7538899	Boolgeeda
Site	**Survey Type**	**Location**		**Land System**
		Easting	**Northing**	
PLNB 8	Targeted SM2 Bat site	579698	7538919	Boolgeeda
PLNB 9	Targeted SM2 Bat site	575700	7553511	Platform
PLNB 10	Targeted SM2 Bat site	573191	7554825	River
PLNB 11	Targeted SM2 Bat site	570906	7536682	Calcrete
PLNB 13	Targeted SM2 Bat site	583458	7550174	Newman
PLNB 14	Targeted SM2 Bat site	581766	7550792	Boolgeeda
PLNB 15	Targeted SM2 Bat site	572977	7557618	River
PLNB 16	Targeted SM2 Bat site	571609	7546564	River
PLNB 17	Targeted SM2 Bat site	584400	7538898	Boolgeeda
PLNB 18	Targeted SM2 Bat site	580003	7552469	Platform
PLNB 19	Targeted SM2 Bat site	574421	7550655	River
PLNB 20	Targeted SM2 Bat site	583212	7550486	Boolgeeda
PLNB 21	Targeted SM2 Bat site	577796	7553095	Platform
PLNB 22	Targeted SM2 Bat site	575455	7553216	River
PLNB 23	Targeted SM2 Bat site	571026	7542952	River
PLNB 25	Targeted SM2 Bat site	583799	7551463	Boolgeeda
PLNB 26	Targeted SM2 Bat site	570258	7560802	River
PLNB 27	Targeted SM2 Bat site	571561	7538882	Calcrete
PLNB 28	Targeted SM2 Bat site	585818	7551512	Boolgeeda
PLNB 29	Targeted SM2 Bat site	573791	7548181	River
PLNB 30	Targeted SM2 Bat site	569873	7533439	Brockman

Datum: GDA94
Zone: 50Y

560000 580000 600000 620000 640000

7580000 7560000 7540000 7520000

Legend

- Avifauna survey
- Diurnal opportunistic search
- Motion camera
- SM2BAT recorder
- Systematic trapping
- Targeted Northern Quoll trapping

Legend

- Central Pilbara Project mine (ecologia 2011)
- Central Pilbara Project rail (ecologia 2012)
- Firetail (Coffey 2008)
- Firetail (Ecoscape 2010)
- Investigator (ecologia 2013)
- Kings (Coffey 2008 /ecologia 2010)
- Mt Macloed (Rapallo 2011)
- Mt Macloed (ecologia 2013)
- Stingray (ecologia 2013)
- Solomon mine monitoring (ecologia ongoing)
- Solomon mine (Coffey 2011)
- Solomon rail (Coffey 2011)
- Solomon South (Outback 2014)
- Study area

N

0 5 10

Kilometres

Absolute Scale - 1:250,000

ecologia ENVIRONMENT

Location of previous Solomon survey sites

Figure: 3.1
Project ID: 1593

Drawn: BG & AH
Date: 22/10/2014

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

Unique Map ID: BG368

A3

560000 580000 600000 620000 640000

7580000

7560000

7540000

Legend

- Systematic Trapping
- Diurnal opportunistic search
- SM2BAT recorder
- Motion camera
- Targeted Northern Quoll Trapping
- Previous survey sites (Figure 3.1)
- Study area

N

0 5 10

Kilometres

Absolute Scale - 1:250,000

ecologia ENVIRONMENT

Location of current Solomon survey sites

Figure: 3.2
Project ID: 1593

Drawn: BG
Date: 1/09/2014

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

Unique Map ID: BG369

A3

3.4 CONSERVATION SIGNIFICANT AND PRIORITY LISTED FAUNA

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

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

- fauna habitats and their condition known to exist within the study area;
- distance of previously recorded conservation significant species from the study area;
- frequency of occurrence of conservation significant species records in the region; and
- time passed since conservation significant species were recorded within, or surrounding, the study area.

Each conservation significant or priority listed species potentially occurring in the study area, was assigned a likelihood of occurrence based on the below category (Table 3.4). 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.

Table 3.4 – Likelihood of occurrence categories

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

3.5 ECOLOGIA SAMPLING METHODS

The survey methods adopted by *ecologia* for this survey and all previous *ecologia* surveys (*ecologia* 2010, 2011b, 2012a, 2013a, b, e) were aligned with the EPA's Guidance tatement No. 56 (EPA 2004), Position Statement No. 3 (EPA 2002) and *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2010).

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 Trapping

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 3.3):

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

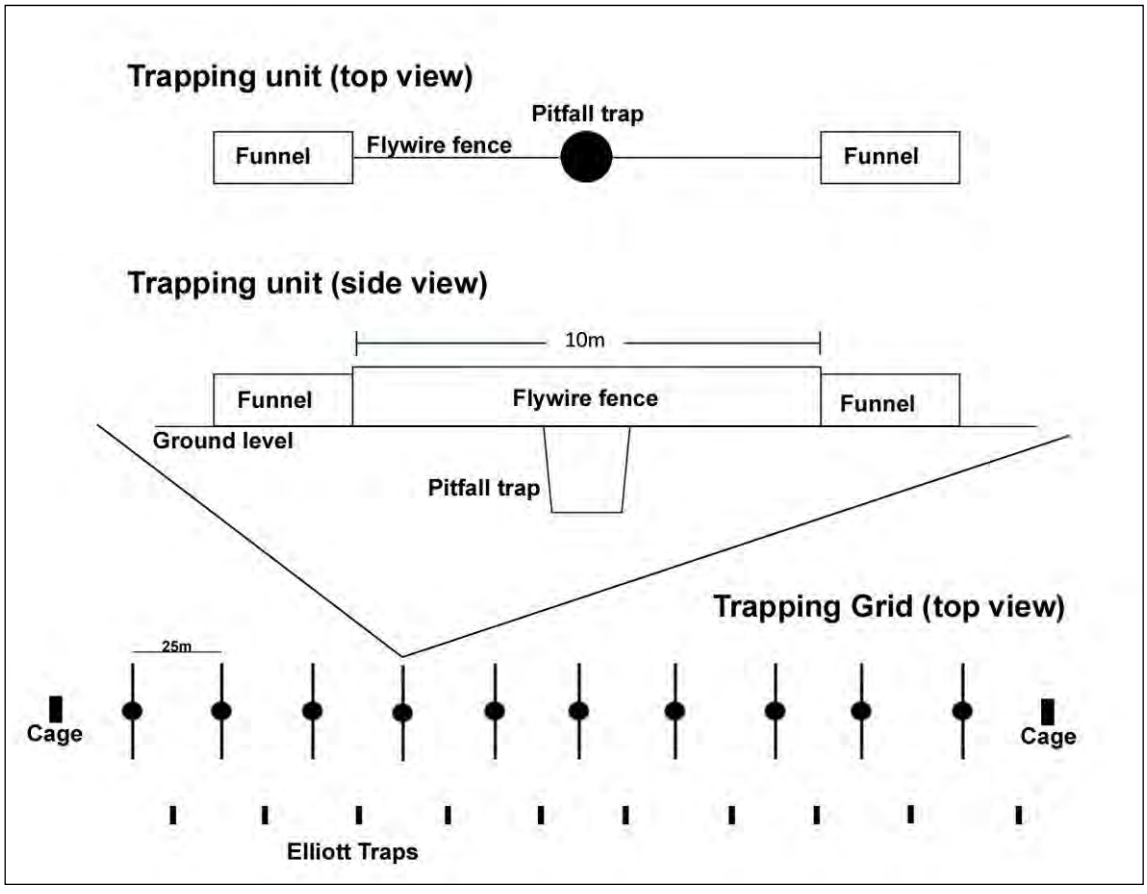


Figure 3.3 – *ecologia* systematic sampling trap arrangement

Figure 3.4 – Image of single *ecologia* trap point

3.5.2 Avifauna

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

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

3.5.3 Bats

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

3.5.4 Diurnal Opportunistic Searching

Both trapping and opportunistic sites were searched by hand for cryptic species, which comprised searching beneath the bark of dead trees, breaking open old logs, stumps and dead free-standing trees, investigating burrows and over-turning logs and stones. Sites were selected on the basis of fauna habitat (targeting uncommon habitats or habitats poorly represented by trapping sites) and the possibility of their harbouring conservation significant fauna. A habitat assessment was completed ay each diurnal opportunistic search sites, to aid in habitat mapping.

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

3.5.5 Camera Trapping

Motion sensor cameras were used predominately to target Northern Quoll. A total of 38 cameras were established during the level 2 survey. These were then left for a period of 10 weeks and collected during the targeted Northern Quoll survey. Cameras were baited with sardines in an attempt to lure Northern Quolls to the area. A combination of Bushnell Trophy Cam, Reconyx HC500 Hyperfire and UOVision UV565 motion cameras were used.

All cameras are triggered by movement by a highly sensitive Passive Infra-Red motion sensor and functions day and night taking either video footage or photos.

3.5.6 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 study 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 the Level 2 survey, a targeted survey was undertaken for conservation significant fauna species potentially occurring in the study area, with a focus on EPBC listed species the Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat. Targeted survey methodology for the three EPBC Act listed species was consistent with those listed in species specific survey guidelines (DSEWPaC 2011a, b, c, d) and is described in further detail below.

3.5.6.1 Northern Quoll

Habitat mapping information was used to estimate all potential Northern Quoll habitats within the study area. The total area of habitat and the relative accessibility is presented below (Table 3.5)

Table 3.5 – Area of Potential Northern Quoll Habitat

Accessibility of Potential Northern Quoll habitat	Area (ha)
Denning Habitat	1,716
Foraging habitat	25,540
Total area of Potential Northern Quoll Habitat	27,256

Trapping survey effort was designed using the formula described in the Northern Quoll referral guideline document (DSEWPaC 2011a) which is described below. The trapping effort was calculated using the total area of suitable habitat, although only the area of potential habitat that is accessible for trapping (pers. comms. Tim McGrath, DSEWPaC 2011) is typically used. The referral guidelines also recommend that traps are left open for a minimum of 7 nights and that if 2 or more individuals are caught twice, the traps should be closed after 4 nights.

$$y=50x^{0.5}$$

y= number of trapnights, x = area of potential habitat in hectares

Based on the above formula, 8,255 trap nights are recommended to determine the presence and abundance of Northern Quoll within the study area. Over 10,000 trapnights (cage traps) have been surveyed during the previous vertebrate fauna surveys and monitoring conducted within the study area (Table 3.7), which exceeds the required number of trap nights to adequately assess the likelihood of occurance for Northern Quoll within the study area. However to fill any geographic gaps in the previous surveys, an additional eight Northern Quoll trapping sites, utilising a total of 200 traps were established during the current survey (Figure 3.2).

During all surveys, traps were baited with universal bait (peanut butter, oats and sardines) which was changed every two days and all traps were shaded with Hessian bags (Cage Traps) and industrial roof insulation (Elliott traps) to reduce the likelihood of trap death due to heat/cold stress, as per referral guidelines. All traps were checked and cleared each morning and any captured quolls are marked

using ear notches or Passive Integrated Transponder (PIT), measured and released. Ear notches were retained and sent to the WAM for future genetic analysis.

Motion cameras were utilised in areas inaccessible for systematic trapping, and baited with sardines in an attempt to lure Northern Quoll and other animals in to the area.

3.5.6.2 Pilbara Leaf-nosed Bat

Habitat mapping was also used to highlight areas that had the potential to provide habitats that this species is thought to prefer. Passive acoustic detectors are listed as the best means of non-invasive survey and the survey guidelines for Threatened Bats (DEWHA 2010) indicate that 16 survey nights are recommended for areas less than 50 ha over a minimum of four nights, repeated twice with 6 months separating surveys. No recommendations are available for project areas greater than 50 ha so survey staff maximised the number of survey nights and locations that could be completed.

Across all surveys conducted within the study area 3,197 hours of recordings from 136 locations were analysed. From this total survey effort, 636 hours of recordings from 51 locations were analyses during the current assessment.

3.5.6.3 Pilbara Olive Python

Survey methods for Pilbara Olive Pythons consist of nocturnal road spotting transects, opportunistic searches for individuals, sloughed skin and faecal pellets (DSEWPaC 2011d). No guidance is given on survey intensity, however it can be interpreted that all suitable habitat should be searched for secondary evidence of this species.

Due to the lack of guidance on survey methodologies for this cryptic species, opportunistic searches were conducted during all assessments. Searches were conducted in suitable habitat within the study area and included searches of all water bodies encountered, for evidence of this species. As the suitable habitat for Pilbara Olive Python is similar to that required by both Northern Quoll and Pilbara Leaf-nosed Bats, opportunistic searches were carried out concurrently.

Additionally monitoring of Pilbara Olive Python has been conducted annually since 2012 (*ecologia* 2013c, 2014a) incorporating nocturnal road transects and searches of suitable habitat within the study area. The monitoring was conducted during summer which is considered the optimal survey timing for this species.

3.6 SAMPLING METHODS – NON ECOLOGIA SURVEYS

Three previous Level 2 surveys have been completed by different companies within the study area. Systematic sampling methodology used was slightly different to survey methods conducted by ecologia, however all key sampling techniques were consistant with relevant guidleines (EPA 2004a; EPA and DEC 2010), hence data from the below survey methods were utilised during this assessment. Survey methods used during each survey are described in detail in the below sections.

3.6.1 Trapping Site Design (Coffey 2008)

Each trapping site consisted of the following (Figure 3.5).

- Pitfall trap and drift fence: Three 20 L PVC buckets and three 150x500 mm PVC pipes as pit-traps were established at each site evenly spaced along a 30 m fly-wire drift fence (250 mm high). Four drift fences were established at each trapping site resulting in 24 pitfall traps per site. Some trapping sites in Valley of the Kings did not have pitfall traps due to the rockiness of the substrate.
- Elliott box Traps: Three Elliott traps (two small: 100x90x330 mm and one large: 380x120x110 mm) were set along each drift fence resulting in 12 Elliott traps per site. Elliott traps were baited with a mixture of sardines, rolled oats and peanut butter.
- Funnel traps: Six funnel traps were placed in pairs along each drift fence with each pair located between a pair of bucket and PVC pitfall traps.

Trap lines were arranged either parallel to each other or end-on depending on the habitat type. For example, in some creek lines each trap line was located end-on and run parallel to the direction of water flow.

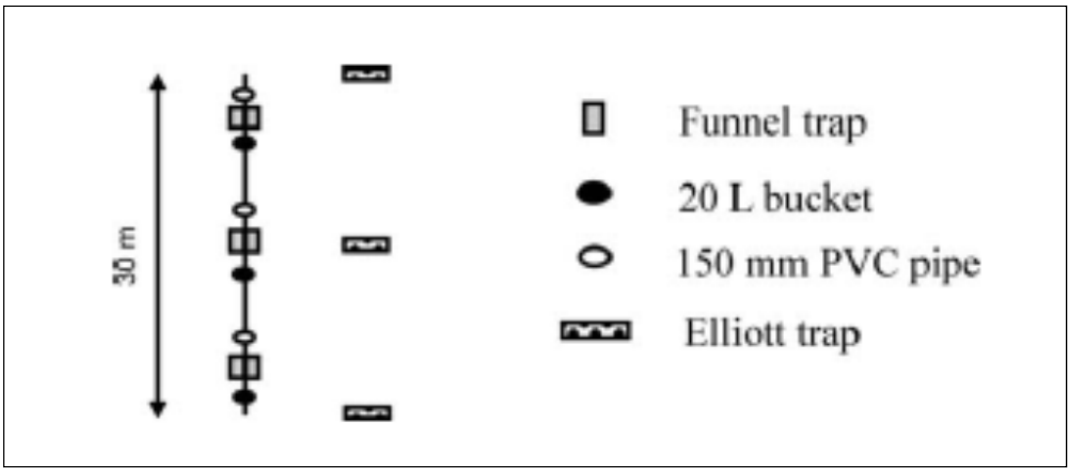


Figure 3.5 – Coffey systematic sampling trap arrangement

3.6.2 Trapping Site Design (Rapallo 2011)

Each site consisted of:

- three Elliot traps;
- six cage traps;
- three funnel traps;
- three bucket pitfall traps;
- three pipe pitfall traps.

A line of pitfall traps ran through the centre of each site with three 20 litre bucket pitfalls and three 150 mm pipe pitfall traps deployed approximately 6 metres (m) apart, alternating along a 40 m length of drift fence.

Each pitfall trap had a white styrofoam trap to provide shelter for any captures. On occasions the location of the pitfall trap was moved a short distance to accommodate layers of bedrock that would prevent the installation of the trap. The drift fence was moved and extended where appropriate.

Funnel traps were installed along the length of fence and covered with a sheet of Glare-foil insulation to shelter any captives from extreme daytime temperatures. Each funnel trap was set equidistant from adjacent pitfall traps.

Elliot traps were set spaced approximately 10 m apart leading from end of the pitfall fence. Each trap location was marked with flagging tape and baited with a mixture of peanut butter, rolled oats and honey.

Cage traps were laid in a straight line perpendicular to the drift fence approximately 50 m apart, starting 50 m from the fence. Each trap was marked with flagging tape and baited with a mixture of peanut butter, rolled oats and honey.

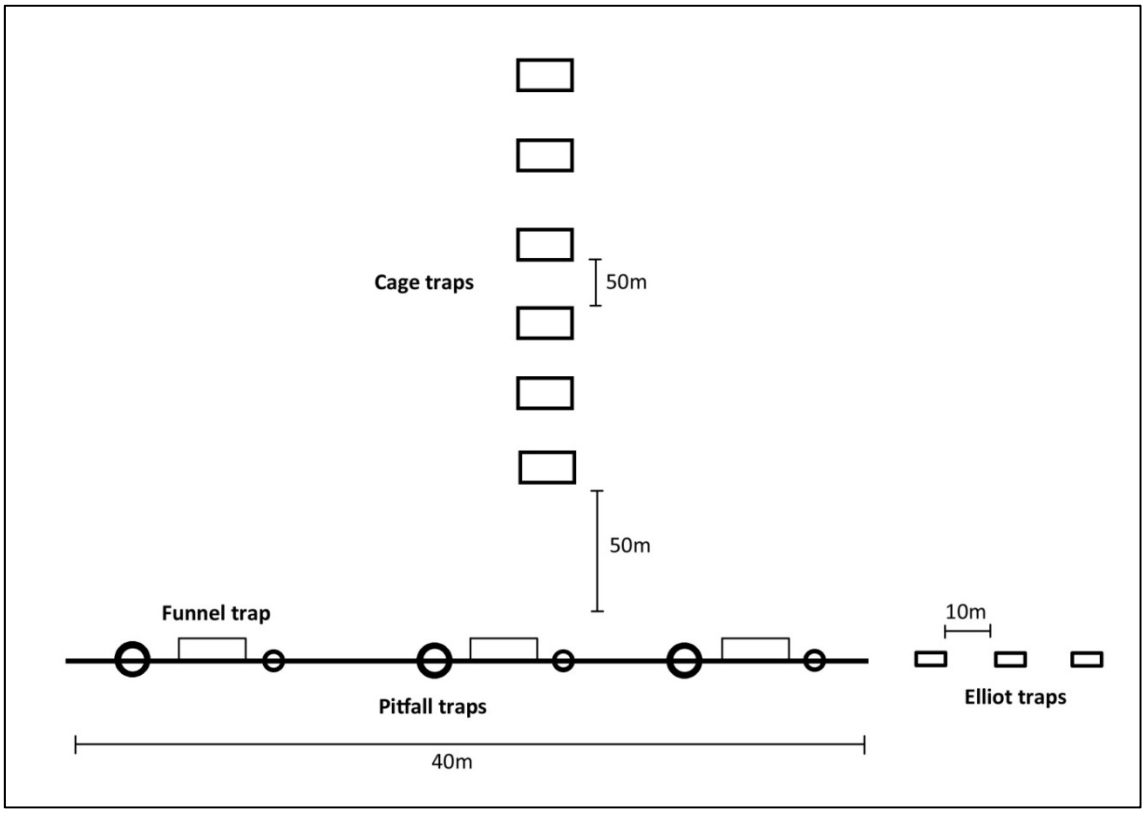


Figure 3.6 – Rappallo systematic sampling trap arrangement

3.6.3 Ecoscape Firetail (Ecoscape 2010d)

The locations of the Ecoscape Phase 2 survey trap sites were selected to maximise sampling of dense vegetation cover and all available microhabitats within each habitat type. Six survey sites consisting of ten pitfall traps, five cage, twenty funnels and twenty Elliot traps were established to complete the trap site design. Pitfall traps were spaced approximately 50m apart along a transect through each of the selected sites (Figure 3.7). Trapping surveys were conducted over seven nights.

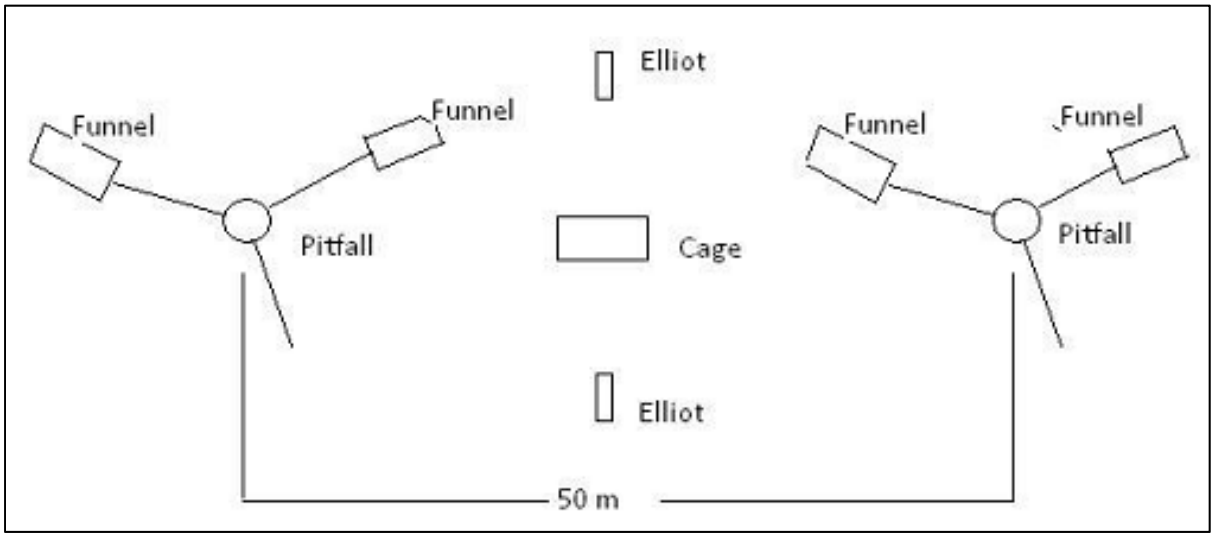


Figure 3.7 – Ecoscape systematic sampling trap arrangement

3.7 FAUNA HABITAT MAPPING

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

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

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

- Landform.
- Vegetation type and structure.
- Soil characteristics (soil structure and substrate).
- Composition of terrestrial fauna species.
- Habitat condition (Table 3.7).

These observations did not take into account any degradation as a result of exploration or other recent mining activities (e.g. drilling, clearing) other than the cleared areas within the Solomon Hub study area as provided by Fortescue.

Areas previously mapped within and outside the study area were incorporated in the current mapping.

Habitat mapping was provided for following areas:

- Inside the study area.
- Within 30 km of the study area (includes previously mapped areas and extrapolated areas).
- Between 30 – 130 km of the study area (includes previously mapped areas only).

Table 3.6 – Habitat condition assessment

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

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

3.8 SURVEY EFFORT

Survey effort expended within the study area for the current survey included the following:

- trapping grids were open for seven trap nights;
- 1,120 pitfall trap nights were completed;
- 2,240 funnel trap nights were completed;
- 1,120 elliott trap nights were completed;
- 1,672 cage trap nights were completed;
- 36 hours were spent surveying for birds;
- 17.5 hours were spent on opportunistic diurnal searching;
- 63,840 hours of camera trapping (left in situ between Level 2 and targeted surveys) were completed; and,
- 636 hours of recordings were analysed to determine bat assemblage and distribution.

Total survey effort per site is presented in Table 3.7. Included in Table 3.7 is a summary of all previous survey effort of surveys completed within the study area, showing significant survey effort has been completed within the study area.

Table 3.7 – Survey effort of current and previous surveys

Site	Pit Traps (trap nights)	Funnels (trap nights)	Elliotts (trap nights)	Cages (trap nights)	Bird Survey (hour)	Diurnal Opp Search (hour)	Bat Recording (hour)	Nocturnal Opp Search (hour)	Camera Trapping (hour)
Current Level 2 and targeted conservation significant fauna survey									
SLM S1	70	140	70	16	2		12		
SLM S2	70	140	70	16	2		12		
SLM S3	70	140	70	16	2		12		
SLM S4	70	140	70	16	2		12		
SLM S5	70	140	70	16	2		24		
SLM S6	70	140	70	16	2		24		
SLM S7	70	140	70	16	2		12		
SLM S8	70	140	70	16	2		12		
SLM S9	70	140	70	16	2		12		
SLM S10	70	140	70	16	1.5		12		
SLM S11	70	140	70	16	2		12		
SLM S12	70	140	70	16	1.5		12		
SLM S13	70	140	70	16	1.5		12		
SLM S14	70	140	70	16	1.5		12		
SLM S15	70	140	70	16	2		12		
SLM S16	70	140	70	16	2.5		12		
Opportunistic	-	-	-	16	5.5	17.5	60	14	-
Targeted survey	-	-	-	1,400	-	-	360	-	63,840
Sub Total	**1,120**	**2,240**	**1,120**	**1,672**	**36**	**17.5**	**636**	**14**	**63,840**
Previous Level 2 surveys within the study area									
Total	**21,430**	**30,405**	**22,320**	**3,029**	**268**	**283**	**1,610**	**544**	**901**
Previous Level 1 surveys within the study area									
Total	**-**	**-**	**-**	**1,200**	**2**	**85.5**	**60**	**12**	**408**
Previous targeted conservation significant fauna surveys and monitoring within the study area									
Total	**-**	**-**	**3,465**	**6,713**	**-**	**-**	**938.5**	**101.5**	**2,712**
Combined survey effort									
Grand Total	**22,550**	**32,645**	**26,905**	**12,614**	**306**	**386**	**3,244.5**	**671.5**	**67,861**

3.9 DATA ANALYSIS

3.9.1 Survey Adequacy

There are three general methods of estimating species richness from sample data: extrapolating species-accumulation curves (SACs), fitting parametric models of relative abundance, and using non-parametric estimators (Bunge and Fitzpatrick 1993; Colwell and Coddington 1994; Gaston 1996). In this report, the level of survey adequacy was estimated using SACs, which graphically illustrate the accumulation of new species as more individuals are recorded. Ultimately, the asymptotic plateau is reached at the level at which no new species are present. To eliminate inconsistent values caused by random or periodic variation over time, an algorithm (Mao Tau) was applied to the sampling data using EstimateS (version 8, Colwell 2009). This algorithm effectively smoothes the curve of the number of species observed by simulating an infinite number of randomisations of the sample order. In order to estimate the theoretical maximum number of species for each fauna group, a number of species richness estimators were provided, in order to give an indication as to survey adequacy.

Only the results of systematic sampling are included in SAC calculations, since the algorithms assume a standard sampling effort. Therefore, species recorded through opportunistic methods are not included. Separate analyses were carried out for terrestrial mammals, birds and reptiles. Due to the slight systematic sampling difference by previous surveys by other companies (Section 0), only data collected by *ecologia* during previous surveys was used for SAC calcualtions.

3.9.2 Fauna Assemblage and Habitat Assessment

Analysis of the fauna survey data was undertaken to determine potential differences in fauna communities and subsequently identify distinct fauna habitats.

Data was transformed to presence/absence to remove abundance effects (e.g. those caused by differing environmental conditions between surveys). Separate analyses were carried out for terrestrial fauna (mammal and reptile) and avifauna. An association matrix, measuring the similarity between sites and similarity between occurrence of species (species that are likely to occur together will have a higher measure of association), using the Bray-Curtis Similarity Index with 1000 permutations. This data was then used to create a dendrogram (cluster analysis) which clusters sites according to the similarity of their fauna assemblages. A two way table was also produced, showing groupings of species and sites simultaneously (and indicating which species were present at each site). Separate analyses were conducted for trappable fauna and birds. These analyses were conducted using the PATN software package (Belbin 1989)

Bird survey data was also analysed through analyses of similarity (ANOSIM) (Clarke 1993) comparisons made using the one-way ANOSIM function, to test whether the differences in species diversity between habitat types were significant. Data was first subjected to a log+1 transformation, which prepares it for analyses that are not robust against outliers. The ANOSIM was calculated using the Bray-Curtis Similarity Index with 1000 permutations. Non-metric multidimensional scaling (MDS) was also applied to the Bray-Curtis similarity matrix. Resulting stress values below 0.20 were considered to indicate a good fit of the scaling to the matrix. The dimensions that reduced the majority of the “raw stress” were chosen for the final scaling. Analysis was undertaken using the PAST software package (Hammer *et al.* 2001). Due to the slight systematic sampling difference by previous surveys by other companies (Section 0), only data collected by *ecologia* during previous surveys was used for habitat assessment.

3.10 TAXONOMY AND NOMENCLATURE

Nomenclature for mammals, reptiles and amphibians within this report is as per *Western Australian Museum Checklist of the Vertebrates of Western Australia*, birds according to Christidis and Boles (2008). References used for fauna identification are listed in Table 3.8.

Table 3.8 – 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)

3.11 SURVEY TEAM AND LICENCES

Field survey team members for the current field assessment are listed in Table 3.9. The survey was conducted under DPaW Regulation 17 Licence SF009811.

Table 3.9 – Field survey personnel

Survey Member	Expertise	Qualification	Experience
Damien Cancilla	Mammalogy	B.Sc. (Hons)	10 years
Astrid Heidrich	Herpetology	M.Sc.	9 years
John Graff	Ornithology	B.Sc. (Hons)	9 years
Sean White	Invertebrate Zoology	-	8 years
Jordan Vos	Herpetology	-	9 years
Leigh Smith	Herpetology	-	5 years
Farhan Bokhari	Invertebrate Zoology	B.Sc. (Hons)	5 years
Kellie McMaster	Ecology	Phd.	5 years
Plaxy Barratt	Ornithology	B.Sc. (Hons)	3 years
Paul Anderson	Field assistant	-	-

3.12 ANIMAL ETHICS

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

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

4 RESULTS AND DISCUSSION

4.1 FAUNA HABITATS

A total of 11 broad fauna habitats were recorded from the study area:

- Drainage line/River/Creek (Major)
- Plain (stony gibber) (includes lower slopes and midslopes)
- Plain (Cracking clay)
- Hummock grassland
- Plain (Alluvial)
- Shrubland (Open)
- Hilltops/ridges/plateaux
- Gorges/Gullies
- Woodland (Open Eucalypt)
- Plain (stony calcrete)
- Tussock grassland (on loam/clay)

All eleven broad habitat types have previously been mapped outside of the study area, and are therefore not considered unique to the study area (Table 4.1, Figure 4.14, Figure 4.15).

Three habitat types are considered suitable for three EPBC Act threatened fauna known to occur within the study area:

The Gorges/Gullies habitat type is considered suitable habitat for:

- Northern Quoll (denning and foraging)
- Pilbara Leaf-nosed Bat (foraging)
- Pilbara Olive Python (winter shelter and foraging)

The Drainage line/River/Creek (Major) is considered suitable habitat for:

- Northern Quoll (dispersal and foraging)
- Pilbara Leaf-nosed Bat (foraging)
- Pilbara Olive Python (dispersal and foraging)

The Hilltops/ridges/plateaux habitat type is considered suitable habitat for:

- Northern Quoll (dispersal and foraging)
- Pilbara Olive Python (dispersal and foraging)

Table 4.1 – Summary of fauna habitat areas

Fauna Habitat	Vegetation units	Extent inside study area before clearance (ha)	Current extent inside study area (after clearance) (ha)	Precent of current fauna habitats after clearance (%)	Area within 30 km of study area* (ha)	Percent of fauna habitats within 30 km of study area (%)	Area previously mapped 30-130 km of the study area# (ha)	Percent of fauna habitats mapped within 30-130 km of study area (%)
Plain (stony gibber) (includes lower slopes and midslopes)	ChAiTw1, ChAiTw2, ChAiTw1, EllAbTw4, EllAbTw5, AaAbTw, ApAaTe, AaAbTe, ChAdTe1, AaAbTt, ApAaTe, EgAaTe1, EgAaTe4, EllHllTw, AhGwTe, EcApCa, EllAbTw4	84,585.3	81,380.7	45.4	710,269.2	66.5	89,646.8	32.4
Drainage line/River/Creek (Major)	AaPsCf, EcApCa, EvVfCc, AhGwTe,	3,866.5	3,844.9	2.1	12,005.2	1.1	21,723.5	7.9
Tussock grassland (on loam/clay)	AaSfAl, EvAcCc, ChAoCf	122.52	113.1	0.1	5,802.6	0.5	1,145.9	0.4
Gorges and Gullies	EllApTw2, EllHcTw1, EllHcTw3,	1,711.6	1,704.4	1.0	6,678.8	0.6	838.1	0.3
Hilltops/ridges/plateaux	EllGwAmClTw (AJ), EllAbTw (AP), EllAiTw, EllHcTw1, EllApTw1, EllApTw2, EllAbTw4	22,697.7	22,481.8	12.5	60,044.8	5.6	70,162.0	25.4
Hummock grassland	ChApTe1, EllHllTw, AaAbTe	10,723.1	10,722.7	6.0	22,964.1	2.1	30,509.0	11.0
Woodland (Open Eucalypt)	AhGwTe, EvAcCc, AaAbTw, EllAaTw1, EllAbTw1, EllAbTw4, EllHcTw4	5,971.7	5,953.6	3.3	19,542.9	1.8	8,145.2	2.9

Fauna Habitat	Vegetation units	Extent inside study area before clearance (ha)	Current extent inside study area (after clearance) (ha)	Precent of current fauna habitats after clearance (%)	Area within 30 km of study area* (ha)	Percent of fauna habitats within 30 km of study area (%)	Area previously mapped 30-130 km of the study area# (ha)	Percent of fauna habitats mapped within 30-130 km of study area (%)
Plain (Cracking clay)	AaPsCf, AaVfTH1, AaVfTH2, ExApTw, VfAl, TH, AiGwTp, HllAvCf,	18,442.6	18,424.4	10.3	70,462.6	6.6	91.6	<0.1
Plain (stony calcrete)	ExApTw, HllAvCf, ApAaTe,	5,446.6	5,446.6	3.0	10,459.5	1.0	-	-
Plain (Alluvial)	AalmTe, AaElCf, AaSvCc, AaPsCf, AaPlAcTe, AaAvCc, AaPlAc, AaAbTw, AaAoPtPoCf, AaElfTe, AaVfCfTspH2, ChAaAoPsCf, AaSspvCc, AalmTe, AaSfAlAcCmnTe	20,368.9	20,271.1	11.3	135,774.2	12.7	-	-
Shrubland (Open)	AaAbTw, AhGwTe, ApAaTe, EgAaTe4, EllAiTw, AaAbTe, EvAaEa,	9,240.4	8,877.7	5.0	14,350.8	1.3	54,252.8	19.6
Total		**183,176.9**	**179,221.0**		**1,068,354.7**		**276,514.9**	

*includes previously mapped habitats and extrapolated areas.
includes previously mapped habitats (during previous assessments), excludes extrapolated areas.

4.1.1 Drainage line/River/Creek (Major)

The Drainage line/River/Creek (Major) habitat occurred across the study area, but mostly to the west (Figure 4.13). This habitat supported mature *Eucalyptus victrix* trees with patches of dense mixed *Acacia* spp. shrubs and tussock grasses such as *Themeda triandra*, *Chrysopogon fallax* and *Cenchrus ciliaris* lining the banks. The trees of the major drainage line habitat contained varying sized hollows and an abundance of woody debris (Figure 4.1). Leaf litter was abundant on the banks and under large trees. The substrate of the major drainage line was a clay-loam on the banks and a continuous bed of smooth river pebbles in larger areas of the creek.

The terrestrial fauna assemblage supports species such as *Strophurus wellingtonae* and *Gehyra variegata*, and Pilbara generalists such as *Demansia psammophis*, *Pseudomys desertor* and *Pseudechis australis.* Several frog species including *Cyclorana maini*, *Litoria rubella* and *Uperoleia saxatilis* have been recorded where water pools are present, such as in Kangeenarina Creek.

The avian fauna assemblage is relatively diverse; however, the exact composition of this assemblage varies depending on the floral assemblage. The relatively dense shrub layer favours species such as Rufous Whistler, Crested Bellbird Chestnut-rumped Thornbill, and Variegated Fairy-wren. If eucalypts are present, White-plumed and Black-chinned Honeyeater can occur, while flowering shrubs can attract nomadic Black, Pied and White-fronted Honeyeater.

This habitat is the only habitat suitable for freshwater fish within the study area. Hyrtl's Tandan, Western Rainbowfish, Barred Grunter and Spangled Perch are characteristic species of this habitat, occurring in pools along the major watercourses (e.g. Kangeenarina Creek).

EPBC Act and WC Act threatened fauna associated with this habitat include Northern Quoll (*Dasyurus hallucatus*; dispersal and foraging), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form); foraging), and Pilbara Olive Python (*Liasis olivaceus barroni*; dispersal and foraging). EPBC Act migratory listed species associated with this habitat include the Eastern Great Egret (foraging habitat when pools are present) and Rainbow Bee-eater (foraging and nesting). Additionally, the Bush Stone-curlew (DPaW P4) and Peregrine Falcon (WC Act S4) occupy this habitat.

Figure 4.1 – Drainage line/River/Creek (Major) habitat

4.1.2 Plain (stony gibber) (includes lower slopes and midslopes)

The Plain (stony gibber) habitat type, which includes lower slopes and midslopes, was a large habitat within the study area (Figure 4.13). This habitat was the third most elevated of the habitat types following the hilltop habitat type and the gorge and gully habitat type. It was mainly found in the northern section of the study area. This habitat consisted of a very open to open shrubland of *Acacia aptaneura*, *A. pruinocarpa*, *A. binevosa* and *Senna glutinosa* over *Triodia wiseana* hummock grassland on a continuous layer of bedrock and scattered pebbles and stones (Figure 4.2). Wood litter and leaf litter was generally sparse in this habitat.

The terrestrial fauna assemblage that characterises this habitat type includes all the more commonly recorded Pilbara species such as *Carlia munda*, *Ctenotus inornatus*, *C. pantherinus*, *C. superciliaris*, *Cyclodomorphus melanops*, *Ctenophurus caudicinctus*, *Demansia psammophis*, *Diplodactylus conspicillatus*, *Lucasium stenodactylum*, *Dasykaluta rosamondae*, *Ningaui timealeyi*, *Pseudomys desertor*, *P. hermannsburgensis* and *Sminthopsis macroura*.

The avifauna assemblage also includes a wide range of typical Pilbara species. Dense spinifex favours Spinifexbird and Rufous-crowned Emu-wren. Eucalypts host Weebills, Grey-headed Honeyeaters in more hilly country, and occasionally Black-tailed Treecreepers. When in flower, they may also attract species such as Black-chinned Honeyeater and Masked Woodswallow. Shrubs are attractive to Rufous Whistler, Crested Bellbird and Singing Honeyeater, along with White-winged Fairy-wren. Little Button-quail and Spinifex Pigeon occur where there is sufficient ground cover.

EPBC Act and WC Act threatened fauna associated with this habitat include the Pilbara Olive Python (*Liasis olivaceus barroni*; dispersal and foraging). EPBC Act migratory listed species associated with this habitat include Rainbow Bee-eater (foraging). Additionally, the DPaW Priority listed Western Pebble-mound Mouse (*Pseudomys chapmani*), Australian Bustard and Bush Stone-curlew occupy this habitat.

Figure 4.2 – Plain (stony gibber) habitat

4.1.3 Plain (Cracking clay)

The cracking clay grasslands plain occupied the majority of the south of the study area (Figure 4.13). The cracking clay plains comprised a unique habitat type that contained little to no overstorey and was dominated by one or two tussock grass species (Figure 4.3). The vegetation was described as isolated shrubs of *Sida spinosa* and *Vachellia farnesiana* located amongst dense tussock grassland dominated by *Chrysopogon fallax*, *Themeda* sp. Hamersley Station (P3) and/or *Astrebla pectinata* grass species. The soils comprised firm cracking clays containing abundant cracks and crevices. Rocks/stones/pebbles, leaf litter and woody debris were almost entirely lacking from this habitat type.

As a result of the unique habitat characteristics, the associated fauna assemblage was significantly different to other assemblages in the study area. The terrestrial fauna assemblage is characterised by several specialist species that are typically only found in this habitat type, including *Ctenotus robustus* and *Tympanocryptis cephalus*. Small mammals such as planigales and *Sminthopsis macroura* are also commonly recorded in this habitat type.

The bird assemblage is not especially diverse, but is distinctly different to most other habitat types. It is characterised by open grassland species such as Australasian Pipit and Horsfield's Bushlark, along with several raptor species that hunt over the plains, including Nankeen Kestrel and Spotted Harrier. There is an almost complete absence of species requiring trees and shrubs (e.g. pardalotes and honeyeaters), or spinifex (e.g. Spinifexbird).

No EPBC Act listed threatened fauna are associated with this habitat. The DPaW Priority listed Australian Bustard and Short-tailed Mouse (*Leggadina lakedownensis*) occupy this habitat.

Figure 4.3 – Plain (Cracking clay) habitat

4.1.4 Hummock grassland

The hummock grassland plains habitat was limited to the south-west of the study area (Figure 4.13). The vegetation was characterised by isolated trees of *Eucalyptus leucophloia* subsp. *leucophloia* and *Acacia aptaneura* over sparse to medium dense *Acacia*/*Senna* spp. shrubs over *Triodia epactia/pungens* hummock grassland over a loam substrate (Figure 4.4). These often undulating plains consisted of firm, red, fine clay-sands with numerous loose rocks. The amount of leaf litter and woody debris was usually low within these habitats.

The terrestrial fauna assemblage consists of *Carlia munda*, *Pseudomys desertor*, *Dasykaluta rosamondae*, *Ningaui timealeyi* and *Ctenophorus isolepis* and *Varanus acanthurus* but a lack of woody debris and trees appears to limit the diversity of species recorded in this habitat type.

The relative lack of trees and shrubs limits the diversity of the avian fauna assemblage. Species such as Spinifexbird, Rufous-crowned Emu-wren and White-winged Fairy-wren occur. Isolated eucalypts can host Weebill and Grey-headed Honeyeater, while shrubs can be enough for Crested Bellbird, Singing Honeyeater or Variegated Fairy-wren to occur. Seeding spinifex can attract Budgerigars and Spinifex Pigeon.

No EPBC Act listed threatened fauna are associated with this habitat. The EPBC Act migratory listed Rainbow Bee-eater is known to forage in hummock grasslands. Additionally, the DPaW Priority listed Australian Bustard, Bush Stone-curlew and Lined Soil-crevice Skink (*Notoscincus butleri*) occupy this habitat.

Figure 4.4 – Hummock grassland habitat

4.1.5 Plain (Alluvial)

This habitat type was limited to the eastern and southern Borefields of the study area (Figure 4.13). It was most often characterised by mulga open woodland to woodland, occasionally with *Acacia citrinoviridis,* over *Acacia* spp. scattered shrubs to high open shrubland over *Chrysopogon fallax* and *Eragrostis* spp. tussock grassland and/or spinifex very open hummock grassland (Figure 4.5). However, there were patches of *Triodia epactia* open hummock grassland with *Acacia xiphophylla* (snakewood) scattered tall shrubs and isolated low trees (Figure 4.6). The substrate of this habitat was observed to be firm, red-brown, loamy clay, with some surface crust and cracks with common ironstone gravel of pebbles and stones or occasionally with calcrete stones. Areas of mulga woodland had fairly sparse leaf litter accumulated under shrubs/trees and moderate wood litter. All areas were observed to be long unburnt.

The terrestrial fauna assemblage consisted of mulga specialists such as *Diporiphora amphiboluroides*, open mulga woodland species such as *Menetia surda,* and Fortescue plain species such as *Diplodactylus galaxias.* Other species that characterised this habitat type include *Suta punctata* and *Ctenophorus reticulatus*.

A number of bird species are characteristic of this assemblage. Slaty-backed Thornbill and Grey Honeyeater are largely restricted to mature mulga, while Chestnut-rumped and Inland Thornbill also occur. Species such as Spiny-cheeked Honeyeater, Red-capped Robin and Redthroat are also characteristic, but may also occur in other assemblages.

No EPBC Act listed threatened fauna are associated with this habitat. The EPBC Act migratory listed Rainbow Bee-eater is likely to forage in the habitat, particularly near drainage lines. Additionally, the DPaW Priority listed Australian Bustard and Bush Stone-curlew occupy this habitat.

Figure 4.5 – Plain (Alluvial) with Acacia (mulga) woodland habitat

Figure 4.6 – Patch of snakewood (*Acacia xiphophylla*), within the alluvial plain habitat

4.1.6 Shrubland (Open)

The open shrubland habitat was mostly recorded in the southern borefield, but also had smaller occurrences across the study area (Figure 4.13). The vegetation of this habitat was dominated by an open mixed shrubland to high shrubland of *Acacia* spp., including *Acacia aptaneura*, *Acacia atkinsiana*, *Acacia synchronicia* and other *Acacia* spp. over spinifex hummock grassland and occasionally with *Corymbia hamersleyana* or *Acacia aptaneura* isolated trees (Figure 4.7). Soils in this habitat were firm, red-brown loamy clay with continuous ironstone pebble gravel. This habitat contained only minimal woody debris and leaf litter, mostly accumulated under the larger shrubs and trees.

The terrestrial fauna assemblage that characterises this habitat type includes all the more commonly recorded Pilbara species such as *Carlia munda*, *Ctenotus inornatus*, *C. pantherinus*, *C. superciliaris*, *Cyclodomorphus melanops*, *Ctenophurus caudicinctus*, *Demansia psammophis*, *Diplodactylus conspicillatus*, *Lucasium stenodactylum*, *Dasykaluta rosamondae*, *Ningaui timealeyi*, *Pseudomys desertor*, *P. hermannsburgensis* and *Sminthopsis macroura*.

The avifauna assemblage also includes a wide range of typical Pilbara species. When in flower, this habitat may also attract nomadic species such as Masked Woodswallow, Pied Honeyeater, Black Honeyeater and Crimson Chat. Shrubs are attractive to Rufous Whistler, Crested Bellbird and Singing Honeyeater, along with White-winged Fairy-wren. Little Button-quail and Spinifex Pigeon occur where there is sufficient ground cover.

No EPBC Act listed threatened fauna are associated with this habitat. The EPBC Act migratory listed Rainbow Bee-eater is likely to forage in the habitat, particularly near drainage lines. Additionally, the DPaW Priority listed Australian Bustard and Bush Stone-curlew occupy this habitat.

Figure 4.7 – Shrubland (Open) habitat

4.1.7 Hilltops/ridges/plateaux

The Hilltops/ridges/plateaux habitat was limited to the northern and central section of the study area and occupied the majority of habitat within the Solomon Mine area and the Northern Exploration tenements (Figure 4.13). This was the most elevated habitat type within the study area. Cliffs existed along the side of ridges and hills where hillslopes broke away into sheer rock faces. The crevices and caves which occur in cliff faces can provide shelter for a range of fauna species. Vegetation in this habitat was dominated by *Triodia wiseana* open hummock grasslands, with *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees and occasional shrubs including *Acacia bivenosa*, *Acacia hamersleyensis* and subspecies of *Senna glutinosa* on a continuous layer of bedrock and scattered pebbles and stones (Figure 4.8).

The terrestrial fauna assemblage combines common rocky spinifex species such as *Sminthopsis macroura*, *Planigale* sp., *Gehyra punctata*, *Demansia rufescens, C. rubicundus, C. supraciliaris*, *C. inornatus* and *C. pantherinus* with less common species that prefer micro habitats only found on top of the hills and ridges such as *Underwoodisaurus seorsus* and caves and crevices associated with cliff faces that species such as *Zyzomys argurus*, *Cryptoblepharus ustulatus* and M*orethia ruficauda* prefer.

The bird fauna of the Hilltops/ridges/plateaux shares affinities with the Gorges/Gullys and Plain (stony gibber) fauna assemblages. Grey-headed Honeyeater is usually common, and the Pilbara race *whitei* of Striated Grasswren is largely restricted to these areas. Other species characteristic to this habitat include Little Woodswallow, Spinifex Pigeon, Painted Finch, Striated Pardalote and Weebill.

EPBC Act and WC Act threatened fauna associated with this habitat include Northern Quoll (*Dasyurus hallucatus*; dispersal and foraging) and Pilbara Olive Python (*Liasis olivaceus barroni*; dispersal and foraging). Additionally, the DPaW Priority listed Pilbara Barking Gecko (*Underwoodisaurus seorsus*), Long-tailed Dunnart (*Sminthopsis longicaudata*) and Western Pebble-mound Mouse (*Pseudomys chapmani*) primarily occur in this habitat.

Figure 4.8 – Hilltops/ridges/plateaux habitat

4.1.8 Gorges/Gullies

The Gorges/Gullies habitat type was limited to areas adjacent to the hills/ ranges/ plateaux habitat type (Figure 4.13). It was a minor habitat type, but due to the sheltered nature of this habitat, it provides a microclimate that is more shaded, slightly cooler and often more humid than surrounding open areas of hillslopes and plains and thus, can act as a refuge for a number of specialised vertebrate and invertebrate fauna species. Further, due to the rocky cliffs and breakaways associated with gorges and gullies, there are often crevices and caves in this habitat that can provide shelter for a range of fauna species (Figure 4.9). The vegetation of this habitat was broadly described as *Eucalyptus leucophloia* subsp. *leucophloia*, and/ or *Acacia citrinoviridis* low woodland over *Acacia bivenosa* and other *Acacia* spp. tall scattered shrubs to high open shrubland over *Cymbopogon ambiguus* and *Eriachne mucronata* very open tussock grassland and *Triodia wiseana* very open hummock grassland on areas of large boulders, outcropping and bedrock, with skeletal red-brown sandy clay loam soils.

Terrestrial fauna species characteristic of the assemblage include Rothschilds's Rock-wallaby (*Petrogale rothschildi*), Gorge Toadlet (*Pseudophyrne douglasi*), Marbled Velvet Gecko (*Oedura marmorata*), and Southern Pilbara Rock Monitor (*Varanus hamersleyensis*).

The avian component of the assemblage is somewhat limited. Few (if any) species are restricted to this habitat type, but it does provide key habitat for Western Bowerbird. Other species characteristic of this habitat include Painted Finch, Little Woodswallow, Grey-headed Honeyeater and Grey Shrike-thrush. Gorges and gullies also provide dense vegetation, caves and rock crevices that are used by roosting night birds such as Australian Owlet-nightjar and Tawny Frogmouth.

EPBC Act and WC Act threatened fauna associated with this habitat include Northern Quoll (*Dasyurus hallucatus*; denning and foraging), Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form); foraging), and Pilbara Olive Python (*Liasis olivaceus barroni*; winter shelter and foraging). Additionally, the DPaW Priority Gane's Blindsnake (*Ramphotyphlops ganei*) is primarily recorded from this habitat.

Figure 4.9 – Gorges/Gullies habitat

4.1.9 Woodland (Open Eucalypt)

The Woodland (Open Eucalypt) was a minor habitat type within the study area and was limited to the south of the study area (Figure 4.13). This habitat type consisted of moderately dense *Eucalyptus leucophloia* subsp*. leucophloia* and *Acacia aptaneura* trees over *Acacia* spp. shrubs over mixed tussock and hummock grasslands on loam or clay soils with pebbles present (Figure 4.10). Wood litter was usually sparse to moderately dense. Leaf litter can build up over time in denser areas which have not been subject to fire, such as the acacia thickets.

The terrestrial fauna assemblage that characterises this habitat type includes all the more commonly recorded Pilbara species such as *Carlia munda*, *Ctenotus inornatus*, *C. pantherinus*, *C. superciliaris*, *Cyclodomorphus melanops*, *Ctenophurus caudicinctus*, *Demansia psammophis*, *Diplodactylus conspicillatus*, *Lucasium stenodactylum*, *Aspidites melanocephalus*, Dasykaluta *rosamondae*, *Ningaui timealeyi*, *Pseudomys desertor*, *P. hermannsburgensis* and *Sminthopsis macroura*.

The avifauna assemblage also includes a wide range of typical Pilbara species. Dense spinifex favours Spinifexbird and Rufous-crowned Emu-wren. Eucalypts host Weebills, Grey-headed Honeyeaters, Red-browed Pardalote, and occasionally Black-tailed Treecreepers. When in flower, they may also attract nomadic species such as Black-chinned Honeyeater and Masked Woodswallow.

No EPBC Act threatened fauna are associated with this habitat. The EPBC Act migratory listed Rainbow Bee-eater is known to forage in the habitat. Additionally, the DPaW Priority listed Bush Stone-curlew and Western Pebble-mound Mouse (*Pseudomys chapmani*) occupy this habitat.

Figure 4.10 – Woodland (Open Eucalypt) habitat

4.1.10 Plain (Stony Calcrete)

The stony calcrete plain habitat was limited to the southern and eastern Borefield and was associated with, but not limited to, the Calcrete and Coolibah Landsystems (Figure 4.13). The two areas of calcrete plains were located adjacent to major drainage lines. Vegetation of the stony calcrete plains was described as *Eucalyptus victrix* and/or *Corymbia hamersleyana* isolated low trees over *Acacia wanyu, A. synchronicia, Hakea lorea* and *Melaleuca* sp. scattered shrubs to high open shrubland over *Triodia epactia* hummock grassland, occasionally also with **Cenchrus ciliaris* open tussock grassland (Figure 4.11). The substrate of this habitat was firm red-brown clay-loam with a 30-70% cover of pebble gravel and only sparse leaf litter or woody debris.

The terrestrial fauna assemblage that characterises this habitat type includes all the more commonly recorded Pilbara species such as *Carlia munda*, *Ctenotus inornatus*, *C. pantherinus*, *C. superciliaris*, *Ctenophurus caudicinctus*, *Antaresia stimsoni*, *Lucasium stenodactylum*, *Dasykaluta rosamondae*, *Ningaui timealeyi*, *Pseudomys desertor*, *P. hermannsburgensis* and *Sminthopsis macroura*. The skink *Notoscincus butleri* (DPaW P4) regularly occupies this habitat.

The avifauna assemblage includes a low diversity species. Spinifexbird and Rufous-crowned Emu-wren can occur in large spinifex clumps, while raptors including Brown Falcon, Spotted Harrier hunt small birds and reptiles.

No EPBC Act threatened or migratory fauna are associated with this habitat. The DPaW Priority listed Australian Bustard and Lined Soil-crevice Skink (*Notoscincus butleri*) are known to occupy this habitat.

Figure 4.11 – Plain (Stony Calcrete) habitat

4.1.11 Tussock grassland (on loam/clay)

The tussock grassland predominately occurred to the east of the study area and bordered the mulga woodland of the study area (Figure 4.13), which sometimes created large ecotones between the two habitat types. The vegetation within the tussock grasslands was dominated by *Eragrostis* spp., *Themada* spp., and *Astrebla spp.,* with sparse *Acacia* sp. and **Vachellia farnesiana* shrubs and occasional *Eucalyptus* sp. and *Acacia* sp. trees (Figure 4.12). Soil within the area was relatively bare and contained almost no leaf litter and woody debris. The soil varied from weakly formed cracking clays to firm clay-loam. The tussock grassland habitat of the study area was heavily grazed by cattle.

The terrestrial fauna assemblage consisted of grassland specialists such as the gecko *Diplodactylus galaxias* and Robust Ctenotus (*Ctenotus robustus*). Other species that characterised this habitat type include *Suta punctata* and *Ctenophorus reticulatus*.

A number of bird species are characteristic of this habitat, including the Australasian Pipit, Horsfield's Bushlark and Brown Quail.

No EPBC Act threatened or migratory fauna are associated with this habitat. The DPaW Priority listed Australian Bustard and Short-tailed Mouse (*Leggadina lakedownensis*) are known to occupy this habitat.

Figure 4.12 – Tussock grassland habitat

560000 580000 600000 620000 640000

7560000

7540000

7520000

Legend

- Study area
- Cleared Areas
- Drainage line/River/Creek (Major)
- Gorge/gully
- Hilltops/ridges/plateaux
- Hummock grassland
- Plain (alluvial)
- Plain (cracking clay)
- Plain (stony calcrete)
- Plain (stony gibber)
- Shrubland (open)
- Tussock grassland
- Woodland (open eucalypt)

N

0 5 10

Kilometres

Absolute Scale - 1:240,000

ecologia ENVIRONMENT

Habitats of the study area

Figure: 4.13
Project ID: 1593

Drawn: AH
Date: 28/10/14

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

Unique Map ID: AH514

A3

550000
600000
650000
700000
7600000
7550000
7500000

0 10 20
Kilometres

Absolute Scale - 1:460,000

Legend

- Regional area (study area + 30km buffer)
- Study area
- Extrapolated areas
- Drainage line/River/Creek (Major)
- Gorge/gully
- Hilltops/ridges/plateaux
- Hummock grassland
- Plain (alluvial)
- Plain (cracking clay)
- Plain (stony calcrete)
- Plain (stony gibber)
- Shrubland (open)
- Tussock grassland
- Woodland (open eucalypt)
- Cleared area/Agriculture

ecologia ENVIRONMENT

Regional fauna habitats (within 30 km of the study area)

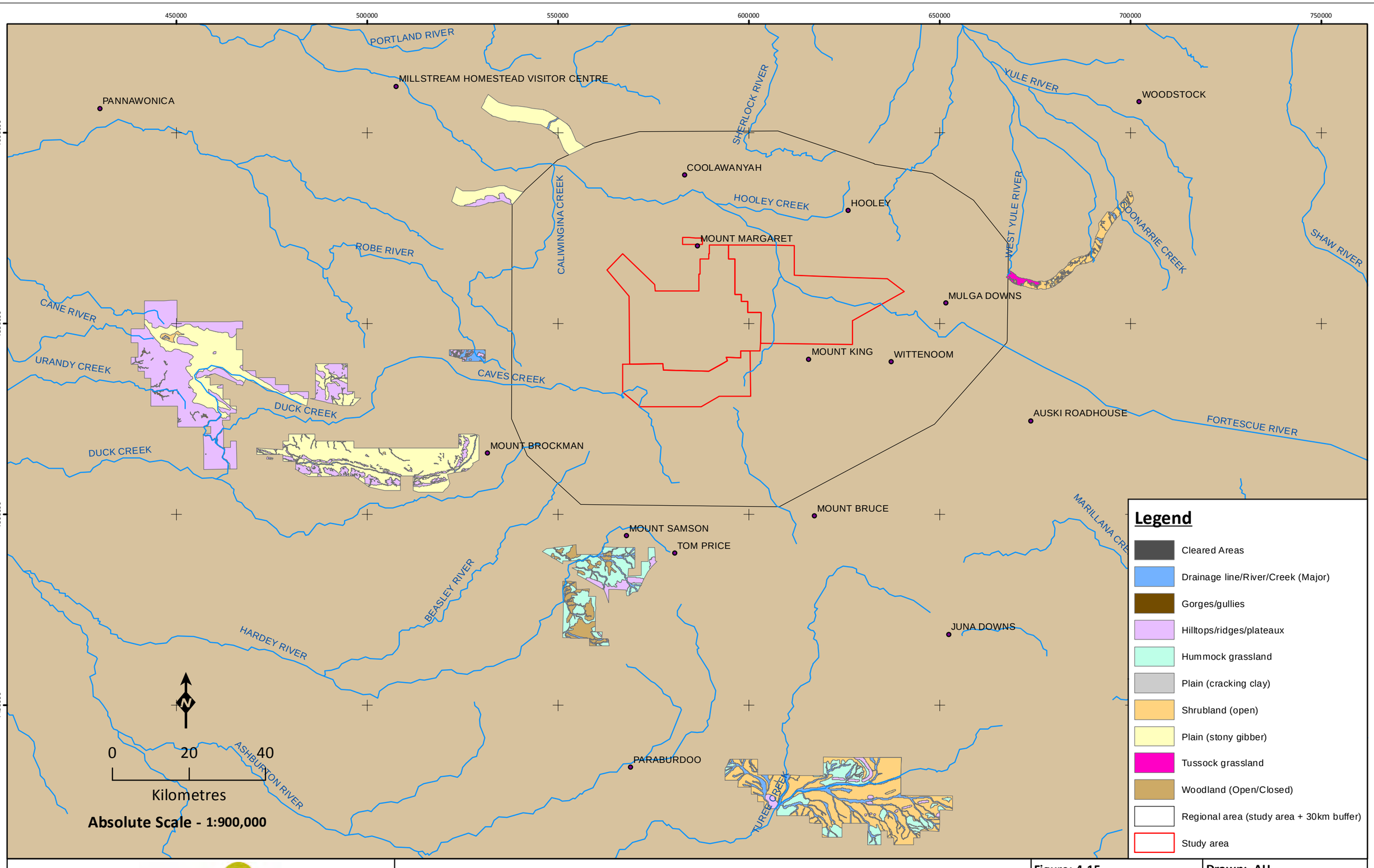
Figure: 4.14
Project ID: 1593

Drawn: AH
Date: 27/10/14

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

Unique Map ID: AH514a

A3



ecologia ENVIRONMENT

Regional fauna habitats (30 - 130 km of the study area)

Figure: 4.15
Project ID: 1593

Drawn: AH
Date: 27/10/14

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

Unique Map ID: AH514b

A3

This page has been left blank intentionally

4.2 FAUNA ASSEMBLAGE

4.2.1 Mammals

In total, a combined 34 mammal species have been recorded within the study area across all fauna surveys conducted within the study area, including 23 during the current survey. The most commonly captured species across all surveys within the study area were *Dasykaluta rosamondae*, *Ningaui timealeyi*, *Sminthopsis macroura* and *Pseudomys hermannsburgensis*. The most commonly captured species on the current survey were *Ningaui timealeyi*, *Dasykaluta rosamondae* and *Pseudomys desertor*. Another notable record was the dead remains of two Black Flying-fox, which are not widely distributed in the Pilbara. These remains were recorded on barb wire fences situated in the southern borefield.

Three introduced mammal species have been recorded in the study area, all three of which were recorded during the current survey (House Mouse, Feral Cat and Cattle).

Two EPBC Act/WC Act Schedule 1 listed mammal species have been recorded within the study area; Northern Quoll (*Dasyurus hallucatus*), and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form); foraging only). An additional four priority listed species were recorded from the study area; Ghost Bat (*Macroderma gigas*), Long-tailed Dunnart (*Sminthopsis longicaudata*), Short-tailed Mouse (*Leggadina lakedownensis*) and Western Pebble-mound Mouse (*Pseudomys chapmani*).

4.2.2 Birds

In total, a combined 114 bird species have been recorded within the study area across all fauna surveys conducted within the study area, including 81 during the current survey. These are relatively high species counts for Pilbara surveys. Several observatons of birds near the edge of their known ranges occurred during the survey, including records of Flock Bronzewing (south of typical range), Australian Pratincole (south-western limit of range), and White-backed Swallow (few records in the Hamersley Range, likely because it prefers sandy habitat types).

Three EPBC Act migratory/WC Act Schedule 3 listed species, Rainbow Bee-eater (*Merops ornatus*), Eastern Great Egret (*Ardea modesta*) and Fork-tailed Swift (*Apus pacificus*) and one WC Act Schedule 4 listed species, Peregrine Falcon (*Falco peregrinus*) were recorded within the study area. An additional three priority listed species have also been recorded within the study area; Australian Bustard (*Ardeotis australis*), Bush Stone-curlew (*Burhinus grallarius*), Flock Bronzewing (*Phaps histrionica*). Three of these were recorded on the current survey (Australian Bustard, Bush Stone-curlew and Rainbow Bee-eater.

4.2.3 Herpetofauna

In total, a combined 104 reptile and 5 amphibian species have been recorded within the study area across all fauna surveys conducted within the study area, including 69 reptiles and 3 amphibians during the current survey. The most commonly captured species across all surveys within the study area were *Uperoleia saxatilis* (ex-*russelli*; 9,391 captures), *Cyclorana maini* (1,514), *Ctenotus inornatus* (ex. *helenae*/*severus*; 581), *C. superciliaris* (ex. *saxatilis*; 468), *C.pantherinus* (384) and *Carlia munda* (336). The most commonly captured species on the current survey were *Ctenotus pantherinus* (79 captures), *Carlia munda* (39), *Ctenophorus isolepis* (33) and *Diplodactylus conspicillatus* (27).

One EPBC Act/WC Act Schedule 1 listed species has been recorded from the study area; Pilbara Olive Python (*Liasis olivaceous barroni*). An additional three priority listed species; *Ramphotyphlops ganei*, Pilbara Barking Gecko (*Underwoodisaurus seorsus*) and *Notoscincus butleri*. Two of these were recorded during the current survey (*Underwoodisaurus seorsus* and *Ramphotyphlops ganei*).

4.2.4 Fish

In total, four freshwater fish species have been recorded across all fauna surveys conducted within the study area. These include the Spangled Perch (*Leiopotherapon unicolor*), Barred Grunter (*Amniataba percoides*), Hyrtl's Tandan (*Neosilurus hyrtli*) and Western Rainbowfish (*Melanotaenia australis*).

No species of conservation significant fish have been recorded from the study area.

4.3 FAUNA HABITAT ANALYSIS

Eight of the 11 fauna habitats within the study area have been sampled with systematic trapping sites during the current Level 2 survey and/or previous Level 2 surveys in the study area. Including both the current survey, and trapping sites on previous surveys that were located within the study area, 23 trap sites were installed within the plain (stony gibber) habitat type, six within the drainage line/river/creek (major) habitat type and plain (cracking clay) habitat types, four within the plain (alluvial) habitat type, three within the hilltops/ridges/plateaux, two within the plain (stony calcrete) habitat type, and one each within the shrubland (open) and hummock grassland habitat types. No systematic trapping sites were installed within the gorges and gullies habitat type due to its rocky and uneven terrain. However, this habitat type was targeted with greater opportunistic survey effort (diurnal, nocturnal and camera trapping) and targeted cage trapping during the targeted assessment to ensure adequate sampling. Two other habitat types, woodland (open eucalypt) and tussock grassland (on loam/clay) do not have systematic trapping sites assigned to them. This is in part due to their relatively small coverage within the study area (particularly in the case of the tussock grassland (on loam/clay) habitat type. However, difficulties in assigning single habitat types to some areas is also a confounding factor; for example, SLM S6 from the current survey is considered to fall within the stony plain habitat type, but also shows some features typical of open eucalypt woodland.

One-way analysis of similarity (ANOSIM) tests indicated that trappable mammal, and trappable herpetofaunal assemblages and observable bird assemblages did vary by habitat type. nMDS plots are not included as stress levels on the plots were high across all three faunal groups, indicating that they do not provide a good representation of the data.

The ANOSIM test on trappable mammal assemblages produced an R value of 0.1378 (R value ranges from -1 to 1, with 1 indicating that the groups are dissimilar and -1 indicating that the groups are similar) and a p value of 0.0001 (p-value of <0.05 indicating a significant difference). Post-hoc pairwise comparisons indicated that the plain (cracking clay) habitat type was the most distinct in terms of trappable mammal assemblage; the pairwise tests indicated that the assemblage was significantly different to six of the seven other habitat types tested (Table 4.2). No other significant differences were detected in pair-wise comparisons. However, the gorges/gullies habitat type was not included in this analysis due to insufficient systematic survey data, but is also expected to show a terrestrial mammal assemblage that is significantly different to most other habitat types.

The ANOSIM test on avian assemblages produced an R value of 0.1475 and a p value of 0.0001. Post-hoc pairwise comparisons indicated that the two most distinct habitat types in terms of avian assemblages were the drainage line/river/creek (major) and hilltops/ridges/plateaux habitat types, both of which were statistically significantly different to those of five of the seven other habitat types (Table 4.3). There was also a significant difference indicated between the assemblages of the plain (cracking clay) and plain (stony gibber) habitat types.

The ANOSIM test on trappable herpetofaunal assemblages produced an R value of 0.1758 and a p value of 0.0001. Post-hoc pairwise comparisons indicated that the drainage line/river/creek (major) and hilltops/ranges/plateaux habitat types were the most distinct in terms of trappable herpetofaunal assemblage; the pairwise tests indicated that the assemblages of these habitats were significantly different to those of five of the seven other habitat types tested (Table 4.4). The herpetofaunal assemblage of the plain (stony gibber) habitat type was the next most distinct, differing significantly from four of the seven other habitat types tested. In common with mammalian assemblages, the herpetofaunal assemblage of the gorges/gullies habitat type is also expected to be significantly different to most other habitat types.

It should be noted that some caution is required when interpreting the results of these analyses, as small sample size for some of the habitats is likely to have affected results for those habitat types. For example, only one systematic trapping site was located within the shrubland (open) habitat type. Analyses indicate the faunal assemblage of the shrubland (open) habitat type is not significantly different to those other habitat types in almost all cases, but this is likely to be partly due to the small sample size available for comparison. The habitats types that are most likely to be significantly affected in this way are shrubland (open), hummock grassland, and plain (stony calcrete).

Table 4.2 – Post-hoc pair-wise comparisons (mammal assemblages / habitat types).

	P(A)[1]	P(SC)[2]	P(CC)[3]	DL/R/C[4]	H/R/P[5]	HG[6]	S(O)[7]	P(SG)[8]
P(A)	-							
P(SC)	1	-						
P(CC)	0.0168*	0.0252*	-					
DL/R/C	0.2072	1	0.0084*	-				
H/R/P	1	1	0.0056*	1	-			
HG	1	1	0.5292	1	1	-		
S(O)	1	1	0.0392*	1	1	1	-	
P(SG)	1	1	0.0028*	1	1	1	1	-

Values are Bonferroni-corrected p-values. * indicates significant difference.

[1] Plain (alluvial), [2] Plain (Stony Calcrete), [3] Plain (Cracking Clay), [4]Drainage line/River/Creek (Major), [5] Hilltops/Ranges/Plateaux, [6] Hummock grassland, [7] Shrubland (Open), [8] Plain (Stony Gibber)

Table 4.3 – Post-hoc pair-wise comparisons (avian assemblages / habitat types).

	P(A)[1]	P(SC)[2]	P(CC)[3]	DL/R/C[4]	H/R/P[5]	HG[6]	S(O)[7]	P(SG)[8]
P(A)	-							
P(SC)	0.0504	-						
P(CC)	1	0.896	-					
DL/R/C	0.0028*	0.0028*	0.0028*	-				
H/R/P	0.0028*	0.0056*	0.0028*	0.0028*	-			
HG	0.1904	1	1	1	0.0504	-		
S(O)	1	1	1	1	1	0.742	-	
P(SG)	1	0.1288	0.0028*	0.0028*	1	1	1	-

Values are Bonferroni-corrected p-values. * indicates significant difference.

[1] Plain (alluvial), [2] Plain (Stony Calcrete), [3] Plain (Cracking Clay), [4]Drainage line/River/Creek (Major), [5] Hilltops/Ranges/Plateaux, [6] Hummock grassland, [7] Shrubland (Open), [8] Plain (Stony Gibber)

Table 4.4 – Post-hoc pair-wise comparisons (herpetofaunal assemblages / habitat types).

	P(A)[1]	P(SC)[2]	P(CC)[3]	DR/R/C[4]	H/R/P[5]	HG[6]	S(O)[7]	P(SG)[8]
P(A)	-							
P(SC)	1	-						
P(CC)	1	0.1708	-					
DL/R/C	0.0028*	0.0028*	0.0028*	-				
H/R/P	0.0028*	0.0028*	0.0028*	0.0028*	-			
HG	1	1	1	0.112	0.0028*	-		
S(O)	1	1	1	1	0.0588	1	-	
P(SG)	0.0028*	0.0196*	0.0028*	0.0028*	1	0.238	1	-

Values are Bonferroni-corrected p-values. * indicates significant difference.

[1] Plain (alluvial), [2] Plain (Stony Calcrete), [3] Plain (Cracking Clay), [4]Drainage line/River/Creek (Major), [5] Hilltops/Ranges/Plateaux, [6] Hummock grassland, [7] Shrubland (Open), [8] Plain (Stony Gibber)

4.4 SURVEY ADEQUACY

Species accumulation curves (SACs) were calculated for mammals, birds and reptiles to test the adequacy of survey effort in the study area. Systematically obtained data (trapping results for terrestrial fauna and set-time surveys for birds) from the current survey, in combination with all previous surveys within the study area for which complementary systematic data is available, were used to prepare the SACs. This amounted to 833 trap nights for terrestrial fauna (terrestrial mammals and reptiles) and 690 standardised bird surveys.

The results of SAC calculations are displayed in Table 4.5 and Figure 4.16, Figure 4.17 and Figure 4.18 for trappable mammals, avifauna and herpetofauna species groups respectively.

Analysis of mammal data shows variation between the species richness estimators, with estimates ranging from 68-108% of mammal species recorded from this survey (Table 4.5, Figure 4.16). The variance between estimators is likely a result of relatively small number of mammal species recorded overall (13 species).

Analysis of the data produced steady SACs for avifauna and herptofauna, with various richness estimators nearing the asymptotic plateau. Estimated avifauna richness ranged from 88-106% of bird species recorded (Table 4.5, Figure 4.17), indictaing the majority of bird species were recorded during the current survey. Estimated herptofauna richness ranged from 87-101% of reptile species recorded (Table 4.5, Figure 4.18), indicating the majority of reptile species were recorded during the current survey.

Table 4.5 – Mean estimates of species richness of systematically-surveyed vertebrate fauna

Richness estimators	Total richness estimator					
	Mammals	%	Avifauna	%	Herpetofauna	%
ACE	15	87	118	94	101	94
ICE	17	76	122	91	102	93
Chao 1	14	93	116	96	103	92
Jack 1	16	81	124	89	107	89
Jack 2	19	68	126	88	109	87
Bootstrap	14	93	117	95	101	93
Michaelis-Menten	12	108	105	106	94	101
Species observed	**13**	**-**	**111**	**-**	**95**	**-**

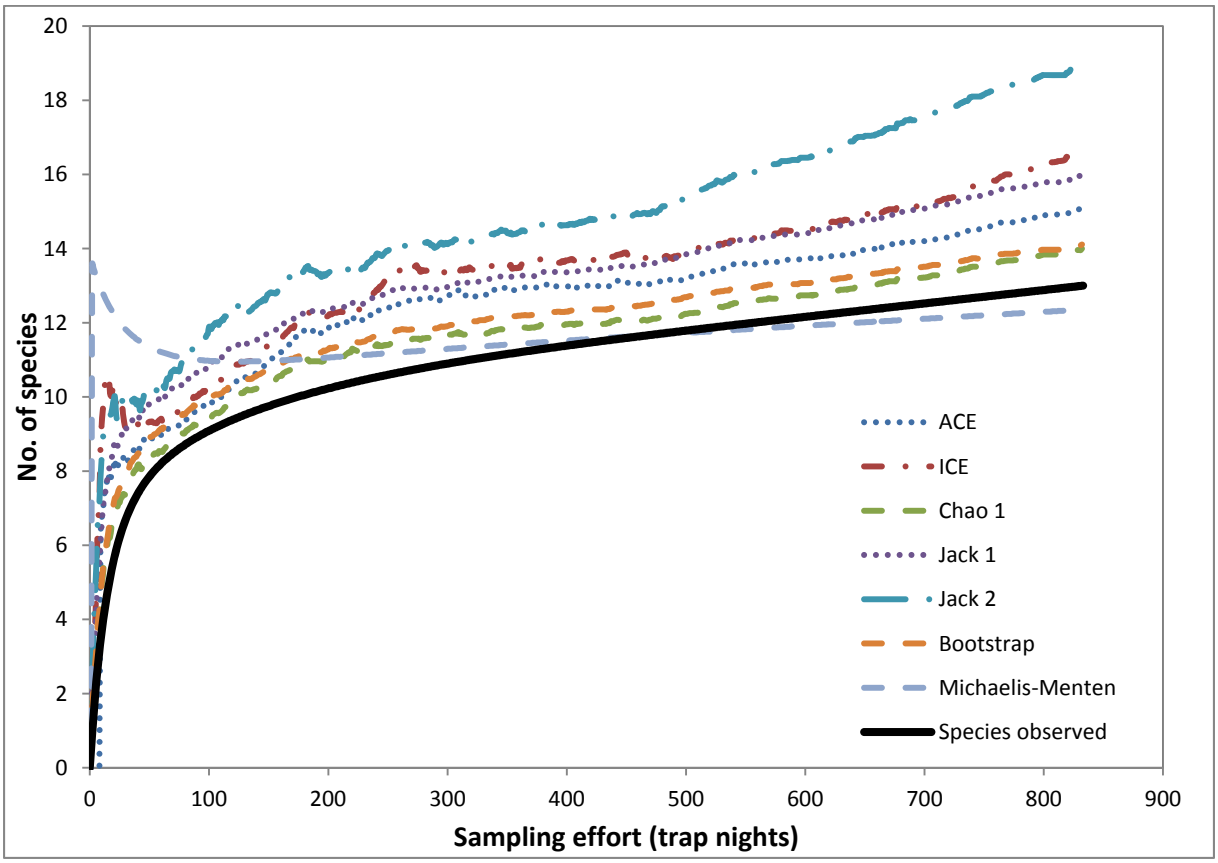


Figure 4.16 – Species accumulation curve for trappable mammals

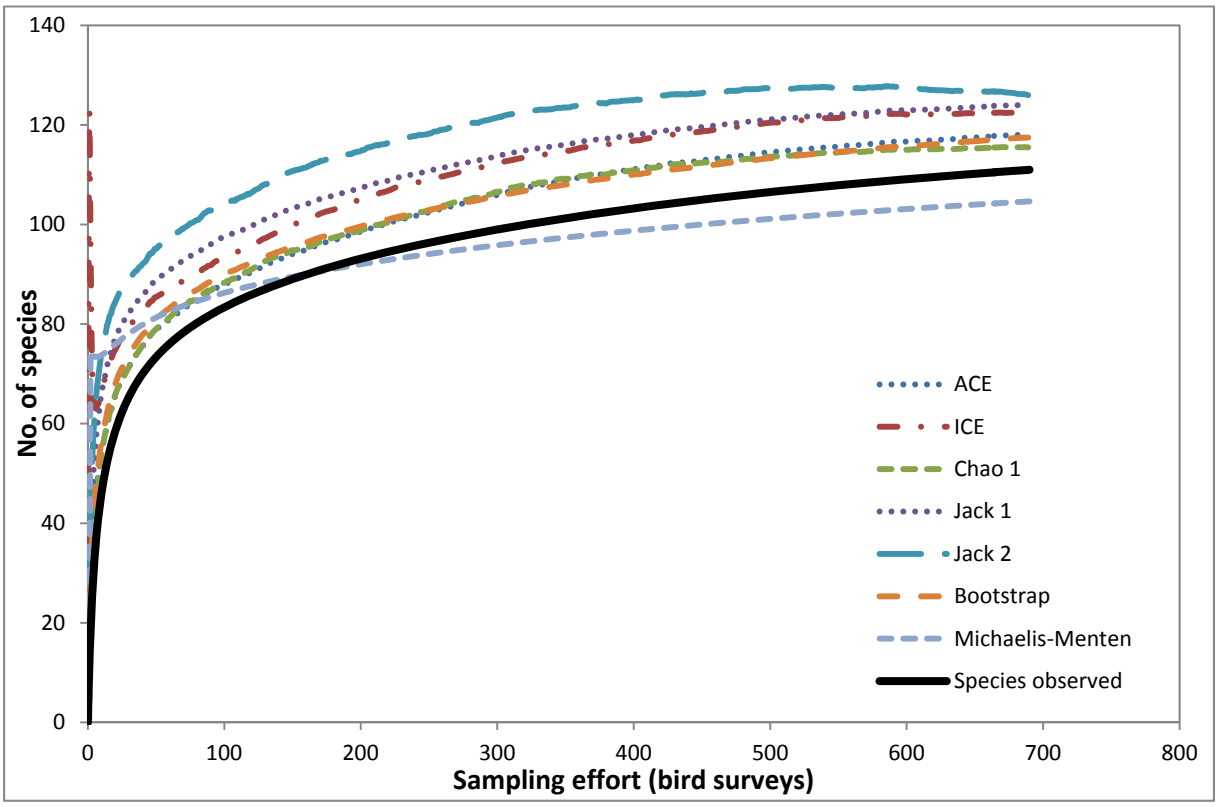


Figure 4.17 – Species accumulation curve for birds

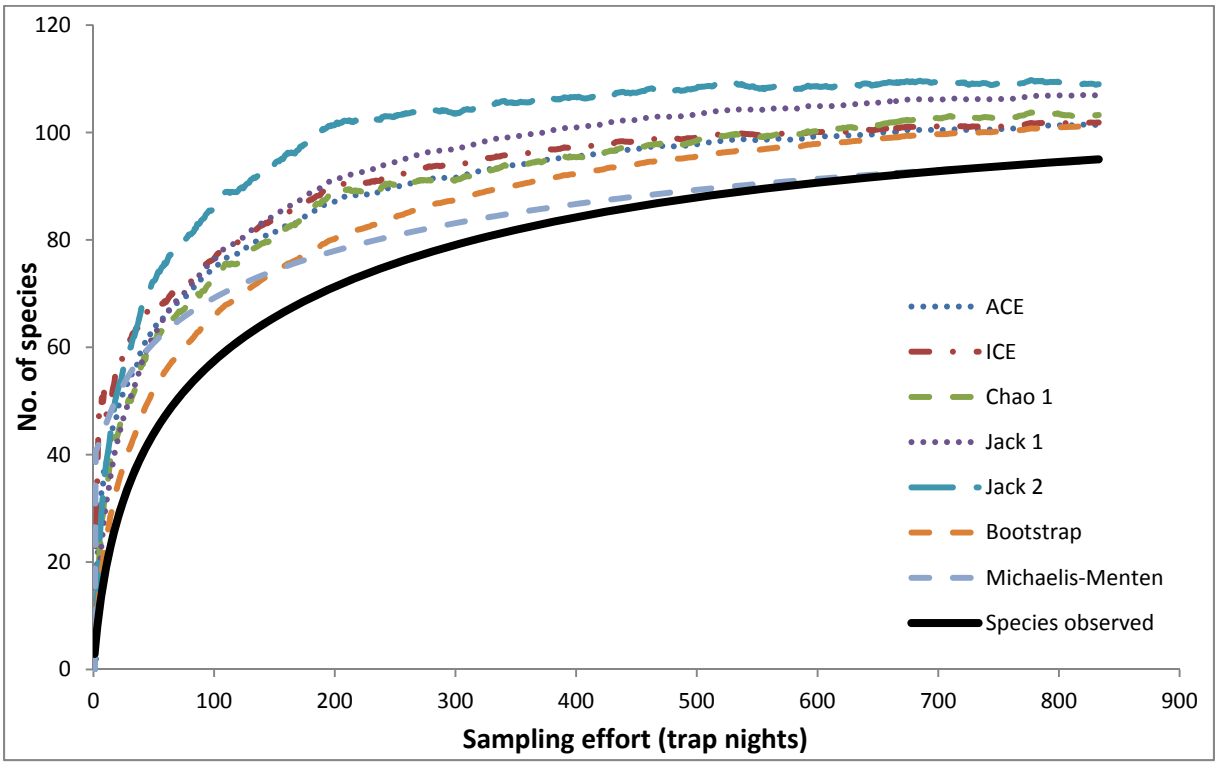


Figure 4.18 – Species accumulation curve for reptiles

4.5 CONSERVATION SIGNIFICANT AND PRIORITY VERTEBRATE FAUNA

The literature review identified 30 vertebrate fauna species, listed as either conservation significant (EPBC Act, WC Act Schedule 1) or as priority fauna (DPaW Priority list), that could potentially occur within the study area; nine mammal species, 17 bird species and four reptile species. An assessment of their likelihood of occurrence was completed, based on the categories outlined in section 3.4, with the results summarised in Table 4.6.

A total of 16 of these listed species were recorded during the current survey, and from surveys conducted previously which overlap the study area (section 4.10). A further three species are assessed as having a high likelihood of occurrence and one species as having a medium likelihood of occurrence. The remaining 11 species are considered to have a low likelihood of occurrence.

Species that were recorded or assessed as having a high or medium likelihood of occurrence are discussed in further detail below. Species assessed as low likelihood of occurrence are not discussed further.

Table 4.6 – Conservation significant and priority listed fauna likelihood of occurrence status

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.	Sporadic records from previous surveys in the region (Biologic 2013; Biota 2008; *ecologia* 2013f; Ecoscape 2011). The low number of records from these surveys indicates low population densities in the Hamersley Range and further south.	**RECORDED** Recorded from 38 locations within the study area (Coffey 2008, 2011a; *ecologia* 2010, 2011b, 2013c, 2014b; Ecoscape 2010d; Outback Ecology 2014). Suitable habitat includes Gorges/gullies, Drainage lines and Hilltops/ridges/plateaux.
Greater Bilby *Macrotis lagotis*	VU	S1	VU	Variety of habitats on soft soil including spinifex hummock grassland, acacia shrubland, open woodland and cracking clays.	Secondary evidence recorded during two previous surveys within 30 km (ecologia internal database, Ninox 1995). Not recorded on NatureMap within 100 km (DPaW 2014).	**LOW** Low quality habitat present with lack of confirmed records close by.
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Pilbara form)	VU	S1	VU	Roost in caves with high humidity (95%) and temperature (32°C). Forage along water bodies with fringing vegetation.	Previous records from three locations within 30 km of the study area (DPaW 2014). Recorded from six previous surveys in the region (Biologic 2013; Coffey 2013; *ecologia* 2011a, 2012d, 2013f, g)	**RECORDED** Based on the timing and number of calls, only foraging individuals have been recorded from eight locations (*ecologia* 2011b, 2013c, 2014a, b; Outback Ecology 2014) within the study area, no roost cave recorded or expected to occur within the study area.
Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*)			P3	Inhabits grasslands, open forests, open woodlands and tall shrublands and shelters during the day under tussocks of *Triodia* spp.	One NatureMap record from 1966 near Mt Sheila (20 km east of Project area); two further records from Chichester Range from 1979 (DEC Threatened Fauna database).	**MEDIUM** One confirmed previous record within 20 km of the study ares. Distribution and status of species currently poorly understood within the Pilbara.
Brush-tailed Mulgara *Dasycercus blythi*			P4	Sand plains and gibber plains with moderately dense spinifex with 'runways' between clumps.	Previous records occur to the north east between the Chichester Range and the Coast	**LOW** No typical suitable habitat exists.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Long-tailed Dunnart *Sminthopsis longicaudata*			P4	Rocky hills, ranges and escarpments with spinifex.	Recorded on one previous survey within the study area. Recorded from six regional locations to the west of the study area (DPaW 2014).	**RECORDED** Recorded from two locations (*ecologia* 2011b) within the study area.
Ghost Bat *Macroderma gigas*			P4	Roost in caves, rock piles and abandoned mines. Will travel 2 km from roost to hunt.	Recorded on three previous surveys with locations within and outside the study area (*ecologia* 2011a, 2013g; Ecoscape 2011).	**RECORDED** Recorded from eight locations within the study area (*ecologia* 2010, 2011b, 2013c, e). Suitable hunting and roosting habitat is present within the study area.
Short-tailed Mouse *Leggadina lakedownensis*			P4	Spinifex and tussock grassland on cracking clays. Also acacia shrubland, samphire, woodlands, and stony ranges.	Multiple records from four previous surveys within the study area and recorded on the current survey.	**RECORDED** Recorded from 10 locations within the study area (*ecologia* 2013a, b, e; Rapallo 2011). Resident within suitable cracking clay habitat in the study area.
Western Pebble-mound Mouse *Pseudomys chapmani*			P4	Footslopes of rocky ranges and rocky hills where the ground has continuous small pebbles and vegetated by spinifex.	Commonly recorded on previous surveys. Recorded on current survey.	**RECORDED** Active and inactive mounds recorded from 44 locations within the study area (Coffey 2010a; *ecologia* 2010, 2011b, 2012a, 2014b; Ecoscape 2010d). Occurs within Hilltops/ridges/plateaux and Plain (stony gibber) habitat of the study area.
Birds						
Night Parrot *Pezoporus occidentalis*	EN	S1	CR	Mostly ground-dwelling; spinifex grasslands or samphire and chenopod shrublands near water bodies.	Recorded from EPBC Protected Matters Search only with no specific record information. .	**LOW** Biology and habitat utilisation not fully understood. No chenopod habitats within study area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Fork-tailed Swift *Apus pacificus*	M	S3		Nomadic, almost entirely aerial lifestyle over a variety of habitats; associated with storm fronts.	Recorded during on number of previous surveys including within the study area.	**RECORDED** Recorded from four locations within the study area (*ecologia* 2010, 2011b). Only expected to overfly the study area due to entirely aerial lifestyle.
Rainbow Bee-eater *Merops ornatus*	M	S3		Open country, most vegetation types, dunes, banks; prefer lightly wooded, preferably sandy, country near water.	Commonly recorded during previous surveys with many records within the study area.	**RECORDED** Recorded from 53 locations within the study area (Coffey 2008; *ecologia* 2010, 2011b, 2013a, b, 2014a; Ecoscape 2010d; Outback Ecology 2014; Rapallo 2011). Common throughout various habitats within the study area and across the Pilbara region.
Eastern Great Egret *Ardea modesta*	M	S3		Wide range of wetland habitats, including floodwaters, rivers, shallows of wetlands, intertidal mudflats.	Commonly recorded across the Pilbara where suitable habitat with surface water is present (*ecologia* 2012a, b; Muir 1983).	**RECORDED** Recorded from one location within the study area (*ecologia* 2013c). Likely to occur within Drainage line/River/Creek (Major) habitats when surface water is present (Johnstone and Storr 1998).
Cattle Egret Ardea ibis	M	S3		Grassy habitats, shallow wetlands and water bodies, particularly damp pastures.	Recorded from EPBC Protected Matters Search only with no specific record information.	**LOW** Typical habitat absent within study area with lack of previous records.
Eastern Osprey *Pandion cristatus*	M			Coastal and near coastal water bodies, along river systems. Inhabits most types of habitats except closed forest.	Few regional previous records.	**LOW** Absence of typical habitat.
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.	Few regional previous records.	**LOW** Absence of typical habitat.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
White-winged Black Tern *Chlidonias leucopterus*	M	S3		Wetlands and inland waterbodies.	Single NatureMap record within 100 km of study area.	**LOW** Typical habitat absent within study area with lack of previous records.
Glossy Ibis *Plegadis falcinellus*	M	S3		Typically shallows and adjacent flats of freshwater lake and swamps, but it is also found in river pools, flooded samphire and sewage ponds	Recorded from Birdata and three records from NatureMap within 100 km.	**LOW** Scattered records throughout the Pilbara. No typical habitat for this species within Project area.
Oriental Plover *Charadrius veredus*	M	S3		Open plains, including samphire; bare rolling country; bare claypans; open ground near inland swamps.	Recorded from Protected Matters Search only with no specific record information.	**LOW** Typical habitat absent within study area with lack of 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.	One location record within vicinity of study area (Muir 1983).	**LOW** Typical wetland habitat absent within study area.
Grey Falcon *Falco hypoleucos*		S1	T	Generally open inland plains and woodland.	Recorded on number of previous surveys in the region. Not recorded within study area (Biota 2008, 2011; Coffey 2013; *ecologia* 2013f, in prep.).	**HIGH** Potential to occur in all habitats. Foraging habitat consists of open plains, drainage lines and shrublands. Breeding recorded from cliff faces, communication towers and large trees (Johnstone and Storr 1998; Schoenjahn 2011, 2012).
Peregrine Falcon *Falco peregrinus*		S4	Other	Widespread; coastal cliffs, riverine gorges and wooded watercourses.	Recorded on number of previous surveys including within the study area (*ecologia* 2011b, 2012d, 2013f, in prep.; Muir 1983).	**RECORDED** Recorded from two locations within the study area (*ecologia* 2013c, 2014a). Suitable foraging and nesting habitat (cliff faces) present within study area.
Australian Bustard *Ardeotis australis*			P4	Open grasslands, chenopod flats and low heathland.	Commonly recorded within open plains habitat within the study area and in the surrounding region (Biota 2005; Coffey 2013; *ecologia* 2011c, 2013f, g).	**RECORDED** Recorded from nine locations within the study area (*ecologia* 2013a, b, e).

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Bush Stone-curlew *Burhinus grallarius*			P4	Lightly wooded country next to daytime shelter of thickets or long grass.	Recorded from 11 surveys in the region surrounding the study area (Coffey 2013; *ecologia* 2011b, 2012a, c, 2013f, 2014c, in prep.).	**RECORDED** Recorded from three locations within the study area (Ecoscape 2010d; Rapallo 2011). Suitable habitat includes Drainage line/River/Creek (Major) habitat and adjacent shrublands and woodlands
Star Finch (western) *Neochmia ruficauda clarescens*			P4	Vegetation around watercourses, particularly thick reed beds.	Recorded on previous survey overlapping study area (*ecologia* 2012a), with location record approximately 5 km west of study area.	**HIGH** Recorded within 5 km of the study area with equivalent reed bed microhabitats recorded within the Drainage line/River/Creek (Major) habitat present within study area.
Flock Bronzewing *Phaps histrionica*			P4	Sparsely wooded plains near water. Nomadic visitor to areas of suitable habitat.	Few previous records in the surrounding region (Muir 1983). .	**RECORDED** Recorded from three locations within the study area during a single survey (Rapallo 2011) which is a result of the nomadic, eruptive nature of the species.
Reptiles						
Pilbara Olive Python *Liasis olivaceus barroni*	VU	S1	VU	Watercourses and areas of permanent water in rocky gorges, escarpments and gullies.	Recorded from six surveys in the surrounding region (Biota 2009, 2011; *ecologia* 2011a, 2013d; Ecoscape 2011; Muir 1983).	**RECORDED** Recorded from nine locations within the study area (Coffey 2010a; *ecologia* 2010, 2013c, 2014a; Ecoscape 2010d). Recaptures indicate individuals are resident within study area in suitable Drainage line/River/Creek (Major), Hilltops/ridges/plateaux and Gorge/Gullies habitat.
Gane's Blind Snake *Ramphotyphlops ganei*			P1	Variety of habitats; thought to prefer moist gorges.	Sporadically recorded across the Pilbara region (DPaW 2014). One regional record from the Blacksmith project (Ecoscape 2011).	**RECORDED** Recorded from four locations within the study area (*ecologia* 2010, 2011b; Rapallo 2011).

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence
	EPBC Act	WC Act	DEC			
Pilbara Barking Gecko *Underwoodisaurus seorsus*			P1	Rocky upland habitats including hills, plateaus and ranges.	Type locality close by, recorded in the surrounding region during previous surveys (*ecologia* 2011b, 2012d, 2013c; Ecoscape 2011).	**RECORDED** Recorded from three locations within the study area (*ecologia* 2014a). Occurs on the top of hills and ridges in the Hilltops/ridges/plateaux habitat.
Lined Soil-crevice Skink *Notoscincus butleri*			P4	Associated with spinifex dominated areas near creek and river margins	Recorded across the surrounding region during eight previous surveys (Biologic 2013; Biota 2005, 2009; Coffey 2008; *ecologia* 2011b, 2012a, c, 2013f).	**RECORDED** Recorded from two locations within the study area (*ecologia* 2011b, 2012a).

4.6 EPBC ACT THREATENED FAUNA

A total of three species listed under the EPBC Act as threatened fauna (and under the WC Act as Schedule 1) were recorded from this survey or previous surveys. These species include the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python. These records are summarised in the sections below and mapped in Figure 4.23.

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

Ecology: Northern Quolls are the smallest of the Australian quolls. Northern Quolls are nocturnal and opportunistic omnivores feeding primarily on small vertebrates, large insects and soft fruits. Breeding tends to occur near creeklines, where individuals go to drink when water is available (Oakwood 2008).

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

Likelihood of occurrence: Northern Quolls were recorded on 34 occasions during the current survey. This included 32 motion camera records from 10 locations and two trap captures. A further 26 records have been obtained during previous surveys. All records of Northern Quoll within the study area, including previous surveys are summarised in Table 4.7 and mapped in Figure 4.23. The distribution of the Pilbara population of Northern Quolls is displayed in Figure 4.19 which shows that the study area is located in the centre of the Northern Quoll population with scattered records throughout the surrounding of the study area.

Morphological details of the two captured individuals from this survey are shown in Table 4.8. Detection of Northern Quoll during the current survey was focussed in areas not previously targeted for Northern Quoll, in particular in suitable habitat in the northern areas of the study area (Figure 3.2). The inaccessibility of the habitat in the northern section of the study area has precluded surveys in this area previously. The detection of Northern Quoll via motion camera and capture records during this survey has notably increased the known occupancy of Northern Quoll within the study area.

The Northern Quoll has been recorded from three fauna habitats within the study area; Gorges/Gullies, Drainage line/River/Creek (Major), and Hilltops/ridges/plateaux. The most critical habitat for the Northern Quoll is the Gorges/Gullies habitat, where this species is likely to den. Northern Quolls have regularly been recorded along Kangeenarina Creek, which provides suitable foraging and dispersal habitat. Currently the highest densities of the Northern Quoll population is thought to be located in the northern section of the study area (Figure 4.23), with records south of Firetail, likely to be dispersing individuals.

Figure 4.19 – Distribution of the Northern Quoll in the Pilbara region (Naturemap 2014)

Of the nine trap capture records for which gender data is available, seven were males, suggesting the majority of Northern Quolls occuring within the study area may represent dispersing males searching for females. This information supports the theory that the core population is located in the northern section of the study area.

Table 4.7 – Summary of Northern Quoll records

Survey	Easting	Northing	Site	Record type	Comments
This survey	595866	7560616	SLM NQ C 2	Trap capture	Female trap capture. ID 941000016202851
	594446	7559111	SLM NQ C 24	Trap capture	Female trap capture. ID 941000016202850
	588851	7563824	SLM NE Mc11	Motion camera	Single record on the 30/5/14
	583662	7571550	SLM NE Mc02	Motion camera	Single record on the 28/4/14
	588719	7563967	SLM NE Mc13	Motion camera	Three records; 30/4/14, 16/5/14, 26/6/14
	592974	7563138	SLM NE Mc15	Motion camera	Two records; 14/5/14, 20/5/14
	592991	7563245	SLM NE Mc14	Motion camera	Four records; 28/4/14, 13/5/14, 14/5/14, 19/5/14
	588769	7563928	SLM NE Mc12	Motion camera	Two records; 15/5/14, 24/5/14 (Figure 4.20)
	588837	7563811	SLM NE Mc10	Motion camera	Four records; 8/5/14, 10/5/14, 2/6/14, 11/6/14
	590572	7560854	SLM NE Mc18	Motion camera	Seven records; 4/5/14, 5/5/14, 6/5/14, 7/5/14, 8/5/14, 19/5/14, 28/5/14
	590457	7560965	SLM NE Mc20	Motion camera	Two records; 5/5/14, 18/6/14
	591099	7559313	SLM NE Mc16	Motion camera	Six records; 2/5/14, 4/5/14, 7/5/14, 8/5/14, 9/5/14, 13/5/14
Solomon Mine Conservation Significant Fauna Monitoring (2014) (ecologia 2014b)	590472	7555902	NQ I2 T5	Trap capture	Male, ID 941000016202857
	590447	7555941	NQ I2 T4	Recapture	ID 941000016202857
	590457	7554931	NQ I2 T22	Trap capture	Male, ID 941000016595573
	590490	7554989	NQ I2 T21	Recapture	ID 941000016595573
	589600	7554102	NQ I2 T43	Trap capture	Male, ID 941000016595572
	589458	7553905	NQ I2 T47	Recapture	ID 941000016595572
	592575	7554667	NQ I1T20	Trap capture	Male, ID 941000016595536
Solomon South Project (Outback Ecology 2014)	589993	7542276	Opportunistic	Secondary evidence	Scat
Solomon Mine Conservation Significant Fauna Monitoring (2013) (ecologia 2014a)	590498	7555850	NQI2 T6	Trap capture	Male, ID M1
	590419	7555993	NQI2 T3	Recapture	M1 recapture
	589600	7554102	NQI2 T43	Trap capture	Male, ID M2
	590447	7555941	NQI2 T4	Trap capture	Male, ID M3
	590419	7555993	NQI2 T3	Recapture	M3 recapture
Solomon Project – Firetail (Ecoscape 2010d)	594473	7553309	Opportunistic	Secondary evidence	Scat
	586308	7548153	Opportunistic	Secondary evidence	Scat
	591879	7554210	Opportunistic	Secondary evidence	Scat
	595225	7553697	Opportunistic	Secondary evidence	Scat
	595264	7553988	Opportunistic	Secondary evidence	Scat
Solomon Project – Mine (Coffey 2008)	586308	7548853	Opportunistic	Observation	Recorded while spotlighting
Solomon Project – Kings Area (ecologia 2010)	586381	7552168	Opportunistic	Secondary evidence	Scat
Central Pilbara Project – Mine (*ecologia* 2011b)	568937	7545504	Opportunistic	Secondary evidence	Scat
Solomon Mine Conservation Significant Fauna Monitoring (2012) (ecologia 2013c)	578019	7546548	Opportunistic	Motion camera	Single record.

Survey	Easting	Northing	Site	Record type	Comments
Solomon Project – Mine (Coffey 2011a)	589286	7553783	Trap 27	Trap capture	Initial trap capture.
	588752	7553158	Trap 38	Recapture	Recapture
	588642	7553043	Trap 40	Recapture	Recapture
	594682	7552922	Opportunistic	Secondary evidence	Scat

Datum: GDA94
Zone: 50K

Table 4.8 – Captured Northern Quoll morphological details

Quoll ID (PIT no)	Sex	Date	Capture	Weight (g)	Short Pes (mm)	Head (mm)	Reproduction Status	Condition (out of 5)
941000016202851	Female	08/07/14	Initial Capture	300	32	59.5	Young female, reaching maturity	4
941000016202850	Female	10/07/14	Initial capture	455	32	60.0	Developing pouch, no young	4.5

Datum: GDA94
Zone: 50K

Figure 4.20 – Northern Quoll recorded on motion camera (SLM NE Mc12) during current survey

4.6.2 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara form))

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

Distribution and habitat: The Pilbara Leaf-nosed Bat is the Pilbara form of the Orange Leaf-nosed Bat (*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 the shallow 'breakaway' caves that occur along mesas and strike ridges.

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

Likelihood of occurrence: The Pilbara Leaf-nosed Bat occurs patchily in the surrounding of study area (Figure 4.21). During the previous vertebrate fauna assessment of the Central Pilbara Project (*ecologia* 2011a, b), Pilbara Leaf-nosed Bats were recorded from 16 locations. The species has also been recorded from the study area on eight occasions Table 4.9, Figure 4.23). Figure 4.23 shows Pilbara Leaf-nosed Bats have previously been recorded predominately in the south-west of the study area. Using the number and timing of all calls it was interpreted that the recorded individuals were travelling from and returning to the location of their roost site and that the area where they were recorded constitutes a regular foraging area. The recorded calls were distributed evenly throughout the night, which was interpreted as individual(s) foraging (*ecologia* 2011a). Based on the timing of the calls near midnight and the speed that Pilbara Leaf-nosed Bat can travel, it was estimated that a roost was located 25-35 km south of the study area. It was hypothesised that the Pilbara Leaf-nosed bats travelled north along Barnett creek, to forage amongst the hills surrounding Mt Sheila, then returning south to roost.

The current survey also recorded the Pilbara Leaf-nosed Bat in a location further north than the previous records (Figure 4.23) indicating that the individual could belong to a population to the north of the study area (Possibly from the Chichester Range).

Call patterns recorded from areas that contain Pilbara leaf-nosed Bat roost caves typically constist of a high number of calls with a correlation between the distance to the cave and the time of the recording (Pilbara Leaf-nosed Bats are closest to their roost caves at dawn and dusk). Despite the large numbers of hours (3,244 hrs) of recordings to date, this call pattern has not been collected within the study area indicating that no roost cave habitat exists within the study area. This is supported by the fact that all records within the study area have consisted of single calls, indicating individual bats utilising the study area as foraging habitat only.

Figure 4.21 – Distribution of the Pilbara Leaf-nosed Bat in the Pilbara region (Naturemap 2014)

Table 4.9 – Summary of Pilbara Leaf-nosed Bat records

Survey	Easting	Northing	Comments
This survey	594445	7559098	Single call recorded (foraging)
	575013	7537910	Single call recorded (foraging)
Solomon South Project (Outback Ecology 2014)	590245	7541516	Single call recorded (foraging)
Solomon Mine Conservation Significant Fauna Monitoring (2014) (*ecologia* 2014b)	574511	7541378	Single call recorded (foraging)
	579034	7543185	Single call recorded (foraging)
Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)	571185	7542549	Single call recorded (foraging)
	580759	7551738	Single call recorded (foraging)
Solomon Mine Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013c)	571443	7538981	Single call recorded (foraging)

4.6.3 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 2008b). In late winter or early spring males will travel large distances to find, and mate with, females (Pearson 2006).

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

Likelihood of occurrence: Recorded from within the study area from nine locations (Table 4.10), the Pilbara Olive Python is known to occur from three fauna habitats within the study area; Gorges/Gullies, Drainage line/River/Creek (Major), and Hilltops/ridges/plateaux. All three habitats are considered to be important habitat for the Pilbara Olive Python as this species utilises different habitats for extended periods during the different seasons. Pilbara Olive Python will utilse all three habitats during the hot wet summer period to forage and then they retreat to the Gorge/Gully habitats during the dry winter period to hibernate and to lay eggs. The species has been found in the surrounding of the study area with several records to the south along the Hamersley Range (Figure 4.22)

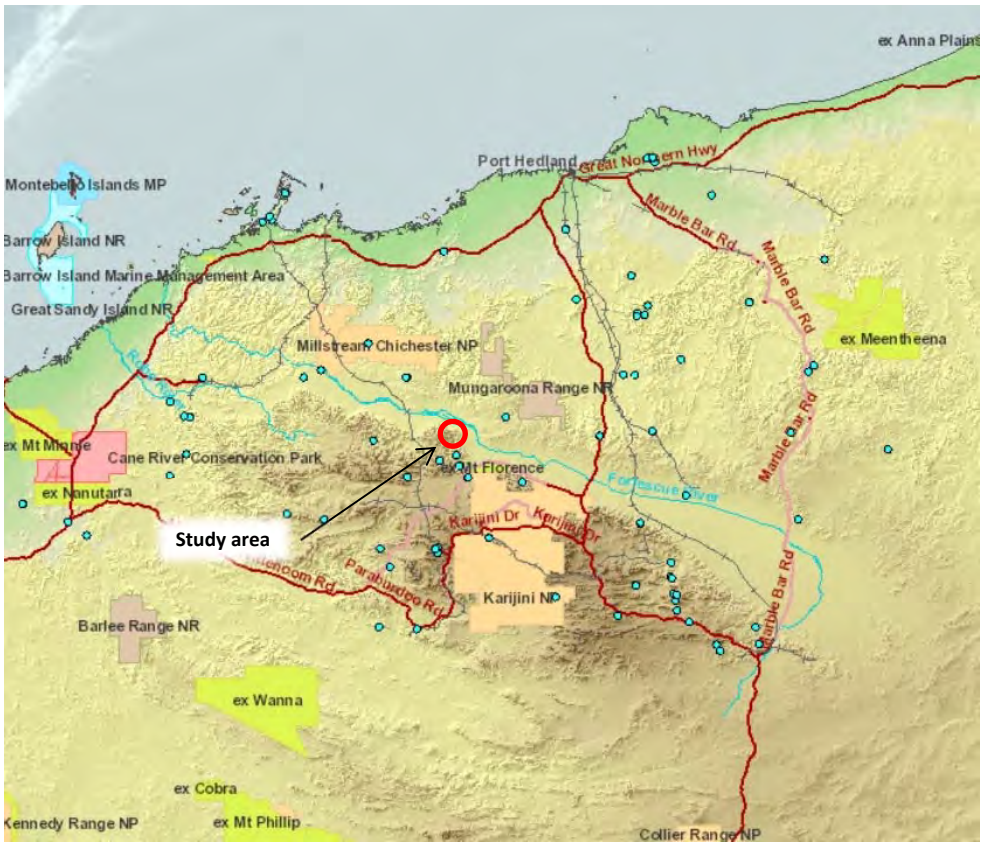


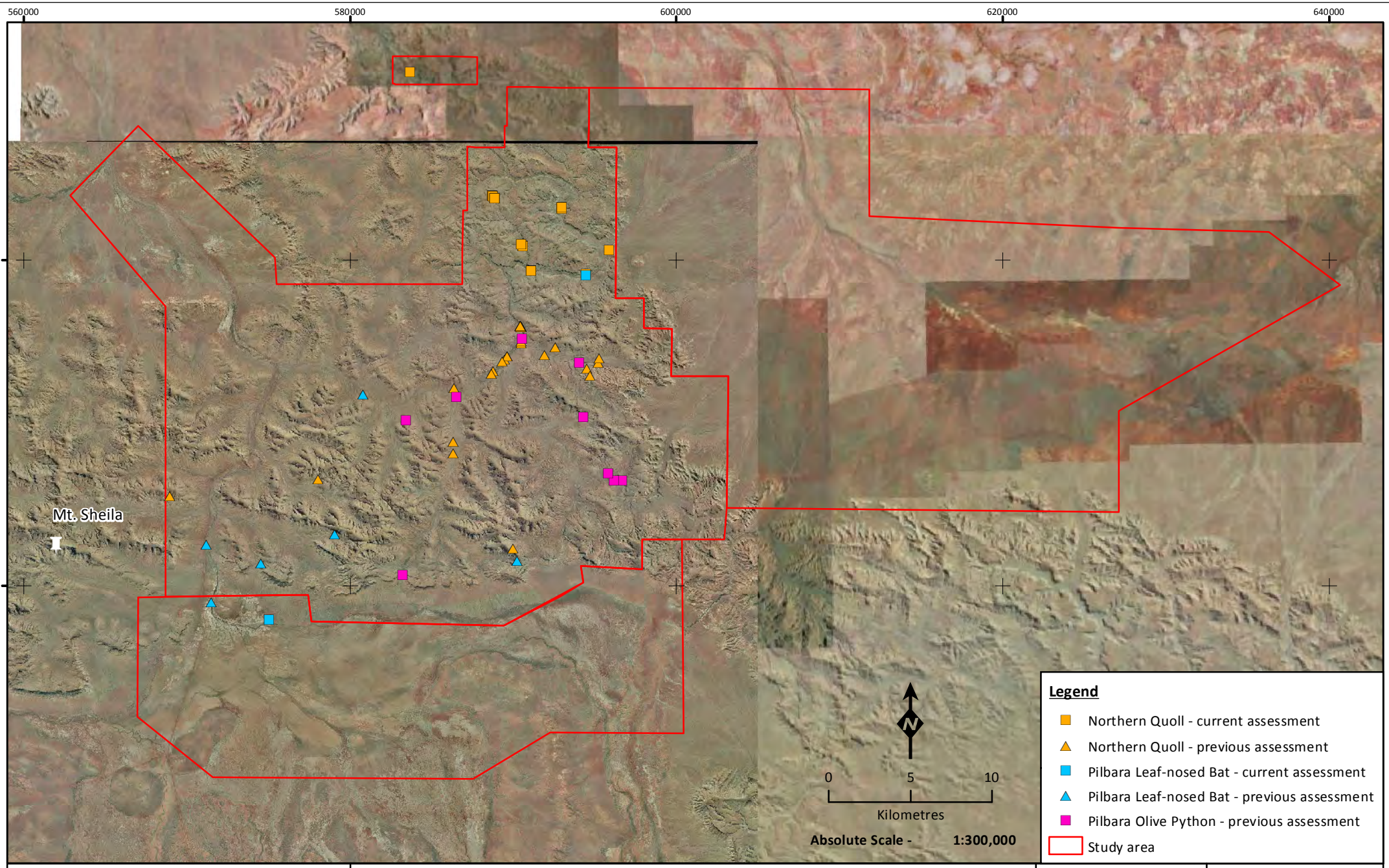
Figure 4.22 – Distribution of the Pilbara Olive Python in the Pilbara region (Naturemap 2014)

Pilbara Olive Python have been recorded along Kangeenarina Creek and Zalamaea Pools, which provides suitable foraging and dispersal habitat. All current records have been located in the vicinity of the Valley of the Kings and Kangeenarina Creek, however individuals have also been recorded in the surrounding region including from Karajini National Park (*ecologia* 2013c, 2014a)

Table 4.10 – Summary of Pilbara Olive Python records

Survey	Easting	Northing	Comments
Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)	583408	7550201	Motion Camera
	596165	7546464	1 individual (PIT tagged)
Solomon Mine Conservation Significant Fauna Monitoring (2012) (ecologia 2013c)	596668	7546469	1 individual (juvenile)

Survey	Easting	Northing	Comments
Solomon Project – Kings Area (ecologia 2010)	595835	7546944	1 individual
	586516	7551601	1 individual
Solomon Project – Firetail (Ecoscape 2010d)	590512	7555143	1 individual
Fortescue significant fauna database	594055	7553710	1 individual
	594305	7550404	1 individual
Solomon Project - Rail (Coffey 2010a)	583200	7540681	1 individual



ecologia ENVIRONMENT

EPBC Act Threatened fauna recorded

Figure: 4.23
Project ID: 1593

Drawn: NJ & AH
Date: 22/10/14

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

Unique Map ID: NJ115

A4

4.7 EPBC ACT THREATENED FAUNA HABITATS

Based on the results of the combined surveys within the study area, four fauna habitats are known to be suitable for EPBC Act listed threatened species. These include:

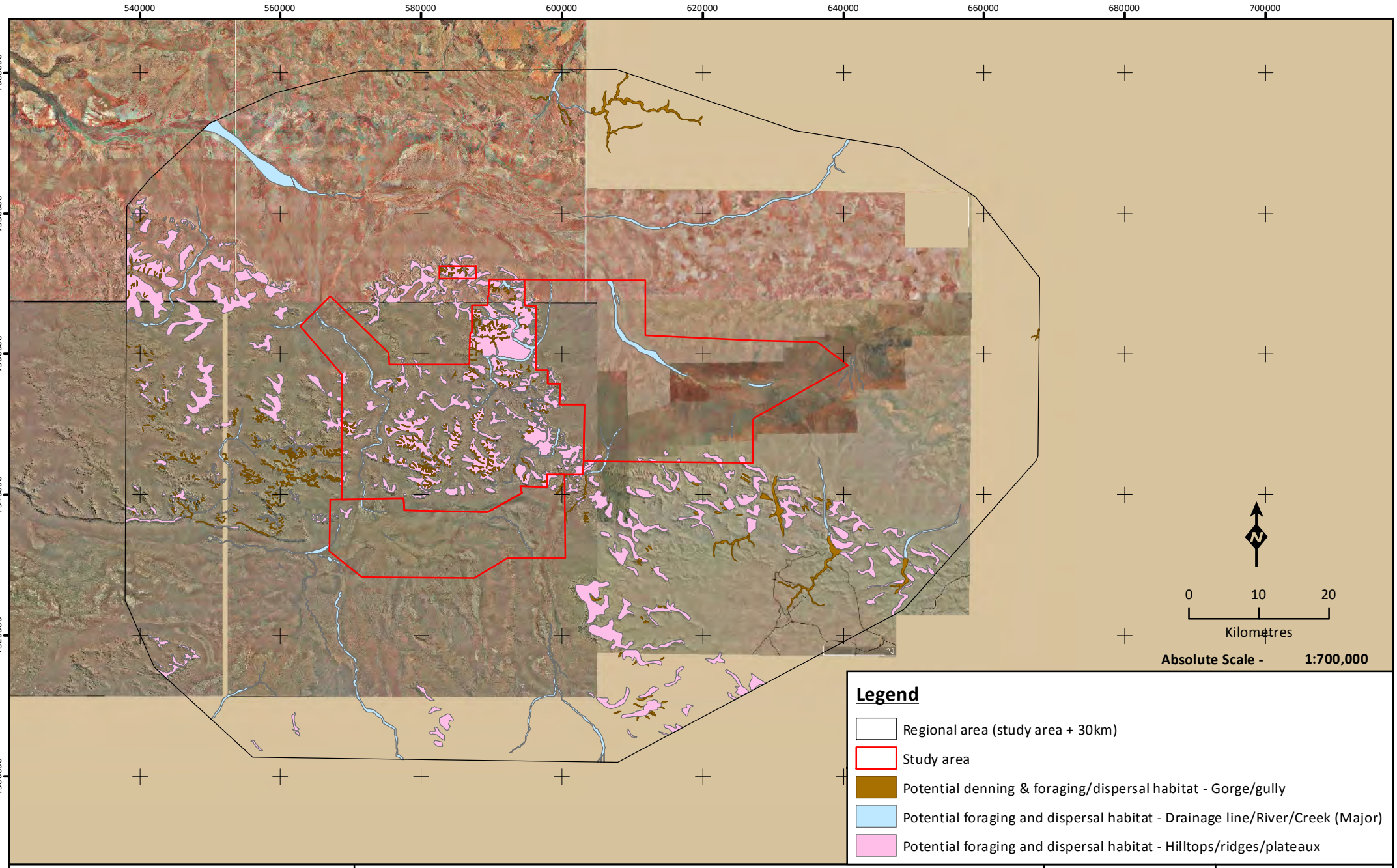
- Gorges/Gullies;
- Drainage line/River/Creek (Major); and
- Hilltops/ridges/plateaux.

A summary of potential habitat area for the EPBC Act threatened fauna is provided in Table 4.11 and mapped in Figure 4.24, Figure 4.25 and Figure 4.26

Table 4.11 – Summary of habitats for EPBC Act threatened fauna within the study area

EPBC Act Threatened Fauna	Fauna Habitat	Area inside study area (ha)	Percentage of total study area (%)	Area within 30 km of study area* (ha)
Northern Quoll (*Dasyurus hallucatus*) Endangered	**Potential denning habitat**. Areas of rocky habitat in the study area that may contain suitable den sites, preferably near a water source. Assoicated fauna habitat: Gorges/Gullies.	1,712	0.9	6,671.6
	Potential foraging and 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). Associated fauna habitats: Gorges/Gullies; Drainage line/River/Creek (Major); and Hilltops/ridges/plateaux.	28,031	15.6	72,050.0
Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Pilbara form) Vulnerable	**Potential roosting habitat**: Areas of rocky gorges and gullies that contain suitably deep cave structures and humidity for roosting.	0	0	0
	Potential 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. Associated fauna habitats: Gorge/gully and Drainage line/River/Creek (Major).	5,549.3	3.1	17,684.0
Pilbara Olive Python (*Liasis olivaceaus barroni*) Vulnerable	**Potential winter shelter habitat.** Areas which may contain escarpments, gorges, preferably with rock crevices and outcrops near water holes, which attract prey species. Associated fauna habitat: Gorges/Gullies.	1,712	0.9	6,671.6
	Potential foraging and dispersal habitat. Areas which may contain escarpments, gorges, preferably with rock crevices and outcrops near water holes, which attract prey species. Associated fauna habitat: Gorges/Gullies; Drainage line/River/Creek (Major); and Hilltops/ridges/plateaux.	28,031	15.6	72,050.0

*includes previously mapped habitats and extrapolated areas.



ecologia ENVIRONMENT

Habitat for Northern Quoll within and outside the study area

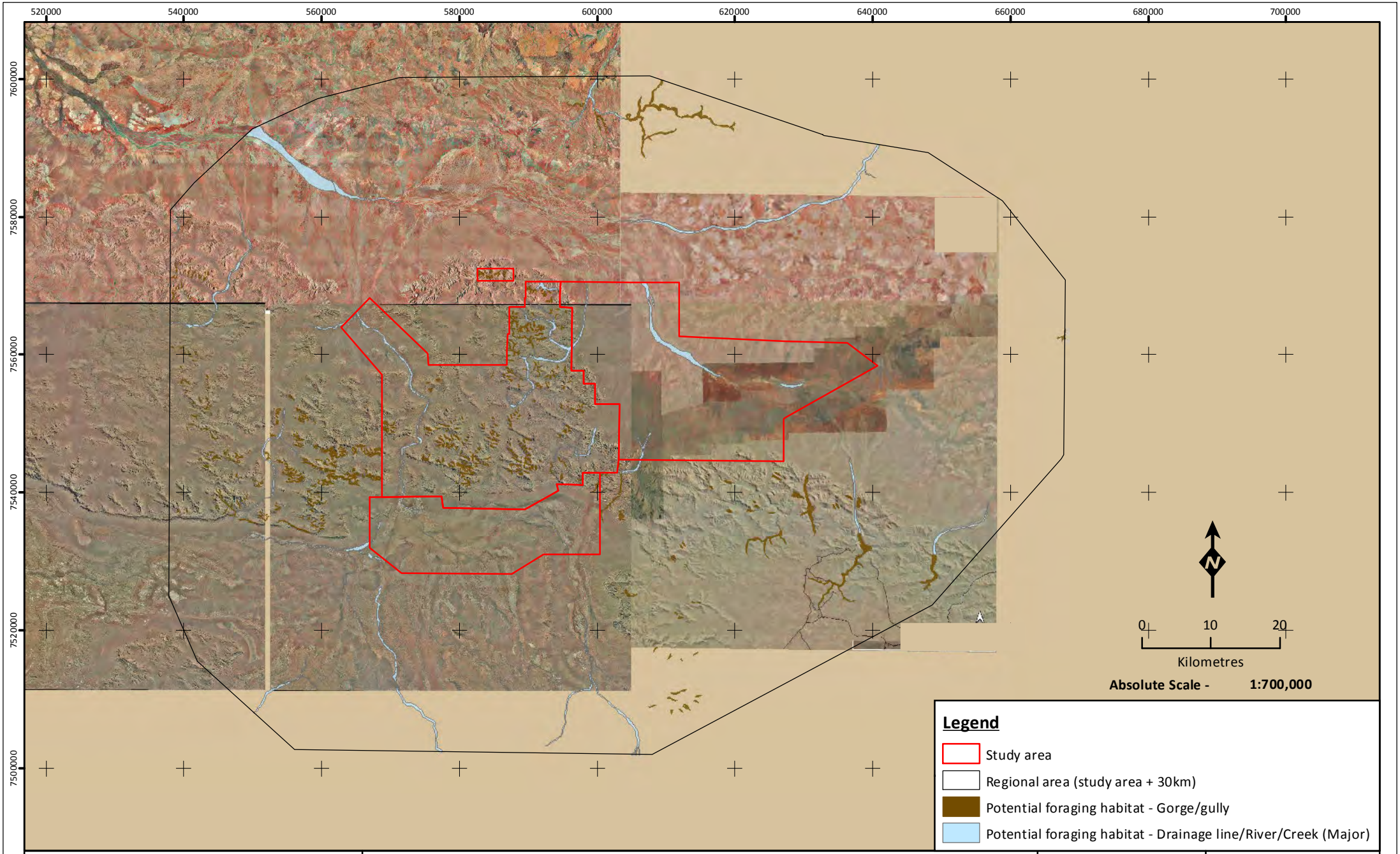
Figure: 4.24
Project ID: 1593

Drawn: NJ & AH
Date: 24/10/14

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

Unique Map ID: NJ117

A4



ecologia ENVIRONMENT

Habitat for Pilbara Leaf-nosed Bat within and outside the study area

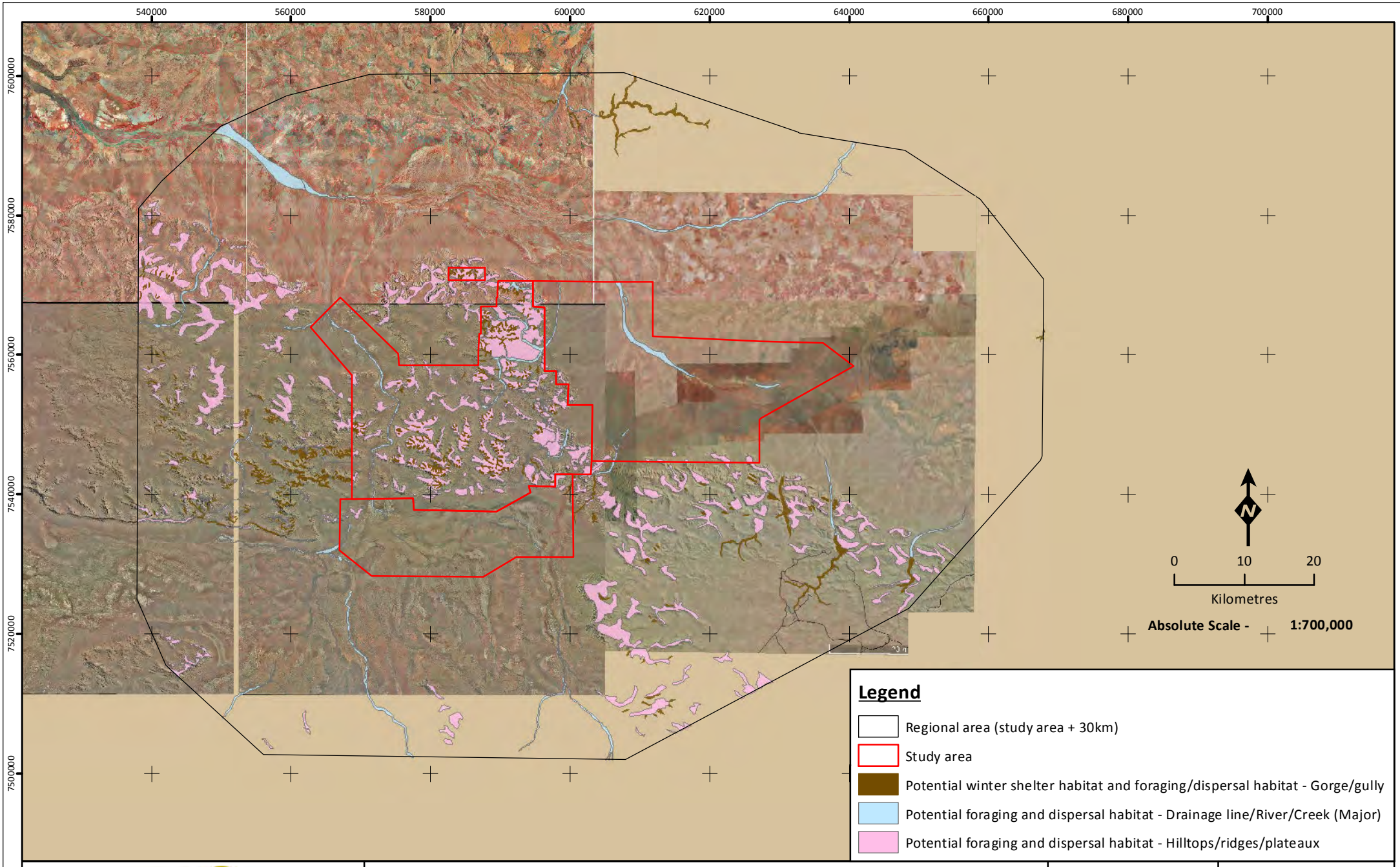
Figure: 4.25
Project ID: 1593

Drawn: NJ &AH
Date: 24/10/14

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

Unique Map ID: NJ116

A4



ecologia ENVIRONMENT

Habitat for Pilbara Olive Python within and outside the study area

Figure: 4.26
Project ID: 1593

Drawn: NJ & AH
Date: 24/10/14

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

Unique Map ID: NJ115

A4

4.8 EPBC ACT MIGRATORY FAUNA

A total of three species listed under the EPBC Act as migratory fauna (and under the WC Act as Schedule 3) were recorded from the study area. These species include the Fork-tailed Swift, Rainbow Bee-eater and Eastern Great Egret. These records are summarised in the sections below and mapped in Figure 4.30.

4.8.1 Fork-tailed Swift (*Apus pacificus*)

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

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

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

Likelihood of occurrence: A number of records from previous surveys, including from within the study area and likely to be a regular but erratic summer-autumn visitor (Table 4.12). Records involve overflying birds, as the species is almost entirely aerial in habits while in Australia. The species has been recorded throughout the Pilbara region with the study area being located in the centre of its distribution (Figure 4.27).

Table 4.12 – Summary of Fork-tailed Swift records

Survey	Easting	Northing	Comments
Central Pilbara Project – Mine (*ecologia* 2011b)	572191	7544388	205 individuals
	575780	7542089	25 individuals
Solomon Project – Kings Area (*ecologia* 2010)	599996	7544982	33 individuals
	598522	7545119	<20 individuals (taken from FMG database)

Figure 4.27 – Distribution of the Fork-tailed Swift in the Pilbara region (Naturemap 2014)

4.8.2 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: Numerous records throughout the study area in a variety of habitats. Rainbow Bee-eaters were recorded from 53 locations within the study area (Table 4.13) and the species is regularly sighted throughout the Pilbara region (Figure 4.28). This species is commonly recorded in any habitat that supports trees where they can perch whilst hawking insects such as along drainage lines and in open woodlands.

Table 4.13 – Summary of Rainbow Bee-eater records

Survey	Easting	Northing	Comments
This survey	580596	7540709	1 individual
	577802	7538938	5 records
	591100	7541803	2 individuals
	602506	7559729	3 records
	608576	7561881	21 records
	614304	7559688	2 individuals
	618131	7560148	1 individual
	622204	7555686	1 individual
	620922	7550522	4 records
	591173	7559308	1 individual
	586468	7554328	2 individuals
	621099	7555057	1 individual
	600762	7543218	1 individual
	599222	7546602	1 individual
Solomon South Project (Outback Ecology 2014)	592840	7542053	3 individuals
	591504	7541841	1 individual
Mt Macleod Project (*ecologia* 2013b)	596483	7532374	1 individual
Investigator Project (*ecologia* 2013a)	635059	7559399	1 individual
	635525	7555903	3 individuals
	637166	7559506	1 individual
	635179	7556499	3 individuals
	637776	7559027	2 individuals
Solomon Mine Conservation Significant Fauna Monitoring (2012) (ecologia 2013c)	595583	7546554	1 individual
Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)	571503	7545566	2 individuals
Central Pilbara Project – Rail (*ecologia* 2012a)	570352	7561721	2 records
	565860	7563923	4 records
Central Pilbara Project – Mine (*ecologia* 2011b)	571784	7544611	2 records
	571287	7538970	3 records
	571484	7538950	5 records
	574349	7541963	1 records
	571401	7539125	3 records
	569406	7539910	3 records
	570194	7541399	1 record
	570991	7546895	1 record
Solomon Project – Firetail (Ecoscape 2010d)	594533	7553054	1 individual
Solomon Project – Kings Area (*ecologia* 2010)	600185	7543379	6 individuals
	595610	7546858	1 individual
	598522	7545119	42 individuals
	600571	7545155	1 individual
	600473	7545046	8 individuals
	585413	7552034	3 individuals

Survey	Easting	Northing	Comments
	589524	7553181	8 individuals
	588886	7549762	4 individuals
	593062	7548950	2 individuals
	599996	7544982	3 individuals
	600775	7544024	2 individuals
Solomon Project – Mine (Coffey 2008)	576390	7553570	9 individuals
	577992	7553599	15 individuals
	586177	7549694	1 individual
	588419	7549219	2 individuals
	589605	7549256	2 individuals
	593790	7545499	1 individuals
	589545	7553151	1 individuals

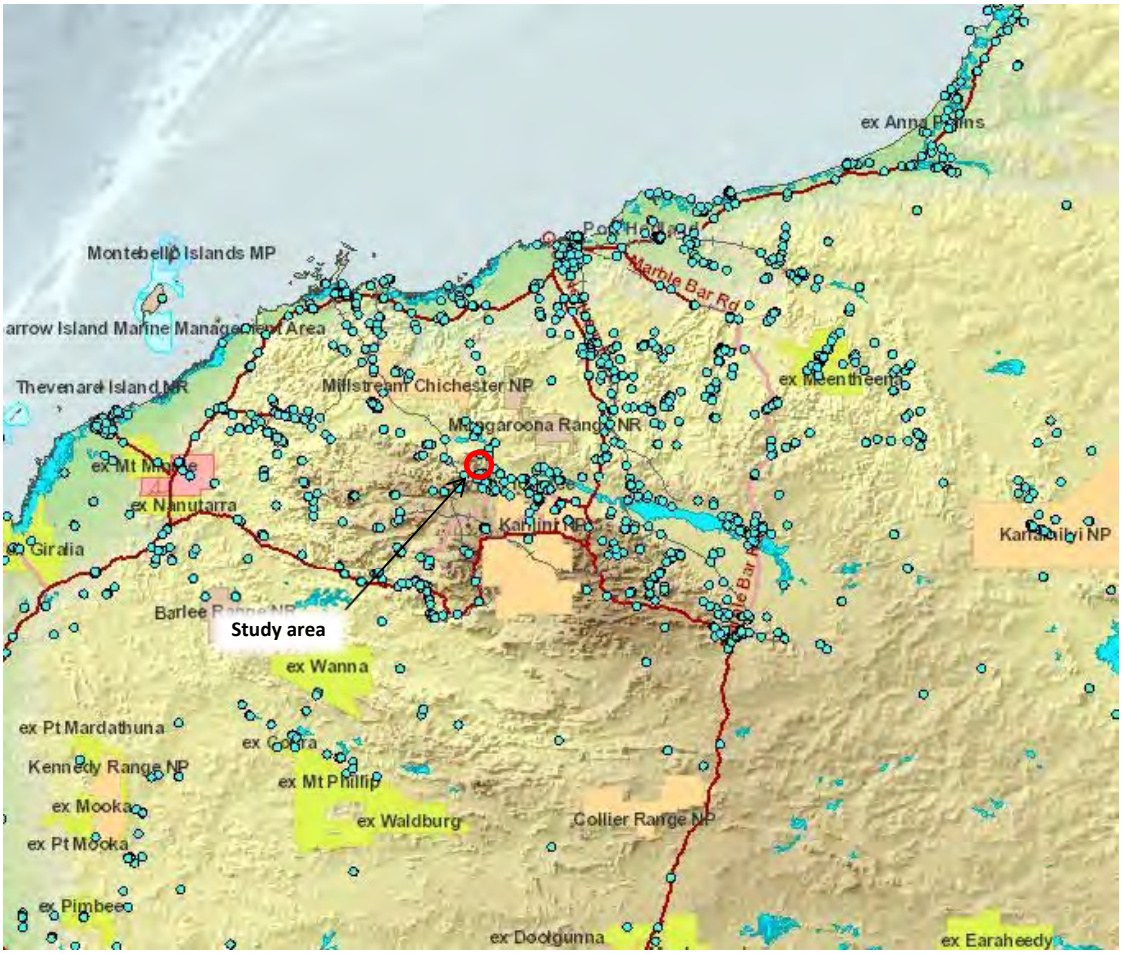


Figure 4.28 – Distribution of the Rainbow Bee-eater in the Pilbara region (Naturemap 2014)

4.8.3 Eastern Great Egret (*Ardea modesta*)

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

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

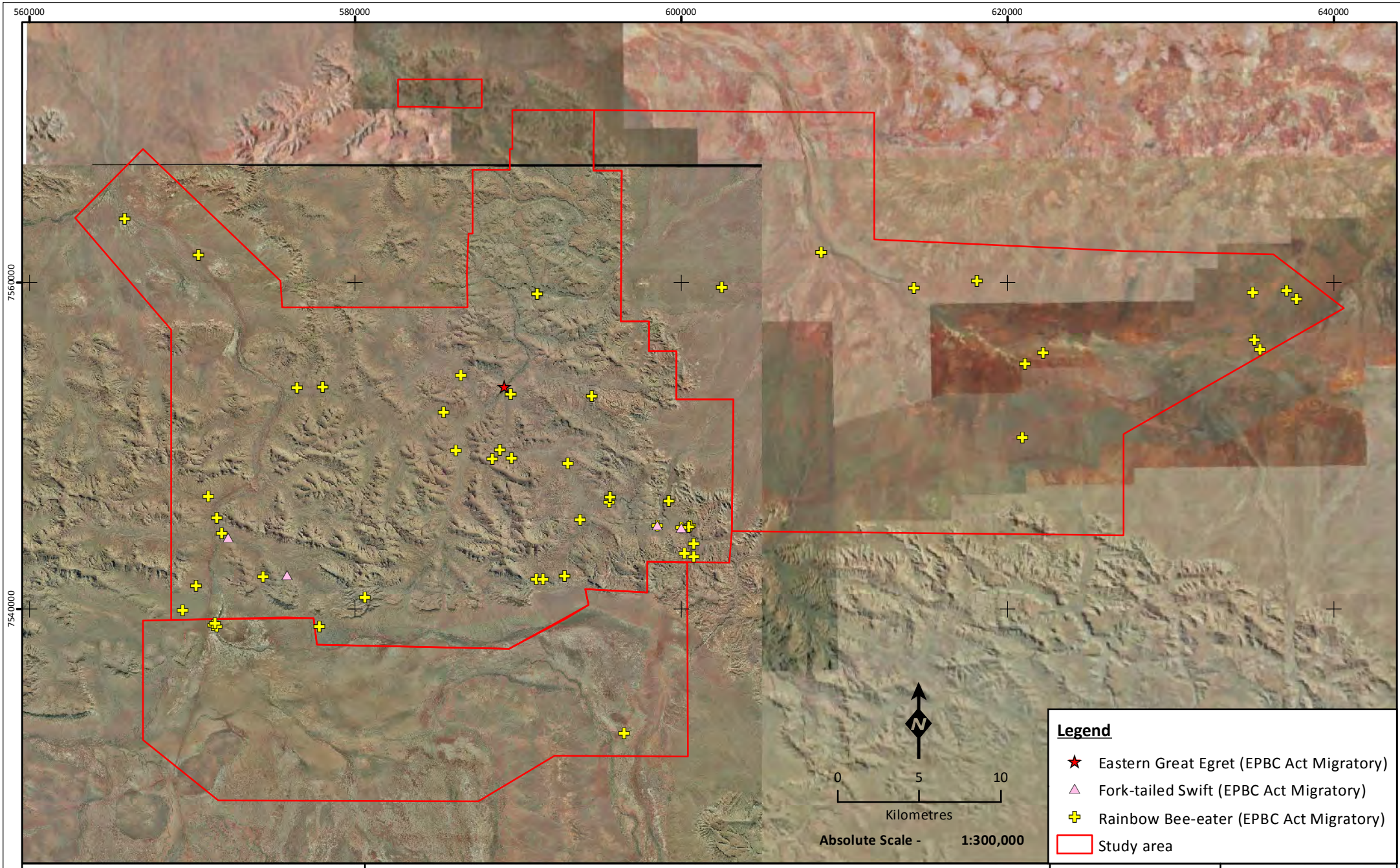
Ecology: This species' diet consists predominantly of small fish and crustaceans. Eastern Great Egrets breed colonially in trees standing in water around wooded swamps and river pools, 4-13 m above water (Morcombe 2000). The nest is built as a rough, loose, shallow platform. Four eggs are laid in summer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

Likelihood of occurrence: A single record of an Eastern Great Egret within the study area exists (Table 4.14) therefore it is considered likely to be an occasional visitor when sufficient rainfall creates suitable patches of habitat within the study area, such as when surface water is present in Drainage line/River/Creek (Major) habitats. The study area is located in the centre of the distribution of the Eastern Great Egret in the Pilbara (Figure 4.29).

Table 4.14 – Summary of Eastern Great Egret records

Survey	Easting	Northing	Comments
Solomon Mine Conservation Significant Fauna Monitoring (2012) (ecologia 2013c)	589140	7553623	2 individuals

Figure 4.29 – Distribution of the Eastern Great Egret in the Pilbara region (Naturemap 2014)



ecologia ENVIRONMENT

EPBC Act Migratory fauna recorded

Figure: 4.30
Project ID: 1593

Drawn: NJ & AH
Date: 22/10/14

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

Unique Map ID: NJ119

A4

4.9 WC ACT SCHEDULE FAUNA

Two fauna species listed under the WC Act (and not listed under the EPBC Act) have been recorded within the study area or have a high likelihood of occurring in the study area; Grey Falcon and Peregrine Falcon. The locations of the Peregrine falcon records are shown in Figure 4.34.

4.9.1 Grey Falcon (*Falco hypoleucos*)

Conservation status: WC Act Schedule 1, DPaW Vulnerable.

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

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

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

Likelihood of occurrence: The Grey Falcon has a high likelihood of occurring within the study area due to numerous records from the surrounding region (Biota 2008, 2011; Coffey 2013; *ecologia* 2013f, in prep.) and the presence of suitable foraging and nesting habitat across the study area. Records of the species are generally scattered throughout the Pilbara region (Figure 4.31).

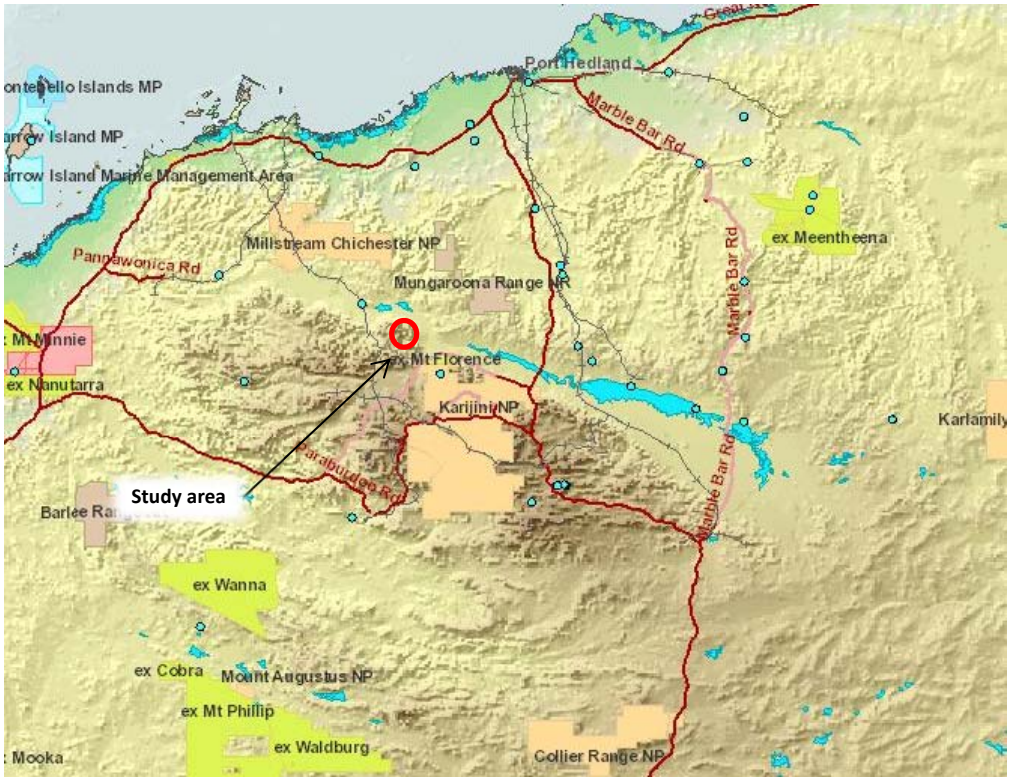


Figure 4.31 – Distribution of the Grey Falcon in the Pilbara region (Naturemap 2014)

4.9.2 Peregrine Falcon (*Falco peregrinus*)

Conservation status: WC Act Schedule 4, DPaW Specially Protected Fauna.

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

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

Likelihood of occurrence: Two Peregrine Falcons were recorded from the study area during two previous monitoring surveys (Table 4.15). It is unknown if the same pair was recorded on each occasion. Suitable foraging and nesting (cliff faces) habitat is present within the study area. The species is recorded regularly throughout the Pilbara region (Figure 4.32).

Table 4.15 – Summary of Peregrine Falcon records

Survey	Easting	Northing	Comments
Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)	571207	7543236	2 individuals
Solomon Mine Conservation Significant Fauna Monitoring (2012) (ecologia 2013c)	595937	7546982	2 individuals

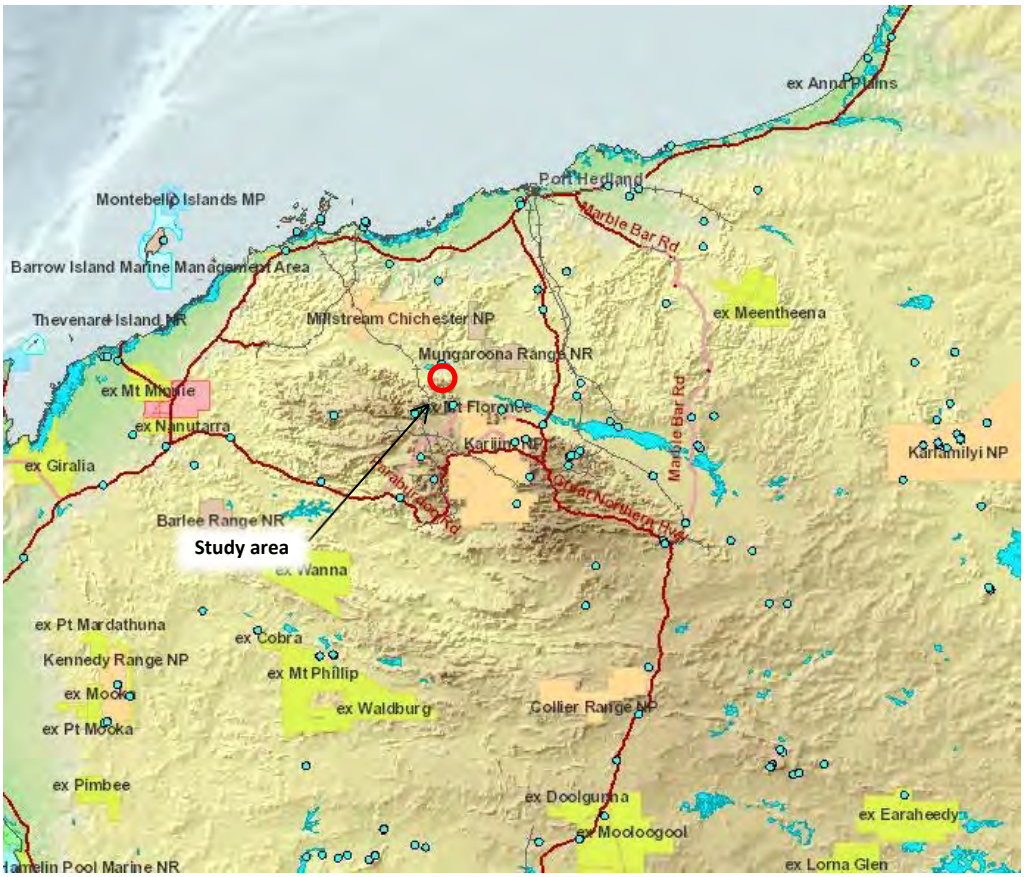


Figure 4.32 – Distribution of the Peregrine Falcon in the Pilbara region (Naturemap 2014)

4.10 DPAW PRIORITY LISTED FAUNA RECORDED

A further twelve species listed as Priority Fauna by DPaW were recorded from the study area or are considered likely to occur there. These species are the Spectacled hare-Wallaby, Ghost Bat, Long-tailed Dunnart, Short-tailed Mouse, Western Pebble-mound Mouse, Flock Bronzewing, Bush Stone-curlew, Australian Bustard, Star Finch, Pilbara Barking Gecko, *Ramphotyphlops ganei* and *Notoscincus butleri*. These records are summarised in the sections below and mapped in Figure 4.34 below.

4.10.1 Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*)

Conservation status: DPaW Priority 3.

Distribution and habitat: This mainland subspecies of the Spectacled Hare-wallaby is a medium-sized wallaby found across northern Australia and in the Pilbara region. It inhabits grasslands, open forests, open woodlands and tall shrublands, and shelters during the day under *Triodia* tussocks (DEWHA 2008a).

Ecology: The Spectacled Hare-wallaby is solitary, but up to three individuals may occasionally be seen feeding together. Breeding takes place throughout the year. Its diet consists of grass and herbs. It is well adapted to harsh conditions; it has a low urine production and the water turnover is far less than has been measured in any other mammal of comparative size (Burbidge and Johnson 2008).

Likelihood of occurrence: Medium. An old (1966) confirmed record from within 20 km of the study area, and may still be present in the area in low densities. The species' distribution and status within the Pilbara is poorly understood.

4.10.2 Long-tailed Dunnart (*Sminthopsis longicaudata*)

Conservation status: DPaW Priority 4.

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

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

Threatening processes have not yet been identified as only little is known about this species. Threats could 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: Two individuals were recorded from two separate locations within the study area in 2011 (Table 4.16). This species is expected to occur in low densities in the Hilltops/ridges/plateaux habitat as despite a significant amount of survey effort, this species has been rarely recorded.

Table 4.16 – Summary of Long-tailed Dunnart records

Survey	Easting	Northing	Comments
Central Pilbara Project – Mine (*ecologia* 2011b)	570194	7541399	1 individual
	570991	7546895	1 individual

4.10.3 Ghost Bat (*Macroderma gigas*)

Conservation status: DPaW Priority 4.

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

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

Likelihood of occurrence: Recorded from eight locations within the study area (Table 4.17). Based on the low number of recorded calls on bat recording devices, recorded individuals appear to utilise the study area for foraging only and are not expected to roost within the study area. Suitable hunting and roosting habitat consisting of open plains in proximity to Hilltops/ridges/plateaux habitat which provides suitable rocky ledges for this species to consume its prey. Additional records occur from the surrounding region (*ecologia* 2011a, 2013g; Ecoscape 2011).

Table 4.17 – Summary of Ghost Bat records

Survey	Easting	Northing	Comments
Stingray Project (*ecologia* 2013e)	572711	7532769	Call recorded
Solomon Mine Conservation Significant Fauna Monitoring (2012) (ecologia 2013c)	571792	7544604	Call recorded
	585009	7543600	Call recorded
	575026	7547485	Call recorded
Central Pilbara Project – Mine (*ecologia* 2011b)	571287	7538970	1 call recorded
Solomon Project – Kings Area (ecologia 2010)	586911	7550328	Call recorded
	587145	7551714	Call recorded
	585518	7550300	Call recorded

4.10.4 Short-tailed Mouse (*Leggadina lakedownensis*)

Conservation status: DPaW Priority 4.

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

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

Likelihood of occurrence: Short-tailed Mice have been recorded from ten locations within the study area (Table 4.18). Consistant with its known habitat within the Pilbara, the records are primarily from the Plain (cracking clay) habitat type.

Table 4.18 – Summary of Short-tailed Mouse records

Survey	Easting	Northing	Comments
This survey	574464	7531208	3 records
	581685	7528272	2 records
Mt Macleod Project (*ecologia* 2013b)	584639	7534712	2 records
	584600	7534794	2 records
	594127	7534175	1 record
	594171	7534109	1 record
	596519	7532387	1 record
Stingray Project (*ecologia* 2013e)	572604	7532725	8 records
Investigator Project (*ecologia* 2013a)	635014	7556529	1 record
Mt Macleod Project (Rapallo 2011)	578552	7528532	2 records

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

Conservation status: DPaW Priority 4.

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

Ecology: In suitable habitats, pebble mounds of this species can be found in large numbers, although not all of these mounds are active and occupied by Pebble-mound Mice at the same time. The demographic structure of the groups that inhabit the mounds and their patterns of movement around the mounds is still unknown (Anstee 1996; Anstee *et al.* 1997). Mounds can cover an area of 0.5 to 9.0 m^2, and a single mound can house up to 25 mice (Start 2008). Breeding occurs throughout the year with females producing several litters of four young per year (Start 2008).

Likelihood of occurrence: Recorded from 44 locations within the study area (Table 4.19). A significant proportion of these were active at the time of detection, indicating that the species is likely to be quite common within the study area. This species is commonly recorded on the top of hills with the landscape and is associated with this landscape feature within the Hills/Ridges/Plateaux and Plain (stony gibber) habitats.

Table 4.19 – Summary of Western Pebble-mound Mouse records

Survey	Easting	Northing	Comments
Solomon Mine Conservation Significant Fauna Monitoring (2014) (*ecologia* 2014b)	584078	7549728	Active mound
Central Pilbara Project – Rail (*ecologia* 2012a)	570253	7541389	Active mound
	575721	7542176	Active mound
	575670	7541986	Active mound

Survey	Easting	Northing	Comments
Central Pilbara Project – Mine (*ecologia* 2011b)	570253	7541389	Active mound
	575721	7542176	Active mound
	575670	7541986	Active mound
	575670	7541989	Potentially active
	567845	7537471	Potentially active
	566973	7537495	Inactive mound
	567281	7537777	Inactive mound
Solomon Project – Firetail (Ecoscape 2010d)	595865	7553998	Active mound
Solomon Project – Kings Area (ecologia 2010)	590988	7549282	Potentially active
	591032	7549119	Inactive mound
	591477	7549002	Active mound
	591603	7548970	Potentially active
	592097	7548592	Inactive mound
	592099	7548539	Active mound
	592189	7548478	Active mound
	592323	7548434	Potentially active
	592325	7548417	Active mound
	592364	7548494	Active mound
	592269	7548568	Potentially active
	592161	7548648	Potentially active
	593301	7548815	Active mound
	593502	7548765	Potentially active
	593627	7548703	Active mound
	593378	7548700	Active mound
	593356	7548745	Active mound
	593219	7548820	Active mound
	590985	7549163	Inactive mound
	594927	7546039	Potentially active
	595761	7545776	Inactive mound
	595465	7545491	Potentially active
	594509	7547525	Active mound
	596023	7545650	Active mound
Solomon Project - Rail (Coffey 2010a)	599600	7552836	Active/inactive not recorded
	601376	7554500	Active/inactive not recorded
	599800	7552936	Active/inactive not recorded
	599899	7552407	Active/inactive not recorded
	600325	7553210	Active/inactive not recorded
	599749	7552928	Active/inactive not recorded
	602209	7547651	Active/inactive not recorded
	601671	7548009	Active/inactive not recorded

4.10.6 Australian Bustard (*Ardeotis australis*)

Conservation status: DPaW Priority 4.

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

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

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

Likelihood of occurrence: Australian Bustards were recorded from nine locations within the study area (Table 4.20). This species is commonly recorded from across the pilbara region and is associated with plain type habitats.

Table 4.20 – Summary of Australian Bustard records

Survey	Easting	Northing	Comments
This survey	609281	7563336	2 individuals
	607274	7564917	1 individuals
	615413	7555905	1 individuals
	614355	7555276	1 individuals
	608994	7563035	3 individuals
Stingray Project (*ecologia* 2013e)	572604	7532725	1 record
Investigator Project (*ecologia* 2013a)	635059	7559399	Secondary evidence (scat)
Mt Macleod Project (Rapallo 2011)	578532	7528495	1 individuals
	590783	7533136	2 individuals

4.10.7 Bush Stone-curlew (*Burhinus grallarius*)

Conservation status: DPaW Priority 4.

Distribution and habitat: The Bush Stone-curlew occurs across much of Australia, except the arid interior and central south coast, preferring lightly wooded country near thickets or long grass that acts as daytime shelter (Johnstone and Storr 1998). Historically, this species was widely distributed throughout most of WA, but has since declined, particularly in the southern part of the State. 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 (NSW National Parks and Wildlife Service 1999a).

Ecology: The species is insectivorous, preying primarily upon beetles, although they will also eat seeds and shoots, frogs, lizards and snakes (Marchant and Higgins 1993; NSW National Parks and Wildlife Service 1999a). 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 (NSW National Parks and Wildlife Service 1999a).

Since Bush Stone-curlews are a ground-dwelling and non-migratory species, they are quite susceptible to local disturbances by humans and to predation by cats and foxes (Frith 1976;

Johnstone and Storr 1998). They are most common where land disturbance is minimal, and generally become rare or extinct around human settlements (Johnstone and Storr 1998).

Likelihood of occurrence: Bush Stone-curlew was recorded from three locations within the study area (Table 4.21). Suitable habitat includes drainage lines and other thickly vegetated areas within most plain type habitats

Table 4.21 – Summary of Bush Stone-curlew records

Survey	Easting	Northing	Comments
This survey	620657	7548535	2 individuals
Mt Macleod Project (Rapallo 2011)	590071	7554338	Number of individuals not given
Solomon Project – Firetail (Ecoscape 2010d)	590071	7554338	1 record

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

Conservation status: DPaW Priority 4.

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

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

Likelihood of occurrence: Recorded within 5 km of the study area (*ecologia* 2012a) along the Weelumurra Creek. Commonly recorded where suitable reed bed habitat is present with 29 records from the Central Pilbara Project – Rail survey (*ecologia* 2012a) between Karratha and the study area. Suitable habitat in the form of reed bed microhabitats recorded within the Drainage line/River/Creek (Major) habitat is present within study area..

4.10.9 Flock Bronzewing (*Phaps histrionica*)

Conservation status: DPaW Priority 4.

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

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

Likelihood of occurrence: Recorded from three locations within the study area (Table 4.22). Due to the nomadic and eruptive nature of this species, it was only recorded during one survey. When conditions are suitable after significant rainfall in arid areas, this species can occur in the various plain habitats found within the study area.

Table 4.22 – Summary of Flock Bronzewing records

Survey	Easting	Northing	Comments
Mt Macleod Project (Rapallo 2011)	578532	7528495	2 individuals
	578189	7528790	2 individuals
	580000	7529000	80 individuals, approximate location only

4.10.10 Gane's Blindsnake (*Ramphotyphlops ganei*)

Conservation status: DPaW Priority 1.

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

Ecology: It has been suggested that *R. ganei* prefer to live in subterranean habitats near moist gullies and gorges (Wilson and Swan 2010), although there is a record from sandy soil vegetated with spinifex (DPaW 2014). 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: Recorded from four locations within the study area (Table 2.1) this species is rarely observed due to its fossorial habits. Not much information is available regarding its preferred habitat, however it is often associated with moist areas in Gorges/Gullies habitat. Althought rarely observed, this species has been recorded across much of the Pilbara from Roy Hill (*ecologia* 2009) to Panawonica (DPaW 2014).

Table 4.23 – Summary of Gane's Blindsnake (*Ramphotyphlops ganei*) records

Survey	Easting	Northing	Comments
This survey	572922	7556943	1 individual
Central Pilbara Project – Mine (*ecologia* 2011b)	568254	7535860	1 individual
Mt Macleod Project (Rapallo 2011)	597447	7534873	1 individual
Solomon Project – Kings Area (ecologia 2010)	595626	7546821	1 individual

4.10.11 Pilbara Barking Gecko (*Underwoodisaurus seorsus*)

Conservation status: DPaW Priority 1.

Distribution and habitat: This gecko is found only on ridge tops and in rocky gorges of the Hamersley Range (Doughty and Oliver 2011; Wilson and Swan 2010, DEC 2013).

Ecology: Little is known of the Pilbara Barking Geckos ecology, but it is presumably similar to other *Underwoodisaurus* and *Nephrurus* species, which are nocturnal ground dwellers that feed mostly on insects and smaller geckos (Wilson and Swan 2010).

Likelihood of occurrence: Recorded from three locations within the study area (Table 4.24). A single Pilbara Barking Gecko was recorded during the current survey (Figure 4.33). Suitable habitat is typically the top of Hills/Ridges/Plateaux habitats.

Table 4.24 – Summary of Pilbara Barking Gecko (*Underwoodisaurus seorsus*) records

Survey	Easting	Northing	Comments
This survey	580596	7540709	1 individual
Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)	593339	7544567	1 individual
	592712	7543436	1 individual

Figure 4.33 – Pilbara Barking Gecko recorded on current survey.

4.10.12 Lined Soil-crevice Skink (*Notoscincus butleri*)

Conservation status: DPaW Priority 4.

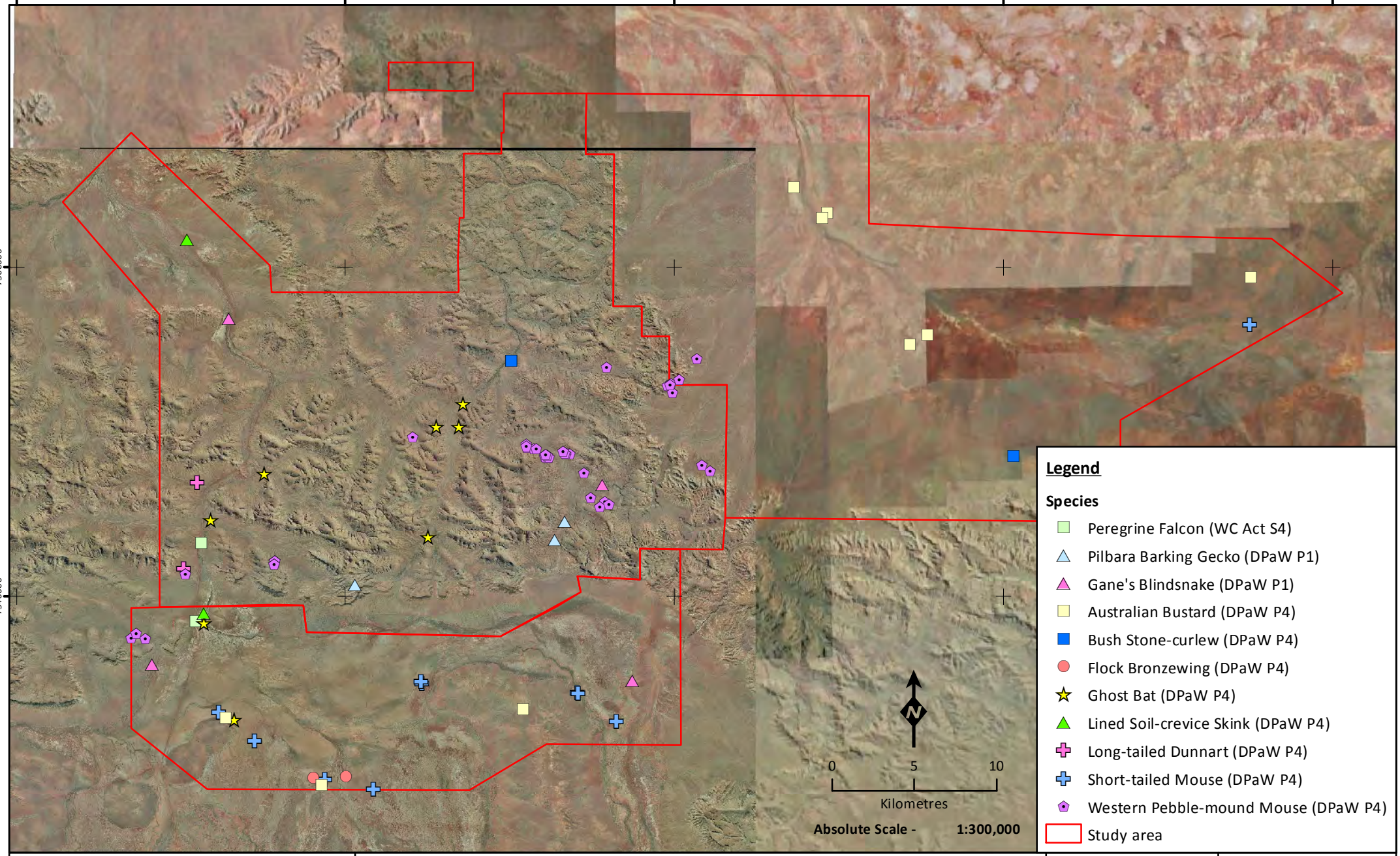
Distribution and habitat: This small skink has a limited distribution, restricted to the arid north-west near-coastal Pilbara of the Dampier district to Harding River dam (Storr *et al.* 1999; Wilson and Swan 2010). Its habitat is typically spinifex dominated areas near creek and river margins, though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

Ecology: Very little is known about this species of skink. There are only two species belonging to the *Notoscincus* genus. These species are secretive, but readily bask in sunshine (ecologia 2013g; Wilson and Swan 2010). *Notoscincus butleri* is an egg layer and feeds on invertebrates (Wilson and Swan 2010).

Likelihood of occurrence: Recorded from two locations within the study area (Table 4.25). Notoscincus butleri is typically recorded from spinifex dominated areas in proximity to Drainage line/River/Creek (Major) habitats. Recorded across the surrounding region during eight previous surveys (Biologic 2013; Biota 2005, 2009; Coffey 2008; *ecologia* 2011b, 2012a, c, 2013f)

Table 4.25 – Summary of Lined Soil-crevice Skink (*Notoscincus butleri*) records

Survey	Easting	Northing	Comments
Central Pilbara Project – Rail (*ecologia* 2012a)	570352	7561721	1 individual
Central Pilbara Project – Mine (*ecologia* 2011b)	571287	7538970	3 records



ecologia ENVIRONMENT

WC Act Schedule 4 and DPaW Priority fauna recorded

Figure: 4.34
Project ID: 1593

Drawn: NJ
Date: 24/09/14

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

Unique Map ID: NJ120

A4

4.11 SURVEY LIMITATIONS AND CONSTRAINTS

Limitations of the current survey are summarised in Table 4.26. Given no limitations were encountered, it can be confirmed that an adequate level of survey has been undertaken.

Table 4.26 – Summary of survey limitations

Constraint	Relevant (yes/no)	Comment
Competency/experience of the consultant carrying out the survey.	No	All key members of the survey team were experienced in Pilbara fauna identification and fauna surveys.
Scope (what fauna groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	All faunal groups have been comprehensively sampled throughout the study area using a variety of sampling techniques, including pitfall-trapping, cage-trapping, set-time avifauna bird surveys, targeted freshewater fish surveys, SM2 Bat recording, camera-trapping, and extensive opportunistic sampling in all identified fauna habitats.
Proportion of fauna identified, recorded and/or collected.	No	Richness estimators indicated 12-19 trappable mammals, 105-126 birds, and 94-109 trappable herpetofauna occur within the study area (Table 4.5). The results of the combinded surveys indicate 68-108% of trappable mammals, 88-106% of birds, and 87-101% of trappable herpetofauna have been recorded through systematic sampling to date within the study area. Additional opportunistic sampling has resulted in a total of 34 mammals, 114 birds, and 109 herpetofauna species having been recorded, indicating the adequacy for each fauna group is very high. All captured species were identified in the field.
Sources of information (previously available information as distinct from new data).	No	Twenty biological surveys have been conducted in the vicinity of the study area. Data from these surveys were used included to provide regional context (Table 2.6).
The proportion of the task achieved and further work which might be needed.	No	A one-phase Level 2 vertebrate fauna assessment and targeted EPBC Act threatened fauna survey was completed during the current survey, supplemented by the results of previously-completed Level 2 fauna assessments of six study areas within or immediately adjacent to the current study area.
Timing/weather/season/cycle.	No	Level 2 fauna assessments have been conducted in multiple survey seasons, following high rainfall events/seasons when conditions are considered optimal. Targeted surveys and monitoring surveys for EPBC listed fauna have been conducted during the periods recommended in relevant guidelines (DSEWPaC 2011a, d; EPA 2004a)
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	No significant disturbances affected the current assessment.
Intensity (in retrospect was the intensity adequate).	No	The survey intensity was adequate, all habitat types were surveyed systematically or opportunistically, and the majority of species expected to occur were recorded.
Completeness (e.g. was relevant area fully surveyed).	No	The study area was comprehensively surveyed.

Constraint	Relevant (yes/no)	Comment
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 (see Table 3.9 for competencies). There were no resource issues encountered.
Remoteness and/or access problems.	No	All areas were reasonably accessible. Opportunistic surveys and the use of other survey techniques, such as the use of long-term motion cameras, allowed relatively inaccessible areas to be surveyed adequately. Helicopter use also permitted sampling in remote locations within the study area.
Availability of contextual (e.g. biogeographic) information on the region).	No	Sufficient contextual information was available on the Pilbara region and the study area.
Efficacy of sampling methods (i.e. any groups not sampled by survey methods).	No	Survey methods were suitable to record all terrestrial vertebrate fauna groups. Systematic sampling of reptiles, frogs, trappable mammals and birds was undertaken throughout the study area in the majority of identified fauna habitats. Extensive opportunistic sampling has also permitted fish, and many additional mammals, reptiles, frogs and birds to be sampled throughout. No additional vertebrate fauna groups occur within the study area.

5 CONCLUSION

The main conclusions from this study are as follows:

- A total of 19 vertebrate fauna assessments have been conducted within or overlapping the study area. Only data from sites located within the study area was used during this assessment. These previous surveys include:
    - Solomon South Project (Outback Ecology 2014)
    - Mt Macleod Project (*ecologia* 2013b)
    - Stingray Project (*ecologia* 2013e)
    - Investigator Project (*ecologia* 2013a)
    - Solomon Mine Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013c)
    - Solomon Mine Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014a)
    - Solomon Mine Conservation Significant Fauna Monitoring (2014) (*ecologia* 2014b)
    - Mt Macleod Project (Rapallo 2011)
    - Solomon Project – Firetail (Ecoscape 2010d)
    - Solomon Project – Kings Area (*ecologia* 2010)
    - Solomon Project – Airstrip (Ecoscape 2010a)
    - Solomon Project – Mine (Coffey 2011a)
    - Solomon Project – Mine (Coffey 2008)
    - Central Pilbara Project – Mine (*ecologia* 2011b)
    - Solomon Rail Conservation Significant Fauna Monitoring (2012) (*ecologia* 2013d)
    - Solomon Rail Conservation Significant Fauna Monitoring (2013) (*ecologia* 2014c)
    - Solomon Rail Conservation Significant Fauna Monitoring (2014) (*ecologia* in prep.)
    - Solomon Project – Rail (Coffey 2011b)
    - Central Pilbara Project – Rail (data from sites within 100 km) (*ecologia* 2012a)
- A Level 2 vertebrate fauna survey was conducted between 22 April and 4 May 2014, with a total of 16 systematic trapping sites established, to cover any areas not adequately surveyed previously. The Level 2 survey was completed by a targeted conservation significant fauna conducted 10 weeks after the Level 2 survey (1 - 11 July 2014), with 8 sites totalling 200 cage traps targeting Northern Quoll and 30 SM2Bat sites targeting Pilbara Leaf-nosed Bat. 39 motion cameras were left in situ between surveys in habitat suitable for Northern Quoll and Pilbara Olive Python
- Survey effort within the study area during the current and previous surveys included the following; 1,120 pitfall trap nights; funnel trap nights; 22,550 pitfall trap nights; 32,645 funnel trap nights; 26,905 elliott trap nights; 12,614 cage trap nights; 306 were spent surveying for birds; 386 hours were spent on opportunistic diurnal searching; 67,861 hours of camera trapping was analysed; and 3,244.5hours of SM2BAT recordings were analysed to determine bat assemblage and distribution.
- Previous survey effort within the study area was the following; 16 trapping grids were open for seven trap nights; 1,120 pitfall trap nights, 2,240 funnel trap nights, 1,120 elliott trap nights; 1,672 cage trap nights; 36 hours were spent surveying for birds; 17.5 hours were spent on opportunistic diurnal searching; 63,840 hours of motion camera trapping was

analysed; and, 636 hours of recordings were analysed to determine bat assemblage and distribution.

- A total of 11 broad-scale fauna habitats were identified and described within the study area. Each habitat type and the precentage of their extent within the study area are following:
    - Plain (stony gibber) (includes lower slopes and midslopes) (45.4%);
    - Hilltops/ridges/plateaux (12.5%);
    - Plain (Alluvial) (11.3%);
    - Plain (Cracking clay) (10.3%);
    - Hummock grassland (6.0%);
    - Shrubland (Open) (5.0%);
    - Woodland (Open Eucalypt) (3.3%);
    - Plain (stony calcrete) (3.0%);
    - Drainage line/River/Creek (Major) (2.2%);
    - Gorges and Gullies (1.0%); and
    - Tussock grassland (on loam/clay) (<0.1%).

  Regional habitat mapping from projects adjacent to the study area were also consolidated.
- Species accumulation curves (SACs) were calculated for mammals, birds and reptiles to test the adequacy of survey effort in the study area. Analysis of the data produced steady SACs for all three groups, each nearing the asymptotic plateau, indicating that sufficient surveys have been completed to detect the majority of fauna species present within the study area
- The literature review identified 30 vertebrate fauna species, listed as either conservation significant (EPBC Act, WC Act Schedule 1) or priority fauna (DPaW Priority list), that could potentially occur within the study area; nine mammal species, 17 bird species and four reptile species. An assessment of their likelihood of occurrence was completed, based on the categories outlined in section 3.4, with the results summarised in Table 4.6.
- A total of 16 of these listed species were recorded during the current survey, and from surveys conducted previously which overlap the study area. A further three species are assessed as having a high likelihood of occurrence and one species as having a medium likelihood of occurrence. The remaining 11 species are considered to have a low likelihood of occurrence
- Three conservation significant fauna species have been recorded within the study area:
    - Northern Quoll – EPBC Act Endangered, WC Act Schedule 1 (Endangered);
    - Pilbara Leaf-nosed Bat – EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable) (foraging only); and
    - Pilbara Olive Python – EPBC Act Vulnerable, WC Act Schedule 1 (Vulnerable).

  Habitats that are significant to these species have been mapped to allow accurate impact assessments to be completed.
- Based on the results of the combined surveys within the study area, three habitat types are considered suitable for three EPBC Act threatened fauna known to occur within the study area:

- The Gorges/Gullies habitat type covers 1.0% of the sudy area and 0.6% of the area within 30 km of study area. It is considered suitable habitat for:
  - Northern Quoll (denning and foraging)
  - Pilbara Leaf-nosed Bat (foraging)
  - Pilbara Olive Python (winter shelter and foraging)
- The Drainage line/River/Creek (Major) covers 2.1% of the sudy area and 1.1% of the area within 30 km of study area, and is considered suitable habitat for:
  - Northern Quoll (dispersal and foraging)
  - Pilbara Leaf-nosed Bat (foraging)
  - Pilbara Olive Python (dispersal and foraging)
- The Hilltops/ridges/plateaux habitat type covers 12.5% of the sudy area and 5.6% of the area within 30 km of study area. It is considered suitable habitat for:
  - Northern Quoll (dispersal and foraging)
  - Pilbara Olive Python (dispersal and foraging)

- No significant survey limitations were encountered during the current survey. By consolidating the results of all previous surveys, survey limitations caused by survey timing, climate etc have been minimised as the surveys conducted within the study area have occurred over a 5 year period, during all seasons and using a wide variety of sampling methodology.

This page has been left blank intentionally

6 REFERENCES

Anstee, S. D. 1996. Use of external mound structures as indicators of the presence of the Pebble-mound Mouse, *Pseudomys chapmani*, in mound systems. Wildlife Research 23: 429-434.

Anstee, S. D., Roberts, J. D., and O'Shea, J. E. 1997. Social structure and patterns of movement of the Western Pebble-mouse, *Pseudomys chapmani*, at Marandoo, Western Australia. . Wildlife Research 24: 295-305.

Armstrong, K. N. 2001. The distribution and roost habitat of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia. Wildlife Research 28: 95-104.

Armstrong, K. N. 2008. Pilbara Leaf-nosed Bat, *Rhinonicteris aurantia*. pp. 470-471 *in* Van Dyck, S., and Strahan, R., eds. The Mammals of Australia. 3rd edition. Reed New Holland, Sydney.

Armstrong, K. N. and Anstee, S. D. 2000. The ghost bat in the pilbara: 100 years on. Australian Mammalogy 22: 93-101.

Ayers, D., Nash, S., and Bagget, K. 1996. Threatened Species of Western NSW. National Parks and Wildlife Service, Hurstville.

Beard, J. S. 1975. The vegetation of the Pilbara region. Explanatory notes to map sheet 5 of vegetation survey of Western Australia: Pilbara. University of Western Australia Press, Nedlands.

Belbin, L. 1989. PATN Technical Reference. CSIRO Division of Wildlife and Ecology, Canberra.

Bettenay, E., Churchward, H. M., and McArthur, W. M. 1967. Atlas of Australian Soils – Explanatory Data for Sheet 6: Meekatharra – Hamersley Range Area *in* Commonwealth Scientific and Industrial Research Organisation (CSIRO), and Melbourne University Press, eds. Cambridge University Press, London and New York.

Biologic Environmental. 2013. The Edge Level 2 Fauna Assessment. Prepared for Fortescue Metals Group.

Biota Environmental Sciences. 2005. Fauna habitats and fauna assemblage of the Brockman Syncline 4 project, near Tom Price. Unpublished report for Hamersley Iron Pty Ltd.

Biota Environmental Services. 2008. Marandoo Mine Phase 2 Seasonal Fauna Survey. Unpublished report for Rio Tinto Iron Ore Pty Ltd.

Biota Environmental Sciences. 2009. West Turner Syncline Section 10 Development Two-Phase Fauna Survey. Unpublished report for Pilbara Iron Company.

Biota Environmental Sciences. 2011. Western Range Two-Phase Fauna Survey. Unpublished report for Rio Tinto Iron Ore Pty Ltd. Unpublished report for Rio Tinto Iron Ore Pty Ltd.

Boland, C. R. J. 2004. Breeding biology of Rainbow Bee-eaters (*Merops ornatus*): a migratory, colonial, cooperative bird. The Auk 121(3): 811-823.

BoM. 2014. Bureau of Meteorology. Available at: http://www.bom.gov.au. Commonwealth of Australia, Canberra.

Braithwaite, R. W. and Griffiths, A. 1994. Demographic variation and range contraction in the northern quoll *Dasyurus hallucatus* (Marsupialia: Dasyuridae). Wildlife Research 21: 203-217.

Bunge, J. and Fitzpatrick, M. 1993. Estimating the number of species: A review. Journal of the American Statistical Association 88: 364-373.

Burbidge, A. A. and Johnson, P. M. 2008. Spectacled Hare-wallaby, *Lagorchestes conspicillatus.* pp. 314-316 *in* van Dyck, S., and Strahan, R., eds. The Mammals of Australia. 3rd edition. Reed New Holland, Sydney.

Burbidge, A. A., McKenzie, N. L., and Fuller, P. J. 2008. Long-tailed Dunnart, *Sminthopsis longicaudata*. pp. 148-150 *in* Van Dyck, S., and Strahan, R., eds. The Mammals of Australia. 3rd edition. Reed New Holland, Sydney.

Christidis, L. and Boles, W. E. 2008. Systematics and Taxonomy of Australian Birds. CSIRO Publishing, Collingwood.

Churchill, S. 1998. Australian Bats. Reed New Holland, Sydney.

Clarke, K. R. 1993. Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18: 117-143.

Coffey Environments. 2008. Level 2 Terrestrial Vertebrate Fauna Assessment for the Solomon Project. Prepared for Fortescue Metals Group Ltd.

Coffey environments. 2010a. Level 1 Vertebrate Fauna Assessment - Solomon Rail Project. Unpublished Report for Fortescue Metals Group Ltd.

Coffey Environments. 2010b. Solomon Regional Flora Assessment. Unpublished Report for Fortescue Metals Group Ltd.

Coffey Environment. 2011a. Targeted Surveys - Northern Quolls and Pilbara Leaf-nosed Bats. Unpublished report for Fortescue Metals Group.

Coffey Environments. 2011b. Targeted Surveys - Northern Quolls, Mulgara and Pilbara Olive Pythons at the Solomon Rail Project. Unpublished report for Fortescue Metals Group.

Coffey Environments. 2013. Level 2 Vertebrate Fauna Assessment of the Turee Exploration Tenements. Unpublished report for Fortescue Metals Group Ltd.

Cogger, H. G. 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney.

Colwell, R. K. 2009. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.

Colwell, R. K. and Coddington, J. A. 1994. Estimating terrestrial biodiversity through extrapolation. Philosophical Transactions of the Royal Society of London, B Biological Sciences 345(1311): 101-118.

Department of Environmental Protection. 2000. Bush Forever Volume 2: Directory of Bush Forever Sites. Western Australia, Department of Environment Protection, Perth.

Department of Environment, Water, Heritage and the Arts. 2008a. Approved Conservation Advice for *Lagorchestes conspicillatus conspicillatus*, Spectacled Hare-wallaby (Barrow Island). Environment Protection and Biodiversity Conservation Act 1999, Canberra.

Department of Environment, Water, Heritage and the Arts. 2008b. Approved Conservation Advice for *Liasis olivaceus barroni* (Olive Python-Pilbara subspecies). Environment Protection and Biodiversity Conservation Act 1999, Canberra.

Department of Environment, Water, Heritage and the Arts. 2008c. Approved Conservation Advice for *Rhinonicteris aurantius* (Pilbara form) (Pilbara Leaf-nosed Bat). Environment Protection and Biodiversity Conservation Act 1999, Canberra.

Department of Environment, Water, Heritage and the Arts. 2010. Survey Guidelines for Australia's Threatened Bats.

Dickman, C. R., Letnic, M., and Mahon, P. S. 1999a. Population dynamics of two species of dragon lizards in arid Australia: the effects of rainfall. Oecologia 119: 357-366.

Dickman, C. R., Mahon, P. S., Masters, P., and Gibson, D. F. 1999b. Long-term dynamics of rodent populations in arid Australia: the influence of rainfall. Wildlife Research 26(4): 389-403.

Doughty, P. and Oliver, P. M. 2011. A new species of Underwoodisaurus (Squamat: Gekkota: Carphodactylidae from the Pilbara region of Western Australia). Zootaxa 3010: 20-30.

Department of Parks and Wildlife. 2014. NatureMap: Mapping Western Australia's Biodiversity.

Department of Sustainability, Environment, Water, Population and Communities. 2011a. EPBC Act 1999 referral guidelines for the endangered northern quoll, *Dasyurus hallucatus*.

Department of Sustainability, Environment, Water, Population and Communities. 2011b. Survey Guidelines for Australia's Threatened Bats.

Department of Sustainability, Environment, Water, Population and Communities. 2011c. Survey guidelines for Australia's threatened mammals.

Department of Sustainability, Environment, Water, Population and Communities. 2011d. Survey Guidelines for Australia's Threatened Reptiles.

DSEWPaC. 2012. Interim Biogeographic Regionalisation for Australia (IBRA), Version 7. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.

ecologia Environment. 2009. Roy Hill - Vertebrate Fauna Assessment. Unpublished Report for Hancock Prospecting Pty Ltd.

ecologia Environment. 2010. Vertebrate fauna assessment: Solomon project: Kings area. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2011a. Central Pilbara Project: Mine, Targeted Conservation Significant Fauna Survey. Unpublished Report for Fortescue Metals Group Ltd.

ecologia Environment. 2011b. Central Pilbara Project: Mine. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group. Unpublished report for Fortescue Metals Group Ltd.

ecologia Environment. 2011c. Greater Nammuldi Irrigated Agriculture Project: Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Rio Tinto.

ecologia Environment. 2012a. Central Pilbara Project: Rail. Level 2 vertebrate fauna assessment. Unpublished report for Fortescue Metals Group Ltd.

ecologia Environment. 2012b. Western Hub project - Delphine. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2012c. Western Hub project - Eliwana and Flying Fish. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2012d. Western Hub project - Mt Farquhar. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2013a. Investigator Vertebrate Fauna Survey 2013. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2013b. Mt Macleod Vertebrate Fauna Survey 2013. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2013c. Solomon Mine Annual Monitoring. Conservation Significant Fauna Monitoring Report 2012. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2013d. Solomon Rail Annual Monitoring. Conservation Significant Fauna Monitoring Report 2012/2013. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2013e. Stingray Vertebrate Fauna Survey 2013. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2013f. Western Hub project - Delphine. Level 2. Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2013g. Western Hub project - Eliwana and Flying Fish. Level 2 Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group.

ecologia Envrionment. 2014a. Solomon Mine Annual Monitoring. Conservation Significant Fauna Monitoring Report 2013. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2014b. Solomon Mine Annual Monitoring. Conservation Significant Fauna Monitoring Report 2014. Unpublished report for Fortescue Metals Group.

ecologia Environment. 2014c. Solomon Rail Annual Monitoring. Conservation Significant Fauna Monitoring Report 2013. Unpublished report for Fortescue Metals Group. Ltd, U. R. f. F. M. G.

ecologia Environment. in prep. Hamersley Line Annual Monitoring. Conservation Significant Fauna Monitoring Report 2014. Unpublished Report for Fortescue Metals Group Ltd. *ecologia* Environment

Ecoscape (Australia) Pty Ltd. 2010a. Solomon Project - Airstrip Fauna Assessment. Unpublished report for Fortescue Metals Group.

Ecoscape Australia. 2010b. Solomon Project – Rail Camp Sites 1, 2 and 3: Fauna Assessment. Prepared by Ecoscape (Australia) Pty Ltd for Fortescue Metals Group Ltd.

Ecoscape Australia. 2010c. Solomon Project – Rail Re-alignment: Fauna Assessment. Prepared by Ecoscape (Australia) Pty Ltd for Fortescue Metals Group Ltd, Unpublished report for Fortescue Metals Group.

Ecoscape Australia. 2010d. Vertebrate Fauna and Fauna Habitat Assessment for the Firetail Project. Prepared for Fortescue Metals Group Ltd by Ecoscape (Australia) Pty Ltd.

Ecoscape (Australia). 2011. Pilbara Iron Ore Project - Blacksmith Vertebrate Fauna and Short Range Endemic Survey. Flinders Mine Limited.

Ecoscape. 2012a. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Delphine. Unpublished report for Fortescue Metals Group.

Ecoscape. 2012b. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Eliwanna. Unpublished report for Fortescue Metals Group.

Ecoscape. 2012c. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Flying Fish. Unpublished report for Fortescue Metals Group.

Ecoscape. 2012d. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Raven. Unpublished report for Fortescue Metals Group.

Ecoscape Australia. 2013. Level 1 Vegetation, Flora and Fauna Assessment, and Targeted Conservation Significant Flora and Fauna Survey: Mt Macleod West. Unpublished report for Fortescue Metals Group.

Ehmann, H. and Watson, M. 2008. Grey Falcon, *Falco hypoleuca*. South Australian Arid Lands Natural Resources Management Board, South Australia.

Environmental Protection Authority. 2002. Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection. Environmental Protection Authority, Perth.

Environmental Protection Authority. 2004a. Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.

Environmental Protection Authority. 2004b. Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. Environmental Protection Authority, Perth.

Environmental Protection Authority and Department of Environment and Conservation. 2010. Technical Guide - Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment. Technical report for the Environmental Protection Authority and the Department of Environment and Conservation.

ESCAVI. 2003. Australian Vegetation Attribute Manual: National Vegetation Information System (NVIS). Executive Steering Committee for Australian Vegetation Information System (ESCAVI), Australian Government Department of Environment and Heritage, Canberra.

Frith, A. J. 1976. Reader's Digest Complete Birds of Australia. Reader's Digest, Sydney.

Garnett, S. T. and Crowley, G. M. 2000. The Action Plan for Australian Birds. Environment Australia, Canberra.

Gaston, K. J. 1996. Species richness: measure and measurement. Biodiversity, a biology of number and difference. Blackwell Science, Cambridge.

Hammer, Ø., Harper, D. A. T., and Ryan, P. D. 2001. PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica 4(1).

Higgins, P. J. and Davies, S. J. J. F. 1996. Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons. Oxford University Press, Melbourne.

Johnstone, R. E. and Storr, G. M. 1998. Handbook of Western Australian Birds, Volume I - Non-Passerines (Emu to Dollarbird). Western Australian Museum, Perth.

Johnstone, R. E. and Storr, G. M. 2004. Handbook of Western Australian Birds, Volume II - Passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth.

Kendrick, P. 1995. Vertebrate Fauna of the Marandoo to Great Northern Highway Road. Unpublished report for Main Roads Western Australia and CALM.

Kendrick, P. 2001a. Pilbara 2 (PIL2 - Fortescue Plains subregion). A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. Department of Conservation and Land Management, Perth, Western Australia.

Kendrick, P. 2001b. Pilbara 3 (PIL3 - Hamersley subregion). A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. Department of Conservation and Land Management, Perth, Western Australia.

Kendrick, P. and McKenzie, N. 2001. Pilbara 1 (PIL1 - Chichester subregion). A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions. Department of Conservation and Land Management, Perth, Western Australia.

Marchant, S. and Higgins, P. J. 1993. Handbook of Australian, New Zealand and Antarctic Birds. Oxford University Press, Melbourne.

Masters, P. 1993. The effects of fire-driven succession and rainfall on small mammals in spinifex grassland at Uluru National Park, Northern Territory. Wildlife Research 20: 803-813.

Maxwell, S., Burbidge, A. A., and Morris, K. D., eds. 1996. The 1996 Action Plan for Australian Marsupials and Monotremes. Wildlife Australia, Canberra.

Menkhorst, P. and Knight, F. 2011. *A Field Guide to the Mammals of Australia*. Oxford University Press, Melbourne.

Morcombe, M. 2000. Field Guide to Australian Birds. Steve Parish Publishing Pty Ltd, Archerfield, Australia.

Moro, D. and Kutt, A. S. 2008. Northern Short-tailed Mouse, *Leggadina lakedownensis*. pp. 583-584 *in* van Dyck, S., and Strahan, R., eds. The Mammals of Australia. Reed New Holland, Sydney.

Muir, B. G., ed. 1983. A Fauna Survey of the Hamersley Range National Park Western Australia. Bulletin No. 1. National Parks Authority of Western Australia.

National Health and Medical Research Council. 2004. Australian code of practice for the care and use of animals for scientific purposes. Canberra.

Ninox Wildlife Consulting. 1995. Vertebrate fauna of the northern transport corridor option. Unpublished report for Hamersley Iron Pty Ltd.

1999a. Threatened Species Information: Bush Stone-curlew *Burhinus grallarius* (Latham, 1801). Hurstville, NSW www.npws.nsw.gov.au,.

1999b. Flock Bronzewing *Phaps histrionica*. Hurstville, NSW. www.npws.nsw.gov.au.

Oakwood, M. 2008. Northern Quoll, *Dasyurus hallucatus*. pp. 57-59 *in* van Dyck, S., and Strahan, R., eds. The Mammals of Australia. 3rd edition. Reed New Holland, Sydney.

Olsen, J., Fuentes, E., Dykstra, R., and Rose, A. B. 2006. Male Peregrine Falcon *Falco peregrinus* fledged from a cliff-nest found breeding in a stick-nest. Australian Field Ornithology 23: 8-14.

Outback Ecology. 2014. Solomon South Terrestrial Vertebrate Fauna Assessment. Unpublished report for Fortescue Metals Group Ltd.

Pavey, C. 2006. Threatened Species of the Northern Territory: Long-tailed Dunnart (*Sminthopsis longicaudata*). Department of Natural Resources Environment and the Arts, Northern Territory.

Pearson, D. J. 2006. Giant pythons of the pilbara. Landscope 19: 32-39.

Rapallo Environment. 2011. Terrestrial Vertebrate Fauna Survey of the Mt Macleod Project Area. Unpublished report for Fortescue Metals Group Limited.

Richards, G. C., Hand, S., and Armstrong, K. N. 2008. Ghost Bat, *Macroderma gigas*. pp. 449-450 *in* van Dyck, S., and Strahan, R., eds. The Mammals of Australia. Reed New Holland, Sydney.

Schoenjahn, J. 2011. How scarce is the Grey falcon? Boobook 29(1): 24-25.

Schoenjahn, J. 2012. A hot environment and one type of prey: investigating why the Grey Falcon (*Falco hypoleucos*) is Australia's rarest falcon. Emu.

Shepherd, D. P., Beeston, G. R., and Hopkins, A. J. M. 2001. Native vegetation in Western Australia: Extent, type and status. Technical Report 249. Department of Agriculture, South Perth, Western Australia.

Shepherd, *et al.* 2002. Native Vegetation in Western Australia. Technical Report 249. Department of Agriculture, Western Australia, South Perth.

Simpson, K. and Day, N. 2004. Field Guide to the Birds of Australia. Penguin Group, Camberwell.

Start, A. N. 2008. Western Pebble-mouse, *Pseudomys chapmani*. pp. 621-622 *in* van Dyck, S., and Strahan, R., eds. The Mammals of Australia. Reed New Holland, Sydney.

Storr, G. M., Smith, L. A., and Johnstone, R. E. 1983. Lizards of Western Australia II: Dragons and Monitors. Western Australian Museum, Perth.

Storr, G. M., Smith, L. A., and Johnstone, R. E. 1990. Lizards of Western Australia III: Geckos and Pygopods. Western Australian Museum, Perth.

Storr, G. M., Smith, L. A., and Johnstone, R. E. 1999. Lizards of Western Australia I: Skinks. Western Australian Museum, Perth.

Storr, G. M., Smith, L. A., and Johnstone, R. E. 2002. Snakes of Western Australia. Western Australian Museum, Perth.

Tidemann, C. R., Priddel, D. M., Nelson, J. E., and Pettigrew, J. D. 1985. Foraging behaviour of the Australian Ghost Bat, *Macroderma gigas* (Microchiroptera: Megadermatidae). Australian Journal of Zoology 33: 705-713.

Toop, J. 1985. Habitat requirements, survival strategies and ecology of the ghost bat, *Macroderma gigas* Dobson (Microchiroptera, Megadermatidae) in central coastal Queensland. Macroderma 1(2): 37-41.

Tyler, M. J. and Doughty, P. 2009. Field Guide to Frogs of Western Australia. Western Australian Museum, Perth.

van Dyck, S. and Strahan, R. 2008. *The Mammals of Australia*. Reed New Holland, Sydney.

Van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A., and Hennig, P. 2004. An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No. 92. Department of Agriculture, Western Australia.

Wilson, S. and Swan, G. 2010. *A Complete Guide to Reptiles of Australia*. New Holland Publishers, Sydney.

This page has been left blank intentionally

APPENDIX A EXPLANATION OF CONSERVATION CODES

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

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

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

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

Appendix A3 Definition of DPaW Threatened and Priority Fauna Codes

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

This page has been left blank intentionally

APPENDIX B DAILY WEATHER DATA DURING LEVEL 2 AND TARGETED SURVEYS

Level 2 Survey

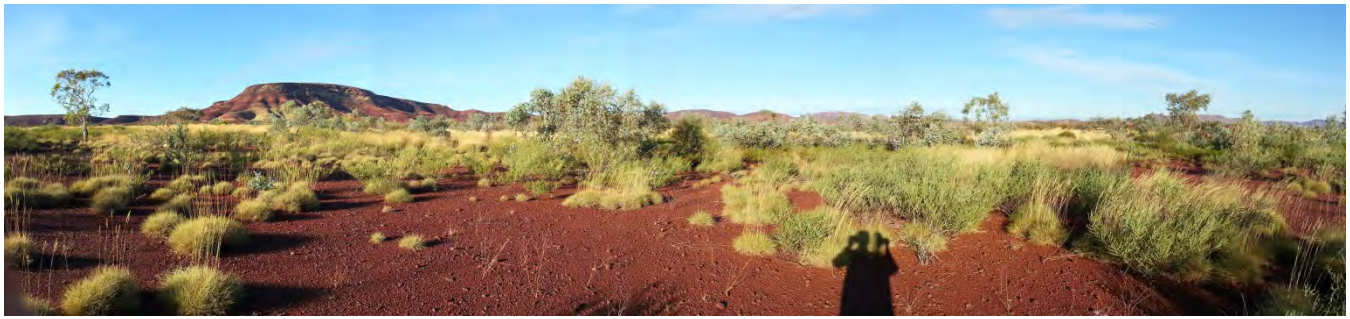
Date	Mean Minimum Temperature (°C)	Mean Maximum Temperature (°C)	Rainfall (mm)
22 April 2014	20.4	36.0	0.0
23 April 2014	19.8	35.7	0.0
24 April 2014	21.3	36.2	0.0
25 April 2014	20.7	35.7	0.0
26 April 2014	22.8	33.7	0.0
27 April 2014	20.9	33.8	0.0
28 April 2014	22.2	34.4	3.6
29 April 2014	20.7	30.0	0.0
30 April 2014	16.4	31.0	0.0
1 May 2014	20.3	33.2	0.0
2 May 2014	19.2	30.4	0.0
3 May 2014	17.5	28.4	0.0
Mean	20.2	33.0	0.3

NQ Targeted Survey

Date	Mean Minimum Temperature (°C)	Mean Maximum Temperature (°C)	Rainfall (mm)
1 July 2014	8.5	25.0	0.0
2 July 2014	9.0	25.3	0.0
3 July 2014	8.4	26.2	0.0
4 July 2014	8.5	26.4	0.0
5 July 2014	9.0	26.7	0.0
6 July 2014	8.2	26.5	0.0
7 July 2014	7.5	27.4	0.0
8 July 2014	14.7	25.8	0.0
9 July 2014	11.8	22.1	0.0
10 July 2014	9.8	23.2	0.0
11 July 2014	6.4	24.0	0.0
Mean	9.3	25.3	0.0

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

APPENDIX C SURVEY SITE DESCRIPTIONS

Vegetation and Fauna Habitat Description	Site Photo
SLM 01 Spinifex hummock grassland with scattered *Corymbia* sp. trees over an open layer of mixed shrubs over spinifex hummock grassland on firm red clay with continuous pebble gravel. Extensive areas around the site were recently burnt (< 1 year) although the site itself appeared unburnt for at least 5 years. Little wood and leaf litter were present. Habitat type: Stony spinifex plain and hillslopes	
SLM 02 *Eucalyptus* woodland over a mixed tall shrubland over tussock grassland of grazed Buffel (**Cenchrus ciliaris*) on weak red loamy clay, with river gravel. The site had been very recently burnt (< 1 year). Large pools of water evident in 5 to 30 m wide major creek bed. Moderate leaf litter and wood litter. Habitat type: Major Drainage line	
SLM 03 Open spinifex hummock grassland with low mixed shrubs and *Eucalyptus* and *Corymbia* spp. scattered trees on firm red loam with a surface layer of continuous pebble and stone gravel. Unburnt for > 5 years. Sparse leaf and wood litter present. Habitat type: Hillstops, hillslopes, ridges and cliffs	

SLM 04 Spinifex open hummock grassland with patches of Acacia shrubs and occasional *Eucalyptus* spp. trees on firm red loamy clay with continuous pebble gravel. Sparse wood and leaf litter under shrubs and trees. Habitat type: Stony spinifex plain and hillslopes	
SLM 05 Mulga very open trees over open Mulga and other *Acacia* spp. shrubs over Spinifex open hummock grassland on firm loamy clay soil with continuous pebble and stone gravel. Sparse wood and leaf litter under shrubs and trees. Habitat type: Mixed shrubland on stony plain	
SLM 06 Spinifex hummock grassland with *Corymbia* spp. scattered trees and mixed low open shrubland on firm red loam with continuous pebble gravel. Fire age > 5 years. Sparse leaf and wood litter under shrubs and trees. Habitat type: Stony spinifex plain and hillslopes	

SLM 07 Tussock grassland on firm red cracking clay, with no pebble gravel. Site grazed and with some vehicle tracks nearby, but otherwise in good condition. No leaf and wood litter. Habitat type: Cracking Clay	
SLM 08 Tussock grassland on firm red-brown cracking clay, with no pebble gravel. Site grazed and with some vehicle tracks nearby, but otherwise in good condition. No leaf and wood litter. Habitat type: Cracking Clay	
SLM 09 *Triodia epactia* hummock grassland with Mulga and *Corymbia hamersleyana* isolated low trees and *Acacia bivenosa, A. pruinocarpa* and *A. tumida* mixed open shrubland, on firm red-brown loamy clay soil with 10-30% pebble cover. Sparse wood and leaf litter under shrubs and trees. Habitat type: Hummock grassland on loam	

SLM 10 *Acacia wanyu, A. synchronicia* and *Melaleuca* sp. high open shrubland with *Eucalyptus victrix* isolated low trees over *Triodia epactia* open hummock grassland and **Cenchrus ciliaris* open tussock grassland on firm red-brown soil with 30-70% gravel/pebble cover. Calcrete rocky base. Habitat type: Stony Calcrete plain	
SLM 11 *Eucalyptus victrix* and Mulga low woodland over Mulga and *Acacia synchronicia* high open shrubland over **Cenchrus ciliaris* very open tussock grassland on firm red-brown loamy clay with surface crust and no rocks. Dispersed eucalyptus leaf litter and sparse wood litter. Habitat type: Major Drainage line	
SLM 12 *Triodia epactia* open hummock grassland with *Acacia xiphophylla* scattered tall shrubs and isolated low trees on firm red-brown loamy clay with continuous pebble gravel. Unburnt for > 5 years. Sparse wood and leaf litter accumulated under shrubs/trees. Habitat type: Alluvial/floodplain with acacia (mulga) woodland	

SLM 13 *Triodia wiseana* open hummock grassland with *Corymbia* sp. scattered low trees and *Acacia ancistrocarpa, A. arida* and *A. pruinocarpa* high open shrubland on firm red-brown loamy clay with continuous pebble gravel. Unburnt for > 5 years. Fairly sparse leaf litter under shrubs/trees and sparse wood litter. Habitat type: Stony spinifex plain and hillslopes	
SLM 14 Mulga and *Acacia citrinoviridis* low open woodland over *Acacia synchronicia* high open shrubland over *Chrysopogon fallax* and *Eragrostis* spp. tussock grassland on firm red loamy clay, with some surface cracks and common calcrete stones. Unburnt for > 5 years. Fairly sparse leaf litter under shrubs/trees and sparse wood litter. Habitat type: Cracking clay	

SLM 15 *Triodia epactia* hummock grassland with *Corymbia hamersleyana* scattered low trees and *Acacia* spp. and *Hakea lorea* scattered shrubs on firm red-brown soil with pebble gravel. Unburnt for > 5 years. Minimal leaf litter under shrubs/trees and sparse wood litter. Habitat type: Stony Calcrete plain	
SLM 16 *Triodia epactia* very open hummock grassland with *Corymbia hamersleyana* scattered low trees, *Acacia inaequilatera* and *A. atkinsiana* very open shrubland on firm red-brown loamy clay with continuous pebble gravel. Moderately recently burnt (1-5 years). Sparse leaf litter under trees/shrubs and sparse wood litter. Habitat type: Stony spinifex plain and hillslopes	

This page has been left blank intentionally

APPENDIX D REGIONAL FAUNA DATA

Please see Appendix D on attached CD

This page has been left blank intentionally

APPENDIX E FAUNA RECORDED DURING THIS SURVEY

Appendix F.1 - Mammals

Family and Species	Common name	EPBC Act	WC Act	DPaW	SLM 1	SLM 2	SLM 3	SLM 4	SLM 5	SLM 6	SLM 7	SLM 8	SLM 9	SLM 10	SLM 11	SLM 12	SLM13	SLM 14	SLM 15	SLM 16	Opportunistic
DASYURIDAE																					
Dasykaluta rosamondae	Little Red Kaluta				1			6								4	9				1
Ningaui timealeyi	Pilbara Ningaui				3	2	5	4	1	7			5	4		1	3		2		
Planigale sp. (prev. *maculata*)	Common Planigale				2		1	1			3	3									
Sminthopsis macroura	Stripe-faced Dunnart										3	4	1		1			3		1	
MACROPODIDAE																					
Macropus rufus	Red Kangaroo																		1		2
PTEROPODIDAE																					
Pteropus alecto	Black Flying-fox										2*										
EMBALLONURIDAE																					
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat					R	R		R	R					R	R				R	R
Taphozous georgianus	Common Sheathtail Bat								R	R											R
VESPERTILIONIDAE																					
Chalinolobus gouldii	Gould's Wattled Bat				R	R		R	R	R	R		R	R	R	R				R	R
Scotorepens greyii	Little Broad-nosed Bat					R		R		R			R	R	R	R					R
Vespadelus finlaysoni	Finlayson's Cave Bat					R	R	R	R	R			R	R	R	R				R	R
MOLOSSIDAE																					
Chaerophon jobensis	Northern Freetail Bat				R	R	R		R	R	R			R	R	R				R	R
Mormopterus beccarii	Beccari's Freetail Bat				R	R	R	R												R	R
Tadarida australis	White-striped Freetail Bat																				R
MURIDAE																					
Leggadina lakedownensis	Short-tailed Mouse			P4							3	2									
Pseudomys delicatulus	Delicate Mouse					1													1		
Pseudomys desertor	Desert Mouse				1	2	2	2	3				3			3	3				
Pseudomys hermannsburgensis	Sandy Inland Mouse					1		1		2				1			1		3	5	
Zyzomys argurus	Common Rock-rat						3			1											
CANIDAE																					
Canis lupus dingo	Dingo																				S
INTRODUCED MAMMALS																					
Mus musculus	House Mouse					4	1	1										1	1	4	
Felis catus	Cat																				1
Bos taurus	Cow																				25

R recorded
* remains

Appendix F.2 – Birds

Family and Species	Common Name	EPBC Act	WC Act	DPaW	SLM 1	SLM 2	SLM 3	SLM 4	SLM 5	SLM 6	SLM 7	SLM 8	SLM 9	SLM 10	SLM 11	SLM 12	SLM 13	SLM 14	SLM 15	SLM 16	Opportunistic
CASUARIIDAE																					
Dromaius novaehollandiae	Emu																				8
COLUMBIDAE																					
Phaps chalcoptera	Common Bronzewing									1								1	1		2
Ocyphaps lophotes	Crested Pigeon				20			12	23			3	1	2	6	7	1	2		101	1
Geophaps plumifera	Spinifex Pigeon					1															12
Geopelia cuneata	Diamond Dove									1					6						
Geopelia striata	Peaceful Dove					3		8							2						
EUROSTOPODIDAE																					
Eurostopodus argus	Spotted Nightjar																				3
AEGOTHELIDAE																					
Aegotheles cristatus	Australian Owlet-nightjar				1					1											
ARDEIDAE																					
Ardea pacifica	White-necked Heron																				1
ACCIPITRIDAE																					
Elanus axillaris	Black-shouldered Kite																				1
Haliastur sphenurus	Whistling Kite					3		2			2		1	1		1	1	1	2	3	1
Milvus migrans	Black Kite												3							1	
Accipiter fasciatus	Brown Goshawk										1			1							
Accipiter cirrocephalus	Collared Sparrowhawk																				1
Circus assimilis	Spotted Harrier										1	1	2			2					1
Aquila audax	Wedge-tailed Eagle																			2	1
Hieraaetus morphnoides	Little Eagle																				1
FALCONIDAE																					
Falco cenchroides	Nankeen Kestrel										2	1								3	
Falco berigora	Brown Falcon				1					1											2
Falco longipennis	Australian Hobby																				1
OTIDIDAE																					
Ardeotis australis	Australian Bustard			P4																	8
BURHINIDAE																					
Burhinus grallarius	Bush Stone-curlew			P4																	2
CHARADRIIDAE																					
Vanellus tricolor	Banded Lapwing																				1
TURNICIDAE																					
Turnix velox	Little Button Quail												1								1
CACATUIDAE																					
Eolophus roseicapillus	Galah					8			7					29	3			2		31	
Cacatua sanguinea	Little Corella							12						8						18	
Nymphicus hollandicus	Cockatiel							7		2	18			20	4	23	2	3	3	13	
PSITTACIDAE																					
Barnardius zonarius	Australian Ringneck					9	2		4	3			1	7	7				7		
Melopsittacus undulatus	Budgerigar					23		55	16	10				8	11	15			5	12	
HALCYONIDAE																					
Dacelo leachii	Blue-winged Kookaburra					4															
Todiramphus pyrrhopygius	Red-backed Kingfisher								1	2											1
MEROPIDAE																					
Merops ornatus	Rainbow Bee-eater	M	S3				1		5	2			3		21	2	1		1	4	3
PTILONORHYNCHIDAE																					
Ptilonorhynchus guttatus	Western Bowerbird																				1
MALURIDAE																					
Malurus leucopterus	White-winged Fairy-wren				6			4	1				1			3	2	5	4	10	
Malurus lamberti	Variegated Fairy-wren				11	25		9	15								3		8	4	2
Amytornis striatus	Striated Grasswren						4														1

Family and Species	Common Name	EPBC Act	WC Act	DPaW	SLM 1	SLM 2	SLM 3	SLM 4	SLM 5	SLM 6	SLM 7	SLM 8	SLM 9	SLM 10	SLM 11	SLM 12	SLM 13	SLM 14	SLM 15	SLM 16	Opportunistic
ACANTHIZIDAE																					
Pyrrholaemus brunneus	Redthroat																		1		
Smicrornis brevirostris	Weebill				16	85	3	8	30	12			4	8		2	9	5	13	11	7
Gerygone fusca	Western Gerygone								5												
Acanthiza uropygialis	Chestnut-rumped Thornbill								10					1				6			
Acanthiza apicalis	Inland Thornbill								3												
PARDALOTIDAE																					
Pardalotus rubricatus	Red-browed Pardalote						1												2		1
Pardalotus striatus	Striated Pardalote					13															
MELIPHAGIDAE																					
Certhionyx variegatus	Pied Honeyeater																				1
Lichenostomus virescens	Singing Honeyeater				7			11	18	5			10	4		5	6	2	6	40	5
Lichenostomus keartlandi	Grey-headed Honeyeater				13		24	1		30											
Lichenostomus penicillatus	White-plumed Honeyeater					23								17	90	1	11	6	36		7
Manorina flavigula	Yellow-throated Miner					6	3	4	8	13						1	5	2	5	10	12
Acanthagenys rufogularis	Spiny-cheeked Honeyeater							1	3									1			
Conopophila whitei	Grey Honeyeater								3												1
Epthianura tricolor	Crimson Chat																			10	
Sugomel niger	Black Honeyeater								1												
Lichmera indistincta	Brown Honeyeater					3											8				1
Melithreptus gularis	Black-chinned Honeyeater				1		1			3											
POMATOSTOMIDAE																					
Pomatostomus temporalis	Grey-crowned Babbler					16			12					9							3
CAMPEPHAGIDAE																					
Coracina maxima	Ground Cuckoo-shrike																				3
Coracina novaehollandiae	Black-faced Cuckoo-shrike				2	1			6	2				2	3			1	1	2	2
Lalage sueurii	White-winged Triller								1								1				
PACHYCEPHALIDAE																					
Pachycephala rufiventris	Rufous Whistler					3		3	5	4			3	5	6	2	3	1	10	1	1
Colluricincla harmonica	Grey Shrike-thrush				5				2	3					1						
Oreoica gutturalis	Crested Bellbird				3		1	4	9	8					5	2	1	1	5	8	2
ARTAMIDAE																					
Artamus personatus	Masked Woodswallow																				2
Artamus cinereus	Black-faced Woodswallow				1			22		5		5		3	4	5		3	18	29	2
Artamus minor	Little Woodswallow				7		7			1				3						7	
Cracticus torquatus	Grey Butcherbird							1	1				1		1				2	1	
Cracticus nigrogularis	Pied Butcherbird				1	1	2		4			1			1					3	
Cracticus tibicen	Australian Magpie							1	2		1									1	
RHIPIDURIDAE																					
Rhipidura leucophrys	Willie Wagtail				1	2		4	5	5		2						4	3	8	4
CORVIDAE																					
Corvus bennetti	Little Crow															2	1			36	1
Corvus orru	Torresian Crow				1	4		5	3	1	3		1	3	2	1		1		8	
MONARCHIDAE																					
Grallina cyanoleuca	Magpie-lark					5									9	2		3	4	2	
PETROICIDAE																					
Melanodryas cucullata	Hooded Robin								5	1											
ALAUDIDAE																					
Mirafra javanica	Horsfield's Bushlark										4	7									
MEGALURIDAE																					
Cincloramphus mathewsi	Rufous Songlark																				1
Eremiornis carteri	Spinifexbird				4		2	4	4	8											
HIRUNDINIDAE																					
Cheramoeca leucosterna	White-backed Swallow						**1**														

Family and Species	Common Name	EPBC Act	WC Act	DPaW	SLM 1	SLM 2	SLM 3	SLM 4	SLM 5	SLM 6	SLM 7	SLM 8	SLM 9	SLM 10	SLM 11	SLM 12	SLM 13	SLM 14	SLM 15	SLM 16	Opportunistic
Petrochelidon nigricans	Tree Martin				1																
NECTARINIIDAE																					
Dicaeum hirundinaceum	Mistletoebird													1							
ESTRILDIDAE																					
Taeniopygia guttata	Zebra Finch				26	13	19	159	93	51		15	8	26	10	10	17		31	99	41
Emblema pictum	Painted Finch					2	9	5		36				1						4	1
MOTACILLIDAE																					
Anthus novaeseelandiae	Australasian Pipit										1	1									

Appendix F.3 – Reptiles

Family and Species	Common name	EPBC Act	WC Act	DPaW	SLM 1	SLM 2	SLM 3	SLM 4	SLM 5	SLM 6	SLM 7	SLM 8	SLM 9	SLM 10	SLM 11	SLM 12	SLM13	SLM 14	SLM 15	SLM 16	Opportunistic
AGAMIDAE																					
Amphibolurus longirostris						9										1		1		1	6
Ctenophorus caudicinctus	Ring-tailed Dragon					1		1	1				1			3	1				4
Ctenophorus isolepis	Central Military Dragon										2		17	1		1	3		1	8	22
Ctenophorus reticulatus	Western Netted Dragon										1			1							
Diporiphora valens								1													
Pogona minor	Dwarf Bearded Dragon																1	1	4		
Tympanocryptis cephalus	Pebble Dragon										2										
DIPLODACTYLIDAE																					
Diplodactylus conspicillatus	Fat-tailed Gecko				2				1				11	1			3			9	
Diplodactylus galaxias	Northern Pilbara Beak-faced Gecko													1							
Diplodactylus savagei							2				1		1								
Lucasium stenodactylum					1				1				3	7			1		5	6	
Lucasium wombeyi						1	1			1										1	
Oedura marmorata	Marbled Velvet Gecko																				1
Rhynchoedura ornata	Beaked Gecko								1				2	2							
Strophurus elderi							1		1	1			1								
Strophurus jeanae																				1	
Strophurus wellingtonae						1														1	
CARPHODACTYLIDAE																					
Nephrurus wheeleri																	1			1	
Underwoodisaurus seorsus				P1			1														
GEKKONIDAE																					
Gehyra punctata																					1
Gehyra variegata						9		1					2		3	2		3		5	7
Heteronotia binoei	Bynoe's Gecko					2				1			4			4	1			1	
PYGOPODIDAE																					
Delma elegans					1																
Delma nasuta										1											
Delma pax					1																1
Delma tincta								1	1												
Lialis burtonis								1								1					1
Pygopus nigriceps													1							1	
SCINCIDAE																					
Carlia munda						5	2	5	2	3				4			13	3		2	1
Carlia triacantha					4	1					1			3							
Cryptoblepharus buchananii															1						1
Ctenotus duricola					5			2	1	2										1	
Ctenotus hanloni																1	2				
Ctenotus inornatus					4	2		3	2				1			2	6		1	2	
Ctenotus pantherinus	Leopard Ctenotus				23	2	1	8	13	7			6	10		2	2		1	4	1
Ctenotus robustus											4	5						9			
Ctenotus rutilans							4														
Ctenotus superciliaris					5		9	4	1	3											
Ctenotus uber																	1				
Cyclodomorphus melanops	Slender Blue-tongue													2							
Egernia cygnitos																					1
Lerista flammicauda																			1		
Lerista timida																		2			
Menetia greyii							1											1			
Morethia ruficauda							1														
Notoscincus ornatus																			1		

Family and Species	Common name	EPBC Act	WC Act	DPaW	SLM 1	SLM 2	SLM 3	SLM 4	SLM 5	SLM 6	SLM 7	SLM 8	SLM 9	SLM 10	SLM 11	SLM 12	SLM13	SLM 14	SLM 15	SLM 16	Opportunistic
Proablepharus reginae										1			1				1				
Tiliqua multifasciata	Central Blue-tongue						1						1						1		
VARANIDAE																					
Varanus acanthurus	Spiny-tailed Monitor						1									1					
Varanus brevicauda	Short-tailed Pygmy Monitor				1			1										1			
Varanus bushi	Pilbara Mulga Monitor												1								
Varanus caudolineatus																				1	
Varanus eremius	Pygmy Desert Monitor					1							5	1			1			1	
Varanus panoptes	Yellow-spotted Monitor																				1
Varanus tristis tristis	Racehorse Monitor							1													
TYPHLOPIDAE																					
Ramphotyphlops ganei				P1		1															
Ramphotyphlops grypus							1	1													
BOIDAE																					
Antaresia stimsoni	Stimpson's Python															1					2
ELAPIDAE																					
Acanthophis wellsi	Pilbara Death Adder																1				
Brachyurophis approximans	Shovel-nosed Snake						1														
Demansia psammophis	Yellow-faced Whipsnake								1				1	2				3	1	1	
Demansia rufescens	Rufous Whipsnake						1														
Furina ornata	Moon Snake						1			1											
Parasuta monachus	Hooded Snake									1				2			1				1
Pseudechis australis	Mulga Snake																				1
Pseudonaja mengdeni	Western Brown Snake															2				1	
Pseudonaja modesta	Ringed Brown Snake						1														
Suta fasciata	Rosen's Snake								1												
Suta punctata	Spotted Snake												2								

Appendix F.4 – Amphibians

Family and Species	Common name	EPBC Act	WC Act	DPaW	SLM 1	SLM 2	SLM 3	SLM 4	SLM 5	SLM 6	SLM 7	SLM 8	SLM 9	SLM 10	SLM 10	SLM 11	SLM 12	SLM13	SLM 14	SLM 15	SLM 16	Opportunistic
HYLIDAE																						
Cyclorana maini	Main's Frog					3			1		2	1										
Litoria rubella	Little Red Tree Frog					2																
MYOBATRACHIDAE																						
Uperoleia saxatilis	Pilbara Toadlet					263																

This page has been left blank intentionally

APPENDIX F FAUNA RECORDED WITHIN STUDY AREA ON PREVIOUS SURVEYS

Please see Appendix F on attached CD