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FORTESCUE METALS GROUP LTD
NORTH STAR PROJECT
LEVEL 2 TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT

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FORTESCUE METALS GROUP LTD

NORTH STAR PROJECT

LEVEL 2 TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT



Fortescue
The New Force in Iron Ore

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ACRONYMS

CAMBA	China-Australia Migratory Bird Agreement
DEC	Department of Environment and Conservation
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EP Act	Environmental Protection Act
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
JAMBA	Japan-Australian Migratory Bird Agreement
NHMRC	National Health and Medical Research Centre
SAC	Species Accumulation Curve
WC Act	*Wildlife Conservation Act 1950*

EXECUTIVE SUMMARY

Fortescue Metals Group Limited (Fortescue) is developing the Pilbara Iron Ore and Infrastructure Project, which involves a series of iron ore mines in the Pilbara region of Western Australia, and associated rail and port infrastructure.

As part of the environmental approvals processes for Fortescue's North Star Project, a baseline Level 2 vertebrate survey of the proposed mine and infrastructure was required to assess potential impacts, identify appropriate management strategies and assist with environmental approvals for proposed exploration and development.

Fortescue commissioned *ecologia* Environment (*ecologia*) to undertake a comprehensive biological survey of the vertebrate fauna of the North Star Project area as part of the environmental impact assessment for the project. *ecologia* conducted a two phase Level 2 survey of the proposed ore body footprint and infrastructure corridor, which connects the mine site with the established Fortescue rail infrastructure to the west. *ecologia* also conducted a single phase (Phase 3) Level 2 survey of the proposed mine infrastructure area, which is located around the proposed ore body footprint. In addition a targeted survey for the EPBC listed species the Northern Quoll, the Pilbara Leaf-nosed Bat and the Olive Python was carried out in the Project area.

Separate phases of the survey were conducted in autumn and spring, as per recommendations in the relevant guidance statements and technical guides. Sixteen survey sites were established in areas that represent the full range of habitats present in the Project area. Land system maps and aerial photos were used along with on-site reconnaissance to aid site selection. All trapping sites were set within the proposed Project area, taking into consideration the location of potential impact areas such as proposed mine pits and infrastructure.

Survey effort expended during the Level 2 survey included the following:

- Trapping grids were open for eight nights for all three phases, totalling 9,984 trap nights;
- 62 hours were spent systematically surveying for birds;
- 54 hours were spent on opportunistic diurnal searching;
- 28 hours and 25 minutes were spent on opportunistic nocturnal searching;
- Motion-sensing cameras were deployed for 156 hours;
- 395 hours and 40 minutes of recordings were analysed to determine bat assemblage and distribution.

In addition, the survey effort expended in the Project area during the targeted surveys included:

- A total of 172 cage traps and large Elliott traps were set up for a total of 1137 trap nights in accessible, suitable Northern Quoll habitat;
- 287.5 hours of SM2Bat recordings from 25 locations were analysed determining the presence/absence and abundance of the Pilbara Leaf-nosed Bats;
- A total of 52 nights of motion-sensing camera recordings were developed targeting the Northern Quoll and Pilbara Olive Python;

- A total of 103.5 hours of targeted searches for secondary evidence of the Northern Quoll and the Pilbara Olive Python and potential roost cave habitat for the Pilbara Leaf-nosed Bat.

The potential fauna assemblage of the region comprises 47 native and six introduced mammals, 150 birds, 111 reptiles, and seven amphibians. During this survey, a total of 19 native and three introduced mammals, 81 birds, 75 reptiles, and six amphibians were recorded.

Based on database searches and the results of previous biological surveys in the surrounding region, nine mammal, 13 bird and three reptile species of conservation significance could potentially occur in the Project area. Eleven species of conservation significance (five mammal, five bird and one reptile species) were recorded from within the Project area during the Level 2 survey and the targeted surveys. An additional seven species were assessed as having a medium to high likelihood of occurrence, with the remaining five species assessed as having a low likelihood.

In total, seven fauna habitats were recorded from the Project area:

- Rocky spinifex hills;
- Rocky plains with spinifex;
- Rocky ridges/breakaway/gorges;
- Sandy plains with spinifex and scattered granites;
- Acacia shrubland on hard soil;
- Creek lines; and
- Granite outcrops.

During *ecologia* flora and vegetation survey at the North Star Project area a total of 33 vegetation communities were described and mapped within the Project area. Of these, six vegetation types (*ElApEm, At, ApTp, Tl, FpAtCo* and *EvCc)* are considered to be of significance due to their suitability as foraging and/or breeding habitat to the Northern Quoll (Endangered), Pilbara Leaf-nosed Bat (Vulnerable) or Pilbara Olive Python (Vulnerable). It should be noted that only a portion of the area encompassed by these vegetation units within the Project area is expected to be utilised by these fauna.

Based on the results of the survey and assessment that is included in this report, the following conclusions were made:

- The North Star Project area supports a wide variety of species typically found in the Pilbara region. The increased variety of species is attributed to the numerous habitat types that occur in the mining areas and infrastructure corridors.
- Five EPBC listed conservation significant fauna species were recorded within the Project area, including Northern Quoll, Pilbara Leaf-nosed Bat, Rainbow Bee-eater, Fork-tailed Swift and Pilbara Olive Python. Six DEC Priority 3 and Priority 4 listed species were also recorded: Ghost Bat, Western Pebble-mound Mouse, Long-tailed Dunnart, Grey Falcon, Australian Bustard and Bush Stone-curlew.
- Twenty Northern Quoll individuals were caught, four recorded on motion camera and five recorded from secondary evidence within the Project Area, mainly within the proposed mining area and infrastructure areas. Northern Quolls were also recorded in large numbers (18

individuals) from Wodgina Project (approximately 10 km west). However, previous records in the surrounding area suggest that suitable habitat is present outside the Project area.

- Pilbara Leaf-nosed Bats were recorded from 18 locations within the Project Area. Based on analysis of the timing of the call density peaks, three of these locations were considered to be associated with roost cave locations. The majority of records were from the proposed North Star mining area and infrastructure areas and consisted of the rocky ridge/breakaway/rocky gorge habitat with or without semipermanent water. Several potential roost caves are also known from Lalla Rookh mine (approximately 10 km north-east) which may suggest that the records within the Project are part of a stronghold area for the Pilbara Leaf-nosed Bat. Previous records in the surrounding area show that suitable habitat is present outside the Project area but may be restricted to three Land systems in the region (Capricorn, Talga, Uaroo).
- Six individual Pilbara Olive Pythons were recorded from four locations within the North Star Project area. Remains of one individual, a sloughed skin and a single scat were also recorded during opportunistic searches. Regional records of this species are restricted to five locations within 40 km to the Project area. Suitable habitat for this species within the project area may be significant for the survival of this species on a local level.
- Based on the number of records collected during this survey the Project area may form a significant area of habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python populations.

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group Limited (Fortescue) is developing the Pilbara Iron Ore and Infrastructure Project, which involves a series of iron ore mines in the Pilbara region of Western Australia, and associated rail and port infrastructure.

Fortescue intends to expand its current operations to include the development of a new mine site, North Star, approximately 100 km south of Port Headland and 25 km east of the Fortescue Rail Line together with support infrastructure such as access roads, ore transport and power infrastructure (Figure 1.1). The proposed North Star project (the Project) consists of an open pit mine, targeting a large magnetite ore body, and associated infrastructure areas covering approximately 9000 ha.

As part of the environmental approvals processes for Fortescue's North Star Project, a baseline Level 2 vertebrate survey of the proposed mine and infrastructure was required to assess potential impacts and identify appropriate management strategies. This survey will also assist with environmental approvals for proposed exploration and development.

1.2 LEGISLATIVE FRAMEWORK

The *Environmental Protection Act 1986* (EP Act) is "an Act to provide for an Environmental Protection Authority, for the prevention, control and abatement of environmental pollution, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing." Section 4a of this Act outlines five principles that are required to be addressed to ensure that the objectives of the Act are addressed. 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 Principles of Intergenerational Equity*

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

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

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

In addition to these principles, projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines produced by the Environmental Protection Authority (EPA), in this case Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004), principles outlined in EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002) and the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010).

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

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 Project area are provided in Appendix A.

The WC Act was developed to provide 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). The current listing was gazetted in August 2011.

In addition, the Department of Environment and Conservation (DEC) maintains a Threatened Fauna and Priority Fauna list. Threatened fauna that is listed as Schedule 1 under the WC Act are further ranked by the DEC according to their level of threat using IUCN Red List criteria. Species can be listed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU). Species that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are listed as Priorities 1, 2 or 3, which 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, are rare but not threatened, or meet 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. Conservation Dependent species 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 vertebrate fauna of the North Star Project area as part of the environmental impact assessment for the project. *ecologia* conducted a two phase Level 2 survey of the proposed ore body footprint and infrastructure corridor, which connects the mine site with the established Fortescue rail infrastructure to the west. *ecologia* also conducted a single phase (Phase 3) Level 2 survey of the proposed mine infrastructure area, which is located around the proposed ore body footprint.

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

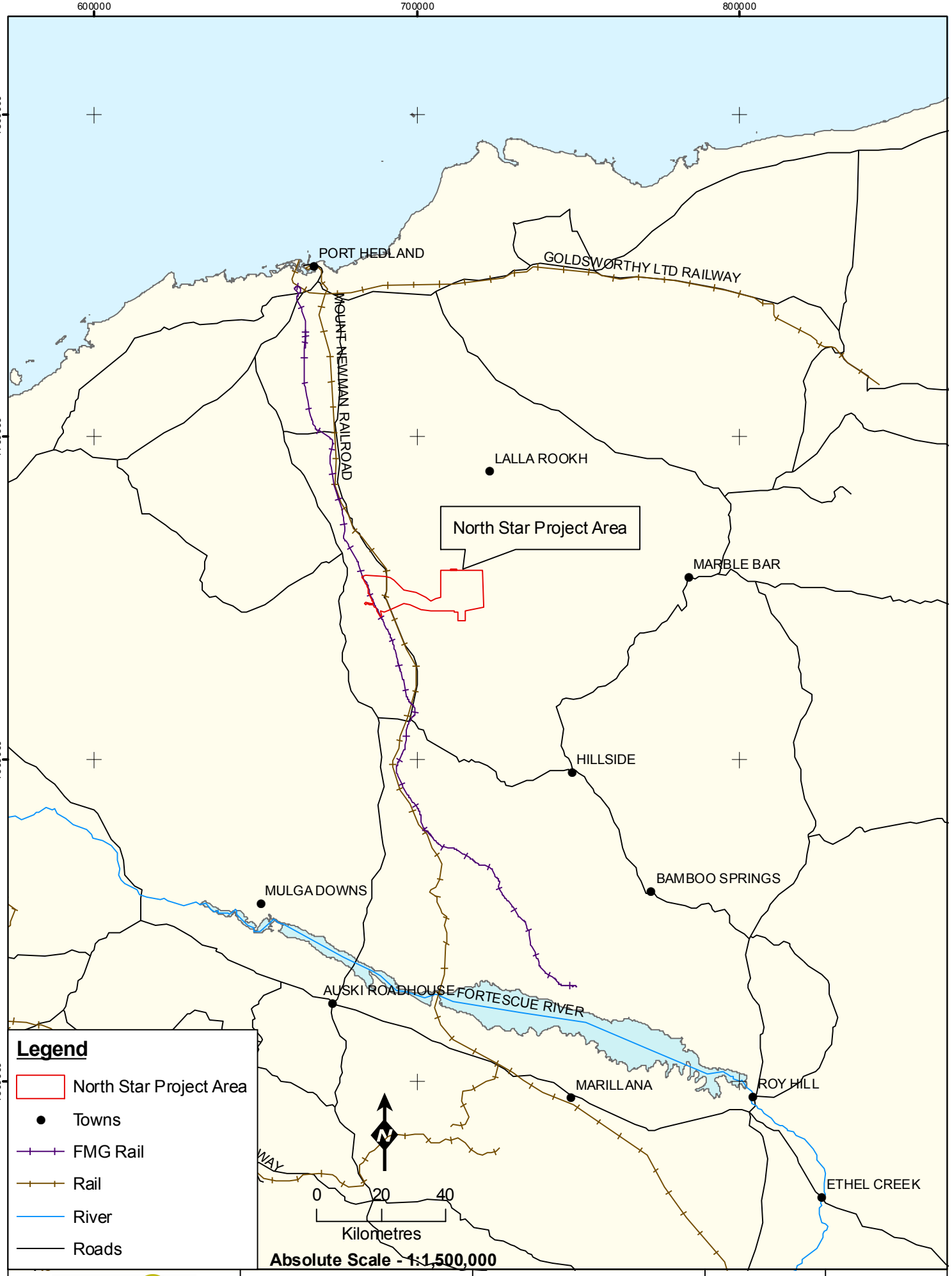
- maintain the abundance, species diversity and geographical distribution of terrestrial fauna; and

- protect Specially Protected (Threatened) fauna, consistent with the provisions of the WC Act.

The aim of this study was to provide sufficient information to the EPA to assess the impact of the project on the vertebrate fauna of the area, thereby ensuring that these objectives will be upheld.

This report satisfies the requirements documented in 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 in the Project area, incorporating recent published and unpublished records;
- an inventory of species of biological and conservation significance recorded or likely to occur within the Project area and surrounds;
- a description of fauna habitats occurring in the Project area;
- a description of the characteristics of the faunal assemblage;
- an appraisal of the current knowledge base for the area, including a review of previous surveys conducted in the area that are relevant to the current study; and
- a review of regional and biogeographical significance, including the conservation status of species recorded in the Project area.



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Location of the Project Area

Figure: 1.1
Project ID: 1322

Drawn: AH
Date: 18/08/11

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

Unique Map ID: AH367

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2 BIOPHYSICAL CLIMATE

2.1 CLIMATE

The study area is situated in the Pilbara biogeographic region of Western Australia and 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 low 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. The majority of the Pilbara has a bimodal rainfall distribution; from January 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 sometimes reach the Pilbara. 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 climatic station is Marble Bar, which is 60 km NE of North Star. Marble Bar experiences a hot climate with wet summers and dry winter months (Figure 2.1). Rainfall is low throughout and is often quite variable, depending on the occurrence of tropical cyclones in the region (BOM 2010). Most of the summer rain comes from scattered thunderstorms and the occasional tropical cyclone. A secondary peak in the monthly rainfall occurs in May because of rainfall caused by tropical cloud bands which intermittently affect the area mostly in May and June (BOM 2010).

Marble Bar is one of the hottest places in Western Australia. Marble Bar recorded 160 consecutive days of 37.8°C or more in the period between the 31st October 1923 and the 7th April 1924. Marble Bar has an average daily maximum temperature of 38°C or more for all the months from November to March (BOM 2010). The normal inland maximum temperature range in summer is between 37°C and 42°C. Winter is a short 6 to 8 week period and retreats quickly by late August, with average temperatures ranging from 23°C to 27°C in the south and 25°C to 30°C in the north (BOM 2010).

During the current survey the maximum temperatures ranged from 21.3°C to 38.2°C. There was a mean rainfall of 87.1 mm recorded during March 2011 (phase 1) and a mean rainfall of 3 mm recorded during October 2011 (phase 2) in Marble Bar.

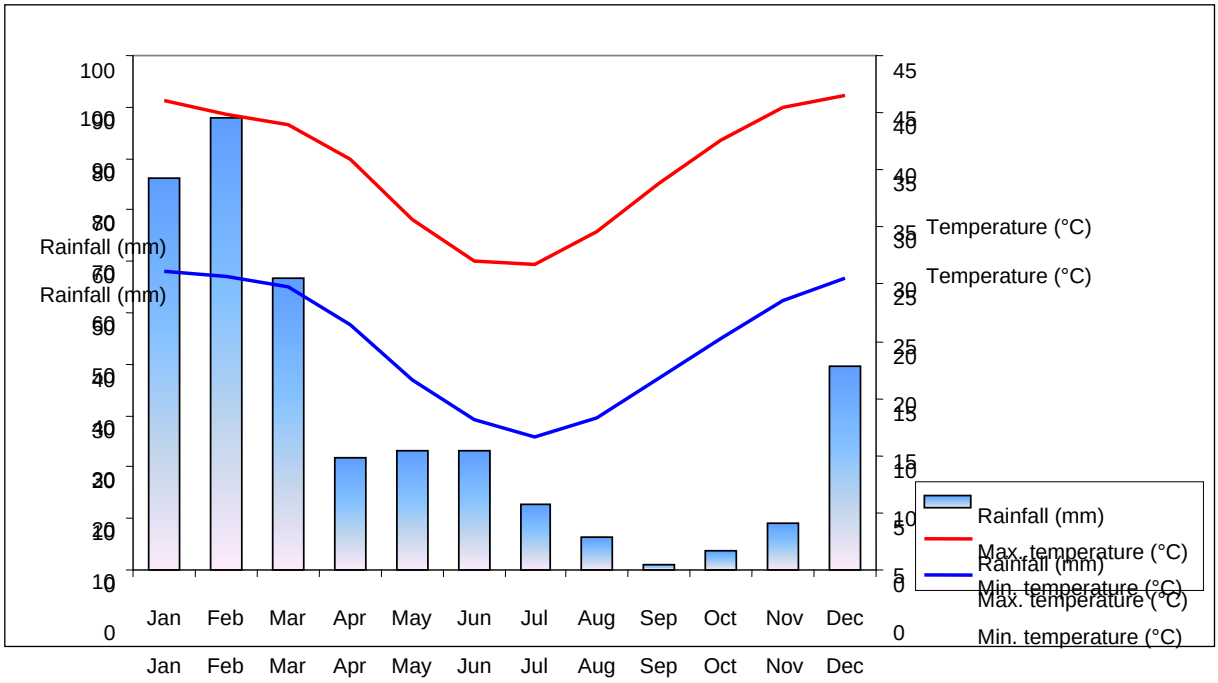


Figure 2.1 – Climatic Data for Marble Bar

2.2 LAND SYSTEMS

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

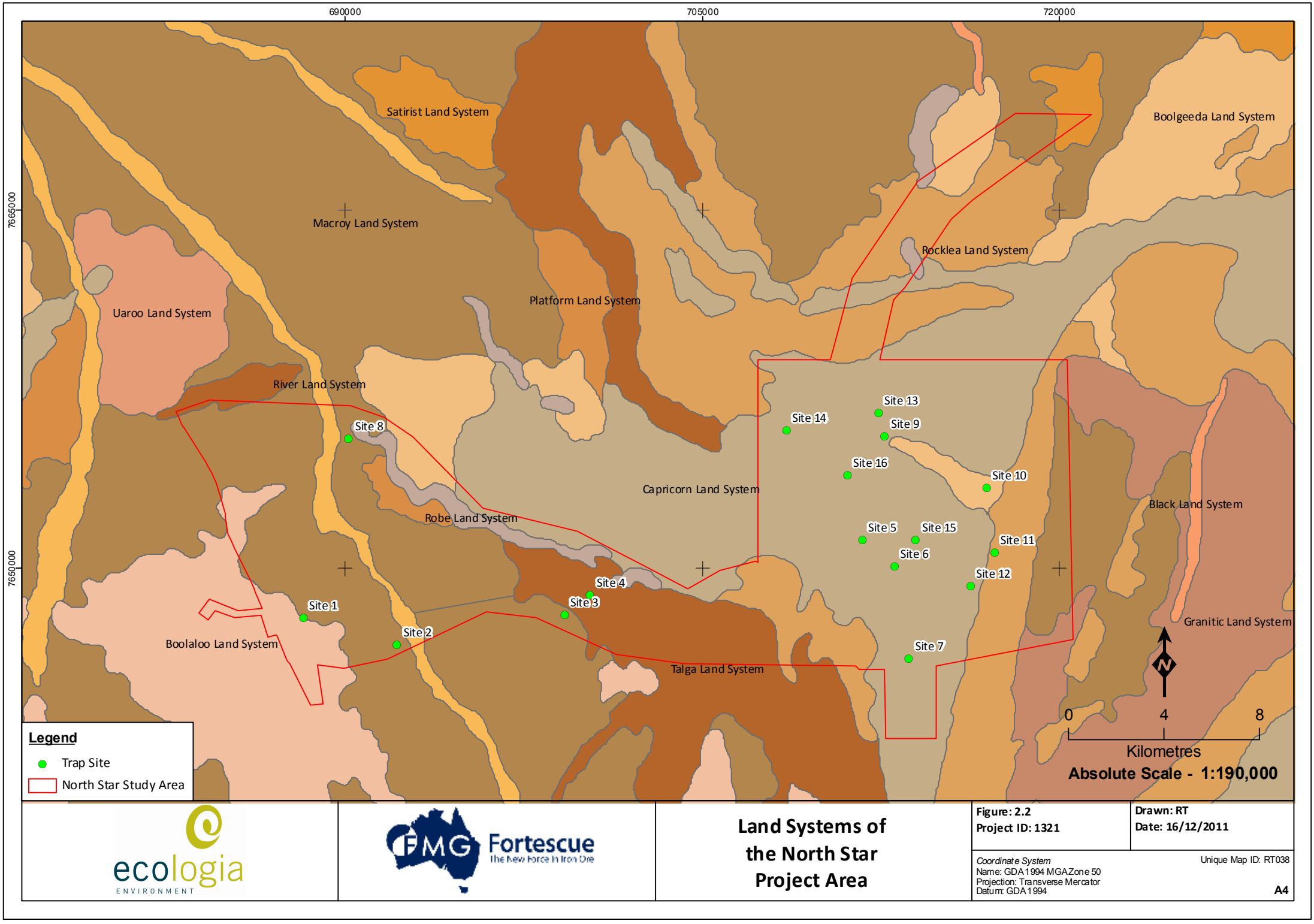
The Project area comprises nine of the land systems mapped by Van Vreeswyk *et al.* (2004) (Table 2.1, Figure 2.2). The largest land system within the Project area is the Capricorn land system, occupying 35.9% of the Project area, covering most of the ore body footprint and mine infrastructure. This land system typically consists of hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands. The Macroy land system (26.2%), which consists of stony plains and occasional tor fields based on granite supporting hard and soft spinifexes, is located in the western side of the Project area in the ore transport infrastructure corridor.

The Rocklea (14.9%), and Talga (8.8%) land systems also form a large part of the project area with both land systems containing various geologically derived hills and ridges all dominated by spinifex grasses. All land systems are well-represented outside of the Project area, with the majority having less than 1% of the total land system within the Project area. The River land system has approximately 4% located within the Project area, however it occurs in the western end of the ore transport infrastructure corridor, which is an area that expects minimal disturbance from the development of the project.

Table 2.1 – Land Systems of the Project Area

Land System	Description	Survey Sites	Total Area in WA (ha)	Area in Project Area (ha)	Percent of Total Land System (%)
Boolaloo	Granite hills, domes and tor fields and sandy plains with shrubby spinifex grasslands.	NS S1	238,374	1,275	0.53
Boolgeeda	Stoney lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands.	NS S10	961,637	1,232	0.13
Capricorn	Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands.	NS S5, NS S6, NS S7, NS S9, NS S12, NS S13, NS S14, NS S15, NS S16,	698,526	12,531	1.79
Granitic	Rugged granitic hills supporting shrubby hard and soft spinifex grasslands.	-	410,002	251	0.06
Macroy	Stony plains and occasional tor fields based on granite supporting hard and soft spinifexes.	NS S2, NS S3, NS S8	1,331,610	9,120	0.68
Platform	Dissected slopes and raised plains supporting hard spinifex grasslands.	-	236,336	388	0.16
River	Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands.	-	15,242	720	4.72
Robe	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands.	-	128,620	978	0.76
Rocklea	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands.	NS S11	2,881,897	5,180	0.18
Satirist	Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands.	-	43,484	80	0.18
Talga	Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.	NS S4	202,420	3,100	1.53

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Land Systems of the North Star Project Area

Figure: 2.2
Project ID: 1321

Drawn: RT
Date: 16/12/2011

Coordinate System
Name: GDA1994 MGAZone 50
Projection: Transverse Mercator
Datum: GDA1994

Unique Map ID: RT038

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2.3 VEGETATION

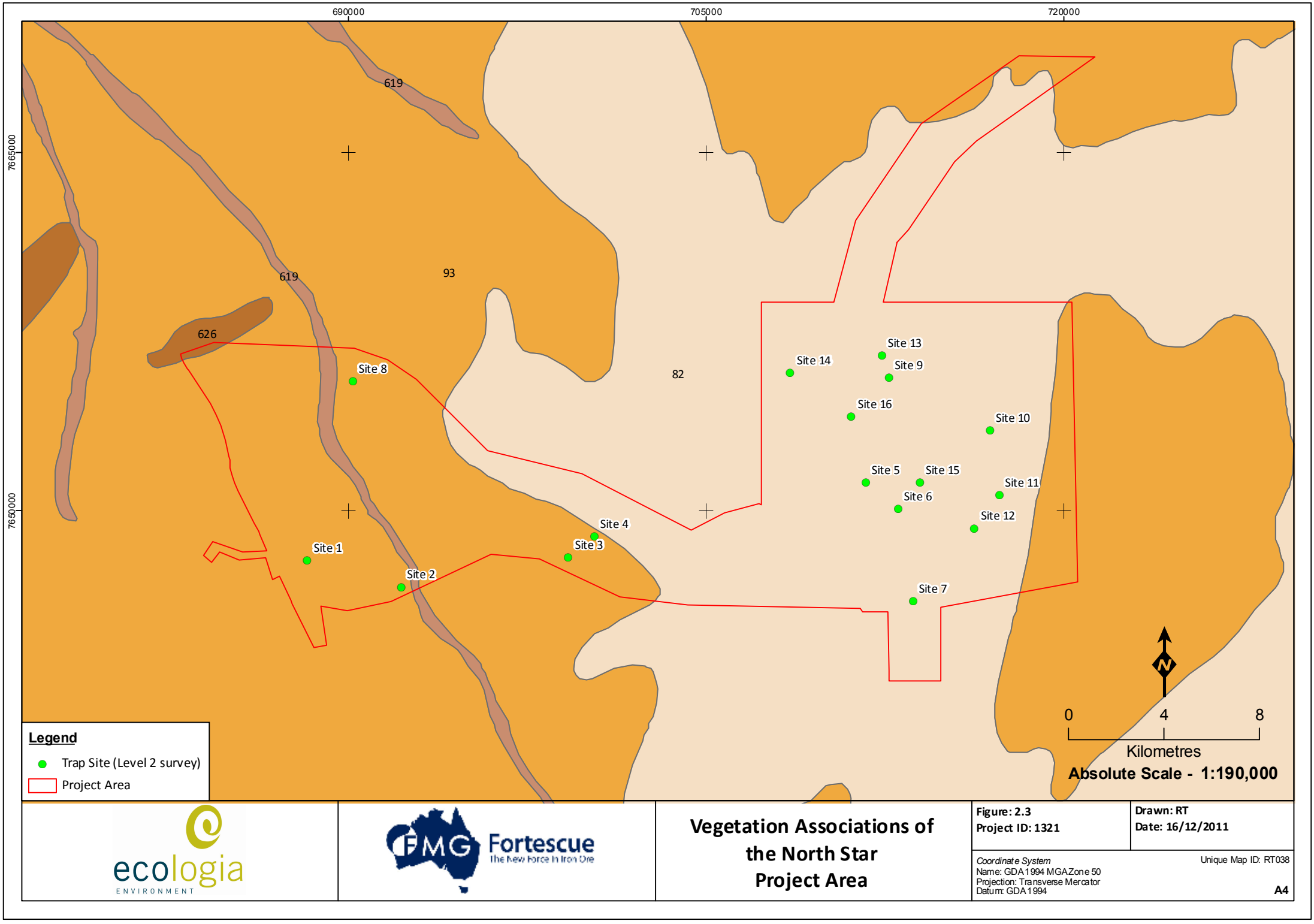
The vegetation of Western Australia was originally mapped at the 1:1,000,000 scale by Beard (1975), and was subsequently reinterpreted and updated to reflect the National Vegetation Information System standards (Shepherd *et al.* 2002). The Project area lies within the Eremaean Botanical Province of the Pilbara (Beard 1975). Four vegetation associations occur in the Project area (Shepherd *et al.* 2001), and are described in Table 2.2 and displayed in Figure 2.3.

Hummock grassland with low tree steppe (snappy gum) and shrub steppe (typically comprising *Grevillia sp*.) and kanji (*Acacia inaequilatera*) over spinifex is the most dominant vegetation type (82, 93 and 626) accounting for 98% of the total vegetation type. The remaining 2% is represented by riverine vegetation (619) which comprises river gum woodland over a variety of shrubs and grasses.

Table 2.2 – Vegetation Associations of North Star Project Area

Beard Unit	Vegetation Description	Area in the Project Area (Ha)	Percent in Project Area (%)
82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*.	21152	61
93	Hummock grasslands, shrub steppe; kanji over soft spinifex.	13113	38
619	Medium woodland; river gum (*Eucalyptus camaldulensis*).	537	1.9
626	Hummock grasslands, shrub-steppe; kanji over soft spinifex & *Triodia brizioides*.	52	0.1

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FMG Fortescue The New Force in Iron Ore

Vegetation Associations of the North Star Project Area

Figure: 2.3
Project ID: 1321

Drawn: RT
Date: 16/12/2011

Coordinate System
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Datum: GDA1994

Unique Map ID: RT038

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2.4 BIOGEOGRAPHY

The Interim Biogeographic Regionalisation for Australia (IBRA) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (DSEWPC 2010). According to IBRA (version 6.1), the Project area is located in the Pilbara bioregion.

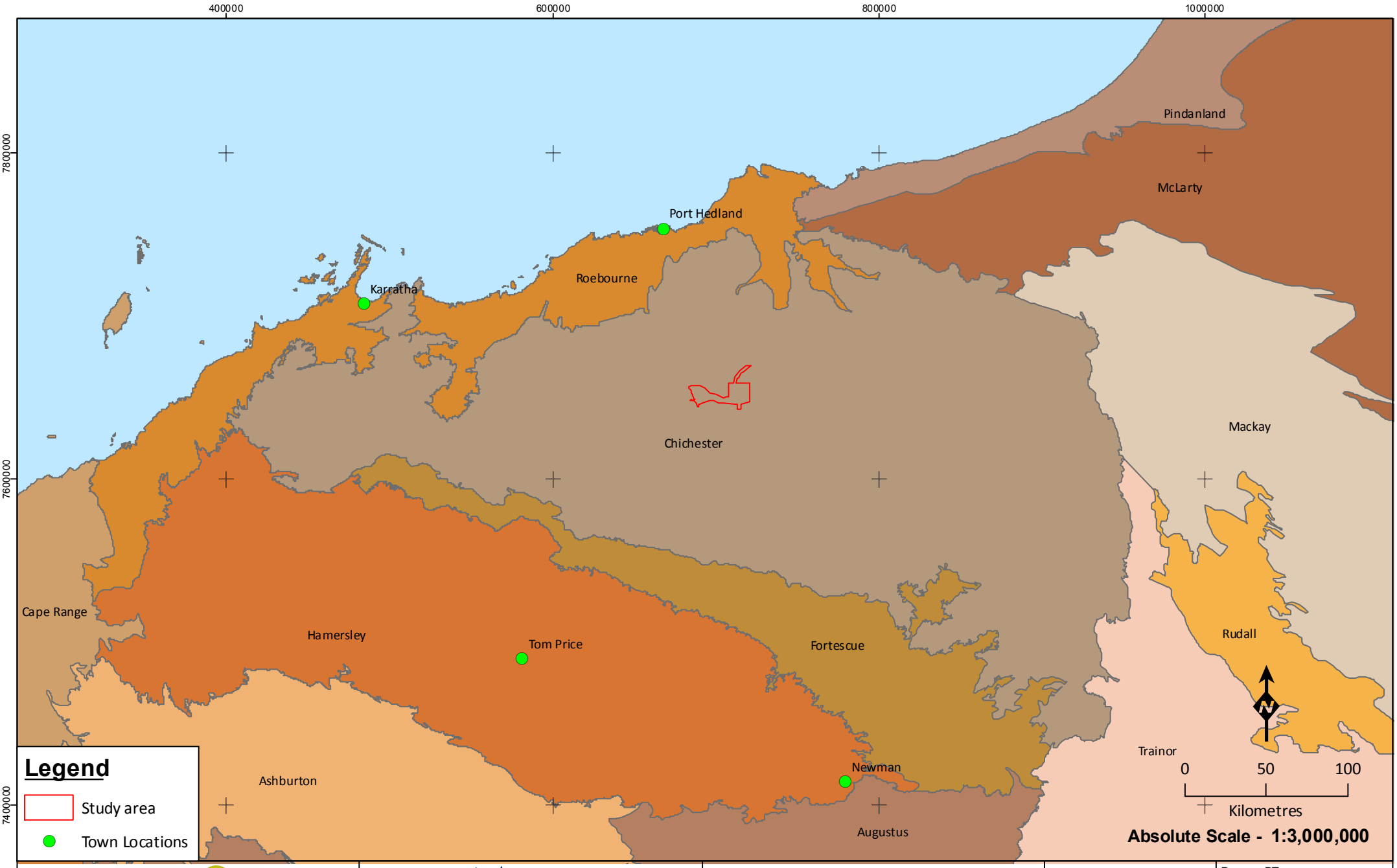
Dominant limiting factors and constraints for the Pilbara bioregion listed by Thackway and Creswell (1995) include extinction of critical weight range animals, wildfire, feral animals, weeds and grazing or pastoral activities. The reservation status of the bioregion is 1-5%, which is relatively low (some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

With an area of 179,287 km², the Pilbara bioregion is in the largest area class. Other bioregions vary from 2,372 to 423,751 km², most being between 14,000 and 200,000 km². The size of the Pilbara bioregion is fairly typical of bioregions situated in remote arid and semi-arid areas (Thackway and Cresswell 1995). The Pilbara bioregion is further divided into the Chichester (PIL1), Fortescue Plains (PIL2), Hamersley (PIL3) and Roebourne (PIL4) subregions. The Project Area is located within the Chichester subregion of the Pilbara IBRA Bioregion (Figure 2.4).

The Chichester subregion comprises the northern section of the Pilbara Craton and is characterised by undulating Archaean granite and basalt plains include significant areas of basaltic ranges. The dominant land use of the area is grazing of native pastures, with a number of Aboriginal lands and Reserves, Crown Reserves, Conservation Areas and Mining leases (Kendrick and McKenzie 2001).

The vegetation of the Chichester subregion is described by Kendrick and McKenzie (2001) as a shrub steppe of *Acacia inaequilatera* over *Triodia wiseana* and *Triodia pungens* hummock grasslands, with *Eucalyptus leucophloia* tree steppes occur on the ranges.

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FMG Fortescue The New Force in Iron Ore

IBRA Subregions of North Star Study Area

Figure: 2.4
Project ID: 1321

Drawn: RT
Date: 31/01/2012

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

Unique Map ID: RT038

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3 SURVEY METHODS

3.1 DETERMINATION OF SURVEY SAMPLING DESIGN AND INTENSITY

Prior to the development of survey methods, a review was undertaken of factors likely to influence survey design (Table 3.1). Based on this review, it was deemed that a comprehensive Level 2 survey was required to be conducted within the Project Area.

Table 3.1 – Factors Likely to Influence Survey Design (from EPA 2004)

Factor	Relevance	Comment
Bioregion – level of existing survey-knowledge of the region and associated ability to predict accurately.	The Project area is located in the Chichester subregion of the Pilbara biogeographic region. Several fauna surveys of similar size and scope have been undertaken in the region.	The scope of the project requires a Level 2 survey. Given the quantity of contextual information available, a two phase survey was considered sufficient to document the fauna of the study area and to determine the presence of conservation significant species.
Landform special characteristics/specific fauna/specific context of the landform characteristics and their distribution and rarity in the region.	The Chichester subregion supports a shrub steppe characterised by *Acacia inaequilatera* over *Triodia* hummock grasslands, with eucalyptus tree steppes on ranges. Drainage occurs north via numerous rivers.	Survey sites were selected to be representative of major landforms and habitats and to correspond with proposed areas of disturbance or clearing.
Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present.	The initial phase of surveying was completed in early autumn, the remaining two surveys were conducted in spring 2011.	Although high temperatures occurred during all three phases of surveying, differences in seasonal conditions occurred (quite high rainfall in phase 1, very low rainfall phase 2 and phase 3) therefore the diversity of fauna assemblages sampled is not thought to be restricted.
Level of existing knowledge and results of previous regional sampling (e.g. species accumulation curves, species/area curves).	Surrounding region well studied however limited surveys in the habitats associated with the ore body footprint and mine infrastructure.	Regional knowledge is sufficient, however a Level 2 survey was deemed suitable to document the specific fauna of the study area.
Number of different habitats or degree of similarity between habitats within a survey area.	The study area was divided into two distinct areas. The infrastructure corridor is associated with spinifex plains on stony soil. The mining area is associated with rocky hillsides, breakaways and drainage channels with acacia shrubs and eucalyptus over spinifex.	Trapping sites and opportunistic surveys covered the full range of habitat types present in the study area. The majority of the survey area is made up of spinifex dominated habitat.
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 mild winters with light rains. Rainfall is highly unpredictable.	The three phases of surveying were conducted during Autumn and Spring. Hot conditions during Phase 3may have limited the activity of some species, particularly birds, while increasing activity of reptiles.
Sensitivity of the environment to the proposed activities.	The majority of the impact area for the North Star project will be in habitat types which are well represented in the surrounding area.	Areas most sensitive to impacts are the permanent water bodies and rock pools found in creek lines and gorges. These areas were surveyed both systematically and opportunistically.

Factor	Relevance	Comment
Size, shape and location of the proposed activities.	The project consists of one mining area with proposed infrastructure areas and a proposed infrastructure corridor	Eight trapping sites were established along the proposed mining area and infrastructure corridor in phase 1 and phase 2, and eight additional sites were established in the proposed infrastructure areas during Phase 3. Targeted searches for conservation significant fauna were also undertaken to augment the systematic survey data.
Scale and impact o the proposal.	The location and scale of the project warrants a Level 2 survey (detailed field survey), in accordance with EPA guidelines.	A large scale mining project located in the Pilbara bioregion necessitates a Level 2 survey.

3.2 LITERATURE REVIEW AND DATABASE SEARCHES

Several databases were consulted in the preparation of lists of potential fauna (and conservation significant fauna) (Table 3.2). In addition, four publications reporting on vertebrate fauna surveys and an additional three publications focussing on conservation significant fauna within 110 km of the Project area were consulted (Table 3.3). The results of all database searches and previous surveys are presented in Appendix D.

Table 3.2 – Fauna Databases Searched to Determine the Potential Fauna Assemblage of the Project Area.

Database	Search Details
Department of Environment and Conservation (DEC) Threatened Fauna Database	Conservation significant fauna records within 40 km of the Project area
DEC NatureMap	Fauna records within 40 km of the Project area
Birds Australia Birdata	Avifauna records within 100 km of the Project area
Department of Sustainability, Environment, Water, Population and Community (DSEWPaC) protected matters database	Fauna records within 50 km of the Project area
ecologia internal database	One Level 1 survey, three Level 2 surveys (1 one-phase, 2 two-phase), and three Targeted Fauna surveys.

Table 3.3 - Previous Biological Survey Reports within 115 km of the Project Area

Survey Location and Author(s)	Distance to Project Area (km)	Comments
Bamford (2001)	8	Two-phase Level 2 survey
Biota (2005)	93	One-phase Level 2 survey
Biota (2007)	9	Targeted fauna survey
Outback Ecology (2006)	105	Two-phase Level 2 survey and additional one-phase survey
Outback Ecology (2010)	40	Bat and Northern Quoll monitoring
Outback Ecology (2011)	40	Two-phase Level 2 fauna survey
Molhar Pty Ltd (2007)	6	Targeted Bat survey

3.3 SURVEY TIMING

Separate phases of the survey were conducted in autumn and spring as per recommendations in the relevant guidance statements and technical guides (EPA 2002, 2004; EPA and DEC 2010).

Table 3.4 - Summary of Survey Timing and Duration

Survey	Survey Dates	Survey Duration
Phase 1	29/03/2011 – 09/04/2011	12 days
Phase 2	25/10/2011 – 05/11/2011	12 days
Phase 3 (Mine Infrastructure Areas)	10/10/2011 – 21/10/2011	12 days
Targeted Survey Mine Area	07/07/2011 – 15/07/2011	9 days
Targeted Survey Infrastructure Areas	22/07/2011 – 30/07/2011	9 days

3.4 SITE SELECTION

Sites were selected to represent the full range of habitats present in the Project area. Land system maps and aerial photos were used along with on-site reconnaissance to aid site selection. All trapping sites were set within the proposed Project area (Figure 3.1) with site selections taking into consideration the location of proposed impact areas such as mine pits and infrastructure.

Two survey sites were located on Sandy spinifex plain with mixed shrubs and occasional granite domes, two survey sites were located in Rocky plains with spinifex, seven survey sites were set up in Rocky spinifex hills and hill slopes, three survey sites were set along Rocky ridge/Breakaway/Gorge habitat and the remaining two sites were located in Creekline habitat. Recordings of bat calls were made at all trapping sites and in habitats that could potentially support conservation significant bat species such as creek lines and caves along ridges. Sampling sites information is presented in Table 3.5.

Opportunistic searches were conducted in less accessible habitat such as rocky ridges and breakaway habitat that support conservation significant fauna such as Pilbara Olive Python, Pilbara Leaf-nosed Bat, Ghost Bat and Northern Quoll, rocky spinifex plain that support Western Pebble Mound Mouse, and creek lines that support Bush Stone-curlew, Rainbow Bee-eater. Additional habitat assessments were conducted to aid habitat mapping and verify that the habitats surveyed by systematic and opportunistic sites were representative of those found throughout the Project area.

The details of each survey site are described in Table 3.5 and Appendix C and site locations are shown in Figure 3.1.

Table 3.5 - Systematic Survey Site Information

Site	Location		Land System	Habitat Type
	Easting	Northing		
NS S1	688236	7647898	Boolaloo	Sandy plains with spinifex and scattered granites
NS S2	691618	7647702	Macroy	Rocky plains with spinifex
NS S3	699195	7648049	Macroy	Rocky plains with spinifex
NS S4	700273	7648898	Talga	Rocky spinifex hills
NS S5	711690	7651182	Capricorn	Rocky ridge / Breakaway / Gorge
NS S6	713040	7650065	Capricorn	Rocky spinifex hills
NS S7	713654	7646208	Capricorn	Rocky spinifex hills

Site	Location		Land System	Habitat Type
	Easting	Northing		
NS S8	690134	7655438	Macroy	Patch of sandy plain with spinifex, surrounded by rocky plains
NS S9	712644	7655550	Capricorn	Rocky ridge / Breakaway / Gorge
NS S10	716903	7653361	Boolgeeda	Creekline
NS S11	717270	7650650	Rocklea	Rocky spinifex hills
NS S12	716248	7649263	Capricorn	Rocky ridge / Breakaway / Gorge
NS S13	712375	7656502	Capricorn	Rocky spinifex hills
NS S14	708520	7655785	Capricorn	Creekline
NS S15	713946	7651179	Capricorn	Rocky spinifex hills
NS S16	711075	7653905	Capricorn	Rocky spinifex hills

Datum: GDA 94
Zone: 50k

682500 690000 697500 705000 712500 720000

7665000

7657500

7650000

Legend

Survey Sites (Level 2 survey)

- Trap Site
- Project Area

Fauna habitat types

- Acacia shrubland on hard soil
- Creekline
- Granite outcrop
- Rocky plains with spinifex
- Rocky spinifex hills
- Rocky ridge/breakaway/gorge
- Sandy plains with spinifex and scattered granites

Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Site 9
Site 10
Site 11
Site 12
Site 13
Site 14
Site 15
Site 16

N

0 2.5 5

Kilometres

Absolute Scale - 1:110,000

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Trapping Site locations of the North Star Project Area

Figure: 3.1
Project ID: 1322

Drawn: AH
Date: 05/12/11

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

Unique Map ID: AH409

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3.5 SAMPLING METHODS

The survey methods adopted by *ecologia* were aligned with the EPA's Guidance statement 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 Sampling

3.5.1.1 Terrestrial Mammals and Herpetofauna

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

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

- Pit-trap and drift fence: Five PVC pipe (16 cm diameter, minimum 50 cm deep) and five 20 L plastic buckets (30 cm diameter, 40 cm deep) were established at each site. A ten metre flywire drift fence (30 cm high) bisected each pits, directing fauna into the traps, with each pit separated by at least 25 m.
- Elliott box traps: Twenty 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). One trap was placed opposite the pit trap and one trap was placed in between pit traps.
- Funnel traps: Funnel traps (Ecosystematica Type III) were placed at each end of with drift fences. Twenty funnel traps were used per site, with one trap being placed at each end of the drift fence.
- Cage traps: Two traps were used per site with one trap placed at each end of the trap line. Traps were baited with Universal Bait.

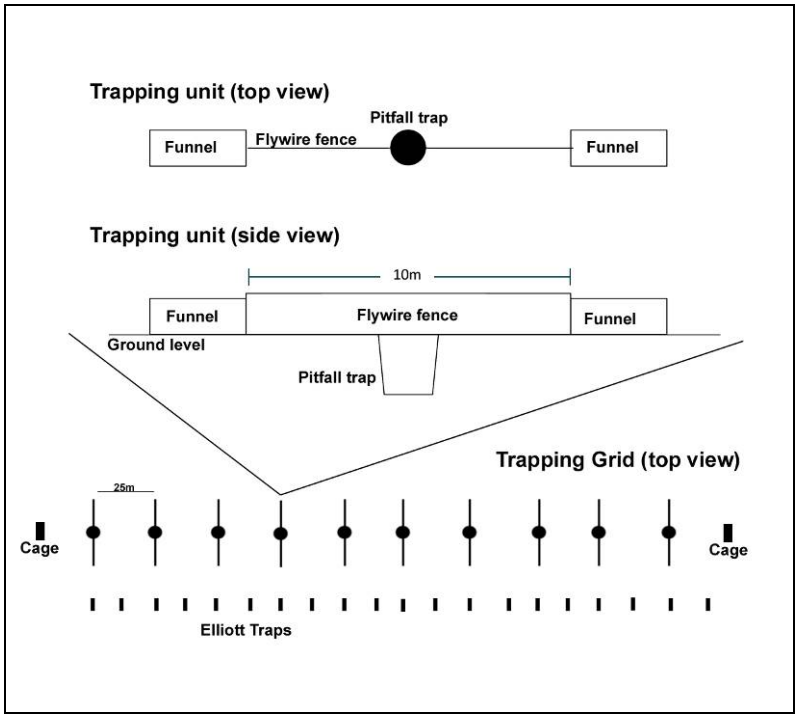


Figure 3.2 – Diagram of Systematic Sampling Trap Arrangement

3.5.1.2 Avifauna

Twenty 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 a 2.0 ha area. This is the preferred survey method for the ongoing Birds Australia *Atlas of Australian Birds* project.

Survey effort was concentrated between the post-dawn and pre-dusk time periods, as these are deemed to be the optimal times to record most bird species. Surveys between these times were also conducted, as they may yield species less frequently observed in the early morning or late evening, e.g. diurnal raptors.

At least six twenty minute set-time surveys were completed at all systematic survey sites during optimal times.

3.5.1.3 Bats

Bat echolocation calls were detected using both the Anabat II system (Titley Electronics, Ballina, NSW and the Sm2bat 384 kHz system. The Anabat Bat Detector is able to transform ultrasonic bat echolocation calls for analysis with computer software. The transformed calls were stored on Minidiscs and played back onto a PC for analysis. The Anabat system was used during the Phase 1 survey. The Sm2bat records high sampling frequencies constantly over a predefined period, enabling ultrasonic bat echolocation calls to be recorded. Different species can be distinguished based upon unique variation between their calls. Sm2bat devices were used during the phase 2 and phase 3 surveys with recorders placed in locations likely to attract bats, including cave entrances, gorges and next to permanent water.

Over 383 hours of recordings were taken, including at least 12 hours at each systematic survey site. Sm2bat devices were also deployed at 18 opportunistic sites where it seemed likely that bats would occur.

3.5.2 Opportunistic Data

3.5.2.1 Nocturnal Searching

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

Around 20 hours were spent on nocturnal searches at both systematic trapping sites and several opportunistic sites, and 8 hours were spent on road transects.

3.5.2.2 Diurnal Searching

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

Fauna were also recorded while searching, travelling and establishing traps within the Project area during the day. Tracks, diggings, scats, burrows and nests were recorded where possible.

Fifty-four hours of diurnal searching was conducted, both at systematic trapping sites, and at various opportunistic sites covering a range of habitat types throughout the Project area.

3.5.2.3 Camera Trapping

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

Camera traps were deployed for 156 hours at 14 opportunistic survey sites. Both universal bait and/or containers of water were used as attractants at many of these locations.

3.5.2.4 Targeted Conservation Significant Fauna Surveying

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

On the basis of the habitats observed during surveying, specific searches were also undertaken to determine the presence of the following conservation significant fauna species using the following methods:

- Bush-stone Curlew: 2 hours were spent targeting this species in suitable habitats. Call playback was also used.

- Australian Bustard: 2 hours were spent carrying out diurnal searches on spinifex plains.
- Rainbow Bee-eater: 2 hours were spent carrying out diurnal surveys along dry rivers and creek beds in suitable habitat for this species.
- Northern Quoll: 2480 Elliot trap-nights, 208 cage-trap nights and 26 search hours were spent targeting accessible rocky habitat which included areas with large boulders and crevices that may provide den sites.
- Mulgara: 3 hours were spent carrying out targeted searches on sandy spinifex plains.
- Greater Bilby: 3 hours were spent searching sandy plains with large spinifex clumps
- Pilbara Leaf-nosed Bat: 395 hours of SM2Bat recordings were made in areas where Bats may feed, drink or roost, and 11 hours spent searching caves for Bat roosts suitable for the conservation significant bat species.
- Olive Python: 22 hours were spent searching rocky areas around large pools of water.

Two separate targeted conservation significant fauna surveys were also conducted in the North Star project area in July 2011. Targeted searches were carried out to determine the presence of conservation significant species using the following methods:

- Northern Quoll: 172 cage traps and large Elliott traps were set up for a total of 1137 trap nights, 52 nights of motion-sensing camera recordings were developed and 103.5 hours were spent on targeted searches for secondary evidence;
- Pilbara Leaf-nosed Bat: 287.5 hours of SM2Bat recordings from 25 locations were made in rocky habitat potentially comprising roosting habitat;
- Pilbara Olive-Python: A total of 52 nights of motion-sensing camera recordings were made and 103.5 hours were spent searching along breakaways and around rocky pools.

3.6 SURVEY EFFORT

Survey effort expended within the Project area during the Level 2 survey included the following:

- Trapping grids were open for eight nights for all three phases, totalling 9,984 trap nights;
- 62 hours were spent systematically surveying for birds;
- 54 hours were spent on opportunistic diurnal searching;
- 28 hours and 25 minutes were spent on opportunistic nocturnal searching;
- Motion-sensing cameras were deployed for 156 hours;
- 395 hours and 40 minutes of recordings were analysed to determine bat assemblage and distribution.

Total survey effort per site is presented in Table 3.6.

In addition, the survey effort expended in the Project area during the targeted surveys included:

- A total of 172 cage traps and large Elliott traps were set up for a total of 1137 trap nights;
- 287.5 hours of SM2Bat recordings from 25 locations were developed and analysed;
- A total of 52 nights of motion-sensing camera recordings were developed;
- A total of 103.5 hours of targeted searches were carried out.

Details on survey effort and site locations are described in the targeted survey report (*ecologia* 2011) and Appendix F.

Table 3.6 – Survey Effort

Site	Pit Traps (trap nights)			Funnels (trap nights)			Elliotts (trap nights)			Cages (trap nights)			Bird Survey (min)			Diurnal Opp. Search (min)			Nocturnal Opp. Search (min)			Bat Recording (min)		
	Ph1	Ph2	Ph3	Ph1	Ph2	Ph3	Ph1	Ph2	Ph3	Ph1	Ph2	Ph3	Ph1	Ph2	Ph3	Ph1	Ph2	Ph3	Ph1	Ph2	Ph3	Ph1	Ph2	Ph3
S1	80	80	-	160	160	-	160	160	-	16	16	-	120	60	-	-	-	-	-	-	-	720	-	-
S2	80	80	-	160	160	-	160	160	-	16	16	-	120	100	-	-	-	-	-	-	-	720	-	-
S3	80	80	-	160	160	-	160	160	-	16	16	-	120	140	-	-	-	-	-	-	-	260	-	-
S4	80	80	-	160	160	-	160	160	-	16	16	-	120	160	-	-	-	-	-	-	-	630	720	-
S5	80	80	-	160	160	-	160	160	-	16	16	-	120	120	-	-	-	-	-	-	-	720	720	-
S6	80	80	-	160	160	-	160	160	-	16	16	-	120	140	-	-	-	-	-	-	-	630	-	-
S7	80	80	-	160	160	-	160	160	-	16	16	-	120	140	-	-	-	-	-	-	-	620	-	-
S8	80	80	-	160	160	-	160	160	-	16	16	-	120	100	-	-	-	-	-	-	-	720	-	-
S9	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
S10	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
S11	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
S12	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
S13	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
S14	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
S15	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
S16	-	-	80	-	-	160	-	-	160	-	-	16	-	-	120	-	-	-	-	-	-	-	-	720
Opp.	-	-	-	-	-	-	-	-	-	-	-	-	320	380	140	555	1040	1650	645	140	920	-	11520	-
Total	**640**	**640**	**640**	**1280**	**1280**	**1280**	**1280**	**1280**	**1280**	**128**	**128**	**128**	**1280**	**1340**	**1100**	**555**	**1040**	**1650**	**645**	**140**	**920**	**5020**	**12960**	**5760**

Figure 3.3 – Combined Survey Effort at North Star (Level 2 and Targeted Surveys)

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3.7 TAXONOMY AND NOMECLATURE

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

Table 3.7 - References used for Identification

Fauna Group	Reference
Mammals	Menkhorst and Knight (2011), Van Dyck and Strahan (2008)
Bats	Churchill (1998), Menkhorst and Knight (2011)
Birds	Simpson and Day (2004)
Reptiles	Cogger (2000), Wilson and Swan (2010)
Geckos	Storr *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)

3.8 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).

3.9 DATA ANALYSIS

3.9.1 Survey Adequacy

There are three general methods of estimating species richness from sample data: extrapolating species-accumulation curves (SACs), fitting parametric models of relative abundance, and using non-parametric estimators (Bunge and Fitzpatrick 1993; Colwell and Coddington 1994; Gaston 1996). In this report, the level of survey adequacy was estimated using SACs, which graphically illustrate the accumulation of new species as more individuals are recorded. Ultimately, the asymptote is reached at the level at which no new species are present. To eliminate features caused by random or periodic temporal variation, the sample order was randomised 10,000 times using EstimateS (version 8, Colwell 2009). In order to estimate the theoretical maximum for each fauna group, a Michaelis-Menten enzyme kinetic curve was calculated and used as a stopping rule technique. Theoretical maxima using other richness estimators were also compared.

SAC analysis was conducted for two fauna groups: birds (20-minute survey data) and terrestrial fauna (trapping data). This form of analysis assumes a standard sampling effort. Therefore, species recorded through opportunistic methods are not included.

3.9.2 Habitat Assessment

Analysis of the fauna survey data was undertaken to determine the similarities in fauna communities and identify any unique fauna habitats, based on differences in species diversity. With an aim to minimise variables, separate analyses were conducted for the two primary methods of systematic sampling: terrestrial fauna (mammals, reptiles, amphibians; trapping data) and birds (20-minute set-time surveys). In order to reduce the impact of having a few very dominant (abundant) species, the bird survey data were subjected to log+1 transformation. This was not considered necessary for the terrestrial fauna dataset, as abundance was generally low.

To test whether the differences in species diversity between habitat types were significant, analyses of similarity (ANOSIM) (Clarke 1993) comparisons were made using the one-way ANOSIM function. ANOSIM was calculated using the Bray-Curtis Similarity Index with 9999 permutations. A resulting positive R-value that nears 1 indicates that the greatest similarities occur within groups (fauna habitats) rather than between groups, suggesting discrete habitat types. A p-value below 0.05 was considered to indicate statistical significance.

Non-metric multidimensional scaling (MDS) was also applied to each dataset, using the Euclidean similarity measure. Resulting stress values below 0.20 were considered to indicate a good fit of the scaling to the matrix. Three dimensional scaling was selected to reduce the "raw stress". Analysis was undertaken using the PAST software package (Hammer *et al.* 2001).

Seven fauna habitats (Acacia Shrubland on Hard Soil, Creekline, Granite Outcrop, Rocky Plains with Spinifex, Rocky Spinifex Hills, Rocky Ridge/Breakaway/Gorge, and Sandy Plains with Spinifex and Scattered Granites) were identified during the current survey. Five of these habitat types (Creekline, Rocky Ridge/Breakaway/Gorge, Rocky Spinifex Hills and Sandy Plains with Spinifex and Scattered Granites) were systematically sampled for terrestrial fauna by the installation of trapping sites during the Level 2 survey. These same habitat types with the addition of Acacia Shrubland on Hard Soil were systematically surveyed for birds. During the targeted conservation significant species survey two systematic trapping sites (Site Y, Z) were established in the granite outcrops.

3.10 CONSERVATION SIGNIFICANT FAUNA

After the results of the literature review, database searches and survey results from the Level 2 and targeted surveys were compiled, fauna species that are listed under current legislative frameworks were identified. Three conservation lists have been developed at national (EPBC Act) and state level (WC Act and DEC priority list).

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

- fauna habitats and their condition known to exist within the Project area;
- distance of previously recorded conservation significant species from the Project 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 Project area.

For each conservation significant species potentially occurring in the Project area, the examined factors were collated, and assigned to their corresponding category (Table 3.8).

Table 3.8 – – Likelihood of Occurrence Categories

HIGH	Species recorded within, or in proximity to, the Project area within 50 yrs; suitable habitat occurs
MEDIUM	Species recorded outside Project area, but within 100 km; limited suitable habitat occurs
LOW	Species rarely, or not recorded, within 100 km, and/or suitable habitat does not occur

If a conservation significant species was located within the Project area, the impact of disturbance to these individuals was assessed at a regional scale. All of these species are significant as they have been assigned a conservation status by the DEC and any disturbance to populations located within the Project area should be avoided where possible. The regional impact to each species was categorised into three levels (Table 3.9).

Table 3.9 - Regional Impact to the Conservation Significant Species

HIGH	Disturbance to individuals will have a major regional impact as this is the only, or one of few, records within the region.
MEDIUM	There are some additional records for this species outside the Project area within the region, and the nature and scale of disturbance to these individuals would determine impact to the species at a regional scale.
LOW	The species has many records within the region and disturbance to individuals is unlikely to be regionally significant.

3.11 SURVEY TEAM

Field survey team members and external consultants are listed in Table 3.10. The survey was conducted under DEC Regulation 17 Licence SF007862.

Table 3.10 – Field Survey Personnel.

Survey Member	Expertise	Relevant Qualifications	Experience
George Swann	Ornithology	-	41 years
Dr. Lazaro Roque-Albelo	Invertebrate Zoology	Ph.D.	20 years
Bob Bullen (external consultant)	Bat Call WA	-	15 years
David Algaba	Herpetology	-	11 years
Damien Cancilla	Mammalogy	B.Sc. (Hons)	7 years
Astrid Heidrich	Herpetology	M.Sc.	6 years
Jordan Vos	Herpetology	-	6 years
Laura Quinn	Invertebrate Zoology	M.Sc.	5 years
Bruce Greatwich	Ornithology	B.Sc.	3 years
Jesse Forbes-Harper	Zoology	B.A., B.Sc. (Hons)	2 years
Anna Nowicki	Zoology	B.Sc. (Hons)	2 years
Kaisan Critchell	Environmental Management	P.G.Dip.	2 years
Teagan Douglas	Ornithology	B.Sc. (Hons)	2 years
Leigh Smith	Herpetology	Certificate for vet nursing	2 years
Adam Young	Zoology	B.Sc.	1 year

4 RESULTS

4.1 LITERATURE REVIEW

The potential fauna assemblage of the Project area was determined using the results of database searches and records of previous surveys in proximity to the Project area (Table 3.2 and Table 3.3). A comparison of the number of species recorded during previous surveys and the current survey is presented in Table 4.1. Regional fauna records can be found in Appendix D.

The potential fauna assemblage of the region comprises 47 native and six introduced mammals, 150 birds, 111 reptiles, and seven amphibians.

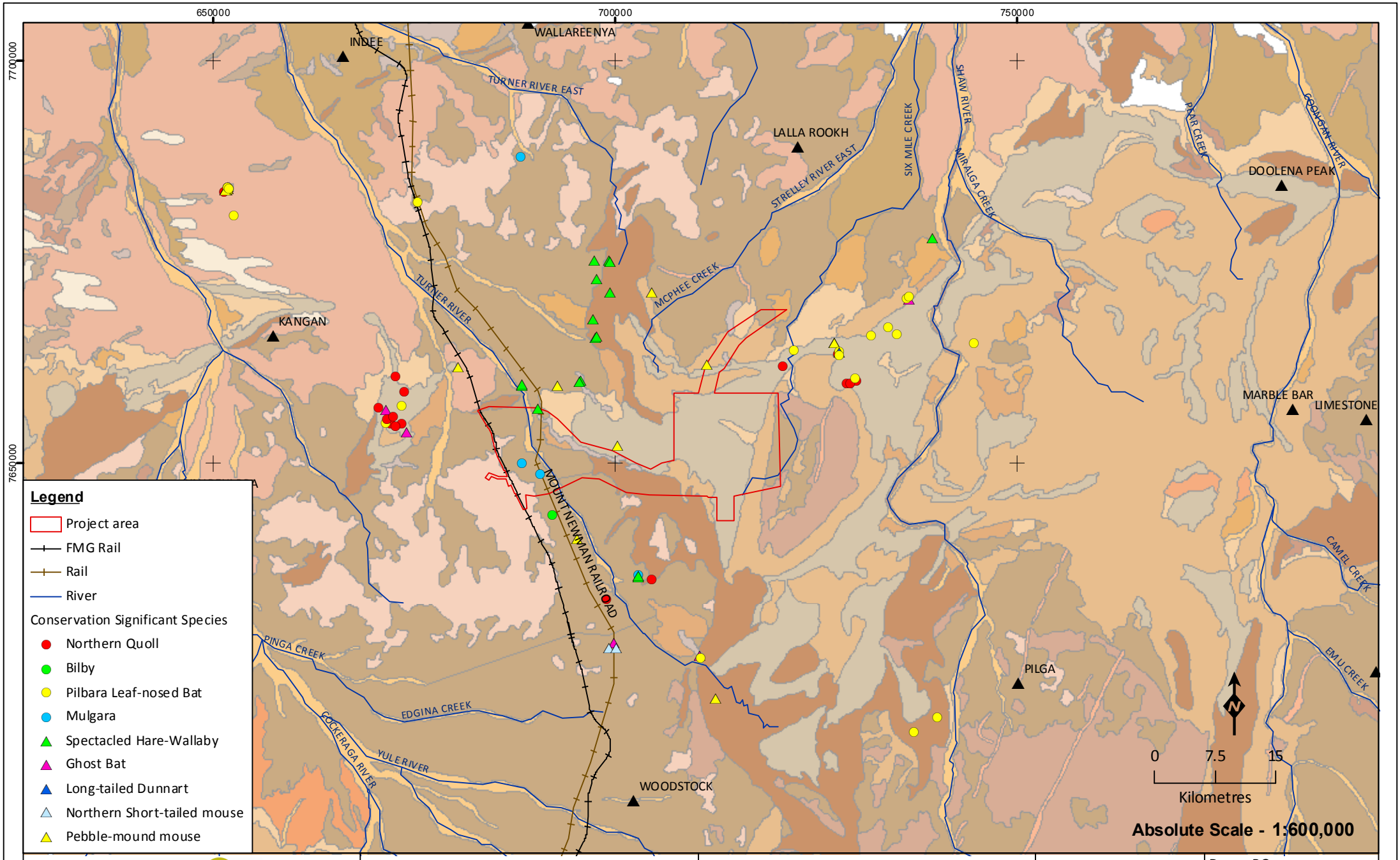
Table 4.1 – Comparison of Results to Previous Fauna Surveys

Reference	Native Mammals (introduced mammals)	Birds	Reptiles	Amphibians
ecologia Internal Database	30 (6)	103	75	4
Bamford (2001)	18 (4)	79	28	2
Biota (2005)	19 (6)	74	55	6
Biota (2007)	6	2	-	-
Outback Ecology (2006)	19 (1)	79	61	3
Outback Ecology (2010)	1	-	-	-
Outback Ecology (2011)	18 (6)	40	30	1
Molhar Pty Ltd (2007)	1	-	-	-
NatureMap	30 (6)	111	85	7
DEC Threatened and Priority Fauna Search	9	5	3	0
DSEWPaC Protected Matters Search	4	8	1	0
Birdata	-	112	-	-
This Survey	19 (3)	81	75	6
Total	**47 (6)**	**150**	**111**	**7***

The frog genus *Uperoleia* has recently undergone taxonomic revision with the description of a new species (U. saxatilis). Previous records of *Uperoleia* may include this new species.

4.2 CONSERVATION SIGNIFICANT SPECIES

Based on database searches and the results of previous biological surveys in the surrounding region, nine mammal, 13 bird and three reptile species of conservation significance could potentially occur in the Project area (. Information on the distribution, ecology, likelihood of occurrence and potential impacts to the species are summarised in Table 4.3.



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Regional Records of Conservation Significant Mammals

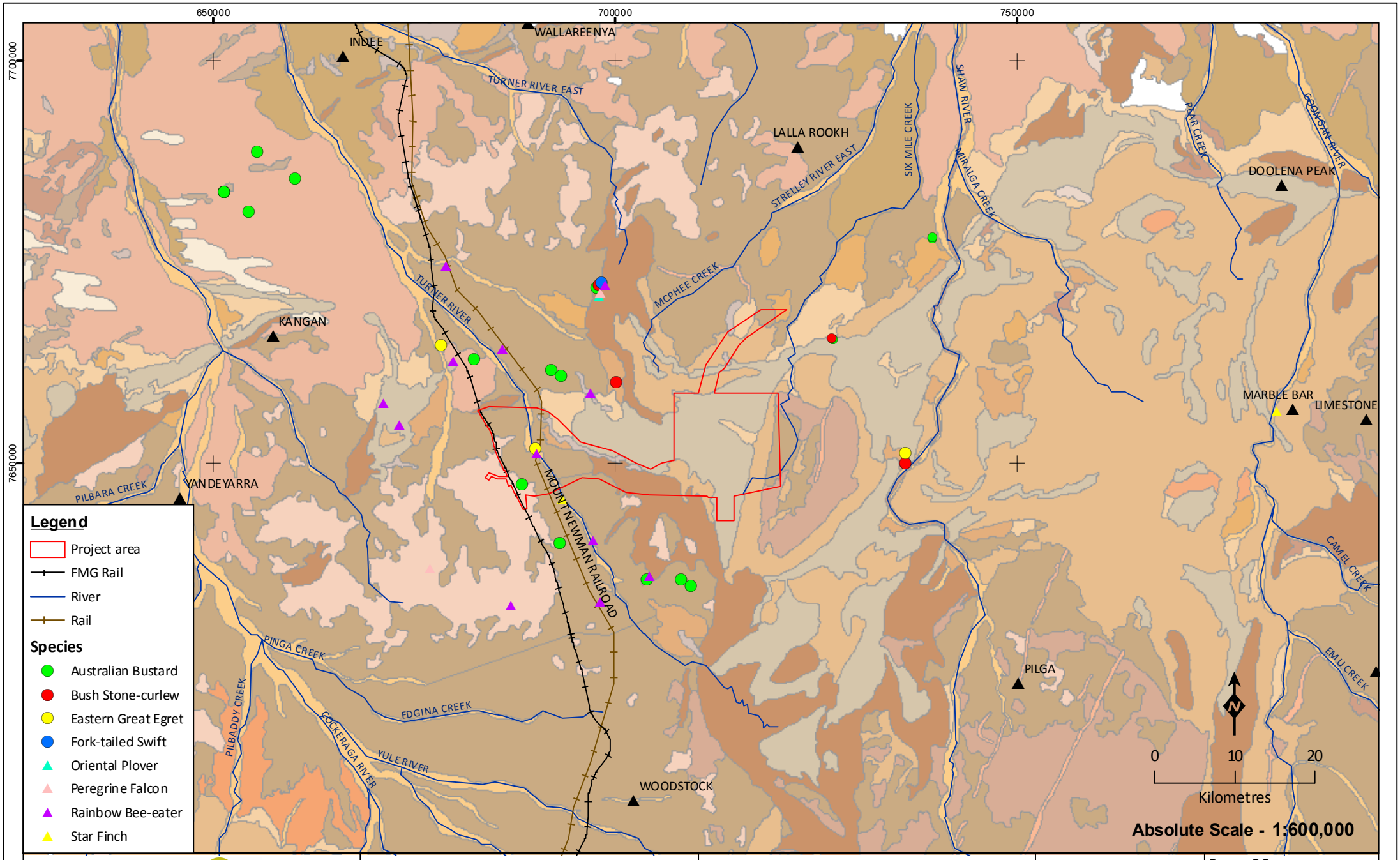
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Project ID: 1322

Drawn: BG
Date: 05/12/11

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

Unique Map ID: BG199

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Regional Records of Conservation Significant Birds

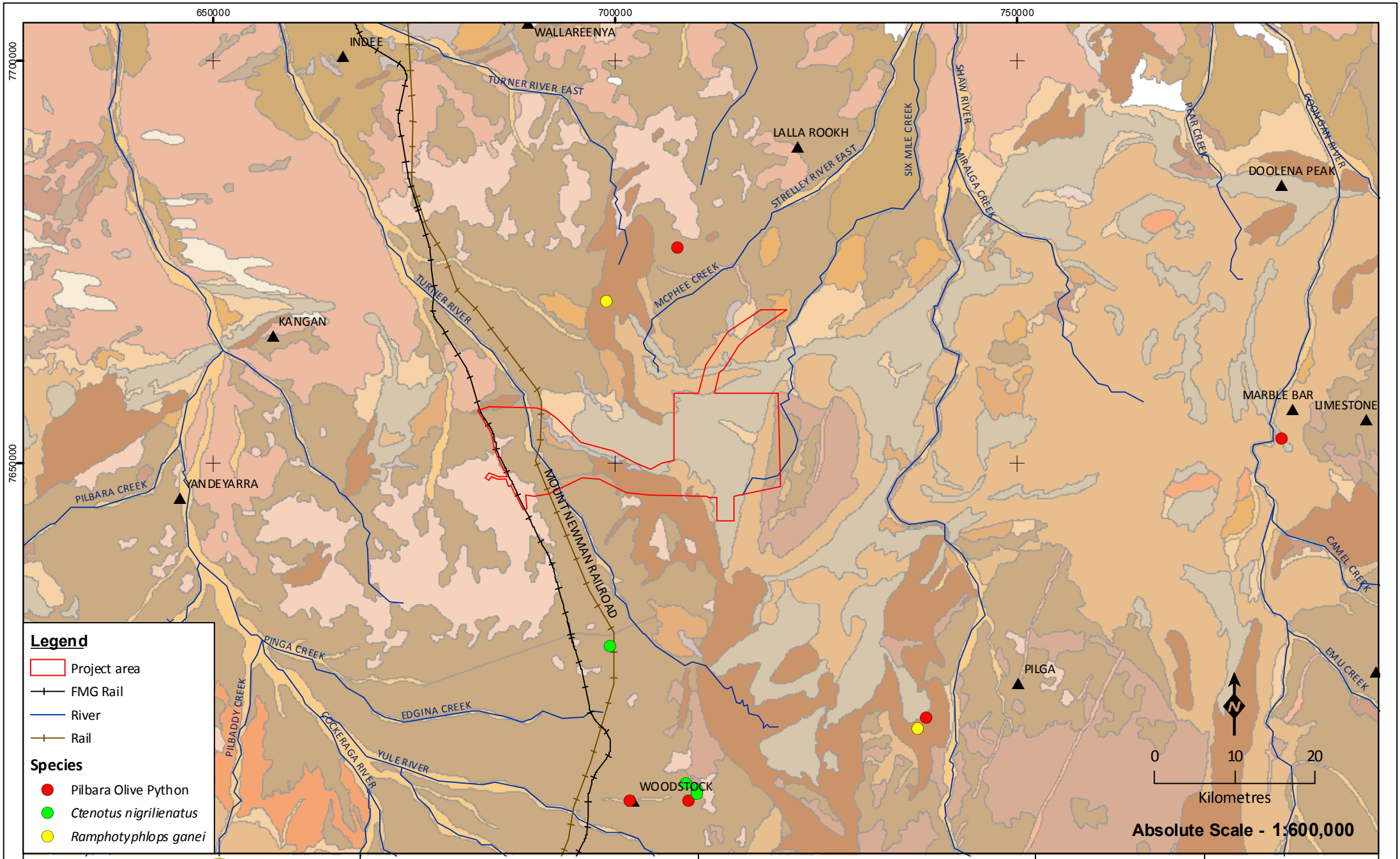
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Drawn: BG
Date: 05/12/11

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Projection: Transverse Mercator
Datum: GDA 1994

Unique Map ID: BG200

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FMG Fortescue The New Force in Iron Ore

Regional Records of Conservation Significant Reptiles

Figure: 4.3
Project ID: 1322

Drawn: BG
Date: 05/12/11

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

Unique Map ID: BG201

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4.3 SURVEY RESULTS

The current survey resulted in the identification of 19 native and three introduced mammal species, 81 bird species, 75 reptile species and six amphibian species (Appendix E).

4.3.1 Mammals

The native mammal fauna assemblage included six dasyurid species (small carnivorous marsupials), two macropods (kangaroos), five murids (mice) and six Microchiropteran (small echolocating bats). Mice and dasyurids were captured in pitfall and Elliott traps at systematic trapping sites. The Kangaroo species were observed during diurnal and nocturnal opportunistic searches, nocturnal road-spotting, and incidentally whilst conducting bird surveys. All bat species were identified from Sm2 bat-recording devices.

Two of the dasyurids recorded are conservation significant species; the Northern Quoll (*Dasyurus hallucatus*, EPBC Act Endangered) and the Long-tailed Dunnart (*Sminthopsis longicaudata*, DEC Priority 4). Northern Quolls were only found in proximity to rocky gorges and cliff faces that were present on the edge of the plateaux and escarpments present in the Project area. The Long-tailed Dunnarts were caught at sites 5, 6 and 7, on top of the 'Darby' ridgeline in stony spinifex habitat. These records are significant because Long-tailed Dunnarts have not been previously recorded in this region (Appendix D). For the most part, greater numbers of both dasyurids and murids were caught at sites 1-8 during the second phase of the survey which may be a result of the delayed effects (flowering and seeding) of increased rainfall in March 2011 (prior Phase 1). Phase 1 of the Level 2 survey was carried out immediately after rainfall in autumn 2011 and therefore the flowering and seeding of most plants had not taken place yet.

A few potentially active mounds of Western Pebble-mouse (DEC Priority 4) were found in the Project area on rocky spinifex hills. One of the bat species identified, the Pilbara Leaf-nosed Bat, is also conservation significant (EPBCA Vulnerable), and was recorded at several sites near rocky gorges. In regards to the bats, the Ghost Bat (DEC Priority 4) is of interest because the Project area has potential to comprise both, foraging and roost habitat. However, despite the large number of nights of bat recordings, the Ghost Bat was not recorded during the Level 2 survey, and only recorded once (foraging individual) during the targeted surveys conducted in July 2011 (*ecologia* 2011). Therefore the species appears to occasionally utilize the Project are as hunting ground.

During the Level 2 survey three species of introduced mammal were recorded. Both cows and camels were seen, whilst evidence of feral cats was also found. These species were most likely present due to the numerous sources of permanent water found throughout the Project area.

4.3.2 Birds

A total of 80 bird species were identified during the Level 2 survey. This high diversity is similar to the number of species recorded during surveys in nearby regions. The avifaunal assemblage was augmented by the various permanent or long-standing water bodies either within or near some of the survey sites (e.g. sites 9, 12, 13), and those in the wider Project area. The considerable range of habitats throughout the Project area is thought to have contributed to this diversity.

Four DEC Priority 4 bird species were recorded; the Australian Bustard, Bush Stone-curlew, Star Finch and Grey Falcon. Most noteworthy is the record of four Grey Falcons – two adults and two juveniles – as this species is considered the rarest raptor in Australia (Ehmann and Watson 2008; Olsen and Olsen 1985) Fork-tailed Swifts and Rainbow Bee-eaters (EPBCA Migratory) were also identified within

within the Project area. Two other bird species, the Buff-banded Rail and Whiskered Tern, are notable in that they are previously unrecorded in the region. The majority of the avifaunal assemblage was comprised of generalist species which commonly occupy stony spinifex habitats, such as honeyeaters, woodswallows, pigeons, doves and finches.

4.3.3 Reptiles

The reptile assemblage consisted of 75 species in total, comprised of 14 geckos, seven pygopods (legless lizards), 25 skinks, six agamids (dragon lizards), eight varanids (goannas), two typhlopids (blind snakes), three pythons, and ten elapids (venomous snakes). Whilst the majority of these species are commonly found in stony spinifex habitats, the relatively high diversity is largely due to the wide variety of habitats in the survey area. For example, a number of the species identified, including *Heteronotia spelea*, *Oedura marmorata* and *Egernia depress*, only inhabit rock walls. Others prefer areas near permanent water, such as *Varanus pilbarensis* and the conservation significant Pilbara Olive Python (*Liasis olivaceus barroni*, EPBCA Vulnerable). The unusually high number of Pilbara Olive Pythons caught, particularly at site 12 (four of six individuals recorded) but also at several other areas with permanent water, indicated that highly suitable habitat for this species was present throughout the Project area. It is also noteworthy that two of the reptile species (*Diplodactylus galaxias* and *Delma fraseri*) have not been recorded previously in the region.

4.3.4 Amphibians

Six species of frog were recorded during this survey, including four species of burrowing frog and two terrestrial species. The majority of individuals were caught during the first phase, due to high levels of rainfall in the weeks and months preceding this survey. The frogs found during the second phase were active in response to rainfall on a day of the survey. During the third phase, when there was no rain, frogs (mostly *Uperoleia*) were only seen at site 12 and survey locations where there was permanent water present (Near site 9, site 10, opp searches). Recent taxonomic revisions of the *Uperoleia* genus (Catullo *et al.* 2011) describe a new species found across the Pilbara region, *Uperoleia saxatilis*. Distribution maps indicate that the species recorded during this survey may be the new species *Uperoleia saxatilis* or *Uperoleia glandulosa*.

4.3.5 Fish

Four species of fish were recorded from within the Project area at three locations. These locations consisted of two ephemeral water pools along creek lines during the first phase of surveying as well as the permanent water source at site 12. During phase 2 and 3 of surveying, all ephemeral water pools had dried up with fish species only present at site 12. Interestingly, one of the permanent water sources recorded within the Project area contained no fish species, despite the presence of a series of long permanent pools of water, which typically act as refuge for fish species during the dry season. Water quality from this water source was thought to not be suitable for fish species, due to a thick layer of brown, silty substrate from plant material on the bottom of the pools.

4.3.6 Conservation Significant Fauna

Eleven species of conservation significance (five mammal, five bird and one reptile species) were recorded from within the Project area during the Level 2 survey; these records are summarised in Table 4.2, and Figure 4.5. Additional seven species were assessed as having a medium to high likelihood of occurrence, with the remaining five species assessed as having a low likelihood of

occurrence. Species with medium to high likelihood of occurrence are described in greater detail in Section 5.1.

Table 4.2 - Conservation Significant Fauna Recorded during the Survey

Species (ID)	Location				Conservation Significant Species	
	Easting	Northing	Site	Survey	Individuals	Evidence
Mammals						
Northern Quoll (no ID)	711690	7651181	NS S5	Phase 1	1	captured
Northern Quoll (no ID)	711690	7651181	NS S5	Phase 1	1	captured
Northern Quoll (NS7)	711690	7651181	NS S5	Phase 2	1	captured
Northern Quoll (NS7)	711690	7651181	NS S5	Phase 2	1	captured
Northern Quoll (NS4)	713654	7646207	NS S7	Phase 2	1	captured
Northern Quoll (no ID)	713227	7644656	Opp.	Phase 1	1	sighted
Northern Quoll (no ID)	714547	7655542	Opp.	Targeted	n/a	scats
Northern Quoll (no ID)	715822	7654745	Opp.	Targeted	n/a	motion camera
Northern Quoll (no ID)	718439	7656215	Opp.	Targeted	n/a	motion camera
Northern Quoll (no ID)	715787	7652345	Opp.	Targeted	n/a	skull
Northern Quoll (no ID)	715174	7649349	Opp.	Targeted	n/a	tracks
Northern Quoll(no ID)	716122	7649359	Opp.	Targeted	n/a	motion camera
Northern Quoll (no ID)	712805	7654493	Opp.	Targeted	n/a	skull
Northern Quoll (no ID)	713468	7644660	Opp.	Phase 1	n/a	motion camera
Northern Quoll (no ID)	715908	7649247	Opp.	Targeted	n/a	remains
Northern Quoll (NS1)	711537	7651137	Opp.	Targeted	1	captured
Northern Quoll (NS2)	711648	7651037	Opp.	Targeted	1	captured
Northern Quoll (NS3)	713394	7643895	Opp.	Targeted	1	captured
Northern Quoll (NS4)	713311	7644664	Opp.	Targeted	1	captured
Northern Quoll (NS5)	712918	7648805	Opp.	Targeted	1	captured
Northern Quoll (NS6)	711957	7650706	Opp.	Targeted	1	captured
Northern Quoll (NS7)	711476	7651205	Opp.	Targeted	1	captured
Northern Quoll (NS8)	713117	7646259	Opp.	Targeted	1	captured
Northern Quoll (NS9)	713311	7644660	Opp.	Targeted	1	captured
Northern Quoll (NS10)	712257	7650549	Opp.	Targeted	1	captured
Northern Quoll (AA1)	718348	7655633	Opp.	Targeted	1	captured
Northern Quoll (AA2D)	713229	7657185	Opp.	Targeted	1	captured
Northern Quoll (AA2B)	718069	7655602	Opp.	Targeted	1	captured
Northern Quoll (AA3)	718914	7658171	Opp.	Targeted	1	captured
Northern Quoll (AA4)	718680	7658073	Opp.	Targeted	1	captured
Northern Quoll (AA5)	718069	7655602	Opp.	Targeted	1	captured
Northern Quoll (AA6)	718914	7658171	Opp.	Targeted	1	captured
Northern Quoll (AA7)	718914	7658171	Opp.	Targeted	1	captured
Northern Quoll (AA8)	718765	7658124	Opp.	Targeted	1	captured
Northern Quoll (AA9)	718680	7658073	Opp.	Targeted	1	captured
Northern Quoll (no ID)	714504	7655427	Opp.	Phase 2	n/a	motion camera

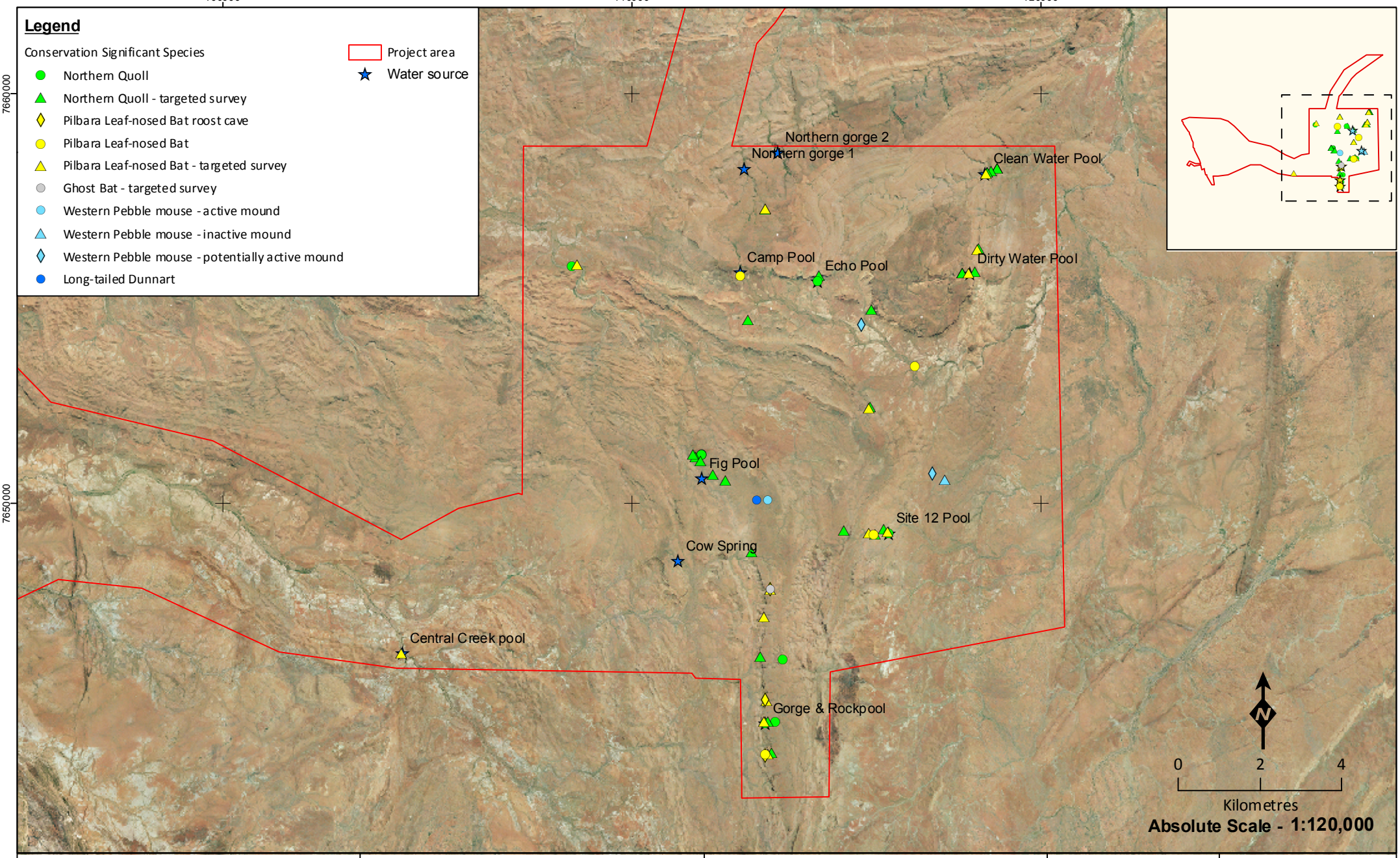
Species (ID)	Location				Conservation Significant Species	
	Easting	Northing	Site	Survey	Individuals	Evidence
Northern Quoll (AA1, AA2)	716248	7649263	NS12	Phase 3	6	captured
Northern Quoll (no ID)	708520	7655785	NS14	Phase 3	1	captured
Pilbara Leaf-nosed Bat	713217	7644678	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	704322	7646345	Opp.	Targeted	n/a	potential roost cave
Pilbara Leaf-nosed Bat	713307	7643882	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	718626	7658052	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	715775	7652328	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	708641	7655822	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	713235	7657190	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	718223	7655604	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	718436	7656199	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	716220	7649315	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	715756	7649289	Opp.	Targeted	n/a	foraging
Pilbara Leaf-nosed Bat	715885	7649253	NS 12	Phase 3	n/a	possible recording
Pilbara Leaf-nosed Bat	712644	7655550	NS 9	Phase 3	n/a	possible recording
Pilbara Leaf-nosed Bat	716903	7653360	NS 10	Phase 3	n/a	possible recording
Pilbara Leaf-nosed Bat	713368	7647895	Opp.	Phase 2	n/a	roost cave
Pilbara Leaf-nosed Bat	713243	7645213	Opp.	Phase 2	n/a	roost cave
Pilbara Leaf-nosed Bat	713246	7643861	Opp.	Phase 2	n/a	roost cave (high activity)
Pilbara Leaf-nosed Bat	713234	7643873	Opp.	Phase 2	n/a	roost cave (nearby)
Ghost Bat	713368	7647895	Opp.	Targeted	n/a	recording
Long-tailed Dunnart	711690	7651182	NS 5	Phase 1	1	captured
Long-tailed Dunnart	713040	7650065	NS 6	Phase 1 & 2	5	captured
Long-tailed Dunnart	713654	7646208	NS 7	Phase 2	5	captured
Pebble Mound mouse	717644	7650588	Opp.	Targeted	n/a	pebble mound (old)
Pebble Mound mouse	715576	7654376	Opp.	Targeted	n/a	pebble mound (possibly active)
Pebble Mound mouse	717332	7650735	Opp.	Targeted	n/a	pebble mound (possibly active)
Pebble Mound mouse	713289	7650074	Opp.	Phase 2	n/a	pebble mound (active)
Birds						
Fork-tailed Swift	713654	7646207	NS 7	Phase 1	8	observed
Fork-tailed Swift	699195	7648049	NS 3	Phase 1	1	observed
Fork-tailed Swift	685332	7665038	Opp.	Phase 1	8	observed
Grey Falcon	691618	7647701	NS 2	Phase 1	4	observed
Australian Bustard	688236	7647898	NS 1	Phase 1	1	observed
Australian Bustard	690134	7655437	NS 8	Phase 1	1	observed
Australian Bustard	692508	7660645	Opp.	Phase 1	1	observed
Australian Bustard	687425	7660645	Opp.	Phase 1	2	observed

Species (ID)	Location				Conservation Significant Species	
	Easting	Northing	Site	Survey	Individuals	Evidence
Australian Bustard	691965	7647213	Opp.	Phase 2	1	observed
Australian Bustard	690760	7649444	Opp.	Phase 2	2	observed
Bush-stone Curlew	693397	7645486	Opp.	Phase 2	2	observed
Bush-stone Curlew	693494	7645505	Opp.	Phase 2	1 + chick	observed
Bush-stone Curlew	707785	7656380	Opp.	Targeted	1	observed
Rainbow bee-eater	688236	7647898	NS 1	Phase 2	1	observed
Rainbow bee-eater	691618	7647701	NS 2	Phase 1	9	observed
Rainbow bee-eater	699195	7648049	NS 3	Phase 1	1	observed
Rainbow bee-eater	700273	7648898	NS 4	Phase 2	3	observed
Rainbow bee-eater	713654	7646207	NS 7	Phase 2	3	observed
Rainbow bee-eater	690134	7655437	NS 8	Phase 2	2	observed
Rainbow bee-eater	712644	7655550	NS 9	Phase 3	11	observed
Rainbow bee-eater	716903	7653360	NS 10	Phase 3	3	observed
Rainbow bee-eater	716248	7649263	NS 12	Phase 3	35	observed
Rainbow bee-eater	708520	7655785	NS 14	Phase 3	5	observed
Rainbow bee-eater	711075	7653905	NS 16	Phase 3	1	observed
Rainbow bee-eater	690122	7651442	Opp.	Phase 2	1	observed
Rainbow bee-eater	689945	7652966	Opp.	Phase 2	1	observed
Rainbow bee-eater	708778	7656575	Opp.	Phase 2	6	observed
Rainbow bee-eater	693369	7645543	Opp.	Phase 2	6	observed
Reptiles						
Pilbara Olive Python	716113	7649224	NS 12	Phase 3	1	observed
Pilbara Olive Python	716313	7649424	NS 12	Phase 3	1	observed (in pool)
Pilbara Olive Python	716213	7649324	NS 12	Phase 3	1	observed
Pilbara Olive Python	717827	7655606	Opp	Phase 3	1	observed
Pilbara Olive Python	711107	7648592	Opp	Phase 2	1	observed
Pilbara Olive Python	711673	7650631	Opp	Phase 2	1	observed
Pilbara Olive Python	714916	7648959	Opp	Targeted	n/a	scats
Pilbara Olive Python	712944	7648754	Opp	Targeted	n/a	skin
Pilbara Olive Python	715787	7652345	Opp	Targeted	n/a	remains

Zone 50K; Datum WGS 84

*Individuals = animals seen at the same time and, therefore, numbers are confirmed. Records = may be separate bird surveys or different days at a trap site and, therefore, some individuals may have been observed multiple times.

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Conservation Significant Mammals Recorded during the Level 2 and Targeted Survey

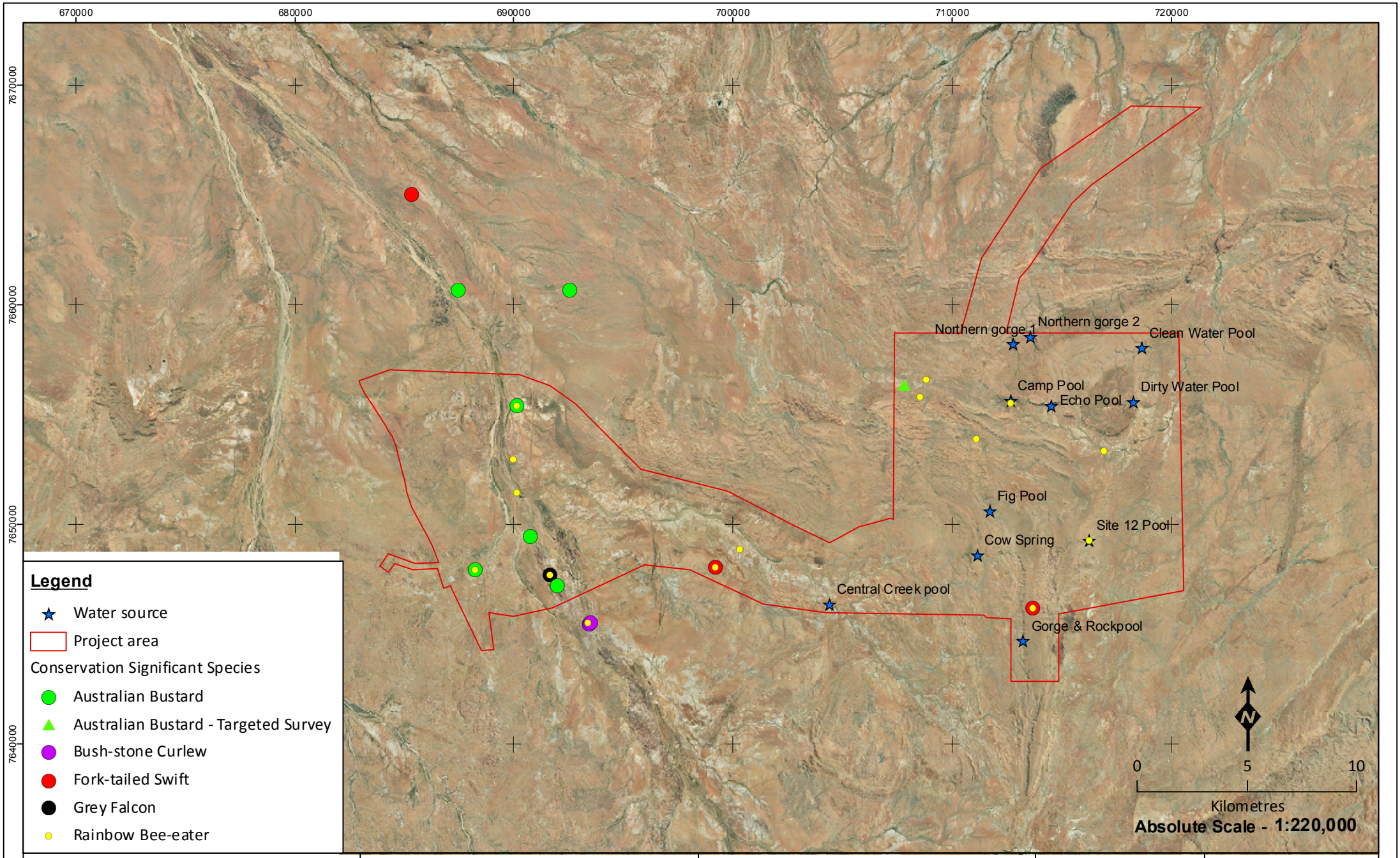
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Date: 2/12/11

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Datum: GDA 1994

Unique Map ID: BG198

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FMG Fortescue The New Force in Iron Ore

Conservation Significant Birds Recorded during the Level 2 and Targeted Survey

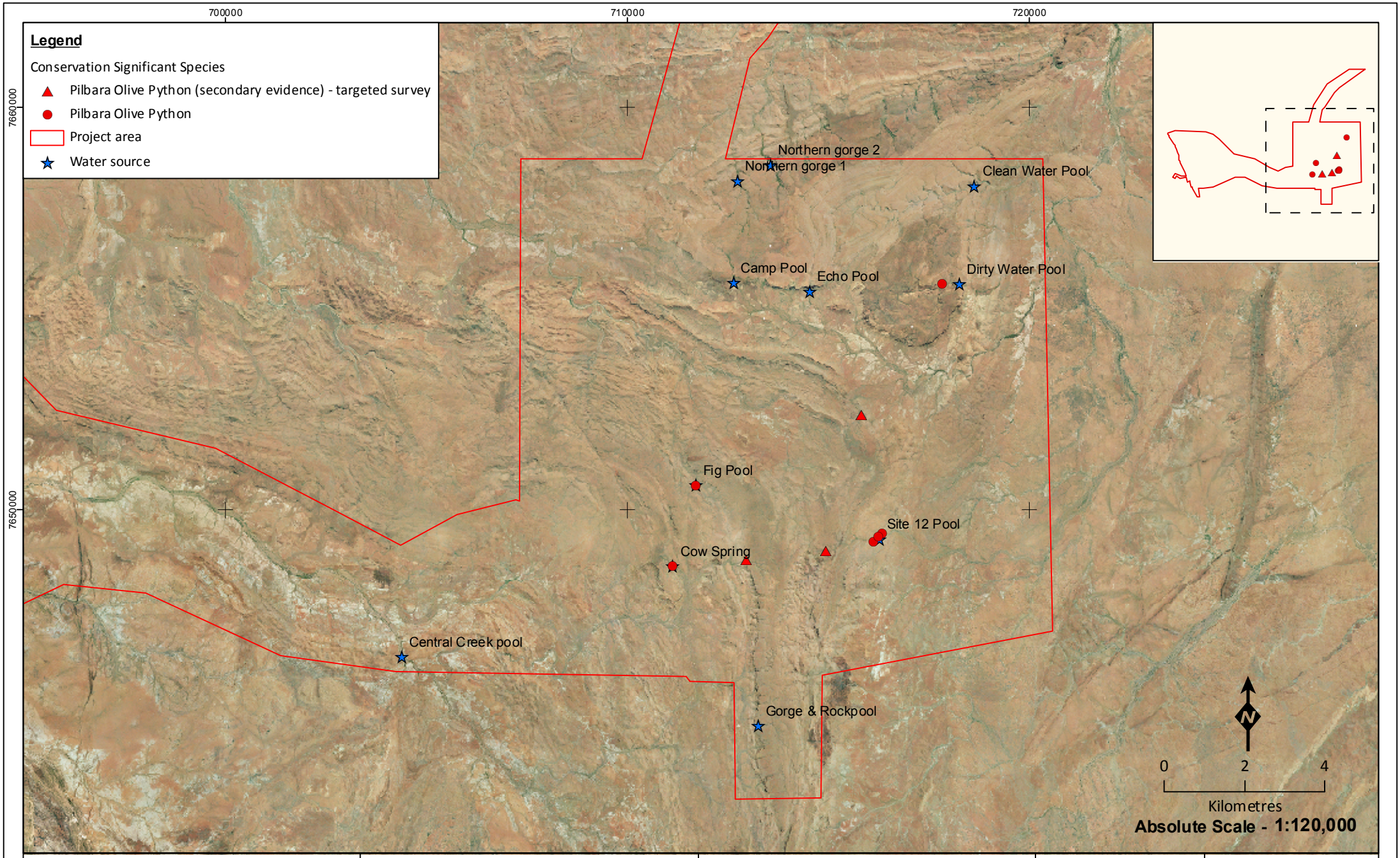
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Date: 2/12/11

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Unique Map ID: BG197

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FMG Fortescue The New Force in Iron Ore

Conservation Significant Reptiles Recorded during the Level 2 and Targeted Survey

Figure: 4.6
Project ID: 1322

Drawn: BG
Date: 2/12/11

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

Unique Map ID: BG198b

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Table 4.3 – Conservation Significant Fauna Occurring or Potentially Occurring in the Project area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Regional Impacts
	EPBC Act	WC Act	DEC				
Mammals							
Northern Quoll *Dasyurus hallucatus*	EN	S1	EN	Typically rocky areas, but also eucalypt forest and woodland.	Six previous records from within 13km of the Project area from database searches and previous records.	**RECORDED** Suitable habitat and large number of records (38 records of at least 20 individuals) from within the Project area during the Level 2 survey and targeted survey.	**HIGH** High value habitat exists within the Project area, the destruction of which has the potential to significantly impact the local population. Impact on a regional scale is anticipated to be moderate due to the species' ability to disperse.
Greater Bilby *Macrotis lagotis*	VU	S1	VU	Variety of habitats on soft soils, including spinifex grasslands, acacia shrublands, open woodlands and cracking clays.	One NatureMap record from 2.7 km south of the Project area.	**MEDIUM** Some suitable habitat located to the west of the infrastructure corridor, closest record from 2.7 km south of the Project area (NatureMap).	**LOW** Suitable habitat exists outside the Project area. Bilbies are likely to disperse away from impacts. No evidence of presence within Project area.
Pilbara Leaf-nosed Bat *Rhinonicteris aurantius*	VU	S1	VU	Roosts in hot, humid caves during dry season and in eucalypt trees along creek lines in wet season.	Two *ecologia* records approximately 100 km from the Project area (*ecologia* internal database). Several individuals from eight locations within 50 km from the Project area, including two records approximately 10 km away and one maternity roost cave with approximately 50-100 individuals at Lalla Rookh mine (NatureMap, DEC Threatened Fauna Database).	**RECORDED** Three confirmed roost caves located within the Project area. Previously recorded roost cave at Lalla Rookh.	**MEDIUM** If roost caves are affected impact to species will be significant on a local scale and moderate on a regional scale.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Regional Impacts
	EPBC Act	WC Act	DEC				
Crest-tailed Mulgara *Dasycercus cristicauda*	VU			Restricted to sandridges with an understorey dominated by spinifex.	Species has only been recently split up and the taxonomic status of previous records is unknown. The WA Museum indicates that taxonomy is expected to undergo revision (Ric How, WA Museum, pers. comment). Possible burrow found in 2008 approximately 35 km from Project area (*ecologia* internal database). Two records from inside the Project area (1958, 2001) and one recent record (2011) from 10 km south of the Project area (NatureMap).	**LOW** Likelihood of occurrence uncertain due to lack of knowledge. No suitable habitat present within project area and some previous records of Mulgara sp. in the area.	**LOW** Potential impacts uncertain due to lack of knowledge, but species are likely to be widely distributed outside the Project area.
Brush-tailed Mulgara *Dasycercus blythi*			P4	Sand plains and gibber plains with moderately dense spinifex with 'runways' between clumps.		**MEDIUM** Likelihood of occurrence uncertain due to lack of taxonomic knowledge but the species is thought to have a potential to occur based on some suitable habitat present in the west of the Project area and some previous records of Mulgara in the area.	**LOW** Potential impacts uncertain due to lack of knowledge, but no suitable habitat present within Project area.
Long-tailed Dunnart *Sminthopsis longicaudata*			P4	Rocky habitat with spinifex or open habitat with a rocky mantle	No previous records from database searches within 40 km or previous surveys within 100 km of Project area. NatureMap lists nearest record from approximately 70 km from Project area.	**RECORDED** Extensive suitable habitat exists within the Project area. Recorded during current survey.	**MEDIUM** Relatively large number of records from within Project area (11 individuals versus one previous record in the region) Extent of impact difficult determine as threatening processes are unknown.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Regional Impacts
	EPBC Act	WC Act	DEC				
Spectacled Hare-wallaby *Lagorchestes conspicillatus leichardti*			P3	Tussock or hummock grassland with mid-dense or sparse tree and shrub cover.	A total of 102 individuals previously recorded from 16 locations from within 20 km of the Project area, of which two individuals were recorded from inside the Project area (NatureMap, DEC Threatened Fauna Database).	**HIGH** Some suitable habitat, large number of previous records nearby, including two inside the Project area.	**LOW** Majority of records (NatureMap) for the species are clustered in the area surrounding the Project area. The Project area is unlikely to provide key habitat and suitable habitat is available outside the Project area.
Ghost Bat *Macroderma gigas*	-	-	P4	Caves, rockpiles and abandoned mines. Will travel 2 km from roost to hunt.	One *ecologia* record approximately 100 km from Project area (*ecologia* internal database). 17 individuals within 100 km of the Project area (Outback Ecology 2006, NatureMap, DEC Threatened Fauna Database).	**RECORDED** Large amounts of potentially suitable habitat, several nearby recent records. Single foraging individual recorded from targeted survey (*ecologia* 2011)	**LOW** Individuals may be impacted, particularly if transient Ghost Bats hunt and temporarily roost in the Project area, but suitable habitat exists outside Project area.
Short-tailed Mouse *Leggadina lakedownensis*	-	-	P4	Mixed grasslands, samphire, acacia shrublands and stony ranges on cracking clay.	Two records approximately 20 and 40 km from Project area, and 12 records approximately 90 km from Project area (ecologia internal database, Biota 2005, NatureMap, DEC Threatened Fauna Database).	**LOW** Fourteen records within 100 km, but little suitable habitat within Project area.	**LOW** Species unlikely to occur in Project area.
Western Pebble-mound Mouse *Pseudomys chapmani*	-	-	P4	Spurs and rocky hills with many small pebbles vegetated by spinifex.	Numerous *ecologia* and other records between 20 and 100 km from Project area.	**RECORDED** Large quantities of suitable habitat and many nearby records. Three active or recently active Pebble Mound-mouse mounds observed within Project area.	**LOW** Widely distributed in region and suitable habitat exists outside Project area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Regional Impacts
	EPBC Act	WC Act	DEC				
Birds							
Peregrine Falcon *Falco peregrinus*	-	S4	-	Coastal cliffs, riverine gorges and wooded watercourses.	Three records within 100 km from the Project area (Biota 2005, NatureMap) of which two recent records from within 20 km of Project area (NatureMap).	**HIGH** Some suitable habitat present along creek lines and cliff faces and previously recorded nearby.	**LOW** Widely distributed in region and suitable habitat exists outside Project area.
Grey Falcon *Falco hypoleucos*	-	-	P4	Lightly wooded coastal and riverine plains.	One NatureMap record from 1980 from within the Project area. Several Birdata and DEC Fauna Search records near the Project area.	**RECORDED** Four individuals recorded during survey. Suitable breeding and hunting habitat in the west of the Project area present.	**LOW** Widely distributed in region and suitable habitat exists outside Project area.
Australian Bustard *Ardeotis australis*	-	-	P4	Open grasslands, chenopod flats and low heathland.	One *ecologia* record approximately 20 km from the Project area (*ecologia* internal database). Two more records from about 100 km from Project area (*ecologia* internal database). Several DEC rare fauna, NatureMap and Birdata records within 50 km of Project area.	**RECORDED** Numerous nearby records. Suitable habitat in Project area.	**LOW** Widely distributed in region and suitable habitat exists outside Project area.
Bush Stone-curlew *Burhinus grallarius*	-	-	P4	Lightly wooded country next to daytime shelter of thickets or long grass.	Several DEC Threatened Fauna Database, NatureMap and Birdata records within 50 km of Project area, as well as records from previous surveys (Biota 2005; Outback Ecology 2006, ecologia Internal Database).	**RECORDED** Numerous nearby records and extensive suitable habitat within the Project area.	**LOW** Widely distributed in region and suitable habitat exists outside Project area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Regional Impacts
	EPBC Act	WC Act	DEC				
Star Finch (Western) *Neochmia ruficauda subclarescens*	-	-	P4	Vegetation around watercourses, particularly thick reed beds.	Two *ecologia* records from approximately 20 and 100 km of the Project area respectively; also recorded 100 km to the north-east (Outback Ecology 2006). Several Birdata records approximately 50 km from the Project area.	**RECORDED** Several records and suitable habitat occurs.	**LOW** Likely to impact local population, widely distributed outside Project area where suitable habitat occurs.
Fork-tailed Swift *Apus pacificus*	M	S3	-	Nomadic, almost entirely aerial lifestyle over a variety of habitats.	One *ecologia* record approximately 100 km from Project area (*ecologia* internal database). Three NatureMap records between approximately 30 and 50 km from Project area.	**RECORDED** Species recorded during the survey.	**LOW** Entirely aerial and highly nomadic.
Eastern Great Egret *Ardea modesta*	M	S3	-	Shallow water bodies; both fresh and saline.	Four NatureMap and numerous Birdata records from within 50 km, of which one record is from within the Project area.	**HIGH** Numerous nearby records, including within Project area.	**LOW** Widely distributed in region and suitable habitat exists outside Project area.
Cattle Egret *Ardea ibis*	M	S3	-	Grassy habitats, shallow water bodies and wetlands.	Reported by DSEWPaC to have the potential to occur throughout the region. No other records.	**LOW** No nearby records, has the potential to occur along Turner River if conditions are suitable.	**LOW** Suitable habitat is widespread outside the Project area.
White-bellied Sea Eagle *Haliaeetus leucogaster*	M	S3	-	Large rivers and near-coastal wetlands.	Reported by DSEWPaC to have the potential to occur throughout the region. No other records within 100 km of Project area.	**LOW** No nearby records or suitable habitat.	**LOW** Species unlikely to occur in Project area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Regional Impacts
	EPBC Act	WC Act	DEC				
Oriental Plover *Charadrius veredus*	M	S3	-	Sparsely vegetated plains, including samphire and short-grass flats, roosts on beaches or mudflats.	One recent record from within 20 km of Project area. Listed as 'species or species habitat may occur within area' (DSEWPaC Protected Matters Database).	**LOW** Few records, mostly concentrated near coast. Species may occur transitionally in area, but Project area provides little suitable habitat.	**LOW** Species unlikely to occur in Project area.
Wood Sandpiper *Tringa glareola*	M	S3	-	Freshwater swamps, river pools, claypans, salt lakes.	Only three recent records approximately 50 km form Project area (*ecologia* Internal Database, NatureMap) and one 1957 record approximately 15 km south of Project area (NatureMap).	**LOW** Little suitable habitat. Few nearby records	**LOW** Species unlikely to occur in Project area.
Rainbow Bee-eater *Merops ornatus*	M	S3	-	Open country, most vegetation types, dunes, banks.	Numerous records in and around Project area (Biota 2005; Outback Ecology 2006, ecologia Internal Database, NatureMap, Birdata, DSEWPaC Protected Matters Database).	**RECORDED** Numerous records in and around Project area, and large amounts of suitable habitat.	**LOW** Species is widespread in the region and suitable habitat exists outside the Project area.
Oriental Pratincole *Glareola maldivarum*	M	S3	-	Open plains, bare rolling country, bare claypans, open ground near inland swamps.	Recorded from DSEWPaC Protected Matters search only with no specific record information.	**LOW** Little suitable habitat within the Project area.	**LOW** Species unlikely to occur in Project area.

Species	Conservation Significance			Habitat	Previous Records	Likelihood of Occurrence	Regional Impacts
	EPBC Act	WC Act	DEC				
Reptiles							
Pilbara Olive Python *Liasis olivaceus barroni*	VU	S1	VU	Inhabits watercourses and areas of permanent water in rocky gorges and gullies.	Six NatureMap records 10 – 65 km from the Project area, and three DEC Fauna Search records approximately 50 km from the Project area. Also recorded by Outback Ecology (2006), approximately 100 km from the Project area.	**RECORDED** Six individuals recorded during current survey and secondary evidence found during targeted survey. Suitable habitat within Project area.	**HIGH** Project area provides critical habitat. Insufficient knowledge of species to assess impacts. Given the few records of the species, loss of individuals could be significant locally and moderate on a regional scale.
Ctenotus nigrilineatus	-	-	P1	Spinifex near granite outcrops.	One recent (2001) record approximately 18 km south of Project area (DEC Threatened Fauna Database). Three older records (1988 and 1990) approximately 30 km south of Project area (DEC Threatened Fauna Database, NatureMap).	**MEDIUM** Previous records near Project area. Limited suitable habitat occurs.	**LOW** Species has restricted distribution but the proposed Project will have a small impact on the sandy plains (suitable habitat for this species)
Ramphotyphlops ganei	-	-	P1	Suggested that they prefer to live in subterranean habitats near moist gullies and gorges although there is a record from sandy soil vegetated with spinifex.	Two NatureMap records near Project area, including one within 15 km (NatureMap, DEC Threatened Fauna Database).	**HIGH** Recently recorded nearby. Suitable habitat occurs through much of Project area.	**LOW** Species has been previously recorded from a variety of habitats within the Pilbara region. Suitable habitat present outside Project area.

Note: Description of conservation significant codes provided in Appendix A.

4.4 FAUNA HABITATS

In total, seven fauna habitats were recorded from the Project area:

- Rocky spinifex hills;
- Rocky plains with spinifex;
- Rocky ridges/breakaway/gorges;
- Sandy plains with spinifex and scattered granites;
- Acacia shrubland on hard soil;
- Creek lines; and
- Granite outcrops.

The extent of each habitat type is listed in Table 4.4 and mapped in Figure 4.10.

Table 4.4 – Fauna Habitat Types within the Project Area

Vegetation Description	Area in the Project Area (Ha)	Percent in Study Area (%)
Acacia shrubland on hard soil	457.8	1.3
Creekline	1527.6	4.3
Granite Outcrop	51.4	0.1
Rocky Plains with Spinifex and open shrubland	5554.8	15.9
Rocky ridge/breakaway/gorge	519.8	1.4
Rocky Spinifex Hills	23842.6	68.4
Sandy Plains with Spinifex and scattered granites	2889.1	8.2

4.4.1 Rocky Spinifex hills

The most common habitat type is the rocky spinifex hill occupying 68.4% of the Project area. It occurs east of the Turner River and comprises the majority of the proposed mining area and infrastructure areas and the east of the proposed infrastructure corridor. This fauna habitat type is characterised by an open vegetation structure with usually small clumps of spinifex and scattered low and mid-sized shrubs. The vegetation has been previously burnt which is visible by the small and low character of the spinifex clumps. The substrate comprises hard loamy soils with continuous pebbles and stones. The majority of fauna occupying this habitat type comprises spinifex specialists and species preferring of open habitats.

Mammals of conservation significance recorded in the Project area occupying this habitat type are Western Pebble-mound Mouse (DEC Priority 4) and Long-tailed Dunnart (DEC Priority 4). Western Pebble-mound Mouse mounds were found on low rocky slopes whereas the Long-tailed Dunnart were recorded from flat tops of mesas and low rocky slopes which are dominated by pebbles and rocky substrate.

Due to the open character of this habitat type and the lack of the cover and food sources the avifauna from rocky spinifex hills was moderate. Specialists such as the Spinifex Pigeon and Striated Grasswren were recorded from rocky spinifex slopes and hills.

The reptile species that typically inhabit rocky spinifex hills comprise a number of skinks and snakes that live between the spinifex clumps. There is lack of burrowing specialists such as burrowing snakes and skinks within this habitat type due to the hard ground and the inability of these species to burrow or dig into the substrate.

4.4.2 Rocky plains with spinifex and open shrubland

Rocky plains with spinifex and open shrubland were recorded from the centre of the proposed infrastructure corridor. A total of 5,554.8 ha was recorded which represents 15.9 % of the Project area. This habitat has a slightly denser vegetation structure than the rocky spinifex hills with a moderate layer of spinifex and denser shrub layer.

Trapping sites located in this habitat included parts of the creek line and acacia shrubland on hard soil due to accessibility of this habitat type and the fact that was intersected by creek lines or hard soils with acacia shrubs. Therefore not all recorded fauna species from these trapping sites can be classified as typical inhabitants of rocky spinifex plains with open shrubland. However, the majority of mammal, bird and reptiles species living on these plains are generalists and can utilise different adjacent habitat types. Birds of prey, in particular the Grey Falcon prefers this habitat type as hunting ground due to its open character and the ability to spot prey from far distances. Large *Varanus* species such as the Perentie (*Varanus giganteus*) and the Yellow-spotted Monitor (*Varanus panoptes*) are the only reptile species with the ability to dig burrows in the hard rocky ground. Both species are likely to hunt and live on the rocky spinifex plains.

Other inhabitants but not necessarily specialist of this habitat type is the Pilbara Ningaui (*Ningaui timealeyi*), Spinifex Pigeon, Diamond Dove, Zebra Finches, Fat-tailed Gecko (*Diplodactylus conspicillatus*), Bynoe's Gecko (*Heternotia binoei*) and the Western Brown Snake (*Pseudonaja mengdeni*).

4.4.3 Rocky ridges, breakaway and rocky gorges

Rocky ridges, breakaways and rocky gorges were recorded from the east of the Project area, along the proposed mining area, near the proposed infrastructure areas and along the north of the infrastructure corridor. It covers a total of 519.8 ha representing 1.4% of the Project area. Rocky ridges and breakaways are usually surrounded by large areas of rocky spinifex hills but differ not only in the vegetation structure and substrate but also in its distinct landform with altitudes of up to 300 m. It comprises cliff faces along rocky ridges and breakaways with numerous vertical and horizontal crevices and rocky gorges with semi-permanent waterholes. Crevices, caves and boulder piles provide excellent shelter for a number of mammal and reptile species whereas the semi-permanent waterholes support trees and a dense vegetation structure and attract a large number of mammals, birds and reptiles. Six gorges were recorded to contain semipermanent waterpools based on the vegetation, movement of water, the presence of aquatic snails and fish (Figure 4.7.-Figure 4.9). All six gorges were located in the north and east of the Project area (Figure 4.10). Trap site 12 was located at one of these gorges containing water with fish and aquatic snails. Four additional springs and one water pool near a rocky outcrop were recorded from the centre and western part of the Project area potentially providing moisture and surface water for most months of the year. All water pools were recorded or revisited during Phase 2 and Phase 3 conducted in October which is

usually at the end of the dry season in the Pilbara. Water present at this time of the year usually indicates that water is present most years of average rainfall.



Figure 4.7 – Water pools recorded from "Dirty River gorge"



Figure 4.8 – One of the water pools at Trap Site 12



Figure 4.9 – One of the water pools at "Northern gorge 1"

Mammal species of conservation significance recorded from this habitat type included the Northern Quoll (EPBC Act Endangered, WC Act Schedule 1) and the Pilbara Leaf-nosed Bat (EPBC Vulnerable, WC Act Schedule 1). The Northern Quoll shelters and breeds within mid-sized rocky crevices and hunts along cliff faces and areas of permanent waterholes. The Pilbara Leaf-nosed Bat roosts during the dry season in humid, deep caves near surface water which provides increased humidity within the roost cave as this is necessary for the survival of the species. The species often hunts along gorges with dense vegetation and a high level of biomass that attracts a large number of insects. Overall, rocky ridges, breakaways and rocky gorges represent critical habitat for the survival of these two conservation significant species. Several other mammal species are specialists of this habitat type: Rothschilds Rock-wallaby (*Petrogale rothschildi*), Common Rock-rat (*Zyzomys argurus*), and Long-tailed Dunnart (*Sminthopsis longicaudata* – DEC Priority 4). In addition to these native mammal species, water pools and natural springs are known to also attract a number of introduced species such as cats and cattle (at accessible springs) which were encountered on numerous occasions.

The majority of bird species avoid open cliff faces and breakaways but some specialist species can be found along the ridges: Fairy Martins are known to breed in cave openings and rock shelters, Peregrine Falcons (*Falco peregrines* – WC Act Schedule 4) are known to build their nests along cliff faces, Spotted Nightjars and Masked Owls can also be found sheltering and nesting in caves and rocky overhangs. In comparison to cliff faces a large number of bird species occur along rocky gorges with dense vegetation of fig and eucalypt trees. This habitat type provides higher biomass and humidity which acts as an attractor for insect as a food source for Western Bowerbird, Grey Shrike-thrush, White-plumed Honeyeaters and Little Woodswallows.

Similar to the mammal and bird assemblages, some reptile species are specialised to this fauna habitat type. The Desert Cave Gecko (*Heteronotia spelea*), the skinks *Egernia formosa* and *Morethia ruficauda* and the goanna *Varanus pilbarensis* can only be found in crevices along cliff faces of breakaways and rocky gorges. The Pilbara Olive Python is a species of conservation significance (EPBC Vulnerable, WC Act Schedule 1) that mostly shelters in crevices near watercourses but can travel long distances during mating season and therefore can occasionally be found along adjacent creek lines and rocky spinifex hills. However, Rock faces and permanent water pools are considered critical habitat for the Pilbara Olive Python representing a refuge to forage, shed their skin and mate.

Rocky ridges and breakaways are not sensitive to bush fires due to their discontinuous character and the low coverage of vegetation which will not support large fires. Large trees along gorges are usually not affected by fires and can form large and dense vegetation along hills and cliff faces. Permanent and semipermanent water pools often represent the only available water source during drier months and attract cattle and other introduced animals. Impact by cattle can be significant to the vegetation surrounding springs and gorges with surface water, resulting in heavily grazed vegetation as recorded from the majority of the water pools in the Project area.

4.4.4 Sandy plains with spinifex and scattered granites

Sandy plains with spinifex and scattered granite domes dominated both sides of the Turner River in the west of the infrastructure corridor. A total of 2889.1 ha of this habitat type were identified in the Project area. The spinifex vegetating sandy plains around the Turner River were recorded as being of different maturity stage. An area of very large spinifex clumps was recorded from the vicinity of Turner River, enclosing the area from west and east and therefore protecting it from fires. The remaining areas of this habitat type were dominated by small to medium sized spinifex clumps. Scattered small granite domes can be found throughout this habitat type.

The mammal assemblage of the sandy spinifex plains can be described as rich, given the ability of mammals to hide within spinifex and dig burrows in the sandy substrate. Typical inhabitants observed during this study of this habitat type are the Delicate Mouse (*Pseudomys delicatulus*) and Lesser Hairy-footed Dunnart (*Sminthopsis youngsoni*). Two mammal species of conservation significance have the potential to occur in this habitat type if spinifex clumps are large and the substrate is a sandy-clay soil suitable for digging extensive burrows: Greater Bilby (*Macrotis lagotis* – EPBC Act Vulnerable, WC Act Schedule 1) and Brush-tailed Mulgara (*Dasycercus blythi* – DEC Priority 4). Neither of these species were observed during this study.

The avifauna of this habitat type was moderate with a large number of Little Button-quails, Fairy Martins, Zebra Finches and Variegated Fairy-wrens. Bird species specialised in sandy spinifex plains are in particular the Little Button-quails which live between the large clumps of spinifex. However, due to the open vegetation of this habitat type the number of bird species inhabiting these plains is usually low. Birds of prey often use the open vegetation as hunting ground, utilizing the ability to spot potential prey over a long distance. One bird species of conservation significance was recorded from sandy spinifex plains: the Australian Bustard (*Ardeotis australis* – DEC Priority 4).

The sandy substrate of this habitat type attracts a large number of reptiles due to the ability to dig holes and burrows which are used as shelters during the hot daytime temperatures. Typical inhabitants of this habitat type that were recorded during this survey include: Fat-tailed Gecko (*Diplodactylus conspicillatus*), Knob-tailed Gecko (*Nephrurus levis*), the skink *Ctenotus pianka*, the burrowing skink *Lerista bipes* and the dragon lizards *Diporiphora valens* and *Ctenophorus isolepis.*

Five of the potential six species of amphibian were recorded after rainfall from the trapping sites installed on sandy plains (NS1 & NS8). Six individuals of the Desert Spadefrog (*Notaden nichollsi*) were recorded only from trapping site NS1. Sandy plains with spinifex provide suitable habitat for a number of burrowing frog species considering the soft substrate which is suitable for this amphibians to stay in over drier months.

Sandy plains with spinifex and scattered granite domes are usually not impacted by cattle because of the low number of food plants. In areas adjacent the Turner River spinifex grass is vulnerable to be overgrown by Buffel grass after bush fires and degraded by cattle.

4.4.5 Acacia shrubland on hard soil

Acacia shrubland habitat on hard soil was recorded from three larger patches totalling an area of 457.8 ha within the Project area. This area represents 1.3% of all habitats in the Project area. Acacia shrubland on hard soil was recorded from the west of the Project area in the vicinity of Turner River and adjacent spinifex grasslands (see Figure 4.1). The acacia shrubland is of moderate density and therefore provides more coverage than the majority of the habitat types within the Project area. The ground cover usually comprises low shrubs and medium sized spinifex clumps. The hard soil does not allow for the construction of burrows.

The vertebrate fauna of the acacia shrubland on hard soil is moderate, comprising a number of generalists that were recorded during the survey such as: the Pilbara Ningaui (*Ningaui timealeyi),* the Desert Mouse *(Pseudomys desertor),* Singing Honeyeater, Magpie-lark, Painted Finches, the skinks *Ctenotus saxatilis* and *Carlia munda,* and the legless lizard *Delma pax*. Similar to the rocky plains habitat type more mammals, birds and reptiles can be recorded in denser vegetation structure, particularly in spinifex. After rain fall this habitat has the potential to attract a large number of birds. Acacia shrubs usually flower in autumn, after extensive rainfall, providing food for most nectar eating birds. Up to eleven species of honeyeaters potentially occurring in the area have the potential to feed on the flowering acacia shrubs.

Acacia shrubland on hard soil is a flat landscape easily inhabited by cattle. Low shrubs and patches of Buffel grass provide a food source and the proximity of this habitat type to the Turner River make the acacia shrubland to a suitable habitat for grazing cattle.

4.4.6 Creek lines

Major creek lines were recorded in the west of the infrastructure corridor (Turner River) and smaller rivers are present in the east of the Project area, surrounding the proposed mining area. Creek line habitat is characterised by large eucalypt trees fringing water courses with or without surface water. Creek lines along areas of high human impact such as main roads, are usually dominated by Buffel grass whereas creek lines in areas of low human impact generally contain lemon grass and sword grass. A total of 1527.6 ha of creek line habitat were recorded from the Project area which represents 4.3%.

The mammal assemblage of this habitat is relatively high with the majority of bats recorded in this habitat during the survey foraging between the trees and above the water where insects are abundant. Creek lines are used by the Pilbara Leaf-nosed Bat (EPBC Act Vulnerable, WC Act Schedule 1) as wet season roost. The Pilbara Leaf-nosed Bat requires high humidity which is present in hollow trees near waterholes and surface water.

The avifauna of the creek line habitat is very diverse and comprises the majority of bird species recorded. Forty-nine of the 81 species of bird recorded were encountered along creek lines in the east and west of the Project area. Of these, two species are of conservation significance: Bush Stone-curlew (DEC Priority 4) and Rainbow Bee-eater (*EPBC Act* Migratory, *WC Act* Schedule 3). Both species are typical inhabitants of creek lines and the Rainbow Bee-eater finds suitable nestinghabitat in sand banks along the creek lines. At the two trapping sites installed along creek lines (NS S3, NS S12) a combined total of 39 species were encountered. At Sites NS S12 alone, a total of 720 individuals of 31 bird species were recorded. Several species are creek line specialists and are often found in this habitat type: Black Swan, Grey Teal, Pacific Black Duck, White-faced Heron, Whiskered Tern, Sacred Kingfisher, Black-fronted Dotterel and Buff-banded Rail. Birds of prey, Galahs and Corellas are often seen nesting in trees in this habitat type. The Grey Falcon was recorded from an area close to the Turner River and is likely to utilize nests of crows and other large birds along the creek line.

The herpetofauna of the creek line habitat is relatively rich in comparison to the plains and low hills in the Project area. The high abundance of insects attracts numerous reptiles. In total, 35 species out of a total of 75 reptile species recorded were encountered at the two locations in this habitat (NS3 and NS12). A specialist of the creek line habitat is the Long-nosed Dragon (*Amphibolurus longirostris*). The Pilbara Olive Python can be encountered along creeklines when water pools are present.

The creek line habitat is the habitat type most sensitive to grazing and degradation. Areas close to roads and human activity were dominated by introduced Buffel grass and grazed by cattle. Creek lines are usually easy to access and any surface water will attract cattle present in the area which increase the dispersal of weeds into adjacent habitat types.

4.4.7 Granite outcrops

A total of 51.4 ha of granite outcrops were identified in the west of the Project area. This represents the smallest area of habitat type with 0.1% of the North Star Project area. The granite outcrop habitat type contains large boulders of granite domes with low spinifex tussock grassland and

occasional low shrubs. All granite outcrops recorded in the Project area were surrounded by sandy spinifex plains.

A large variety of mammals have the potential to find shelter in granite outcrops. Woolley's Pseudantechinus was recorded from this habitat type during the targeted survey (*ecologia* 2011). This species utilises the crevices of granite boulder piles. Small to medium sized mammals such as the Euro find shelter in large crevices and rock shelter within the boulder piles.

None of the bird species potentially occurring or recorded from the Project area are specialised in inhabiting granite outcrops. Several generalists can be found foraging between the granite boulders, catching insects or feeding on grass seeds: Diamond Dove, Spinifex Pigeon, Striated Grasswren, Masked Woodswallow and Torresian Crow. Granite outcrops do not provide critical habitat for any of the recorded bird species.

The herpetofauna of the granite outcrop habitat type is relatively diverse with a number of reptiles that are rock-dwelling such as Eastern Pilbara Spiny-tailed Skink (*Egernia ebsisolus*), the Pilbara Rock goanna (*Varanus pilbarensis*) and the Spiny-tailed Monitor (*Varanus acanthurus*). The Eastern Pilbara Spiny-tailed Skink was only found in crevices of granite boulders. The rock crevices and spinifex clumps in the surrounding area provide suitable shelter for a variety of small and mid-sized reptiles.

Granite outcrops are not specifically sensitive to grazing and bush fires but provide refuge for mammals and reptiles in the area.

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Legend

- Project Area

Fauna habitat types

- Acacia shrubland on hard soil
- Creekline
- Granite outcrop
- Rocky plains with spinifex
- Rocky spinifex hills
- Rocky ridge/breakaway/gorge
- Sandy plains with spinifex and scattered granites
- Water pools

Northern gorge 2
Northern gorge 1
Clean Water Pool
Camp Pool
Echo Pool
Dirty Water Pool
Fig Pool
Site 12 Pool
Cow Spring
Central Creek pool
Gorge & Rockpool

N

0 2.5 5
Kilometres

Absolute Scale - 1:110,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Fauna Habitat Types of the North Star Project Area

Figure: 4.10
Project ID: 1322

Drawn: AH
Date: 05/12/11

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

Unique Map ID: AH409

A3

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4.5 FAUNA HABITAT ANALYSIS

Four habitat types were trapped systematically and their adequacy statistically analysed. Analysis of similarity of terrestrial fauna data using a one-way ANOSIM indicated there were mixed degrees of similarity between and within groups (habitat types), meaning the four habitat types are statistically similar (R = 0.1614, p = 0.0001) (Table 4.5). A pair-wise comparison (Table 4.5) indicated that the Creekline, and Sandy Plains with Spinifex and Scattered Granites habitat exhibited the greatest degree of dissimilarity (R = 0.6057, p-value = 0.0001). Pair-wise comparison of all other habitat types indicated that the habitats were similar (Table 4.5).

Analysis of the habitat types using non-metric MDS (stress = 0.1853) indicated that, although some differences between habitat types are apparent, a large proportion of common species occurred in all habitat types (Figure 4.11). This would suggest that there are no habitat types within the Project area that support a distinct and restricted fauna assemblage.

Table 4.5 – One-way ANOSIM Results from Terrestrial Trapping Data

R-value (p-value)	Sandy Plains with Spinifex and Scattered Granites	Rocky Ridge/ Breakaway/Gorge	Rocky Spinifex Hills	Creekline
Sandy Plains with Spinifex and Scattered Granites	0	0.0083 (0.4178)	0.2421 (0.0013)	0.6057 (0.0001)
Rocky Ridge/ Breakaway/Gorge	0.0083 (0.4178)	0	0.1848 (0.0001)	0.1730 (0.0042)
Rocky Spinifex Hills	0.2421 (0.0013)	0.1848 (0.0001)	0	0.0250 (0.3568)
Creekline	0.6057 (0.0001)	0.1730 (0.0042)	0.0250 (0.3568)	0

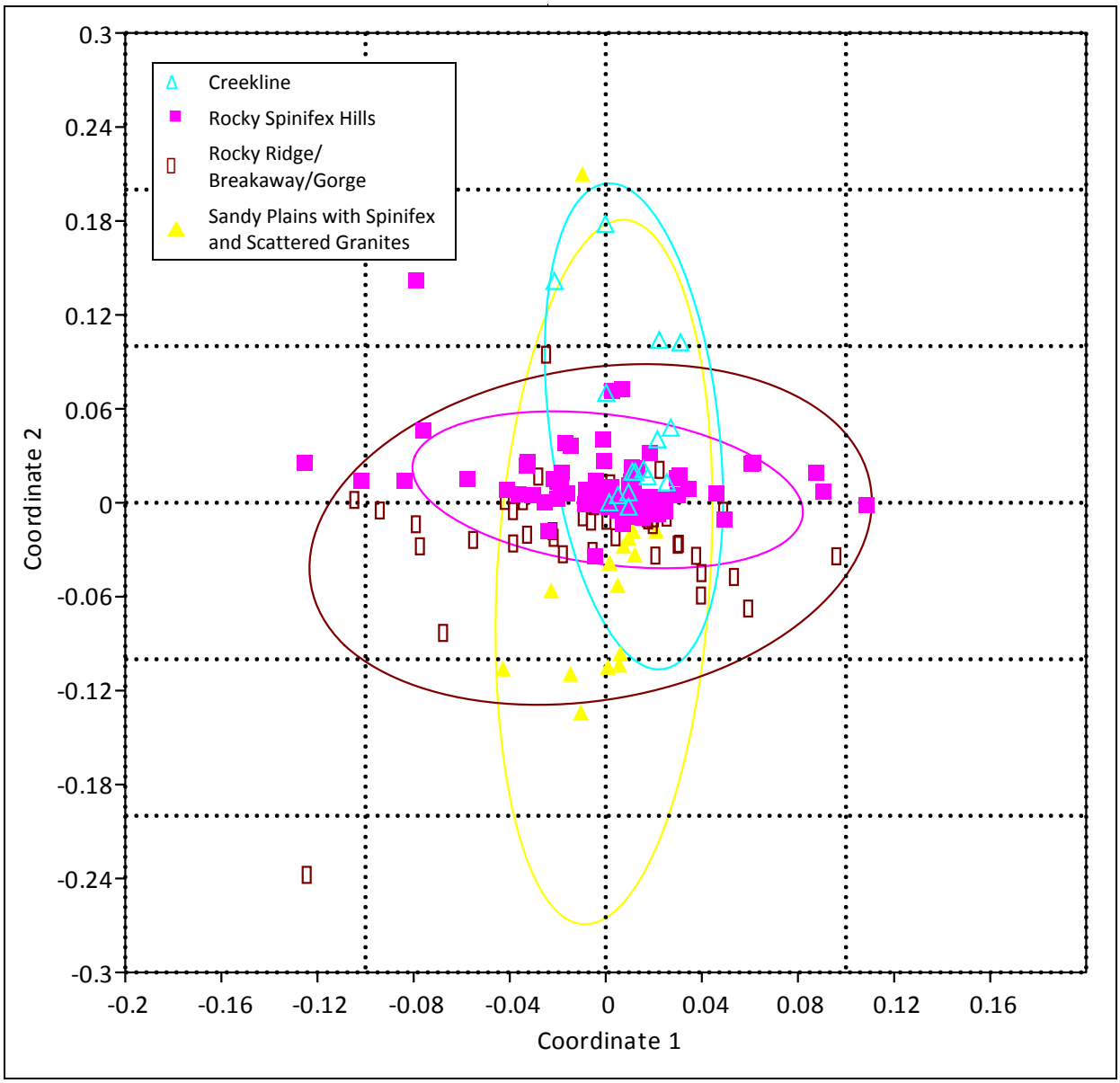


Figure 4.11 – MDS Analysis of Fauna Habitats: Terrestrial Fauna Data.

Analysis of similarity of bird data using a one-way ANOSIM revealed a much greater degree of dissimilarity between habitat types (R = 0.3074, p = 0.0001). As for the terrestrial fauna data analysis, Creekline habitat appeared to have the most distinct fauna assemblage (Figure 4.10). The highest degree of dissimilarity was apparent between the Creekline and Acacia Shrubland on Hard Soil habitat types (R = 0.6968); however, with a relatively high p-value of 0.1111, this result may not be statistically significant.

Analysis of habitat types using non-metric MDS (stress = 0.2089) again indicated that, although some differences between habitat types are apparent, a large proportion of common species occurred in all habitat types (Figure 4.12).

Table 4.6 – One-way ANOSIM Results from Bird Survey Data

R-value (p-value)	Creekline	Rocky Ridge/ Breakaway/ Gorge	Rocky Spinifex Hills	Acacia Shrubland on Hard Soil	Sandy Plains with Spinifex and Scattered Granites
Creekline	0	0.1407 (0.0071)	0.3494 (0.0001)	0.6968 (0.1111)	0.5542 (0.0001)
Rocky Ridge/ Breakaway/ Gorge	0.1407 (0.0071)	0	0.2534 (0.0001)	0.2206 (0.1491)	0.1493 (0.0212)
Rocky Spinifex Hills	0.3494 (0.0001)	0.2534 (0.0001)	0	0.5938 (0.0662)	0.4801 (0.0001)
Acacia Shrubland on Hard Soil	0.6968 (0.1111)	0.2206 (0.1491)	0.5938 (0.0662)	0	0.4044 (0.1792)
Sandy Plains with Spinifex and Scattered Granites	0.5542 (0.0001)	0.1493 (0.0212)	0.4801 (0.0001)	0.4044 (0.1792)	0

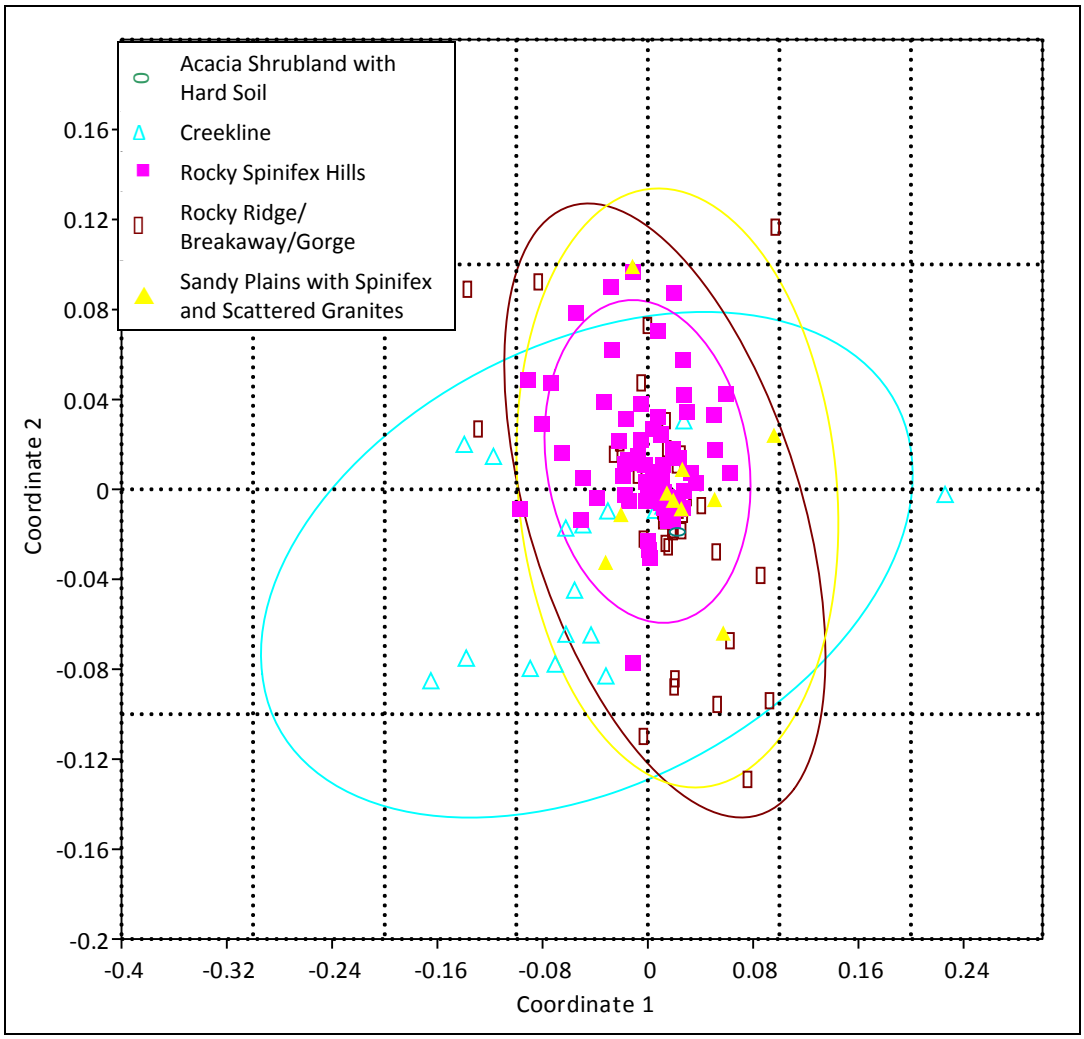


Figure 4.12 – MDS Analysis of Fauna Habitats: Bird Data.

4.6 SURVEY ADEQUACY

Parametric (SAC) analysis of systematically obtained survey data for terrestrial vertebrates (mammals, reptiles and amphibians) and bird groups revealed that survey effort was adequate. Table 4.7 provides a summary of the theoretical maximum number of species, as estimated using seven different methods, based on the rate of accumulation of species as more individuals are collected, *i.e.* by using species accumulation curves to estimate the total number of species.

Table 4.7 – Mean Estimates of Total Species Richness of the Vertebrate Fauna Groups.

Richness Estimators	Total Richness Estimate	
	Terrestrial Vertebrates	Birds
ACE	93.16	74.51
ICE	93.31	78.14
Chao-1	94.67	73.11
Jack-1	98.93	80.94
Jack-2	103.92	77.08
Bootstrap	92.46	77.29
Michaelis-Menten	91.22	73.91
Species observed	86	72

Analysis of the terrestrial vertebrate trapping data produced a smooth SAC, tending towards, but not yet reaching, asymptote (Figure 4.13). The Michaelis-Menten (MM) estimator used as a stopping rule suggests that 93.99% of the total reptile assemblage had been captured at the completion of 192 sampled nights (Table 4.7). This indicates that at least an additional five species could have been trapped with additional survey effort. Other richness estimators (Table 4.7) suggest that as many as eight additional species may have been trapped (totalling 104). Overall, it may be considered that the terrestrial vertebrate fauna group was adequately sampled, given a total of 100 species recorded during the two-phase survey (including opportunistic records). Additional trapping was conducted during the targeted survey which resulted in two additional mammal species recorded (Appendix D). The trapping effort of the targeted survey was not included in this analysis due to the different methodology.

A SAC analysis of the avifauna set-time survey dataset also produced a smooth SAC, tending towards, but not yet reaching, asymptote (Figure 4.14). The Michaelis-Menten (MM) estimator, used as stopping rule, indicated that the survey was 97.42% adequate at the completion of 146 set-time surveys. The MM estimator generated a theoretical maximum of 74 species. Other richness estimates ranged between 73 and 81 (Table 4.7), suggesting further survey effort may have identified nine additional species. Given that an additional eight (totaling 80 species) bird species were observed opportunistically, it may be deemed that total survey effort was sufficient.

Analysis of both fauna assemblages (birds and terrestrial fauna) indicate that, at the completion of both phases of fauna survey, survey effort was adequate to provide a true representation of the fauna assemblage present in the Project area.

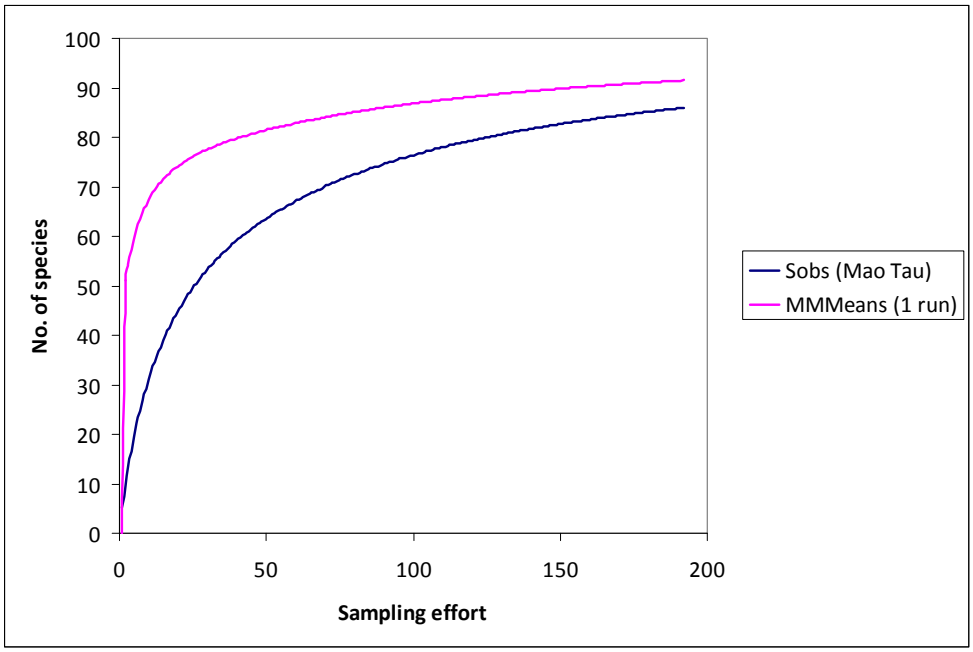


Figure 4.13 – Species Accumulation Curve: Terrestrial Fauna.

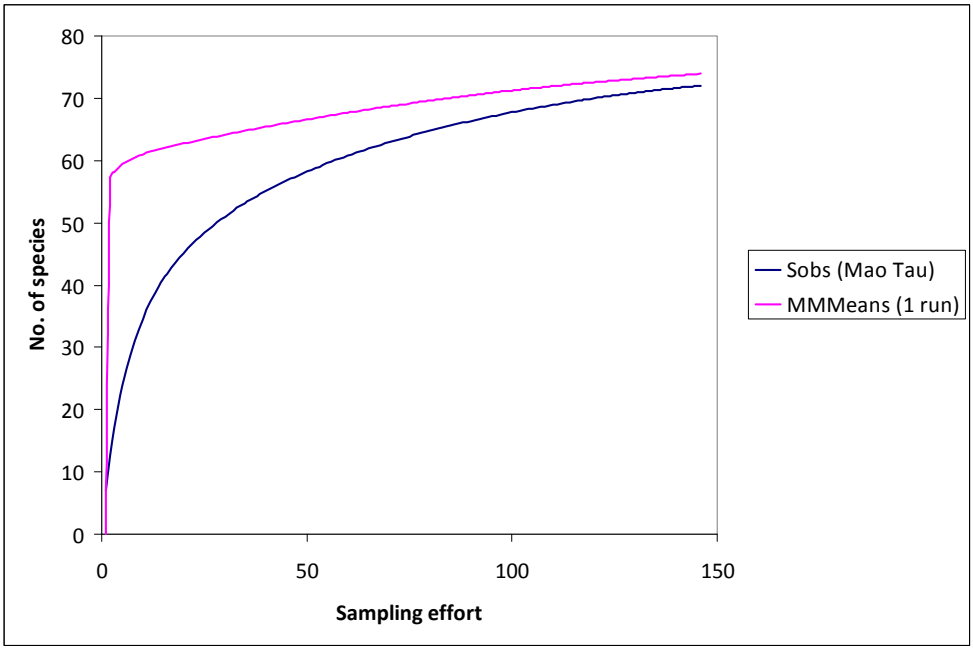


Figure 4.14 – Species Accumulation Curve: Birds.

4.7 SURVEY LIMITATIONS

Limitations of the current survey are summarised in Table 4.8. Given the few limitations encountered, it is deemed that an adequate level of survey has been undertaken.

Table 4.8 – Summary of Survey Limitations.

Constraint	Relevant (yes/no)	Comment
Competency/ experience of the consultant carrying out the survey.	No	An experienced vertebrate zoologist was present to identify all reptile and mammal species in the field. Bird surveys were conducted by an experienced ornithologist.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	Weather conditions varied across the survey phases allowing all faunal groups to be surveyed. The previous wet season was above average increasing the abundance of some taxa.
Proportion of fauna identified, recorded and/ or collected.	No	The majority of fauna species that occur within the Project area were recorded, as indicated by SACs (Section 4.6). All captured species were identified.
Sources of information (previously available information as distinct from new data).	No	Many database records and several previous fauna surveys in the surrounding area.
The proportion of the task achieved and further work which might be needed.	No	Systematic and opportunistic sites were surveyed in all habitats identified.
Timing/ weather/ season/ cycle.	No	The first phase of the Level 2 survey was conducted in autumn following a good wet season during the previous summer. The second and third phase was conducted after flowering and seeding and during warmer temperatures.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	Some high rainfall events during the phase 2 survey affected the SM2bat recorders so not all calls could be analysed. The large survey effort for bats during the other survey phases is sufficient to compensate for the reduced number of identifiable bat calls
Intensity (in retrospect was the intensity adequate).	No	Systematic sites were open for eight nights. A sufficient amount of time was spent on bird surveys and opportunistic searches.
Completeness (e.g. was relevant area fully surveyed).	No	The majority of the Project area was accessible and all habitat types were sufficiently surveyed. All proposed major impact areas were surveyed
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	All fauna were identified to species level by experienced and appropriately qualified personnel in the field.
Remoteness and/ or access problems.	No	Some areas were inaccessible but all habitat types were surveyed
Availability of contextual (e.g. biogeographic) information on the region).	No	Results from previous surveys from within 100 km of the Project area and available database information were adequate.
Efficacy of sampling methods (i.e. any groups not sampled by survey methods).	No	Survey methods were suitable to record all vertebrate fauna groups except amphibians during Phase 2 and 3, however suitable conditions during the phase 1 survey allowed amphibians to be detected.

5 DISCUSSION

5.1 CONSERVATION SIGNIFICANT FAUNA

Further information regarding the distribution, ecology, likelihood of occurrence and potential impacts to conservation significant fauna that were assessed as having a medium or high likelihood of occurring in the Project area are discussed below.

5.1.1 Vegetation units in relation to Conservation Significant Fauna recorded

During *ecologia* flora and vegetation survey at the North Star Project area a total of 33 vegetation communities were described and mapped within the Project area (ecologia 2012). Of these, six vegetation units (*ElApEm, At, ApTp, Tl, FpAtCo* and *EvCc)* are considered to be of significance due to their suitability as foraging and/or breeding habitat to the Northern Quoll (Endangered), Pilbara Leaf-nosed Bat (Vulnerable) or Pilbara Olive Python (Vulnerable) (Table 5.1). It should be noted that only a portion of the area encompassed by these vegetation units within the Project area is expected to be utilised by these fauna.

Table 5.1 – Vegetation Units Considered of Significance for the Survival of EPBC listed Fauna Species

Vegetation Units	Fauna Species	Conservation Status	Comment
ElApEm	Northern Quoll	Endangered	Contains areas of potential breeding and foraging habitat, particularly in the eastern parts of the Study Area
	Pilbara Leaf-nosed Bat	Vulnerable	
	Pilbara Olive Python	Vulnerable	
At	Northern Quoll	Endangered	Contains areas of potential breeding and foraging habitat, particularly where it passes through steep, rocky gorges
	Pilbara Leaf-nosed Bat	Vulnerable	
	Pilbara Olive Python	Vulnerable	
ApTp	Northern Quoll	Endangered	Contains areas of potential breeding and foraging habitat, particularly where it passes through steep, rocky gorges
	Pilbara Leaf-nosed Bat	Vulnerable	
	Pilbara Olive Python	Vulnerable	
Tl	Northern Quoll	Endangered	Contains areas of potential breeding and foraging habitat
	Pilbara Leaf-nosed Bat	Vulnerable	
	Pilbara Olive Python	Vulnerable	
FpAtCo	Northern Quoll	Endangered	Suitable breeding and foraging habitat
	Pilbara Leaf-nosed Bat	Vulnerable	Potential foraging habitat
	Pilbara Olive Python	Vulnerable	Suitable breeding and foraging habitat
EvCc	Northern Quoll	Endangered	Potential dispersal habitat
	Pilbara Leaf-nosed Bat	Vulnerable	Potential foraging and wet-season roosting habitat
	Pilbara Olive Python	Vulnerable	Potential foraging habitat

5.1.2 Mammals

5.1.2.1 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 north 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, house roofs 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.

The most common cause of adult 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 - RECORDED: During the initial phase of the Level 2 survey two Northern Quolls were recorded from trap sites NS5, one individual was recorded on motion camera in the south of the proposed mining area and one individual was seen during nocturnal searches. A further 34 records of this species (minimum of 20 confirmed individuals) were obtained in subsequent targeted surveys (*ecologia* 2011), Phase 2 and Phase 3 of the Level 2 survey (Table 4.2 and Figure 4.4). All records are located in the east of the Project area. Previous records of Northern Quoll include: a total of 18 individuals from 12 km west of the Project area (Outback Ecology 2010), two individuals from Mt Dove (40 km west of the Project area) (Outback Ecology 2011b), 15 individuals from Panorama Project (3-8 km from the Project area) (Bamford and Wilcox 2001; Biota 2007) and three individuals from 10 km south of the Project area (NatureMap). All the records within 30 km were made within the Capricorn and Macroy Land system. The Capricorn Land system is well represented in the east of the Project area and extents to the north-east and south-east of the Project area (Figure 4.1). The Macroy Land system is present in the west of the Project area, supporting granite domes and therefore potential habiatt for the Northern Quoll (Figure 4.1, Figure 4.10). The two individuals recorded from Mt. Dove were located within the Uaroo Land system. This Land system is not found within the Project area.

A total of 294.4 ha of suitable Northern Quoll denning habitat was identified in the Project area, particularly within the Rocky Ridge/Breakaway/Gorge and Creekline habitat type. A further 606.3 ha of foraging and dispersal habitat was identified during the targeted Northern Quoll survey. During this targeted survey a total of 20 individuals were captured, measured and weighed, health condition assessed and tissue samples collected. All individuals were in good health condition with only one male showing some signs of fighting and missing fur. Of these 20 captured individuals, four individuals were identified as female, the remaining 16 individuals were males. As females are known to obtain small home-ranges of approximately 13 ha, the presence of females indicate a permanent breeding population inhabiting the North Star Project area and these individuals are not expected to have moved into the area from the surrounding region (Oakwood 2002). Of the 20 individuals captured during the targeted survey two individuals were recaptured from the same ridge

(proposed mining area) during the second pahse of the Level 2 survey which suggest a permanent breeding population to be present in the area. The recaptured animals were in poor health condition, as expected at the end of the mating season.

The high local densities of Northern Quolls are likely a reflection of the quality of habitat present in the area, as well as the availability of permanent surface water in some of the gorges in and near the Project area. The large number of Northern Quolls also suggests that introduced predators such as the feral cat are not present in the Project area (as trapping results confirm).

Potential Impacts: Several locations within the Project area provide suitable denning habitat for Northern Quolls. As such, destruction of habitat and potential den sites, and disturbance from humans is likely to have a significant impact on the local population of Northern Quolls, potentially causing mortality and/or forced relocation away from disturbed areas. Impact on a regional scale will likely be moderate due to the species' ability to disperse from impact areas to areas of similar habitat surrounding the Project area. The current local cumulative impact is anticipated to be low.



Figure 5.1 – An Image of a Northern Quoll within the Project Area (Motion Camera).

5.1.2.2 Greater Bilby (*Macrotis lagotis*)

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

Distribution and Habitat: Once common over 70% of mainland Australia's arid and semiarid regions, Bilbies are currently patchily distributed through the Tanami, Great Sandy and Gibson Deserts (Maxwell *et al.* 1996). Isolated populations also occur in south-west Queensland and to the north-east of Alice Springs. Bilbies occur in a variety of habitats, including spinifex grassland, acacia shrubland, open woodland and cracking clays (Johnson 2008; Maxwell *et al.* 1996). The species underwent a sudden and widespread collapse in population size in the early 1900s, and the distribution may still be contracting and fragmenting. Reasons for the decline include predation by feral predators on both young and adult bilbies, competition from rabbits and livestock, reduced food as a result of changed fire regimes, and drought (Johnson 2006; Maxwell *et al.* 1996; O'Malley 2006).

Ecology: The Bilby is a nocturnal marsupial with soft, silky fur (Pavey 2006a). It uses its strong forelimbs and claws to construct an extensive tunnel system of up to 3 m long and 1.8 m deep in which it shelters during the day. Its long tongue is an adaptation to its specialised diet of seeds, insects, bulbs, fruit and fungi (Johnson 2008).

Likelihood of Occurrence - MEDIUM: Several records of Bilbies exist from within 100 km of the Project area (NatureMap, DEC Threatened Fauna Database, DSEWPaC Protected Matters Database), including at least two records from within the last decade (2001 and 2006, NatureMap). The nearest Bilby record is approximately 2.7 km to the south of the infrastructure corridor component of the Project area (NatureMap). No sign of Bilbies were found during the current or previous surveys. However, some habitat suitable for Bilbies exists within the Project area, particularly the sandy plains with Spinifex and scattered granites habitat type in the west.

Potential Impacts: Bilbies are widely distributed throughout the Pilbara (and other areas of Western Australia). Bilbies are most likely to occur in the 'Sandy plains' habitat within the Project area. This habitat type is restricted to the western part of the Project area, where only a small area in the proposed infrastructure corridor is expected to be impacted by the proposed North Star Project. Similar habitat exists outside the Project area and it is likely that any Bilbies present would disperse into surrounding areas, particularly given the species' capacity to travel over large distances.

5.1.3 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*)

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

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

Recent evidence suggests 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 due to the lack of humidity in these caves.

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 – RECORDED: This species was recorded during the level 2 survey and targeted survey. Calls were recorded from eighteen locations, which were located in close proximity to creek lines and rocky ridges and along gorges (Table 4.2 and Figure 4.4). The Pilbara Leaf-nosed Bat is thought to occupy riverine habitat and forrests during the wet season, and retreat back to their roost caves during the dry season (Churchill 2008).

During the targeted surveys in July 2011 four locations were identified by the the call patterns of the bats to have a potential to be a roost cave (*ecologia* 2011). Calls recorded immediately after sunset and before sunrise indicate bats leaving their roost cave, whereas calls recorded scattered throughout the night indicate bats foraging. All locations were targeted during the Phase two and Phase 3 of the Level 2 survey to collect data of the presence and absence and call pattern of the Pilbara Leaf-nosed Bats. However, out of the four potential roost locations three were confirmed to be a potential dry season roost cave (Table 4.2). These were located along the ironstone ridge in the east of the Project area (Figure 4.4). Results of call analyses indicate that the Project area contains both foraging habitat and roost caves for Pilbara Leaf-nosed Bats.



Figure 5.2 – Cliff face with potential roost cave(s) 1 for the Pilbara Leaf-nosed Bat



Figure 5.3 – Potential roost cave 2 for the Pilbara Leaf-nosed Bat

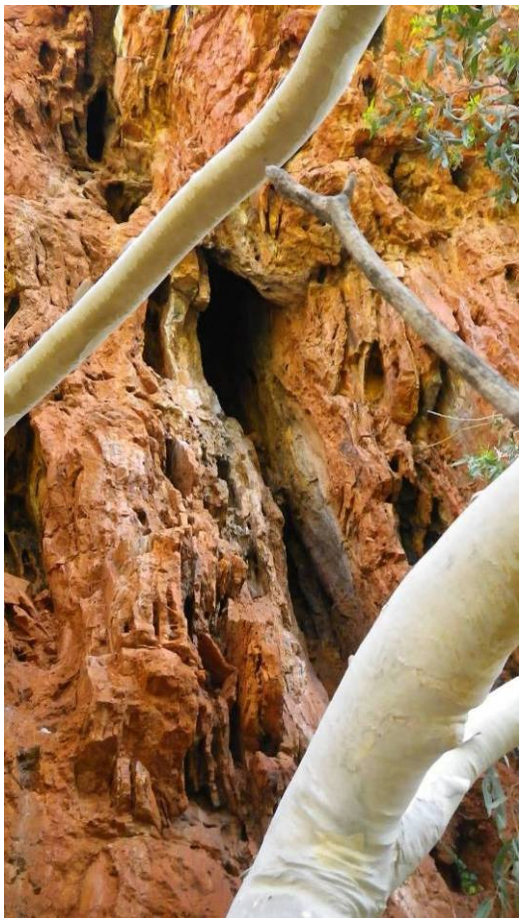


Figure 5.4 – Potential roost cave 3 for the Pilbara Leaf-nosed Bat

Pilbara Leaf-nosed Bats have also previously been recorded approximately 100 km from the Project area (*ecologia internal database*). There are several records of the species within 50 km from the Project area, including potential roost caves around Lalla Rookh mine approximately 10 km north-east and west of the Project area (DEC 2011; Molhar 2007). The records around Lalla Rookh mine are located in the Capricorn Land system which is well presented in the east of the Project area (proposed mine area). It extents to the north-east of the North Star Project towards the Lalla Rookh mine and south-east of the Project area (Figure 4.1). Furthermore, three records are known from 20-40 km south of the Project area (NatureMap), located in the Talga Land system. The Talga Land system was recorded from the south of the Project area where no suitable roost cave habitat was observed during this survey.

Potential Impacts: Due to the sensitivity of Pilbara Leaf-nosed Bats to disturbance, any construction/mining activities within 50m of roost caves will impact on this species as they are known to abandon roost caves if disturbed (Outback Ecology 2011a). If roost caves are impacted upon, there is the potential for a loss in the local population of this species. Pilbara Leaf-nosed Bats are dependent on caves with very hot and humid roost sites (28-32 °C), which are uncommon in the Pilbara (Churchill 2008). During the dry season, Pilbara Leaf-nosed Bats are highly reliant on roost caves for humidity and warmth, bats are known to die within hours if removed from roost caves, due to their exceptionally highly susceptability to dehydration (Churchill 2008).

The development of the North Star Project will result in a loss of wet- and dry-season roost habitat as well as foraging habitat for the Pilbara Leaf-nosed Bat and therefore will impact this species on a local level. It is anticipated bats impacted upon will be able to find new hunting ranges, as suitable habitat exists outside the Project area. However, the level of impact at a regional scale will be determined by the nature of development/mining activities and their proximity to roost caves.

5.1.3.1 Brush-tailed Mulgara (*Dasycercus blythi*)

Conservation Status: DEC Priority 4. The Brush-tailed Mulgara has only recently been reclassified and separated from the genetically and morphologically distinct Crest-tailed Mulgara (*Dasycercus cristicauda*; EPBC Act Vulnerable) (Woolley 2006). As such, the more widespread Brush-tailed Mulgara is not listed in the EPBC Act, but is listed as Priority 4 (fauna in need of monitoring) on the DEC Priority and Threatened Fauna list (2008).

Distribution and Habitat: Brush-tailed Mulgara occur in spinifex grasslands and gibber plains throughout much of the arid zone, digging burrows in flats or between gentle slopes (Pavey *et al.* 2011; Woolley 2006).

Ecology: Believed to be generally solitary, Brush-tailed Mulgara construct several single-entranced, multi-tunnelled burrows within their home range (Woolley 2008). According to Koertner *et al.* (2007), home ranges and burrows encompass both mature spinifex and open regrowth areas, with Brush-tailed Mulgara not preferring either habitat type over the other. However, utilisation of open habitats might increase the risk of predation, especially following fire. Brush-tailed Mulgara are nocturnal hunters, feeding on arthropods and small vertebrates. Breeding is believed to occur from late winter to spring (Woolley 2008).

Likelihood of Occurrence – MEDIUM: Mulgaras are known to occur in the area, with four records of the species from within 50 km of the Project area (Biota 2005, NatureMap, DEC Threatened Fauna Database, DSEWPaC Protected Matters Database; 2007) including one historical record (1958) and one more recent record (2001) from within the infrastructure corridor (NatureMap, Figure 4.1). The taxonomy of these records can not be identified at this stage as the species is currently undergoing taxonomic revision (Ric How, WA Museum, pers. comment). A possible Mulgara burrow was also

recorded approximately 35 km from the Project area (*ecologia* Internal Database, NatureMap). Suitable habitat for Brush-tailed Mulgaras exists within the Project area, particularly within the Sandy Plains with Spinifex and Scattered Granites habitat type in the west of the Project area.

Potential Impacts: Little is known about the cause of decline and threatening processes to the Mulgara, making it difficult to determine potential impacts. However, it is likely that environmental degradation and habitat homogenisation negatively affect the species. Changes in fire regimes, grazing by introduced herbivores including cattle and rabbits, and predation by introduced predators are also likely threatening processes (Pavey *et al.* 2006). Therefore, habitat degradation, altered fire regimes and changes to flora and fauna asseblages (particularly an increase in introduced species) may impact on local populations of Brush-tailed Mulgara. Due to the aforementioned taxonomic revision, the distribution of the Brush-tailed Mulgara is uncertian. However, it is likely that the species is widely distributed and may be locally abundant in some areas. Pavey et al. (2011) describes an increase on identified habitat preferrence, including gibber plains as suitable habitat. The Project is, therefore, anticipated to have a low impact on Brush-tailed Mulgara at a local or regional scale.

5.1.3.2 Long-tailed Dunnart (*Sminthopsis longicaudata*)

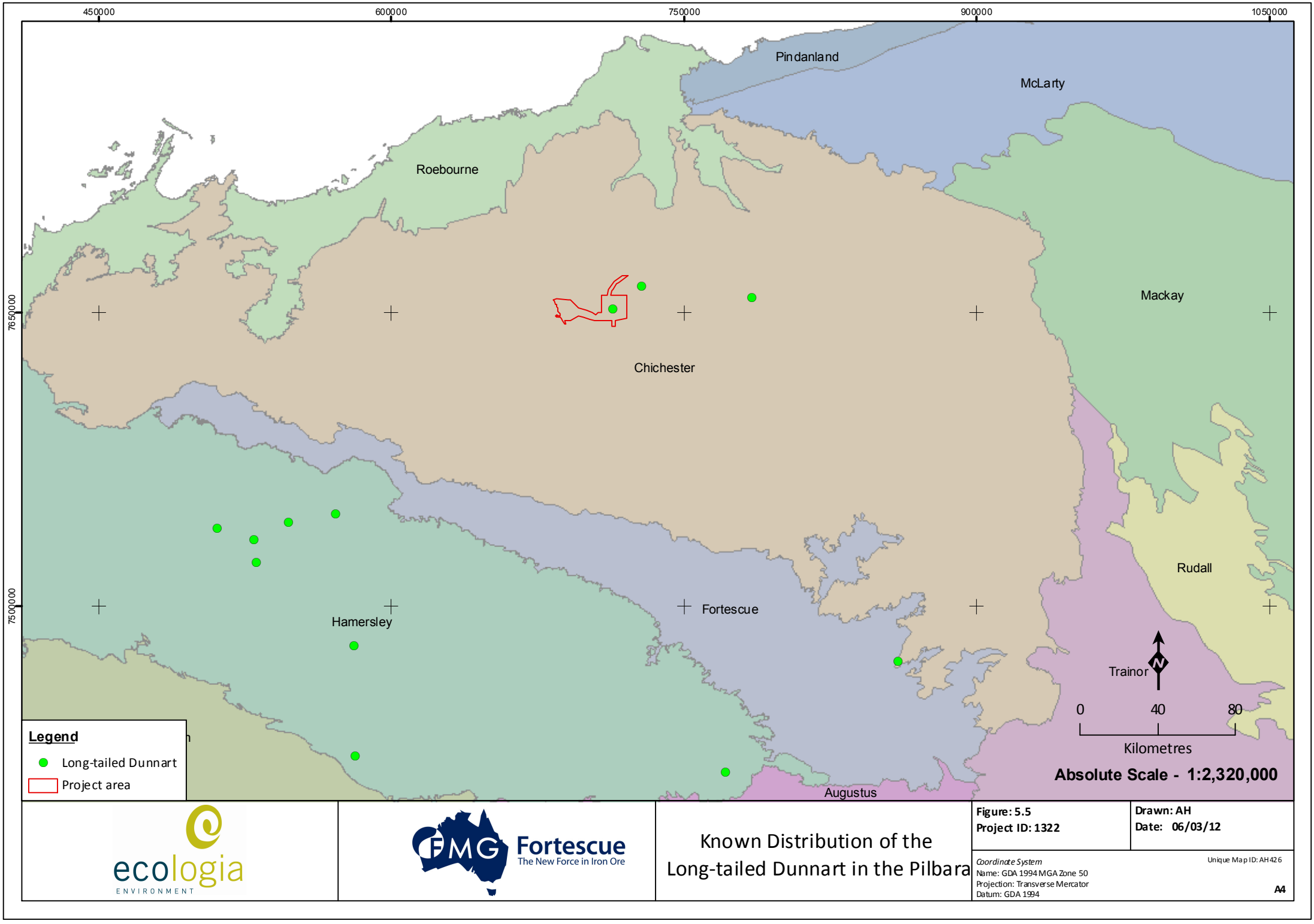
Conservation Status: DEC Priority 4.

Distribution and Habitat: Long-tailed Dunnarts are mostly found in rocky country in the western arid zone, although 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 counterveight; this, along with striated foot pads, suggest it is adapted to climbing (Burbidge *et al.* 2008).

No threatening processes have been identified at this stage as only little is known about this species. Threats could be inappropriate fire regimes and habitat modification as a result of the activities of introduced herbivores such as horses and cattle, invasion by Buffel grass and predation by feral cats and foxes (Pavey 2006b).

Likelihood of Occurrence - RECORDED: Database searches and literature review did not return any previous records of Long-tailed Dunnarts, and the nearest known record of the species is 70 km east of the Project area (Naturemap). However, the current survey resulted in 11 captures of Long-tailed Dunnart from three locations. These dunnarts were trapped at sites 5, 6 and 7, in the eastern part of the Project area (Table 4.2, Figure 4.5, Figure 5.6). Extensive suitable habitat exists throughout the Project area, with open or spinifex-dominated rocky areas preferred by the dunnarts; such habitat comprises the vast majority of the Project area.



ecologia ENVIRONMENT

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Known Distribution of the Long-tailed Dunnart in the Pilbara

Figure: 5.5
Project ID: 1322

Drawn: AH
Date: 06/03/12

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

Unique Map ID: AH426

A4



Figure 5.6 – Long-tailed Dunnart Recorded during this Survey

Potential Impacts: The NatureMap record, as well as those form the current survey, represent the northernmost distribution of the Long-tailed Dunnart, suggesting records from the current survey are significant, though it is unlikely they represent a range extension. The current knowledge of the ecology and threatening processes of the species is not sufficient to determine a level of potential impact with any certainty. It is likely that, while there may be a loss of individuals, Long-tailed Dunnarts may relocate to similar habitat outside the Project area. However, this ability to disperse will be reduced if neighbouring mining tenements undergo development, thus elevating the importance of habitat within the Project area as refuge sites.

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

Conservation Status: DEC 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 tussocks of *Triodia* spp. (DEWHA 2008a).

Ecology: The Spectacled Hare-wallaby is solitary, but up to three 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 concentrated low urine production and the water needed is far less than in any other mammal of comparative size (Burbidge and Johnson 2008).

Likelihood of Occurrence - HIGH: No evidence of Spectacled Hare-wallaby from the current within the Project area. However, a total of 107 individual Spectacled Hare-Wallabies were recorded within 100 km of the Project area, several of which were made nearby, and one inside the Project area (recorded in 1990 near the north-eastern border of the Project area) (NatureMap, DEC Threatened Fauna Database). The species is most likely to occur in the Sandy Plains with Spinifex and Scattered Granites habitat type in the west of the Project area. The 1990 NatureMap record was made near an area of this habitat type, but in the adjacent Rocky Plains with Spinifex habitat type.

Potential Impacts: Spectacled Hare-wallabies are widely distributed throughout the Pilbara and Kimberly regions, although, the majority of records (NatureMap) for the species are clustered in the region surrounding the Project area. However, the Project area is unlikely to provide key habitat for

the species, and more habitat is available outside the Project area. Therefore, while some individuals may be impacted by the Project, Spectacled Hare-wallabies are unlikely to be impacted on a local or regional scale.

5.1.4 Ghost Bat (*Macroderma gigas*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Ghost Bat has a patchy but widespread distribution across northern Australia. Preferred roosting habitats in the Pilbara include caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles. They 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 (maternity caves) (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 bat's roost (Tidemann *et al.* 1985).

Likelihood of Occurrence - RECORDED: A Single call recorded during the Targted surveys (*ecologia* 2011) which is believed to be either a transient or foraging individual. Four maternity caves are located to the east of the Project area. These include one cave within 25 km of the Project area, and three caves within 65-75 km (Armstrong and Anstee 2000). Ghost bat calls have previously been recorded by *ecologia* approximately 100 km from the Project area, and several recent NatureMap records exist in the area. Several areas with potentially suitable Ghost Bat caves occur in the Project area, particularly within the Rocky Ridge/Breakaway/Gorge habitat type.

Potential Impacts: Ghost Bats are regarded as being shy of human presence and will abandon their roosts if disturbed. No known roosts will be directly impacted, however roost caves may occur in the Project area but the low number of records suggest a low density of this species in the region. Ghost Bats may be impacted through loss of hunting territory and a reduction in prey. The Project may impact Ghost bats locally, particularly if caves utilised by Ghost Bats occur in the Project area, but suitable habitat exists outside the Project area and it is anticipated most individuals will move away from disturbance. Hence, Ghost Bats are unlikely to be significantly impacted by the Project.

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

Conservation Status: DEC 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. However, the species appears relatively secure in its remaining range (Start 2008). Western Pebble-mound Mice inhabit 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*.

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 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 0.5-9.0 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: The current survey located four Western Pebble-mound Mouse mounds with indications of current or recent activity (Table 4.2 and Figure 4.4). Literature and database searches revealed several records of the Western Pebble-mound Mouse records nearby the Project area (Outback Ecology 2006, *ecologia Internal* Database, NatureMap, DEC Threatened Fauna Database).

Potential Impacts: Western Pebble-mound Mice have a very limited ability to move away from disturbance and any impacts to spinifex-covered hill slope habitat are likely to affect significantly local populations. This species has narrow habitat requirements and its patchy distribution makes it prone to local extinction. However, as the species has been recorded across the Pilbara, no significant regional impacts to the species are anticipated. Suitable habitat exists outside the Project area, where several records of Pebble-mound Mice have been made.

5.1.6 Birds

5.1.6.1 Peregrine Falcon (*Falco peregrinus*)

Conservation Status: WC Act Schedule 4.

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

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

Likelihood of Occurrence - HIGH: Three sightings of the Peregrine Falcon have been recorded previously from within 100 km of the Project area (Biota 2005, NatureMap, DEC Threatened Fauna Database). Two recent records exist from approximately 20 km to the north and the south of the Project area (NatureMap). Suitable nesting habitat exists within the Project area along the cliff faces of the Rocky Ridge/Breakaway/Gorge habitat type, with suitable hunting territory throughout the Project area in all habitat types.

Potential Impacts: Peregrine Falcons are widely distributed throughout Western Australia. If this species is disturbed within the Project area, it can disperse to suitable nesting and hunting habitat outside the Project area. The impacts to Peregrine Falcons at a local and regional scale are anticipated to be low due to the ability of the Peregrine Falcon to move away from disturbance, and the presence of similar habitat in the surrounding the region.

5.1.6.2 Grey Falcon (*Falco hypoleucos*)

Conservation Status: DEC Priority 4.

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

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

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

Likelihood of Occurrence - RECORDED: A family of four Grey Falcons were recorded within the Project area during the second phase of the level 2 survey (Table 4.2 and Figure 4.5). Though widely distributed, Grey falcons are rarely sighted. This sighting confirms the species' presence in the area, as ascertained by numerous previous records within 100 km of the Project area (Biota 2005, *ecologia* Internal Database, NatureMap, Birdata).

Potential Impacts: Some Grey Falcon individuals may be impacted through loss of foraging habitat and prey resources, as well as by loss of nesting sites. However, Grey Falcons are highly mobile, widely distributed and not restricted to any particular habitat type. Therefore, the impacts to Grey Falcons at a local and regional scale are anticipated to be low due to the ability of the Grey Falcon to move away from disturbance.

5.1.6.3 Australian Bustard (*Ardeotis australis*)

Conservation Status: DEC Priority 4.

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

Ecology: It is a nomadic species, ranging over very large areas, and its abundance varies locally and seasonally from scarce to common, largely dependent on rainfall and food availability. The 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). Bustards readily desert nests in response to disturbance by humans, sheep or cattle (Garnett and Crowley 2000).

Likelihood of Occurrence - RECORDED: Australian Bustards are widely distributed throughout the region. Numerous recordings of the species have been made in the vicinity of the Project area (Biota

2005; Outback Ecology 2006, ecologia Internal Database, NatureMap, DEC Threatened Fauna Database, Birdata). One record of Australian Bustard has been made within the Project area, in the western section (NatureMap). These records were confirmed with a total of nine individuals sighted during both phases of the current survey (Table 4.2 and Figure 4.5).

Potential Impacts: This species is highly mobile and widely distributed throughout Western Australia. Any affected individuals will likely move away from impact. A low significant impact to this species are anticipated on a local and regional scale.

5.1.6.4 Bush Stone-curlew (*Burhinus grallarius*)

Conservation Status: DEC Priority 4.

Distribution and Habitat: The Bush Stone-curlew occurs across much of Australia, except the arid interior and central south coast, preferring lightly wooded country near thickets or long grass that acts as daytime shelter (Johnstone and Storr 1998). The Bush Stone-curlew inhabits woodlands, dry and open grasslands and croplands with cover nearby (NSW National Parks and Wildlife Service 1999).

Ecology: The species is insectivorous, preying primarily upon beetles, although they will also eat seeds and shoots, frogs, lizards and snakes (Marchant and Higgins 1993; NSW National Parks and Wildlife Service 1999). They are usually seen in pairs, although may occasionally flock together during the breeding season (August to January) and are generally nocturnal, particularly active on moonlit nights (NSW National Parks and Wildlife Service 1999). Historically, this species was widely distributed throughout much of Western Australia, but it is now considered rare, with an estimated Australian population of 15,000 individuals (Garnett and Crowley 2000). Since Bush Stone-curlews are a ground-dwelling and non-migratory species, they are quite susceptible to local disturbances by humans and to predation by cats and foxes (Frith 1976; Johnstone and Storr 1998). They are most common where land disturbance is minimal, and generally become rare or extinct around human settlements (Johnstone and Storr 1998).

Likelihood of Occurrence - RECORDED: Several records of Bush Stone-curlew exist surrounding the Project area (Biota 2005, ecologia Internal Database, NatureMap, Birdata, DEC Threatened Fauna Database; Outback Ecology 2006). Bush Stone-curlew tracks were observed in the south-western part of the Project area during phase 1 of the current survey (Table 4.2 and Figure 4.5). These indicators of Bush Stone-curlew presence were confirmed in the second phase with two individuals recorded.

Potential Impacts: This species is highly mobile, and any affected individuals will likely move away from impact. No significant impacts to this species are anticipated.

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

Conservation Status: DEC Priority 4.

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

Ecology: 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 - HIGH: *ecologia* has made two previous records of Star Finches from approximately 20 and 100 km of the Project area respectively. Star Finches have also been recorded from 100 km to the north-east (Outback Ecology 2006) and several Birdata records have been made approximately 50 km from the Project area. A group (20+ individuals) of Star Finches was recently recorded within 1.5 km to the Project area (Jonny Schoenjahn, Ornithologist, pers. comm.), in a small bed of reeds in the Turner River, which runs through the western section of the Project area. Star Finches are likely to occur along the length of this river/creek system (in the east of the Project area) wherever water pools and reeds grow. Suitable habitat for Star Finches may also occur within the Rocky Ridge/Breakaway/Gorge habitat type which occurs throughout the central and eastern sections of the Project area.

Potential Impacts: This species is sensitive to habitat clearing and development as they are habitat specific. A loss of habitat is likely to result in a loss of individuals and/or forced relocation to surrounding areas of similar habitat. Areas of seemingly permanent surface water (springs) occur within the Project area. However, there are several records of Star Finches in surrounding areas, and the Project is unlikely to impact Star Finches on a regional scale.

5.1.6.6 Fork-tailed Swift (*Apus pacificus*)

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

Distribution and Habitat: The Fork-tailed Swift is a small, insectivorous species with a white throat and rump, and a deeply forked tail (Morcombe 2000). It is distributed from central Siberia 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 in 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 - RECORDED: The Fork-tailed Swift was recorded twice during phase 1 of the level 2 survey, with nine individuals recorded (Table 4.2 and Figure 4.5). The species has also been recorded in the area previously, with one *ecologia* record approximately 100 km from Project area and three NatureMap records between approximately 30 and 50 km from Project area.

Potential Impacts: Due to the aerial and highly mobile nature of Fork-tailed Swift, no impacts are anticipated, either at a local or regional scale.

5.1.6.7 Eastern Great Egret (*Ardea modesta*)

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

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

Ecology: This species' diet consists predominantly of small fish and crustaceans. They 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 - HIGH: Numerous Eastern Great Egrets have been recorded from around the Project area (Outback Ecology 2006, NatureMap, Birdata), including records from within the Project area (NatureMap). Little typical habitat (wide expanses of shallow water such as lakes, swamps and floodwaters) exists within the Project area, but the species may utilise the Creekline habitat. The previous records of Eastern Great Egret within the Project area were made from pools within creeklines, confirm these as potential habitat.

Potential Impacts: Eastern Great Egrets are widely distributed throughout Western Autsralia. They are likely to move away from impact to areas surrounding the Project area, where habitat is likely more typical for wader species.

5.1.6.8 Rainbow Bee-eater (*Merops ornatus*)

Conservation Status: EPBC Act Migratory.

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 burrow from August to January (Boland 2004). Bee-eaters are most susceptible to predation during breeding.

Likelihood of Occurrence - RECORDED: Rainbow Bee-eaters are commonly recorded across the Pilbara. Suitable nesting and foraging habitat is present within the Project area. Numerous previous records exist of Rainbow Bee-eaters in and surrounding the Project area (Biota 2005; Outback Ecology 2006, ecologia Internal Database, NatureMap, Birdata, DSEWPaC Protected Matters Database). These were confirmed with a total of 128 Rainbow Bee-eaters recorded during both phases of the current survey throughout the Project area (Table 4.2 and Figure 4.5). The high abundance of this species suggests that the habitat may be locally valuable to the species.

Potential Impacts: Suitable nesting habitat exists for the Rainbow Bee-eater within the Project area within the Creekline and Rocky Ridge/Breakaway/Gorge habitat types. The Rainbow Bee-eater burrows into sandy embankments to nest, therefore if areas with suitable habitat are impacted upon during the breeding season of this species, it could result in loss of individuals. However, no regional

impacts are anticipated for this species due to its wide distribution and availability of suitable habitat outside the Project area.

5.1.7 Reptiles

5.1.7.1 Ctenotus nigrilineatus

Conservation Status: DEC Priority 1.

Distribution and Habitat: Only a few (40 to date) records have been made of the species. These are restricted to a relatively small area, within about 100 km of Marble Bar. The holotype, as well as two subsequent specimens, were collected from near Woodstock (Storr 1990, NatureMap). Specimens collected to date had been found in spinifex at the base of granite outcrops, and so it is assumed that this is the preferred habitat of *Ctenotus nigrilineatus* (Storr 1990).

Ecology: There is no information available on the ecology of this species. However, it may be assumed that it is similar to that of other *Ctenotus* species, which are generally described as swift, sun-loving skinks that bask and forage on exposed surfaces (in the case of *Ctenotus nigrilineatus*, most likely on the surfaces of granite outcrops), and shelter in narrow crevices (Wilson and Swan 2010).

Likelihood of Occurrence - MEDIUM: *Ctenotus nigrilineatus* has a very restricted distribution, with 40 known records from six wider areas. The western edge of the known distribution occurs near the Project area. One recent (2001) record exists 18 km south of the Project area (DEC Threatened Fauna Database). Three older records (1988 and 1990) were made near Woodstock, approximately 32 km south (DEC Threatened Fauna Database, NatureMap) of the Project area. The species was not recorded from the current survey, though the species is very rarely encountered. The preferred habitat of *C. nigrilineatus* comprises spinifex-dominated areas near granite outcrops. Such habitat is present within the Project area and is most likely to occur in the Boolaloo land system.

Potential Impacts: There is insufficient knowledge of the distribution and ecology of this species to determine the scale of impact with any certainty. If *Ctenotus nigrilineatus* occurs in Project area, the Project is anticipated to have a low impact on the species on a regional scale due to the low impact of the infrastructure corridor. However, any granite outcrops within the Project area should be excluded from development/mining activities as a precaution.

5.1.7.2 Ramphotyphlops ganei

Conservation Status: DEC Priority 1.

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

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

Likelihood of Occurrence - HIGH: There are five recent records of *R. ganei* within 100 km of the Project area. The nearest record, and also the northernmost record for the species, is 15 km north of

the Project area (NatureMap). The species' preferred habitat is expected to be contained within the Rocky Ridge/Breakaway/Gorge, Rocky Spinifex Hills and Rocky Plains with Spinifex habitat types, which together comprise the majority of the Project area.

Potential Impacts: Due to the lack of knowledge of *R. ganei*, assessing the potential impacts to the species is problematic. It is a rarely encountered species, with only 28 records currently available on NatureMap. The distribution of these records indicates suitable habitat is present locally in form of rocky plain, gullies and breakaways in adjacent areas; however, the species has a very limited ability for dispersal/relocation, suggesting any habitat loss or degradation would result in a loss of individuals within the Project area. Given the total population size of *R. ganei* is unknown, the regional implications of local losses are also unknown. *R. ganei* are fairly widely distributed through the region, suggesting the Project's impact to the species at a regional scale would be low. However, this should be considered with precaution.

5.1.7.3 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, including rock wallabies, 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.

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

Likelihood of Occurrence - RECORDED: The targeted survey conducted by *ecologia* (2011) recorded secondary signs of Pilbara Olive Pythons (a sloughed skin, the remains of one Pilbara Olive Python and scats). Pilbara Olive Pythons had also been recorded from within 100 km of the Project area previously (Outback Ecology 2006, *ecologia* Internal Database, NatureMap, DEC Threatened Fauna Database, DSEWPaC Protected Matters Database). The species' presence was confirmed during phase 2 of the current survey, with captures of six Pilbara Olive Python individuals (Figure 5.7, Table 4.2 and Figure 4.6). Given the rarity of encounters with this subspecies, these records, particularly given their frequency, were significant. All individuals were opportunistically captured in rocky gorges with surface water present, which represents critical habitat for the species.



Figure 5.7 – Olive Python Recorded During this Survey

Potential Impacts: Critical and suitable habitat is present within the Project Area (*ecologia* 2011). The habitat comprises rocky gorges with semipermanent or permanent water pools and large creek beds such as the Turner River. The quality of the habitat, particularly in the mining and infrastructure areas, is excellent, which was reflected by the high number of captures during the survey. This suggests that this area may be significant for this subspecies. The Pilbara Olive Python has the potential to occur anywhere throughout the Project area while they are dispersing over the summer months. It is likely to shelter in the Rocky Ridge/Breakaway/Gorge habitat type over the cooler winter months, when this species aestivates within deep rocky crevices. Critical habitat for the Pilbara Olive Python includes areas where surface water collects such as deep bowls and depressions within rocky gorges. Some of these areas within the Project area appear to have a permanent (spring) source of water.

If quality habitat of the Pilbara Olive Python is significantly impacted, this will result in forced relocation and/or mortality within the local population. Though few records exist for Pilbara Olive Python (as little as 43 currently available on NatureMap), this subspecies is fairly widely distributed through the region, suggesting the Project's impact to the species at a regional scale would be moderate to low. However, there is insufficient information on the population size for this subspecies to determine the level of impact with any certainty.

5.2 THREATENING PROCESSES

Greater human activity in the area, processes/activities associated with the development of the Project and processes/activities associated with the continued operation of the Project all create threatening processes that could potentially impact vertebrate fauna. These processes/activities are discussed below.

5.2.1 Vegetation Clearing

Impacts to native fauna arising from vegetation clearing activities will include a reduction in the amount of available fauna habitat, and mortality of small and sedentary fauna that are unable to move out of the area prior to clearing (Western Pebble-mound Mouse, Long-tailed Dunnart). Clearing activities which result in the fragmentation of habitats result in the inability of individuals to move between areas of habitat and increase the risk of predation as individuals move across cleared areas. Examples relevant to the Project include the clearing of the valley bottoms which will separate the rocky ridge habitats. In general, vegetation clearing will cause a local loss of biodiversity and ecological function.

5.2.2 Vegetation Degradation

Vegetation degradation is caused through the effects of dust pollution or increased weed invasion. Development of the North Star Project will involve the clearing of native vegetation and the construction and operation of mine site and associated infrastructure. The activities involved in clearing vegetation and construction and operation of a mine will increase the level of dust pollution and can facilitate the spread of weed species already present in the area, and the increase in vehicle and equipment movement may introduce species from other areas.

Dust pollution has many potential impacts to vegetation including physical damage to plant tissue, introduction of disease causing chemicals, reductions in physiological processes and changes to species compositions of vegetation communities (Farmer 1993). The resulting changes to the vegetation communities alter the associated fauna habitats, typically resulting in reduced suitability of the vegetation as a habitat, food source or other ecological aspect.

The impacts of the introduction of weed species are similar to the effects of dust, in that it alters the associated fauna habitats. In a worst case scenario, this may result in weed species dominating the understorey to the exclusion of annuals and eventually larger perennial flora. Of 20 studies of environmental weed impact in Australia, 19 demonstrated that weed species contribute to a decline in flora species richness, canopy cover or frequency of native flora species. Although no studies have been undertaken in sub-tropical Australia, studies on vertebrates in tropical Australia (Braithwaite *et al.* 1989; Griffin *et al.* 1989), South Africa (Winterbottom 1970) and the United States (Brock *et al.* 1986) indicate a substantial decline in fauna species richness and abundance following the introduction of exotic weed species.

5.2.3 Noise and Light Pollution

Noise pollution is expected to occur due to the use of heavy machinery and transportation. Noise pollution may cause fauna species to move away, alter their behaviour, or change community structure due to the negative response of wildlife to new stimuli (Larkin 1996; Radle 1998).

Bat species are sensitive to both light and noise pollution, particularly approaching and during the maternity season (Mann *et al.* 2002). The presence of light and noise may be advantageous to some species, for example those that feed on insects around lights, and disadvantageous to others, for example species in which the noise pollution interferes with their echolocation calls (Zagorodniuk 2003). This has the potential to alter the species composition within the Project area. Mercury vapour lights in particular have been found to affect the predator-prey relationship between bats and moths (Longcore and Rich 2004).

Noise and light can attract feral predators to areas as they associate human activity with food resources. An increase in feral predator numbers will result in a corresponding increase in predation

rates on native animals. High predation rates (from both feral and native fauna) have also been found to occur in areas of high illumination, and small mammals tend to forage less in these areas (Longcore and Rich 2004).

Light pollution can disrupt bird migrations, particularly nocturnally migrating species when environmental conditions force them to fly lower to the ground at night (Longcore and Rich 2004). Birds can become trapped in artificially lit areas as they will not move out into dark areas where they have difficulty navigating. Trapped individuals may become exhausted, collide with other individuals or suffer from increased predation (Longcore and Rich 2004).

The potential impacts of noise and/or light pollution is difficult to estimate due to the lack of specific studies related to mine sites in the Pilbara. Due to the wide spacing of mine sites in the Pilbara it is expected that impacts will be minimal and the most species will either habituate to the light and noise associated with development of the North Star Project, or move to a suitable distance away from the noise source so that it is no longer disturbing (Larkin 1996; Radle 1998). Due to the mobility of most species, individuals should be able to move away from light and noise sources and thus reduce the impact. However, this ability to move away will be reduced if neighbouring mining tenements undergo development

5.2.4 Fire

Increased human activity is often associated with an increased risk of fire or altered fire regimes, which may lead to temporary destruction of fauna habitats or more lasting degradation of natural vegetation if, for example, fire frequency is increased (Williams 2002). In particular the continuous spinifex plains are sensitive to fire due to the ability of fire to travel long distances if spinifex hummock grassland is present in a continuous manner. Frequent fires will reduce the ability of fauna species to recolonise burnt areas as unburnt areas tend to become scarcer with increased fire occurrence.

Movement of vehicles, machinery and human influences have the potential to increase the frequency of spot fires, particularly in the highly flammable spinifex that occurs across the North Star Project area.

5.2.5 Vehicle Strike

The construction of roads and access tracks within the Project area will increase the likelihood of vehicle strikes on native fauna. Reptiles, in particular the Pilbara Olive Python may be killed on roads while basking during the day and mammals, particularly macropods, but also dasyurids such as the Northern Quoll are commonly killed on roads following dusk. This attracts scavenging species such as the Wedge-tailed Eagle, which are then more likely to be killed themselves. Species such as Pilbara Leaf-nosed Bats also forage close to ground (Churchill 2008) and, therefore, are susceptible to vehicle strikes.

5.2.6 Food Waste and Artificial Open Water

The presence of artificial open water sources and accessible food wastes can cause an increase of feral fauna densities, in particular dogs and cats and allow these species to occur in areas that would not otherwise be possible in the arid zones of Australia. An increase in feral fauna densities will have an increased negative impact on the abundance and diversity of native fauna due to increased predation pressure and resource competition. Feral cats are known to be predators for the Northern Quoll (Maxwell *et al.* 1996; Oakwood 2008). Water as such will not have a significant impact at the

North Star Project area as natural springs and gorges are already present throughout the east of the Project area. Food wastes are typically concentrated around accommodation camps (such as poorly disposed kitchen scraps), though poorly disposed lunch scraps from staff members working away from the camp can also provide a food resource for feral fauna species.

5.3 IMPACTS ON FAUNA HABITATS

Seven fauna habitat types were recognised within the Survey area: Rocky spinifex hills, rocky plains with spinifex, rocky ridges/Breakaways/gorges, sandy plains with spinifex and scattered granites, acacias shrubland on hard soils, creek lines and granite outcrops. The majority of these habitat types are widespread throughout the surrounding region; however, the quality of the rocky ridges/breakaways/gorges habitat within the Project area for conservation significant species is very high.

Creek lines and sandy spinifex plains with scattered granite are most sensitive to clearing and fire as the continuous spinifex layer supports fire and cleared vegetation is fatal for most species in this habitat type. Large trees and large mature spinifex clumps will take several years to regrow.

5.4 IMPACTS ON FAUNAL ASSEMBLAGES

5.4.1 Biodiversity

The majority of the diversity of fauna assemblages within the surrounding region is unlikely to be significantly affected by the proposed North Star Project. Most terrestrial fauna are expected to be able to move to adjacent areas of suitable habitat. However, individuals of sedentary fauna, e.g. burrowing species and individuals of specialised fauna, e.g. Pilbara Leaf-nosed Bat, Western Pebble-mound Mouse and Long-tailed Dunnart, may be impacted. Vegetation surrounding the Project area may also be degraded from impacts, such as fire, dust and weeds, which may reduce the quality of local fauna habitats thereby reducing local fauna diversity; however, the impacts to regional biodiversity are expected to be low.

5.4.2 Ecological Function

Localised reduction in ecological function can be expected as a result of habitat clearing, fragmentation, traffic, noise, and light pollution. However, ecological function at a regional scale is not expected to be impacted.

Biodiversity and ecological function are expected to recover as vegetation communities regenerate in rehabilitated areas and stabilise, allowing native fauna to re-colonise from adjacent areas. Adequate weed management, including regular monitoring for exotic weeds, is important for rehabilitation of disturbed areas to succeed in re-creating some of the original fauna habitats present prior to the Project. It should be noted that it is unlikely that full restoration of the original habitat and ecosystems can be achieved, and therefore, vegetation clearing should be minimised.

6 CONCLUSION

- The North Star Project area supports a wide variety of species typically found in the Pilbara region. The increased variety of species is attributed to the numerous habitat types that occur in the mining areas and infrastructure corridors.
- Five EPBC listed conservation significant fauna species were recorded within the Project area, including Northern Quoll, Pilbara Leaf-nosed Bat, Rainbow Bee-eater, Fork-tailed Swift and Pilbara Olive Python. Six DEC Priority 3 and Priority 4 listed species were also recorded: Ghost Bat, Western Pebble-mound Mouse, Long-tailed Dunnart, Grey Falcon, Australian Bustard and Bush Stone-curlew.
- Twenty Northern Quoll individuals were caught, four recorded on motion camera and five recorded from secondary evidence within the Project Area, mainly within the proposed mining area and infrastructure areas. Northern Quolls were also recorded in large numbers (18 individuals) from Wodgina Project (approximately 10 km west). However, previous records in the surrounding area suggest that suitable habitat is present outside the Project area.
- Pilbara Leaf-nosed Bats were recorded from 18 locations within the Project Area. Based on analysis of the timing of the call density peaks, three of these locations were considered to be associated with roost cave locations. The majority of records were from the proposed North Star mining area and infrastructure areas and consisted of the rocky ridge/breakaway/rocky gorge habitat with or without semipermanent water. Several potential roost caves are also known from Lalla Rookh mine (approximately 10 km north-east) which may suggest that the records within the Project are part of a stronghold area for the Pilbara Leaf-nosed Bat. Previous records in the surrounding area show that suitable habitat is present outside the Project area but may be restricted to three Land systems in the region (Capricorn, Talga, Uaroo).
- Six individual Pilbara Olive Pythons were recorded from four locations within the North Star Project area. Remains of one individual, a sloughed skin and a single scat were also recorded during opportunistic searches. Regional records of this species are restricted to five locations within 40 km to the Project area. Suitable habitat for this species within the project area may be significant for the survival of this species on a local level.
- Based on the number of records collected during this survey the Project area may form a significant area of habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python populations.

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APPENDIX A EXPLANATION OF CONSERVATION CODES

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

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 Department of Environment and Conservation Priority Codes.

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

APPENDIX B DAILY WEATHER OBSERVATIONS

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Appendix B1 – Daily Weather Observations from Marble Bar Weather Station

Date	Maximum Temperature (°C)	Minimum Temperature (°C)	Rainfall (mm)
Phase 1*			
29/03/11	24.4	36.1	0.0
30/03/11	27.0	36.7	0.0
31/03/11	28.2	36.5	0.0
01/04/11	26.2	36.1	0.0
02/04/11	26.5	35.5	0.0
03/04/11	25.8	34.6	0.0
04/04/11	25.0	34.7	0.0
05/04/11	22.6	-	0.0
06/04/11	21.8	26.6	-
07/04/11	20.3	29.2	3.2
08/04/11	21.6	35.3	0.4
09/04/11	23.9	34.9	3.4
Phase 2*			
25/10/11	22.4	41.7	0.0
26/10/11	23.8	41.4	0.0
27/10/11	26.0	40.1	0.0
28/10/11	24.7	40.5	0.0
29/10/11	23.8	40.5	0.0
30/10/11	20.8	38.7	0.0
31/10/11	21.4	36.3	0.0
01/11/11	19.7	33.5	3.8
02/11/11	20.4	34.1	0.8
03/11/11	20.0	36.7	0.0
04/11/11	23.5	35.8	0.0
05/11/11	19.8	37.1	0.0
Phase 3*			
10/10/11	18.8	35.9	0.0
11/10/11	17.8	38.4	0.0
12/10/11	19.0	37.7	0.0
13/10/11	16.8	39.3	0.0
14/10/11	21.1	38.5	0.0
15/10/11	18.7	39.5	0.0
16/10/11	20.8	40.4	0.0
17/10/11	22.2	41.4	0.0
18/10/11	22.3	39.3	0.0
19/10/11	20.2	38.9	0.0
20/10/11	23.7	40.4	0.0
21/10/11	26.0	39.0	0.0

Phase 1: North Star Phase 1 of Level 2

Phase 2: North Star Phase 2 of Level 2

Phase 3: Single Phase survey at Additional Areas

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APPENDIX C SITE DESCRIPTIONS

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Site 1 Hummock spinifex grassland plain very scattered *Acacia* spp. shrubs and very few scattered *Corymbia* sp. trees as the dominant vegetation. Soil substrate consisting of sandy-loam of weak strength with scattered small granite outcrops and boulders. **Habitat type**: Sandy plains with spinifex and scattered granites.	
Site 2 Located in close proximity to creekline habitat, this site comprises greater vegetation density and is more sandy then typically associated with this habitat type. Vegetation consists of dense spinifex hummock grass, with moderate dense *Acacia* spp. and *Eromophila* spp. shrub layer with open *Eucalyptus* sp. trees. Soil substrate is typically brown in colour, sandy-loam of firm strength. **Habitat type**: Rocky plains with spinifex.	

Site 3 Open hummock grassland plain, recently burnt within 1-5 years. Scattered *Acacia* spp. shrubs and *Eucalyptus* sp. trees. Small to large granite domes in the near vicinity with soil being sandy-loam with scattered lose stones on the soil surface. **Habitat type:** Rocky plains with spinifex.	
Site 4 This site is situated within a broad valley on gently sloping hill slopes. Spinifex grass of medium to high density covers the ground along with *Ptilotus* sp., with scattered to medium densities of *Acacia* spp. and *Eromophila* spp. shrubs. *Eucalyptus* sp. trees of low densities are found throughout. Soil substrate is stony loamy-sand of greyish colour, with pebbles and stones on the soil surface. **Habitat type:** Rocky spinifex hills.	

Site 5 This site is situated within one of the drainage channels draining west off the main escarpment. It is of primarily rocky substrate with many large boulders and rock crevices. *Eucalyptus victrix* grown in open densities through the drainage lines, with medium dense *Acacia* spp. shrubs with moderately dense spinifex grass cover. Remnant surface pools of water are found within the drainage line following rainfall. **Habitat type:** Rocky ridge / breakaway / gorge.	
Site 6 This site is located on top of the north-south running main escarpment. This habitat on top of the escarpment is relatively flat, with an open shrubland of mixed *Acacia* spp. Over spinifex grass. Scattered *Eucalyptus* sp. trees occur. Soil substrate is loamy-sand with tightly packed rocks of pebble size throughout the substrate and on the surface. **Habitat type:** Rocky spinifex hills.	

Site 7 As with site 6, this site is located on top of the "Darby" escarpment, but in close proximity to the western edge. A low *Acacia* spp. Shrubland is mixed with regenerating spinifex of small size following recent fire. Scattered *Eucalyptus* sp. trees occur. Soil substrate is loamy-sand with tightly packed rocks of pebble size throughout the substrate and on the surface. **Habitat type:** Rocky spinifex hills.	
Site 8 Located within a small drainage line, this site is more sandy in soil substrate then surrounding areas. A medium dense *Acacia* sp. shrubland is above a medium to high dense spinifex grassland with scattered *Eucalyptus* sp. trees. Soil is firm in strength, brown in colour with substrate being sandy-loam. Scattered pebbles occur across the surface and within the soil. **Habitat type:** Rocky plains with spinifex.	

Site 9 This site is located at the base of the edge of a southern facing hillslope bordering the rocky escarpment in the north of the Project area. The site transects up the slope to approximately three-quarters of the way up. Large boulders and rock piles occur, with dense spinifex grass of mature age, scattered *Acacia* spp. Shrubs and scattered *Eucalyptus* sp. occurring. **Habitat type:** Rocky ridge / breakaway / gorge.	
Site 10 This site runs parallel to a creekline within the alluvial sediments associated with the drainage system. Soil colour is brown, consisting of sandy-loam substrate of medium strength. It is an open eucalypt woodland of mixed species with mixed *Acacia* spp. Shrubs. Grasses consist of early regenerating spinifex from fire, with buffle grass in patches. The grass and low vegetation was relatively highly degraded from cattle. **Habitat type:** Creekline.	

Site 11 Scattered *Acacia inequalatera* stands above dense spinifex of good size on very rocky soil. Many small boulders are scattered on the surface, with the substrate containing stones and rocks. **Habitat type:** Rocky spinifex hills.	
Site 12 This site is located within a deep rocky gorge, part of the drainage network running east off the "Darby" escarpment. Permanent spring feed water pools are present, with medium dense *Eucalyptus* sp. and *Maleleuca* sp. trees over *Acacia* spp. Shrubs, spinifex hummock grass and lemon and sword tussock grasses. Extensive cracks and fissures are present within the steep and vertical rocky cliff slopes and faces. **Habitat type:** Rocky ridge / breakaway / gorge.	

Site 13 This site is located on top of the rocky escarpment in the north of the Project area. It consists of rolling hill slopes of rocky soil substrate. Spinifex hummock grass of good size and medium to high density occurs, with *Acacia* spp. Shrubs occurring from scattered to medium densities. Scattered *Eucalyptus* sp. trees are present. **Habitat type:** Rocky spinifex hills.	
Site 14 This site was located within a creekline, adjacent to an isolated but significant rocky escarpment cliff face. This shrubland consisted of greater diversity and density of shrubs then of surrounding areas. The mixed shrub layer was made up predominately of *Acacia* and *Eromophila* spp., with areas of large, dense spinifex. Large mature *Eucalyptus victrix* trees occur in low to medium density, with the soil substrate being sandy, of weak strength. **Habitat type:** Creekline.	

Site 15 Numerous large rocky boulder piles of basalt type geology make this site relatively different to other sites in the same habitat type of rocky hills and hillslopes. At the base of the outcrops, the soil substrate is relatively sandy due to the weathering of surrounding rocks. Mixed *Acacia* spp. Shrubs are at low densities on outcrops and medium density at the base. Spinifex is at medium to low densities throughout with scattered *Eucalyptus* sp. trees. **Habitat type:** Rocky hills.	
Site 16 This open hummock grassland has spinifex of medium density with scattered *Acacia inequalatera* shrubs and *Eucalyptus* sp. trees. Soil substrate is more clayey then surrounding areas, is of greyish colour with continuous pebbles on the surface and within the substrate. **Habitat type:** Rocky hills.	

APPENDIX D REGIONAL FAUNA DATA

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Appendix D1 – Mammals

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
TACHYGLOSSIDAE																
Tachyglossus aculeatus	Echidna				S	•	S			•		•	•			
DASYURIDAE																
Dasycercus blythi	Brush-tailed Mulgara			P4	S		S	S					•	•	•	
Dasycercyus cristicauda	Crest-tailed Mulkgara	VU	S1													
Dasykaluta rosamondae	Little Red Kaluta				•		•			•		•	•			•
Dasyurus hallucatus	Northern Quoll	EN	S1	EN	•	•	S	•			•	•	•	•	•	•
Ningaui ridei	Wongai Ningaui						•									
Ningaui timealeyi	Pilbara Ningaui				•	•	•			•			•			•
Planigale sp. (prev. *maculata*)	Common Planigale				•		•			•		•	•			•
Planigale sp.2						•				•						
Pseudantechinus roryi	Rory's Pseudantechinus				•	•							•			
Pseudantechinus woolleyae	Woolley's Pseudantechinus									•			•			Δ
Sminthopsis longicaudata	Long-tailed Dunnart			P4				•								•
Sminthopsis macroura	Stripe-faced Dunnart				•		•			•		•	•			
Sminthopsis ooldea	Ooldea Dunnart												•			
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart						•			•			•			•
THYLACOMYIDAE																
Macrotis lagotis	Bilby	VU	S1	VU									•	•	•	

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
PHALANGERIDAE																
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum												•			
MACROPODIDAE																
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby			P3		•		•					•	•		
Macropus robustus	Euro				•	•	•			•		•	•			•
Macropus rufus	Red Kangaroo				•							•	•			
Petrogale rothschildi	Rothschild's Rock-wallaby				•	•	•						•			•
MEGADERMATIDAE																
Macroderma gigas	Ghost Bat			P4	•	•		•		•		•	•	•		Δ
HIPPOSIDERIDAE																
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat	VU	S1	VU	•	•		•	•			•	•	•	•	•
EMBALLONURIDAE																
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat				•							•	•			
Taphozous georgianus	Common Sheathtail Bat				•	•				•		•	•			•
MOLOSSIDAE																
Chaerophon jobensis	Northern Freetail Bat				•											
Mormopterus beccarii	Beccari's Freetail Bat				•											
Tadarida australis	White-striped Freetail Bat				•	•										
VESPERTILIONIDAE																
Chalinolobus gouldii	Gould's Wattled Bat				•		•					•	•			•
Nyctophilus geoffroyi	Lesser Long-eared Bat				•											•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
Nyctophilus bifax daedalus	Northwestern Long-eared Bat				•					•						
Scotorepens greyii	Little Broad-nosed Bat				•		•					•	•			•
Vespadelus finlaysoni	Finlayson's Cave Bat				•	•	•			•		•	•			•
MURIDAE																
Notomys alexis	Spinifex Hopping-mouse				•					•		•				
Leggadina lakedownensis	Short-tailed Mouse			P4	•		•						•	•		
Pseudomys chapmani	Western Pebble-mound mouse			P4	•	•				•		•	•	•		•
Pseudomys delicatulus	Delicate Mouse					•	•						•			•
Pseudomys desertor	Desert Mouse				•	•	•			•			•			•
Pseudomys hermannsburgensis	Sandy Inland Mouse				•		•			•		•	•			•
Zyzomys argurus	Common Rock-rat				•	•	•			•			•			•
CANIDAE																
Canis lupus dingo	Dingo				•	•				•		•				
INTRODUCED MAMMALS																
Mus musculus	House Mouse				•	•	•						•			
Canis lupus familiaris	Dog				•		•					•	•			
Vulpes vulpes	Fox											•				
Felis catus	Cat				•	•	•			•		•	•			•
Equus asinus	Donkey				•	•	•					•	•			
Camelus dromedarius	Camel				•	•	•					•	•			•
Bos taurus	Cow				•		•					•	•			•

Δ = Recorded during targeted survey
S = Secondary evidence (mounds, tracks, burrows)

Appendix D2 - Birds

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
CASUARIIDAE																	
Dromaius novaehollandiae	Emu				•							•					
PHASIANIDAE																	
Coturnix pectoralis	Stubble Quail				•												
Coturnix ypsilophora	Brown Quail					•						•	•	•			•
ANATIDAE																	
Dendrocygna eytoni	Plumed Whistling-duck												•				
Cygnus atratus	Black Swan				•								•				•
Tadorna tadornoides	Australian Shelduck												•				
Malacorhynchus membranaceus	Pink-eared Duck													•			
Anas gracilis	Grey Teal				•								•	•			•
Anas superciliosa	Pacific Black Duck				•	•							•	•			•
Aythya australis	Hardhead												•	•			
PODICIPEDIDAE																	
Tachybaptus novaehollandiae	Australasian Grebe				•								•	•			
Poliocephalus poliocephalus	Hoary-headed Grebe												•				
COLUMBIDAE																	
Phaps chalcoptera	Common Bronzewing				•	•						•	•	•			•
Phaps histrionica	Flock Bronzewing														•		
Ocyphaps lophotes	Crested Pigeon				•	•						•	•	•			•
Geophaps plumifera	Spinifex Pigeon				•	•						•	•	•			•
Geopelia cuneata	Diamond Dove				•	•							•	•			•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
Geopelia striata	Peaceful Dove				•	•							•	•			•
PODARGIDAE																	
Podargus strigoides	Tawny Frogmouth				•	•								•			•
EUROSTOPODIDAE																	
Eurostopodus argus	Spotted Nightjar				•	•						•	•	•			•
AEGOTHELIDAE																	
Aegotheles cristatus	Australian Owlet-nightjar				•	•							•	•			•
APODIDAE																	
Apus pacificus	Fork-tailed Swift	M	S3		•									•		•	•
ANHINGIDAE																	
Anhinga novaehollandiae	Australasian Darter/ Darter					•	•			•			•	•			•
PHALACROCORACIDAE																	
Microcarbo melanoleucos	Little Pied Cormorant				•	•				•			•	•			
Phalacrocorax carbo	Great Cormorant												•				
Phalacrocorax sulcirostris	Little Black Cormorant					•				•			•	•			
Phalacrocorax varius	Pied Cormorant												•				
PELECANIDAE																	
Pelecanus conspicillatus	Australian Pelican					•				•			•	•			
CICONIIDAE																	
Ephippiorhynchus asiaticus	Black-necked Stork					•	•			•			•	•			

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
ARDEIDAE																	
Ardea pacifica	White-necked Heron				•	•				•				•			
Ardea modesta	Eastern Great Egret	M	S3			•				•			•	•		•	
Egretta novaehollandiae	White-faced Heron				•	•	•			•			•	•			•
Ardea ibis	Cattle Egret	M	S3													•	
Egretta garzetta	Little Egret									•			•	•			
Nycticorax caledonicus	Nankeen Night Heron					•							•	•			
THRESKIORNITHIDAE																	
Threskiornis spinicollis	Straw-necked Ibis				•	•							•	•			
Platalea flavipes	Yellow-billed Spoonbill									•							
ACCIPITRIDAE																	
Elanus axillaris	Black-shouldered Kite				•	•	•			•			•	•			
Lophoictinia isura	Square-tailed Kite				•		•						•				•
Hamirostra melanosternon	Black-breasted Buzzard						•										
Haliaeetus leucogaster	White-bellied Sea-Eagle	M	S3													•	
Haliastur sphenurus	Whistling Kite				•	•	•			•		•	•	•			•
Milvus migrans	Black Kite						•			•			•	•			•
Accipiter fasciatus	Brown Goshawk				•	•	•						•	•			
Accipiter cirrocephalus	Collared Sparrowhawk				•	•	•						•	•			•
Circus assimilis	Spotted Harrier				•	•	•			•			•	•			
Circus approximans	Swamp Harrier						•										
Aquila audax	Wedge-tailed Eagle				•	•	•			•		•	•	•			•
Hieraaetus morphnoides	Little Eagle				•	•	•						•				

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
FALCONIDAE																	
Falco cenchroides	Nankeen Kestrel				•	•	•			•		•	•	•			•
Falco berigora	Brown Falcon				•	•	•			•		•	•	•			•
Falco longipennis	Australian Hobby						•			•			•	•			
Falco hypoleucos	Grey Falcon			P4	•		•						•	•	•		•
Falco subniger	Black Falcon												•	•			
Falco peregrinus	Peregrine Falcon		S4				•							•	•		
RALLIDAE																	
Gallirallus philippensis	Buff-banded Rail																•
Porzana tabuensis	Spotless Crake				•												
Fulica atra	Eurasian Coot									•			•	•			
OTIDIDAE																	
Ardeotis australis	Australian Bustard			P4	•	•	•	•		•		•	•	•	•		•
BURHINIDAE																	
Burhinus grallarius	Bush Stone-curlew			P4	•	•	•	•		•			•	•	•		•
RECURVIROSTRIDAE																	
Himantopus himantopus	Black-winged Stilt				•		•						•				
CHARADRIIDAE																	
Charadrius veredus	Oriental Plover	M	S3											•		•	
Elseyornis melanops	Black-fronted Dotterel				•	•	•			•			•	•			•
Erythrogonys cinctus	Red-kneed Dotterel													•			
Vanellus tricolor	Banded Lapwing													•			

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
SCOLOPACIDAE																	
Tringa glareola	Wood Sandpiper	M	S3		•									•			
TURNICIDAE																	
Turnix velox	Little Button-quail				•	•	•			•			•	•			•
LARIDAE																	
Chlidonias hybrida	Whiskered Tern																•
GLAREOLIDAE																	
Glareola maldivarum	Oriental Pratincole	M	S3													•	
Stiltia isabella	Australian Pratincole												•				
CACATUIDAE (PSITTACIDAE)																	
Eolophus roseicapillus	Galah				•	•	•			•		•	•	•			•
Cacatua sanguinea	Little Corella				•	•	•			•		•	•	•			•
Nymphicus hollandicus	Cockatiel				•	•	•			•			•	•			•
PSITTACIDAE																	
Barnardius zonarius	Australian Ringneck				•	•				•		•	•	•			•
Melopsittacus undulatus	Budgerigar				•	•	•			•			•	•			•
CUCULIDAE																	
(Centropodidae) *Centropus phasianinus*	Pheasant Coucal				•	•				•			•	•			•
Chalcites basalis	Horsfield's Bronze-Cuckoo				•	•	•			•		•	•	•			•
Chalcites osculans	Black-eared Cuckoo				•									•			
Cacomantis pallidus	Pallid Cuckoo				•	•	•			•			•	•			•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
STRIGIDAE																	
Ninox connivens	Barking Owl												•	•			
Ninox novaeseelandiae	Southern Boobook				•		•			•		•	•	•			•
TYTONIDAE																	
Tyto javanica	Eastern Barn Owl				•												
HALCYONIDAE																	
Dacelo leachii	Blue-winged Kookaburra				•	•	•			•			•	•			•
Todiramphus pyrrhopygius	Red-backed Kingfisher				•	•	•			•		•	•	•			•
Todiramphus sanctus	Sacred Kingfisher				•	•	•						•	•			•
MEROPIDAE																	
Merops ornatus	Rainbow Bee-eater	M	S3		•	•	•			•		•	•	•		•	•
CLIMACTERIDAE																	
Climacteris melanura	Black-tailed Treecreeper												•				
PTILINORHYNCHIDAE																	
Ptilonorhynchus guttatus	Western Bowerbird				•	•				•		•	•	•			•
MALURIDAE																	
Malurus lamberti	Variegated Fairy-wren				•	•	•			•		•	•	•			•
Malurus leucopterus	White-winged Fairy-wren				•		•			•		•	•	•			•
Stipiturus ruficeps	Rufous-crowned Emu-wren					•				•			•				
Amytornis striatus	Striated Grasswren				•	•				•			•	•			•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
ACANTHIZIDAE																	
Smicrornis brevirostris	Weebill				•	•	•			•			•	•			•
Gerygone fusca	Western Gerygone				•	•				•			•	•			
Acanthiza robustirostris	Slaty-backed Thornbill				•		•										
Acanthiza uropygialis	Chestnut-rumped Thornbill				•		•										
Acanthiza apicalis	Inland Thornbill				•												
PARDALOTIDAE																	
Pardalotus rubricatus	Red-browed Pardalote				•	•	•			•			•	•			•
Pardalotus striatus	Striated Pardalote				•	•				•			•	•			
MELIPHAGIDAE																	
Certhionyx variegatus	Pied Honeyeater					•								•			
Lichenostomus virescens	Singing Honeyeater				•	•	•			•		•	•	•			•
Lichenostomus keartlandi	Grey-headed Honeyeater				•	•				•			•	•			•
Lichenostomus plumulus	Grey-fronted Honeyeater											•	•	•			
Lichenostomus penicillatus	White-plumed Honeyeater				•	•	•					•	•	•			•
Manorina flavigula	Yellow-throated Miner				•	•	•			•		•	•	•			•
Acanthagenys rufogularis	Spiny-cheeked Honeyeater				•		•			•				•			•
Conopophila whitei	Grey Honeyeater				•									•			
Epthianura tricolor	Crimson Chat				•	•	•			•		•	•	•			•
Sugomel niger	Black Honeyeater				•		•			•			•				

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
Lichmera indistincta	Brown Honeyeater				•		•			•				•			•
Melithreptus gularis	Black-chinned Honeyeater				•	•				•			•	•			•
POMATOSTOMIDAE																	
Pomatostomus temporalis	Grey-crowned Babbler				•					•			•	•			•
Pomatostomus superciliosus	White-browed Babbler				•		•						•				
PSOPHODIDAE (CINCLOSOMATIDAE)																	
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush						•										
NEOSITTIDAE																	
Daphoenositta chrysoptera	Varied Sittella						•										
CAMPEPHAGIDAE																	
Coracina maxima	Ground Cuckoo-shrike				•									•			
Coracina novaehollandiae	Black-faced Cuckoo-shrike				•	•	•			•		•	•	•			•
Lalage sueurii	White-winged Triller				•	•	•			•			•	•			•
PACHYCEPHALIDAE																	
Pachycephala rufiventris	Rufous Whistler				•	•	•			•		•	•	•			•
Colluricincla harmonica	Grey Shrike-thrush				•	•				•			•	•			•
Oreoica gutturalis	Crested Bellbird				•	•	•			•		•	•	•			•
ARTAMIDAE																	
Artamus leucorhynchus	White-breasted Woodswallow									•							
Artamus personatus	Masked Woodswallow				•		•						•				•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
Artamus cinereus	Black-faced Woodswallow				•	•	•			•		•	•	•			•
Artamus minor	Little Woodswallow				•	•				•			•	•			•
Cracticus torquatus	Grey Butcherbird				•		•			•		•		•			•
Cracticus nigrogularis	Pied Butcherbird				•	•	•			•		•	•	•			•
Cracticus tibicen	Australian Magpie					•	•			•			•	•			•
RHIPIDURIDAE (DICRURIDAE)																	
Rhipidura albiscapa	Grey Fantail												•				
Rhipidura leucophrys	Willie Wagtail				•	•	•			•		•	•	•			•
CORVIDAE																	
Corvus bennetti	Little Crow				•								•	•			
Corvus orru	Torresian Crow				•	•	•			•		•	•	•			•
MONARCHIDAE (DICRURIDAE)																	
Grallina cyanoleuca	Magpie-lark				•	•	•			•		•	•	•			•
PETROICIDAE																	
Petroica goodenovii	Red-capped Robin				•		•										
Melanodryas cucullata	Hooded Robin				•		•			•			•	•			
ALAUDIDAE																	
Mirafra javanica	Horsfield's Bushlark				•		•						•	•			•
ACROCEPHALIDAE (SYLVIIDAE)																	
Acrocephalus australis	Australian Reed-Warbler				•					•			•	•			
MEGALURIDAE (SYLVIIDAE)																	
Cincloramphus mathewsi	Rufous Songlark				•	•	•			•			•	•			•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	Birdata	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC													
Cincloramphus cruralis	Brown Songlark					•	•			•		•	•	•			•
Eremiornis carteri	Spinifex-bird				•	•	•			•		•	•	•			•
HIRUNDINIDAE																	
Cheramoeca leucosterna	White-backed Swallow												•				
Hirundo neoxena	Welcome Swallow				•									•			
Hirundo rustica	Barn Swallow															•	
Petrochelidon ariel	Fairy Martin				•		S			•			•	•			•
Petrochelidon nigricans	Tree Martin				•	•				•			•	•			•
NECTARINIIDAE (DICAEIDAE)																	
Dicaeum hirundinaceum	Mistletoebird					•	•			•			•	•			
ESTRILDIDAE																	
Taeniopygia guttata	Zebra Finch				•	•	•			•		•	•	•			•
Neochmia ruficauda subclarescens	Star Finch (western)			P4	•					•			•				•
Emblema pictum	Painted Finch				•	•	•			•		•	•	•			•
MOTACILLIDAE																	
Anthus novaeseelandiae	Australasian Pipit				•		•			•		•	•	•			•

Appendix D3 – Reptiles

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
CHELUIDAE																
Chelodina steindachneri	Flat-shelled Turtle						•						•			•
DIPLODACTYLIDAE																
Crenadactylus ocellatus	Clawless Gecko					•				•			•			•
Diplodactylus conspicillatus	Fat-tailed Gecko				•		•			•		•	•			•
Diplodactylus galaxias	Northern Pilbara Beak-faced Gecko															•
Diplodactylus mitchelli					•											
Diplodactylus savagei	Southern Pilbara Beak-faced Gecko				•					•			•			•
Lucasium stenodactylum	Sand-plain Gecko				•		•			•			•			•
Lucasium wombeyi					•		•			•			•			•
Oedura marmorata	Marbled Velvet Gecko				•					•		•	•			•
Rhynchoedura ornata	Beaked Gecko				•					•		•	•			•
Strophurus elderi					•	•	•			•			•			•
Strophurus jeanae							•						•			
Strophurus wellingtonae					•		•									
CARPHODACTYLIDAE																
Nephrurus levis							•			•			•			•
Nephrurus wheeleri					•					•						
GEKKONIDAE																
Gehyra pilbara	Pilbara Dtella					•				•		•	•			
Gehyra punctata	Spotted Dtella				•	•							•			•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
Gehyre purparescens	Purplish Dtella											•				
Gehyra variegata	Tree Dtella				•	•	•			•		•	•			•
Heteronotia binoei	Bynoe's Gecko				•	•	•			•		•	•			•
Heteronotia planiceps	Bynoe's Prickly Dtella												•			
Heteronotia spelea	Desert Cave Gecko				•					•		•	•			•
PYGOPODIDAE																
Delma butleri					•								•			
Delma elegans					•		•			•			•			•
Delma fraseri						•										•
Delma haroldi																
Delma nasuta					•	•	•			•			•			•
Delma pax					•	•	•			•			•			•
Delma tincta					•		•			•			•			•
Lialis burtonis					•	•	•			•		•	•			•
Pygopus nigriceps					•								•			•
SCINCIDAE																
Carlia munda					•	•	•			•		•	•			•
Carlia triacantha					•		•					•	•			•
Cryptoblepharus buchananii					◊	◊										•
Cryptoblepharus ustulatus													•			•
Ctenotus ariadnae							•									
Ctenotus duricola					•		•			•		•	•			•
Ctenotus grandis					•		•			•		•	•			•
Ctenotus hanloni										•						

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
Ctenotus helenae					•		•			•		•	•			•
Ctenotus leonhardii					•								•			
Ctenotus nigrilineatus				P1									•	•		
Ctenotus pantherinus	Leopard Ctenotus				•		•			•		•	•			•
Ctenotus piankai																•
Ctenotus rubicundus					•	•	•						•			•
Ctenotus saxatilis	Rock Ctenotus				•	•	•			•		•	•			•
Ctenotus schomburgkii							•						•			•
Ctenotus serventyi													•			
Ctenotus uber					•											
Cyclodomorphus melanops	Spinifex Slender Blue-tongue				•	•	•			•			•			•
Egernia ebsisolus	Eastern Pilbara Spiny-tailed Skink				•								•			•
Egernia formosa						•				•			•			•
Egernia pilbarensis										•						
Eremiascincus fasciolatus	Narrow-banded Sand-swimmer												•			
Eremiascincus isolepis										•						
Eremiascincus richardsonii	Broad-banded Sand-swimmer												•			
Lerista bipes					•		•			•		•	•			•
Lerista clara													•			
Lerista flammicauda										•						
Lerista jacksoni	(L.muelleri group)												•			•
Lerista muelleri					•	•	•						•			•
Lerista verhmens													•			•
Lerista zietzi							•									

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
Liopholis striata	Night Skink											•	•			
Menetia greyii					•		•			•			•			•
Menetia surda						•				•			•			
Morethia ruficauda					•	•				•		•	•			•
Notoscincus butleri										•						
Notoscincus ornatus					•	•	•			•			•			•
Proablepharus reginae					•	•	•						•			•
Tiliqua multifasciata	Central Blue-tongue				•		•			•			•			•
AGAMIDAE																
Amphibolurus longirostris	Long-nosed Dragon				•	•	•			•			•			•
Caimanops amphiboluroides	Mulga Dragon				•		•									
Ctenophorus caudicinctus	Ring-tailed Dragon				•	•	•			•		•	•			•
Ctenophorus isolepis	Central Military Dragon				•		•			•		•	•			•
Ctenophorus nuchalis	Central Netted Dragon				•					•		•	•			•
Ctenophorus reticulatus	Western Netted Dragon				•								•			
Ctenophorus scutulatus	Lozenge-marked Dragon				•											
Diporiphora winneckei	Canegrass Dragon											•				
Diporiphora valens					•								•			•
Pogona minor	Dwarf Bearded Dragon				•					•		•	•			•
Tympanocryptis cephalus	Pebble Dragon				•		•									
VARANIDAE																
Varanus acanthurus	Spiny-tailed Monitor				•	•	•			•			•			•
Varanus brevicauda	Short-tailed Pygmy Monitor				•		•			•			•			•
Varanus bushi	Pilbara Monitor				•											

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
Varanus caudolineatus	Stripe-tailed Monitor				•											
Varanus eremius	Pygmy Desert Monitor				•		•			•		•	•			•
Varanus giganteus	Perentie				•	•							•			•
Varanus gouldii	Gould's Monitor				•		•					•	•			•
Varanus panoptes	Yellow-spotted Monitor				•		•			•			•			•
Varanus pilbarensis	Pilbara Rock Monitor				•					•			•			•
Varanus tristis	Black-headed Monitor				•					•			•			•
TYPHLOPIDAE																
Ramphotyphlops ammodytes					•		•					•	•			•
Ramphotyphlops ganei				P1									•	•		
Ramphotyphlops grypus	Beaked Blind Snake				•		•			•			•			•
Ramphotyphlops pilbarensis	Pilbara Blind Snake									•		•				
BOIDAE																
Antaresia perthensis	Pygmy Python				•	•	•									•
Antaresia stimsoni	Stimson's Python				•		•			•			•			•
Aspidites melanocephalus	Black-headed Python				•		•									
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1	VU	•								•	•	•	•
ELAPIDAE																
Acanthophis wellsi	Pilbara Death Adder									•						•
Brachyurophis approximans	NW Shovel-nosed Snake				•		•			•			•			•
Brachyurophis fasciolata	Narrow-banded Shovel-nosed Snake												•			
Demansia psammophis	Yellow-faced Whipsnake				•		•			•			•			•
Demansia rufescens	Rufous Whipsnake				•	•	•			•			•			•

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota 2007	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
Furina ornata	Moon Snake				•		•			•		•	•			•
Parasuta monachus	Monk Snake				•					•						•
Pseudechis australis	Mulga Snake				•		•			•			•			•
Pseudonaja mengdeni	Western Brown Snake				•					•			•			•
Pseudonaja modesta	Ringed Brown Snake				•					•		•	•			•
Suta fasciata	Rosen's Snake						•						•			•
Suta punctata	Spotted Snake						•						•			
Vermicella snelli	Bandy Bandy												•			

Appendix D4 - Amphibians

Family and Species	Common name	Conservation Status			*ecologia* Internal Database	Bamford (2001)	Biota (2005)	Biota (2007)	Molhar Pty Ltd (2007)	Outback Ecology (2006)	Outback Ecology (2010)	Outback Ecology (2011)	NatureMap	DEC Threatened Fauna Database	DSEWPaC Protected Matters Database	Current Survey
		EPBC Act	WC Act	DEC												
HYLIDAE																
Cyclorana australis	Giant Frog						•						•			•
Cyclorana maini	Sheep Frog				•		•			•		•	•			•
Litoria rubella	Little Red Tree Frog				•	•	•			•			•			•
LIMNODYNASTIDAE																
Neobatrachus sutor	Shoemaker Frog												•			
Notaden nichollsi	Desert Spadefoot						•						•			•
Platyplectrum spenceri	Centralian Burrowing Frog				•		•						•			•
MYOBATRACHIDAE																
Uperoleia glandulosum	Northwest Toadlet				◊	◊	◊			◊			◊			◊
Uperoleia saxalitis sp. nov.	Northwest Toadlet															

APPENDIX E FAUNA SPECIES RECORDED DURING TRAPPING

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Appendix E1 - Mammals

Family and Species	Common name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph1	Ph 2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
DASYURIDAE																															
Dasykaluta rosamondae	Little Red Kaluta																		1					2							
Dasyurus hallucatus	Northern Quoll	EN	S1	EN									2	2				2						6		1			2		1
Ningaui timealeyi	Pilbara Ningaui						4		1		3	2			1	11	1	5		3		2	2		4	4	3	3			
Planigale sp. (prev. *maculata*)	Common Planigale					1												1			5		2		1		2	1			
Sminthopsis longicaudata	Long-tailed Dunnart			P4									1		1	4		5													
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart																		1												
MACROPODIDAE																															
Macropus robustus	Euro												1	1												1	4		1		1
Petrogale rothschildi	Rothschild's Rock-wallaby																													3	2
HIPPOSIDERIDAE																															
Rhinonicteris aurantius	Pilbara Leaf-nosed Bat	VU	S1	VU																	A	A		A		A				A	
EMBALLONURIDAE																															
Taphozous georgianus	Common Sheathtail Bat														A		A				A	A			A	A		A		A	
VESPERTILIONIDAE																															
Chalinolobus gouldii	Gould's Wattled Bat																				A	A				A	A			A	
Nyctophilus geoffroyi	Lesser Long-eared Bat																					A			A						
Scotorepens greyii	Little Broad-nosed Bat										A	A			A							A		A	A		A	A		A	
Vespadelus finlaysoni	Finlayson's Cave Bat										A	A			A						A	A		A	A	A	A	A		A	
MURIDAE																															
Pseudomys chapmani	Western Pebble-mound mouse			P4																										S	S
Pseudomys delicatulus	Delicate Mouse									2																1					
Pseudomys desertor	Desert Mouse					1	1	1			2						1		2	2						1		1			
Pseudomys hermannsburgensis	Sandy Inland Mouse					3										1				1		4						2			
Zyzomys argurus	Common Rock-rat											1		16					10					2			1				
INTRODUCED MAMMALS																															
Felis catus	Cat								S																				S		
Camelus dromedarius	Camel																												1		
Bos taurus	Cow																												11	15	9

A = Call Recorded using a SM2Bat
S = Secondary Evidence

Appendix E2 - Birds

Family and Species	Common name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
PHASIANIDAE																															
Coturnix ypsilophora	Brown Quail											2																		6	
ANATIDAE																															
Cygnus atratus	Black Swan																												3		
Anas gracilis	Grey Teal																													5	
Anas superciliosa	Pacific Black Duck																												3	23	
COLUMBIDAE																															
Phaps chalcoptera	Common Bronzewing						2						1	1				1	1		1			29						22	6
Ocyphaps lophotes	Crested Pigeon					1		8							2									1					3	1	
Geophaps plumifera	Spinifex Pigeon							2	2	1				7	1	2		7			7		5	29					8	66	14
Geopelia cuneata	Diamond Dove				5	3	8	4	10	2	2	16	2		11		2		7	10	14	3		232				3	5	93	4
Geopelia striata	Peaceful Dove																			3									2	2	
PODARGIDAE																															
Podargus strigoides †	Tawny Frogmouth																													1	1
EUROSTOPODIDAE																															
Eurostopodus argus	Spotted Nightjar					1						2												1						3	3
AEGOTHELIDAE																															
Aegotheles cristatus	Australian Owlet-nightjar																													1	
APODIDAE																															
Apus pacificus	Fork-tailed Swift	M	S3						1								8														
ANHINGIDAE																															
Anhinga novaehollandiae	Australasian Darter/ Darter																												2		
ARDEIDAE																															
Egretta novaehollandiae	White-faced Heron																													7	
ACCIPITRIDAE																															
Lophoictinia isura	Square-tailed Kite																				2					1					
Haliastur sphenurus	Whistling Kite				2			2											4	2									1	2	
Milvus migrans	Black Kite																													1	
Accipiter cirrocephalus	Collared Sparrowhawk																													1	
Aquila audax	Wedge-tailed Eagle							1																							
FALCONIDAE																															
Falco cenchroides	Nankeen Kestrel				2					1						1				1											
Falco berigora	Brown Falcon					1		3	1	4					2		2	1										1		9	1
Falco hypoleucos	Grey Falcon			P4				4																							
RALLIDAE																															
Gallirallus philippensis	Buff-banded Rail																													1	
OTIDIDAE																															
Ardeotis australis	Australian Bustard			P4		1														1									3	4	

Family and Species	Common name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
BURHINIDAE																															
Burhinus grallarius	Bush Stone-curlew			P4	S		S																							2	
CHARADRIIDAE																															
Elseyornis melanops	Black-fronted Dotterel																												2	21	
TURNICIDAE																															
Turnix velox	Little Button-quail				9	2	17	1	2	1	2	2			1				21			3								1
LARIDAE																															
Chlidonias hybrida	Whiskered Tern																													3	
CACATUIDAE (PSITTACIDAE)																															
Eolophus roseicapillus	Galah				1			8	8	4	2	4					1	12				2		17		15		1		15	
Cacatua sanguinea	Little Corella					1		3		2	1	4								2						5			50	26	
Nymphicus hollandicus	Cockatiel																												21		
PSITTACIDAE																															
Barnardius zonarius	Australian Ringneck											4												6		2				3	
Melopsittacus undulatus	Budgerigar				15		2		2		22	7					20			6									12		
CUCULIDAE																															
(Centropodidae) *Centropus phasianinus*	Pheasant Coucal											2												1							
Chalcites basalis	Horsfield's Bronze-Cuckoo						1								2															1	
Cacomantis pallidus	Pallid Cuckoo															3						1			1					1	1
STRIGIDAE																															
Ninox novaeseelandiae	Southern Boobook																													1	
HALCYONIDAE																															
Dacelo leachii	Blue-winged Kookaburra							2				1								2		1								3	
Todiramphus pyrrhopygius	Red-backed Kingfisher								1	3		1	1	2	2	1		6				1					1	1	1		3
Todiramphus sanctus	Sacred Kingfisher										2	4												2		1				14	
MEROPIDAE																															
Merops ornatus	Rainbow Bee-eater	M	S3			1	9		1		1	2					1	2		2	11	3		35		5		1	7	37	10
PTILINORHYNCHIDAE																															
Ptilonorhynchus guttatus	Western Bowerbird											3				2					5			7				2		17	
MALURIDAE																															
Malurus lamberti	Variegated Fairy-wren						18		6		7		5		24	12			21	3		14		2	5	5	7		2	14	
Malurus leucopterus	White-winged Fairy-wren				7	4				14		3								4									1		
Amytornis striatus	Striated Grasswren				1								7	3							4		1							13	5
ACANTHIZIDAE																															
Smicrornis brevirostris	Weebill											1		1		1		1								4				4	

Family and Species	Common name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
PARDALOTIDAE																															
Pardalotus rubricatus	Red-browed Pardalote							2		1		6								1		9		2		7	1	3		2	
MELIPHAGIDAE																															
Lichenostomus virescens	Singing Honeyeater				3	2		13		4						4	1		3	22		5	2	6		1	2		2	12	
Lichenostomus keartlandi	Grey-headed Honeyeater					5	4		3	7	9	7	13	17	12	68	5	57		10	27	12	14	119	9	34	17	26	1	181	10
Lichenostomus penicillatus	White-plumed Honeyeater						6		4		1	24	1		1				11	8	2			1		11			6	40	
Manorina flavigula	Yellow-throated Miner					5	1		1	1	4	14	1			1	9	4			6	1		29		9	3	1	1	37	3
Acanthagenys rufogularis	Spiny-cheeked Honeyeater										2				1																
Epthianura tricolor	Crimson Chat																		2									1		6	
Lichmera indistincta	Brown Honeyeater				2		1	1	14		4	3			2														7	26	
Melithreptus gularis	Black-chinned Honeyeater											6										2		4		11	4			6	
POMATOSTOMIDAE																															
Pomatostomus temporalis †	Grey-crowned Babbler																													S	
CAMPEPHAGIDAE																															
Coracina novaehollandiae	Black-faced Cuckoo-shrike						2	2		3		8			5	9	4	6		6	1	1		6	2	2		1	2	6	2
Lalage sueurii	White-winged Triller											2						2				7		11		3	2			8	
PACHYCEPHALIDAE																															
Pachycephala rufiventris	Rufous Whistler																										1		1		
Colluricincla harmonica	Grey Shrike-thrush				1		1		1		2	4	9	3	3	7	4	4			1	4		9	6	6	4	3		9	6
Oreoica gutturalis	Crested Bellbird											3	7	1	7	10	4	3				2	1				2	2		2	
ARTAMIDAE																															
Artamus personatus	Masked Woodswallow				2																								2		
Artamus cinereus	Black-faced Woodswallow				2		2	1		12	5	12	1		2	25	11	4		4		6	6	1			12			29	4
Artamus minor	Little Woodswallow				8				1						9		1	2	2		2			3		3			1	9	4
Cracticus torquatus	Grey Butcherbird																							2							
Cracticus nigrogularis	Pied Butcherbird					5		2	2	3	2	3	7	8	1	6	2	2		2	1			3	1		2	1		3	1
Cracticus tibicen	Australian Magpie				1		2		1	5	2											3							1	4	
RHIPIDURIDAE (DICRURIDAE)																															
Rhipidura leucophrys	Willie Wagtail									2			1			1					3	1		13	2	3		2	2	5	3
CORVIDAE																															
Corvus orru	Torresian Crow				5	1	1	2		5		7								1	5	3	1	3		2				14	3
MONARCHIDAE (DICRURIDAE)																															
Grallina cyanoleuca	Magpie-lark						6													1				3		1			3	17	
ALAUDIDAE																															
Mirafra javanica	Horsfield's Bushlark				1	1			2	1																					
MEGALURIDAE (SYLVIIDAE)																															
Cincloramphus	Rufous Songlark					1						1		1		8		5	4	3		5						3		9	

Family and Species	Common name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
mathewsi																															
Cincloramphus cruralis	Brown Songlark					1						1																			
Eremiornis carteri	Spinifex-bird				2	3	4	1	1	6	1	5		3		4	2		8	3	2	1	8		12	7		1	2	1	
HIRUNDINIDAE																															
Petrochelidon ariel	Fairy Martin				24	18														10				2						11	
Petrochelidon nigricans	Tree Martin				8														4	3											1
ESTRILDIDAE																															
Taeniopygia guttata	Zebra Finch				6		17	12			11								47	37		14		26		30			5	212	
Emblema pictum	Painted Finch				12		10	4			2	7			4			2	63	5				115	4				11	138	
MOTACILLIDAE																															
Anthus novaeseelandiae	Australasian Pipit				1					2	1																			2	

Appendix E3 - Reptiles

Family and Species	Common Name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph1	Ph 2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
CHELUIDAE																															
Chelodina steindachneri	Flat-shelled Turtle																												2		
DIPLODACTYLIDAE																															
Crenadactylus ocellatus												1					1							1	1	1					
Diplodactylus conspicillatus	Fat-tailed Gecko				1	7	1	3	5	6	3	2																			
Diplodactylus galaxias	Northern Pilbara Beak-faced Gecko																				1		1								
Diplodactylus savagei										1	1	4	5	13	2	2	5	2						1							
Lucasium stenodactylum	Sand-plain Gecko				6	2	4	10		8	2	9							1	4		12	1			1					
Lucasium wombeyi										1		2	3		8	6	2	2					3		2						
Oedura marmorata												1	1															3	1	1
Rhynchoedura ornata	Beaked Gecko				1		4													2											
Strophurus elderi							1				1							1			2			1							
CARPHODACTYLIDAE																															
Nephrurus levis pilbarensis	Knob-tailed Gecko				1					1																					
GEKKONIDAE																															
Gehyra punctata					1	1				7				2									1	6	5	1	1		14	4	8
Gehyra variegata							1					1	1		1	1					1	3		10	4	1		1	1	2	9
Heteronotia binoei	Bynoe's Gecko				1		3	1	4	1	9	2			6		3		5	3			3	10	10	10	4	5			1
Heteronotia spelea	Desert Cave Gecko																							2							4
PYGOPODIDAE																															
Delma elegans														2							2										
Delma fraseri														1																	
Delma nasuta											3		1						1		2	1		2	3	1	1				
Delma pax							2	4			1	2		1						1					1						
Delma tincta																						1			1		2				
Lialis burtonis							1												1							4					
Pygopus nigriceps								1				1								1											
SCINCIDAE																															
Carlia munda							5	7	1	1		8					1			2				1	1		1			21	34
Carlia triacantha																					1	2		4							7
Cryptoblepharus buchananii																														1	
Cryptoblepharus ustulatus	Russet Snake-eyed Skink																							1					9		14
Ctenotus duricola					3				1	1	1	2										2	3			2		9			
Ctenotus grandis					2	3	5	3				1							8	10		5	2			1	5				
Ctenotus helenae					3	3	2	3	1		1								8	3											
Ctenotus pantherinus	Leopard Ctenotus				4	2	1	1	1										2	3											
Ctenotus piankai					21	2	1	2	5	2	1								3	1											
Ctenotus rubicundus														2		3	2	9			1								1		
Ctenotus saxatilis	Rock Ctenotus				18	8	45	7	11	7	22	13	17	14	21	20	1	3	2	16	21	6	17	33	28	15	11	6			3
Ctenotus schomburgkii															1																
Cyclodomorphus melanops	Spinifex Slender Blue-							1	2				1		1		1							1	1			1			

Family and Species	Common Name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph1	Ph 2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
	tongue																														
Egernia ebsisolus	Eastern Pilbara Spiny-tailed Skink								1	2																				1	
Egernia formosa																					1			1					1	12	1
Lerista bipes					5	2		2	1	4									16	11		1	1	2							
Lerista jacksoni															1						1		2	1			2				
Lerista muelleri											1							1													
Lerista verhmens																2							2		1						
Menetia greyii					1																	1									
Morethia ruficauda exquisita												1	3	3		1					8		2	3		1	1		1		
Notoscincus ornatus					1	2			2	1	1	1	1			1					2	4	2			1	5	15			
Proablepharus reginae																						1	1		1	3		3			
Tiliqua multifasciata	Central Blue-tongue											1			1				1												
AGAMIDAE																															
Amphibolurus longirostris	Long-nosed Dragon						2		21	2														2						1	1
Ctenophorus caudicinctus	Ring-tailed Dragon				3				22	27	2	8	5	2	31	7	4	10							1		5	6			6
Ctenophorus isolepis	Central Military Dragon				22	11	3	1	4	6	2																				9	
Ctenophorus nuchalis	Central Netted Dragon					6	5													10											
Diporiphora valens						2													1												
Pogona minor	Dwarf Bearded Dragon				1	3													1				1								
VARANIDAE																															
Varanus acanthurus	Spiny-tailed Monitor				3	2	1		3	1		1		3			1	1	1	1	1		5	2	3	7	4	1			
Varanus brevicauda	Short-tailed Pygmy Monitor				1	2		1					1																		
Varanus eremius	Pygmy Desert Monitor				2	1			2	2		1								1		8					3				
Varanus giganteus	Perentie						1																							1	1
Varanus gouldii	Gould's Monitor																													1	1
Varanus panoptes	Yellow-spotted Monitor																											1			
Varanus pilbarensis	Pilbara Rock Monitor									1											2							1		1	
Varanus tristis	Black-headed Monitor											1		1												2		1	1		
TYPHLOPIDAE																															
Ramphotyphlops ammodytes							1					1									1	1				1					
Ramphotyphlops grypus	Beaked Blind Snake							2													1					1		1			
BOIDAE																															
Antaresia perthensis	Pygmy Python													1	1	1					2						1				
Antaresia stimsoni	Stimson's Python										2																				
Liasis olivaceus barroni	Pilbara Olive Python	VU	S1	VU																				3						2	1
ELAPIDAE																															
Acanthophis wellsi	Death Adder												1														1				
Brachyurophis approximans	NW Shovel-nosed Snake												2		2		1		1			3			1	3	1	1			
Demansia psammophis	Yellow-faced Whipsnake					1		1																1							
Demansia rufescens	Rufous Whipsnake												2		1	2					1			6							
Furina ornata	Moon Snake											2			1		1						1		1						

Family and Species	Common Name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph1	Ph 2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
Parasuta monachus	Monk Snake																											1			
Pseudechis australis	Mulga Snake										1																				
Pseudonaja mengdeni	Western Brown Snake										2																				
Pseudonaja modesta	Ringed Brown Snake					2				1	1			1																	
Suta fasciata	Rosen's Snake													1																	

Appendix E4 - Amphibians

Family and Species	Common Name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC Act	WC Act	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph1	Ph 2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
HYLIDAE																															
Cyclorana australis	Giant Frog				1		2		3																						
Cyclorana maini	Sheep Frog								2											7											
Litoria rubella	Little Red Tree Frog								2																				20		4
LIMNODYNASTIDAE																															
Notaden nichollsi	Desert Spadefoot				6																										
Platyplectrum spenceri	Centralian Burrowing Frog						2		2										1												
MYOBATRACHIDAE																															
Uperoleia glandulosum	Centralian Burrowing Frog				10*		8*		2*															28*							1*
Uperoleia saxalitis sp. nov.	Centralian Burrowing Frog																														

* *U. Russelli* has been recently split up into several species. North Star is likely to harbour either species.

Appendix E5 - Fish

Family and Species	Common Name	Conservation Status			Site 1		Site 2		Site 3		Site 4		Site 5		Site 6		Site 7		Site 8		S 9	S 10	S 11	S 12	S 13	S 14	S 15	S 16	Opportunistic		
		EPBC	WCA	DEC	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph2	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2	Ph1	Ph 2	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 3	Ph 1	Ph 2	Ph 3
CLUPEIDAE																															
Nematalosa erebi	Bony Bream																												6		
PLOTOSIDAE																															
Neosilurus hyrtlii	Hyrtl's Tandan																														8
MELANOTAENIIDAE																															
Melanotaeniidae australis	Western Rainbowfish																							110							
TERAPONTIDAE																															
Leiopotherapon unicolor	Spangled Perch																							50							

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APPENDIX F NORTH STAR TARGETED CONSERVATION SIGNIFICANT FAUNA SURVEY REPORT

MARCH 2012



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



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NORTH STAR PROJECT

TARGETED CONSERVATION SIGNIFICANT FAUNA SURVEY

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ACRONYMS

CAMBA	China-Australia Migratory Bird Agreement
DEC	Department of Environment and Conservation
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBIF	Global Biodiversity Information Facility
JAMBA	Japan-Australian Migratory Bird Agreement
WAM	Western Australian Museum
WC Act	*Wildlife Conservation Act 1950*

EXECUTIVE SUMMARY

In April 2011 *ecologia* Environment (*ecologia*) conducted the first phase of a Level 2 vertebrate fauna assessment of the Fortescue Metals Group North Star Project area. During the survey, the Northern Quoll (*Dasyurus hallucatus*) was recorded from three locations (one on video, one observed, two captured) in the northern part of the North Star Project area and extensive suitable habitat was recorded for Northern Quoll, Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* - Pilbara form) and Pilbara Olive Python (*Liasis olivaceus barroni*). As the Northern Quoll is listed under the *Environmental Protection and Biodiversity Conservation Act 1999* as Endangered and the Pilbara Leaf-nosed Bat and Pilbara Olive Python are listed as Vulnerable, Fortescue Metals Group (Fortescue) commissioned *ecologia* to undertake a targeted conservation significant fauna survey of the North Star Project area. The purpose of the survey was to provide information regarding the presence and area of suitable habitat of the three threatened species within the Project area.

Trapping methods and layout were conducted in accordance with the referral guidelines for Northern Quolls (DSEWPaC 2011a), survey guidelines for threatened reptiles of Australia (DSEWPaC 2011c), survey guidelines for threatened mammals of Australia (DSEWPaC 2011b) and survey guidelines for threatened bats of Australia (DEWHA 2010a). Northern Quolls were targeted using typically one trap (large Elliott trap or cage trap) placed approximately every 100 m along linear denning/shelter habitat. In total, 172 traps were placed in suitable accessible habitat within the Project area over seven nights. In addition to trapping, nine remote sensing cameras were set up at 34 locations for three consecutive nights, and searches for secondary signs (scats, tracks, etc.) were conducted for 103.5 hours. Two SM2Bat recorders were set up at 25 locations within potential Pilbara Leaf-nosed Bat habitat for a total of 287.5 hours. Pilbara Olive Pythons were targeted during opportunistic surveys along cliff faces and rocky ridges for approximately 103.5 hours.

A total of 20 Northern Quolls were captured during the survey, with additional individuals recorded on motion cameras at three locations. Two species of native mammal, Common Rock-rat (*Zyzomys argurus*) and Woolley's Pseudantechinus (*Pseudantechinus woolleyae*), were also trapped which indicated that the trapping methods and density were adequate for small to medium sized mammals. The Pilbara Leaf-nosed Bat was recorded from 14 of the 25 recording sites, and a Ghost Bat (*Macroderma gigas*) was recorded at a single location. Secondary evidence of the Pilbara Olive Python in the form of sloughed skin, scats and remains was recorded during opportunistic searches from three locations within the North Star Project.

Large areas of habitat considered to be suitable for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python were recorded within the North Star Project area. The Project area also contains patches of potential foraging and dispersal habitat for Northern Quoll and Pilbara Olive Python comprising granite boulder piles on sand plains and/or major creek lines with fringing eucalypts.

Northern Quolls appear to be widespread within the North Star Project area. A total of 900.7 ha of potential Northern Quoll habitat were identified within the Project area (which totals 32,132.82 ha). Of this, 294.4 ha were classified as suitable denning habitat, 108.4 ha was identified to be potential denning/foraging habitat with a low number of crevices and/or limited extent in area. Riverine foraging/dispersal habitat, which comprised 403.0 ha, consisted of low quality rocky habitat without rocky boulders and crevices and eucalypt woodland along Turner River. The remaining 94.9 ha of rocky habitat were identified on aerial photography, but due to access limitations these areas were not confirmed in-field for their suitability as denning, foraging or dispersal habitat for the Northern Quoll during the survey. Instead, these areas were desktop assessed as potential habitat using aerial photography, topography and vegetation descriptions.

Previous surveys revealed numerous records of the Northern Quoll in the surrounding region which indicated that the Project area occurred within the Northern Quolls distribution. NatureMap (DEC 2011) data comprised six records of Northern Quoll approximately 20 km northeast of the North Star Project area in 2010. Given that few surveys have been conducted in the immediate vicinity of North Star and more records could be made with further survey effort, this would indicate that the area could be potentially significant for Northern Quoll.

Pilbara Leaf-nosed Bats were recorded in high densities from 14 locations within the Project area. A total of 712.94 ha of potential roost habitat was identified within the Project area and consisted of a mix of cliff face habitat with associated caves and gullies (Dry season roost habitat, 294.35 ha) and major creekline habitat with fringing eucalypt trees (wet season roost habitat, 418.58 ha)

Secondary evidence in the form of potential scats, remains and sloughed skin of Pilbara Olive Python was recorded from three locations within the Project area. A total of 1045.2 ha of Pilbara Olive Python habitat were identified within the Project area. Of this, 432.0 ha of critical habitat (rocky gorges with surface water) were identified in the Project area and is classified as good to excellent habitat for this species. A further 520.7 ha of potential habitat of moderate quality were also recorded, consisting of cliffs and rock faces with no surface water, and creek lines with no rock faces. An area of 92.5 ha of rocky habitat was identified on aerial photography but its suitability for Pilbara Olive Pythons has not been confirmed due to access limitations.

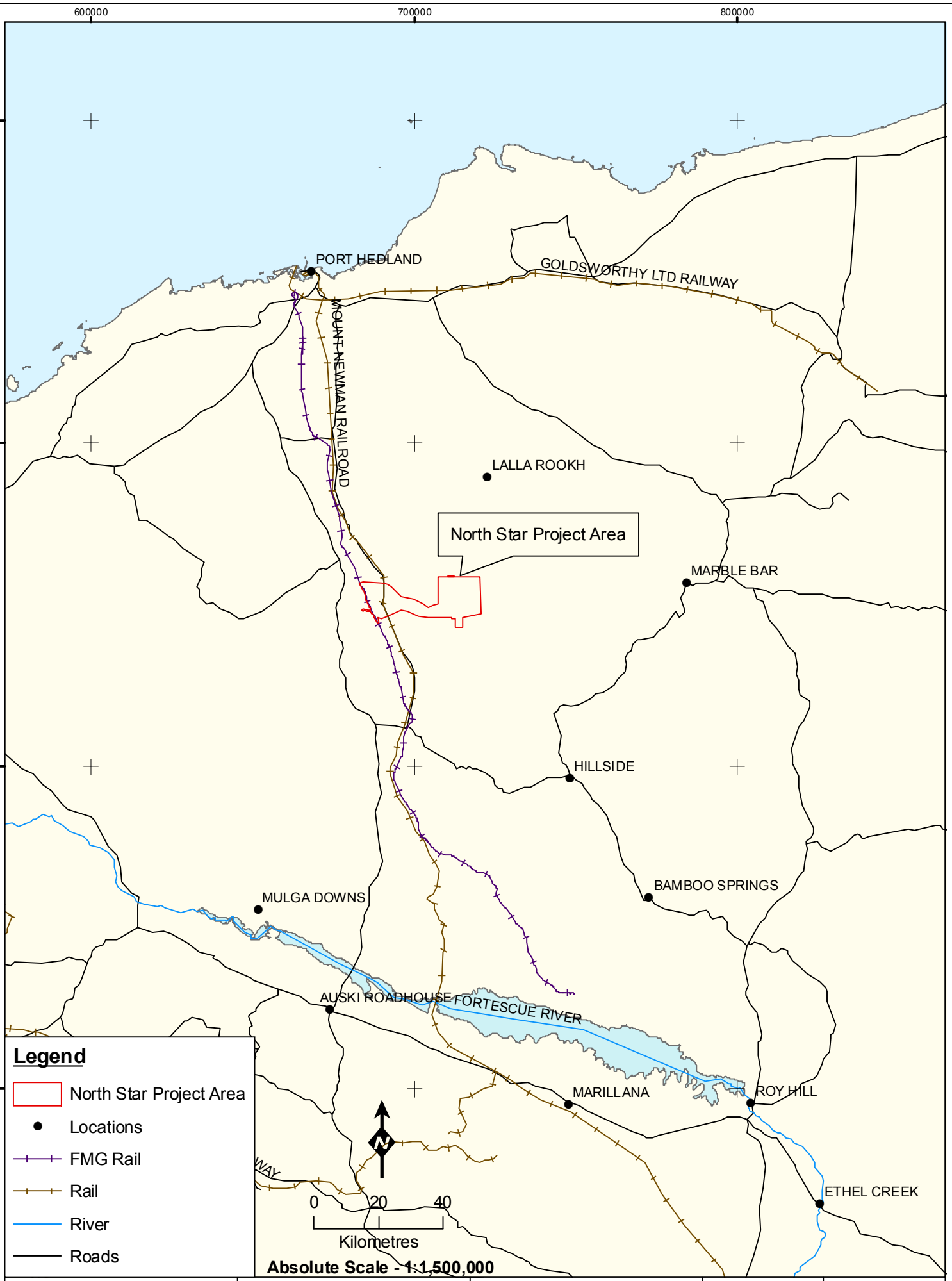
The North Star Project area will directly impact suitable denning and roosting habitat for Northern Quolls and Pilbara Leaf-nosed Bats and suitable habitat for Pilbara Olive Pythons. It is anticipated that the local population of these three species will be impacted by the development of the proposed Project. Further studies on habitat availability and condition are required to enable assessment of impacts to populations at a regional scale.

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Fortescue Metals Group Limited (Fortescue) is developing the Pilbara Iron Ore and Infrastructure Project, which involves a series of iron ore mines in the Pilbara region of Western Australia, and associated rail and port infrastructure. Fortescue intends to expand its current operations to include the development of a new mine site, North Star, approximately 100 km south of Port Headland and 25 km east of the Fortescue Rail Line together with support infrastructure such as camps and road access (Figure 1.1).

As part of the environmental approvals processes for the proposed North Star Project, *ecologia* Environment (*ecologia*) was commissioned by Fortescue to undertake a comprehensive vertebrate fauna assessment of the North Star Project area. During the first phase survey, recordings of Northern Quolls (*Dasyurus hallucatus*) were made in the North Star Project area and suitable habitat was recorded for Northern Quoll, Pilbara Olive Python (*Liasis olivaceus barroni*) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* - Pilbara form). Northern Quolls, Pilbara Olive Pythons and Pilbara Leaf-nosed Bats are listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and, therefore, a targeted conservation significant vertebrate fauna survey was commissioned. The purpose of the survey was to provide information on the presence and suitable habitat of the three threatened species within the Project area, and to assess potential impacts and identify appropriate management strategies. Additional conservation significant vertebrate fauna were also recorded but these are detailed separately in the Level 2 vertebrate fauna report of the North Star Project area.



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Location of the Project Area

Figure: 1.1
Project ID: 1373

Drawn: AH
Date: 18/08/11

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

Unique Map ID: AH367

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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 addressed. 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 Principles of Intergenerational Equity*

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

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

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

In addition to these principles, projects undertaken as part of the Environmental Impact Assessment (EIA) process are required to address guidelines produced by the Environmental Protection Authority (EPA), in this case Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004), principles outlined in EPA Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002) and the *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC 2010).

Native flora and fauna in Western Australia that are formally recognised as rare, threatened with extinction, or as having high conservation value are protected at a federal level under the EPBC Act and at a state level under the *Wildlife Conservation Act 1950* (WC Act). International agreements include the Japan-Australian Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA).

The EPBC Act 1999 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.

The WC Act was developed to provide 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). The current listing was gazetted in August 2010.

In addition, the Department of Environment and Conservation (DEC) maintains a Threatened and Priority Fauna list which includes species removed from the WC Act and other species known from only a few populations or in need of monitoring. Five Priority codes are recognised (Appendix A).

1.3 TARGETED SURVEYS FOR REFERRAL TO THE DSEWPAC

When conservation significant species listed under the EPBC Act are likely to be impacted by a project, the project is required to be referred to the Department for Sustainability, Environment, Water, Population and Communities (DSEWPaC). DSEWPaC has released a number of guidelines to assist proponents with the referral process and typically targeted surveys are required to provide regulators with sufficient information to make an informed decision about the impact of each project.

Northern Quolls were recorded during initial environmental impact assessment surveys of the Project area in 2011 and suitable habitat for Pilbara Olive Python and Pilbara Leaf-nosed Bat was recorded within the Project area. Based on referral guidelines for Northern Quoll (DSEWPaC 2011a) and survey guidelines for reptiles, bats and mammals (DEWHA 2010a; DSEWPaC 2011b, c), targeted surveys were undertaken to determine the abundance and distribution of Northern Quoll within the Project area and to determine the presence of Pilbara Olive Python and Pilbara Leaf-nosed Bat from within the Project area.

1.4 SURVEY OBJECTIVES

Fortescue commissioned *ecologia* Environment (*ecologia*) to undertake a targeted survey of the conservation significant fauna of the North Star Project area as part of the environmental impact assessment for the Project.

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

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

The aim of this study was to provide sufficient information to the EPA and the DSEWPaC to assess the impact of the Project on the conservation significant fauna of the area, thereby ensuring that these objectives will be upheld.

This report satisfies the requirements documented in *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*, *EPA Guidance Statement No. 56 and Position Statement No. 3* and *Referral guidelines for Northern Quoll*, *Threatened Bats* and *Reptiles* (DSEWPaC 2011a, b, c), by providing:

- a review of background information (including literature and database searches) for EPBC listed species that potentially occur in the North Star Project area, including an appraisal of the current level of knowledge for the area, and a review of previous surveys conducted in the area that are relevant to the current study;

- a review of regional and biogeographical significance, including the conservation status of species recorded in the Project area;
- a description of potential habitat occurring in the Project area, including mapping and area calculations; and
- a detailed summary of the findings of the current targeted survey.

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2 SURVEY METHODS

2.1 LITERATURE REVIEW AND DATABASE SEARCH

Three databases (*ecologia* internal database, NatureMap (which includes DEC and Western Australian Museum records) and GBIF (Global Biodiversity Information Facility) were consulted to determine the regional occurrence of Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat. Several reference books, scientific journal papers and reports where consulted to determine biological and ecological information for these species (referenced throughout this document).

2.2 DETERMINATION OF SURVEY SAMPLING DESIGN AND INTENSITY

ecologia was commissioned by Fortescue to conduct the vertebrate fauna assessment of the North Star Project for inclusion into their environmental approval documentation for this Project. The first phase of the Level 2 survey was conducted between 29th March and 9th April 2011. Information from this survey was utilised to develop the survey methods for this current targeted survey. Habitat assessments were conducted during the first phase Level 2 survey to determine the likelihood of occurrence of fauna species and to aid in the impact assessment for the Project.

2.2.1 Northern Quoll

Habitat mapping information was used to identify and delineate potential Northern Quoll habitat within the Project area. This area was then assessed to determine the accessibility of each area for survey to ensure trapping complied with animal welfare. The total area of habitat identified prior to the survey and relative accessibility is presented below in Table 2.1 and Figure 2.1.

Table 2.1 - Area of Potential Northern Quoll Habitat Identified Prior to Survey

Accessibility of potential Northern Quoll habitat	Area (ha)
Access sufficient for trapping	209.39
Access sufficient for opportunistic searches	201.45
No access available	189.18
Total area of potential Northern Quoll habitat	600.02

Areas with no access were identified using aerial photography, vegetation descriptions and topographic data. Their suitability to be classified as foraging or breeding habitat for Northern Quolls could not be assessed due to access limitations.

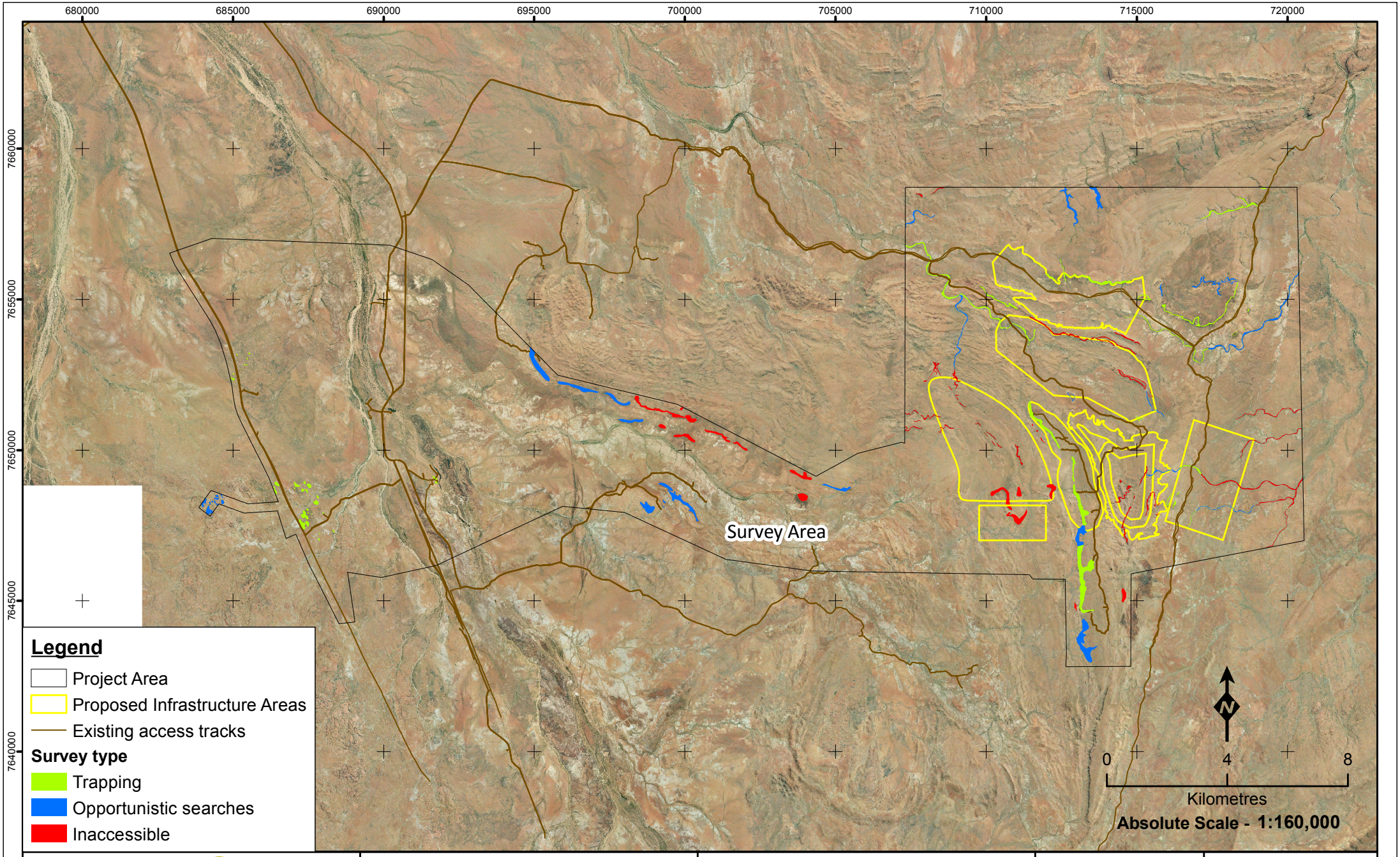
Trapping survey effort was designed using the formula described in the referral guideline document (DSEWPaC 2011a) which is described below. The trapping effort was calculated using only the area of potential habitat that was accessible for trapping (Tim McGrath, DSEWPaC 2011, pers. comms.). The referral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

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

y= number of trap nights, x = area of potential habitat in hectares

Based on the above formula, 723.5 trap nights were recommended to determine the presence and abundance of Northern Quoll within the North Star Project area. Based on the recommendation that traps are open for a minimum of seven nights, a total of 103 traps were estimated to be required to accurately determine the presence and abundance of Northern Quoll in the Project area. Due to the limited access, additional traps were set up in areas identified during the survey as accessible potential habitat. As a result, a total of 172 cage traps were used to determine the presence and abundance of Northern Quolls, which is in excess of the recommended survey intensity.

In addition to cage traps, motion sensing cameras were set up in areas of suitable Northern Quoll habitat that were not suitable for trapping. Opportunistic searches were also undertaken in these areas.



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Survey Types at Potential Northern Quoll Habitat Identified Prior Survey

Figure: 2.1
Project ID: 1373

Drawn: AH
Date: 01/06/11

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

Unique Map ID: AH343

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2.2.2 Pilbara Leaf-nosed Bat

Habitat mapping was used to identify areas of (assumed) preferred habitat and areas that had the potential to provide roosting caves. Passive acoustic recorders were used to confirm the species presence. The recorders are described as the most appropriate technique for non-invasive survey and the survey guidelines for threatened bats (DEWHA 2010a) indicate that 16 survey nights are recommended for areas less than 50 ha over a minimum of 4 nights, repeated twice with 6 months separating surveys.

Based on the area of suitable dry season roosting habitat within the Project area (294 ha), approximately 80 survey nights were recommended. However, it was not considered necessary to expend such a high survey effort to record Pilbara Leaf-nosed Bats in the area. This was confirmed with the success of the acoustic recorders in picking up Pilbara Leaf-nosed Bat calls. A total of 25 survey nights was conducted during the targeted survey with additional bat recorders set up during the Level 2 vertebrate fauna survey. The survey effort and results are combined in the Level 2 vertebrate fauna report.

2.2.3 Pilbara Olive Python

Survey methods for Pilbara Olive Pythons are relatively simple, consisting of nocturnal road spotting transects, opportunistic searches for individuals, sloughed skin and faecal pellets (DSEWPaC 2011c). The DSEWPaC survey guidelines for reptiles (DSEWPaC 2011c) do not provide recommendations for survey intensity; however, the guidelines can be interpreted such that all suitable habitat should be searched for primary and secondary evidence of this species, i.e. scats, skin and remains.

2.3 SURVEY TIMING

The targeted survey was conducted in winter over two survey periods from the 7th - 15th July 2011 and from 22nd - 30th July 2011.

2.4 FAUNA HABITAT ASSESSMENT

Fauna habitat types were determined during the initial phase Level 2 survey conducted in April 2011. The distribution and extent of each habitat was estimated and mapped using aerial photography, topography and GIS software to help estimate the location and area of each habitat type. During the targeted survey the location and extent of suitable habitat for the listed conservation significant fauna species was re-evaluated and adjusted accordingly. Suitable habitat for each species was then given a suitability classification and the area of each classified habitat calculated and reported. Some areas listed as inaccessible in this report were assessed as potential habitat using aerial photography, topography and vegetation descriptions. These areas were mapped as desktop assessed but were inaccessible for ground truthing due to the lack of access tracks. Therefore, their suitability and classification as denning, dispersal or foraging habitat for the targeted species could not be assessed.

2.5 SITE SELECTION AND TRAPPING

All accessible areas of suitable Northern Quoll habitat were targeted and the number of traps per site based on the extent of the habitat, ability to transport traps and ability to allow all traps to be checked within three hours of sunrise (DSEWPaC 2011a). Opportunistic search areas were assessed to accurately determine suitability as habitat for conservation significant fauna species, and actively searched for secondary evidence of the targeted species.

A total of 17 trapping sites were established in areas of suitable habitat (Table 2.2, Figure 2.2).

Survey trap sites from the previous Phase 1 of the Level 2 survey at North Star proposed mining area and infrastructure corridor are mapped in Figure 2.2 in conjunction with the targeted survey sites set up during the targeted surveys of the Project area.

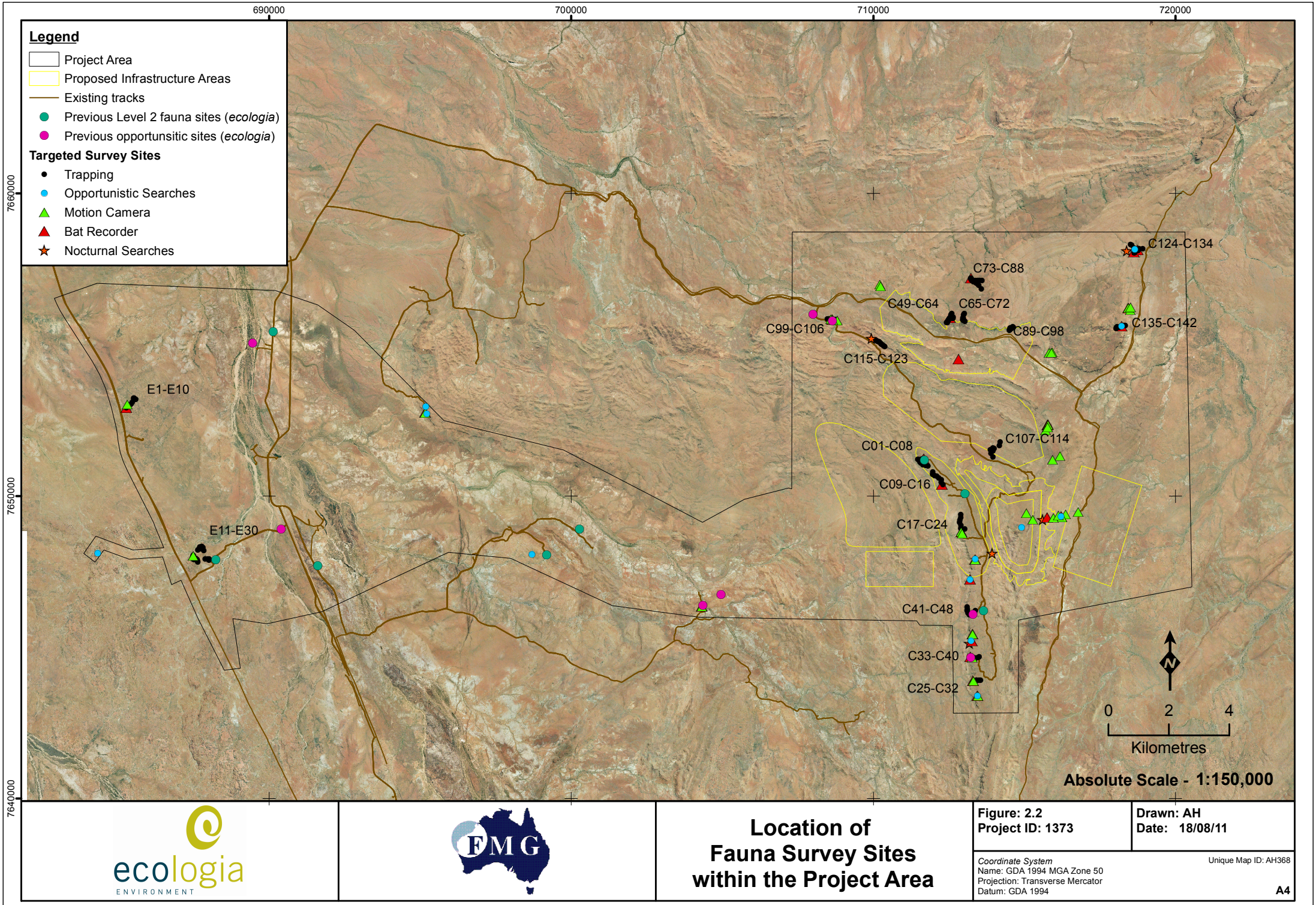
Table 2.2 – Fauna Survey Site locations

Site	Survey Area	Survey Type	Number of Traps	Location	
				Easting	Northing
A	North Star proposed mining area	Trapping	8	711709	7651197
B	North Star proposed mining area	Trapping	8	712315	7650404
C	North Star proposed mining area	Trapping	8	712918	7649398
D	North Star proposed mining area	Trapping	8	713297	7643801
E	North Star proposed mining area	Trapping	8	713394	7644638
F	North Star proposed mining area	Trapping	8	713164	7646403
Y	Infrastructure Corridor	Trapping	20	688165	7647772
Z	Infrastructure Corridor	Trapping	10	685090	7652841
1	Proposed Infrastructure Areas	Trapping	16	712517	7655862
2	Proposed Infrastructure Areas	Trapping	8	712979	7655872
3	Proposed Infrastructure Areas	Trapping	16	713394	7657128
4	Proposed Infrastructure Areas	Trapping	10	714535	7655547
5	Proposed Infrastructure Areas	Trapping	8	708615	7655839
6	Proposed Infrastructure Areas	Trapping	8	713958	7651503
7	Proposed Infrastructure Areas	Trapping	9	710192	7655094
8	Proposed Infrastructure Areas	Trapping	11	718659	7658149
9	Proposed Infrastructure Areas	Trapping	8	718198	7655629
NS Opp1	Infrastructure Corridor	Opportunistic	-	684335	7648110
NS Opp2	Infrastructure Corridor	Opportunistic	-	698701	7648059
NS Opp3	Infrastructure Corridor	Opportunistic	-	695230	7652709
NS Opp4	Infrastructure Corridor	Opportunistic	-	695186	7652948
NS Opp5	North Star proposed mining area	Opportunistic	-	713377	7647922
NS Opp6	North Star proposed mining area	Opportunistic	-	713205	7647235
NS Opp7	North Star proposed mining area	Opportunistic	-	713448	7643390
NS Opp8	North Star proposed mining area	Opportunistic	-	713236	7645210
NS Opp9	North Star proposed mining area	Opportunistic	-	713205	7647235
AA Opp1	Proposed Infrastructure Areas	Opportunistic	-	718659	7658149
AA Opp2	Proposed Infrastructure Areas	Opportunistic	-	718659	7658149
AA Opp3	Proposed Infrastructure Areas	Opportunistic	-	718223	7655604
AA Opp4	Proposed Infrastructure Areas	Opportunistic	-	716219	7649314
AA Opp5	Proposed Infrastructure Areas	Opportunistic	-	714916	7648960
BatRec 01	Proposed Infrastructure Areas	Bat recorder	1	712272	7650376
BatRec 02	Proposed Infrastructure Areas	Bat recorder	1	713307	7643882
BatRec 03	North Star proposed mining area	Bat recorder	1	713448	7643390
BatRec 04	North Star proposed mining area	Bat recorder	1	713285	7645431
BatRec 05	Infrastructure Corridor	Bat recorder	1	685276	7652908
BatRec 06	Infrastructure Corridor	Bat recorder	1	704322	7646345
BatRec 07	Proposed Infrastructure Areas	Bat recorder	1	712831	7654516
BatRec 08	North Star proposed mining area	Bat recorder	1	711676	7651226
BatRec 09	North Star proposed mining area	Bat recorder	1	712922	7648806
BatRec 10	North Star proposed mining area	Bat recorder	1	713217	7644678
BatRec 11	North Star proposed mining area	Bat recorder	1	713262	7645204
BatRec 12	Infrastructure Corridor	Bat recorder	1	695165	7652746
BatRec 13	North Star proposed mining area	Bat recorder	1	713368	7647895
BatRec 14	North Star proposed mining area	Bat recorder	1	713205	7647235

Site	Survey Area	Survey Type	Number of Traps	Location	
				Easting	Northing
BatRec 15	Proposed Infrastructure Areas	Bat recorder	1	718626	7658052
BatRec 16	Proposed Infrastructure Areas	Bat recorder	1	718754	7658120
BatRec 17	Proposed Infrastructure Areas	Bat recorder	1	715775	7652328
BatRec 18	Proposed Infrastructure Areas	Bat recorder	1	708641	7655822
BatRec 19	Proposed Infrastructure Areas	Bat recorder	1	713235	7657191
BatRec 20	Proposed Infrastructure Areas	Bat recorder	1	715785	7652347
Bat Rec 21	Proposed Infrastructure Areas	Bat recorder	1	718223	7655604
Bat Rec 22	Proposed Infrastructure Areas	Bat recorder	1	718436	7656200
Bat Rec 23	Proposed Infrastructure Areas	Bat recorder	1	716220	7649315
Bat Rec 24	Proposed Infrastructure Areas	Bat recorder	1	715757	7649289
Bat Rec 25	Proposed Infrastructure Areas	Bat recorder	1	712542	7655888
NSMC 1	North Star proposed mining area	Motion Camera	1	712917	7648809
NSMC 2	North Star proposed mining area	Motion Camera	1	713311	7643886
NSMC 3	North Star proposed mining area	Motion Camera	1	713463	7643392
NSMC 4	North Star proposed mining area	Motion Camera	1	713284	7645431
NSMC 5	North Star proposed mining area	Motion Camera	1	713278	7644659
NSMC 6	North Star proposed mining area	Motion Camera	1	712944	7648754
NSMC 7	North Star proposed mining area	Motion Camera	1	713368	7647895
NSMC 8	Infrastructure Corridor	Motion Camera	1	695165	7652746
NSMC 9	Infrastructure Corridor	Motion Camera	1	687490	7648024
NSMC 10	Infrastructure Corridor	Motion Camera	1	685307	7653032
NSMC 11	Infrastructure Corridor	Motion Camera	1	704322.5	7646345
AAMC1	Proposed Infrastructure Areas	Motion Camera	1	715822	7654744
AAMC2	Proposed Infrastructure Areas	Motion Camera	1	708595	7655841
AAMC3	Proposed Infrastructure Areas	Motion Camera	1	715923	7654756
AAMC4	Proposed Infrastructure Areas	Motion Camera	1	708808	7655799
AAMC5	Proposed Infrastructure Areas	Motion Camera	1	715893	7654739
AAMC6	Proposed Infrastructure Areas	Motion Camera	1	708657	7655824
AAMC7	Proposed Infrastructure Areas	Motion Camera	1	715785	7652347
AAMC8	Proposed Infrastructure Areas	Motion Camera	1	710220	7656988
AAMC9	Proposed Infrastructure Areas	Motion Camera	1	715704	7652164
AAMC10	Proposed Infrastructure Areas	Motion Camera	1	710242	7656936
AAMC11	Proposed Infrastructure Areas	Motion Camera	1	715767	7652269
AAMC12	Proposed Infrastructure Areas	Motion Camera	1	718503	7656152
AAMC13	Proposed Infrastructure Areas	Motion Camera	1	718439	7656215
AAMC14	Proposed Infrastructure Areas	Motion Camera	1	718515	7656233
AAMC15	Proposed Infrastructure Areas	Motion Camera	1	716785	7649468
AAMC16	Proposed Infrastructure Areas	Motion Camera	1	716365	7649392
AAMC17	Proposed Infrastructure Areas	Motion Camera	1	716244	7649294
AAMC18	Proposed Infrastructure Areas	Motion Camera	1	715966	7649280
AAMC19	Proposed Infrastructure Areas	Motion Camera	1	716122	7649359
AAMC20	Proposed Infrastructure Areas	Motion Camera	1	715278	7649220
AAMC21	Proposed Infrastructure Areas	Motion Camera	1	715067	7649430
AAMC22	Proposed Infrastructure Areas	Motion Camera	1	716184	7651333
AAMC23	Proposed Infrastructure Areas	Motion Camera	1	715936	7651195

Datum: WGS84
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Location of Fauna Survey Sites within the Project Area

Figure: 2.2
Project ID: 1373

Drawn: AH
Date: 18/08/11

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

Unique Map ID: AH368

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2.6 SAMPLING METHODS

The survey methods adopted by *ecologia* were aligned with the EPA's Guidance tatement No. 56 (EPA 2004), Position Statement No. 3 (EPA 2002), *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA 2010) and survey guidelines for Northern Quolls, Pilbara Leaf-nosed Bats and Pilbara Olive Pythons developed by the Federal Government (DEWHA 2010a, b, c; DSEWPaC 2011b, c).

The survey was undertaken using methods described in sections below.

2.6.1 Northern Quoll

Seventeen survey sites were established with a total of 172 cage and large Elliott traps (Table 2.2) set at 50-100 m spacing. All traps were baited with universal bait (peanut butter, oats and sardines) and changed every two days and all traps were shaded with Hessian bags (cage traps) and industrial roof insulation (Elliott traps) to minimise the likelihood of trap death due to heat/cold stress.

All traps were checked each morning and captured quolls were marked using ear notches, measured and released. Each quoll was marked with a unique ear notch number using the system shown below in Figure 2.3, which allowed recaptured quolls to be quickly identified and released immediately. The ear notch was retained and sent to the Western Australian Museum (WAM) for future genetic analysis (WA Museum TM381-TM400). Previous surveys used Passive Integrated Transponder tags to identify individuals, but due to the annual nature of the surveys and short life span of Northern Quolls (1-2 years), it is estimated that only two captures over the life of the animal will be made. Therefore, *ecologia* did not consider this system for future work.

The following parameters were recorded for captured Northern Quolls: weight, sex, head and short pes length, reproductive condition and health condition noted (ascertained from thickness of tail and general appearance: 1 = Poor, 3 = Average, 5 = Good). Health status of males is a good indicator of reproduction timing as their condition declines steadily throughout the breeding season resulting in post reproduction male die-off.

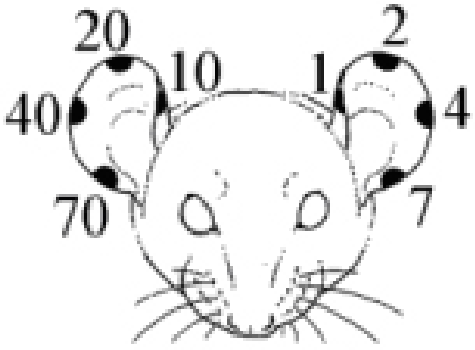


Figure 2.3 – Ear notch identification system

2.6.2 Pilbara Leaf-nosed Bat

Bat echolocation calls were detected using SM2Bat 384 kHz and an Anabat II system. The Anabat Bat Detector is able to transform ultrasonic bat echolocation calls using zero crossing and the resulting calls were saved on an Olympus digital recorder. The SM2Bat has a high sampling frequency, enabling calls to be recorded without being transformed.

During the first phase of the Level 2 survey of the Project area, one Anabat II system and one SM2bat were used to survey bat species at eight trapping and opportunistic sites. During the targeted survey, two SM2Bat recorders were set up at 25 locations within the Project area (Table 2.2, Figure 2.2). Site locations were selected by the presence and condition of suitable roost habitat for Pilbara Leaf-nosed Bats such as deep humid caves.

2.6.3 Pilbara Olive Python

Opportunistic surveys were conducted in suitable habitat such as rock faces of rocky ridges, rocky gorges and rock faces along creek lines. Targeted searches included all water bodies that were encountered. As the suitable habitat for Pilbara Olive Python is similar to that required by both the Northern Quoll and Pilbara Leaf-nosed Bat, opportunistic searches could be carried out concurrently while checking traps in the early morning.

2.6.4 Opportunistic Data

2.6.4.1 Nocturnal Searching

The Project area was searched at night using a combination of road transects and opportunistic ground searches using head torches and hand held spotlights. As all targeted species can be considered nocturnal, this method is typically useful; however, cooler conditions (reduced activity of some species) and occupational health and safety requirements limited the amount of nocturnal work that could be completed.

A total of 29 hours of nocturnal searches was conducted at five locations within the Project area (Figure 2.2).

2.6.4.2 Diurnal Searching

Both trap and opportunistic survey sites were searched by hand for primary or secondary evidence of the Northern Quoll, Pilbara Olive Python and Pilbara Leaf-nosed Bat. Sites were selected in habitat likely to support conservation significant fauna.

Fauna were also recorded while searching, travelling and establishing traps within the Project area during the day and night. Tracks, diggings and scats were recorded where possible.

A total of 74.5 hours of targeted diurnal searches was conducted during the survey to identify the presence and abundance of fauna of conservation significance (Table 2.2, Figure 2.2).

2.6.4.3 Motion Sensing Cameras

Bushnell Trophy Cam motion sensing cameras were used to detect fauna species in areas with a high likelihood of animal activity such as water sources. The camera is triggered by movement by a highly

sensitive passive infra-red motion sensor and functions day and night taking either video footage or photos (Bushnell Outdoor Products 2009).

Motion sensing cameras were set up at 34 locations which were selected on the basis of possible shelter/den sites such as caves or crevices in boulders. Sardines and/or universal bait was used as bait to attract Northern Quolls. A total of 52 nights of recording was analysed (Figure 2.2, Table 2.2).

2.7 SURVEY EFFORT

Survey effort expended within the Project area included the following:

- 172 traps were open for 1137 trapnights;
- approximately 29 hours of diurnal searches and 74.5 hours of nocturnal searches were spent surveying for Northern Quoll;
- approximately 29 hours of diurnal searches and 74.5 hours of nocturnal searches were spent targeting Pilbara Olive Pythons;
- approximately 45 hours were spent surveying for roost caves for Pilbara Leaf-nosed Bat;
- camera trapping using motion sensing cameras were deployed for 1248 hours; and
- 278.5 hours of recordings were analysed to determine presence of Pilbara Leaf-nosed Bat and Ghost Bat.

2.8 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) and as per EPBC Act guidelines for Northern Quolls (DSEWPaC 2011a)

2.9 SURVEY TEAM

Field survey team members and external consultants are listed in Table 2.3. The survey was conducted under DEC Regulation 17 Licence SF007862.

Table 2.3 – Field Survey Personnel

Survey Member	Qualification	Experience
Damien Cancilla	B.Sc. (Hons)	7 years
Astrid Heidrich	M.Sc.	6 years
Jordan Vos	-	6 years
Bret Stewart	B.Sc. (Hons)	6 years
Bruce Greatwich	B.Sc.	3 years
Leigh Smith		2 years
Jesse Forbes-Harper	BA, B.Sc. (Hons)	1 years
Bob Bullen (external consultant, bat call analysis)		12 years

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3 RESULTS

3.1 LITERATURE REVIEW AND DATABASE SEARCH

3.1.1 Northern Quoll (*Dasyurus hallucatus*)

The Northern Quoll is the smallest of the four Australian Quoll species and is primarily insectivorous, with some vertebrate prey and fruit also consumed (Braithwaite and Begg 1995). Northern Quolls are both arboreal and terrestrial (Braithwaite and Begg 1995) and are primarily nocturnal (Oakwood 2008). Northern Quolls are generally considered to be solitary, with females having mutually exclusive denning areas, although foraging areas can be overlapping, with territoriality likely to be related to the abundance, dispersion and availability of food (Oakwood 2002).

Male and female home ranges are of similar size outside of the breeding season; however, during the breeding season male home ranges expand significantly and can overlap extensively with several female ranges and numerous other male territories (Oakwood 2008). Female home ranges are up to 35 ha, preferring rocky habitat. Males can occupy territories of over 100 ha which overlap with territories of females and occasionally other males (Oakwood 2008). Individual males have been recorded travelling up to 3.5 km over seven days. In the more northerly areas of their distribution mating occurs from late May to June with young born in September and October (King 1989), while in the Pilbara breeding is thought to occur between August and September. However, females have been recorded with pouch young as late as February (How *et al.* 1991). During the breeding season, males adopt a roving strategy, regularly visiting several widely spaced females in rapid succession, presumably to monitor the onset of oestrus. The energetic cost of this behaviour is a likely cause of the annual male die-off which is a sudden, sharp decline in the Northern Quoll population after the breeding season (Oakwood 2008).

Northern Quoll formerly occurred across northern Australia from the Pilbara region in Western Australia to south-eastern Queensland. A 75% reduction in habitat range occurred during the 20th century (Braithwaite and Griffiths 1994), so that the species is now restricted to the Pilbara and north Kimberley in Western Australia and a few discrete populations across the Northern Territory and eastern Queensland. This reduction in the population size along with the male die-off that occurs after breeding, resulting in a slow population recovery ability, resulted in the listing of the Northern Quoll as Endangered in 2005 under the EPBC Act (DSEWPaC 2011a).

Reduction of the population size of Northern Quoll is thought to be a result of a combination of several factors. The most common cause of adult mortality is predation, typically by dingoes, feral cats, snakes, owls and kites (Maxwell *et al.* 1996; Oakwood 2008). The level of predation upon Northern Quolls is increased through the removal of groundcover by fire. Other causes of mortality include domestic dogs, motor vehicles and pesticide poisoning. There is also evidence to implicate poisoning following predation upon cane toads as a factor in more recent population declines (Woinarski *et al.* 2008). For this reason the Pilbara region of Western Australia is considered an important refuge area as cane toads are currently not thought to pose a threat to this region due to the arid conditions.

The majority (87%; 111 of 127 records) of Northern Quoll records in the Pilbara have been recorded from the Chichester IBRA subregion (NatureMap, *ecologia* internal database, GBIF) (Figure 3.1). The remaining individuals were caught in the west of the Hamersley region (6.3%), the Roebourne region (3.9%) and in the north-west of the Fortescue region (2.7%). The Project area lies near the centre of the species' distribution in the Pilbara. NatureMap lists 20 records within 50 km of the North Star

Project area. Another 30 records were made by the WA Museum within 50 km of the North Star Project area.

During previous surveys conducted by *ecologia*, 21 individuals and 39 scats or tracks have been recorded within 50 km of the Project area (Figure 3.4). All records were from the northern or north-western part of the Project area with the exception of one individual which was captured in 2010 approximately 34 km south-east of the Project area. In addition, the WA Museum lists a further 62 records of the Northern Quoll from within 50 km of the Project area with records from the vicinity of Marble Bar, Woodstock, approximately 10 km north-east, 20 km east, 40 km south and 40 km north of the Project area (WA Museum, NatureMap, Figure 3.4).

Previous records of Northern Quoll near the Project area include: a total of 18 individuals from 12 km west of the Project area (Outback Ecology 2010), two individuals from Mt Dove (40 km west of the Project area; Outback Ecology 2011), 15 individuals from Panorama Project (3-8 km from the Project area) (Bamford and Wilcox 2001; Biota 2007) and three individuals from 10 km south of the Project area (NatureMap).

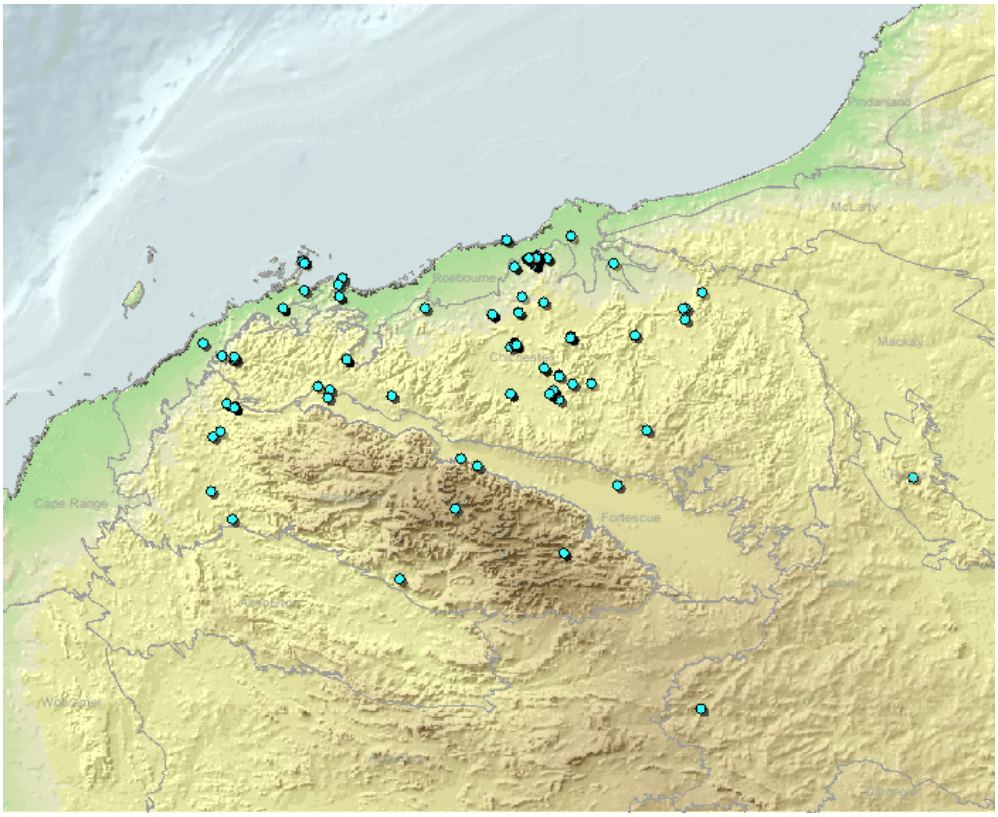


Figure 3.1 – Northern Quoll records in the Pilbara region (NatureMap 2011)

3.1.2 Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*)

The Pilbara Leaf-nosed Bat is a form of the Orange Leaf-nosed Bat (*Rhinonicteris aurantia*), a small brightly orange coloured bat that occurs across northern Australia. During the tropical dry season this species roosts in warm and very humid caves (32 °C and 95% humidity) as they are exceptionally vulnerable to cooling and descication. They feed mostly on moths and beetles (but will take most flying insects) and hunt by flying in a zigzag pattern usually within a metre of the ground (Churchill *et al.* 2008), resulting in them frequently being seen and killed by motorists driving at night.

The Pilbara Leaf-nosed Bat is considered an anachronism, a relict from wetter times (Armstrong 2008) and is restricted to the Pilbara region of Western Australia surviving by utilising warm humid roost caves. While it is considered a separate form, formal reclassification has been hampered by the small sample size of the Pilbara population (Armstrong 2008). This distinction is reconised in the EPBC Act with the Pilbara Leaf-nosed Bats classification as Vulnerable.

At dusk Pilbara Leaf-nosed Bats emerge from their roosting sites to forage in gorges, small gullies and large watercourses for insects such as moths, beetles and flying termites. They fly and hunt in the same manner as the Orange Leaf-nosed Bat, rapidly with a fast wing beat following zigzag flight pattern low to the ground (Armstrong 2008; Churchill 2008). Reproductive information is limited; however, *ecologia* assumes the reproduction of the Pilbara Leaf-nosed Bat takes place at the same time as the Orange Leaf-nosed Bat, with mating occuring in July and females giving birth to a single young in December or January.

Recent evidence suggests two main stronghold areas for the Pilbara Leaf-nosed Bat; in the western Pilbara and north of Marble Bar, and an additional subpopulation occupying caves in Barlee Range Nature Reserve, where a confirmed roost cave was found (Armstrong 2008). In the western Pilbara, these bats 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 with very hot and humid roost sites (28-32°C and 96-100%) and areas of high relief with gorges, watercourses and permanent surface water (Armstrong 2001; Churchill 2008; McKenzie and Bullen 2009). They are unlikely to occur in the shallow 'breakaway' caves that occur along mesas and strike ridges. During the wet season (November to February) the species abandons its dry season roost caves and becomes a forest or creekline dweller (Churchill 2008).

They are susceptible to disturbance and will abandon roost caves if disturbed. Colonies in mines in the eastern Pilbara are subject to several pressures, including human visitation, and the collapse and flooding of disused mines (Armstrong 2008; DEWHA 2008b). The Pilbara Leaf-nosed Bat is susceptible to dehydration a nd hypothermia and removal from the high humidity and hot temperature of their roost caves will result in death within hours. Large colonies of this species are known to be heavily predated upon by Ghost Bats (*Macroderma gigas*) and, therefore, the Pilbara Leaf-nosed Bats exit the caves at high speed and rapidly enter thicker vegetation, presumably to avoid the Ghost Bats (Churchill 2008).

Regional records of the Pilbara Leaf-nosed Bat are limited and only seven locations in the vicinity of major rivers (Shaw River and Turner River) within 35 km of the Project area were identified (Figure 3.2 and Figure 3.5). All records are recent, from 2006 and 2010 (NatureMap).

Pilbara Leaf-nosed Bats have also previously been recorded approximately 100 km from the Project area (*ecologia internal database*). There are several records of the species within 50 km from the

Project area, including potential roost caves around Lalla Rookh mine approximately 10 km north-east and west of the Project area (DEC 2011; Molhar 2007).

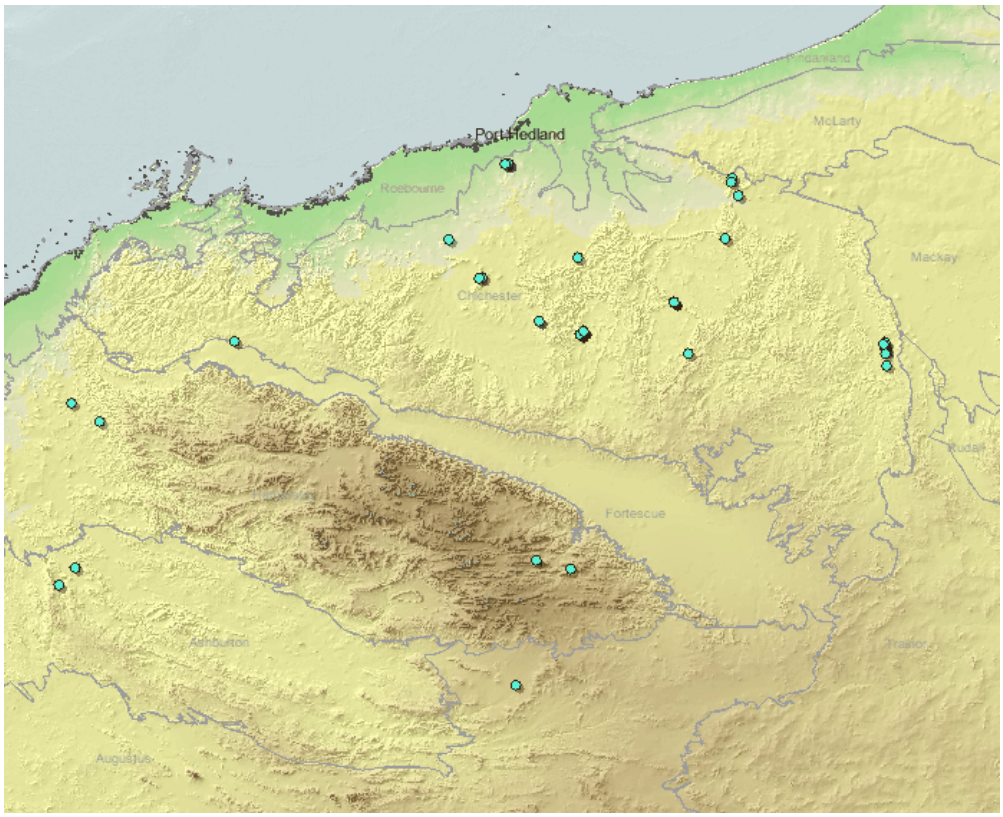


Figure 3.2 – Pilbara Leaf-nosed Bat records in the Pilbara region (NatureMap 2011)

3.1.3 Pilbara Olive Python (*Liasis olivaceus barroni*)

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). This subspecies is an adept swimmer, often hunting in water, and individuals have been seen feeding in the entrance of bat roost caves, both strategies allowing them to feed on a variety of vertebrates, including rock wallabies, 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 but usually in close proximity to water and rock outcrops (DEWHA 2008a). Mating takes place in winter (June-August). Males can travel up to 3 km in search of females. They usually stay together for up to three weeks in which mating occurs repeatedly before the male returns to his home range (Pearson 2006).

Population size estimates are difficult due to the species cryptic nature and lack of a reliable trapping or census methodology (DEWHA 2008a). The main threats to this subspecies come from predation from feral cats and foxes, particularly of juveniles, competition with foxes for food, and destruction of habitat (Pearson 2006). Pilbara Olive Pythons are often killed on WA roads by accident or deliberately. They are slow moving and their instinctive response to approaching cars is to freeze (Pearson 2006).

Pilbara Olive Python records in the Pilbara have been typically recorded from the McKay, Rocklea and Newman Land Systems, which are described as hills and ranges (*ecologia* internal database, GBIF NatureMap). The Project area lies in the north of the species' known distribution. All regional records of the Pilbara Olive Python are mapped in Figure 3.3 and Figure 3.6. During a previous survey in 2010 *ecologia* Environment recorded one individual crossing the road in the vicinity of Marble Bar (approximately 62 km east of the Project area) (Figure 3.3 and Figure 3.6). A further four records of this species exists, comprising one specimen recorded from Marble Bar (approx. 65 km east of Project area), two at Woodstock (approx. 43 km south of the Project area) and one approximately 18 km north of the Project area (NatureMap). The two records from Woodstock were collected in 1965 and 1988 and represent historical records.

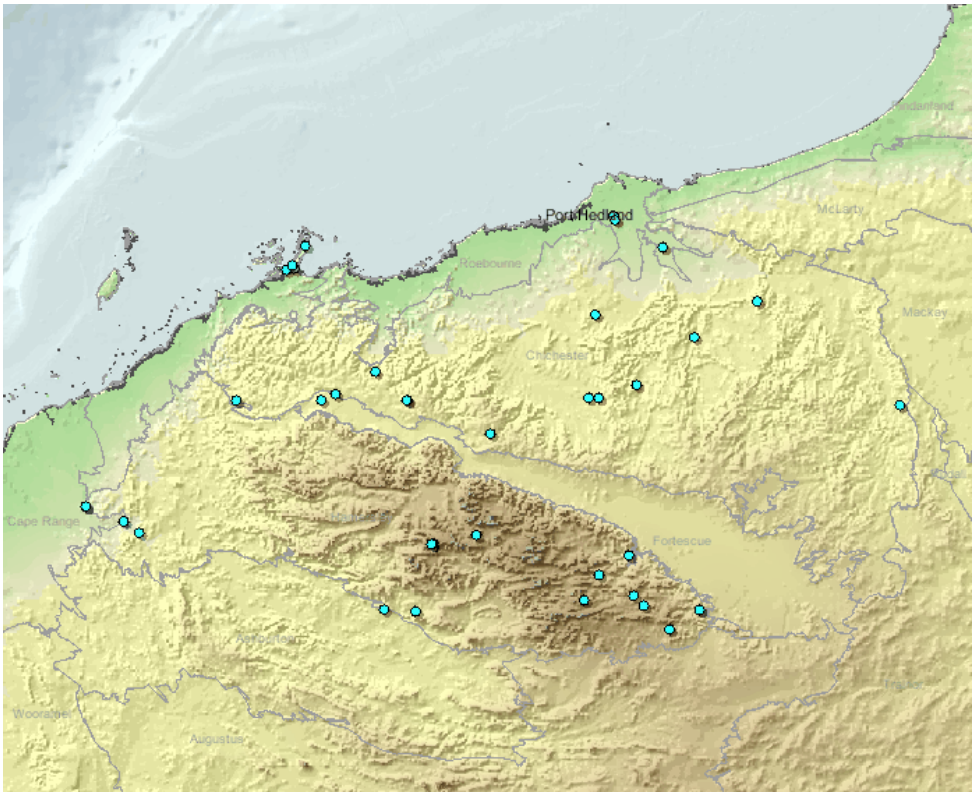
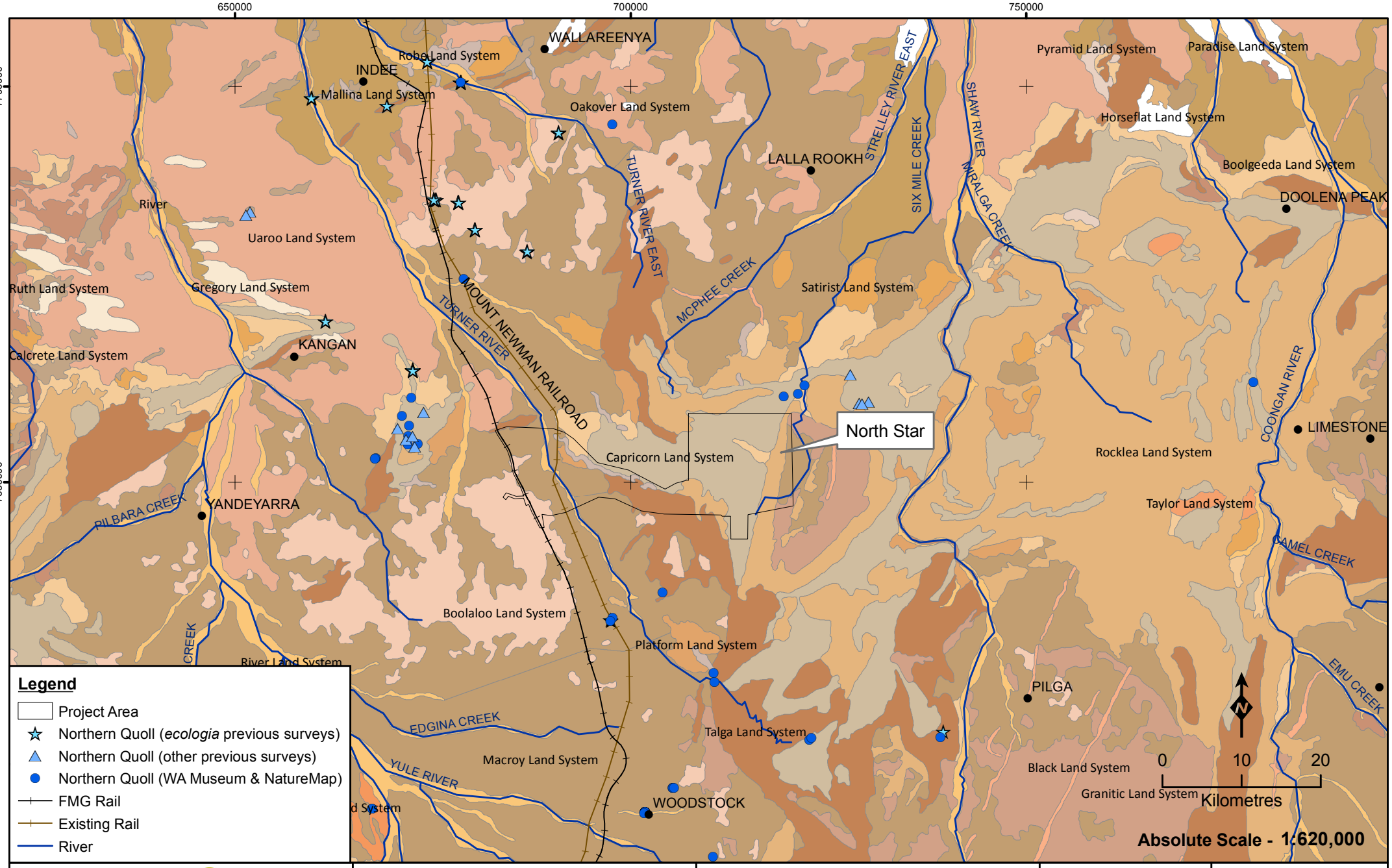


Figure 3.3 – Pilbara Olive Python records in the Pilbara region (NatureMap 2011)



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Regional Records of the Northern Quoll

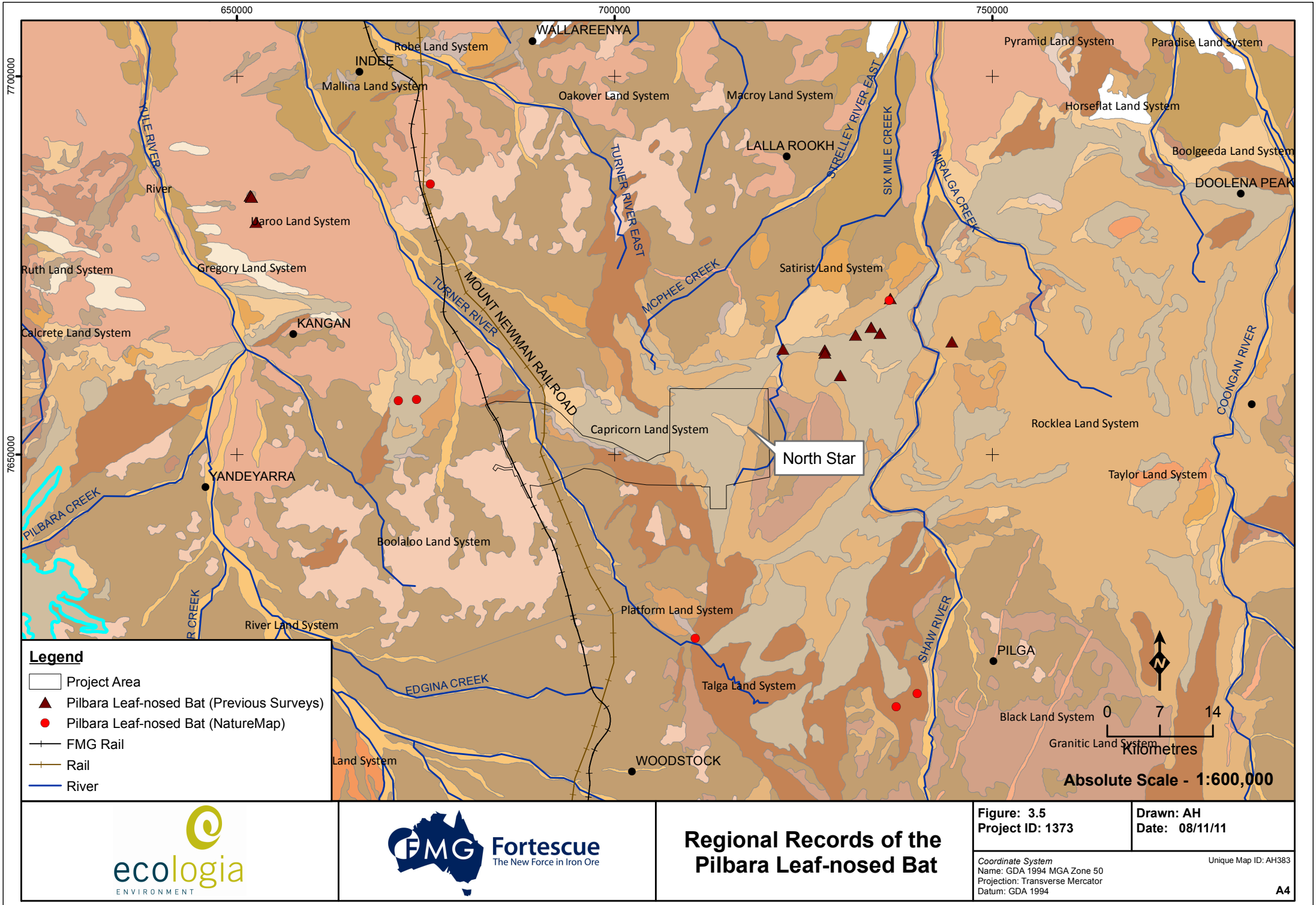
Figure: 3.4
Project ID: 1373

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Date: 08/11/11

Coordinate System
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Projection: Transverse Mercator
Datum: GDA 1994

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FMG Fortescue The New Force in Iron Ore

Regional Records of the Pilbara Leaf-nosed Bat

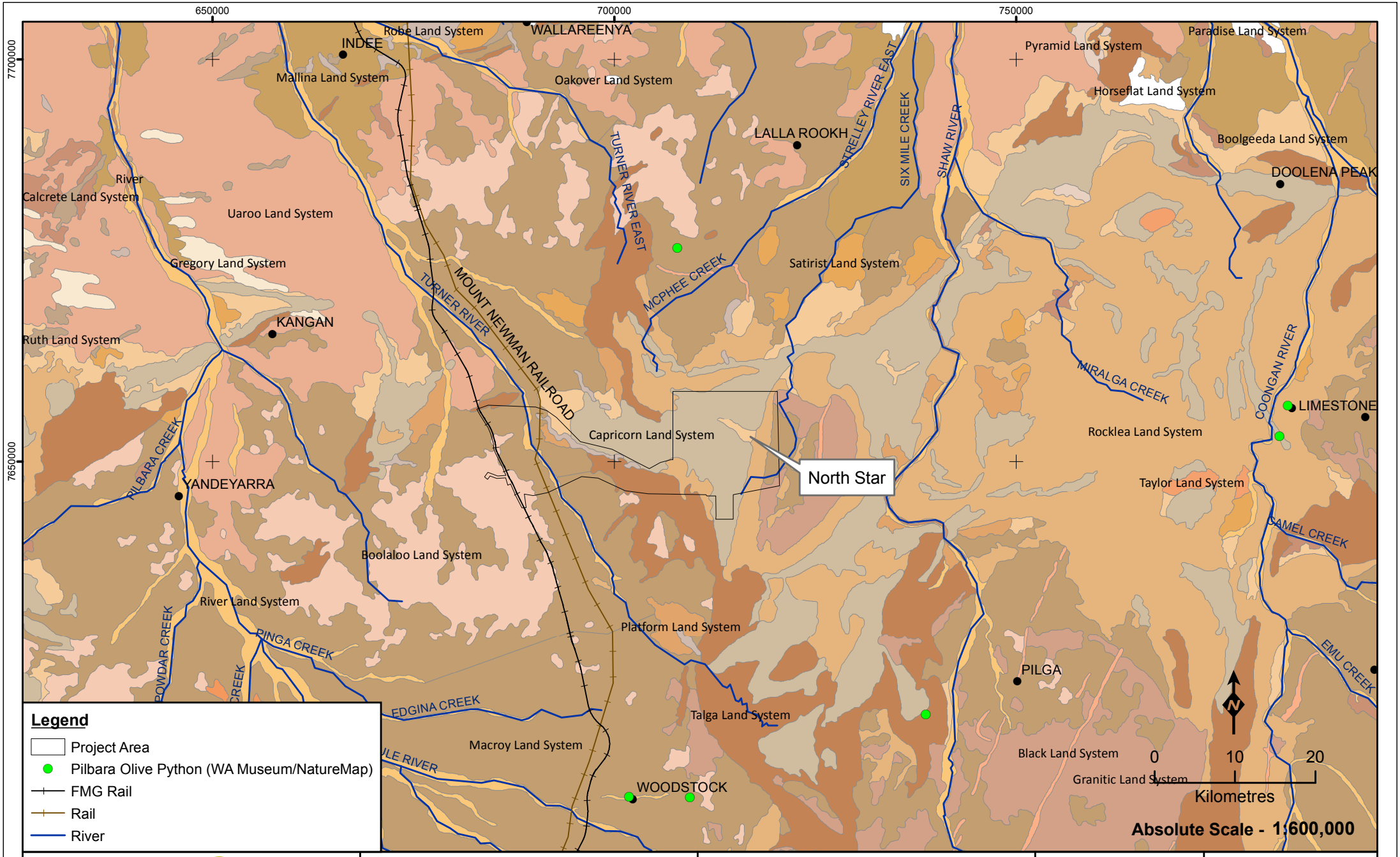
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Projection: Transverse Mercator
Datum: GDA 1994

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Fortescue The New Force in Iron Ore

Regional Records of the Pilbara Olive Python

Figure: 3.6
Project ID: 1373

Drawn: AH
Date: 08/11/11

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

Unique Map ID: AH381

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3.2 SURVEY RESULTS

3.2.1 Northern Quoll

3.2.1.1 Habitat

Habitat for the Northern Quoll was classified in five categories:

- Suitable denning habitat
- Potential denning/foraging habitat
- Riverine foraging/dispersal habitat
- Desktop assessed/inaccessible

Suitable denning habitat for the Northern Quoll is widespread within the North Star mining area. It comprises an ironstone ridge approximately 8.7 km in length running north-south along the western border of the tenement, and several rocky gorges running east-west providing water pools and patches of thick vegetation. The Infrastructure areas contain patches of suitable denning habitat in the form of rocky gorges with or without pools. This habitat type was not found in the infrastructure corridor (excepting the area of corridor adjacent to the mining area). Instead, it comprised some areas of extensive granite boulder piles which were classified as potential denning/foraging habitat (Figure 3.9).

A total of 900.7 ha was assessed and mapped as potential or suitable habitat for the Northern Quoll (Table 3.4, Figure 3.7 - Figure 3.9). Approximately 294.4 ha of this area were classified as suitable denning habitat. An additional 108.4 ha of rocky areas were identified as potential denning and foraging habitat. The Turner River in the east of the rail corridor is likely to be utilised as seasonal foraging and/or dispersal habitat. It comprises a total of 403.0 ha. The remaining 94.9 ha were inaccessible due to a lack of access tracks and, therefore, the suitability for denning or foraging could not be assessed through ground truthing.

Table 3.4 – Areas of suitable and potential Northern Quoll habitat within the Project area

Classification	Area (ha)
Suitable denning habitat	294.4
Potential denning/foraging habitat	108.4
Potential foraging/dispersal habitat (riverine)	403.0
Desktop assessed/inaccessible	94.9
Total	**900.7**

The proposed infrastructure corridor contains areas of suitable habitat in the form of granite boulder piles (which have a potential to provide shelter and foraging habitat) and the Turner River provides suitable foraging and dispersal habitat in the form of well vegetation riverine habitats. However, there were access restrictions due to Aboriginal heritage sites covering most of the Turner River, suitable habitat within the heritage sites were not assessed during the survey. This was acknowledged by Fortescue (Shaun Grein, 01/07/2011, written communication).



Figure 3.7 – Rocky gorge with suitable cliff habitat for the Northern Quoll



Figure 3.8 – Suitable habitat for the Northern Quoll

685000 690000 695000 700000 705000 710000 715000 720000

7665000
7660000
7655000
7650000
7645000

Legend

- Project Area
- Proposed Infrastructure Areas

Targeted Survey Sites

- Trapping
- Opportunistic Searches
- Motion Camera
- Nocturnal Searches

Northern Quoll Habitat

- Desktop assessed / inaccessible
- Riverine potential foraging/dispersal habitat
- Potential denning/foraging habitat
- Suitable denning habitat

E1-E10
E11-E30
C124-C134
C73-C88
C49-C64
C65-C72
C89-C98
C135-C142
C99-C106
C115-C123
C107-C114
C01-C08
C09-C16
C17-C24
C41-C48
C33-C40
C25-C32

N

0 2 4
Kilometres

Absolute Scale - 1:100,000

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Northern Quoll Habitat within the Project Area

Figure: 3.9
Project ID: 1373

Drawn: AH
Date: 08/11/11

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

Unique Map ID: AH388

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3.2.1.2 Trapping Data

Four records of Northern Quolls were made during the initial phase of the Level 2 vertebrate fauna survey conducted for the Project area. Two trapping records were made at trap site NS5, one individual was recorded using a motion camera and another one was observed during nocturnal surveys by *ecologia*.



Figure 3.10 – Northern Quoll recorded during initial phase of Level 2 survey

During the current targeted survey a total of 20 individual Northern Quolls were captured within the North Star Project area (Figure 3.11). All captured individuals were measured and weighed, had their health condition assessed and tissue samples collected. Details of all captured individuals are described in Appendix B. All quolls appeared to be in good condition with good to moderate fat stores although one individual from the Project area was showing some signs of condition deterioration in the form of torn ears and fur loss. The pouches of females were undeveloped indicating that mating activity had not taken place (Figure 3.12). The sex ratio of 4:1 was significant, with a larger number of male quolls than female quolls recorded. This result may be based on the occasionally larger number of males born (Oakwood 2000) or the males' tendency to roam further in search of females prior to and during the mating season. The latter is supported by records of two males travelling distances of 0.8 km and 2.6 km over a single night (Appendix B, North Star Male#1, Additional Area Male#5).



Figure 3.11 – Captured Northern Quoll (North Star Male#1)



Figure 3.12 – Undeveloped Pouch of a Captured Female

Nine out of ten Northern Quolls captured within the North Star Project area were recaptured during the survey; therefore, some traps were subsequently closed for seven trapping nights in accordance with the EPBC Act guidelines for Northern Quolls to prevent stress and significantly reduced foraging time. The number of recaptures within North Star proposed mining area is higher than the number of recaptured individuals in the Infrastructure Area where only four out of ten individuals were encountered more than once.

In addition to the trapped individuals, Northern Quolls were recorded on motion camera at three locations (Figure 3.13, Figure 3.15). At all three locations the motion cameras were set up in areas that were not suitable for trapping due to access not sufficient for trapping and, therefore, no cage trapping was conducted at these sites. Two Northern Quoll skulls and two scat piles were later found at three additional locations within the Project area.



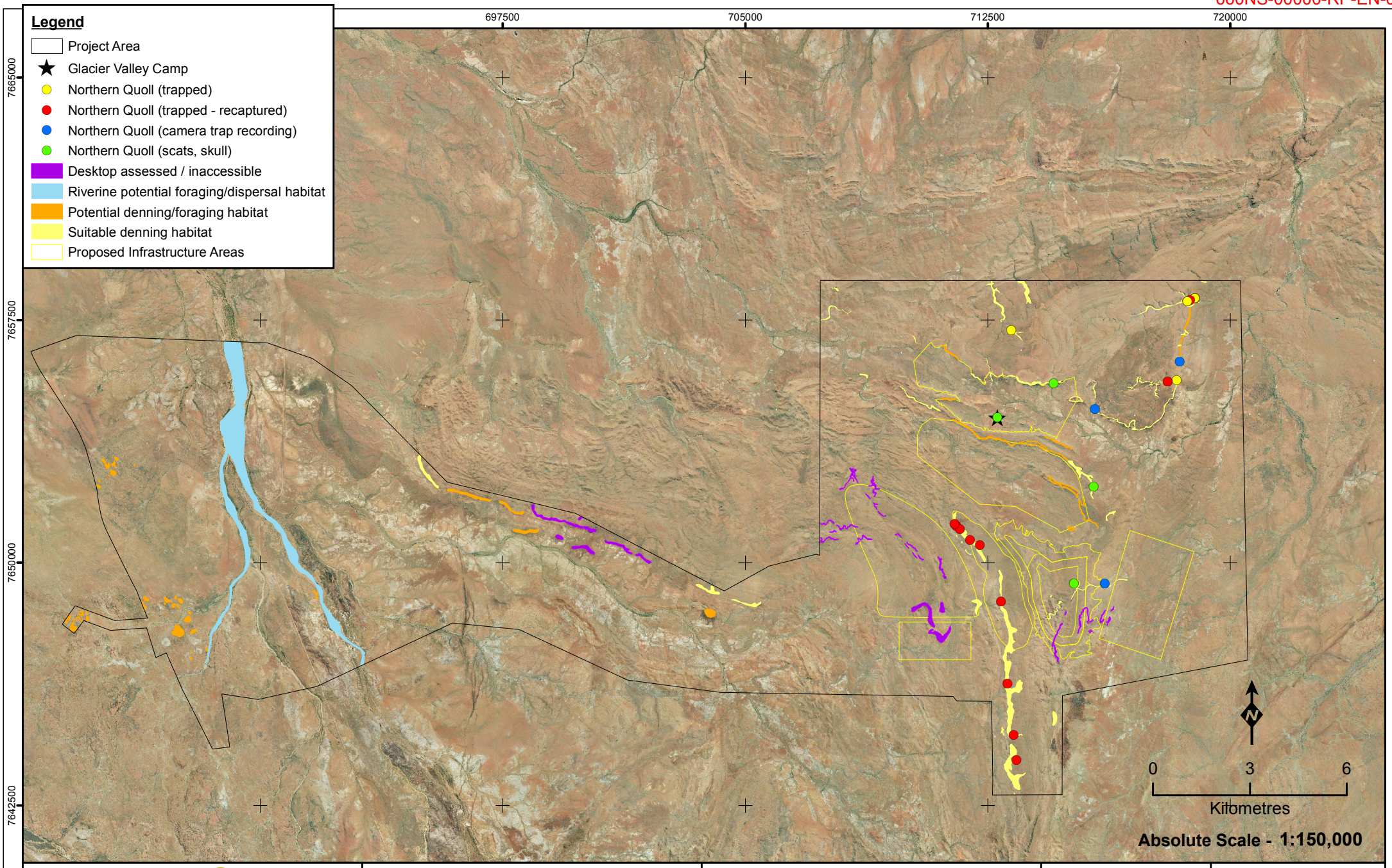
Figure 3.13 – Northern Quoll Recorded on Motion Sensoring Camera

A Northern Quoll skull was found underneath the buildings at Glacier Valley camp where Northern Quolls had been seen previously (Shadi Sayadi, FMG personnel, pers. comm., Figure 3.14). The camp is located on a rocky spinifex plain which is surrounded by rocky ranges and breakaways with patches of suitable denning habitat. Northern Quolls are known to travel long distances through habitat only moderately suitable for foraging while searching for food resources and/or mating partners.



Figure 3.14 – Northern Quoll Skull Recorded

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Location of Northern Quoll Records

Figure: 3.15
Project ID: 1373

Drawn: AH
Date: 08/11/11

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

Unique Map ID: AH384

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3.2.2 Pilbara Leaf-nosed Bat

3.2.2.1 Habitat

Habitat for the Pilbara Leaf-nosed Bat was classified in two categories:

- Potential roost cave habitat (Dry Season)
- Potential roost habitat (Wet Season)

A total of 712.94 ha potential roost habitat for the Pilbara Leaf-nosed Bat was identified along the north-south orientated ridge and east-west running gorges area, along major creek lines with fringing eucalypt trees and along cliff faces in the south and north within the North Star Project (Figure 3.19). Of these, potential wet season roost habitat was recorded from the Turner River and major creek lines in the centre of the rail corridor. This habitat comprised a total of 418.58 ha. The remaining 294.35 ha comprised potential dry season roost caves in the North Star Project area and infrastructure corridor. This habitat type could provide roost caves if conditions such as vegetation, depth of caves and climate within the cave is suitable for Pilbara Leaf-nosed Bats.

Table 3.5 – Area of potential Pilbara Leaf-nosed Bat habitat within the Project area.

Classification	Area (ha)
Potential roost cave habitat (Dry Season)	294.35
Potential roost habitat (Wet Season)	418.58
Total	**712.94**

3.2.2.2 Trapping Data

Pilbara Leaf-nosed Bats were recorded from 14 locations within the Project area (Figure 3.20). Of these, four records were likely to be recordings of bats foraging in the vicinity of their roost cave. The remaining ten records of Pilbara Leaf-nosed Bat were likely to be bats foraging along ridges and in the vicinity of creek lines (Table 3.6). The call patterns of six of the recordings are shown in Appendix C. Calls recorded in a regular pattern or in scattered sections during night time indicated that transient Pilbara Leaf-nosed Bats were recorded foraging (Appendix C1, Appendix C2) whereas individuals recorded in two sections of activity immediately after sunset and before sunrise were expected to be bats leaving and returning to their potential roost cave (Appendix C4, Appendix C5).

The most number of calls were recorded from two caves (Roost cave 1, 2) within small gullies with semipermanent water pools in the centre of the North Star proposed mining area (Table 3.6, Figure 3.16). Potential roost cave 3 was located in an open gully with moderately dense vegetation of shrubs and spinifex. No water was recorded from this open gully which did not indicate that caves in this gully have the ability to provide necessary humidity. The SM2Bat recorder was set up at the top of the gully from where one large cave (Figure 3.17) and two smaller caves with could potentially be utilised by Pilbara Leaf-nosed bats were visible. Safety concerns and difficult accessibility did not allow the entry and assessment of the depth of the three caves and, therefore, the condition and suitability could not be confirmed during this survey. The most western potential roost cave (Roost cave 4) is located along a large creek bed with fringing eucalypt trees approximately 10 m above a semipermanent waterhole (Figure 3.18). The creekline also comprises suitable wet season roost habitat in form of surface water and large eucalypt trees which can provide a high humidity.

Table 3.6 – Records of the Pilbara Leaf-nosed Bat

Site name	Record	Survey Area	Coordinates		Comments
			Easting	Northing	
Roost cave 1	Potential roost cave	North Star mining area	713262	7645204	66 calls (pattern consistent with a roost cave candidate)
Roost cave 2	Potential roost cave	North Star mining area	713368	7647895	59 calls (pattern consistent with a roost cave candidate)
Roost cave 3	Potential roost cave	North Star mining area	713205	7647235	10 calls (pattern consistent with a roost cave candidate)
Roost cave 4	Potential roost cave	North Star mining area	704322	7646345	40 calls (pattern consistent with a roost cave candidate)
Foraging 1	Potential roost cave	North Star mining area	713307	7643882	20 calls (transient bats out foraging)
Foraging 2	Transient/Foraging	North Star mining area	713217	7644678	5 calls (transient bats out foraging)
Foraging 3	Transient/Foraging	Additional Area	715756	7649289	6 calls (transient bats out foraging)
Foraging 4	Transient/Foraging	Additional Area	718626	7658052	2 calls (transient bats out foraging)
Foraging 5	Transient/Foraging	Additional Area	713235	7657190	5 calls (transient bats out foraging)
Foraging 6	Transient/Foraging	Additional Area	718223	7655604	15 calls (transient bats out foraging).
Foraging 7	Transient/Foraging	Additional Area	718436	7656199	8 calls (transient bats out foraging)
Foraging near roost 1	Foraging near roost cave	Additional Area	715775	7652328	48 calls (foraging bats near roost)
Foraging near roost 2	Foraging near roost cave	Additional Area	708641	7655822	42 calls (foraging bats near roost)
Foraging near roost 3	Foraging near roost cave	Additional Area	716220	7649315	27 calls (foraging bats near roost)



Figure 3.16 – Potential roost cave 1 (Top) and roost cave 2 (Bottom) for the Pilbara Leaf-nosed Bat (66 calls and 59 calls recorded)



Figure 3.17 – Potential roost cave 3 (10 calls recorded)



Figure 3.18 – Potential rooast cave 4 (40 calls recorded)

685000 690000 695000 700000 705000 710000 715000 720000

7660000 7655000 7650000 7645000 7640000

Legend

- Project Area
- Proposed Infrastructure Areas
- Opportunistic Searches
- Nocturnal Searches
- Bat Recorder

Potential Pilbara Leaf-nosed Bat habitat

- Potential roost cave habitat (dry season)
- Potential roost habitat (wet season)

N

0 2 4

Kilometres

Absolute Scale - 1:100,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Potential Pilbara Leaf-nosed Bat Habitat within the Project Area

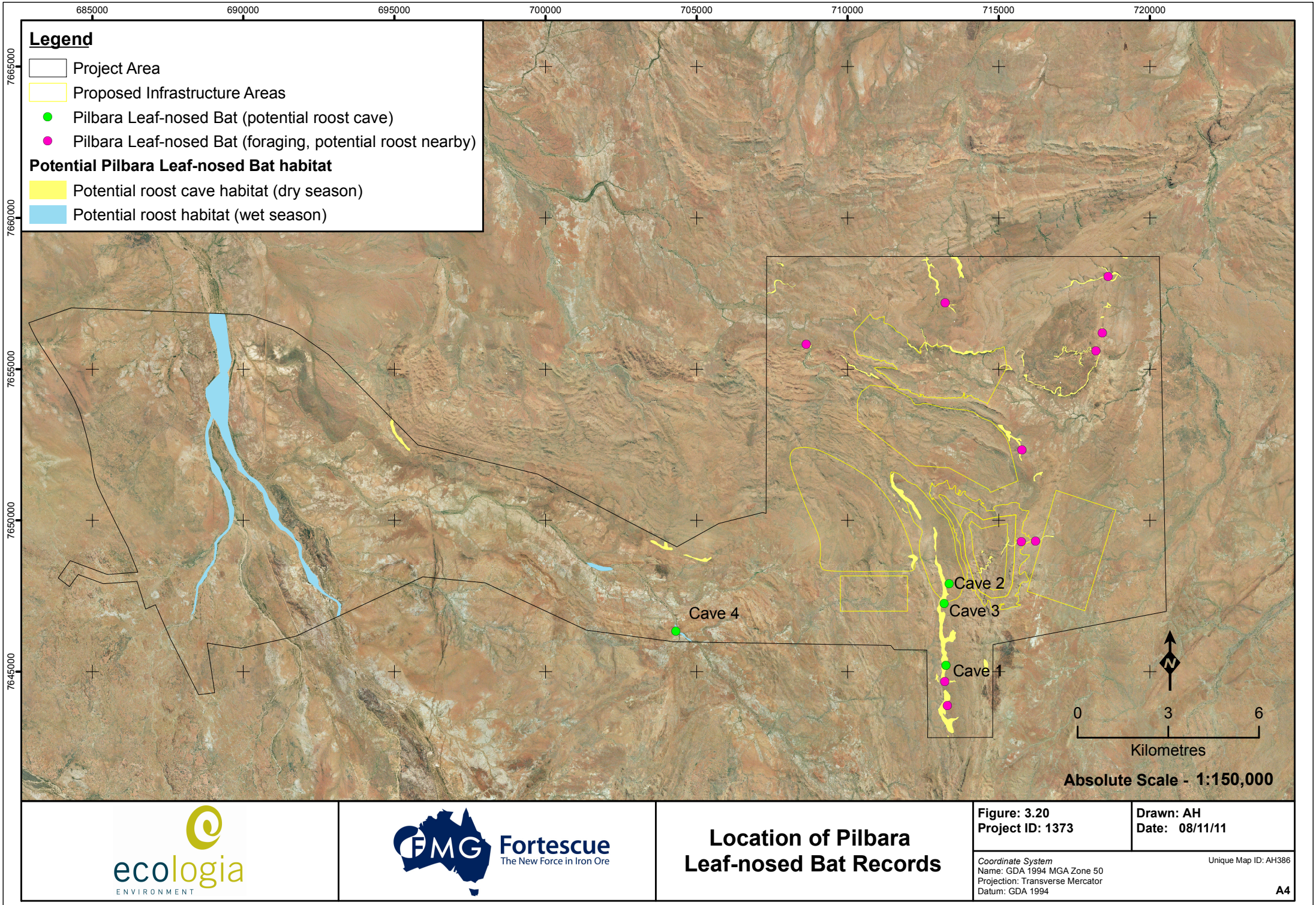
Figure: 3.19
Project ID: 1373

Drawn: AH
Date: 08/11/11

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

Unique Map ID: AH389

A3



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FMG Fortescue The New Force in Iron Ore

Location of Pilbara Leaf-nosed Bat Records

Figure: 3.20
Project ID: 1373

Drawn: AH
Date: 08/11/11

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

Unique Map ID: AH386

A4

3.2.3 Pilbara Olive Python

3.2.3.1 Habitat

Habitat for the Pilbara Olive Python was classified in three categories:

- Critical Habitat (critical to the survival of the species)
- Potential Habitat (species might use this habitat as travel ground)
- Desktop assessed/inaccessible for ground truthing

An overall assessment of habitat for the Pilbara Olive Python within the Project area determined it to be of moderate to excellent condition. This species can travel long distance between suitable habitat and available food sources and, therefore, the species can be recorded from areas of 'Potential Habitat'. However, 'Critical Habitat' for this species consists of semipermanent water pools within rocky gorges and large permanent pools with thick vegetation along gorges which was observed in the North Star Project area. Some suitable habitat was found in the proposed infrastructure corridor in form of pools along the Turner River. Due to existing heritage sites along this river and the low impact of the proposed infrastructure corridor, the Turner River was not surveyed in detail during the current survey.

In total, 1045.28 ha of habitat was recorded within the Project area and mapped in Figure 3.22. Of this, 432.0 ha were classified as critical habitat of good to excellent condition and targeted during searches. This habitat comprised creek lines with pools and rock faces and permanent water pools with or without vegetation along rocky gorges running east-west off the ridges within the North Star mining area and in the north and south of the proposed mine areas (Figure 3.20). A further 520.7 ha were classified as potential habitat. This comprised cliffs, dry rock faces and creek lines without rock faces. Due to inaccessibility, the remaining 92.5 ha were desktop assessed to be potential Pilbara Leaf-nosed Bat habitat by aerial photography, vegetation description and landsystems. An assessment of this habitat through ground truthing to classify if the areas are critical to the species or potential travel ground was not possible.

Table 3.7 – Area of Pilbara Leaf-nosed Bat habitat within the Project area

Classification	Area (ha)
Critical Habitat	432.0
Potential Habitat	520.7
Desktop Assessed/Inaccessible	92.5
Total	**1045.28**



Figure 3.21 – Suitable Habitat for Pilbara Olive Python Present within the Project area

685000 690000 695000 700000 705000 710000 715000 720000

7665000
7660000
7655000
7650000
7645000

Legend

- Project Area
- Proposed Infrastructure Areas

Targeted Survey Sites

- Trapping
- Opportunistic Searches
- Motion Camera
- Nocturnal Searches

Potential habitat for the Pilbara Olive Python

- Critical habitat
- Potential habitat
- Desktop assessed / inaccessible

N

0 2 4
Kilometres

Absolute Scale - 1:100,000

ecologia ENVIRONMENT

FMG Fortescue The New Force in Iron Ore

Pilbara Olive Python Habitat within the Project Area

Figure: 3.22
Project ID: 1373

Drawn: AH
Date: 08/11/11

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

Unique Map ID: AH390

A3

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3.2.3.2 Targeted Searches

Secondary evidence of the Pilbara Olive Python was recorded from three locations within the Project area during the current survey (Figure 3.24). A relatively fresh sloughed skin was found next to a water pool in a rocky gully running east-west off the tenements ridge. Remains of a dead individual and a potential scat pile were found within the proposed infrastructure areas near permanent pools (Table 3.8).

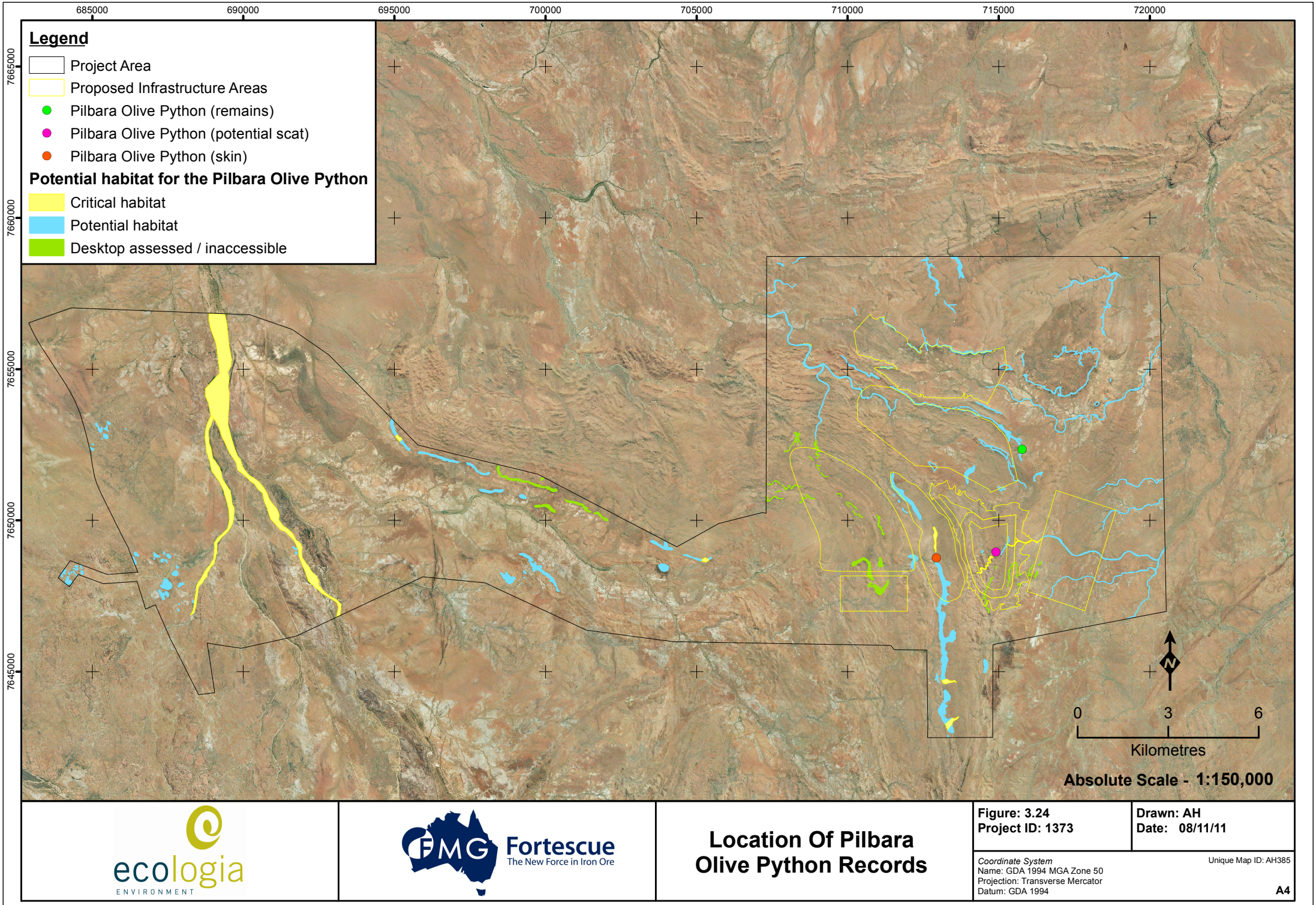


Figure 3.23 – Pilbara Olive Python Remains and Potential Scats (from top to bottom)

Table 3.8 – Pilbara Olive Python Record Information

Record	Date	Coordinates	
		Easting	Northing
Sloughed skin	14/07/11	712944	7648754
Remains	25/07/11	715787	7652345
Potential Scats	29/07/11	714916	7648959

Datum: WGS84
Zone: 50K



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FMG Fortescue The New Force in Iron Ore

Location Of Pilbara Olive Python Records

Figure: 3.24
Project ID: 1373

Drawn: AH
Date: 08/11/11

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

Unique Map ID: AH385

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3.3 SURVEY LIMITATIONS

Limitations of the current survey are summarised in Table 3.9 below. Given the few limitations encountered, it can be confirmed that an adequate level of survey has been undertaken.

Table 3.9 – Summary of Survey Limitations

Constraint	Relevant (yes/no)	Comment
Competency/experience of the consultant carrying out the survey.	No	All staff were experienced in Northern Quoll trapping and bat survey techniques, with survey staff conducting Northern Quoll monitoring surveys and using bat recorder (Anabat 2 system and SM2Bat) over the past 4 years. SM2 recordings were analysed by Bob Bullen (bat call analysis expert). Pilbara Olive Python scats were identified by experienced staff.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	Weather conditions during the North Star survey were mainly cold and wet. Northern Quolls and Pilbara Leaf-nosed Bats were surveyed adequately. Further targeted searches for the Pilbara Olive Pythons were conducted during the Phase 2 Level 2 survey.
Proportion of fauna identified, recorded and/or collected.	No	Fauna was identified by *ecologia* staff in the field. SM2 recordings were analysed by Bob Bullen (bat call analysis expert).
Sources of information (previously available information as distinct from new data).	No	The majority of regional records of conservation significant fauna is of recent history.
The proportion of the task achieved and further work which might be needed.	No	All accessible areas were surveyed adequately and impacts of the proposed Project can be adequately assessed.
Timing/weather/season/cycle.	No	Weather conditions were cold and rainy during the first phase Level2 North Star survey and warm and sunny during the infrastructure areas survey. However, the activity of Northern Quolls and Pilbara Leaf-nosed Bats were not impacted or reduced. Pilbara Olive Python may have been less active and, therefore, the likelihood to encounter the species within the North Star Project area was reduced. The second phase of the Level 2 survey was conducted in October when conditions are warmer and Pilbara Olive Pythons are more active.
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	No	No disturbances affected the survey results.
Intensity (in retrospect was the intensity adequate).	No	Traps were set up in all Northern Quoll habitats suitable for trapping. A total of 172 cage traps were used to determine the presence and abundance of Northern Quolls, which is in excess of the recommended survey intensity.
Completeness (e.g. was relevant area fully surveyed).	No	Habitat of good and medium quality was adequately surveyed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	Staff were experienced in targeted Northern Quoll and bat surveys and targeted searches for Pilbara Olive Pythons in the Pilbara region.

Constraint	Relevant (yes/no)	Comment
Remoteness and/or access problems.	Yes, partially	A total of 94.9 ha of potential Northern Quoll habitat were inaccessible and not trapped. Potential Pilbara Olive Python habitat of a total of 92.5 ha was not accessible for targeted searches. However, these areas were considered as potential habitat as a precautionary measure.
Availability of contextual (e.g. biogeographic) information on the region).	No	Background information of the Pilbara region is available and known.

4 DISCUSSION

Of the 89 Northern Quoll records within a 50-km radius of the Project area, 20 (22.4%) were recorded from within the Project area directly during the current survey (NatureMap, WA Museum, ecologia internal database). This represents 15.75% of the 127 records currently known from the Pilbara (NatureMap).

NatureMap lists seven records of the Pilbara Leaf-nosed Bat within 50 km of the Project area. This species was recorded from 14 locations within the North Star Project area during this survey, which represents twice as many records within the proposed mining area and infrastructure corridor than previously recorded in the region.

Secondary evidence of the Pilbara Olive Python was recorded from three locations during this survey. With six records of Pilbara Olive Python in the region (within 50 km, NatureMap) the North Star Project area comprises a third of the records in the vicinity (Figure 3.4, Figure 3.5), particularly in the proposed North Star Mining area. The paucity of records could be a reflection of relative low survey effort in the area. A regional survey of Pilbara Olive Python would provide further information on the significance of the Project area for the Pilbara Olive Python.

Given that not all areas of suitable habitat were surveyed due to inaccessibility, additional Northern Quolls and Pilbara Leaf-nosed Bats are anticipated to inhabit the Project area. This indicates that the populations of these species may be locally and regionally significant. DSEWPaC's Significant Impact Criteria, intended to assist in determining whether the impacts of a proposed action on any matter of national environmental significance are likely to be significant impacts, are addressed in Table 4.10.

4.1 NORTHERN QUOLL

Four of the 20 Northern Quoll individuals captured were female. Females are known to have significantly smaller home ranges than males as they do not roam prior to the breeding season, as male Northern Quolls do (Oakwood 2008). As such, the presence of females in the Project area indicated a permanent breeding population inhabiting the North Star Project area, and the females were unlikely to have moved into the area from the surrounding region given their smaller home ranges. Male Northern Quolls adopt a roaming strategy during the breeding season which is expected to have resulted in the increased number of males recorded (sex ratio of 4:1). However, 65% of all individuals trapped and marked in the proposed mining area were recaptured after 1-3 nights, indicating that the population in this area is relatively sedentary (Figure 3.15). Due to the large number of individuals recaptured along the ridge within the Project area, traps were closed after six nights of trapping to reduce the impact on trapped individuals such as reduced foraging time and stress through trapping and handling. The number of traps installed for this survey was higher than the recommended number of traps deemed adequate by DSEWPaCs survey guidelines for Northern Quolls. Therefore, the trapping effort was deemed adequate.

One male (North Star Male #1) was recaptured on each of the seven trapping nights, in different traps (nearby traps were closed when individuals were recaptured; however, individuals moved along the ridge to more distant traps). Three of these captures were within 200 m of individual North Star Female #6. Captures of this male indicated he was travelling (up to 0.8 km in one night) southwards of the original capture location, along the same ridge. Another male (Additional Area, male#5) displayed roaming strategy during the survey. He was recaptured after one night at a location 2.6 km from the location of first capture. The long distances some males travelled could indicate that a

number of male Northern Quolls were moving in and out of the Project area, utilising a variety of habitats.

The Chichester Range, to the north of the Project area, is known to provide suitable Northern Quoll habitat which is reflected by the high number of records (87%) in the Chichester IBRA subregion (NatureMap, *ecologia* internal database, Figure 3.4). Records are known from the east and north-east of the Project area which indicates that this region may represent a large population of Northern Quoll in the Pilbara. Although it is difficult to adequately interpret the significance of the populations in the Project area due to the limited published survey reports in the surrounding area, the suitability of the habitat within the ridges and gorges of the Project area is considered excellent.

4.2 PILBARA LEAF-NOSED BAT

Pilbara Leaf-nosed Bats were recorded from 14 locations within the Project area. Based on the call pattern recorded from four of the locations the recordings were likely to be recordings of bats foraging in the vicinity of their roosting cave. These records indicated that the western cliff edges might provide important habitat for this species and might represent critical habitat and/or significant populations of this species.

Due to the limited number of previous records and fauna surveys, the significance of this area as critical habitat for Pilbara Leaf-nosed Bats cannot be easily determined. However, sightings, recordings and roost caves are not commonly detected in the Pilbara which indicates that there is a high likelihood that the Project area is an important refuge for the Pilbara Leaf-nosed Bat.

4.3 PILBARA OLIVE PYTHONS

Pilbara Olive Pythons are known to have an increased activity pattern in the warmer months. The weather conditions during the targeted survey at North Star were cold and partially rainy and thus not optimal for the python's activity. However, a sloughed skin was recorded from critical habitat, although no individual was observed. The remains of one Pilbara Olive Python and potential scats were found during the survey. Further targeted searches are to be conducted during the 2nd phase of the Level 2 North Star Project area survey in October 2011 when temperatures are warmer and the activity of this species is increased. The results are to be summarised in the Level 2 survey report.

Despite the low number of records during the survey, a large area (432.0 ha) of critical habitat (suitable foraging and breeding habitat) was present within the Project area. The habitat comprised rocky gorges with semipermanent or permanent water pools and large creek beds which represented a significant area for this species.

Table 4.10 – Relevance of the Significant Impact Criteria (DEWHA 2006)

Significant Impact Criteria	Relevance
Long-term decrease in the size of a population	Yes Project will impact a large area of important suitable habitat for all three EPBC listed species thus resulting in a reduced local population size. Surrounding area needs to be assessed to compare significance of the Project area.
Reduction in the area of occupancy of the species	Yes/No Pilbara Leaf-nosed Bats will potentially lose several roost caves. Pilbara Olive Pythons could potentially lose several areas of hunting and refuge habitat Northern Quolls are likely to colonise disturbed areas and mine camps.
Fragmentation of an existing population into two or more populations	No Some remnant corridors of habitat remain connecting populations in the region.
Adverse affect to habitat critical to the survival of a species	Possibly Suitable roost caves are required by Pilbara Leaf-nosed Bats and the loss of caves within the Project area may adversely impact the regional populations.
Disruption to the breeding cycle of a population	Possibly Loss of roost caves will impact the seasonal cycle of Pilbara Leaf-nosed Bats and potentially reduce the availability of suitable denning habitat for breeding Northern Quolls.
Modification, destruction, removal, isolation or reduction to the availability or quality of habitat to the extent that the species is likely to decline	Yes The Project area contains approximately 294.4 ha of suitable Northern Quoll denning habitat, 712.94 ha potential roost habitat for the Pilbara Leaf-nosed Bat and 432.0 ha of critical habitat for the Pilbara Olive Python. Regional records of the Pilbara Leaf-nosed Bat and Pilbara Olive Python are very limited and, therefore, the loss of these areas is anticipated to result in a decline of this species on a local level. Impacts on a regional level are unknown.
Establishment of invasive species that are harmful to an endangered species in the endangered species' habitat	No No introduced fauna harmful to the three targeted species was recorded from the Project area.
Introduction of disease that may cause the species to decline	No No diseases are expected to be introduced.
Interference with the recovery of the species	Yes Suitable roost and denning habitat appears to be limited to a few areas of the Pilbara. Loss of this habitat will reduce the total possible population size of Pilbara Leaf-nosed Bats and Northern Quolls as suitable roost caves and denning habitat is critical to this species survival during the dry cool winter months and the breeding season. Critical habitat for the survival of the Pilbara Olive Python is limited to gorges and rocky waterpools.

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6 CONCLUSION

A targeted conservation significant (EPBC list species) vertebrate fauna survey was conducted, conforming to relevant guidelines and best practice, within the North Star Project area. The main conclusions of this targeted survey were:

- Three EPBC listed conservation significant fauna species, Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python were recorded within the Project area. A single DEC Priority 4 listed species (Ghost Bat) was also recorded within the Project area.
- Twenty Northern Quoll individuals were recorded from within the Project area, mainly within the proposed mining areas. Northern Quolls were recorded at and additional three locations using motion cameras, and three locations from secondary evidence.
- 900.7 ha of suitable Northern Quoll habitat were identified from within the Project area. 294 ha of this habitat were confirmed as suitable denning habitat, with the remaining habitat classed as foraging and/or dispersal habitat.
- Pilbara Leaf-nosed Bats were recorded from 14 locations within the Project area. Based on analysis of the timing of the call density peaks, four of these locations were considered to be associated with roost cave locations. The majority of records were from the proposed North Star mining area and infrastructure areas and consisted of gorge habitat with permanent water.
- 712 ha of suitable Pilbara Leaf-nosed Bat habitat was identified from within the Project area. 294 ha of this habitat consisted of potential roost cave habitat, which was considered highly important and uncommon in the Pilbara region.
- Secondary evidence of Pilbara Olive Python was recorded from three locations within the Project area. Remains of one individual, a sloughed skin and a single scat were recorded from within the mining and infrastructure areas.
- 1045 ha of suitable Pilbara Olive Python habitat was identified from within the Project area. 432 ha is considered critical habitat and consists of rocky gorges or cliff faces with permanent surface water.

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APPENDIX A EXPLANATION OF CONSERVATION CODES

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

Conservation Code	Definition
Extinct (EX)	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the wild (EW)	A species is categorised as extinct in the wild if it is only known to survive in cultivation, in captivity or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	The species is facing an extremely high risk of extinction in the wild in the immediate future.
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.
Conservation Dependent (CD)	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming Vulnerable, Endangered or Critically Endangered within a period of five years.

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

Schedule	Definition
Schedule 1 (T)	*Threatened Fauna* (Fauna that is rare or is likely to become extinct) *Threatened Flora* (Declared Rare Flora - Extant) http://www.dec.wa.gov.au/content/view/852/2010/1/1/ - Taxa-defn Taxa that have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
Schedule 2 (X)	*Presumed Extinct Fauna* *Presumed Extinct Flora* (Declared Rare Flora – Extinct) Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
Schedule 3 (IA)	*Birds protected under an international agreement* Birds that are subject to an agreement between governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4 (S)	*Other specially protected fauna* Fauna that is in need of special protection, otherwise than for the reasons mentioned in the above schedules.

Appendix A3 Definition of DEC Threatened and Priority Codes.

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

APPENDIX B MORPHOMETRIC DATA FROM CAPTURED INDIVIDUALS

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Quoll ID	Sex	Date of Capture	Trap No.	Easting	Northing	Weight (g)	Short Pes (mm)	Head (mm)	Caudal Width (mm)	Reproduction Status	WAM Tissue No.	Condition
North Star												
1	Male	08-Jul-11	C04	711537	7651137	705	33.2	77.3	17.5	No signs of fighting	TM381	5 - Excellent. Thick coat
		09-Jul-11	C13	712167	7650597							
		10-Jul-11	C11	712029	7650678	695						
		11-Jul-11	C11	712029	7650678	680						
		12-Jul-11	C13	712167	7650597							
		13-Jul-11	C11	712029	7650678							
		14-Jul-11	C11	712029	7650678	650						
2	Male	08-Jul-11	C06	711648	7651037		32.7	70.1	13.5	Thin fur, few signs of fighting	TM382	3 - Good. Some fur missing
		10-Jul-11	C06	711648	7651037	615						
		12-Jul-11	C02	711578	7651211							
3	Male	09-Jul-11	C28	713394	7643895	590	35.6	71.3	15.5	No signs of fighting	TM383	5 - Excellent.
		10-Jul-11	C28	713394	7643895							
		11-Jul-11	C31	713490	7643914							
		12-Jul-11	C29	713410	7643903							
		13-Jul-11	C32	713551	7643910							
		14-Jul-11	C30	713423	7643918	600						
4	Male	10-Jul-11	C36	713311	7644664	727	36.1	80	15.6	No signs of fighting	TM384	5 - Excellent. Coat thick with no patches, some fat
		11-Jul-11	C37	713278	7644659							
		12-Jul-11	C39	713233	7644651							
		13-Jul-11	C36	713311	7644664							
		14-Jul-11	C37	713278	7644659	715	36.9					

Quoll ID	Sex	Date of Capture	Trap No.	Easting	Northing	Weight (g)	Short Pes (mm)	Head (mm)	Caudal Width (mm)	Reproduction Status	WAM Tissue No.	Condition
5	Male	10-Jul-11	C23	712918	7648805	595	34.6	70.9	16.4	No signs of fighting	TM385	5 - Excellent.
		11-Jul-11	C24	713028	7648914							
		12-Jul-11	C23	712918	7648805							
		13-Jul-11	C22	712893	7648932							
6	Female	10-Jul-11	C10	711957	7650706	330	30.8	63.5	15	Pouch not developed	TM386	5 - Excellent
		12-Jul-11	C11	712029	7650678							
		14-Jul-11	C13	712167	7650597							
7	Male	11-Jul-11	C03	711476	7651205	630	35.4	75	17.1	No signs of fighting	TM387	5 - Excellent, lots of Fat
		12-Jul-11	C03	711476	7651205							
		13-Jul-11	C02	711578	7651211							
8	Male	11-Jul-11	C47	713117	7646259	605	34.5	78.5	13.4	No signs of fighting	TM388	5 - Excellent, some fat, no missing fur
		12-Jul-11	C47	713117	7646259							
		13-Jul-11	C48	713098	7646325							
9	Female	11-Jul-11	C36	713311	764466	320	32.1	59.2	14.8	Pouch not developed	TM388	5- Excellent, not much fat
10	Male	13-Jul-11	C14	712257	7650549	778	40	75.7	18.5	No signs of fighting	TM390	5 - Excellent, some fat, no missing fur
		14-Jul-11	C14	712257	7650549							
Additional Area												
1	Male	25-Jul-11	C135	718348	7655633	660	35.9	83.2	N/A	No signs of fighting	TM391	4 to5
2 D	Male	27-Jul-11	C75	713229	7657185	795	35.2	74.3	17.9	No sign of fighting	TM392	4

Quoll ID	Sex	Date of Capture	Trap No.	Easting	Northing	Weight (g)	Short Pes (mm)	Head (mm)	Caudal Width (mm)	Reproduction Status	WAM Tissue No.	Condition
2 B	Male	27-Jul-11	C140	718069	7655602	575	35.8	68	N/A	No signs of fighting	TM393	4 to5
3	Female	25-Jul-11	C124	718914	7658171	385	33	62.6	N/A	Pouch not developed	TM394	4 to5
4	Female	25-Jul-11	C127	718680	7658073	405	30	68.5	N/A	Pouch not developed	TM395	4 to5
		28-Jul-11	C132	718628	7658202	400						
5	Male	26-Jul-11	C140	718069	7655602	690	36.6	74.6	N/A	No signs of fighting	TM396	4 to 5
		27-Jul-11	C139	718134	7655582	705						
		28-Jul-11	C128	718659	7658149	685						
		29-Jul-11	C126	718765	7658124	680						
6	Male	26-Jul-11	C124	718914	7658171	800	36.6	80.8	N/A	No signs of fighting	TM397	4 to 5
		27-Jul-11	C127	718680	7658073	780						
		28-Jul-11	C126	718765	7658124	830						
		29-Jul-11	C128	718659	7658149							
7	Male	29-Jul-11	C124	718914	7658171	730	37.6	78.2	N/A	No signs of fighting	TM398	4 to 5
8	Male	27-Jul-11	C126	718765	7658124	610	36.2	75	N/A	No signs of fighting	TM399	4 to 5
		29-Jul-11	C127	718680	7658073	625						
9	Male	24-Jul-11	C127	718680	7658073	655	36.8	74.5	N/A	No signs of fighting	TM400	4 to 5

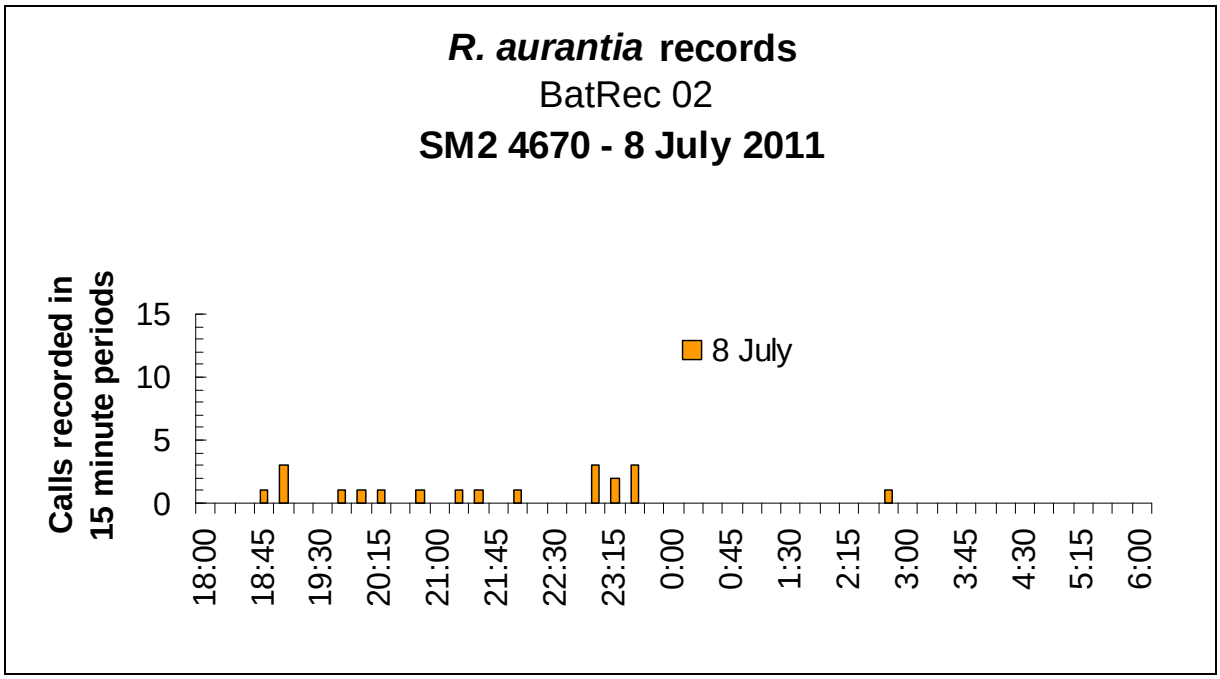
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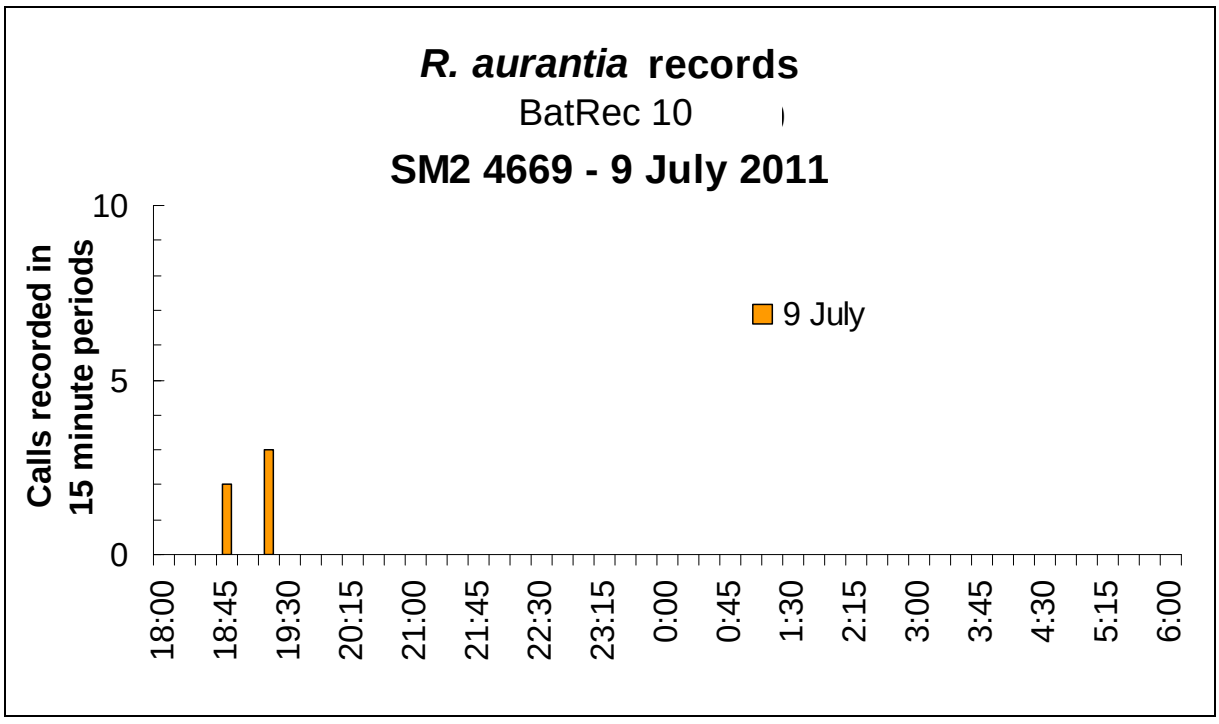
APPENDIX C RECORDED CALL PATTERN PILBARA LEAF-NOSED BAT (EXAMPLES)

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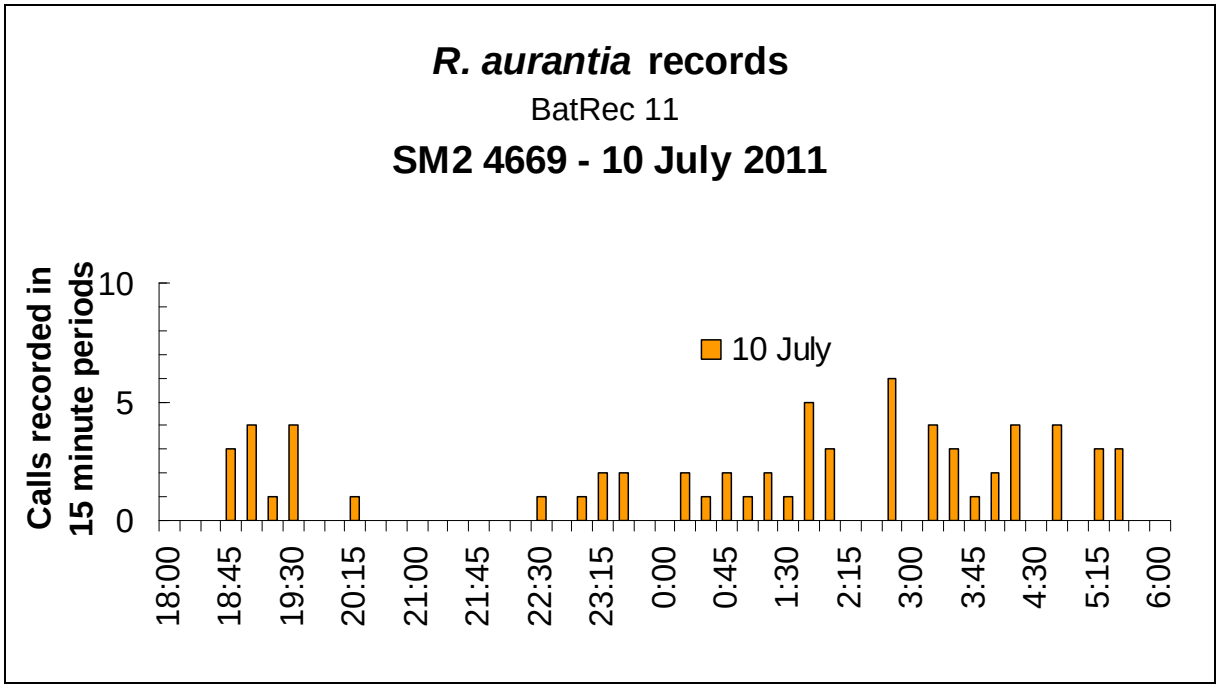
Appendix C1



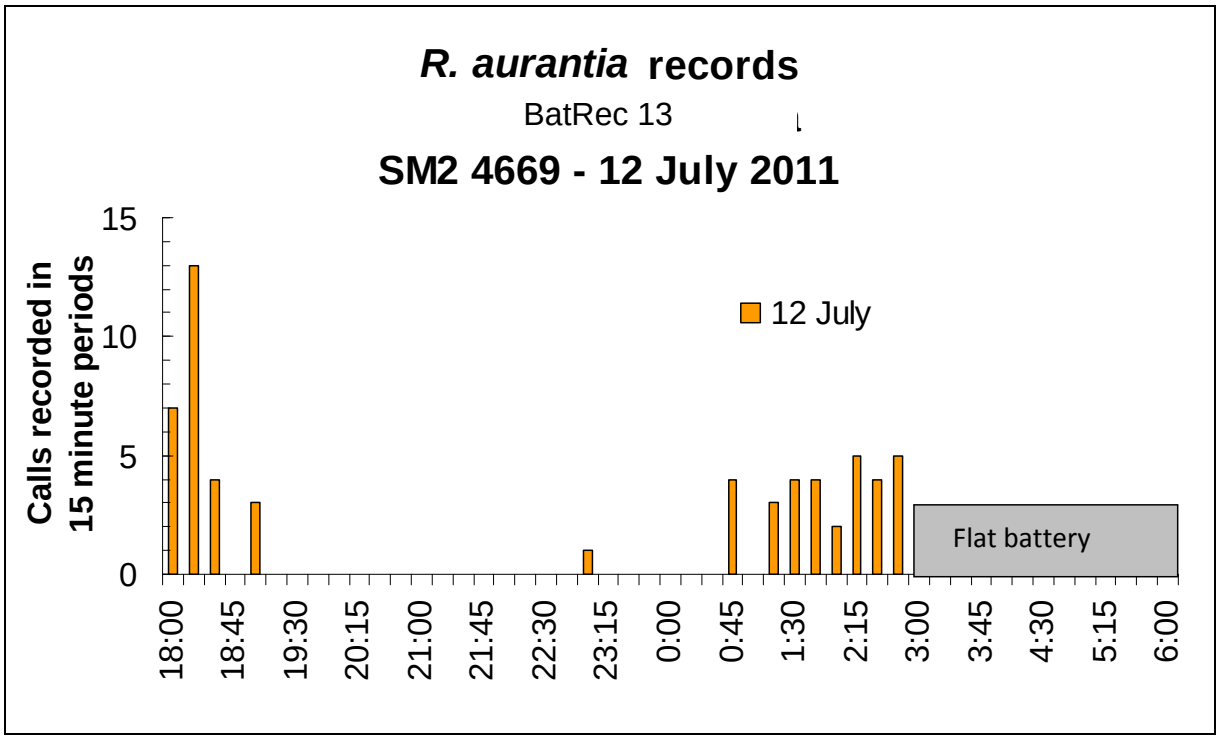
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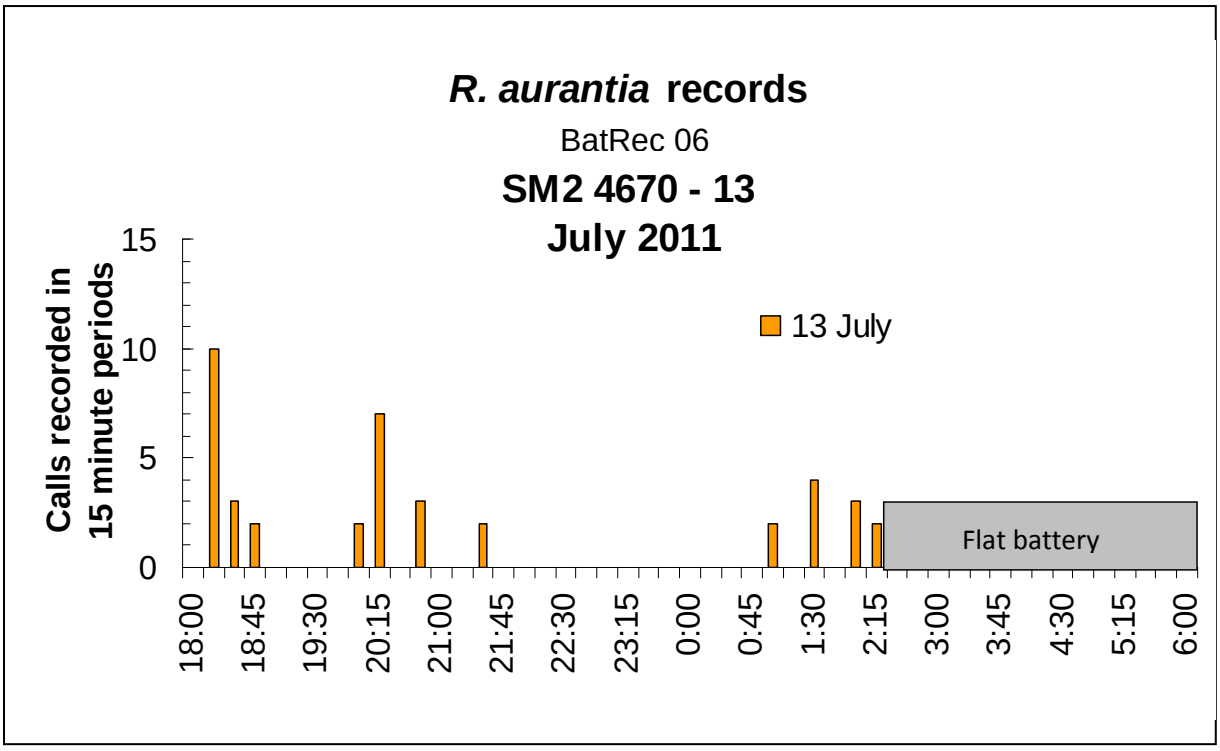
Appendix C3



Appendix C4



Appendix C5



Appendix C6

