Pilbara Iron Ore Project – Blacksmith Vertebrate Fauna and Short Range Endemic Survey

Flinders Mines Limited

science+design

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acronyms

Acronyms used in this report are listed below.

BOM – Bureau of Meteorology

DAFWA – Department of Agriculture and Food Western Australia

DEC – Western Australian Department of Environment and Conservation

DEWHA – Commonwealth Department of the Environment, Water, Heritage and the Arts

DSEWPAC – Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (formerly DEWHA)

EPA – Environmental Protection Authority

EPBC Act – *Environment Protection and Biodiversity Conservation Act (1999)*

FML – Flinders Mines Limited

IBRA - Interim Biogeographical Regionalisation for Australia

OHS – Occupational Health and Safety

SRE – Short Range Endemic species

WAM – Western Australian Museum

WC Act – *Wildlife Conservation Act (1950)*

acknowledgements

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- FML staff for field logistics and Occupational Health and Safety (OHS) advice
- Worley Parsons for project management and providing their desktop data and findings

summary

The Flinders Mines Limited (FML) iron ore exploration tenement (E47/882) is located in the Shire of Ashburton in the Pilbara region of Western Australia. It contains five sites, which FML propose to mine referred to as Blacksmith (**Map 1**). Worley Parsons Pty Ltd was engaged by FML to undertake a study to determine the feasibility of obtaining the necessary engineering and environmental approvals to mine these sites. Ecoscape was engaged to undertake the biological baseline surveys needed for the environmental component of this study. These involved surveys of vertebrate fauna and short range endemic (SRE) invertebrates. The results of these surveys are given in this report.

The objectives of the vertebrate fauna and SRE invertebrate surveys were as follows:

- to undertake a targeted search for conservation significant fauna species, including a desktop assessment and field survey within the Flinders project area
- to evaluate the potential impacts fauna and their habitats
- to deliver results that will form part of the environmental impact assessment for the project, necessary to be assessed by the EPA
- to conduct assessments in accordance with:
    - EPA Guidance Statement No. 56, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*
    - EPA Position Statement No. 3, *Terrestrial Biological Surveys as an Element of Biodiversity reviews* (2002)
    - EPA Guidance Statement No. 20, *Sampling for Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (2009).
- To deliver the results in a form suitable for inclusion in the environmental impact assessment for the mining proposal which will be assessed by the EPA

Fauna surveys of the Flinders project area included:

- a desktop investigation and literature review of relevant previous surveys from the region.
- a fauna assessment of the entire tenement mining area comprising of a reconnaissance survey in June 2010, and a targeted trapping survey in October 2010
- a targeted survey for conservation significant fauna species within the sites FML is proposing to mine.
- a SRE invertebrate survey.

Notable results from the survey included:

- the recording of six conservation significant fauna species, these were the;

- Pilbara Olive Python (*Liasis olivaceus barroni*) *WC Act (1950)* Schedule 1; *EPBC Act (1999)* Endangered
- Northern Quoll (*Dasyurus hallucatus*) *WC Act (1950)* Schedule 1; *EPBC Act (1999)* Endangered
- Pebble-mound Mouse (*Pseudomys chapmanii*) DEC Priority Listed as P4
- a blind snake (*Ramphotyphlops ganei*) DEC Priority Listed as P1
- Ghost Bat (*Macroderma gigas*) DEC Priority Listed as P4
- Rainbow Bee-eater (*Merops ornatus*), EPBC Act (1999) Migratory

- other vertebrate species recorded were predominantly expected.
- impacts to vertebrate fauna from the proposed mining development were assessed as moderate to low, as conservation significant fauna species habitat is predominantly on the slopes and in the gorges, which are outside the areas that will be disturbed by the mining proposal.
- the impacts on SRE invertebrate fauna from the proposed mining were assessed as low as no significant species were recorded from the survey.
- the recent wildfire was found to be sufficiently extensive to have affected the survey results, particularly the medium to large mammal species.

1.0 introduction

1.1 project overview

The Flinders Mines Limited (FML) iron ore exploration tenement, located in the Pilbara region of Western Australia, contains the five sites used for biological baseline survey and which FML propose to mine. Worley Parsons Pty Ltd was engaged by FML to undertake a-study to determine the feasibility of obtaining the necessary engineering and environmental approvals to mine these sites. Ecoscape was engaged to undertake the biological baseline surveys needed for the environmental component of this study. These involved surveys of vertebrate fauna and short-range endemic (SRE) invertebrates. The results of the vertebrate fauna and SRE invertebrates are given in this report.

FML is proposing to mine five sites on their iron ore exporation tenement E47/882, in the Pilbara region of Western Australia. They commissioned Worley Parsons Services Pty Ltd to complete a pre-feasibility study and approvals package in pursuit of approval to mine these nominated sites. A desktop study identifying environmental and social impacts has previously been completed, and a hydrological study is in progress.

The EPA requires this mining proposal to include a Level 2 fauna assessment (*EPA Guidance Statement No. 56 Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* 2004) to assess possible impact on:

- fauna habitats
- faunal assemblages
- Threatened and Priority Fauna
- short-range endemic invertebrate fauna
- bats
- avifauna

Ecoscape undertook both the flora and fauna aspects of this biological survey. Research included a desktop investigation, preliminary survey and a targeted trapping survey

A desktop investigation, including a review of previous regional survey data, was undertaken immediately on engagement. This was followed by a preliminary survey in June 2010, of approximately 6 days length, to establish sampling locations and conduct a preliminary non-invasive Level 2 survey using experts in the field. A more targeted trapping survey was undertaken in October 2010 where more invasive techniques were required to determine the presence of species, particularly conservation significant fauna. A Northern Quoll (*Dasyurus hallucatus*) cage trapping survey was also undertaken in July 2010.

Fauna surveys of the study area included:

- a fauna assessment of the entire tenement mining area comprising of a preliminary survey in June 2010, and a targeted trapping survey in October 2010.
- a Northern Quoll survey within the proposed mining production areas.
- a SRE invertebrate Survey.

1.1.1 LEGISLATIVE FRAMEWORK

The following legislation is relevant to this project:

- *Environmental Protection and Biodiversity Conservation Act (1999)*
- Western Australian *Wildlife Conservation Act (1950)*
- Western Australian *Environmental Protection Act (1986)*.

The following EPA Guidance and Position Statement documents were also referred to for survey method and adequacy:

- EPA Guidance Statement No. 56, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*
- EPA Position Statement No. 3, *Terrestrial Biological Surveys as an Element of Biodiversity Protection*

1.2 study area

1.2.1 DESCRIPTION

The study area is on tenement (E47/882) held by FML in the Hamersley Ranges of the Pilbara Region of Western Australia. This Pilbara Iron Ore Project has been given the name of Blacksmith and is divided into five main valleys proposed for mining production.

Exploration has identified five main areas of inferred iron ore resources in the Blacksmith tenement, known as Ajax, Blackjack, Champion, Delta and Eagle, with Delta likely to be the first area to be developed. Two smaller areas within the tenement, known as Paragon and Badger, were also included in the field survey (**Map 1, Appendix One**).

Approximately 80% of the study area was recently completely burnt by wildfire. The hill tops, some slopes, gorges and most of the valley floors were affected. This effectively reduced the available habitat that could be sampled and results could be skewed due to species congregating in remaining vegetation or dying and dispersing.

The Blacksmith tenement is an area of tall ranges intersected by drainage channels and is typical of the Hamersley Ranges in geology and vegetation types. *Eucalyptus* sp. and *Corymbia* sp. Low Open Woodlands over *Triodia* Hummock Grasslands dominate the landscape with scattered clumps of shrublands in the valley floors.

1.2.2 LOCATION

The Blacksmith tenement is located within the Mt Sheila locality in the Shire of Ashburton, approximately 70 km north-north-west of Tom Price, in the Pilbara region (**Figure 1**).

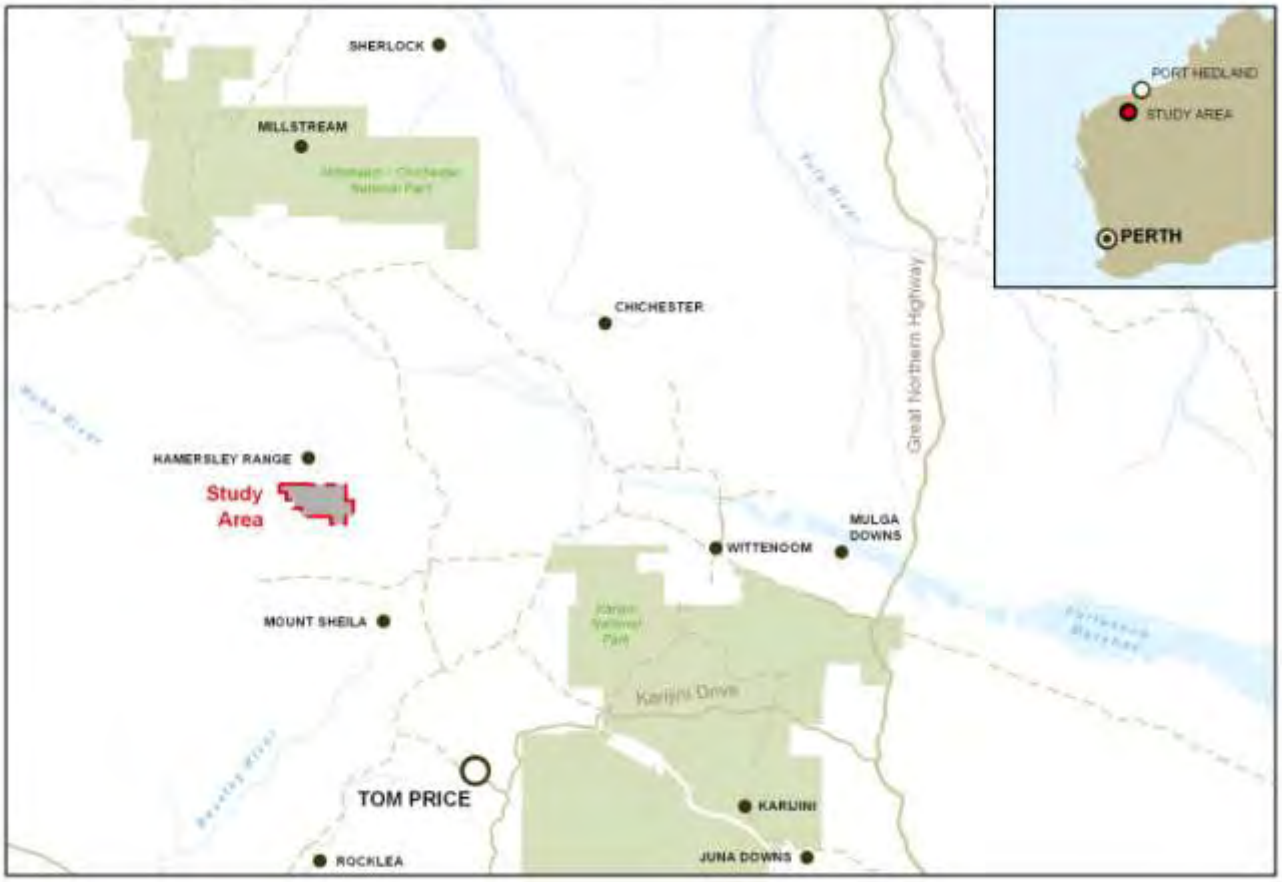

Figure 1 Flinders study area.

1.3 survey objectives

The survey methods adopted broadly follow the guidelines described in the EPA *Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002) and Ecoscapes interpretation of the EPA's *Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

When a development is likely to have a moderate or high impact, the EPA requires a detailed and comprehensive on-site fauna survey in addition to a desktop study. Factors that lead to an impact being potentially moderate or high include:

- the size of the area to be impacted (e.g. 10-50 ha is moderate, and >50 ha is high)
- the potential for rare or range restricted fauna in the area
- the area containing habitat of ecological or conservation significance

- the area serving as an ecological refuge for fauna species or
- the area supporting populations of statutory protected species (e.g. those listed under JAMBA, CAMBA and ROKAMBA treaties).

The objectives of the Fauna Survey were as follows:

- to undertake a targeted search for conservation significant fauna species, including a desktop assessment and field survey within the Flinders project area, satisfying the requirements of an EPA Level 2 survey as stated in Guidance Statement No. 56
- to evaluate the potential impacts to fauna habitats and individual species
- to deliver results that will form part of the final environmental impact assessment for the mining proposal
- to conduct assessments in accordance with:
    - EPA Guidance Statement No. 56, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (2004)*
    - EPA Position Statement No. 3, *Terrestrial Biological Surveys as an Element of Biodiversity protection (2002)*
    - EPA Guidance Statement No. 20, *Sampling for Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia (2009)*.

To achieve these objectives the following scope of works was undertaken:

- a search of the Commonwealth Government's Protected Matters on-line database to identify fauna species of national environmental significance that are protected under the EPBC Act (1999) and potentially occurring in the study area
- a review of the NatureMap database to identify potential vertebrate fauna in the study area
- a review of the Department of Environment and Conservation (DEC) Threatened and Priority species database for species of conservation significance likely to be in the study area
- a review of published and unpublished literature that Ecoscape could access to provide;
    - a list of fauna that could potentially occur in the study area
- a field survey incorporating trapping, spotlighting, bat echolocation recordings and opportunistic observations
- an analysis of all data collected at the project area, including data collected by Coffey Environments
- an inventory and description of the trappable vertebrate fauna assemblage recorded in the Project area during the survey period, including conservation significant species
- a comparison of the fauna assemblage in the project area with data from other surveys in the region and discussion of the potential impacts of the development on fauna and fauna habitat management with the formulation of recommendations to minimise potential impacts of the development on the fauna.

2.0 existing environment

2.1 regional context

The study area predominantly lies within the Hamersley subregion (PIL3). This subregion is part of the Pilbara Bioregion of the IBRA classification system (Environment Australia 2000; McKenzie *et al.* 2003) (**Map 2**). The Pilbara Bioregion falls within the Bioregion Group 2 classification of EPA (2004). This group is described as:

"*Bioregions of the Eremaean Botanical Province, native vegetation is largely contiguous but is used for commercial grazing*."

Key threatening processes identified for fauna species at risk include habitat changes associated with land use, feral predators and grazing. Various other plant, mammal, reptile and bird species are listed as priority species and have similar processes threatening them with the addition of mining, changes to hydrology, weeds and changed fire regimes (McKenzie *et al.* 2003).

2.2 physical environment

2.2.1 CLIMATE

The Pilbara region experiences an arid climate which is influenced by two air masses, the Indian Tropical Maritime air moving in from the west or north-west, and the tropical continental air from the inland. During the warmer part of the year (November to February), there is a hot low-pressure system over the region resulting in and very high temperatures with average maxima generally between 35°C and 40°C. During the winter months the average maximum temperature generally falls to between 22°C and 30°C, the range of which is generally greater in inland areas away from the moderating effects of onshore winds common in coastal areas during winter (DEWHA 2009).

The Pilbara lies south of the area normally penetrated by the northwest monsoon in the summer months, and is only occasionally influenced by weather systems of the westerly circulation in the winter months. Rainfall is therefore low and variable, with an annual average of 200-350mm. The majority of rainfall occurs between December and March, as the result of moist tropical storms and cyclones originating in the north, with a pronounced dry period between August and November. Tropical cyclones contribute 40% - 60% of the rainfall on the northern coast, with falls reducing to as little as 30% in the south and east of the region.

Figure 2 outlines monthly rainfall and temperature averages from the Bureau of Meteorology (BOM) site located at Tom Price derived from data collected between 1950 and 2010.

The average yearly evaporation (about 2,500mm) exceeds average yearly rainfall. This is consistent throughout the year.

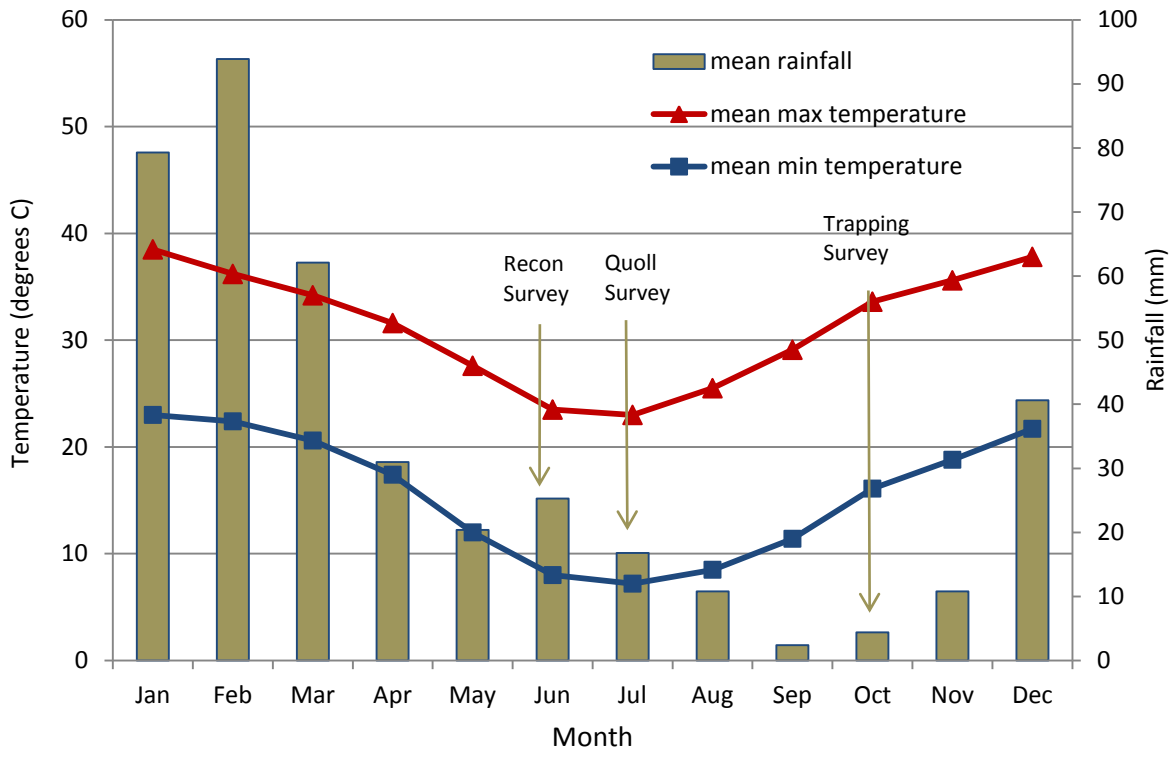

Figure 2 Mean monthly rainfall and daily maxima and minima temperatures for Tom Price BOM site (1950-2010).

2.3 landscape description

2.3.1 LAND SYSTEMS

The Department of Agriculture and Food WA (DAFWA), as part of the rangeland resource surveys, has comprehensively described and mapped the biophysical resources of the Pilbara region, together with an evaluation of the condition of the soils and vegetation throughout (Van Vreeswyk et al. 2004b). As part of this process an inventory of land types, land systems and land units with particular use capabilities, habitats or conservation values was established to assist in land use planning. According to this mapping, the following land systems, grouped according to land type, occur within the study area (**Table 1**).

Table 1 Land systems within the FML tenements.

Land Type	Land System Name and Description
Land type 1 - Hills and ranges with spinifex grasslands	Newman - Rugged ironstone ridges, plateaux and mountains; hard spinifex pastures in good to excellent condition; no erosion.
Land type 5 - Dissected plains with spinifex grasslands	Platform - Dissected slopes and raised plains supporting hard spinifex grasslands.
Land type 8 - Stony plains with spinifex grasslands	Boolgeeda - Stony lower slopes and plains below hill systems; not degraded or eroded.

Regionally, the study area represents only a minimal proportion of the land systems that it encompasses, with all systems represented by less than 0.5% of their regional extent.

Similar land systems are grouped into land types on the basis of a combination of landform, soil, vegetation and drainage characteristics. This grouping allows for more accurate interpretation of information when considered at a regional scale.

2.3.2 DRAINAGE

There are numerous small ephemeral drainage channels occurring within the study area, none can be considered major watercourses. There is a permanent channel in Ajax that supports water holes and is therefore significant as a source of shelter and food resources for fauna (**Map 1**).

2.4 biological environment (flora and vegetation)

The Pilbara biogeographic region includes four major components; the Hamersley, Fortescue Plains, Chichester and Roebourne subregions (Thackway and Cresswell 1995). According to this subregional mapping, the Study area is located within the Hamersley subregion (**Figure 1**). Descriptions of this subregion, as outlined in the 2002 Biodiversity Audit of Western Australia's 53 Biogeographical Subregions (McKenzie *et al.* 2003), is provided below.

Hamersley subregion (PIL3):

Described as - Mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by gorges (basalt, shale and dolerite). Mulga low woodland over bunch grasses on fine textured soils in valley floors, and Eucalyptus leucophloia over Triodia brizoides on skeletal soils of the ranges. The climate is semi-desert tropical, average 300mm rainfall, usually in summer cyclonic or thunderstorm events. Winter rain is not uncommon with drainage into either the Fortescue to the north, the Ashburton to the south, or the Robe to the west.

2.4.1 DOMINANT VEGETATION

Beard's Vegetation Mapping

The Study area lies entirely within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). Beard recognised eight different physiographic units within the Fortescue Botanical District, two of which occur within the Study area:

- Hamersley Plateau: a compact unit defined by the outcrop of Lower Proterozoic rocks, predominantly jaspilite and dolomite with some shale, siltstone and volcanic rock. It is bounded by a well-marked abrupt escarpment on its northern, eastern and western flanks, whereas the outcrop on the southern side is more irregular.

Hopkins et al's (2001) vegetation mapping of Pre-European extent, compiled primarily from Beard's (1975) mapping of the Pilbara, outlines that the Study area contains the following vegetation association, grouped according to physiographic unit:

- Hamersley Plateau: Veg Association 82 comprising hummock grasslands, low tree steppe, and snappy gum over Triodia wiseana.

2.4.2 LAND USE HISTORY

The study area is pastoral land currently under exploration and as such it has many tracks cleared for exploration purposes. Grazing activity is still present although the recent fire in February 2010 has reduced this pressure.

2.5 biological environment (fauna)

The Hamersley IBRA subregion (PIL3) is a mountainous area of Proterozoic sedimentary ranges and plateaux, dissected by basalt, shale and dolerite gorges. The valley floors have low Mulga Woodland over bunch grasses on fine textured soils, while the ranges have *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils (McKenzie *et al.* 2003). The study area is considered to occupy the ranges of this subregion (**Figure 3**).

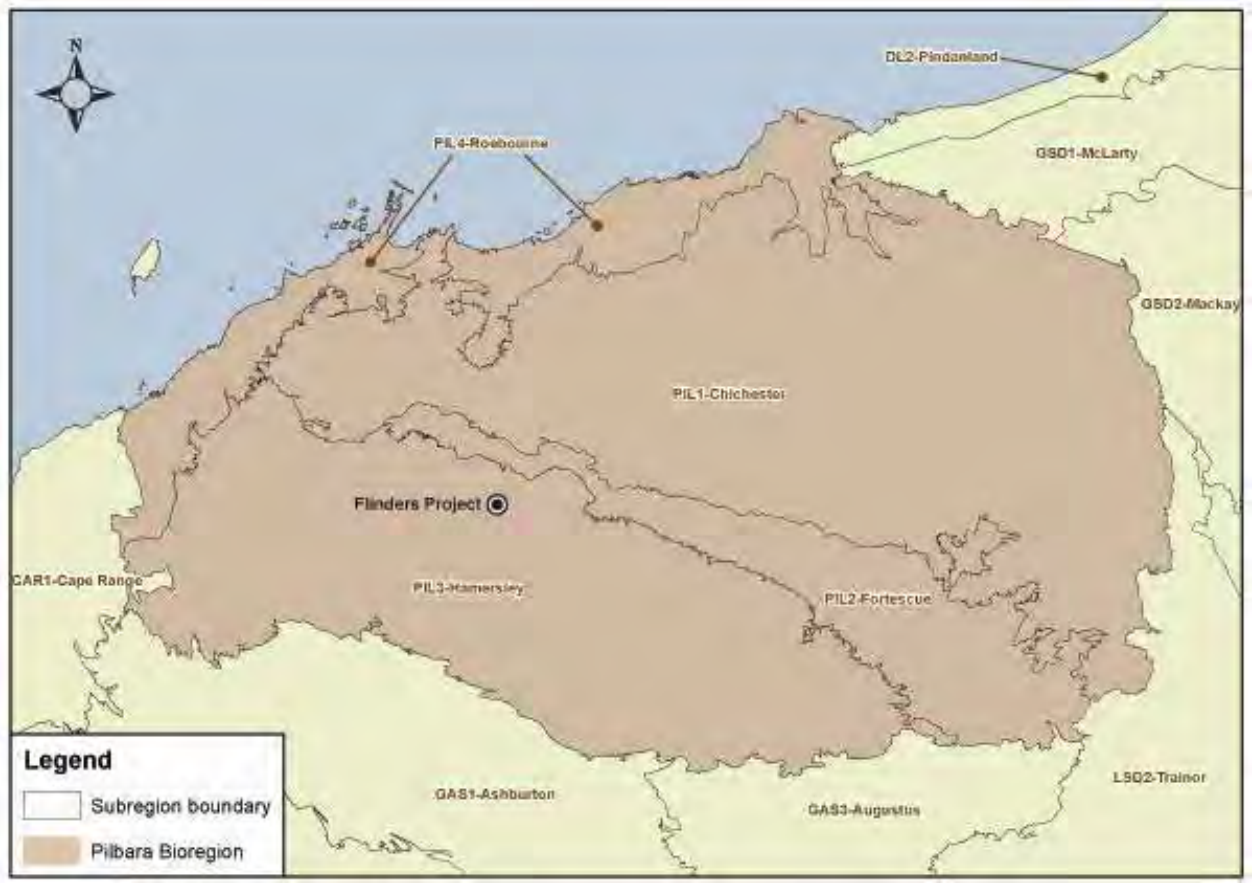

Figure 3 IBRA 6.1 Subregions (DEWHA 2009).

The Hamersley subregion is considered to contain the following values related to fauna (**Table 3**)(Kendrick 2001)

- persisting populations of threatened and endangered species (Mulgara, Spectacled Hare-wallaby, Bilby, Pilbara Leaf-nosed Bat and Princess Parrot)
- arid zone populations of Northern Brushtail Possums, Ghost Bats and North-western Long-eared Bats
- endemic stygofaunal radiations in calcrete aquifers

Bioregional endemics include *Ningaui timealeyi*, *Planigale* sp. 1, P. sp. 2, *Dasykaluta rosamondae*, *Pseudomys chapmani, Pseudantechinus roryi, Diplodactylus savagei, Diplodactylus wombeyi, Delma elegans, Delma pax, Ctenotus rubicundus, Egernia pilbarensis, Lerista zietzi, Lerista flammicauda, Lerista neander, Lerista muelleri, Notoscincus butleri, Varanus pilbarensis, Acanthophis wellsi, Demansia rufescens, Ramphotyphlops pilbarensis, Ramphotyphlops ganei*, and stygofauna of the calcrete aquifers (Kendrick 2001).

Table 2 Conservation significant fauna species found in the Hamersley Subregion as listed by Kendrick (2001).

Common name (scientific name)	Wildlife Conservation Act (1950)	EPBC Act (1999)
Northern Quoll (*Dasyurus hallucatus*)	Schedule 1	Endangered
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantius*)	Schedule 1	Vulnerable
Pilbara Olive Python (*Liasis olivaceus barronii*)	Schedule 1	Vulnerable
Mulgara (*Dasycercus cristicauda*)	Schedule 1	Vulnerable
Peregrine Falcon (*Falco peregrinus*)	Schedule 4	
Spectacled Hare-wallaby (*Lagorchestes conspicillatus leichardti*)	DEC P3	
Western Pebble-mound Mouse (*Pseudomys chapmani*)	DEC P4	
Ghost Bat (*Macroderma gigas*)	DEC P4	
Bush Stone-curlew (*Burhinus grallarius*)	DEC P4	

3.0 survey methods

3.1 risk-based approach to fauna assessment

The alternative to an intensive fauna trapping program is a risk-based approach developed in close consultation with DEC and EPA. We have had success with DEC/EPA using a different approach to the typical "Level 2" assessment type of survey. Given the tight time-frame required this risk-based approach is appropriate and was used to address the tasks required for the Flinders project area.

This risk-based assessment included targeted surveying for conservation significant fauna species and habitats. This method involved targeted survey techniques, with little or no trapping, on the basis that trapping only confirms the presence of species expected. This process involved:

- habitat familiarisation
- searching for evidence of conservation significant fauna species
- identification of significant habitats
- recognition of ecosystem processes that may interact with the proposed development and lead to adverse impacts upon fauna.

This approach required more expertise, fewer people and less time than the traditional approach of intensive and expensive trapping programs. This approach also required liaison and discussion with, and the approval of DEC.

3.2 desktop assessment and literature review

3.2.1 DATA COLLATION AND REVIEW

Worley Parsons and Ecoscape undertook a desktop assessment of the physical environment, flora and fauna considering published and unpublished information from relevant previous surveys.

The following sources were accessed as part of the desktop review, and follow EPA guidelines for a desktop survey:

- DEC threatened fauna database
- EPBC Protected Matters database
- current Rare and Priority Fauna listings
- previous studies for the surrounding area.

Fauna desktop investigations included the following;

- a review of the Western Australian Museum (NatureMap) to identify potential vertebrate fauna within the area
- a search of the DEC Threatened and Priority Species database to identify potential scheduled and threatened species within the region, as listed by the WA Wildlife Conservation Act (1950)
- review of DEC Priority fauna list for species listed for the region as per DEC priority codes
- review of the Birds Australia Atlas Databases
- a search of the Commonwealth database for fauna species of national environmental significance to identify species potentially occurring within the area that are listed under the Environment Protection and Biodiversity Conservation Act (1999)
- a review of any previous fauna assessments conducted in the region.

A list of targeted fauna species was compiled using species identified through the:

- *EPBC Act (1999)*
- *Wildlife Conservation Act (1950)*(WC Act)
- DEC Priority fauna species list.

In addition, there are some species that have no formal listing but that may have small, isolated or extra-limited populations in the region; such species are also of significance for biodiversity and warrant special consideration in EIA.

The study area lies in the Pilbara 3 Hamersley subregion of IBRA. The following table summarises previous fauna surveys that have been undertaken within the vicinity of the study area (**Table 3**).

Table 3 Previous fauna surveys conducted in the vicinity of the Study Area

Survey	Km from study area	Comment
Worley parsons (2010) Preliminary Desktop Environmental Study at E47/882 (Blacksmith) – Pilbara Iron Ore Project	0 km	Initial Study
Ecoscape (2010b) Vertebrate Fauna and Fauna Habitat Assessment for the Firetail Project. Unpublished report for FMG, Perth	39 km	Level 2
Ecoscape (2010a) Solomon Project Rail Re-alignment Fauna Assessment. Unpublished report for FMG, Perth	40-60 km	Level 1
Coffey Environments (2008). Level 2 Terrestrial Vertebrate Fauna Assessment for the Solomon Project. Unpublished report for FMG, Perth	39 km	Level 2
Ecologia (2010). Solomon Project: Kings Area Vertebrate Fauna Assessment. Unpublished report for FMG, Perth	39 km	Level 2
Biota Environmental Sciences (2005b) Fauna habitats and fauna assemblage of the Brockman Syncline 4 project, near Tom Price. Unpublished report for Hamersley Iron Pty Ltd, Perth	60 km	Level 2

Survey	Km from study area	Comment
Biota Environmental Sciences (2005a). Fauna habitats and fauna assemblage of Mesa A and G, near Pannawonica. Unpublished report for Robe River Iron Associates, Perth	200 km	Level 2
Ninox Wildlife Consulting (1992). Vertebrate fauna assessments (1975-1991), Report Marandoo project area. Unpublished report for Enviroscan, Perth	70 km	Level 2
Muir BG (1983). A fauna survey of the Hamersley Range National Park Western Australia 1980. National Parks Authority of Western Australia Bulletin No. 1, Perth	10 km	-

The species lists and fauna assemblages presented in these reports have been used for comparative purposes with the fauna survey data collected during the October 2010 level 2 survey within the study area.

3.2.2 TAXONOMY AND NOMENCLATURE

Taxonomy and nomenclature for fauna species used in this report are generally based on the Western Australian Museum list provided on the NatureMap web site, except for bats, which follow Armstrong and Reardon (2006).

Table 4 lists the references used. Ecoscape has presumed that the identifications referred to in the Appendices or in reports used to provide local and regional comparative data were correct and has only corrected records where the nomenclature was obviously incorrect.

Table 4 References used for species identification.

Reference	Identification
Menkhorst and Knight (2009)	Mammals
Armstrong and Reardon (2006)	Bats
Bamford Consulting Ecologists Data Library	Bats
WA Museum field guides	Reptiles
Slater Simpson and Day (2004)	Birds

3.2.3 DATA ANALYSIS

The diversity of trapped fauna assemblages can be measured in numerous ways utilising one or more of the four most common metrics: species richness, evenness, a single diversity score and relative abundance. There are a range of analytical tools available to quantify and compare these metrics. Ecoscape utilised species richness and evenness to determine the structure and diversity of the fauna assemblages recorded by trapping and used the software package *Species Diversity and Richness IV* from Pisces Conservation (Pisces Conservation 2010). A single diversity score (i.e. the number of species recorded) gives an indication of the level of diversity of the study area when compared to similar survey results.

3.3 justification of survey

These surveys were designed to take into account species expected, activity patterns of assemblages and animal welfare issues. The timing of the surveys was deemed appropriate and the sites chosen adequate to sample assemblages likely to be impacted on by mining activity. Timing of the surveys is consistent with the guidelines as stated in the EPA *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA 2010)*.

3.3.1 TIMING OF SURVEY

A preliminary survey was undertaken in June 2010 followed by a Northern Quoll trapping survey in July 2010 and a targeted trapping survey in October 2010.

Table 5 Summary of Survey Timing and Duration

Survey	Duration	Person Days
preliminary	31 May – 5 June	18 (3 specialists)
Northern Quoll	13-18 July	24
taregted trapping	7-16 October	40
	Total	82

3.3.2 IDENTIFICATION OF PROPOSED SURVEY SITES

The desktop assessment identified locations of proposed survey sites which were discussed with FML, Worley Parsons and DEC prior to the survey.

3.3.3 SURVEY TEAM

Ecoscape put together a highly experienced Vertebrate Fauna Assessment Team in order to adequately survey the Flinders Project area which consisted of:

- Bruce Turner (Senior Zoologist and mammologist) – Project Manager; Fauna Team Leader
- Julie Raines (Ornithologist) – Preliminary Survey Sub consultant
- Monica Russell (Zoologist) – SRE Specialist
- Natalie Randall (Senior Environmental Scientist) – Targeted Survey Team Member
- Jordan Vos (Herpetologist) – SRE and Targeted Survey Sub consultant
- Rob Browne-Cooper (Herpetologist) – Preliminary and Targeted Survey Sub consultant

3.3.4 SURVEY DESIGN AND LOCATION

The locations of the Ecoscape targeted survey trap sites were selected to maximise sampling of dense vegetation cover and all available microhabitats within each habitat type (**Table 6**). Between each pitfall trap, one cage, two funnels and two Elliot traps were established to complete the trap site design. Pitfall traps were spaced approximately 50m apart along a transect through each of the selected sites (Figure 4**Plate 1**). Ecoscapes trapping surveys were conducted in seven trapping sites over seven nights (**Table 7**).

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

Trap Specifications:

- Pit-trap and drift fence: ten 20 L plastic buckets (30 cm diameter, 40 cm deep) were established at each site. Three two metre long drift fence (30 cm high) triangle the pits, directing fauna into the traps.
- Elliott box traps: 10 medium-sized Elliott box traps (9 x 9 x 32 cm) were located at each site, and baited with universal bait (a mixture of peanut butter, rolled oats and sardines). Traps placed in association with the pit trap.
- Funnel traps: ten funnel traps were placed in association with drift fences.
- Cage traps: one trap was used per site with one trap placed at one end of the trap line

Table 6 Location of Survey Sites

Site	Site Name	Landform	Location (GDA 94 MGA 50)	
			Easting	Northing
1	Delta valley	valley	550754	7552385
2	Delta slope	mid-slope	551804	7551491
3	Champion valley	valley	545984	7553793
4	Champion slope	mid-slope	547415	7553077
5	Blackjack valley	valley	543026	7553900
6	Blackjack slope	mid-slope	543253	7554055
7	Paragon slope	mid-slope	550982	7555904

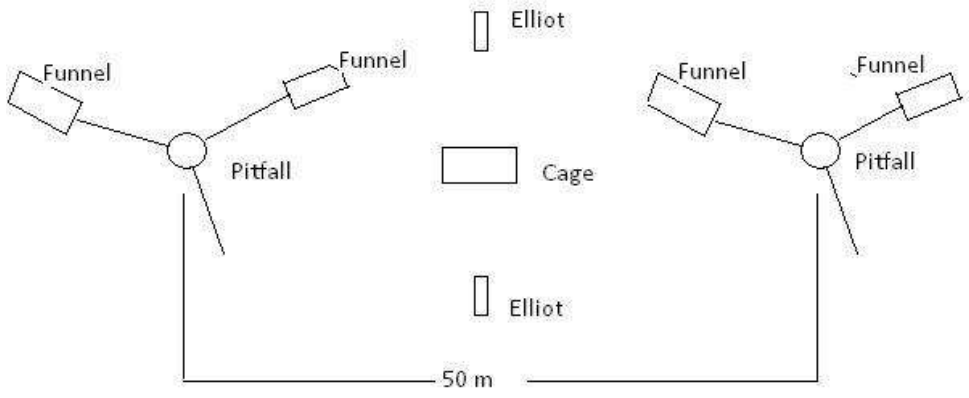

Figure 4 Trap site layout.

Plate 1 Typical pitfall trap layout.

Table 7 Survey Effort

Site	Trap Nights				Time (Minutes)			
	Pit Traps	Funnels	Elliot's	Cages	Bird Survey	Diurnal Search	Anabat	Nocturnal Search
Blackjack Slope	0	20	10	0	120	120		
Blackjack Valley	10	10	10	5	120	120		
Champion Slope	10	10	9	5	202	240	24	240
Champion Valley	10	10	10	5	240	180		
Delta Slope	10	10	10	0	190	180		480
Delta Valley	9	9	8	0	130	120	36	120
Paragon	10	19	20	5	170	120	24	60
Ajax	-	-	-	-	240	480	36	480
Eagle	-	-	-	-	120	480	12	120
Total traps	59	88	77	20				
Survey Total	413	616	539	140	1172	2040	132	1500

3.4 two part vertebrate fauna survey

A Level 2 Fauna survey as outlined in Guidance Statements No. 56 was undertaken to:

- gain an indication of the reptile, small mammal and bird assemblages in the vicinity of the project area so that potential impacts might be adequately assessed.
- identify the presence of species of conservation significance that are present or likely to be present.

- assess the impact and environmental risks associated with the proposed development on the fauna assemblage.
- determine if any additional surveys are required to assess the potential impact on fauna assemblages, in particular, impacts on species of conservation significance.

The Ecoscape Level Two survey is divided in two parts: the Preliminary Survey and the Targeted Trapping Survey. The preliminary survey has three functions:

1. to verify the applicability of desktop studies
2. to familiarise survey personnel with the study area and map major habitats
3. to start the Level Two survey, using specialist zoologists who have the experience to locate and record wildlife using non-invasive passive techniques. The trapping program, which is more invasive, can then be restricted to areas targeting specific species or habitats that need further investigation.

Techniques and knowledge used by specialists include:

- Bird censusing using both visual and auditory techniques.
- Spotlighting significant habitats i.e. gorges, caves and creeks.
- Trail cameras set along likely corridors of fauna movement.
- Anabat echo location recordings in different habitat types.
- Leaf litter raking, rock pile and fallen log hand searching.
- Identification of scats, bones, tracks, diggings and burrow and the analysis of
- predator scats.
- Calling upon wide experience to know where to find remaining species.

Ecoscape and Bamford Consulting Ecologists considers the preliminary phase essential in providing information on fauna species present using non-invasive passive techniques in order to reduce the level of trapping required to adequately sample a study area. When conducted by experienced personnel the preliminary survey can provide a comprehensive species list of common and expected species, accurate habitat maps and detailed planning for trapping studies. This planning can reduce the level of impact from trapping by accurately identifying habitats likely to be important for conservation significant fauna species and therefore targeted for trapping studies. A more targeted level of trapping results in less impact to fauna species and still provides a comprehensive record.

The Ecoscape survey team operated under DEC Regulation 17 Fauna License No. **SF007408**. One team of three personnel undertook phase one of the Level 2 Survey. The team consisted of experienced zoologists, Rob Brown-Cooper (herpetologist), Julie Raines (ornithologist) and Bruce Turner (mammologist) in a six day survey.

3.4.1 OPPORTUNISTIC OBSERVATIONS

Opportunistic observations were made during both the preliminary survey and targeted survey. Observations were made when travelling to and from the study area as well as between sites. Approximately 34 diurnal survey hours and 25 nocturnal survey hours were completed searching and recording observations.

3.4.2 SEARCHING FOR SIGNIFICANT SPECIES

Based on the results of the database searches, species habitats searched for included the Long-tailed Dunnart, Ghost Bat, Lakeland Downs Mouse, Western Pebble-mound Mouse, Pilbara Leaf-nosed Bat, Northern Quoll and the Pilbara Olive Python.

3.4.3 MICRO-HABITAT SEARCHING

Micro-habitat searching was carried out in any areas of interest identified during the preliminary survey and targeted survey. Searching involved: raking through leaf-litter, breaking into dead trees, looking under bark, digging up burrows, turning over rocks, logs and dead vegetation and targeted spotlighting. Termite mounds were searched by spotlight opportunistically; no mounds were sectioned or destroyed.

3.4.4 BIRD CENSUS

A bird census was undertaken on each morning and evening from October 7-16, 2010. An area search technique was used in which a series of 2ha areas was searched, each for 15 minutes. The series of search areas included all habitat types from the creeks to the upper slopes and the isolated mid-slope valleys. Opportunistic observations were also made while travelling between sites and checking traps during the targeted survey.

3.4.5 TRAIL CAMERAS AND ANABAT

Six trail cameras were located in different habitat types at sites chosen to maximise the likelihood of capturing fauna movement (**Table 8**). Cameras were set at cave entrances, narrow active pathways in the creeks and road junctions (**Map 1**). The cameras were setup to capture still images in colour and were operational for a total of five days during the preliminary survey and seven days during the targeted survey.

The Anabat II was placed at a bat roost site in Paragon and at a creek in Ajax other sites in the valleys were also used for recordings (**Table 8**).

Table 8 Trail camera and Anabat locations and habitat type (co-ordinates in GDA 94 MGA 50 meters).

Item	Easting)	Northing	Habitat Type
Anabat	538589.80 E	7555321.10 S	Creek with permanent pool (Ajax)
Anabat	550483.92 E	7556192.58 S	Potential bat roost, rocky hill top with *Triodia* (Paragon)
Anabat	543535.05 E	7552662.08 S	Champion Gorge
Trail camera	538594.66 E	7555605.15 S	Creek line within Ajax
Trail camera	538603.26 E	7555385.96 S	Creek line within Ajax
Trail camera	538530.19 E	7554874.50 S	Creek line within Ajax

Item	Easting)	Northing	Habitat Type
Trail camera	543203.68 E	7553616.73 S	Blackjack Gorge
Trail camera	545840.99 E	7553911.76 S	Low Open Woodland within Champion valley
Trail camera	547575.06 E	7552923.23 S	*Triodia* Grassland Slope Champion
Trail camera	550722.68 E	7552398.99 S	Low Open Woodland within Delta valley
Trail camera	550915.19 E	7552130.54 S	Low Open Woodland within Champion valley
Trail camera	551694.95 E	7551451.75 S	Pebble-mound Mouse active mound
Trail camera	551877.00 E	7551544.18 S	Pebble-mound Mouse active mound
Trail camera	550631.36E	7555770.07 S	Low Open Woodland within Champion valley
Trail camera	550301.28 E	7556093.55 S	Grassland slope Paragon

3.4.1 BAT CALL ANALYSIS

Acoustic recordings were made with a frequency division Anabat SD1 bat detector, which is one of several methods recommended by the EPA and DEC (2010). The frequency division ratio was set to a factor of 8 to maximise the resolution (number of zero crossings) of the recorded signal. Signals were supplied as downloaded sequences to Specialised Zoological for analysis, which was undertaken in AnalookW 3.7w software. Three call variables were measured on good quality search phase pulses in representative call sequences: pulse duration (milliseconds), maximum frequency (kHz) and characteristic frequency (kHz). To double-check that all signals of the Pilbara leaf-nosed bat Rhinonicteris aurantia had been noted, a continuous representation of the Anabat recordings in ZCA and MAP files were examined and reviewed by Bob Bullen. Species were identified based on information in McKenzie and Bullen (2009). Nomenclature follows Armstrong and Reardon (2006).

3.4.2 TARGETED TRAPPING SURVEY

The targeted trapping survey was conducted in October 2010 by Bruce Turner (mammologist), Robert Brown-Cooper (herpetologist), Jordon Vos (herpetologist) and Natalie Randall (Senior Environmental Scientist) to enhance the preliminary survey results by the addition of trapping programs. This trapping survey was designed to focus on habitat likely to contain conservation significant fauna species, as identified through the preliminary survey. One team of four personnel completed the survey over a 12 day period.

Sampling techniques included:

- trapping in identified significant habitat using:
  - Elliott traps
  - Funnel traps with drift fences
  - Pitfall traps
- Additional opportunistic bird observations
- searches for tracks, scats, bones and diggings
- active searching
- spotlighting/head torching
- hand searching litter and rock outcrops

- Anabat recordings for bat species
- trail cameras set on pathways and obvious activity sites.

Data recorded were used to compile a comprehensive species list, locations of sampling sites, habitat descriptions and locations of any conservation significant fauna species encountered.

3.5 SRE fauna survey

3.5.1 SRE RECONNAISSANCE SURVEY AND SAMPLING SITE ESTABLISHMENT

A reconnaissance survey adequately selected trapping and sampling locations for an SRE survey. This involved a site visit to confirm the various habitats and microhabitats existing in the site and propose and establish trapping sites (i.e. for wet pit traps along transects) and sampling locations (i.e. active hand sampling). Methods followed those as set out in EPA *Guidance Statement No. 20 Sampling for Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia, 2009*. Ecoscape invertebrate specialist Monica Russell undertook the SRE survey assisted by Jordon Vos, Natalie Randall and Bruce Turner.

The SRE reconnaissance survey and site establishment were undertaken in July 2010 in conjunction with the vertebrate fauna survey and was of 5 days duration.

3.5.2 SRE DETAILED SAMPLING SURVEY

The following methods were intended for sampling SREs.

3.5.2.1 Wet pit traps

After discussions with DEC (Bradley Durrant, Subterranean Fauna Section) wet pits were used in season one and collected during season two sampling. Five to ten pits were placed (with protective covers) in trap lines in various habitats using propylene glycol (**Map 3, Table 10**). Plates of individual wet pit sites can be found in **Appendices 4**.

3.5.2.2 Dry pit traps

Dry pits were used during the targeted trapping survey in October 2010. These consisted of plastic cups opportunistically placed in the ground at various locations. Microhabitats and related plates are listed in Table 10**Table 9** (**Map 3**).

Table 9 SRE wet pit sites.

Trap Site	Number of Wet Pits	Microhabitat Description	Plate
1	10	Champion low slopes of *Triodia* and *Eucalyptus*	16
2	10	Flat vegetated area with open spinifex and shrubs (Acacia)	17
3	10	Flat vegetated area, open vegetation with minimal spinifex or shrubs (*Acacia* and *Eucalyptus*)	18
4	5	Black Jack valley area with shrubs (*Acacia*)and dense spinifex	19

3.5.2.3 Hand foraging

Due to timing restrictions the first sampling period was in July, when long term wet pit traps were established and then again in October. This is typically a hot and dry period in the Pilbara and no rain was observed during this time. Therefore, some SRE identifications are still pending and will be included as an appendix at a later date.

Two sampling surveys were conducted across two seasons. Sample sites were established during the SRE reconnaissance survey in July 2010. They were then re-sampled in October 2010 to collect remaining traps for sorting and identification and a second season of active sampling was undertaken. The first survey in July consisted of the following techniques:

- 5-10 wet pitfall traps (containing Propylene glycol) per transect across four sites
- 30 dry pit traps established opportunistically and collected after 2 weeks
- active hand sampling in key habitats (in 30-60 minute blocks, with two or more people) including:
  - raking and thoroughly searching leaf litter, soil and debris
  - searching rock piles, trees and beneath bark
- creating a photo record of all key habitats sampled and trapping sites.

The sampling survey in October consisted of the above techniques but only collected the wet pit traps from July. No new wet pits were established during this survey. Dry pit and active sampling sites across both seasons are listed in **Table 10** (**Map 3**).

Table 10 SRE dry pit and active sampling sites.

Microhabitat Type	Microhabitat Description	Plate (Appendices 4)
Steep slopes	Steep rocky and vegetated low slopes of valley (usually spinifex, powder bark and minimal shrubs)	Plate 12
Vegetated flats	Vegetated flats of Triodia, Acacia and Eucalyptus	Plate 15
Flat open spinifex	Flat vegetated area with open spinifex and shrubs (Acacia)	**Error! Reference source not found.**
Flat with dense spinifex and open shrub	Flat vegetated area with dense spinifex and open shrubs	Plate 11
Open flat vegetation, minimal spinifex	Flat vegetated area, open vegetation with minimal spinifex or shrubs (Acacia and Eucalyptus)	Plate 17, Plate 18, Plate 26
Valley slopes	Valley slopes with spinifex, Eucalypt and shrubs	Plate 13, Plate 14, Plate 24, Plate 28
Roadside debris	Directly along roads where there are debris piles and other disturbances	-
Outcrop	Rock outcrop with sparse spinifex and shrubs	Plate 29

Table 11 SRE Trapping site coordinates.

Coordinates (metres GDA 94 MGA 50)		Trap Type
Easting	Northing	
543116.81	7553926.97	Dry Pit
543630.87	7552609.83	Dry Pit
546122.35	7553981.14	Dry Pit
546861.48	7553169.69	Dry Pit
550769.61	7552714.72	Dry Pit
551613.67	7551312.05	Dry Pit
550743.03	7555796.33	Wet Pit
545784.07	7553791.55	Wet Pit
543017.94	7554101.57	Wet Pit
550685.74	7552594.30	Wet Pit
550704.99	7552540.55	Wet Pit
546895.79	7553170.31	Wet Pit

3.5.3 SAMPLE SORTING AND IDENTIFICATION

Samples were cleaned and sorted prior to the West Australian Museum (WAM) identifying them. The WAM is equipped to identify numerous invertebrate groups to species level, Scorpions however were identified by Erich Volschenk of Phoenix Environmental Sciences. Any individuals that were not considered SRE's were not identified further.

3.6 survey design and location

Ecoscape designed the targeted trapping survey in the study area to complement the desktop assessment undertaken by Worley Parsons and after the preliminary survey had identified and categorised available fauna habitats and determined which species required a trapping program. Ideally trap sites are placed in all habitat types with one replication, if site conditions allow. Seven trapping sites in three habitat types were established (**Map 2**). The design was presented to Peter Kendrick of DEC for comment, this comment was received for the survey to proceed as designed prior to the survey commencing. Trap sites were placed in vegetated areas only.

Survey effort is outlined in **Table 7**. A significant amount of effort was put into spotlighting and hand searching in all habitat types to ensure that species restricted to nearby microhabitats were sampled (i.e. some gecko species). This effort was predominantly undertaken in the gorges adjacent to the trapping sites.

3.7 survey limitations

3.7.1 LIMITATIONS

Conclusions regarding the vertebrate fauna assemblage have been based on the results obtained from this survey and data from other surveys reported for the region. This information has allowed a comparison of fauna assemblages and species diversity at a local and regional level. It is acknowledged that multiple surveys conducted in different seasons, repeated over several years are

necessary to cater for all temporal variations in the fauna assemblage and will also pick up rare animals and vagrants.

The study area was largely burnt by wildfire in February 2010 and much of the vegetation was destroyed. This may have impacted on the results achieved particularly for the large mammal and bird species normally expected in this area. Consequently trap effort was confined to unburnt patches of vegetation and focussed on areas of potential impact. Opportunistic searching was undertaken in burnt and unburnt areas and species were recorded from both, however the majority were recorded in unburnt areas as expected. Given good climate conditions the burnt areas are expected to recover within five years.

Trap types sample the small vertebrate assemblage differently. Unlike many of the earlier terrestrial fauna surveys undertaken to support EIAs, this trapping program has used funnel traps in conjunction with other trapping methods which resulted in a more comprehensive survey of the vertebrate fauna. The consequence is that this survey will have captured more individuals of some species than other surveys undertaken in the region, and this needs to be considered when comparing the trapping data recorded during earlier surveys. Large reptiles and mammals are infrequently caught in the traps used; however, their size is such that they are more likely to be seen than many smaller cryptic species. Larger nocturnal species are generally seen while spotlighting.

Weather during the survey period was suitable for terrestrial fauna surveys, with maximum daily temperatures in the high 30s. EPA Guidance Statement No. 56 (EPA 2004) suggests that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in **Table 13**.

Table 12 Statement of Limitations.

Possible Limitations	Constraints (Yes/No):	Significant, Moderate or Negligible	Comment
Competency/experience of the consultant conducting the survey	No Constraint		All field survey staff have relevant recent experience surveying in the Pilbara region. Senior staff have extensive experience with species identification over all fauna assemblages
Scope	No Constraint		Scope was not constrained, sufficient time and effort undertaken for targeted trapping survey to be completed.
Proportion of fauna identified, recorded and/or collected	No Constraint		All observed and captured species identified. No vertebrate species collected, all vertebrate fauna observed identified.
Proportion of the task achieved and further work that may need to be undertaken	No Constraint		Study area surveyed adequately. Further targeted survey required for some conservation significant fauna species for proposal footprint.
Timing/weather/season/cycle	No Constraint		All surveys conducted in appropriate seasons under good weather conditions.
Intensity of survey (e.g. In retrospect was the intensity adequate?)	No Constraint		Survey intensity sufficient to assess fauna species present as indicated by number of species recorded, comparison with similar surveys and results from other surveys undertaken in the region. .
Disturbances which affected results of the survey	Yes	Negligible	Much of the area has suffered from wildfire event in Feb 2010, low level grazing for many years, which will have had a long-term effect on the fauna assemblage. More recently, exploration activity has degraded some of the habitat. .
Sources of information	Yes	Moderate	Vertebrate fauna information was available using NatureMap, surveys conducted at other sites in the region and published and unpublished reports. These survey sites are <50 km away and allows for close comparison..
Completeness (e.g. Was relevant area fully surveyed?)	No Constraint		Area fully covered with all habitats identified and adequately sampled.
Resources (e.g. Degree of expertise available for plant identification)	No Constraint		Adequate resources were available, highly experienced staff on hand for field identifications.
Remoteness and/or access problems	No Constraint		No restrictions other than access to caves at the top of steep slopes difficult to adequately survey.
Availability of contextual (e.g. bioregional) information for the survey area	Yes	Negligible	WA Museum fauna database, Department of Environment and Conservation's Threatened and Priority species database and published and unpublished reports of surveys conducted at other sites in the region were available. The DEC Pilbara regional survey data were not available for comparative purposes. The trapping effort and period of other surveys was limited.

4.0 Survey results

4.1 desktop results

The Blacksmith site has been covered in regional surveys (Worley Parsons 2010) such as:

- Van Vreeswyk *et. al*. (2004a) An inventory and condition survey of the Pilbara region, Western Australia
- DEC (2009) Pilbara Region Biological Survey 2002-2009.

The following reports exist from Rio Tinto's Brockman/Nammuldi operation approximately 28km south of the site (Worley Parsons 2010):

- EPA (1990), Proposed Brockman No.2 detrital iron-ore mine, Hamersley Iron Pty Ltd, Report and Recommendations of the Environmental Protection Authority, Bulletin 467
- Hamersley Iron (2005), Brockman Syncline 4 Iron Ore Project, Public Environmental Review
- EPA (2006), Brockman 4 Syncline Project, Report and Recommendations of the Environmental Protection Authority, Bulletin 1214
- Brockman Syncline 4 Iron Ore Project – Borefield Management Plan (Rio Tinto)
- Brockman Syncline 4 Iron Ore Project – Snail Management Plan (Rio Tinto)

Environmental information was also available from Rio Tinto Iron Ore's Western Turner Syncline 10 Iron Ore Project:

- Western Turner Syncline Section 10 – Environmental Protection Statement (Rio Tinto)
- Biota (2009c), West Turner Syncline Section 10 Development Two-Phase Fauna Survey
- Biota (2007), Vegetation Survey Report
- Biota (2008b), Subterranean fauna assessment
- Biota (2009a), SRE Risk Assessment
- Biota (2008a), Mygalomorph spiders and EIA
- MWH (2009), Groundwater modelling
- Pilbara Iron (2008), Botanical survey report
- Rio Tinto (2007), SCARD (Spontaneous Combustion and Acid Rock Drainage) Management Plan
- Rio Tinto (2008), Closure Management Plan
- Rio Tinto Iron Ore (2008), Weed Management Plan

4.1.1 CONSERVATION SIGNIFICANT FAUNA

There were 6 conservation significant species identified through database searches of the DEC (**Table 13**). Results of the Protected Matters Search Tool of the EPBC Act are shown in **Table 14**.

NatureMap online database identified 152 fauna species as occurring within the area, 7 of these were conservation significant (**Table A3-1, Appendix Three**).

The Birds Australia Data base identified a total of 122 birds in the study area, 1 of which were listed.

Species identified by the desktop assessment that are marine birds, marine mammals or migratory have been discounted. They are listed in the appendices bit will not be discussed further.

No short-range endemics were identified as occurring in or near the study area.

Table 13 DEC conservation fauna search results.

Species	Common Name	DEC Listing	EPBC Act
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby (mainland)	P3	-
Sminthopsis longicaudata	Long-tailed Dunnart	P4	-
Macroderma gigas	Ghost Bat	P4	-
Leggadina lakedownensis	Lakeland Downs Mouse, Kerakenga	P4	-
Pseudomys chapmani	Western Pebble-mound Mouse	P4	-
Notoscincus butleri	Ngadji	P4	-

Table 14 Results of the EPBC Protected Matters Search Tool.

Species	Common Name	Status	EPBC Act
Mammals			
Dasyurus hallucatus	Northern Quoll	Endangered	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	Vulnerable	Species or species habitat likely to occur within area
Reptiles			
Liasis olivaceus barroni	Olive Python (Pilbara subspecies)	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species Birds			
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Merops ornatus	Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species Birds			
Ardea alba	Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus	Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds			
Apus pacificus	Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba	Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Migratory	Species or species habitat may occur within area
Listed Marine Species Birds			
Apus pacificus	Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba	Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis	Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area

Species	Common Name	Status	EPBC Act
Charadrius veredus	Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster	White-bellied Sea-Eagle	Listed - overfly marine area	Species or species habitat likely to occur within area
Merops ornatus	Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area

Three individuals of the P4 *Pseudomys chapmani* (Western Pebble-mound Mouse) were recorded by Biota (2009b) at two locations inside and one location outside the nearby Rio Tinto Syncline 10 area (Worley Parsons 2010). These species or their habitat may also be present in the FMS site (Worley Parsons 2010).

Five potential Short Range Endemic (SRE) species were also recorded during the Biota (2009b) survey of Rio Tinto's nearby resource areas (Worley Parsons 2010). Ecoscape has sampled SREs within the study area to describe this cryptic group.

Worley parsons (2010) also found the Olive Python (Pilbara subspecies, *Liasis olivaceus barroni*) to be listed in their EPBC search results. Ecoscape's search parameters for the EPBC protected Matters Search Tool included a 20 km buffer, but this species was not identified.

4.2 fauna survey

4.2.1 HABITAT TYPES

The prelimnary survey identified three habitat types that remained available for targeted trapping survey after the recent wildfire (**Map 3**). These were valley floors, including secondary drainage lines (H1), slopes of the hills surrounding the valleys (H2) and gorges (H3). The habitats are based on land form and vegetation composition and are described in detail in the following section. The gorges (H3) type were surveyed intensively using hand searching, spotlighting and raking techniques and surveyed with cage traps in July 2010 targeting Northern Quolls only.

4.2.2 HABITAT DESCRIPTIONS

Habitat descriptions are made through information obtained through the flora and vegetation survey of Ecoscape (Ecoscape 2011) and follow the terminology of the Muir classification system.

H1 - The valley floor habitat comprises *Corymbia hamersleyana* and *Eucalyptus gamophylla* Low Open Woodland/Mallee over *Triodia wiseana* Hummock Grasslands and *Triodia* aff. *melvillei* Hummock Grasslands on rises in the valley floors.

H2 – The lower to mid slopes have *Eucalyptus leucophloia* and *Corymbia hamersleyana* Low Open Woodland over *Triodia* aff. *epactia* Hummock Grasslands.

H3 – the gorges located among the slopes of the ranges between each of the three valleys (Delta, Champion, Blackjack) comprise *Corymbia ferriticola* and *Eucalyptus victrix* Low Open Woodland. The gorges are predominantly made up of small drainage lines among large rocky slopes and vertical cliffs, many with numerous small caves and scrapes. The fig *Ficus brachypoda,* is an important shelter and food resource in this habitat and many species take advantage of the deep litter layers and the fruits as food.

4.2.3 SHORT RANGE ENDEMIC HABITAT TYPES

The following SRE habitats were identified during preliminary survey (**Table 15**). They were sampled multiple times throughout the study area. Plates of the various SRE microhabitats samples are in **Appendix 4**.

Table 15 SRE sampled microhabitats.

Site	Habitat Type	Description	Sample Type
1	Valley slopes	Steep rocky and vegetated slopes of valley (*Triodia, Eucalyptus*)	Wet pits (Propylene Glycol traps), dry pits, active searching
2	Flat dense spinifex plain	Flat vegetated area with dense spinifex and shrubs (*Acacia*)	Wet pits (Propylene Glycol traps), dry pits, active searching
3	Flat open vegetation	Flat vegetated area, open vegetation with minimal spinifex or shrubs (*Acacia* and *Eucalyptus*)	Wet pits (Propylene Glycol traps), dry pits, active searching
4	Hillsides	Top and sides of hill (usually spinifex, powder bark and minimal shrubs)	Wet pits (Propylene Glycol traps), dry pits, active searching
5	Road sides and debris piles	Directly along roads where there are debris piles and other disturbances	Active searching and dry pits

4.2.4 HABITAT CONDITION

The condition of fauna habitats within the study area varied from completely burnt to Good, as defined below. There were no areas in between these values.

Fauna habitat condition within the study area was classified according to the five conditions described below.

High quality fauna habitat – These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.

Very good fauna habitats - These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats. Fauna assemblages in these areas are likely to be minimally effected by disturbance.

Good fauna habitat – These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed.

The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.

Disturbed fauna habitat– These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain weeds or have been damaged by vehicle or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.

Highly degraded fauna habitat – These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. They exhibit limited or no fauna habitat connectivity. Faunal assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance (**Map 2**).

4.3 fauna surveys

4.3.1 TRAPPING RESULTS

The fauna survey recorded 105 species through trapping and opportunistic observations. Fauna species recorded are listed in **Table 23** (**Appendix 3**) and displayed in **Figure 5**. There were 32 species recorded from the trapping surveys which were used for the data analysis section and **Figure 5**.

4.3.2 TRAIL CAMERA

Trail camera sets recorded Euro (*Macropus robustus*) during day or night recordings of both survey periods. One camera set on a Pebble-mound Mouse active mound recorded a Pebble-mound Mouse actively building the mound, this was located in the Delta Slope trapping grid.

4.3.3 ANABAT

Anabat II recordings from 6am-6pm over five nights were analysed for bats species. Two bat calls were recorded during the February trapping survey. The calls were analysed and determined to be those of the common species *Chalinolobus gouldi* (Gould's Wattled Bat) and a *Mormopterus sp* (South-western Free-tail Bat).

During the October survey the Anabat II identified the following species (as confirmed by Kyle Armstrong):

- Gould's wattled bat (*Chalinolobus gouldii*)
- Little broad-nosed bat (*Scotorepens greyii*)
- Finlayson's cave bat (*Vespadelus finlaysoni*)

No bat species of conservation significance were detected through Anabat II recordings.

4.4 fauna assemblages

The database searches identified 151 species as potentially occurring within 40 km of the study area (**Appendix 3**). The results from this fauna survey recorded a total of 108 species within the study area or 71.5% of the expected species. The trapped species are displayed as captures per survey site in **Figure 5**. A comparison with previous surveys in the region is given in **Table 17**.

The number of species recorded for each assemblage from the study area is comparable to the other surveys conducted within the region. Ecoscape recorded 140 species from the Firetail Project area approximately 40 km to the east and can be seen as a direct comparison to this survey. The Ninox survey has higher numbers as these are combined results from Hamersley Range NP and Marandoo. The results show that this survey recorded similar numbers of species particularly when compared with the Ecologia survey of February 2010 (Ecologia 2010) and the Biota surveys of 2005 (Biota Environmental Sciences 2005). These results indicate that this survey adequately sampled the study area.

The results from this survey are of interest due to the disturbance effect of the February wildfire when compared to areas that were sampled in other areas where no fire effects were recorded. This may indicate that the majority of small terrestrial species are able to persist in patches of unburnt vegetation which would lead to the conclusion that the burnt areas will be readily repopulated when the vegetation returns.

Locations for conservation significant fauna species recorded are displayed on **Map 1** and listed in **Table 16**. The Pilbara Olive Python was observed at a water pool in Ajax valley and the Ghost Bat corpse was found in a cave near Eagle valley.

Table 16: Co-ordinates for location of conservation significant fauna species. Co-ordinates are given in GDA94 MGA 50 metres.

Scientific Name	Easting	Northing	Habitat Type
Liasis olivaceus barroni	538530	7554874	Ajax water pool
Dasyurus hallucatus	545678	7548668	Gorge
Macroderma gigas	550235	7555911	Cave in Eagle valley

Figure 5 Results of Species Captured in Trapping Survey

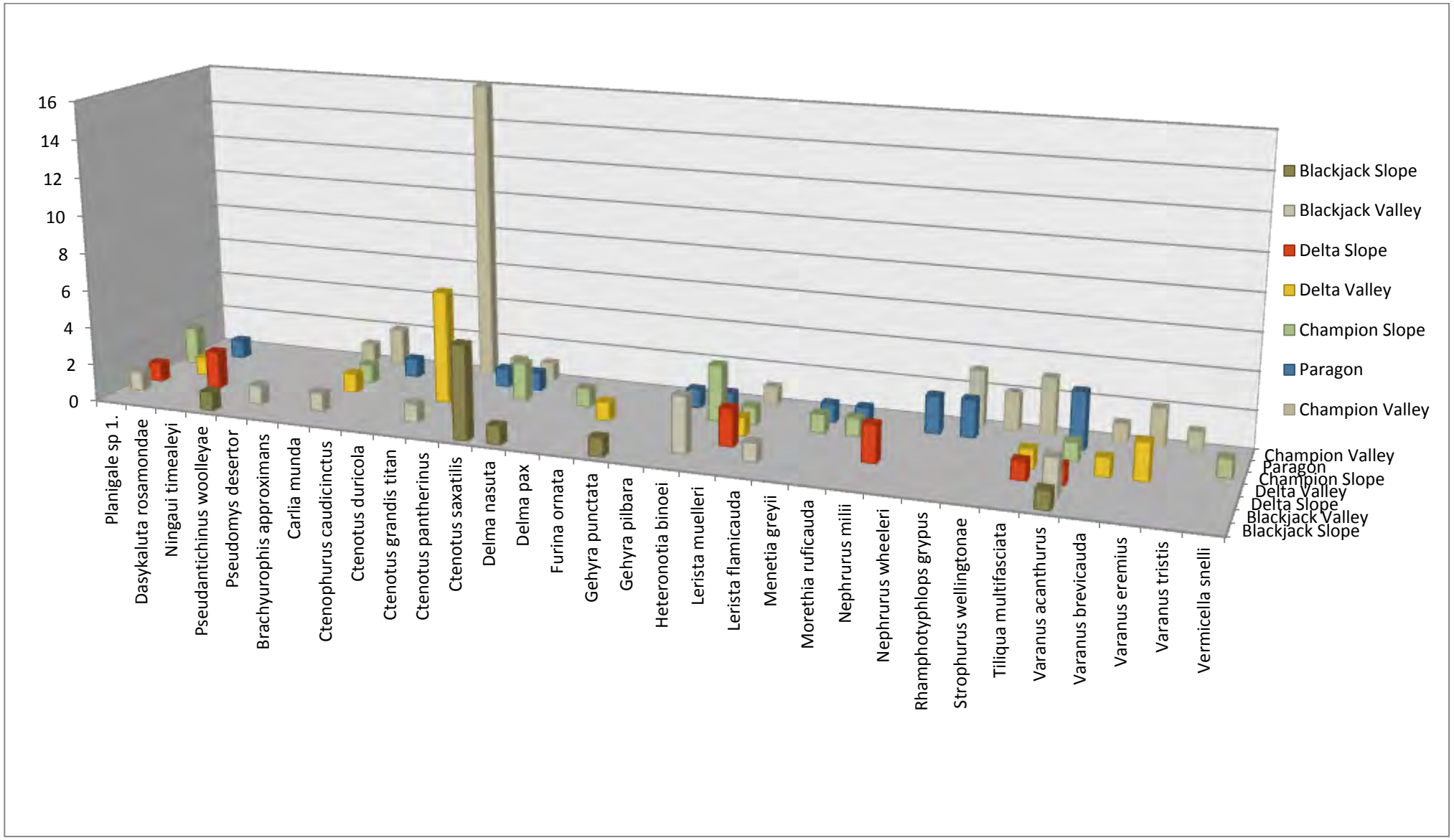

Table 17 Comparison of Number of Species Recorded with Previous Local Surveys

Survey	Survey Date	Survey Effort	Fauna Assemblage			Total Species
			Mammals	Birds	Reptiles	
Ecoscape this survey	October 2010	250 trap nights/site	13	46	47	105
Ecoscape and Coffey Environments 2010 – Firetail	Phase 1 Feb 2008; Phase 2 May 2010	400 trap nights/site	16	52	35	103
Ecologia Kings 2010	February 2010	400 trap nights/site	23	79	75	177
Biota 2005 – Brockman Syncline	October 2004; April 2005	400 trap nights/site	17	75	54	146
Biota 2005 – Mesa A and G	May 2004	75-100 trap nights /site	12	52	31	95
Ninox 1992 – Hamersley Range NP and Marandoo	June 1991; August 1991	None given	35	137	73	245

4.4.1 MAMMALS

Thirteen species of mammals were recorded from the three habitat types (**Table 23**). Seven families were represented in the study area. The most commonly represented families were Dasyuridae (4 species) and Vespertilionidae (3 species). In addition to the trapped animals, scats of the Northern Quoll were recorded from the gorges around Paragon, these scats were confirmed by DEC. Active mounds of the Western Pebble-mound Mouse were observed in numerous locations in the H1 habitats in Delta and Champion Valleys.

Feral Cats and Dingos were recorded during spotlight searches and occasionally in the early morning. Euros were infrequently observed in the Study Area possibly due to the effects of wildfire. Euro scats were abundant in the caves and along the ledges on the steep-sided gorge walls and some Rock Wallaby scats were also identified. As it is not possible to identify the specific Rock Wallaby species from scats alone an additional survey will be required to determine the species of Rock-wallaby in the study area. It is likely to be either Black-footed or Rothschild's. Cattle were seen frequently in the study area, and occasionally at other locations.

Three bat species were recorded at five recording sites surveyed (**Map 1**): *Chalinolobus gouldii*, *Scotorepens greyii* and *Vespadelus finlaysoni*. A dried corpse of a Ghost Bat (*Macroderma gigas*) was recorded just outside the study area in a cave to the south of Eagle Valley but was not recorded on Anabat equipment.

4.4.2 BIRDS

A total of 157 individuals were recorded, represented by 24 families and 46 species (**Table 23**) in the study area. Many species were in low abundance, and because the survey was undertaken at multiple sites over 10 days it is possible that some individuals would have been recorded on multiple occasions. Ecoscape sampled bird species over a 10 day period at Firetail recording 64 species which

is comparable and therefore indicates an adequate representation of the avifauna assemblage present in the study area at the time of survey.

On the whole, the bird fauna were sparse and calling minimally. Relatively few long diagnostic calls were being given, suggesting most birds were not maintaining territories or breeding. This is likely to be a result of the very dry climate this area has experienced recently, compounded by the effect of wildfire.

Much of the Pilbara is covered with spinifex (*Triodia* spp.), usually with scattered emergent shrubs and/or small trees, similar to the vegetation on the tenement. The bird species listed in **Table 23** are largely typical of the assemblage of birds expected in the *Triodia* grassland vegetation structure as determined recently by the Department of Environment and Conservation (Burbidge A. *et al.* 2010). In particular, Black-faced Woodswallow (aerial insectivore), Singing Honeyeater (arboreal insectivore), Zebra Finch (small seed eater), Willie Wagtail (aerial and gleaning insectivore), Torresian Crow (omnivore) and Brown Falcon (generalist carnivore) are found throughout the Pilbara both in this vegetation structure and in open arid and semi-arid areas generally (Burbidge A. *et al.* 2010). These species were reasonably abundant on the tenement. The Diamond Dove (medium sized seed eating birds) was not recorded on the tenement, as expected, but reasonable numbers of Crested Pigeons and some Spinifex Pigeons, which are also medium sized seed eating birds, were found.

Other birds that were common on the tenement included the Variegated Fairy-wren, Crested Bellbird, Magpie-lark, Yellow-throated Miner, Weebill, Rainbow Bee-eater, Pied Butcherbird, Nankeen Kestrel and Australian Ringneck. These species are also reasonably wide spread and commonly encountered in the Pilbara.

Further avifauna surveys of the *Triodia* grassland vegetation structure should not be necessary unless the re-growth, after the fire, reveals that there were other vegetation types present before the fire, which might have contained different avifaunal assemblages. In particular, bunch and tussock grassland vegetation, including *Eragrostis, Chrysopogon, Paspalidium* and *Aristida* species and well developed Mulga woodlands are known to support significantly different avifauna assemblages (Burbidge A. *et al.* 2010). However, these types of vegetation structures were not likely to have been present before the fire, as they are normally associated with clay soils, which appeared not to be present on the tenement (Lyn Atkins pers. comm.).

The Rainbow Bee-eater is listed on the Japan-Australia Migratory Bird Agreement requiring the Commonwealth to protect its habitat. However, this species is fairly widespread throughout this area and requires no particular habitat protection within the tenement. None of the other bird species scheduled under migratory bird agreements and listed in the Level 1 preliminary desktop study (Worley Parsons 2010) were found. Their habitat does not occur within the tenement, except possibly the Oriental Plover, which can be temporarily attracted to large areas of burnt spinifex.

However, as this species prefers flat grassland plains, they are unlikely to visit the tenement (Marchant and Higgins 1993).

Riparian areas are particularly important to birds in the Pilbara, reflected in their high species richness (Burbidge A. *et al.* 2010). These areas can provide surface water to birds and also a range of habitat found nowhere else. They can provide feeding substrates such as eucalypt tree trunks and branches and nesting places such as hollows. Where drinking water is available, the presence of this habitat exerts a fundamental influence on birds from neighbouring habitats: their distribution, daily habits and energetics. They are effectively long linear oases in dry times.

4.4.3 REPTILES

There were 47 reptile species recorded by Ecoscape. There were 10 families represented in the study area. The most commonly represented families are Scincidae (13 species) and Varanidae (6 species). Species were recorded from pit fall traps, funnels and hand searches (**Table 23**). Sampling was conducted similarly at the nearby FMG Firetail site, which yielded lower numbers and fewer species of reptile compared to this site. this suggests that the wildfire was not detrimental to sampling, in this instance, and may have even concentrated the reptiles. No further sampling should be required for reptiles.

A single specimen of the DEC listed P1 species *Ramphotyphlops ganei* was recorded at the camp site. Little is known of its biology, but it is believed that *R. ganei* prefer moist rocky gullies. As at Firetail a high number of Varanid species were observed adding to the richness of the reptile assemblages in the study area. One specimen of the EPBC listed Vulnerable species Pilbara Olive Python was recorded at the pool in Ajax Valley along with four individuals of Stimson's Python making this site of particular importance. This valley was not included in the trapping survey due to the severe effects of wildfire leaving little or no vegetation remaining, it was surveyed by hand searching and spotlighting due to the occurrence of water pools which were still holding water during the October survey period.

4.4.4 AMPHIBIANS

The water holes found within the study area at Ajax Valley produced only two species of amphibians with no fish species being recorded. These water sources are being heavily utilised by cattle and are possibly the only water sources for some distance, they are therefore heavily degraded and disturbed and as such the species composition was very much reduced.

4.4.5 INTRODUCED SPECIES

An increase in human activity is often associated with an increase in the abundance of feral species such as the House Mouse and Feral Cat. This increase may be due to a decline in habitat health, increased road kills and/or poor waste disposal practices.

The Dingo and Feral Cat were recorded in fauna surveys for the study area. The Feral Cat is a particularly damaging predator on native fauna and any increase in their numbers could have a detrimental effect of local native fauna (Kinnear 1993) hence it is important to ensure that populations of feral predators are controlled.

Minimising road kills, removing carcasses and good rubbish management practices around the mine and camp sites will assist in reducing these problems

4.5 data analysis

4.5.1 DIVERSITY, SIMILARITY AND EVENNESS

The diversity for the trapped fauna assemblage can be measured in numerous ways (Hayek and Buzas 1997; Magurran 2004). The four most common attributes are species richness, evenness, a single diversity score and relative abundance. These metrics are interrelated and there are a diverse number of analytical tools available to quantify these metrics and similarity among the trapped assemblages. Ecoscape has used Species Diversity and Richness software (Pisces Conservation 2010) to provide the results on the diversity indices for Shannon-Wiener (H), Simpson (D) and an evenness index (Smith and Wilson B). All indices take into account species richness and abundance data (**Table 18**).

Table 18 Indices of Diversity (H and D), Evenness (B) for each Site

Trap Site	Shannon-Wiener Index (H)	Simpson Index (D)	Evenness (Smith and Wilson B)	No. of Species Caught
Blackjack Slope	1.3	3.6	0.75	5
Blackjack Valley	1.8	11.3	0.89	7
Delta Slope	1.9	15.0	0.93	7
Delta Valley	1.8	5.7	0.78	8
Champion Slope	2.2	18.2	0.90	10
Champion Valley	1.9	4.4	0.65	12
Paragon	2.4	24.0	0.90	12
Combined Sites	2.9	14.1	0.61	32

The Shannon-Wiener Index, combines species richness (number of species) and equability (or evenness) and results show that the sites vary from low (1.3 Blackjack Slope) to moderate (2.4 Paragon) species diversity. When data from all sites were combined, the calculation produced an index of 2.9 suggesting moderate to high species diversity across the sampled sites, presumably because the abundance of species were relatively even across sites.

The Simpson Index is also used to quantify the species diversity. It also takes into account the species richness, but calculates evenness differently. Results indicate that richness and evenness varies considerably between sites.

The Smith and Wilson B index measures the variance in species abundances and ranges between 0 (minimum evenness) and 1 (maximum evenness) the results indicate that evenness is high for the sampled sites with the majority of sites recording an index of greater than 0.5.

In summary, when looking at the combined sites results the study area exhibits moderate to high diversity and high abundance giving high evenness scores. This may be indicative of the effects of fire experienced in the period prior to the survey, which may have concentrated species into the remaining vegetation. The trapping results for small mammals and reptiles showed that a high number of species were present.

4.6 conservation significance

4.6.1 CONSERVATION SIGNIFICANT FAUNA SPECIES RECORDED IN THE STUDY AREA

There were six conservation significant vertebrate fauna species identified from the survey:

- *Liasis olivaceus barroni* (Pilbara Olive Python) – Vulnerable under the EPBC Act (1999); Schedule 1 under Wildlife Conservation Act (1950)
- *Dasyurus hallucatus* (Northern Quoll) – Endangered under the EPBC Act (1999); Schedule 1 under Wildlife Conservation Act (1950)
- *Ramphotyphlops ganei* (a blind snake) – Priority 1 (DEC)
- *Merops ornatus* (Rainbow Bee-eater) – Migratory under the EPBC Act (1999)
- *Pseudomys chapmani* (Western Pebble-mound Mouse) - Priority 4 (DEC)
- *Macroderma gigas* (Ghost Bat) - Priority 4 (DEC).

4.6.2 SPECIES PROFILES OF RECORDED CONSERVATION SIGNIFICANT FAUNA SPECIES

Pilbara Olive Python (*Liasis olivaceus barroni*)

Conservation status

Wildlife Conservation Act (1950) Schedule 1, *EPBC Act (1999)* Vulnerable

Distribution and Preferred habitat

The species is restricted to ranges within the Pilbara region, north-western Western Australia, such as the Hamersley Range, and islands of the Dampier Archipelago. It is known to occur at 17 locations within the Pilbara (Pearson 1993). Four populations occur at Pannawonica, Millstream, Tom Price and Burrup Peninsula (Pearson 2003). Kendrick (2001) reported this species as common and wide-spread in the Pilbara and one that should not be listed as threatened or declining. The species is considered stable and in sizable numbers at some known sites (Pearson 2003). (Pearson 1992)

They are most often seen at night and are generally found around rocky areas, rocky outcrops and cliffs, particularly in the vicinity of watercourses and water holes, but they also shelter in logs, flood

debris, caves, tree hollows and thick vegetation. Habitat for this species is present within the Firetail study area.

Ecology

The Olive Python (Pilbara subspecies) is a dull olive-brown to pale fawn or rich brown python with a white/cream belly. The Pilbara Olive Python can grow to 4 m, but has an average size of 2.5 m (Cogger 2000). Females are slightly longer than males (Shine and Slip 1990).

Likelihood of Occurrence

Ecoscape recorded one individual at Ajax Creek (Plate 2) this species is likely to occur in other similar sites within the study area.

Potential Impacts

Mining activity has the potential to impact on this species by loss of habitat through clearing.

Northern Quoll (*Dasyurus hallucatus*)

Conservation status

Endangered under the *EPBC Act (1999)* and Schedule 1 under the *WC Act (1950)*

Distribution and preferred habitat

How et al. (1991) found this species at numerous locations on the Abydos Plains about 130km to the north-east. Coffey Environments' recent surveys along the rail line corridor from Cloud Break to Port Hedland found additional evidence of Northern Quoll in the vicinity of rocky outcrops, escarpments and vegetated plains. Fresh scats and tracks and possible den sites were seen along the base of gorges and under rock overhangs. The Northern Quoll was not recorded by Biota (2005b) at the Brockman Syncline 4 Project area but a skull was found in a cave at Mesa A Project area. It was not recorded at Marandoo by Ninox Wildlife Consulting (1992).

Ecology

The Northern Quoll is a medium-sized carnivorous marsupial that lives in the savannas of northern Australia. It is found from south eastern Queensland all the way to the northern Western Australian coast. Populations have declined across much of this range, particularly as a result of the spread of the Cane Toad.

Likelihood of Occurrence

Northern Quoll records for the study area are from fresh scats collected by Ecoscape from caves and overhangs along the creek walls, there were no recorded captures from the trapping sites. Coffey Environments however, reported an observation and three records from the Solomon Project area. Ecologia also recorded an observation for the Kings Project area.

Suitable habitat for the Northern Quoll is present in study area, in particular in the gorges. Assessing the potential risk associated with the proposed mining activity on the Northern Quoll is difficult in the absence of any published data on the spatial ecology of this species in the Pilbara.

Potential Impacts

Assessing the potential risk associated with the proposed mining activity on the Northern Quoll is difficult in the absence of any published data on the spatial ecology of this species in the Pilbara. However, it might be anticipated that vegetation clearing in the valleys and scree slopes could result in numerous individuals being displaced.

The identification of Northern Quoll scats from the study area is significant due to the Conservation status of the species and the unknown potential impacts that the introduced Cane Toad may have on the population.

Rainbow Bee-eater (*Merops ornata*)

Conservation status

EPBC Act (1999) Migratory.

Distribution and Preferred habitat

Rainbow Bee-eaters are found in most habitats throughout the Pilbara during the summer breeding season. They are scarce to common throughout much of Western Australia except for the arid interior, preferring lightly wooded, sandy country near water.

Ecology

This species migrates between Australia and Indonesia, moving south over summer and breeding in Australia. It nests in burrows dug usually at a slight angle on flat ground, sandy banks or cuttings, and often at the margins of roads or tracks.

Likelihood of Occurrence

This species was identified frequently and seen throughout the study area.

Potential Impacts

The Rainbow Bee-eater is abundant in many areas of Australia therefore Ecoscape considers it unlikely that the construction or operation of the proposed infrastructure and numerous mine sites will significantly impact on this species.

Western Pebble-mound Mouse (*Pseudomys chapmani*)

Conservation status

Priority 4 (DEC)

Distribution and Preferred habitat

Western Pebble-mound Mice are common in many parts of the Pilbara. The species is restricted to the non-coastal, central and eastern parts of the Pilbara, Western Australia, although it was formerly more widespread (IUCN 2007). The preferred habitat is gentle slopes of rocky ranges sparsely vegetated by *Triodia* grasses, *Senna, Acacia* and *Ptilotus* species.

Ecology

This species has recently been shown to have a reduced distribution, most likely due to fox and feral cat predation. Abandoned mounds found in Gascoyne and Murchison indicate a recent decline in distribution. The species does however appear secure in its remaining range (Start 2008). This species occurs across the central and southern Pilbara and into smaller ranges of the Little Sandy Desert.

Likelihood of Occurrence

The species is considered to occur in the study area as active and inactive mounds were observed during the surveys.

Potential Impacts

Numerous mounds were recorded in Delta and Champion Valleys on the mid-slopes.

The impacts from mining are considered not significant for the persistence of populations in the Pilbara due to the known spatial distribution across the region. Avoidance of lower and mid-slope regions will reduce potential impact to this species at a local scale.

Ghost Bat (*Macroderma gigas*)

Conservation status

This species was expected to be found in this habitat but did not appear on the DEC *Threatened and Priority Fauna* database search list (**Appendix Three**). It is listed as a Priority 4 species (DEC).

Distribution and Preferred habitat

The Ghost Bat is found predominantly in coastal areas and up to 400 km inland, throughout northern Australia, generally north of the Tropic of Capricorn. The Ghost Bat is also found in the Pilbara in Western Australia (Richards and Hand 1995), however, their range appears to have contracted northwards in relatively recent times, especially in Central Australia (Churchill and Helman 1990).

Ecology

This is Australia's only carnivorous bat, eating large insects, frogs, lizards, small birds and mammals. Tideman et al. (1985) reported Ghost Bats in the Northern Territory foraged, on average, 1.9km from their day roost, with a mean size of foraging area of 61ha. Their hunting behaviour utilised vantage points to detect prey with their eyes and ears, rather than using echolocation. These vantage points were changed about every 15min during foraging periods, with a mean distance of 360m between them. The Ghost Bat is an obligate troglodyte, and its survival is critically dependent on finding natural roosts in caves, crevices, deep overhangs and artificial roosts such as abandoned mines (adits).

Likelihood of Occurrence

A single dried corpse of a Ghost Bat was recorded during the survey in a cave just outside of the Study Area (**Plate 3**). Ghost Bats have been recorded in the Karijini National Park gorges and mine adits by Ninox Wildlife Consulting (1992) at Marandoo and by Biota (2005) during its Mesa A and G survey, but not at Brockman Syncline 4. It therefore appears that they are relatively common and widespread in the Pilbara as they are in the Kimberley. Given their preference for roosting in caves and the abundance of suitable caves and rock overhangs in the gorges, it is probable that the study area could support a population of Ghost Bats.

Potential Impacts

Known threats to the Ghost Bat are disturbance to roost sites from mining operations, collapse of old mine adits, barbed wire fences and human disturbance. Also suspected as threats are reduction in prey populations related to predation from cats and foxes, and changed fire regimes. The impact of the proposed mine is likely to be minimal providing activities are focussed on the valley floors and the mine is managed to prevent an increase in introduced predators.

4.6.3 SHORT RANGE ENDEMICS

SRE individuals sampled included araneomorph spiders (not target taxa for short-range endemic surveys and not forming part of this report), mygalomorph spiders (*Barychelidae: Synothele*) and pseudoscorpions in the family Olpiidae (*Beierolpium, Indolpium*). These samples contained no short-range endemic species (**Appendix 5**).

Scorpions identified by Erich Volschenk (Phoenix Environmental Sciences) confirmed that no SREs were collected within the scorpion group (**Appendix 5**).

5.0 discussion

5.1 adequacy of surveys

The targeted trapping surveys conducted by Ecoscape provided a total of 1575 trap nights at seven trap sites. Combined with preliminary surveys completed by highly experienced specialist zoologists, the surveys for vertebrate fauna were more than adequate to record and describe the fauna assemblages present in the study area (**Table 23**). This is based on the survey intensity and effort, as well as appropriate timing and the results of the trapping surveys when compared to other similar surveys i.e. Ecoscape (2010b).

The results from the combined preliminary and targeted surveys produced 383 records representing 105 species over approximately 1600 trap nights resulting in a trap success of approximately 6.6% per trap night. It is Ecoscape's opinion that this is a comparable number of captures based on sampling effort. The results are comparable to similar sized surveys in the region (**Table 3**). Forty six bird species were recorded from census activity across the study area, this compares to 79 and 75 bird species recorded by Ecologia from the Kings area and Biota from Brockman Mesa A and G surveys respectively, we assume the recent wildfire has reduced the populations of bird species within the study area. The preliminary survey provided observations of conservation significant fauna species i.e. Northern Quoll, Pilbara Olive Python and some species that are not readily trappable i.e. Western Pebble-mound Mouse and the blind snake species *Ramphotyphlops ganei*.

There is also the potential for the Schedule 1 species the Black-footed Rock-wallaby to occur, however the evidence is restricted to scats collected during the searching of caves and ledges high up in the landscape. It was not possible to make a definite identification as to whether the scats belong to the Black-footed or Rothschild's Rock-wallaby.

5.2 biodiversity value

EPA Position Statement No. 3 indicates an ecological assessment of a site must consider its biodiversity value at the genetic, species and ecosystem levels, and its ecological functional value at the ecosystem level (EPA 2002). There is insufficient information available to assess biodiversity at the genetic level.

From a fauna perspective, what remaining vegetation is in the study area can be described as being in good to high quality condition. Recent exploration activity has resulted in clearing exploration lines through the H1 habitat type.

Previous surveys undertaken in the Hamersley Ranges National Park and around Marandoo mine site were generally undertaken over a shorter period and using a reduced sampling intensity and design

than this survey. This survey therefore constitutes a major vertebrate survey for this region of the Hamersley Ranges and provides a good representation of the trappable vertebrate fauna assemblages.

5.3 ecological functional value at the ecosystem level

The reptile and small mammal assemblages in the study area are both species rich and diverse. The bat assemblage is considered typical of other sites in this section of the Hamersley Ranges. Ninox Wildlife Consulting (1992) reported five species of bats found within the vicinity of the Marandoo tenements, Biota (2005) reported five species of bats, including Ghost Bat, near Mesa A and G, and seven species at Brockman Syncline 4. Ecologia recorded 10 species from the Kings area, including Ghost Bat. The three species of bats recorded during these surveys were expected. None of the bat species recorded were new to the area.

Five species of small mammals in a relatively small area is considered to be a moderate density. Biota (2005) recorded seven species at Brockman Syncline 4 and four at Mesa A and G. and Ninox Wildlife Consulting (1992) caught nine species, one of which was an unidentified *Pseudomys*. Three of these species were not recorded during these surveys; *Pseudantechinus macdonnellensis*, *Sminthopsis ooldea* and *Notomys alexis*. The *P. macdonnellensis* was caught at a site some 100 km to the east. The *S. ooldea* was caught in mulga scrub and open mallee over mid-dense hummock grass south east of the Karijini National Park boundary and the *N. alexis* was caught about 100 km to the east of the Solomon Project on the edge of the Hamersley Ranges.

A total of 47 reptile species were trapped during the fauna surveys. This is compared with 35 species recorded by Ecoscape (2010a) and 54 reptile species recorded by Biota (2005) at Brockman Syncline 4, and 31 species at Mesa A and G, these surveys had similar survey efforts closest to the this study (**Table 3**). Ecologia (2010) reported 75 species of reptile using a similar trap effort to this survey and it is assumed that the timing produced a larger number of species caught. Johnstone (1983) in his summary based on WAM records and information collected from a variety of sources including his own survey reported 34 genera and 85 species of reptiles excluding tortoises for the Hamersley Ranges.

The amphibian and avian assemblages for this study are considered expected based on other survey results for this section of the Hamersley Ranges. Although the avian survey intensity was greater than that used for other mining projects in the area, the species richness was about the same.

In summary, the study area appears to have a high species richness of small trappable vertebrate fauna species compared to other sites surveyed in the region and a particularly high number of top-order reptile predators.

5.4 ecological processes and impact assessment

Many of the potential impacts of a proposed development on fauna can be linked to ecological processes. This is recognised under the EPBC Act (1999), in which threatening processes are listed. A number of ecological processes are relevant to the proposal and can be related to the potential impacts of the project upon fauna. These are discussed below.

5.4.1 INCREASED MORTALITY

Direct mortality of common species during clearing for the study area is unavoidable but can be minimised. Fragmentation of habitat can adversely affect wildlife and lead to mortality through collision with vehicles (Clevenger and Waltho 2000; Jackson and Griffin 2000; Scheick and Jones 1999). Direct and ongoing mortality (in particular from road collisions) may be a concern for the viability of species that occur at low population densities, especially the Northern Quoll.

5.4.2 LOSS OF HABITAT AFFECTING POPULATION SURVIVAL

The impact of clearing vegetation on fauna habitat is dependent on the location and extent of clearing. Clearing reduces the available amount of habitat, increases mortality through fragmentation and reducing the biodiversity and ecological function. Although the fauna habitats recorded are widespread throughout the region and significant impacts to regional biodiversity are not anticipated, there are likely to be reductions in diversity as fauna and fauna habitats within proposed development footprints are removed.

Fauna habitats along creeks and rocky gullies are moderately common in the region and provide a greater diversity of microhabitats for vertebrate fauna species than ridges or plains. Loss of these habitats will have a greater impact on the faunal assemblages of the immediate area, however they are common and reductions in diversity are expected to be localised.

Areas of *Triodia* grasslands on ridge and hill tops are relatively common across the study area and in the local region. There is potential for this habitat to support conservation significant species, however the level of impact expected and the large areas of similar habitat surrounding the study area would mean that no significant impacts on this fauna habitat are expected.

Some loss of habitat in the study area is unavoidable and can be minimised through controls during clearing. Excessive loss of habitat can reduce the size of a population to the point where it is unsustainable or more vulnerable to other impacts. Loss of habitat has greatest impact when a large proportion of habitat is lost, particularly rare habitats or in areas with extensive previous clearing. The Study Area is comprised of habitat types common to the greater Hamersley Range area and therefore this is not seen as a significant impact.

5.4.3 LOSS OF HABITAT AFFECTING POPULATION MOVEMENTS AND GENE FLOW

Loss of habitat can affect population survival through fragmentation particularly if the impacted habitat is linear and distinctive. This can occur in agricultural landscapes where remnant habitat is often linear, such as along roads, but also in substantially intact landscapes where there are distinctive habitats along watercourses or associated with geological features. The fragmentation or loss of habitat in the study area is not seen as a significant impact to the persistence of species occupying this landscape.

5.4.4 SPECIES INTERACTIONS, INCLUDING PREDATORS AND OVER-ABUNDANT NATIVE SPECIES

Introduced species, including the Feral Cat and Dingo may have adverse impacts upon native species, and the abundance of these species can alter during development projects. In particular, some mammal species are very sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by feral predators (Burbidge A.A. and McKenzie 1989). Changes in the abundance of some native species can also be a concern, such as the increase in abundance of some birds, at the expense of others, due to the provision of watering points. As both the Feral Cat and Dingo are already established in the study area, careful control and monitoring can maintain the current level of impact and perhaps reduce it through good house-keeping and waste management measures.

5.4.5 FIRE

Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Long-unburnt habitats are an important refuge for fauna, but some species require occasional fires, while a mosaic of fire ages may be important to provide both shelter and food resources within a home range. The occurrence of wildfires may be reduced as vegetation is cleared from the site and while this is not seen as a significant impact, there is a possibility that increased activity can be an ignition source resulting in an increase in small frequent fires. It is very important to minimize the possibility of extensive fire.

5.4.6 LIGHT AND NOISE POLLUTION

Activities associated with mining such as noise and lighting can impact on nearby resident fauna. The noise and vibrations associated with blasting and drilling may force some animals to move from the area. Continuous operations mean that much of the site will be lit at night. Lights have the potential to attract species that forage nocturnally on invertebrates that are attracted to the light and force other species to move away from the area. Both of these outcomes may alter the local fauna assemblages.

5.5 impacts on fauna habitat

5.5.1 BIODIVERSITY

The diversity of faunal assemblages of the Hamersley subregion as a whole is unlikely to be significantly affected by the proposal to undertake mining activity at the Flinders Project. Most terrestrial fauna species within the study area, however, are expected to be directly impacted by mortality or indirectly due to loss of habitat (**Table 19**).

Table 19 The potential impacts to fauna of the proposal as assessed following the guidance of the EPA's Guidance Statement No. 56 (Environmental Protection Authority 2004).

Factor	Impact and explanation
Degree of habitat degradation or clearing within the local area or region.	Low (project lies within of a region of continuous habitat with very little existing disturbance)
Size/scale of proposal/impact.	High (>50ha of remnant native vegetation may be disturbed - Bioregion Group 2).
Rarity of vegetation and landforms.	Low (impacted vegetation and landforms are extensive in sub-region).
Refugia.	Low (Vegetation types, soils and landforms are generally widespread).
Fauna protected under international agreements or treaties, Specially Protected or Priority Fauna.	Moderate (faunal assemblage includes species of high conservation significance but impacts on these species is expected to be low).
Size of remnant and condition/intactness of habitat and faunal assemblage.	Low (project area and surrounds comprises intact native vegetation)
Ecological linkage.	Low (vegetation types in project area are largely continuous)
Heterogeneity or complexity of the habitat and faunal assemblage.	Moderate (project area has a moderate habitat heterogeneity but lacks some vegetation and landform types that are important for biodiversity in the region)

6.0 conclusions

The study area is considered to be a typical landscape form of the Hamersley Ranges and did not yield any significant or poorly represented fauna species or habitat types. Six conservation significant fauna species were identified within the study area which were;

- *Liasis olivaceus barroni* (Pilbara Olive Python) – Vulnerable under the *EPBC Act (1999)*; Schedule 1 under *WC Act (1950)*
- *Dasyurus hallucatus* (Northern Quoll) – Endangered under the *EPBC Act (1999)*; Schedule 1 under *WC Act (1950)*
- *Ramphotyphlops ganei* (a blind snake) – Priority 1 (DEC)
- *Merops ornatus* (Rainbow Bee-eater) – Migratory under the *EPBC Act (1999)*
- *Pseudomys chapmani* (Western Pebble-mound Mouse) - Priority 4 (DEC)
- *Macroderma gigas* (Ghost Bat) - Priority 4 (DEC).

Ecoscape recommends that the Northern Quoll and the Pilbara Olive Python may require referral to DSEWPAC for assessment of potential impacts to their population status. Further investigation is required to definitively confirm the presence of the Pilbara Leaf-nosed Bat and Black-footed Rock-wallaby.

The following conclusions were determined through fauna survey:

- there are likely to be localised reductions in diversity as fauna and fauna habitats within proposed development footprints are disturbed and cleared of native vegetation
- the diversity of faunal assemblages of the subregion as a whole is unlikely to be significantly affected by the proposal to undertake mining activity
- Conservation significant species were identified in the area and the proposal is likely to result in some low level impacts on these species populations.

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appendix one: maps

536000 538000 540000 542000 544000 546000 548000 550000 552000 554000

7556000 7554000 7552000 7550000 7548000 7546000

BLACKJACK

AJAX

CHAMPION

PARAGON

DELTA

EAGLE

Olive Python

Northern Quoll

Ghost Bat

SITE: 1

SITE: 2

SITE: 3

SITE: 4

SITE: 5

SITE: 6

SITE: 7

See Enlargement A

Enlargement A

0 100 200 Meters

Legend

- Local Roads
- Hamersley Tracks
- Blacksmith Tenement
- Conservation Significant Fauna
- Anabat
- Camera
- Quoll trap site
- Fauna Survey Tracks
- Trap sites

GDA 1994 MGA Zone 50

Map 1

Feb 2011

Pilbara Iron Ore Project - Blacksmith Vertebrate and Short Range Endemic Survey

Vertebrate Trap Sites, Trail Camera and Anabat Locations

prepared for Flinders Mines Ltd

0 0.5 1 1.5 2 Km

1:50,000 @ A3

Project No. 2463-10

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Legend

- Local Roads
- Hamersley Tracks
- Blacksmith Tenement
- Recently Burnt Areas

Vertebrate Fauna Habitat Types

- H1 - Valley floors, including secondary drainage lines
- H2 - Slopes surrounding valleys
- H3 - Gorges

GDA 1994 MGA Zone 50

Pilbara Iron Ore Project - Blacksmith Vertebrate and Short Range Endemic Survey

Map 2

Vertebrate Fauna Habitat Types

Feb 2011

prepared for Flinders Mines Ltd

0 0.5 1 1.5 2 Km

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Project No. 2463-10

ecoscape

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BLACKJACK

PARAGON

AJAX

CHAMPION

DELTA

EAGLE

Legend

- Local Roads
- Hamersley Tracks
- Blacksmith Tenement

Short-range Endemic Sampling Sites

- Active Search Site
- Dry Pit
- Wet Pit

GDA 1994 MGA Zone 50

Map 3

Feb 2011

Pilbara Iron Ore Project - Blacksmith Vertebrate and Short Range Endemic Survey

Short-range Endemic Wet Pit Trap Site, Dry Pit Sites and Active Search Site Locations

prepared for Flinders Mines Ltd

0 0.5 1 1.5 2 Km

1:50,000 @ A3

Project No. 2463-10

ecoscape

appendix two: definitions and criteria

Table 20 EPBC Act categories.

EPBC Act Category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or 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	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time:
	(a) 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; or
	(b) the following subparagraphs are satisfied:
	(i) the species is a species of fish;
	(ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised;
	(iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory;
	(iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 21 Wildlife Conservation Act (1950) schedules and definitions.

Schedule	Definition
Schedule 1	Fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection
Schedule 2	Fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection
Schedule 3	Birds that 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 special protection
Schedule 4	Declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned in paragraphs (a), (b) and (c)- immediately below

Table 22 DEC definitions of Conservation Codes for fauna.

Code	Definition
T	Rare or likely to become extinct
X	Presumed extinct
IA	Protected under international agreement
S	Other specially protected fauna
One	Taxa with few, poorly known populations on threatened lands, defined as: 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 taxon9 needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Two	Taxa with few, or poorly known populations on conservation lands, defined as: 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.
Three	Taxa with several, poorly known populations, some on conservation lands, defined as: 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.
Four	Taxa in need of monitoring, defined as: 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.
Five	Taxa in need of monitoring, defined as: 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 three: trapping and database search results

Table 23 Results of Trapping and Reconnaissance Surveys (* denotes introduced species).

Family	Species	Common Name	Habitat Types	Number of Individuals	
				This Survey	Ecoscape Firetail
Mammals					
Canidae	**Canus familiaris*	Dingo	H1, H2, H3	3	3
Dasyuridae	*Ningaui timealeyi*	Pilbara Ningaui	H1, H2	2	-
	Pseudantechinus woolleyae	Woolley's False Antechinus	H2, H3	1	-
	Planigale sp 1.	Common Planigale	H2, H3	4	20
	Dasyurus hallucatus	Northern Quoll	H3	scat	scat
	Dasykaluta rosamondae	Kaluta	H2, H3	2	1
Felidae	**Felis catus*	Feral Cat	H1, H2, H3	1	2
Macropodidae	*Macropus robustus*	Euro	H1, H2, H3	1	14
	Petrogale sp		H3	1	1
Muridae	*Pseudomys desertor*	Desert Mouse	H1, H2, H3	1	10
	Pseudomys chapmani	Western Pebble-mound Mouse	H1	Active mounds	Active mounds
	Zyzomys argurus	Rock Rat	H3	1	8
Phalangeridae	*Trichosurus vulpecula*	Brush-tailed Possum	H1, H2, H3	1	2
Megadermatidae	*Macroderma gigas*	Ghost Bat	H1, H2, H3	1	-
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	H1, H2, H3	1	1
	Scotorepens greyii	Little Broad-nosed Bat	H1, H2, H3	1	1
	Vespadelus finlaysoni	Finlayson's Cave Bat	H1, H2, H3	1	1
			Total individuals	22	63
			Total species	17	12
Birds					
Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill	H1, H2, H3	1	4
Accipitridae	*Accipiter fasciatus*	Brown Goshawk	H1, H2, H3	1	2
	Aquila audax	Wedge-tailed Eagle	H1, H2, H3	1	-
Aegothelidae	*Aegotheles cristatus*	Owlet Night-jar	H1, H2, H3	-	1
Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher	H1, H2, H3	1	2
Ardeidae	*Egretta novaehollandiae*	White-faced Heron	H1	1	-
Artamidae	*Artamus cinereus*	Black-faced Woodswallow	H1, H2, H3	4	8
	Artamus personatus	Masked Woodswallow	H1, H2, H3	1	-
	Cracticus nigrogularis	Pied Butcherbird	H1, H2, H3	3	12
	Cracticus tibicen	Australian Magpie	H1, H2, H3	3	-
	Cracticus torquatus	Grey Butcherbird	H1, H2, H3	1	4
Campephagidae	*Eolophus roseicapillus*	Galah	H1, H2, H3	7	4
Casuariidae	*Dromaius novaehollandiae*	Emu	H1	2	-
Columbidae	*Geopelia cuneata*	Diamond Dove	H1, H2, H3	1	-
	Geophaps plumifera	Spinifex Pigeon	H1, H2	1	18
	Ocyphaps lophotes	Crested Pigeon	H1, H2	1	2
	Phaps chalcoptera	Common Bronzewing	H1, H2	2	1
Corvidae	*Corvus orru*	Torresian Crow	H1, H2, H3	3	6
Dicruridae	*Grallina cyanoleuca*	Magpie-lark	H1, H2, H3	2	8
	Rhipidura leucophrys	Willie Wagtail	H1, H2, H3	4	10
Falconidae	*Falco berigora*	Brown Falcon	H1, H2, H3	1	2
	Falco cenchroides	Nankeen Kestrel	H1, H2, H3	1	1
Maluridae	*Malurus lamberti*	Variegated Fairy-wren	H1, H2, H3	3	21

Family	Species	Common Name	Habitat Types	Number of Individuals	
	Malurus leucopterus	White-winged Fairy-wren	H1, H2, H3	1	-
Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater	H1, H2, H3	1	9
	Lichenostomus keartlandi	Grey-headed Honeyeater	H1, H2, H3	3	26
	Lichenostomus penicillatus	White-plumed Honeyeater	H1, H2, H3	1	9
	Lichenostomus virescens	Singing Honeyeater	H1, H2, H3	3	5
	Lichmera indistincta	Brown Honeyeater	H1, H2, H3	1	2
	Manorina flavigula	Yellow-throated Miner	H1, H2, H3	15	26
Meropidae	*Merops ornatus*	Rainbow Bee-eater	H1, H2, H3	10	24
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	H1, H2, H3	5	12
	Oreoica gutturalis	Crested Bellbird	H1, H2, H3	3	6
	Pachycephala rufiventris	Rufous Whistler	H1, H2, H3	2	4
Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote	H1, H2, H3	2	-
	Pardalotus striatus	Striated Pardalote	H1, H2, H3	1	-
	Smicrornis brevirostris	Weebill	H1, H2, H3	8	11
Passeridae	*Emblema pictum*	Painted Finch	H1, H2, H3	21	6
	Taeniopygia guttata	Zebra Finch	H1, H2, H3	20+	30+
Petroicidae	*Melanodryas cucullata*	Hooded Robin	H1, H2, H3	2	1
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	H1, H2, H3	1	3
Psittacidae	*Barnardius zonarius*	Australian Ringneck	H1, H2, H3	6	15
Ptilonorhynchidae	*Ptilonorhynchus guttatus*	Western Bowerbird	H3	2	2
Sylviidae	*Eremiornis carteri*	Spinifex bird	H1, H2	3	1
Turnicidae	*Turnix sp.*	Button-quail sp.	H1, H2	1	2
			Total individuals	157	300
			Total species	45	37
Reptiles					
Agamidae	*Amphibolurus longirostris*	Long-nosed Water Dragon	H1, H2, H3	3	1
	Ctenophorus caudicinctus	Ring-tail Dragon	H1, H2, H3	6	4
	Ctenophorus isolepis	Military Dragon	H1, H2, H3	2	-
	Pogona minor mitchelli	Bearded Dragon	H1, H2, H3	3	1
Boidae	*Antaresia stimsoni*	Stimson's Python	H1, H3	4	1
	Liasis olivaceus barroni	Pilbara Olive Python	H1, H3	1	1
Carphodactylidae	*Nephrurus milii*	Barking Gecko	H1, H2	2	1
	Nephrurus wheeleri	Banded Knob-tailed Gecko	H1, H2	2	1
Diplodactylidae	*Diplodactylus conspicillatus*	Fat-tailed Gecko	H1, H2	1	-
	Diplodactylus savagei		H3	1	-
	Oedura marmorata	Velvet Gecko	H3	17	1
	Strophurus wellingtonae	Spiny-tailed Gecko	H3	2	2
Elapidae	*Brachyurophis approximans*	Pilbara Shovel-nosed Snake	H1, H2	1	1
	Furina ornata	Moon Snake	H1, H2	1	1
	Pseudechis australis	Mulga snake	H1, H2	1	1
	Vermicella snelli	Pilbara Bandy Bandy	H1, H2	1	-
Gekkonidae	*Crenadactylus ocellatus*	Clawless Gecko	H3	1	-
	Gehyra pilbara		H3	1	-
	Gehyra punctata	Spotted Dtella	H3	38	2
	Heteronotia binoei	Binoe's Gecko	H1, H2, H3	9	3
	Heteronotia spelea	Desert Cave Gecko	H3	2	-
Pygopodidae	*Delma butleri*	Legless lizard	H1, H2	1	1
	Delma elegans	Legless lizard	H1, H2	1	1
	Delma nasuta		H1, H2	1	1

Family	Species	Common Name	Habitat Types	Number of Individuals	
	Delma pax	Peaceful Delma	H1, H2, H3	1	8
	Lialis burtonis	Burton's legless lizard	H1, H2, H3	1	1
Scincidae	*Carlia munda*	Rainbow Skink	H1, H2, H3	7	5
	Cryptoblepharus ustulatus	Sun Skink	H1, H2, H3	1	2
	Ctenotus duricola	Striped Skink	H1, H2	1	-
	Ctenotus grandis titan	Titan Skink	H1, H2	23	12
	Ctenotus pantherinus	Leopard Skink	H1, H2	4	2
	Ctenotus saxatilis	Striped Rock Skink	H1, H2	13	36
	Cyclodomorphus m. melanops	Spinifex slender blue-tongue	H1, H2	1	1
	Eremiascincus fasciolatus	Narrow-banded sand swimmer	H3	1	-
	Lerista flammicauda	Flame-tailed Skink	H1, H2	3	-
	Lerista muelleri	Muelleri Skink	H1, H2	5	-
	Menetia greyii	Dwarf Skink	H1, H2	3	8
	Morethia ruficauda	Fire-tailed Skink	H1, H2	5	-
	Tiliqua multifasciata	Central Blue-tongue	H1, H2	5	1
Typhlopidae	*Ramphotyphlops ganei*		H1, H2	1	-
	Ramphotyphlops grypus	Beaked Blind Snake	H1, H2	5	1
Varanidae	*Varanus acanthurus*	Ridge-tailed Monitor	H1, H2, H3	8	2
	Varanus brevicauda	Short-tailed Pygmy Monitor	H1, H2, H3	3	-
	Varanus eremius	Rusty Desert Monitor	H1, H2, H3	4	-
	Varanus giganteus	Perentie	H1, H2, H3	1	1
	Varanus panoptes	Yellow-spotted Monitor	H1, H2, H3	2	1
	Varanus tristis	Black-tailed Monitor	H1, H2, H3	1	1
			Total individuals	205	109
			Total species	47	35
Amphibians					
Hylidae	*Litoria rubella*	Desert tree frog		2	2
Myobatrachidae	*Uperoleia glandulosa*	Glandular toadlet		2	3
			Total individuals	4	5
			Total species	2	2

Table 24 Fauna list from NatureMap search.

Species	Common Name	This Survey	EPBC Act	WC Act
Acanthiza apicalis	Broad-tailed Thornbill (Inland Thornbill	X		
Acanthiza robustirostris	Slaty-backed Thornbill			
Acanthiza uropygialis	Chestnut-rumped Thornbill			
Accipiter fasciatus subsp. didimus				
Amphibolurus longirostris		X		
Antaresia stimsoni	Stimson's Python	X		
Aquila audax	Wedge-tailed Eagle	X		
Ardea pacifica	White-necked Heron	X		
Artamus cinereus subsp. melanops				
Cacatua roseicapilla	Galah	X		
Cacatua sanguinea	Little Corella			
Canis lupus subsp. dingo	Dingo	X		
Carlia munda		X		

Species	Common Name	This Survey	EPBC Act	WC Act
Chaerephon jobensis	Northern Freetail-bat			
Chalinolobus gouldii	Gould's Wattled Bat	X		
Cincloramphus cruralis	Brown Songlark			
Cincloramphus mathewsi	Rufous Songlark			
Colluricincla harmonica subsp. brunnea				
Coracina novaehollandiae subsp. novaehollandiae				
Corvus orru	Torresian Crow	X		
Corvus orru subsp. cecilae	Western Crow			
Coturnix ypsilophora subsp. cervina				
Cracticus nigrogularis	Pied Butcherbird	X		
Cracticus tibicen	Australian Magpie	X		
Cracticus tibicen subsp. tibicen	Black-backed Magpie			
Cryptoblepharus buchananii				
Cryptoblepharus ustulatus		X		
Ctenophorus caudicinctus subsp. caudicinctus		X		
Ctenophorus caudicinctus subsp. mensarum				
Ctenophorus isolepis subsp. citrinus		X		
Ctenophorus isolepis subsp. isolepis				
Ctenophorus reticulatus	Western Netted Dragon			
Ctenotus duricola		X		
Ctenotus grandis subsp. grandis				
Ctenotus grandis subsp. titan		X		
Ctenotus helenae				
Ctenotus pantherinus subsp. acripes		X		
Ctenotus pantherinus subsp. ocellifer				
Ctenotus robustus				
Ctenotus rutilans				
Ctenotus saxatilis	Rock Ctenotus	X		
Cuculus pallidus	Pallid Cuckoo			
Cyclodomorphus melanops subsp. melanops		X		
Cyclorana maini	Sheep Frog			
Delma nasuta		X		
Delma pax		X		
Delma tincta				
Demansia psammophis subsp. cupreiceps				
Demansia rufescens	Rufous Whipsnake			
Dicaeum hirundinaceum subsp. hirundinaceum				
Diplodactylus conspicillatus	Fat-tailed Gecko			
Diplodactylus savagei		X		
Egernia formosa				

Species	Common Name	This Survey	EPBC Act	WC Act
Emblema pictum	Painted Finch	X		
Eremiascincus richardsonii	Broad-banded Sand Swimmer	X		
Eremiornis carteri	Spinifex-bird			
Falco berigora subsp. berigora		X		
Falco cenchroides subsp. cenchroides		X		
Falco longipennis subsp. longipennis				
Felis catus	Cat	X		
Gehyra pilbara		X		
Gehyra punctata		X		
Gehyra variegata		X		
Geopelia cuneata	Diamond Dove	X		
Geopelia striata subsp. placida				
Geophaps plumifera	Spinifex Pigeon	X		
Gerygone fusca subsp. fusca				
Grallina cyanoleuca	Magpie-lark	X		
Hamirostra isura	Square-tailed Kite			
Heteronotia binoei	Bynoe's Gecko	X		
Heteronotia spelea	Desert Cave Gecko	X		
Hirundo nigricans subsp. nigricans				
Lacustroica whitei	Grey Honeyeater			
Lagorchestes conspicillatus subsp. leichardti	Spectacled Hare-wallaby			P3
Lalage tricolor	White-winged Triller			
Leggadina lakedownensis	Short-tailed Mouse			P4
Lerista flammicauda		X		
Lerista muelleri		X		
Lerista verhmens				
Lialis burtonis		X		
Lichenostomus keartlandi	Grey-headed Honeyeater	X		
Lichenostomus penicillatus	White-plumed Honeyeater	X		
Lichenostomus virescens	Singing Honeyeater	X		
Lichmera indistincta subsp. indistincta		X		
Lophognathus longirostris				
Lucasium stenodactylum				
Lucasium wombeyi				
Macroderma gigas	Ghost Bat	X		P4
Macropus robustus subsp. erubescens)	Euro, Biggada	X		
Macropus rufus	Red Kangaroo, Marlu			
Malurus lamberti subsp. assimilis		X		
Manorina flavigula	Yellow-throated Miner	X		
Melopsittacus undulatus	Budgerigar			
Menetia greyii		X		
Menetia surda subsp. surda				

Species	Common Name	This Survey	EPBC Act	WC Act
Merops ornatus	Rainbow Bee-eater	X	Migr.	
Mirafra javanica	Horsfield's Bushlark (Singing Bushlark)			
Mirafra javanica subsp. horsfieldii				
Morethia ruficauda subsp. exquisita				
Mormopterus beccarii	Beccari's Freetail-bat			
Mus musculus	House Mouse			
Nephrurus wheeleri subsp. cinctus		X		
Ningaui timealeyi	Pilbara Ningaui	X		
Notoscincus butleri				P4
Nymphicus hollandicus	Cockatiel			
Ocyphaps lophotes	Crested Pigeon			
Oedura marmorata	Marbled Velvet Gecko	X		
Oreoica gutturalis	Crested Bellbird	X		
Pachycephala rufiventris subsp. Rufiventris		X		
Pardalotus rubricatus	Red-browed Pardalote	X		
Pardalotus striatus subsp. Uropygialis				
Petroica cucullata	Hooded Robin	X		
Planigale ingrami	Long-tailed Planigale	X		
Platycercus zonarius subsp. Zonarius		X		
Pogona minor subsp. minima	Dwarf Bearded Dragon	X	VU	
Pogona minor subsp. minor				
Pomatostomus temporalis subsp. Rubeculus		X		
Pseudantechinus woolleyae	Woolley's Pseudantechinus	X		
Pseudechis australis	Mulga Snake	X		
Pseudomys chapmani	Western Pebble-mound Mouse	X		P4
Pseudomys desertor	Desert Mouse	X		
Pseudomys hermannsburgensis	Sandy Inland Mouse			
Pygopus nigriceps				
Ramphotyphlops ammodytes				
Ramphotyphlops grypus		X		
Ramphotyphlops hamatus				
Ramphotyphlops pilbarensis				
Rhipidura leucophrys subsp. Leucophrys		X		
Rhynchoedura ornata	Beaked Gecko	X		
Scotorepens greyii	Little Broad-nosed Bat	X		
Smicrornis brevirostris	Weebill	X		
Sminthopsis longicaudata	Long-tailed Dunnart			P4
Sminthopsis macroura	Stripe-faced Dunnart			
Stipiturus ruficeps subsp. ruficeps				
Strophurus elderi				

Species	Common Name	This Survey	EPBC Act	WC Act
Strophurus wellingtonae		X		
Tachyglossus aculeatus	Echidna			
Taeniopygia guttata subsp. Castanotis				
Taphozous georgianus	Common Sheathtail-bat			
Taphozous hilli	Hill's Sheathtail-bat			
Todiramphus pyrrhopygia	Red-backed Kingfisher			
Turnix velox	Little Button-quail	X		
Tympanocryptis cephalus	Pebble Dragon			
Uperoleia russelli	Northwest Toadlet	X		
Varanus acanthurus	Spiny-tailed Monitor	X		
Varanus brevicauda	Short-tailed Pygmy Monitor	X		
Varanus eremius	Pygmy Desert Monitor	X		
Varanus tristis subsp. tristis	Racehorse Monitor	X		
Vermicella snelli		X		
Vespadelus finlaysoni	Finlayson's Cave Bat	X		
Zyzomys argurus	Common Rock-rat	X		

Table 25 Australian Bird Atlas database search results.

Species	Common Name	DEC	EPBC Act	WC Act
Dromaius novaehollandiae	Emu			
Coturnix ypsilophora	Brown Quail			
Dendrocygna eytoni	Plumed Whistling-Duck			
Cygnus atratus	Black Swan			
Chenonetta jubata	Australian Wood Duck			
Malacorhynchus membranaceus	Pink-eared Duck			
Anas gracilis	Grey Teal			
Anas superciliosa	Pacific Black Duck			
Aythya australis	Hardhead			
Tachybaptus novaehollandiae	Australasian Grebe			
Poliocephalus poliocephalus	Hoary-headed Grebe			
Phaps chalcoptera	Common Bronzewing			
Ocyphaps lophotes	Crested Pigeon			
Geophaps plumifera	Spinifex Pigeon			
Geopelia cuneata	Diamond Dove			
Geopelia striata	Peaceful Dove			
Podargus strigoides	Tawny Frogmouth			
Eurostopodus argus	Spotted Nightjar			
Aegotheles cristatus	Australian Owlet-nightjar			
Anhinga novaehollandiae	Australasian Darter			
Microcarbo melanoleucos	Little Pied Cormorant			
Phalacrocorax sulcirostris	Little Black Cormorant			

Species	Common Name	DEC	EPBC Act	WC Act
Pelecanus conspicillatus	Australian Pelican			
Ardea pacifica	White-necked Heron			
Ardea modesta	Eastern Great Egret			
Egretta novaehollandiae	White-faced Heron			
Nycticorax caledonicus	Nankeen Night-Heron			
Threskiornis spinicollis	Straw-necked Ibis			
Elanus axillaris	Black-shouldered Kite			
Haliastur sphenurus	Whistling Kite			
Accipiter fasciatus	Brown Goshawk			
Accipiter cirrocephalus	Collared Sparrowhawk			
Circus assimilis	Spotted Harrier			
Aquila audax	Wedge-tailed Eagle			
Hieraaetus morphnoides	Little Eagle			
Falco cenchroides	Nankeen Kestrel			
Falco berigora	Brown Falcon			
Falco longipennis	Australian Hobby			
Falco peregrinus	Peregrine Falcon			
Gallirallus philippensis	Buff-banded Rail			
Porzana pusilla	Baillon's Crake			
Tribonyx ventralis	Black-tailed Native-hen			
Fulica atra	Eurasian Coot			
Ardeotis australis	Australian Bustard	P4		
Burhinus grallarius	Bush Stone-curlew	P4		
Himantopus himantopus	Black-winged Stilt			
Elseyornis melanops	Black-fronted Dotterel			
Actitis hypoleucos	Common Sandpiper			
Turnix velox	Little Button-quail			
Eolophus roseicapillus	Galah			
Cacatua sanguinea	Little Corella			
Nymphicus hollandicus	Cockatiel			
Barnardius zonarius	Australian Ringneck			
Melopsittacus undulatus	Budgerigar			
Centropus phasianinus	Pheasant Coucal			
Chalcites basalis	Horsfield's Bronze-Cuckoo			
Chalcites osculans	Black-eared Cuckoo			
Cacomantis pallidus	Pallid Cuckoo			
Ninox novaeseelandiae	Southern Boobook			
Tyto javanica	Eastern Barn Owl			
Dacelo leachii	Blue-winged Kookaburra			
Todiramphus pyrrhopygia	Red-backed Kingfisher			
Todiramphus sanctus	Sacred Kingfisher			
Merops ornatus	Rainbow Bee-eater		Migr.	

Species	Common Name	DEC	EPBC Act	WC Act
Ptilonorhynchus guttatus	Western Bowerbird			
Malurus leucopterus	White-winged Fairy-wren			
Malurus lamberti	Variegated Fairy-wren			
Stipiturus ruficeps	Rufous-crowned Emu-wren			
Amytornis striatus	Striated Grasswren			
Pyrrholaemus brunneus	Redthroat			
Smicrornis brevirostris	Weebill			
Gerygone fusca	Western Gerygone			
Acanthiza robustirostris	Slaty-backed Thornbill			
Acanthiza chrysorrhoa	Yellow-rumped Thornbill			
Acanthiza uropygialis	Chestnut-rumped Thornbill			
Pardalotus rubricatus	Red-browed Pardalote			
Pardalotus striatus	Striated Pardalote			
Lichenostomus virescens	Singing Honeyeater			
Lichenostomus keartlandi	Grey-headed Honeyeater			
Lichenostomus penicillatus	White-plumed Honeyeater			
Manorina flavigula	Yellow-throated Miner			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater			
Conopophila whitei	Grey Honeyeater			
Epthianura tricolor	Crimson Chat			
Lichmera indistincta	Brown Honeyeater			
Melithreptus gularis	Black-chinned Honeyeater			
Pomatostomus temporalis	Grey-crowned Babbler			
Pomatostomus superciliosus	White-browed Babbler			
Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush			
Daphoenositta chrysoptera	Varied Sittella			
Coracina novaehollandiae	Black-faced Cuckoo-shrike			
Lalage sueurii	White-winged Triller			
Pachycephala rufiventris	Rufous Whistler			
Colluricincla harmonica	Grey Shrike-thrush			
Oreoica gutturalis	Crested Bellbird			
Artamus personatus	Masked Woodswallow			
Artamus cinereus	Black-faced Woodswallow			
Artamus minor	Little Woodswallow			
Cracticus torquatus	Grey Butcherbird			
Cracticus nigrogularis	Pied Butcherbird			
Cracticus tibicen	Australian Magpie			
Rhipidura albiscapa	Grey Fantail			
Rhipidura leucophrys	Willie Wagtail			
Corvus bennetti	Little Crow			
Corvus orru	Torresian Crow			
Grallina cyanoleuca	Magpie-lark			

Species	Common Name	DEC	EPBC Act	WC Act
Petroica goodenovii	Red-capped Robin			
Melanodryas cucullata	Hooded Robin			
Mirafra javanica	Horsfield's Bushlark			
Acrocephalus australis	Australian Reed-Warbler			
Cincloramphus mathewsi	Rufous Songlark			
Cincloramphus cruralis	Brown Songlark			
Eremiornis carteri	Spinifexbird			
Petrochelidon ariel	Fairy Martin			
Petrochelidon nigricans	Tree Martin			
Dicaeum hirundinaceum	Mistletoebird			
Taeniopygia guttata	Zebra Finch			
Neochmia ruficauda	Star Finch			
Emblema pictum	Painted Finch			
Anthus novaeseelandiae	Australasian Pipit			

appendix four: photographs

Plate 2 Pilbara Olive Python.

Plate 3 Ghost Bat Corpse.

Plate 4 A Pebble Mound monitored with a trail camera.

Plate 5 Fauna habitat H1 typical vegetation cover and habitat condition.

Plate 6 Fauna habitat H2 typical vegetation cover and habitat condition.

Plate 7 Fauna habitat H3 typical vegetation cover and habitat condition.

Plate 8 Champion valley.

Plate 9 Delta valley.

Plate 10 SRE wet pit trap site, Delta valley and active search site.

Plate 11 SRE wet pit trap site, Black Jack valley and active search site.

Plate 12 Delta gorge and upper slopes.

Plate 13 Champion low slopes.

Plate 14 SRE active search site, Champion valley hillside.

Plate 15 Champion valley.

Plate 16 SRE active search site, Delta valley, open spinifex and Acacia.

Plate 17 SRE active search site, Delta valley.

Plate 18 Paragon slope.

appendix five: SRE technical reports

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BLACKJACK

AJAX

CHAMPION

PARAGON

DELTA

EAGLE

Legend

- Local Roads
- Hamersley Tracks
- Blacksmith Tenement
- Recently Burnt Areas

Short-range Endemic Sampling Sites

- Active Search Site
- Dry Pit
- Wet Pit

GDA 1994 MGA Zone 50

Map 3

Feb 2011

Pilbara Iron Ore Project - Blacksmith Vertebrate and Short Range Endemic Survey

Short-range Endemic wet pit trap site, dry pit sites and active search site locations

prepared for Flinders Mines Ltd

0 0.5 1 1.5 2 Km

1:50,000 @ A3

Project No. 2463-10

ecoscape

The Short-range Endemic Invertebrate Fauna 60km NW of Tom Price (Western Australia)

Report to *Ecoscape*

26 November 2010

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Summary

The samples from 60km NW of Tom Price submitted to the Western Australian Museum on the 1st November 2010 (accession no. A6817) included araneomorph spiders (not target taxa for short-range endemic surveys and not forming part of this report), mygalomorph spiders (Barychelidae: *Synothele*) and pseudoscorpions in the family Olpiidae (*Beierolpium*, *Indolpium*). None of these species are considered to represent short-range endemic species.

Scorpions were registered with Arachnology and Myriapoda collection of the WAM and forwarded to Erich Volschenk (Phoenix Environmental Sciences) (erich.volschenk@phoenixenv.com.au) for identification and direct reporting to *Ecoscape*.

Short-Range Endemism

The terrestrial invertebrate fauna of inland Australia contains a plethora of species, and the arthropods alone were recently estimated to consist of more than 250,000 species (Yeates *et al.* 2004; Chapman 2009). The vast majority of these are found within the Insecta and Arachnida, although significant numbers of millipedes are to be expected. For many years, the prospect of including invertebrates in assessments of biological systems subject to alteration proved daunting, and were largely ignored as being too diverse and too difficult to comprehend to satisfy the rapid turn-around needed for environmental surveys.

In a recent publication, the issue of Short-Range Endemism in the Australian invertebrate fauna was examined (Harvey 2002) and series of major groups were nominated as having a very high proportion of individual species that satisfied a certain set of criteria. The main criterion nominated for inclusion as a Short-Range Endemic (SRE) was that the species had a naturally small range of less than 10,000 km^2. Harvey (Harvey 2002) found that those species possessed a series of ecological and life-history traits, including:

- poor powers of dispersal;
- confinement to discontinuous habitats;
- usually highly seasonal, only active during cooler, wetter periods; and
- low levels of fecundity.

The Western Australian fauna contains a number of SRE taxa, including millipedes, land snails, trap-door spiders, some pseudoscorpions, slaters, and onychophorans, that should be considered in Environmental Impact Assessment studies (EPA 2009). The south coast region is relatively well known compared with other regions of the state (Framenau *et al.* 2008) but there are many poorly known species and gaps in our understanding of the distributions of many species.

Methods

The short-range endemic fauna of from 60km NW of Tom Price submitted to the Western Australian Museum on the 1st November 2010 (accession no. A6817) was assessed by examination of araneomorph and mygalomorph spiders and millipedes collected by staff from *Outback Ecology*. The specimens were examined using Leica dissecting microscopes (MZ6 & MZ16). Scorpions were registered with Arachnology and Myriapoda collection of the WAM and forwarded to Erich Volschenk (Phoenix Environmental Sciences) (erich.volschenk@phoenixenv.com.au) for identification and direct reporting to *Ecoscape*.

ARANEAE (spiders)

Infraorder Mygalomorphae (Trapdoor Spiders)

Mygalomorph ("trapdoor") spiders belong to one of the focal groups in surveys of short-range endemic taxa (Harvey 2002). Many mygalomorph spiders show low dispersal capabilities, may be restricted to relictual habitats, and have long life cycles with low fecundity. A number of mygalomorph spiders, e.g. *Idiosoma nigrum*, *Kwonkan eboracum*, *Moggridgea tingle*, are listed on Schedule 1 ("Fauna that is rare or likely to become extinct" of the Wildlife Conservation (Specially Protected Fauna) Notice 2010(2) of the Western Australian Government. The Western Australian mygalomorph fauna is vast and, despite long-term and ongoing research by Drs Barbara Main (University of Western Australia) and Robert Raven (Queensland Museum), remains taxonomically poorly known for many families and genera (e.g. Barychelidae: *Idiommata*; Idiopidae: *Aganippe*; Nemesiidae: *Aname*, *Chenistonia*, *Kwonkan*).

The best taxonomic features to distinguish mygalomorph spiders are found within the genitalia of males. Females or juveniles may be indistinguishable, although burrow morphology may allow identification to species level in some cases (B.Y. Main, personal communication). The Western Australian Museum has recently initiated a reference collection of male mygalomorph morphospecies to facilitate an assessment of distribution patterns of these spiders. This collection is assembled in cooperation with Dr Barbara Main and will eventually be consolidated with her collection at the University of Western Australia. Mygalomorph morphospecies are consecutively numbered ("MYG001", "MYG002" etc.) to allow a comparison of taxa between different surveys.

Family Barychelidae (Brush-footed Trapdoor Spiders)

Members of the Barychelidae, the "Brush-footed Trapdoor Spiders" are cryptic spiders. Their burrow often lacks the firm and thick door of the Idiopidae or the extensive web of the Dipluridae (Raven 1994). Five genera are known to occur in Western Australia, namely *Aurecocrypta*, *Mandjelia*, *Moruga*, *Synothele* and *Idiommata*.

Synothele 'MYG127` (family Barychelidae)

The genus *Synothele* is widespread throughout Western and South Australia and a number of species are currently described from Western Australia, some of them with narrow known distributions (Raven 1994). Two male *Synothele* `MYG127` were collected 60km NW of Tom Price (Appendix 1). This species is apparently widespread throughout the Pilbara region of Western Australia and not considered a short-range endemic species.

PSEUDOSCORPIONS

The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats.

Family Olpiidae

Beierolpium `sp. 8/4` (family Olpiidae)

A single specimen of *Beierolpium* `sp. 8/4` was collected 60km NW of Tom Price (Appendix 1). The systematic status of members of this genus has not been fully assessed. At present it is not possible to firmly establish the identity of these species until a complete systematic revision of the Western Australian members of *Beierolpium* is undertaken. It is possible that these specimens represent short-range endemic species, but a full taxonomic revision of the genus *Beierolpium* in Western Australia is necessary to confirm their status.

Indolpium sp. (family Olpiidae)

The specimens collected 60km NW of Tom Price (Appendix 1) comprise a single species and extremely similar specimens have been collected from other regions of Western Australia, suggesting that only a single species is involved. Based on our current levels of knowledge, it is unlikely that this species is a short-range endemic species.

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Appendix 1. Identification of short-range endemic fauna 60km NW of Tom Price.

REGNO	FLDNO	ORDER	FAMILY	GENUS	SPECIES	SITE	LATITUDE	LONGITUDE	NO
107920	Delta Valley	Araneae	Barychelidae	*Synothele*	`MYG127`	60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107919	Delta Valley	Araneae	Barychelidae	*Synothele*	`MYG127`	60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107921	Little A	Pseudoscorpiones	Olpiidae	*Indolpium*		60km NW Tom Price;	22°06’03”S	117°29’37”E	1
107922	Delta Valley	Pseudoscorpiones	Olpiidae	*Indolpium*		60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107923	Delta Valley	Pseudoscorpiones	Olpiidae	*Beierolpium*	`sp. 8/4`	60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107924	Delta Valley	Pseudoscorpiones	Olpiidae	*Indolpium*		60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107925	Delta Valley	Pseudoscorpiones	Olpiidae	*Indolpium*		60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107926	Delta Valley	Pseudoscorpiones	Olpiidae	*Indolpium*		60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107927	Delta Valley	Pseudoscorpiones	Olpiidae	*Indolpium*		60km NW Tom Price;	22°08’05”S	117°29’37”E	1
107928	Little A	Pseudoscorpiones	Olpiidae	*Indolpium*		60km NW Tom Price;	22°06’03”S	117°29’37”E	1
107937	Black Jack	Scorpiones				60km NW Tom Price;	22°07’09”S	117°25’02”E	1
107938	F2	Scorpiones				60km NW Tom Price;	22°07`46"S	117°26`38"E	1
107932	F2	Scorpiones				60km NW Tom Price;	22°07`46"S	117°26`38"E	1
107929	Little A	Scorpiones				60km NW Tom Price;	22°06’03”S	117°29’37”E	1
107936	F5	Scorpiones				60km NW Tom Price;	22°06`15"S	117°29`53"E	1
107933	F2	Scorpiones				60km NW Tom Price;	22°07`46"S	117°26`38"E	1
107931	F5	Scorpiones				60km NW Tom Price;	22°06`15"S	117°29`53"E	1
107930	F5	Scorpiones				60km NW Tom Price;	22°06`15"S	117°29`53"E	1
107934	Champion Valley	Scorpiones				60km NW Tom Price;	22°07’15”S	117°26’53”E	1
107935	Champion Valley	Scorpiones				60km NW Tom Price;	22°07’15”S	117°26’53”E	2
107939	Champion Valley	Scorpiones				60km NW Tom Price;	22°07’15”S	117°26’53”E	2
107940	Champion Valley	Scorpiones				60km NW Tom Price;	22°07’15”S	117°26’53”E	2

Pilbara Scorpion Identification Report

Report no. **ECOS-201011**

Prepared for: Ecoscape

by Erich S. Volschenk

Summary

Ecoscape is undertaking a short-range endemic survey in the Pilbara, and have requested taxonomic identifications and SRE assessments of scorpions from the survey;

The scorpion collection comprised 12 specimens represented by the following four species and numbers of individuals (respectively): *Lychas* 'bituberculatus', 5; *Lychas* 'harveyi' 1; *Lychas* 'multipunctatus', 5; *Lychas* 'pilbara1', 1.

All of the species represented in this collection are well represented and widespread in the Pilbara and current data suggest that none are short-range endemics

Taxonomy, Conservation Status and Recommendations

FAMILY BUTHIDAE

The family Buthidae is the most diverse and wide spread of all scorpion families (Fet and Lowe 2000). In Australia, Buthidae is represented by the genera *Australobuthus* Locket; *Isomerus* Ehrenberg; *Isometroides* Karsch, *Lychas* C.L. Koch, and *Hemilychas* Hirst. In Western Australia, only the *Isometrus*, *Isometroides* and *Lychas*, have been recorded. The taxonomy of the constituent species of *Isometrus*, *Isometroides* and *Lychas* is very problematic and each genus contains numerous undescribed species, most notably in the genus *Lychas* (Volschenk unpublished data). Most Authors refer to LE Koch (1977) for keys and identification. That revision represents an important study of the Australian scorpions; however, several taxonomic decisions made by (Koch 1977) have been rejected by subsequent authors and the taxonomy in that publication is not up to date. Most Australian Buthid species appear to have wide distributions; however, a few taxa have confirmed SRE distributions (Volschenk unpublished data).

Lychas 'bituberculatus'

This undescribed species has been recorded widely throughout the Pilbara and Kimberley regions of Western Australia (Volschenk unpublished data).

Current data on this species indicate that it is NOT a short-range endemic species.

NOTE: This species is a morphospecies name and is NOT published. It is not a valid name under the International code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999).

Lychas 'harveyi'

Lychas 'harveyi' has been widely sampled from the Pilbara region of Western Australia.

This species is not currently considered to be a short-range endemic.

NOTE: *Lychas* 'harveyi' is a morphospecies name and is NOT published. It is not a valid name under the International code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999).

Lychas 'multipunctatus'

This undescribed species has been recorded widely throughout the Pilbara region of Western Australia, where it is one of the most common scorpion species (Volschenk et al. in press).

Current data on this species indicate that it is NOT a short-range endemic species.

NOTE: This species is a morphospecies name and is NOT published. It is not a valid name under the International code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999).

Lychas 'Pilbara 1'

This undescribed species has been recorded widely throughout the Pilbara region of Western Australia. Despite its widespread distribution (Volschenk et al. in press), this species never appears to be particularly common.

Current data on this species indicate that it is NOT a short-range endemic species.

NOTE: This species is a morphospecies name and is NOT published. It is not a valid name under the International code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1999).

Identification Table

ScorpionID	Client Reg. Number	WAM Reg. Number	Adult Males	Adult Females	Undetermined Sex
Lychas 'bituberculatus'	Black Jack-1-107937	107937	1	0	0
Lychas 'bituberculatus'	F5-1-107936	107936	1	0	0
Lychas 'bituberculatus'	Champion Valley-1-107934	107934	0	0	1
Lychas 'bituberculatus'	F2-1-107933	107933	1	0	0
Lychas 'bituberculatus'	F5-1-107930	107930	1	0	0
Lychas 'harveyi'	Champion Valley-1-107935	107935	2	0	0
Lychas 'multipunctatus'	Champion Valley-1-107940	107940	1	0	0
Lychas 'multipunctatus'	Champion Valley-1-107939	107939	1	0	0
Lychas 'multipunctatus'	F2-1-107938	107938	1	0	0
Lychas 'multipunctatus'	F2-1-107932	107932	1	0	0
Lychas 'multipunctatus'	F5-1-107931	107931	1	0	0
Lychas 'pilbara1'	Little A-1-107929	107929	1	0	0

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