# BHPBIO HASHIMOTO

# TERRESTRIAL VERTEBRATE FAUNA ASSESSMENT


**July 2006**

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# SUMMARY

The Hashimoto Project Area is located approximately 50 km east of Newman on Mineral Lease M266SA. The rounded hills and ridges of the project area form part of the East Ophthalmia range and lie along the northern border of the Sylvania pastoral lease.

BHP Billiton Iron Ore (BHPBIO) Pty Ltd commissioned *ecologia* Environment (*ecologia*) to undertake a baseline biological investigation of flora and fauna of Hashimoto. This study was conducted to assess the potential environmental impact of future exploration and mining developments within the project area.

Two phases of a dual-season vertebrate fauna survey of the proposed project area were carried out by *ecologia* in August/September 2005 and February 2006. Intensive opportunistic searching and systematic sampling were combined. The total survey effort for the survey was:

| Survey Technique / Trap Type | Total |
|---|---|
| Person Survey Days | 58 |
| Cage Trap Nights | 360 |
| Pit Trap Nights | 1320 |
| Funnel Trap Nights | 1320 |
| Elliott Trap Nights | 2640 |
| Bird Censusing (min) | 2740 |
| Opportunistic Searching (min) | 3570 |
| Bat Recording (min) | 975 |
| Night Searching | 1165 |

Six sites were surveyed for vertebrate fauna, representing a broad cross-section of the habitat types found in the project area. These sites were divided among six habitats:

- Low Ridge Top;
- Rocky Gully;
- Riverine;
- Scree Slope and Hillslope;
- Minor Drainage Line; and
- Alluvial Plain.

Prior to the survey, species lists were prepared for the project area based on a search of the available literature and relevant databases. The search revealed that an estimated 217 vertebrate fauna species have previously been recorded, or may potentially occur in the project area. The list included 35 native and two introduced mammals, 48 birds, 124 reptiles and eight frog species.

The current survey recorded a total of 180 species, comprising 23 mammal, 85 bird, 52 reptile and five amphibian species. The project area is relatively species rich as a result of the mosaic of landforms and the relatively high number of land systems occurring within it. Consequently, from a faunal perspective, the project area has a high biodiversity compared with other areas in the Pilbara bioregion.

Three vertebrate taxa of conservation significance were recorded:

**1. Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) Vulnerable, Schedule 1**

One species listed as "Vulnerable" under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and as "Schedule 1" (fauna that is rare or likely to become extinct) under the Western Australian *Wildlife Conservation (Specially Protected Fauna) Notice 2003*, was recorded during the survey: the Orange Leaf-nosed Bat, *Rhinonicteris aurantius* (Pilbara form). Several individuals were located at Site 2 (E 212974.6, N 7412843) in what is likely to be an important roost site for this species. The site is notable as it is the south-easternmost roost in the Pilbara and is a significant range extension for this species. No other roost sites were discovered within the project area. The Orange Leaf-nosed Bat is sensitive to human disturbance and may completely abandon a roost if subjected to continual disturbance. Because of this, displacement of the population from the roost as a result of drilling (particularly percussion drilling) has the potential to cause high individual mortalities and loss of the population. For this reason and others, as outlined in Section 5.0, the project should be referred to the Department of the Environment and Heritage under the EPBC Act.

2. **Ghost Bat (*Macroderma gigas*) Priority 4**

The Ghost Bat, *Macroderma gigas*, is listed by CALM as a Priority 4 species (Taxa in need of monitoring) and was recorded at the Orange Leaf-nosed Bat roost. Several Ghost Bats were present at the Orange Leaf-nosed Bat roost in the mine adit at Site 2, and the species was recorded in both spring and summer surveys. During the summer survey, an observation of a hunting Ghost Bat was also made near Site 4, a few kilometres from the roost. Ghost Bats are likely to be disrupted by drilling or mining activities near the roost.

3. **Australian Bustard (*Ardeotis australis*) Priority 4**

This large bird was recorded during the second survey but was absent in Spring, and is listed by CALM as a Priority 4 species. Three individuals were observed. This species is nomadic and capable of evacuating an area when disturbed and will not be significantly impacted by any proposed exploration or mining operations at Hashimoto.

Additionally, one species listed under international agreements was recorded, the EPBC (Migratory) listed Rainbow Bee-eater (*Merops ornatus*).The Rainbow Bee-eater, *Merops ornatus,* migrates between Australia and Japan, breeding in New Guinea and Australia. It was recorded predominantly in the riverine and alluvial plain sites during the survey. Due to this species' broad habitat requirements and the fact that it is a common migrant

occurring throughout the Pilbara, future developments at Hashimoto will not impact this species.

Impacts to fauna arising from exploration drilling or mining activity will be those that directly impact fauna, such as clearing of habitat and death of individuals during clearing, and indirect impacts such as the introduction of weeds, increases in the number of feral animals, increased risk of fire and secondary impacts of noise and dust. The Orange Leaf-nosed Bat roost may also be directly impacted by drilling.

In order to reduce environmental impacts, BHPBIO should continue to implement existing environmental policies, guidelines and procedures for its staff and contractors. This should include practices relating to weed hygiene, fire risk management and awareness of conservation significant fauna and flora.

In addition, the following recommendations should be implemented:

1. Minimise clearing to that which is absolutely necessary.
2. Clearing should be concentrated on ridges and hills, where possible.
3. Avoid impacting creekline systems.
4. Institute a buffer zone around the Orange Leaf-nosed Bat colony at Site 2 of at least 500m.
5. Restrict access to the colony using signage and temporary barriers along tracks accessing Site 2.
6. Refer the project to the Department of the Environment and Heritage under the Commonwealth EPBC Act 1999.
7. Develop an Orange Leaf-nosed Bat Management and Monitoring Plan.

A table outlining the survey's compliance with EPA Position Statement No. 3 (Terrestrial Biological Surveys as an Element of Biodiversity Protection) (EPA, 2004a) and Guidance Statement No. 56 (Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia) (EPA, 2004b) is shown below.

**Table S1 Compliance of survey to EPA Position Statement No. 3 and Guidance Statement No. 56.**

| REQUIREMENT | EPA STATEMENT | RELEVANCE TO PROJECT | PROJECT COMPLIANCE |
|---|---|---|---|
| Impact on Biodiversity | Position Statement No. 3 | Where impact on biodiversity cannot be avoided, the proponent must demonstrate that the impact will not result in unacceptable loss. | The presence of several land systems in the area contributes to a relatively high biodiversity when compared with surveys of similar scope in the region. Impacts to conservation significant species are anticipated Recommendations for reducing the impact on biodiversity are included in this report. . |
| State, National and International Agreements, Legislation and Policy on Biodiversity | Position Statement No. 3 | Information gathered for environmental impact assessment in Western Australia meets State, National and International Agreements, Legislation and Policy in regard to biodiversity conservation. | Impacts to species listed under relevant legislature are addressed in Section 4.4. |
| EPA Standards, Requirements and Protocols | Position Statement No. 3 | The quality of information and scope of field surveys meets the standards, requirements and protocols as determined and published by the EPA. | The current survey conforms to a Level 2 survey, comprising a reconnaissance survey and comprehensive fauna survey, as per Guidance Statement 56. The survey duration used was much longer than prior surveys in the region in order to capture a greater proportion of the fauna potentially occurring in the area. |
| Biodiversity Conservation and Ecological Function Values | Position Statement No. 3 | Sufficient information is provided to address biodiversity conservation and ecological function values. | Impacts to conservation significant species are anticipated (Section 5.0). There will be localised losses of biodiversity arising from clearing and a potential loss of ecological function over the project area. This report describes processes resulting in environmental degradation and gives recommendations to reduce impacts. |
| State Biological Databases | Position Statement No. 3 | Terrestrial biological surveys will be made publicly available and will contribute to the bank of data available for the region. | Survey data was submitted to CALM as per licence regulations (Licence to Take Fauna for Scientific Purposes No. SF005067). |

| REQUIREMENT | EPA STATEMENT | RELEVANCE TO PROJECT | PROJECT COMPLIANCE |
|---|---|---|---|
| Bioregion: level of existing survey or knowledge of the region and associated ability to predict accurately | Guidance Statement No. 56 | The project area lies within the PIL3 subregion (Hamersley) of the Pilbara biogeographic region (IBRA). A large number of fauna surveys of similar size and scope have been undertaken in the region. | The scope of the project requires a Level 2 survey. Coupled with the amount of contextual information, a two season survey was considered sufficient to document fauna of the project area and determine the presence of conservation significant species. |
| Landform special characteristics, specific fauna, and/or specific context of the landform characteristics and their distribution and rarity in the region | Guidance Statement No. 56 | Six main fauna habitats occur within the study area that will be impacted by the Jirridi project. | Survey sites were located to be representative of major landforms and habitats and to correspond with areas of disturbance or clearing. No threatened ecological communities occurred within the project area. The combination of habitats and landforms in the project area is uncommon, contributing to high biodiversity in the project area and increasing its local conservation value. |
| Lifeforms, life cycles, types of assemblages and seasonality (e.g. migration) of species likely to be present | Guidance Statement No. 56 | The Pilbara region experiences a hot summer with occasional cyclonic rain events, followed by a mild winter with light rains. Rainfall is highly unpredictable. | The timing of the first phase of the survey was in August/September coinciding with the emergence of annuals (wildflower season). This was ideal for botanical surveys and birds. Mammals were also well sampled at this time. Amphibians were observed during spring but were more common in summer following cyclonic rain. The second phase of the survey coincided with a cyclonic period in summer (February) 2006. Relatively frequent rainfall resulted in good amphibian capture rates and a greater diversity than observed in spring, however reptile activity periods were shortened and consequently capture rates were relatively low. |

| REQUIREMENT | EPA STATEMENT | RELEVANCE TO PROJECT | PROJECT COMPLIANCE |
|---|---|---|---|
| Number of different habitats or degree of similarity between habitats within a survey area | Guidance Statement No. 56 | Six major fauna habitats were described and are represented by six sites in this study. | Survey sites were located to be representative of major landforms and habitats and to correspond with areas of disturbance or clearing. |
| Climatic constraints, e.g. temperature or rainfall that preclude certain sampling methods | Guidance Statement No. 56 | The Pilbara region experiences a hot summer with occasional cyclonic rain events, followed by a mild winter with light rains. Rainfall is highly unpredictable. Fauna in the Pilbara are generally highly mobile (birds) or have a "boom or bust" life cycle. | The spring survey was undertaken during August/September, prior to summer rainfall events. Weather during the spring survey was hot (average temperature in high 30s) and dry. Consequently, amphibians capture rates were reduced.<br>The Pilbara experienced above average rainfall during the months preceding the summer survey, and periods of rainfall occurred within the project area on most days during the survey. This resulted in cooler temperatures and increased humidity and reduced reptile and mammal activity, although diversity remained high and more amphibians were collected. |
| Sensitivity of the environment to the proposed activities | Guidance Statement No. 56 | The Hashimoto Project Area is located at the confluence of several land systems, some of which are not common in the bioregion (Section 2.4). | The large number of land systems and high biodiversity of the project area increase its sensitivity to disturbance. The ridges and hilltops are the least conservation significant landforms and habitats because they are part of the Newman Land System, which is common outside of the project area. Clearing should be concentrated on these areas. No Western Pebble-mound Mouse burrow systems have been located in these areas, although they have been located nearby (Section 4.4.2). Orange Leaf-nosed Bats have been recorded as roosting within the project area and are sensitive to disturbance, particularly percussion drilling; recommendations are included which should reduce the likelihood of disturbing the colony. |

| REQUIREMENT | EPA STATEMENT | RELEVANCE TO PROJECT | PROJECT COMPLIANCE |
|---|---|---|---|
| Size, shape and location of proposed activities | Guidance Statement No. 56 | The lease area is approximately 20 $km^2$. Clearing will not be contiguous, consisting of discrete drill pads and access tracks. | All major fauna habitats within the lease were surveyed and recommendations took into account the scale and shape of the proposed impacts, as well as likely impacts on conservation significant species. |
| Scale and impact of the proposal | Guidance Statement No. 56 | Clearing of over 50 ha in the Pilbara bioregion requires a Level 2 survey to be undertaken. | The location and scale of the project warrants a Level 2 survey (detailed field survey), in accordance with EPA guidelines. A two phase field survey was undertaken as per these guidelines contained in the EPA's Guidance Statement 56. |

# 1.0 INTRODUCTION

## 1.1 PROJECT BACKGROUND

The Hashimoto Project Area is located approximately 50 km east of Newman on Mineral Lease M266SA (Figure 1.1). The rounded hills and ridges of the project area form part of the East Ophthalmia range and lie along the northern border of the Sylvania pastoral lease.

BHPBIO proposes to increase exploratory drilling activities within the project area which will result in the clearing of native vegetation as tracks and drill pads are created.

## 1.2 OBJECTIVES

BHPBIO commissioned *ecologia* Environment (*ecologia*) to undertake a two-season baseline biological investigation of the fauna of the Hashimoto project area.

The study was conducted to assist with the assessment of the potential impacts of the project on fauna and fauna habitats. This report provides:

(a) An inventory of:

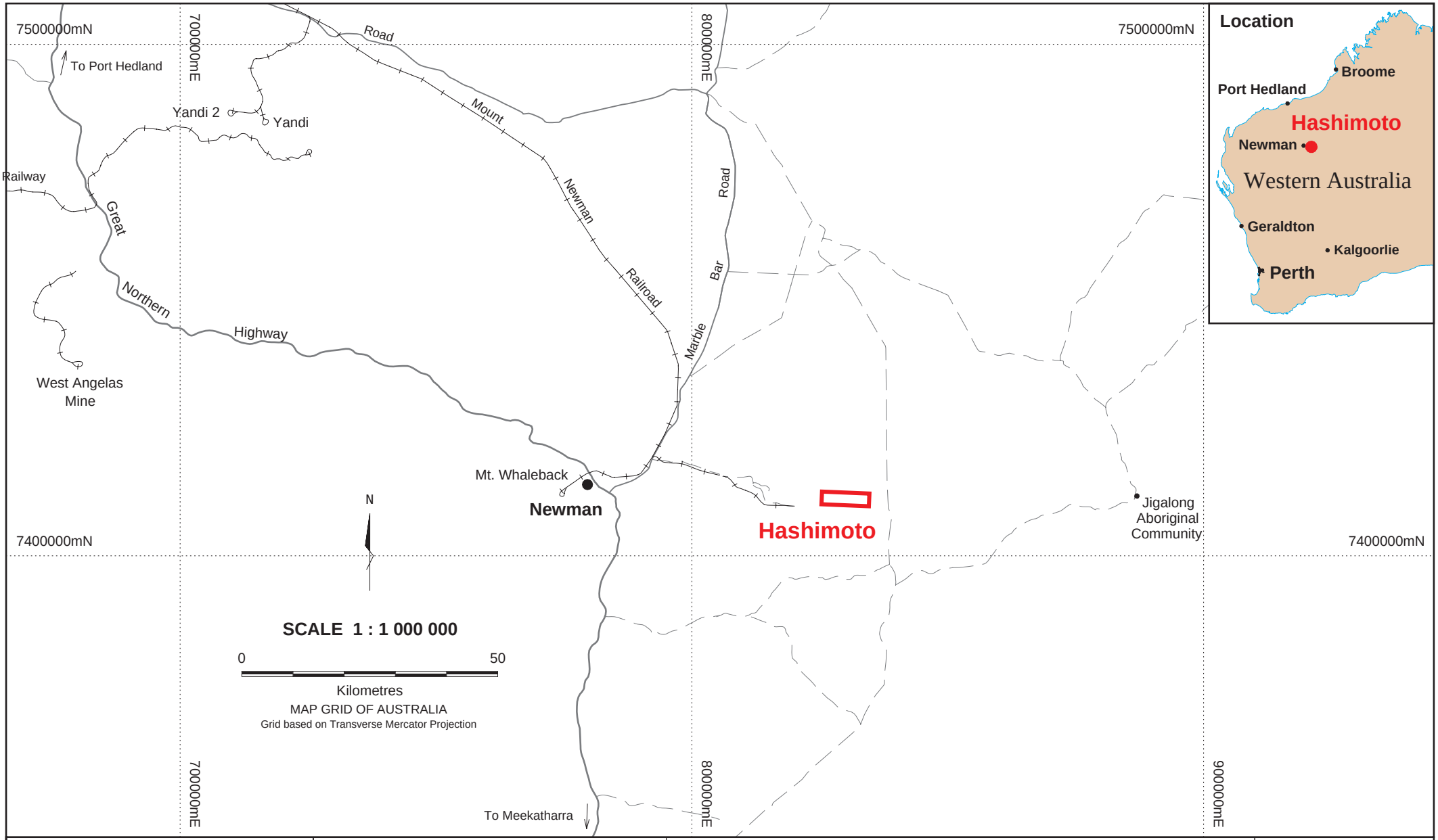
- Vertebrate fauna species occurring in the study area, incorporating recent published and unpublished records;
- Biologically significant species, including rare fauna in the study area;
- Fauna communities occurring in the study area; and
- Habitats and vegetation associations in the study area that are poorly represented, or which are essential to the survival of rare fauna.

(b) A review of:

- Fauna populations and habitats in the broader study area;
- The regional and local conservation value of fauna present, or likely to be present, in the study area;
- The fauna of particular conservation value, such as Scheduled or Priority species that are likely to occur in the study area;

(c) Recommendations for:

- Fauna and fauna habitat management that will accommodate future exploration and mining activities;

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| ecologia ENVIRONMENT | Client: BHP BILLITON | REGIONAL LOCATION | Date: 26 July 2006 |
| | | | Scale: 1:1 Million |
| | Project: HASHIMOTO | | Figure No. 1.1 |
| Author: S. Ford / Drawn: S. Coleman | | A4 | Plan No. HM-001 |

# 2.0 PHYSICAL ENVIRONMENT

## 2.1 CLIMATE

Hashimoto is situated in the Pilbara region of Western Australia and experiences an arid-tropical climate with two distinct seasons; a hot summer from October to April and a mild winter from May to September. Annual evaporation exceeds rainfall by as much as 500 mm per year. Seasonally low but unreliable rainfall, together with high temperatures and high diurnal temperature variations are also characteristic climatic features of the region. This region has in the past experienced no rainfall in any month of the year, which is typical of a desert climate (Beard, 1975).

Within the study region, meteorological data has been recorded at the Bureau of Meteorology (BOM) weather station at Newman (23°22'S, 119°44'E). This BOM weather station is located approximately 50 km to the west of Hashimoto, providing an indication of climatic conditions experienced within the project area (Figure 2.1).

The average annual rainfall is 310.3 mm, occurring over 45 rain days. It loosely follows the typical Pilbara bimodal distribution pattern, with a peak between December and March and a smaller peak in May and June (Figure 2.1). Most of the rainfall occurs in the summer period, with over 55 % of total annual precipitation occurring between December and March.

Mean annual maximum and minimum temperatures for Newman are 31.3°C and 17.3°C respectively. Mean monthly maxima range from 38.8°C during January to 22.2°C in July, while mean monthly minima range from 25.3°C in January to 8.0°C in July (Figure 2.1).

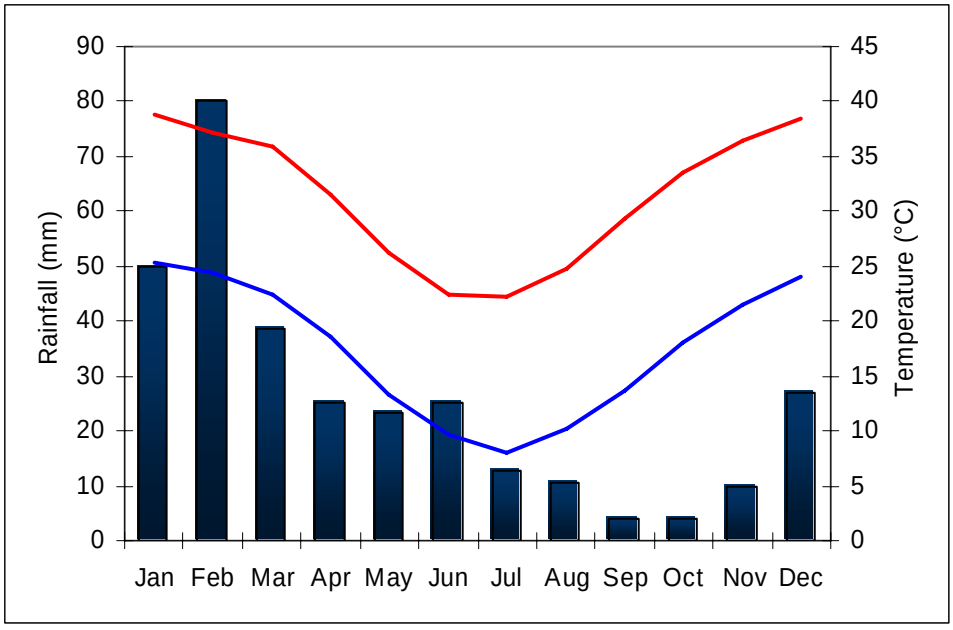



**Figure 2.1 Summary of climatic data for Newman.**

## 2.2 GEOLOGY

The geology of the region around Hashimoto, which is part of the larger Jimblebar lease, has been mapped and described in detail by Tyler and Williams (1990). The minesite lies

within the Ophthalmia Fold Belt, which unconformably overlies Archaean basement rocks and abuts the Sylvania Inlier, an exposed portion of the cratonic basement. A summary of the main geological elements, which are important to both the development of the landscape and the vegetation, is outlined below in chronological sequence:

(a) The main body of Jimblebar is dominated by the Brockman Iron Formation (Hb). This is economically the most important iron formation in the Hamersley Group and forms prominent strike ridges rising 200-400 m above the surrounding countryside, notably at the northern boundary of the Jimblebar lease. This formation is composed of chert, ferruginous chert and minor shale bands (Tyler and Williams, 1990);

(b) North of the Jimblebar minesite, the Weeli Wolli Formation (Hj) occurs, consisting of interbedded banded iron formation, chert and shale. Closely associated with this formation are rocks of the Woongarra Volcanics, consisting of partially metamorphosed igneous rhyolite and rhyodacite as sills or flows;

(c) South of the area dominated by the Brockman Iron Formation, Cainozoic deposits are found, taking the form of partly consolidated and cemented colluvium (Czc) in valley-fill deposits. These deposits are derived from dissection of the Proterozoic rocks; and

(d) Quaternary deposits include colluvium and minor alluvium (Qc) of the scree slopes and talus slopes adjacent to and derived from the bedrock, and alluvial deposits of silt, sand and gravel (Qa) in drainage channels and associated floodplains that lie at the base of the range.

## 2.3 SOILS

Hashimoto lies within a large region of soils that have been classified by Bettenay *et al.* (1967) as 'loamy soils with weak pedologic development' (Um 5). At higher resolution, the area lies upon a region of 'shallow, coherent and porous loamy soils', with shallow profiles (Fa 13). This soil type is associated with the Hamersley and Ophthalmia Ranges. The soils are mainly stony, shallow loams, however there are wide areas with no or limited soil cover.

As a consequence of the sparse vegetation cover and the erosive force of heavy summer cyclonic rains, much of the soil on the hillslopes tends to be transported down to the valleys and plains. Thus, species and associations of vegetation on the hills and slopes tend to be correlated to geology rather than soil type (Beard, 1975). Along drainage lines, superficial deposits influence the distribution of the vegetation, but the presence of surface and groundwater is also a major determining factor.

## 2.4 LAND SYSTEMS

An inventory of the land systems occurring in the Pilbara was completed by Van Vreeswyk et al. (2004). The survey aimed to provide a comprehensive description and mapping of the biophysical resources of the region, together with an evaluation of the condition of soils and vegetation throughout. The project area lies at the northern border of the Sylvania pastoral lease and incorporates unallocated crown land. There are several land systems in the area (Table 2.1) dominated by the Newman land system which forms the series of low, rounded ridges extending west-east through the project area. Each land system is classified into a particular Land Type defined by the landforms and vegetation it contains.

**Table 2.1 Land systems occurring within the Hashimoto project area**

| Land Type | Land System | % of Bioregion | Description |
|---|---|---|---|
| 1. Hills and ranges with spinifex grasslands | Newman (New) | 8.0 | Rugged jaspilite plateaus, ridges and mountains supporting hard spinifex grassland. |
| 10. Stony plains with acacia shrublands | Sylvania (Syl) | 0.6 | Gritty surfaced plains and low rises on granite supporting *Acacia-Eremophila-Senna* shrublands. |
| 11. Sandplains with spinifex grasslands | Divide (Div) | 2.9 | Sandplains and occasional dunes supporting shrubby hard spinifex grasslands. |
| 12. Washplains or hardpan with groved mulga shrublands | Washplain (Wsp) | 0.5 | Hardpan plains supporting groved mulga shrublands. |
| | Zebra (Zeb) | 0.2 | Hardpan plains with large linear gravelly sand banks supporting *Acacia* shrublands with soft and hard spinifiex. |
| | Jamindie (Jam) | 1.1 | Stony hardpan plains and rises supporting groved mulga shrublands, occasionally with spinifex understorey. |

Van Vreeswyk et al. (2004) classified the condition of the vegetation in the area as Excellent (For the land-unit vegetation type, the site's cover and composition of shrubs, perennial herbs and grasses is near optimal, free of obvious reductions in palatable species or increases in unpalatable species, or the site type supports vegetation which is predominantly unattractive to herbivores and is thus largely unaltered by grazing) and Good (Perennials present include all or most of the palatable species expected; some less palatable or unpalatable species may have increased, but total perennial cover is not very different from the optimal).

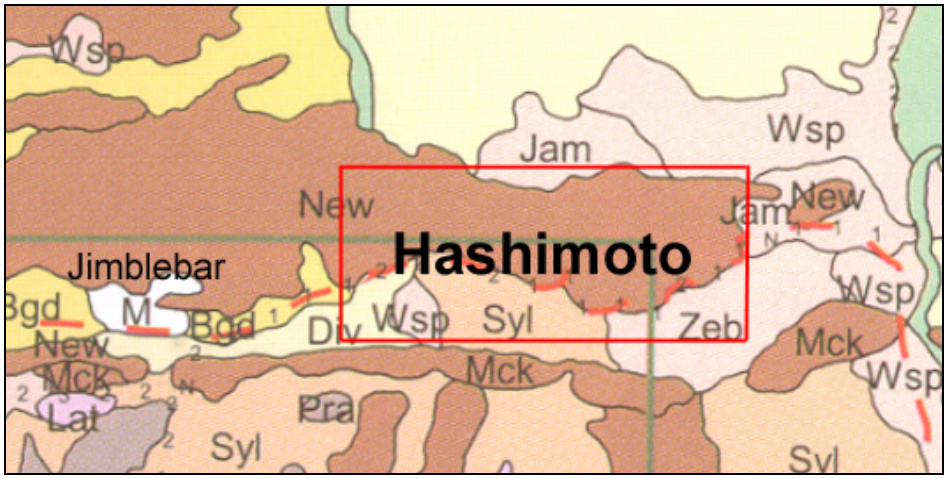



**Figure 2.2 Land Systems of Hashimoto. The project area is bounded in red.**

## 2.5 BIOGEOGRAPHIC REGIONS

The project area lies within the Pilbara near the boundary of the Gascoyne biogeographic region, as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

Hashimoto is located in the PIL2 (Fortescue Plains) subregion and the transition to the GAS3 (Augustus) subregion occurs just to the south. The Fortescue Plains subregion contains alluvial plains and river frontage and river gum woodlands along drainage lines, and forms the northern limit of Mulga (*Acacia aneura*) (Thackway and Cresswell, 1995).

The Augustus subregion contains rugged, low, Proterozoic sedimentary and granite ranges divided by broad flat valleys, as well as the headwaters of the Ashburton and Fortescue Rivers (Thackway and Cresswell, 1995). There are extensive areas of alluvial valley-fill deposits. Mulga woodland on *Triodia* occur on shallow stony loams on rises, while the shallow earthy loams over hardpan on the plains are covered by Mulga parkland (Desmond et al., 2001).

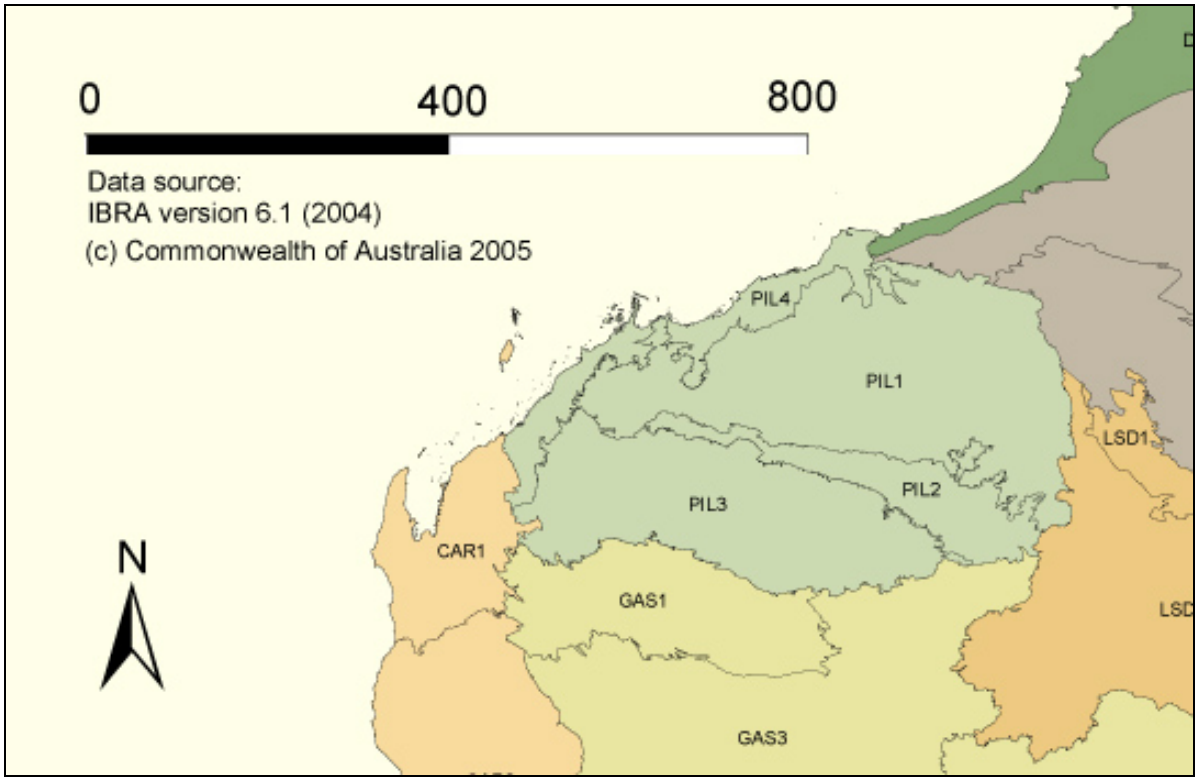



**Figure 2.3 The Pilbara bioregion as defined by IBRA 6.1.**

## 2.6 PREVIOUS BIOLOGICAL SURVEYS

Early work on the vertebrate fauna of the Pilbara region was largely confined to site-specific surveys, including work at Millstream (Burbidge, 1971), Marandoo (Texasgulf Australia Ltd, 1979), Harding River (Dames and Moore, 1982) and the Deepdale area (Natural Systems Research, 1979). This pattern has continued with localised development of mining within the Pilbara. The local and wider-area surveys of relevance to Hashimoto are discussed below.

*Local area*

A significant amount of biological assessment and monitoring has been undertaken in the areas adjacent to Hashimoto as development has progressed. The first surveys encompassing flora and fauna of the Jimblebar Orebody crest, ranges and scree slopes was conducted in 1994 (Endersby, 1994). Surveys of the Jimblebar mining lease were carried out by *ecologia* in December 1995 to determine the presence of the Western Pebble-mound Mouse (*Pseudomys chapmani*), and September/October 1996 to trap and translocate these mice (*ecologia*, 1996a, b). More recent local surveys include a comprehensive fauna and flora assessment at Wheelarra Hill/Jimblebar (*ecologia,* 2004a, 2005a, 2005b) and an exploration fauna and flora survey at East Jimblebar (*ecologia,* 2005). Biota also undertook a field flora and desktop fauna survey of the Jimblebar lease area in January 2004, with specific attention to the W3 deposit (Biota, REF).

*Wider area*

Initial surveys by Butler and Butler (1976) appear to be the first along the eastern Ophthalmia range (Butler and Butler, 1976). Flora and vertebrate studies have also been conducted at the Ophthalmia Dam site, approximately 35 km west of Hashimoto (Murdoch University, 1980, 1981, 1982, 1983). Flora and fauna surveys were conducted in June 1995, approximately 43 km west of Hashimoto at Orebody 25 (*ecologia*, 1995a), and in August 1995, 18 km north-west of Hashimoto at Orebody 18 (*ecologia*, 1995b). These two surveys covered the ridges and hill slopes, scree slopes, outwash plains and gullies/gorges in the Orebody areas. A biological and soil assessment survey of the East Ophthalmia Orebody was conducted in April 2004 (*ecologia*, 2004b), and a biological assessment of Orebody 24 was conducted in June of the same year (*ecologia*, 2004c). A review of the flora and fauna of Orebodies 18, 23 and 15 was conducted as well (*ecologia*, 2004d).

More extensive biological surveys have been undertaken, such as that at Karijini National Park (Muir, 1983). Research projects conducted by Conservation and Land Management (CALM) and opportunistic collecting by amateur naturalists have further supplemented this information. CALM, in association with the Western Australian Museum (WAM) are currently undertaking a five year Pilbara Biological Survey (PBS) to provide comprehensive, long-term baseline data for future management.

# 3.0 METHODS

## 3.1 SURVEY PROGRAMME

A vertebrate fauna assessment survey of the study area was undertaken between the 26th August – 16th September 2005 and the 6th – 15th February 2006.

## 3.2 SITE SELECTION

Following a preliminary reconnaissance, detailed survey sites were chosen as being:

(i) representative of vegetation associations;

(ii) areas of conservation value or ecological sensitivity; and

(iii) areas of environmental impact arising from the proposed development.

The location and number of sites surveyed is summarised in Table 3.1 with the "Criteria for Selection" referring to those criteria listed above. Fauna survey sites were also distributed to encompass a broad geographic spread of the project area (Table 3.1).

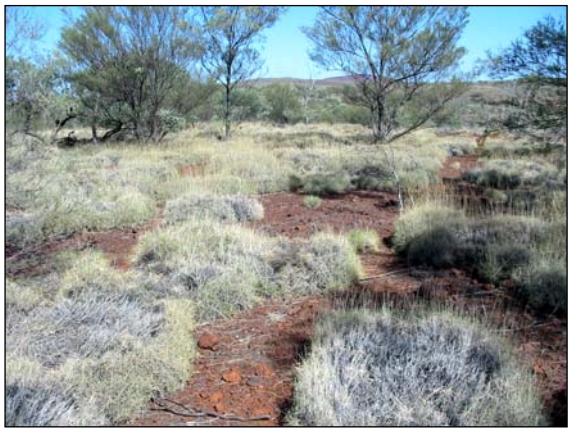
**Table 3.1 Fauna survey site locations (Datum – AGD84).**

| Site Number | Site Description | Eastings | Northings | Criteria for Selection |
|---|---|---|---|---|
| Site 1 | Ridge Top | 51K 212741.0 | 7412605 | i, ii, iii |
| Site 2 | Rocky Gully | 51K 212974.6 | 7412843 | i, iii |
| Site 3 | Riverine | 51K 213916.1 | 7412244 | i, ii, iii |
| Site 4 | Scree Slope | 51K 215836.6 | 7411678 | i, iii |
| Site 5 | Alluvial Plain | 51K 218094.7 | 7411553 | i, ii, iii |
| Site 6 | Alluvial Plain | 51K 219618.9 | 7411870 | i, ii, iii |

Site vegetation descriptions and photographs are presented on the following pages, and the fauna Sites are shown in Figure 3.1.

**Site 1: Low Ridge Top.**

Open, low *Acacia* woodland (mulga) open low and dwarf scrub with mid-dense *Triodia* spinifex on skeletal, rocky and stony soil.



**Site 2: Rocky Gully.**

Mulga woodland and open low scrub over open, patchy *Triodia* spinifex on rocky substrate. The entrance to the mine adit in which the Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) and Ghost Bat (*Macroderma gigas*) roost can be seen at lower left.

**Site 3: Riverine Habitat.**

*Eucalyptus victrix* open woodland fringing a wide, sandy creek (Jimblebar Creek) over dense Buffel Grass (**Cenchrus ciliaris*).

**Site 4: Scree Slope.**

Scattered *Grevillea wickhamii* with some *Acacia*, but *Triodia basedowii* dominates the vegetation. Rocks are emergent as shown and soils are shallow.

**Site 5: Minor Drainage Line.**

*Corymbia hamersleyana* open low woodland over *Petalostylis labicheoides* open low scrub and *Triodia basedowii* open spinifex and **Cenchrus ciliaris*, supported by relatively deep and sandy loam

**Site 6: Alluvial Plain.**

A mix of relatively dense mulga (*Acacia aneura*) with scattered *Corymbia hamersleyana* and moderately dense stands of *Petalostylis labicheoides*, interspersed with more open mulga-spinifex woodland, on fine, deep, loamy soil.

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215000mE
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7415000mN
7412500mN
7410000mN

N

**SCALE 1 : 25 000**

0 1

Kilometres

AUSTRALIAN MAP GRID

Grid based on Transverse Mercator Projection

Jimblebar

Site 1

Site 2

Site 3

Site 4

Site 5

Site 6

Creek

Copper

Creek

530

550

510

520

## Legend

▲ **Site 4** Fauna Survey Site Locations

ecologia ENVIRONMENT

Author: M. O'Connell

Drawn: S.Coleman

Client: **BHP BILLITON**

Project: **524.00 HASHIMOTO**

# FAUNA SITES AT HASHIMOTO

A3

Date: 26 July 2006

Scale: 1:25 000

Figure No. **3.1**

Plan No. **HM-003**

## 3.3 SAMPLING METHODS

The methods adopted for the current survey were formulated in the context of the Environmental Protection Authority's (EPA) Position Statement No. 3 and Guidance Statement No. 56: Guidance Statement for Terrestrial Fauna Surveys for Environmental Impact Assessment (EPA, 2004).

The fauna survey was carried out using a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling refers to data methodically collected over a fixed time period in a discrete habitat type, using an equal or standardised sampling effort. The resulting information can be analysed statistically, facilitating comparisons within and among sites, and between seasons. Opportunistic sampling includes data collected non-systematically within and outside fixed sampling sites.

### *3.3.1 Systematic Data*

Fauna trapping was undertaken using a standardised trapping format. In gully and scree slope areas, the linear series of pits traversed the contour line. At all systematic survey sites, a combination of trapping, opportunistic searching and bird censusing was conducted. The details of these activities are as follows:

*Mammal, Reptile and Amphibian Fauna*

1. Pit-trap and drift fence: A linear series of 10 pit traps spaced at 50 m intervals and consisting of a random array of pits was established at each grid site. PVC pipe (16 cm diameter, minimum 35 cm deep) or 20 L plastic buckets (29 cm diameter, 39 cm deep) or 10 L plastic buckets (27 cm diameter, 27 cm deep) were set into the ground. A flywire drift fence 30 cm high and 6 m long and placed over the pit was used to direct fauna into the pit traps.
2. Elliott box traps: Within each systematic site, a line of twenty medium-sized Elliott box traps (9 x 9 x 32 cm) was arranged parallel to the pit line, and baited every two days with a fresh mixture of rolled oats and peanut paste.
3. Funnel traps: At one end of the drift fence was placed a funnel trap (Ecosystematica Type III).
4. Cage traps: Two cage traps (Sheffield type) were used per site, and baited with universal bait. They were placed at either end of the line of pits.
5. Opportunistic Searching: Systematic sites were hand searched for cryptic species. Foraging techniques included identification of active animals, raking leaf and bark litter drifts, raking bulldozer spoil heaps along existing tracks and survey lines, overturning logs and stones, searching beneath the bark of dead trees, breaking open old logs, stumps and dead free-standing trees, investigating burrows and recording tracks, diggings and scats.
6. Spotlighting: All sites were searched at night using head torches and hand held spotlights for nocturnal species, such as geckoes, snakes and nocturnal birds.

Details of systematic survey effort are shown in Table 3.2.

*Bird Fauna*

Censuses were used to survey the avifauna present at each of the fauna sites. The duration of each census was 20 minutes. Methods utilised by Birds Australia for the Atlas Project (Birds Australia, ongoing) were employed. During the 20 minute census, a 2 ha area surrounding the site and within the same habitat type was conducted. Censuses involved recording the number of individuals of each species observed at a site and were concentrated in the most productive times (06:00-09:00 and 15:00-18:00), although censuses between these times were conducted as well. Despite being outside of the normal 'optimal' time, they often yield species less frequently observed in the early morning or late evening, e.g. diurnal raptors. Repeat surveys were spaced over several days to maximise the number of species recorded (Field et al., 2002).

A total of 45 hours and 40 minutes, was spent undertaking avifauna transects within the project area (Table 3.2). Opportunistic sightings in the project area (including observations at two opportunistic sites) also contributed to the number of species recorded.

*Bat Fauna*

Bat echolocation calls were detected using an Anabat system (Titley Electronics, Ballina, NSW). This consists of an Anabat detector that is able to transform ultrasonic bat echolocation calls for analysis with computer software. During the spring survey, Anabat recording was undertaken at five sites near Sites 2 and 3, over five nights for approximately 2 hours per site. During the summer survey, recording was conducted at each site, and an extra recording was performed at the mine adit at Site 2.

### 3.3.2 Non-systematic Data

To supplement the systematic sampling, the presence of all vertebrate species was assessed via:

1. Secondary evidence: Tracks, diggings, scats, burrows and nests were recorded where possible; and
2. Opportunistic sightings and call records: The presence of species was recorded while searching, travelling and during trap establishment within the project area during the day or night.

As well as the survey effort included in Table 3.2, *ecologia* staff completed 225 minutes of opportunistic searching outside of the systematic Sites and 200 min and 180 min of road searching at night during Phase 1 and Phase 2 of the survey, respectively.

**Table 3.2 Table of survey effort.**

| | **Cage trap nights** | | **Pit trap nights** | | **Funnel trap nights** | | **Elliott trap nights** | | **Bird censusing (min)** | | **Microhabitat searching (min)** | | **Bat recording (min)** | | **Nocturnal searching (min)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Season | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| Site 1 | 30 | 30 | 150 | 70 | 150 | 70 | 300 | 140 | 300 | 240 | 470 | 150 | n/a | 47 | 60 | 120 |
| Site 2 | 30 | 30 | 150 | 70 | 150 | 70 | 300 | 140 | 100 | 240 | 420 | 230 | n/a | 197 | 50 | 240 |
| Site 3 | 30 | 30 | 150 | 70 | 150 | 70 | 300 | 140 | 280 | 280 | 485 | 155 | n/a | 47 | 0 | 140 |
| Site 4 | 30 | 30 | 150 | 70 | 150 | 70 | 300 | 140 | 180 | 240 | 410 | 155 | n/a | 47 | 30 | 130 |
| Site 5 | 30 | 30 | 150 | 70 | 150 | 70 | 300 | 140 | 260 | 200 | 330 | 140 | n/a | n/a | 80 | 120 |
| Site 6 | 30 | 30 | 150 | 70 | 150 | 70 | 300 | 140 | 200 | 220 | 450 | 175 | n/a | 7 | 75 | 120 |
| **TOTAL** | **180** | **180** | **900** | **420** | **900** | **420** | **1800** | **840** | **1320** | **1420** | **2565** | **1005** | ***** | **345** | **295** | **870** |
| | **360** | | **1320** | | **1320** | | **2640** | | **2740** | | **3570** | | **345** | | **1165** | |

Phase 1 (P1) is spring, Phase 2 (P2) is summer.

*During the spring survey bat recording over five nights (total 630 minutes) was conducted at sites near water and not necessarily associated with a particular Site.

## 3.4 TAXONOMY AND NOMENCLATURE

Field identification of vertebrate species was based on the following field guides:

- Mammals — Menkhorst and Knight (2001); Strahan (1995)
- Bats — Churchill (1998)
- Birds — Simpson and Day (2004); Pizzey and Knight (2003)
- Amphibians — Tyler *et al.* (2000)
- Reptiles (General) — Cogger (2000); Wilson and Swan (2003)
- Agamids — Storr *et al.* (1983)
- Geckos — Storr *et al.* (1990)
- Pygopods — Storr *et al.* (1990)
- Skinks — Storr *et al.* (1999)
- Varanids — Storr *et al.* (1983)
- Snakes — Storr *et al.* (2002)

In most cases, fauna species were identified in the field. Where the taxonomy of specimens was not clearly discernable, or for species that are known to exhibit significant morphological variation, or those taxa not yet fully described, vouchers were lodged with the WA Museum. In this report, nomenclature is based on the WA Museum's FaunaBase (WAM 2004).

## 3.5 DATA ANALYSIS

The number of species present (species richness) is a simple and widely used indicator of species diversity (Fowler and Cohen, 1990) and is the indicator of diversity used for this survey. Species accumulation curves employing Michaelis-Menten modelling (Colwell, 2005) were used to estimate the total species richness of flora and fauna in each habitat type. Such modelling allows the maximum number of species of a particular vertebrate group within a given habitat to be estimated.

Species accumulation curves were randomised $10^3$ times using EstimateS (Version 7.5, Colwell, 2005) software. Fauna data were plotted as the number of species observed against individuals as the ordinate (Thompson and Withers, 2003). Total species richness was estimated using the Michaelis-Menten function, an asymptotic curve commonly used for such estimates (Colwell and Coddington, 1994). Species accumulation curves for the majority of taxonomic groups indicate that sufficient sampling has been undertaken (Section 4.2)

# 4.0 VERTEBRATE FAUNA

## 4.1 VERTEBRATE FAUNA RECORDED WITHIN THE PROJECT AREA

Prior to the current survey, a list was prepared of 217 fauna species that had been either previously recorded in the Jimblebar / Wheelarra Hill area or were considered to have the potential to occur in the project area. The list was prepared based on a search of the available literature, information obtained from the WA Museum fauna database, unpublished information relevant to the area and knowledge of known habitat preferences. The list included 35 native and seven introduced mammals, 48 birds, 124 reptiles and eight frog species. The current survey recorded a total of 180 species, comprising 23 mammal, 85 bird, 52 reptile and five amphibian species. These numbers are significantly greater than those previously observed on the Jimblebar operations as a group (see Section 4.3). The high faunal diversity reflects the diversity of landforms, vegetation types and substrate types within the project area. The number of species caught per site per season is presented below (Table 4.1).

**Table 4.1 Species richness of animals captured or observed within the project area.**

| | Birds | | | Mammals | | | Reptiles | | | Amphibians | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | C | P1 | P3 | C | P1 | P2 | C | P1 | P2 | C |
| Site 1 | 21 | 34 | 40 | 0 | 0 | 0 | 9 | 15 | 17 | 0 | 4 | 3 |
| Site 2 | 27 | 43 | 49 | 2 | 0 | 2 | 11 | 11 | 18 | 1 | 5 | 5 |
| Site 3 | 37 | 36 | 46 | 1 | 2 | 3 | 6 | 11 | 14 | 2 | 5 | 5 |
| Site 4 | 9 | 18 | 22 | 1 | 3 | 4 | 5 | 10 | 12 | 0 | 3 | 3 |
| Site 5 | 28 | 33 | 38 | 4 | 2 | 5 | 7 | 14 | 18 | 0 | 1 | 1 |
| Site 6 | 21 | 31 | 33 | 3 | 3 | 4 | 12 | 19 | 27 | 0 | 2 | 2 |
| Area Total | 73 | 71 | **85** | 12 | 8 | **23** | 38 | 45 | **52** | 5 | 5 | **5** |

P1 = spring, P2 = summer, C = combined spring and summer total.

### *4.1.1 Herpetofauna*

Fifty-seven species were recorded in the project area during the current survey (Appendix B1). The most speciose reptile families were the scincidae (skinks: 19 species), gekkonidae (geckoes: 10 species) and pygopodidae (pygopods: 5 species). Five amphibians, *Litoria rubella*, *Limnodynastes spenceri*, *Uperoleia russelli*, *Cyclorana platycephala* and *C. maini* were recorded in the project area were the most abundant herptiles during the summer survey, as a result of a recent cyclonic event followed by continued rainfall.

Just one family, the cheluidae, was represented by a single species: the turtle *Chelodina steindachneri.* None of the reptiles recorded were of conservation significance.

Sixteen species were recorded in the summer survey that were not recorded in spring.

### *4.1.2 Avifauna*

Eighty-five species of bird, from 38 families, were recorded during the current survey (Appendix B2). The most speciose families were the accipitridae (Hawks, Eagles, Kites, Harriers etc.: 6 species), pardalotidae (Pardalotes and allies; five species), columbidae (pigeons and doves; five species) and Meliphagidae (honeyeaters; eight species). Eighteen families were represented by a single species.

Species of conservation significance include the CALM Priority 4 Australian Bustard, *Ardeotis australis*, which was observed during the summer survey. Species of note include Pied Honeyeaters (*Certhionyx variegatus*) and Black Honeyeaters (*C. niger*), which are nomadic and infrequently observed.

Eleven species not recorded during spring were added to the overall list following the summer survey.

### 4.1.3 Mammals

Eighteen native and five introduced species of mammal, representing 12 families, were recorded in the Hashimoto project area during the survey (Appendix B3). Of the eighteen native mammals, half were bats, including two conservation significant species, the Orange Leaf-nosed Bat, *Rhinonicteris aurantius* (Vulnerable/Schedule 1), and Ghost Bat, *Macroderma gigas* (Priority 4).

Rodents were well sampled during the survey, with four native species captured; the Common Rock-rat (*Zyzomys argurus*), Desert Mouse (*Pseudomys desertor*), Spinifex Hopping-mouse (*Notomys alexis*) and Sandy Inland Mouse (*Pseudomys hermannsburgensis*). Four species of dasyurid were collected, the Little Red Kaluta (*Dasykaluta rosamondae*), Stripe-faced Dunnart (*Sminthopsis macroura*), Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Pilbara Ningaui (*Ningaui timealeyi*), while macropods were represented by the Euro (*Macropus robustus*) and Red Kangaroo (*Macropus rufus*).

Introduced mammals observed in the project area were European Cattle (**Bos taurus*), Dingo (**Canis lupus*), Cat (**Felis catus*), Donkey (**Equus asinus*) and House Mouse (**Mus musculus*).

An additional two species were recorded in the summer survey that had not been recorded in the spring survey.

### 4.1.4 Feral Fauna

Five mammal species were recorded that are considered feral or non-native fauna. These were the House Mouse (**Mus musculus*), Dingo (**Canis familiaris dingo*), Donkey (**Equus asinus*), Cat (**Felis catus*) and European Cattle (**Bos taurus*).

## 4.2 SAMPLING ADEQUACY

Sampling adequacy was determined using randomised species accumulation curves for each vertebrate group in each habitat in spring and summer, presented in Appendix C. Only systematic data from censuses (birds) and trapping (reptiles and amphibians) was used in the generation of the curves, i.e. opportunistic sightings were excluded. The axes are standardised for each vertebrate group to facilitate easy comparison between spring and summer surveys.

### 4.2.1 Herpetofauna

Separate curves were generated for amphibians and reptiles. During the spring survey, few amphibians were caught, although the curve for Site 2 suggests that sampling was adequate as it reaches the asymptote (Appendix C-A). Amphibians were most active during the

summer survey, following cyclonic rains and daily downpours. Few species were caught but there were large numbers of individuals, and most species could be observed following 20 to 50 captures at a given site. Site 2 reached saturation (maximal species richness) after just over 50 individual captures, as the number of species did not increase despite nearly 350 individuals being captured at this site. Site 3, the riverine site, had fewer individual captures but more species, and the curve suggests that the maximum number of species was not reached.

Reptiles were relatively well sampled in both spring and summer (Appendix C-B). The species accumulation curves of the spring survey, which was more than twice the duration of the summer survey, show greater maturation as they tend more toward the asymptote. Additionally, the rate of accumulation of reptiles at each site is similar. Overall, fewer species were observed during spring than in summer. As a result, the curves for each site tend to be more linear and do not appear to be approaching the asymptote, suggesting that if the trapping effort had been greater, more species would be caught. The exception is Site 4, which appears to have reached the asymptote at 7 species. Thus, the present survey, despite being run over two seasons with significantly more trap nights than are usually achieved (a total of 22 at each Site), did not adequately sample the habitats within the project area. However, compared with the species richness recorded during other surveys, Hashimoto is particularly diverse (Section 4.3). To achieve asymptotal species accumulation curves for each vertebrate group in each habitat would likely take several years of intensive trapping with multiple sites per habitat, which is beyond the scope of this survey.

### *4.2.2 Avifauna*

The between season pattern for avifauna species accumulation curves is similar to that for reptiles: the curves for each habitat during spring generally appear to be more mature than those from the summer survey, despite the overall survey times being similar. All curves in spring appear to be approaching the asymptote (Appendix C-C), suggesting that sampling was adequate. By contrast, only Sites 3 and 6 appear to have been sampled adequately in summer; these were also relatively consistent between seasons. At all other sites the curves suggest that further species would have been recorded with further survey effort.

### *4.2.3 Mammals*

Mammals were the least frequently captured vertebrate fauna, and were captured predominantly at Sites 5 and 6 (Appendix C-D). The spring survey yielded higher capture rates and greater numbers of species than the summer survey, largely due to the effect of Site 5, at which 19 individuals comprised of four species were captured in spring, compared with just one individual in summer. Only at Site 6, in both seasons, does the species accumulation curve reach the asymptote.

Large mammals recorded within the project area were not systematically trapped. Four feral animals were observed and the total mammal list includes 9 species of bat. Species accumulation curves do not take into account these observations, however, and appear relatively poor as a result.

## 4.3 COMPARISON WITH OTHER SURVEYS

Figure 4.1 presents vertebrate species richness as recorded during the current survey, compared with seven previous surveys in the region. These are Orebody 18 (*ecologia*, 1995b), West Angelas (*ecologia*, 1998), Yandi Stage II (*ecologia*, 1995c), Orebody 24 (*ecologia*, 2004a), Eastern Ophthalmia Range (*ecologia*, 2004b) and Wheelarra Hill (*ecologia*, 2004). All of these surveys were undertaken by *ecologia* using the same methods, except for the West Angelas survey, for which a total of 60 sites was established and run over three months. Additionally, ten sites were run over one month for the Yandi Stage II survey. Despite this, the number of species in each vertebrate group at Hashimoto is consistently among the highest relative to other surveys, with the exception of the amphibians which equal the highest number. Of particular relevance to Hashimoto are the Jimblebar, OB18 and Wheelarra Hill surveys, which are the nearest to the project area. Fewer species were recorded in each of these nearby areas than at Hashimoto.

Based on these figures it would appear that the project area has been adequately sampled, however, as the species accumulation curves presented above demonstrated, this was not the case. Nevertheless approximately 58% of the expected fauna was observed during the survey (54% of mammals, 73% of birds, 46% of herptiles). The higher number of species at Hashimoto compared with other nearby sites is likely to be related to a greater trapping effort but also suggests that Hashimoto has a diverse fauna relative to previous surveys.

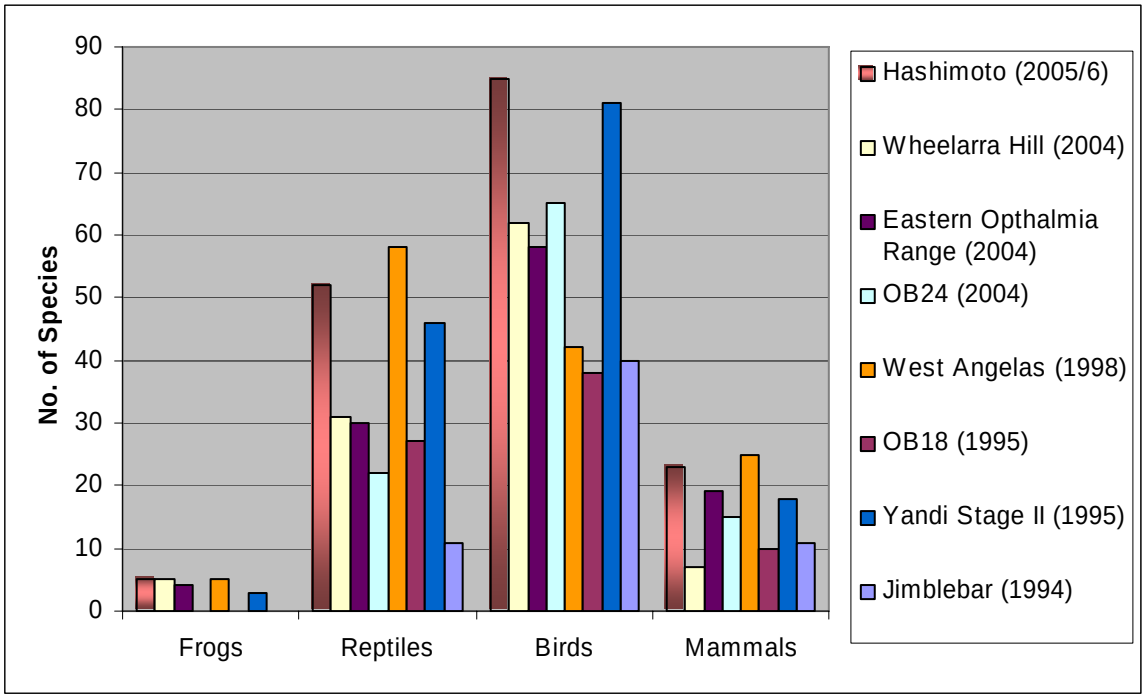


**Figure 4.1 Regional comparison of species richness.**

## 4.4 RARE AND SPECIALLY PROTECTED FAUNA

Fauna species that have been formally recognised as rare, threatened with extinction or as having high conservation value are protected by law under Commonwealth and State Legislation. At the National level, fauna are protected under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Within Western Australia, rare fauna are listed under the *Western Australian Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice 2005*. Additionally, the Department of Conservation and Land Management (CALM) maintains a Priority Fauna List, last updated in 2005.

Searches of EPBC (100 km buffer zone) and CALM (20 km buffer zone) databases yielded several species of significance that may potentially occur in the project area. These are shown in Table 4.2 below.

**Table 4.2 Fauna of conservation significance with the potential to occur in the project area.**

| Scientific Name | Common Name | EPBC | WCA 1950 | CALM | Likelihood of Occurrence |
|---|---|---|---|---|---|
| **Mammals** | | | | | |
| *Dasycercus cristicauda*[b] | Mulgara | Vu | S1 | | Low |
| *Dasyurus hallucatus*[b] | Northern Quoll | En | | | Very Low |
| *Macrotis lagotis*[b] | Bilby | Vu | S1 | | Low |
| *Notoryctes caurinus*[b] | Northern Marsupial Mole | En | S1 | | Very Low |
| *Pseudomys chapmani*[a] | Western Pebble-mound Mouse | | | P4 | Potential |
| *Rhinonicteris aurantius*[b] | Orange Leaf-nosed Bat | Vu | S1 | | Occurs |
| | | | | | |
| **Birds** | | | | | |
| *Acanthiza iredalei iredalei*[b] | Slender-billed Thornbill (Western) | Vu | | | None |
| *Ardea alba*[b] | Great Egret | Mar | | | Potential |
| *Ardea ibis*[b] | Cattle Egret | Mar | | | Potential |
| *Ardeotis australis*[b] | Australian Bustard | | | P4 | Occurs |
| *Charadrius veredus*[b] | Oriental Plover | Mar /Mig | | | Potential |
| *Falco hypoleucos*[b] | Grey Falcon | | | P4 | Low |
| *Falco peregrinus* | Peregrine Falcon | | S4 | | Potential |
| *Merops ornatus*[b] | Rainbow Bee-eater | Mig | | | Occurs |
| *Pezoporus occidentalis*[b] | Night Parrot | En / Mig | S1 | | Very Low |
| *Polytelis alexandrae*[b] | Princess Parrot | Vu | | | Very Low |
| | | | | | |
| **Reptiles** | | | | | |
| *Egernia kintorei*[b] | Great Desert Skink | Vu | S1 | | None |
| *Liasis olivaceus barroni*[b] | Pilbara Olive Python | Vu | S1 | | Potential |

[a] denotes CALM search result, [b] denotes EPBC search result. Vu (Vulnerable), En (Endangered), Mar (Marine), Mig (Migratory), S (Schedule), P (Priority).

### 4.4.1 Commonwealth EPBC Act

Of the marine and migratory birds covered by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, one was recorded within the study area, the Rainbow Bee-eater (*Merops ornatus*). This species is a widespread and relatively common visitor to Australia during the summer months.

Schedule 1 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Extinct, Extinct in the wild and Conservation Dependent (see Appendix E for classification details).

Of the ten Scheduled species that have the potential to occur in the study area, one was recorded, the Orange Leaf-nosed Bat (*Rhinonicteris aurantius*).

**Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) Vulnerable**

*Biology*

Orange Leaf-nosed Bats are dependent on caves and mines with very hot and humid roost sites (28° to 32°C and 96% to 100% relative humidity) for survival during the dry season (Churchill, 1998). Colonies may vary in size from 5 to more than 20,000 individuals. They leave the dry season roost caves from November to February during the wet season, at which time the outside climatic conditions are similar to the roost microclimate, allowing dispersal (Churchill, 1998). They occur in monsoon rainforest, tall open forest, open savannah woodland, black soil grassland and spinifex-covered hills, but are more influenced by the availability of suitable roost caves than habitat types. Their staple diet of moths and beetles is supplemented with flying termites (alates) during the wet season (Churchill, 1998), and they in turn may be preyed upon by Ghost Bats (*Macroderma gigas*). Orange Leaf-nosed bats are very susceptible to dehydration and hypothermia, and will abandon roost caves if disturbed unreasonably.

*Notes on occurrence*

The number of calls recorded suggests that this species roosts within a mine adit at Site 2 (E 212974.6, N 7412843). The same adit is used as a roost by Ghost Bats (*Macroderma gigas*).

This roost represents one of the easternmost roosts in the Pilbara and is locally important, as there did not appear to be any other caves or adits suitable as roosting sites in the surrounding area.

### 4.4.2 WA Wildlife Conservation Act 1950

Classification of rare and endangered fauna under the WA Wildlife Conservation (Specially Protected Fauna) Notice 2005 recognises four distinct Schedules (see Appendix E for schedule descriptions).

One Scheduled species was recorded during the survey, the Orange Leaf-nosed Bat (Schedule 1), which was previously described (see Section 4.4.1).

### 4.4.3 CALM Priority Fauna

Species on the CALM Priority Fauna list include those removed from the Scheduled Fauna list and other species known from only a few populations or in need of monitoring. Four Priority codes are recognised, as shown in Appendix E.

Two Priority fauna species were recorded during the survey, the Australian Bustard (*Ardeotis australis*, Priority 4) and Ghost Bat (*Macroderma gigas*, Priority 4), which are described below.

The Ghost Bat (*Macroderma gigas*) was not listed as potentially occurring within the area based on previous records, but was present at the *Rhinonicteris aurantius* roost at Site 2, and apparently roosts there as well.

**Australian Bustard (*Ardeotis australis*) Priority 4**

*Biology*

The Australian Bustard *Ardeotis australis* is a large ground-dwelling occurring in open or lightly wooded grasslands, chenopod flats and plains (Johnstone and Storr, 2004). It is usually encountered either singly, or in small single-sex groups, but it occasionally occurs in flocks of more than 30 in remote areas (Blakers *et al.,* 1984). It is nomadic and may range over very large areas, largely dependent on rainfall and food availability.

*Notes on occurrence*

This species was observed during the summer survey associated with open mulga woodland on sandy soils to the south of Site 4 and near Site 6, on the lower plains associated with the Zebra land system.

**Ghost Bat (*Macroderma gigas*) Priority 4**

*Biology*

The Ghost Bat *Macroderma gigas* is the largest Microchiropteran bat in Australia with a head-body length of ~115 mm, a forearm length of ~105 mm and weighing an average of 150 g (Strahan, 1995). It is identifiable by its large, joined ears, large eyes, simple nose leaf and lack of a tail. Ghost Bats occur in a variety of habitats, from arid Spinifex hillsides, to open tall forest and tropical rainforest (Churchill, 1998). Their distribution is determined by the availability of suitable roosting sites. The preferred roosting habitats of Ghost Bats in the Pilbara are caves beneath bluffs of low rounded hills composed of Marra Mamba geology, and granite rockpiles. They have also been known to roost in large colonies in sandstone caves, under boulder piles and in abandoned mines (Churchill, 1998).

The Ghost Bat *Macroderma gigas* is Australia's only carnivorous bat, feeding on large insects, spiders, termites and many types of small vertebrates, including birds, reptiles and other bats (Churchill, 1998). It forages in an area of approximately 60 ha, within a radius of approximately two kilometres from its roost (Tidemann *et al.,* 1985). It forages in the same area every night and foraging areas are not exclusive, with up to 20 bats having overlapping ranges (Tidemann *et al.,* 1985).

*Notes on occurrence*

Several Ghost Bat calls were recorded from the mine adit at Site 2 during spring and summer, suggesting that this is a roost site for Ghost Bats (Bullen, pers. comm.).

Additionally, an individual was seen foraging approximately 2 km to the east during the summer survey.

## 4.5 BIOREGIONAL ENDEMISM

When describing fauna and their conservation value, it is pertinent to note whether species have a widespread distribution or only occupy the biogeographic regions from which they were collected. Species that are endemic to a particular bioregion may be considered of higher conservation value than cosmopolitan species. There are exceptions, where cosmopolitan species, such as the Peregrine Falcon, *Falco peregrinus*, are in decline.

Where a biological survey reveals a high level of endemism across a broad range of taxa, it is usually interpreted that the area may have high conservation value. In such instances, the physical characteristics of the region may be unique and impose strong influences or selective pressures on the resident fauna, such that the fauna occurring may be dependant on those characteristics that are not present in other areas. In this instance, loss of habitat can result in a significant loss of fauna diversity in a regional or State context.

The distribution ranges of the species captured during the survey were considered in context with the boundary of the Pilbara biogeographic region so an assessment could be made on the conservation value of the project area.

Just under 10 % of the reptiles captured or observed were bioregional endemics. These were the gecko *Diplodactylus wombeyi*, a legless lizard *Delma elegans* and three skinks, *Ctenotus rutilans*, *Lerista neander* and *L. zietzi*. Two species, the Pygmy Python (*Antaresia perthensis*) and the skink *Ctenotus duricola*, while not strictly endemic to the Pilbara, are located mainly within the bioregion.

Five amphibian species were recorded during the current survey, none of which is restricted to the Pilbara bioregion.

Generally, avifauna shows reduced levels of biogeographic endemism. This is primarily due to their mobility. Only the Pilbara subspecies of the Striated Grasswren (*Amytornis striatus whitei*) could be considered a Pilbara bioregional endemic.

None of the mammals recorded are restricted to the Pilbara bioregion except perhaps the Pilbara population of the Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) which may be a separate taxon to those occurring across the Great Sandy Desert to the north-east. However, two species, the Kaluta (*Dasykaluta rosamondae*) and Pilbara Ningaui (*Ningaui timealeyi*), occur mainly in the Pilbara.

## 4.6 SURVEY LIMITATIONS AND CONSTRAINTS

According to the EPA Guidance Statement for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004), fauna surveys may be limited by several factors. An assessment of these aspects is detailed in Table 4.3.

**Table 4.3 Fauna survey constraints.**

| Aspect | Constraint (yes/no); Significant, moderate or negligible | Comment |
|---|---|---|
| Competency/experience of the consultant carrying out the survey | No | All members of survey team have had appropriate training, experience and mentoring in fauna identification and fauna assemblage surveys. Senior personnel have specific training and have undertaken no less than 15 similar surveys in the immediate area. |
| Scope | No | The survey duration and methods were appropriate for the sampling of all vertebrate fauna groups, including bats. |
| Proportion of fauna identified, recorded and/or collected | Yes - negligible | • All of the animals collected and observed were identified to species level and recorded. Where field identification was uncertain a voucher specimen was collected for submission to the WA Museum.<br>• Approximately 58% of the expected fauna was observed during the survey (54% of mammals, 73% of birds, 46% of herptiles). However, the species richness recorded is greater than that of other surveys in the region of a similar scope and is similar to the number of species recorded during longer surveys undertaken using the same methods. |
| Sources of information e.g. previously available information (whether historic or recent) vs. new | No | Several other unpublished reports for the same client produced by *ecologia* and other groups. Voucher records for most species are present from the area. |
| The proportion of the task achieved and further work which might be needed | No | A survey of the vertebrate fauna of the project area is complete. |
| Timing/weather/season/cycle | No | The survey occurred over two seasons, spring and summer. The spring survey was optimal for mammal captures but cool temperatures reduced reptile capture rates. Amphibian activity was low but birds were very active. In summer, post-cyclonic conditions were experienced. The survey was characterised by high temperatures, overcast conditions and high relative humidity. Reptile and amphibian activity were high, although reptile and mammal activity was negatively affected by frequent rainfall. As in spring, bird activity was high. Combining both surveys ensured that all vertebrate groups were adequately surveyed. |
| Disturbances which affected results of survey | Yes – negligible | Sporadic bouts of heavy rainfall resulted in reduced reptile activity during the summer survey. |
| Intensity (in retrospect, was the intensity adequate?) | No | Intensity of trapping effort was adequate given the small size of the project area and the amount of previous survey work that has been undertaken. |
| Completeness | Yes - negligible | The species accumulation curves suggest that sampling could have been undertaken for a longer duration, despite this survey having a significantly greater trapping effort than is typical amongst biological surveys. However most (approximately 60%) of the vertebrate fauna potentially occurring within the area was recorded. |
| Resources | No | Voucher specimens of amphibians, reptiles and mammals were identified by Mr B. Maryan and Ms N. Cooper of the Western Australian Museum. |

| | | |
|---|---|---|
| Remoteness and/or access problems | No | No access limitations. The habitats that needed to be sampled to adequately represent the project area were easily accessible. |
| Availability of contextual (e.g. biogeographic) information on the region | No | • WA Museum fauna database<br>• Department of Conservation and Land Management Database<br>• EPBC Database<br>• Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Cresswell, 1995)<br>• Land Systems Classifications (van Vreeswyk et al., 2004)<br>• several unpublished reports undertaken by *ecologia* and others |

Significant ≥ 60% of potential fauna not sampled, Moderate = 20-60% of potential fauna not sampled, Negligible ≤ 20% of potential fauna not sampled

212500mE
215000mE
217500mE
220000mE
7415000mN
7412500mN
7410000mN

N

**SCALE 1 : 25 000**

0 1

Kilometres

AUSTRALIAN MAP GRID

Grid based on Transverse Mercator Projection

**Drilling Buffer Zone**

**Orange Leaf-nosed Bat and Ghost Bat Roost**

Jimblebar

Copper Creek

Creek

530 550 510 520

## Legend

▲ Fauna of Conservation Significance

ecologia ENVIRONMENT

Author: M. O'Connell

Drawn: S.Coleman

Client: **BHP BILLITON**

Project: **524.00 HASHIMOTO**

# LOCATION OF FAUNA OF CONSERVATION SIGNIFICANCE

A3

Date: 26 July 2006

Scale: 1:25 000

Figure No. **4.2**

Plan No. **HM-004**

# 5.0 CONSERVATION SIGNIFICANCE

The significance of the biota of the project area has been assessed at four spatial scales; International/National, State, regional and local. Hashimoto represents the easternmost extension of the Newman land system, one of the largest land systems in the Pilbara and the dominant land system of the Hamersley Range. It contains a mosaic of land systems (Section 2.4) supporting a variety of flora and fauna habitats and this in part explains the relatively high diversity of fauna within the project area. An additional factor influencing the diversity is Jimblebar Creek, which bisects the western portion of the project area and forms a large, semi-permanent pool just to the north. This pool represents an important aquatic resource for fauna during dry periods. The creek and pool are therefore areas of local conservation significance within the project area. A major feature of conservation significance is the mine adit (a horizontal entrance) at Site 2, which represents a roost site for Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) (Vulnerable, Schedule 1) and Ghost Bat (*Macroderma gigas*) (Priority 4). Finally, a search of the CALM threatened ecological communities (TEC) database revealed one TEC, the Ethel Gorge aquifer stygobiont community. According to CALM, the aquifer lies within about 15 km of the project area.

The location of conservation significant fauna is shown in Figure 3.1.

## 5.1 INTERNATIONAL/NATIONAL SIGNIFICANCE

Migratory fauna whose conservation is dependent on the action of several nations are of international significance. Such species are recognised by State and Federal legislation and international treaties. National significant refers to those features of the environment which are recognised under legislation as being of importance to the Australian community.

Several species listed as Marine or Migratory under the EPBC Act have the potential to occur in the project area (Table 4.2). One of these species, the Rainbow Bee-eater (*Merops ornatus*), was recorded during the current survey.

The Rainbow Bee-eater has a very widespread distribution over Australia, wintering in northern Australia and Indonesia, and migrating south during September and October (Johnstone and Storr, 2004).

The species noted in Table 4.2, as Marine or Migratory by the EPBC Act, while being of lower conservation significance than Vulnerable or Endangered species, potentially utilise the pool on Jimblebar Creek in the northern part of the study area as a stopover point during migration. Because the project area forms part of the catchment for the creek, increased erosion or chemical spills occurring within it may adversely affect the health of the creek system and could indirectly impact migratory birds utilising this resource.

One species listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was recorded during the current survey.

**Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) Vulnerable, Schedule 1**

This bat occupies the mine adit at Site 2 and is present in large enough numbers for the adit to be considered a roost site for the species (Bullen, pers. comm.). This roost represents the south-easternmost permanent location for *R. aurantius* and is therefore of some significance to the species.

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) assessment and approval is required for actions that are likely to have a significant impact on:

- a matter of national environmental significance
- the environment of Commonwealth land (even if taken outside Commonwealth land)
- the environment anywhere in the world (if the action is undertaken by the Commonwealth)

Threatened species are listed as matters of national environmental significance under the Act. To determine whether a referral to the Department of the Environment and Heritage (DEH) is required in this case, the potential impacts of exploration activities (and particularly percussion drilling) at Hashimoto are compared with the EPBC's *Principal Significant Impact Guidelines for Vulnerable Species* in Table 5.1 below. Note that an "important population" is a population that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

Based on these classifications, and the remote nature of the roost relative to other known *R. aurantius* roosts, the Hashimoto population is classified as an *important population* because it is likely to be necessary for maintaining genetic diversity and it is currently at the limit of the species range.

**Table 5.1 EPBC Act criteria to determine a significant impact to a species listed as Vulnerable**

| Criteria | Impact |
|---|---|
| Lead to a long-term decrease in the size of an important population of a species | Likely |
| Reduce the area of occupancy of an important population | Likely |
| Fragment an existing important population into two or more populations | No |
| Adversely affect habitat critical to the survival of a species | No |
| Disrupt the breeding cycle of an important population | Potential |
| Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline | Likely |
| Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat | No |
| Interferes substantially with the recovery of the species | Likely |

Potential impacts to this species are outlined in Section 6.3.1, and recommendations relating to the ongoing management of the Orange Leaf-nosed Bats at Hashimoto are presented in Section 7.0.

### Threatened Ecological Communities

No TECs of National significance are located within the project area. However, as stated the Ethel Gorge aquifer lies close to Hashimoto and could potentially be impacted by mining activities.

## 5.2 STATE SIGNIFICANCE

State significance refers to those features of the environment that are recognised under State legislation as of importance to the Western Australian community; in particular, species scheduled under the Wildlife Conservation Act 1950.

Fauna that are regarded as "rare and/or endangered", or habitats which are site or type specific and possess high ecological value are of State significance. Habitats which exhibit such a level of significance will contain either specific habitat dependent fauna or high biodiversity, and are poorly represented elsewhere. If a species or habitat is poorly represented in conservation reserves its conservation significance is increased.

The Orange Leaf-nosed Bat, discussed in Section 4.4.1, was the only species scheduled under the *WA Wildlife Conservation Act 1950* that has been recorded in the project area, although there is potential for the Peregrine Falcon (Schedule 4) to use the area transiently and Pilbara Olive Python (Schedule 1) may occur along Jimblebar Creek in suitably vegetated rocky areas near permanent water.

## 5.3 REGIONAL SIGNIFICANCE

EPA Guidance Statement 56 (Environmental Protection Authority, 2004) describes the high diversity of Australia's biota and recommends that the diversity and endemism of terrestrial fauna be considered when undertaking biological survey work for environmental impact assessment. Where endemic fauna occur in an area proposed for disturbance, there is the potential for a loss of fauna diversity.

Regional significance addresses the representation of species and habitats at a biogeographic regional level. Species or habitat types that are endemic to the Hashimoto area, and whose known distributions are limited or unknown, may be considered regionally significant.

Where a biological survey reveals a high level of endemism across a broad range of taxa, it is usually interpreted that the area may have high conservation value. In such instances, the physical characteristics of the region may be unique and impose strong influences or selective pressures on the resident fauna, such that the fauna occurring may be dependent on those characteristics that are not present in other areas. In this instance, loss of habitat can result in a significant loss of fauna diversity in a regional or State context.

Some of the species listed in the CALM Priority list are considered regionally significant because of limited knowledge about their distribution, restricted distribution and/or poor representation within existing conservation reserves.

Fauna species of regional significance (CALM Priority species) occurring at Hashimoto are the Ghost Bat (Priority 4) and Australian Bustard (Priority 4), which were discussed in Section 4.4.3. Potential impacts on these species are discussed in Section 6.0.

## 5.4 LOCAL SIGNIFICANCE

Species are of local significance when their presence is confined to a specialised habitat type that is not common within the local area and whose disturbance or removal may lead to local extinction.

As outlined, the project area lies near the easternmost extension of the Newman Land System (NLS) and consequently may also represent the easternmost extension of saxicolous fauna localised to landforms such as rocky plateaus, ridges, mountains and hills which make up 70% of the NLS (van Vreeswyk et al., 2004). Among the vertebrates there are several such taxa. Some examples are the Pygmy Spiny-tailed Skink (*Egernia depressa*), which inhabits rock crevices in the Pilbara and the rock-dwelling Common Rock Rat (*Zyzomys argurus*), both of which occur at Hashimoto. Such species may occur on the other hill and range landforms surrounding the project area, particularly larger masses such as those associated with the Robertson Land System to the east and the Talga Land System to the south.

## 5.5 BIODIVERSITY

Australia has an International obligation to maintain biodiversity. The Commonwealth government has initiated the National Strategy for the Conservation of Biological Diversity, which incorporates elements of the National Strategy for Ecologically Sustainable Development (NSESD). Biological diversity (biodiversity) relates to the richness of the biota at a local, regional, state, National or even global level, and includes all components of the environment, from bacteria to insects, plants, and vertebrate fauna. Biodiversity can be thought of as existing at several levels, including genetic, population and species (or taxon) diversity.

The extant vertebrate fauna of the region has been described in detail as a result of previous surveys. Relative to other surveys in the Pilbara, the Hashimoto project area is particularly diverse, with a total of 180 vertebrate fauna species recorded during the survey, including 23 mammals, 85 bird species, 52 reptiles and five amphibians. Due to sampling limitations inherent in biological surveys of this nature this is not an all-inclusive list, and the species accumulation curves generated following the survey indicate that, for each vertebrate group, several more species may exist in most habitats. This reflects the high diversity of the land systems, habitats, landforms and soils located within the relatively small project area and serves to increase its conservation value. Hashimoto contains a mosaic of land systems and vegetation types that are small and isolated.

Part of the purpose of the biogeographic regionalisation of Australia (Thackway and Cresswell, 1995) was to examine the representation of ecosystems within conservation reserves at a bioregional level to ensure that the biodiversity of each bioregion was maintained. The closest national parks are Karijini National Park, which lies 160 km to the north-west and is the second largest national park in Western Australia at 627 444 ha, and Chichester Range National Park. The land system to be impacted most as part of the planned exploration program at Hashimoto is the Newman Land System, which is well represented within Karijini NP. This should reduce the impact on other land systems and their interfaces and therefore maintain the relatively high biodiversity of the local area, provided clearing is carefully managed and the secondary affects of drilling activity (e.g. dust, noise, pollution) are actively controlled.

Thus, biodiversity at the bioregional scale is unlikely to be impacted by the proposed exploration activity within the project area, at least as far as the vertebrate fauna is concerned. On a local scale, clearing may reduce the biodiversity of the area, particularly clearing in creekline and outwash plain habitats and the clearing of transitional habitats between land systems.

Issues (other than clearing) that have been identified as important to conservation planning and management in the Pilbara include the extinction of critical weight range mammals, wildfire, grazing and feral animals. The issues relevant to drilling activity are considered in the management strategies proposed for the project area.

# 6.0 ENVIRONMENTAL IMPACTS

The exploration programme proposed for Hashimoto would result in the clearing of small areas of vegetation. As discussed, the number of land systems found in the project area is large relative to other projects of similar size in the Pilbara, suggesting that Hashimoto may be of some conservation and ecological significance, particularly given the high biodiversity of the vertebrate fauna relative to other surveys. Unless carefully managed, the clearing of vegetation and secondary disturbances associated with exploration may reduce the biodiversity of the fauna in within the project area.

A risk assessment was conducted to identify the potential impacts to the vertebrate fauna and fauna habitats within the project area and the actions required to reduce the residual impacts and/or risks to acceptable levels. The risk assessment matrix is presented in Appendix F.

As a result of the risk assessment process, the following potential impacts were identified.

**Direct Impacts**

- Fauna habitat loss and fragmentation through clearing of native vegetation;
- Fauna deaths (especially sedentary fauna);
- Human disturbance of resident fauna.

**Secondary or Indirect Impacts**

- Increased risk of fire associated with movement of personnel and machinery;
- Degradation of fauna habitat due to invasion and spread of weeds;
- Increased movement of feral (introduced) fauna in the area;
- Disruption of resident fauna by noise and dust pollution;

The EPA objective for terrestrial fauna is to maintain abundance, species diversity and geographic distribution of terrestrial fauna and protect specially protected (threatened) fauna consistent with the provisions of the *Wildlife Conservation Act 1950*. If the management recommendations proposed in Section 7.0 are adopted, the impact to terrestrial fauna and the conservation status of specially protected and significant species will be minimised.

## 6.1 DIRECT LOSS OF FAUNA AND FAUNA HABITAT

The most substantial environmental impact arising from the proposed project would be the clearing of native vegetation and consequent loss of fauna and habitat.

The proposed clearing will result in the direct loss of small fauna occurring in the areas demarcated for clearing, particularly sedentary species such as some mammals, all amphibians, most reptiles and potentially some birds, such as Fairy-wrens and species that roost in tree hollows during the day, e.g. Southern Boobook and Australian Owlet-Nightjar. Such species may be unable or unwilling to move out of the area prior to the disturbance occurring.

Another potential impact is the disturbance of resident fauna, particularly roosting bats near Site 2, which is discussed in Section 6.3.1.

## 6.2 INDIRECT LOSS OF FAUNA AND FAUNA HABITAT

Mobile fauna within proposed development areas that are able to avoid direct impact will be displaced into adjacent habitats. Territorial animals may find themselves in direct competition for limited resources with their own or different species, which may cause secondary losses of fauna. They may also be more prone to predation at this time.

Another secondary consequence of disturbance is an increase in the number of pest species and/or the number of individuals of pest species occupying the disturbed areas. In particular the dingo (**Canis familiaris dingo*), cat (**Felis catus*), and the House Mouse (**Mus musculus*) may increase in frequency with an increase in human activity and can significantly impact native fauna communities. Access tracks will improve or ease the access of pest species into the project area, particularly if secondary and cross-tracks are made.

This practice also leads to habitat degradation, particularly when a dense drill pattern is used, as habitats are segmented into smaller blocks. This alters the fauna habitat and may have a detrimental effect on fauna dependent on thickly vegetated or more contiguous habitats, as well as increasing access by predators.

Increased human activity may be associated with changes in fire regimes, leading to degradation of natural ecosystems. Movement of vehicles and human activities such as smoking have the potential to increase the frequency of spot fires. Such practices need to be adequately managed, as outlined in Section 7.0

Weeds may also be introduced by drilling activities where hygiene practices are not implemented or ignored. This too may lead to degradation of fauna habitats as introduced plant species may successfully and rapidly invade cleared or disturbed areas.

Dust generated by vehicles and heavy-duty machinery may degenerate habitat on the windward side of disturbance areas, particularly roads. Because drilling activities are generally short-term, and the impact on a given area is brief, dust is unlikely to be a significant issue for the project.

## 6.3 IMPACTS ON CONSERVATION SIGNIFICANT FAUNA

### *6.3.1 Orange Leaf-nosed Bat (Vulnerable, Schedule 1)*

This species occupies the mine adit at Site 2 and is present in large enough numbers for the adit to be considered a roost site for the species. Drilling activity on top of or near to the rock mass above the mine adit will directly impact these bats, which are disturbance-shy (Churchill, 1998). Being prone to exposure they are unable to survive outside of the roost site except in very warm, humid conditions and if displaced from their roost cave by drilling activity the population would likely be lost unless another roost cave is present in the area. Based on consultation with CALM staff and bat specialists, we recommend that a drilling and disturbance exclusion zone of radius 500 m should be set up around the mine adit to prevent impacting bats utilising the adit. This would also help to protect the Priority 4 Ghost Bats (*Macroderma gigas*) inhabiting the roost.

Another risk is that the mine adit in which the Orange Leaf-nosed Bats and Ghost Bats roost may be punctured during drilling, potentially altering the roost microclimate that is essential to the survival of the population.

Additionally, the risk to the colony of human disturbance at the entrance to the adit is significant. The species is shy of disturbance and any human activity at the entrance may have a negative impact on the colony.

### 6.3.2 Australian Bustard (Priority 4)

Several Australian Bustards were observed within the project area, as discussed. The bustard will not be directly impacted by drilling activity in the project area, as it is mobile and capable of evacuating the area. This is a likely consequence of drilling activity as this species is generally shy of humans. The species will be indirectly impacted by being excluded from the area, however, the areas immediately adjacent to and surrounding Hashimoto contain suitable habitat for displaced bustards. They are nomadic birds (Johnstone and Storr, 2004) and are capable of utilising a range of different habitats. Consequently, the proposed exploration activity at Hashimoto will not affect the population of bustards in the Pilbara.

### 6.3.3 Ghost Bat (Priority 4)

Exploration activity may have a direct effect on the population of Ghost Bats residing in the project area at the Site 2 mine adit. These, like the Orange Leaf-nosed Bats discussed in Section 5.1, will be directly impacted by drilling activity too near to the adit. CALM and regional bat experts have suggested that a 500 m drilling-exclusion zone be set up around the adit as a result, and that monitoring of the population be undertaken.

# 7.0 RECOMMENDATIONS

Recommendations will be supplied separately to Brad Smith and Natasha Baker.

# 8.0 STUDY TEAM

The Hashimoto Biological Survey described in this document was planned, coordinated and executed by:

***ecologia* Environment**
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**Project Staff**

| | | |
|---|---|---|
| Samantha Jarvis | BSc (Hons) | Project Manager |
| Stewart Ford | PhD | Senior Zoologist |
| Jarrad Clark | BSc (Env. Mgmt.) | Zoologist |
| Thomas Rasmussen | | Zoologist |

*ecologia* wishes to acknowledge the assistance of Mr Bob Bullen for bat call identification.

**PERMITS**

The Hashimoto Fauna Survey was conducted under the authorisation of the following licences issued by Conservation and Land Management to:

Stewart Ford, Licence No.: SF005067 "Licence to take fauna for scientific purposes"

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# Appendix A

## Fauna species previously observed or expected to occur in the vicinity of the Hashimoto project area.

**Appendix A1 Herpetofauna species previously observed or expected in the Hashimoto Project area.**

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| **AMPHIBIA** | | | | | | | | |
| HYLIDAE | | | | | | | | |
| *Cyclorana maini* | Main's Frog | ✓ | | ✓ | | | | ✓ |
| *Cyclorana platycephala* | Water-Holding Frog | ✓ | | | | | | ✓ |
| *Litoria rubella* | Desert Tree Frog | ✓ | | ✓ | | | | ✓ |
| MYOBATRACHIDAE | | | | | | | | |
| *Limnodynastes spenceri* | Spencer's Frog | ✓ | | ✓ | | | | ✓ |
| *Neobatrachus kunapalari* | Wheatbelt Frog | ✓ | | | | | | |
| *Neobatrachus sutor* | Shoemaker Frog | ✓ | | | | | | |
| *Notaden nichollsi* | Desert Spadefoot | ✓ | | ✓ | | | | |
| *Uperoleia russelli* | Russell's Toadlet | ✓ | | ✓ | | | | ✓ |
| | | | | | | | | |
| **REPTILIA** | | | | | | | | |
| AGAMIDAE | | | | | | | | |
| *Caimanops amphiboluroides* | Mulga Dragon | ✓ | | | | | | |
| *Ctenophorus caudicinctus* | Ring-tailed Dragon | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| *Ctenophorus isolepis* | Military Dragon | ✓ | | ✓ | ✓ | | | |
| *Ctenophorus nuchalis* | Central Netted Dragon | ✓ | | ✓ | ✓ | | | ✓ |
| *Ctenophorus reticulatus* | Western Netted Dragon | ✓ | | ✓ | | | | |
| *Diporiphora winneckei* | Common two-lined Dragon | ✓ | | | | | | |
| *Lophognathus longirostris* | Long-nosed Water Dragon | ✓ | | | | | | ✓ |
| *Pogona minor* | Dwarf Bearded Dragon | ✓ | | ✓ | ✓ | | | ✓ |
| *Tympanocryptis cephala* | Earless Pebble Dragon | ✓ | | | | | | |
| BOIDAE | | | | | | | | |
| *Antaresia perthensis* | Pygmy Python | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| *Antaresia stimsoni* | Stimson's Python | ✓ | | ✓ | | | | |
| *Aspidites melanocephalus* | Black-headed python | ✓ | | ✓ | | | | ✓ |
| *Liasis olivaceus barroni* | Pilbara Olive Python | ✓ | | | | | | |
| CHELUIDAE | | | | | | | | |
| *Chelodina steindachneri* | Steindachner's turtle | ✓ | | | | | | ✓ |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| ELAPIDAE | | | | | | | | |
| *Acanthophis wellsi* | Death Adder | ✓ | | ✓ | | | | |
| *Brachyurophis approximans* | NW Shovel-nosed Snake | ✓ | | ✓ | | | | |
| *Brachyurophis fasciolata* | Narrow-banded Shovel-nosed Snake | ✓ | | | | | | |
| *Demansia psammophis* | Yellow-faced Whipsnake | ✓ | | ✓ | | | | ✓ |
| *Demansia rufescens* | Rufous Whipsnake | ✓ | | | | | | |
| *Furina ornata* | Moon Snake | ✓ | | | | | | |
| *Parasuta monachus* | Hooded Snake | ✓ | | ✓ | | | | |
| *Pseudechis australis* | Mulga Snake | ✓ | | | | | | ✓ |
| *Pseudonaja modesta* | Ringed Brown Snake | ✓ | | | | | | ✓ |
| *Pseudonaja nuchalis* | Gwardar | ✓ | | ✓ | | ✓ | | ✓ |
| *Simoselaps anomalus* | Desert Banded Snake | ✓ | | | | | | |
| *Simoselaps bertholdi* | Jan`s Banded Snake | ✓ | | | | | | |
| *Suta fasciata* | Rosen's Snake | ✓ | | | | | | |
| *Suta punctata* | Spotted Snake | ✓ | | | | | | |
| *Vermicella snelli* | Pilbara Bandy-Bandy | ✓ | | | | | | |
| GEKKONIDAE | | | | | | | | |
| *Crenadactylus ocellatus* | A Gecko | ✓ | | | | | | |
| *Diplodactylus conspicillatus* | Fat-tailed Gecko | ✓ | | ✓ | | ✓ | | ✓ |
| *Diplodactylus granariensis* | Wheatbelt Stone Gecko | ✓ | | | | | | |
| *Diplodactylus mitchelli* | A Gecko | ✓ | | | | | | |
| *Diplodactylus pulcher* | Beautiful Gecko | ✓ | | ✓ | | | | |
| *Diplodactylus savagei* | A Gecko | ✓ | | | | ✓ | | |
| *Diplodactylus squarrosus* | A Gecko | ✓ | | | | | | |
| *Diplodactylus stenodactylus* | Pale-snouted Ground Gecko | ✓ | | ✓ | | ✓ | | ✓ |
| *Diplodactylus wombeyi* | A Gecko | ✓ | | | | ✓ | | ✓ |
| *Gehyra pilbara* | Pilbara Dtella | ✓ | | | | | | |
| *Gehyra punctata* | Spotted Dtella | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| *Gehyra purpurascens* | Purple Arid Dtella | ✓ | | | | | | ✓ |
| *Gehyra variegata* | Tree Dtella | ✓ | ✓ | ✓ | | | | ✓ |
| *Heteronotia binoei* | Bynoe's Gecko | ✓ | | ✓ | ✓ | | | ✓ |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Heteronotia spelea* | Desert Cave Gecko | ✓ | | ✓ | | | | ✓ |
| *Nephrurus laevissimus* | Smooth Knob-tailed Gecko | ✓ | | | | | | |
| *Nephrurus levis* | Common Knob-tailed Gecko | ✓ | | | | | | |
| *Nephrurus wheeleri* | Banded Knob-tailed Gecko | ✓ | | ✓ | | ✓ | | |
| *Oedura marmorata* | Marbled Velvet Gecko | ✓ | | ✓ | | | | |
| *Rhynchoedura ornata* | Beaked Gecko | ✓ | | | ✓ | ✓ | | ✓ |
| *Strophurus ciliaris* | Northern Spiny-tailed Gecko | ✓ | | | | | | |
| *Strophurus elderi* | Jewelled Gecko | ✓ | | ✓ | | | | |
| *Strophurus jeanae* | A Gecko | ✓ | | | | | | |
| *Strophurus wellingtonae* | A Gecko | ✓ | | ✓ | | | | ✓ |
| PYGOPODIDAE | | | | | | | | |
| *Delma butleri* | Un-banded Delma | ✓ | | | | | | |
| *Delma elegans* | A legless lizard | ✓ | | ✓ | | | | ✓ |
| *Delma haroldi* | A legless lizard | ✓ | | | | | | ✓ |
| *Delma nasuta* | Long-nosed Delma | ✓ | | ✓ | ✓ | ✓ | | |
| *Delma pax* | A legless lizard | ✓ | | | ✓ | ✓ | | ✓ |
| *Delma tincta* | A legless lizard | | | ✓ | | | | |
| *Lialis burtonis* | Burton's Snake Lizard | ✓ | | ✓ | | | | ✓ |
| *Pygopus nigriceps* | Hooded Scaly-foot | ✓ | | ✓ | | | | ✓ |
| SCINCIDAE | | | | | | | | |
| *Carlia munda* | A skink | ✓ | | ✓ | | ✓ | | ✓ |
| *Carlia triacantha* | Rainbow Skink | ✓ | | ✓ | | | | |
| *Cryptoblepharus carnabyi* | A skink | ✓ | | | | | | |
| *Cryptoblepharus plagiocephalus* | Fence Skink | ✓ | | | ✓ | | | |
| *Ctenotus ariadnae* | A skink | ✓ | | | | | | |
| *Ctenotus brooksi* | Central wedge-snout Ctenotus | ✓ | | | | | | |
| *Ctenotus calurus* | Blue-tailed Skink | ✓ | | | | | | |
| *Ctenotus duricola* | A skink | ✓ | | ✓ | | ✓ | | ✓ |
| *Ctenotus dux* | A skink | ✓ | | | | | | |
| *Ctenotus grandis* | A skink | ✓ | | ✓ | | ✓ | | ✓ |
| *Ctenotus helenae* | A skink | ✓ | | ✓ | ✓ | ✓ | | ✓ |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Ctenotus leae* | A skink | ✓ | | | | | | |
| *Ctenotus leonhardii* | A skink | ✓ | ✓ | | ✓ | | | |
| *Ctenotus nasutus* | A skink | ✓ | | | | | | |
| *Ctenotus pantherinus* | Leopard Skink | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| *Ctenotus piankai* | A skink | ✓ | | ✓ | | | | |
| *Ctenotus quattuordecimlineatus* | Fourteen-lined Skink | ✓ | | | | | | |
| *Ctenotus rubicundus* | A skink | ✓ | | ✓ | | ✓ | | |
| *Ctenotus rutilans* | A skink | ✓ | | ✓ | | | | ✓ |
| *Ctenotus saxatilis* | A skink | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| *Ctenotus schomburgkii* | A skink | ✓ | | ✓ | | | | ✓ |
| *Ctenotus uber* | A skink | ✓ | | ✓ | | | | ✓ |
| *Cyclodomorphus melanops* | Spinifex Slender Blue-tongue | ✓ | | ✓ | ✓ | | | ✓ |
| *Egernia depressa* | Pygmy Spiny-tailed Skink | ✓ | | ✓ | | ✓ | | ✓ |
| *Egernia formosa* | Goldfields Crevice Skink | ✓ | | | | ✓ | | |
| *Egernia striata* | Nocturnal Desert Skink | ✓ | | | | | | |
| *Eremiascincus fasciolatus* | Narrow-banded Sand-swimmer | ✓ | | | | | | |
| *Eremiascincus richardsonii* | Banded Skink | ✓ | | | | | | ✓ |
| *Lerista bipes* | A skink | ✓ | | | | | | ✓ |
| *Lerista frosti* | A skink | | ✓ | | | | | |
| *Lerista ips* | A skink | ✓ | | | | | | |
| *Lerista labialis* | A skink | ✓ | | | | | | |
| *Lerista macropisthopus* | Unpatterned Robust Lerista | ✓ | | | | | | |
| *Lerista muelleri* | A skink | ✓ | | ✓ | ✓ | | | ✓ |
| *Lerista neander* | A skink | ✓ | | ✓ | ✓ | | | ✓ |
| *Lerista zietzi* | A skink | ✓ | | ✓ | ✓ | | | ✓ |
| *Menetia greyii* | Common Dwarf Skink | ✓ | | ✓ | ✓ | | | ✓ |
| *Menetia surda* | A skink | ✓ | | ✓ | | | | |
| *Morethia ruficauda* | Three Striped Fire-tail | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| *Tiliqua multifasciata* | Central Blue-tongue Lizard | ✓ | | ✓ | | | | ✓ |
| TYPHLOPIDAE | | | | | | | | |
| *Ramphotyphlops endoterus* | A blind-snake | ✓ | | | | | | |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Ramphotyphlops ganei* | A blind-snake | ✓ | | | | | | |
| *Ramphotyphlops grypus* | A blind-snake | ✓ | | | ✓ | | | ✓ |
| *Ramphotyphlops hamatus* | A blind-snake | ✓ | | ✓ | | | | ✓ |
| *Ramphotyphlops pilbarensis* | A blind-snake | ✓ | | | | | | |
| *Ramphotyphlops waitii* | A blind-snake | ✓ | | | | | | |
| VARANIDAE | | | | | | | | |
| Var*anus acanthurus* | Ridge-tailed Monitor | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| Var*anus brevicauda* | Short-tailed Monitor | ✓ | | ✓ | | | | |
| Var*anus caudolineatus* | Stripe-tailed Monitor | ✓ | | ✓ | | | | |
| Var*anus eremius* | Desert Pygmy Monitor | ✓ | | | | | | |
| Var*anus giganteus* | Perentie | | | ✓ | ✓ | | | ✓ |
| Var*anus gilleni* | A goanna | ✓ | | | | | | |
| Var*anus gouldii* | Gould's Monitor | ✓ | ✓ | | | | | ✓ |
| Var*anus panoptes* | A goanna | ✓ | | | | | | ✓ |
| Var*anus pilbarensis* | Pilbara Rock Monitor | ✓ | | | ✓ | | | |
| Var*anus tristis* | Black-headed Monitor | ✓ | ✓ | ✓ | ✓ | | | ✓ |

125 Expected based on WAM collections
68 Previously caught by *ecologia*
57 Species observed in this survey
0 Species not previously recorded

**Appendix A2 Bird species previously observed or expected in the Hashimoto Project area. [a] indicates species unique to this survey**

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| CASUARIIDAE | | | | | | | | |
| *Dromaius novaehollandiae* | Emu | ✓ | ✓ | | ✓ | | | |
| PHASIANIDAE | | | | | | | | |
| *Coturnix pectoralis* | Stubble Quail | ✓ | | | | | | |
| *Coturnix ypsilophora* | Brown Quail[a] | | | | | | | ✓ |
| TURNICIDAE | | | | | | | | |
| *Turnix velox* | Little Button-quail | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| PHALACROCORIDAE | | | | | | | | |
| *Phalacrocorax carbo* | Great Cormorant | ✓ | | | | | | |
| *Phalacrocorax sulcirostris* | Little Black Cormorant | ✓ | | | | | | ✓ |
| RALLIDAE | | | | | | | | |
| *Gallinula ventralis* | Black-tailed Native-hen[a] | | | | | | | ✓ |
| ANATIDAE | | | | | | | | |
| *Chenonetta jubata* | Australian Wood Duck | ✓ | | | | | | ✓ |
| *Tadornis tadornoides* | Australian Shelduck[a] | | | | | | | ✓ |
| *Anas superciliosa* | Pacific Black Duck | ✓ | | | | | | |
| PELECANIDAE | | | | | | | | |
| *Pelecanus conspicillatus* | Australian Pelican | ✓ | | | | | | |
| ARDEIDAE | | | | | | | | |
| *Egretta novaehollandiae* | White-faced Heron | ✓ | | | | | | ✓ |
| *Egretta garzetta* | Little Egret | ✓ | | | | | | |
| *Ardea pacifica* | White-necked Heron | ✓ | | | | | | ✓ |
| *Ardea alba* | Great Egret | ✓ | | | | | | |
| *Nycticorax caledonicus* | Nankeen Night Heron | ✓ | | | | | | |
| THRESKIORNITHIDAE | | | | | | | | |
| *Threskiornis spinicollis* | Straw-necked Ibis | ✓ | | | | | | |
| LARIDAE | | | | | | | | |
| *Larus novaehollandiae* | Silver Gull | ✓ | | | | | | |
| ACCIPITRIDAE | | | | | | | | |
| *Accipiter cirrhocephalus* | Collared Sparrowhawk | | | | | ✓ | | |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Accipiter fasciatus* | Brown Goshawk[a] | | | | | | | ✓ |
| *Circus assimilis* | Spotted Harrier | | | ✓ | ✓ | ✓ | | ✓ |
| *Elanus axillaris* | Black-shouldered Kite | ✓ | | | ✓ | ✓ | | |
| *Lophoictinia isura* | Square-tailed Kite | ✓ | | | | ✓ | | |
| *Hamirostra melanosternon* | Black-breasted Buzzard | ✓ | | | | | | ✓ |
| *Milvus migrans* | Black Kite | | | | | ✓ | | |
| *Haliastur sphenurus* | Whistling Kite | ✓ | | | ✓ | ✓ | | ✓ |
| *Aquila audax* | Wedge-tailed Eagle | ✓ | | ✓ | | ✓ | | ✓ |
| *Hieraaetus morphnoides* | Little Eagle | ✓ | | | | | | ✓ |
| FALCONIDAE | | | | | | | | |
| *Falco berigora* | Brown Falcon | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| *Falco longipennis* | Australian Hobby | ✓ | | ✓ | | ✓ | | ✓ |
| *Falco peregrinus* | Peregrine Falcon | ✓ | | | | | | |
| *Falco cenchroides* | Australian Kestrel | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| OTIDIDAE | | | | | | | | |
| *Ardeotis australis* | Australian Bustard | ✓ | | ✓ | ✓ | | | ✓ |
| SCOLOPACIDAE | | | | | | | | |
| *Calidris acuminata* | Sharp-tailed Sandpiper | ✓ | | | | | | |
| *Calidris melanotos* | Pectoral Sandpiper | ✓ | | | | | | |
| *Calidris subminuta* | Long-toed Stint | ✓ | | | | | | |
| *Actitis hypoleucos* | Common Sandpiper | ✓ | | | | | | |
| CHARADRIIDAE | | | | | | | | |
| *Charadrius australis* | Inland Dotterel | ✓ | | | | | | |
| *Elseyornis melanops* | Black-fronted Dotterel | ✓ | | | | | | ✓ |
| COLUMBIDAE | | | | | | | | |
| *Phaps chalcoptera* | Common Bronzewing | ✓ | ✓ | ✓ | | | | ✓ |
| *Ocyphaps lophotes* | Crested Pigeon | ✓ | | | | ✓ | | ✓ |
| *Geopelia striata* | Peaceful Dove | ✓ | | ✓ | | | | ✓ |
| *Geophaps plumifera* | Spinifex Pigeon | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| *Geopelia cuneata* | Diamond Dove | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| CACATUIDAE | | | | | | | | |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Cacatua roseicapilla* | Galah | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| *Cacatua sanguinea* | Little Corella | ✓ | | | ✓ | | | ✓ |
| *Nymphicus hollandicus* | Cockatiel | ✓ | | | | ✓ | | ✓ |
| PSITTACIDAE | | | | | | | | |
| *Barnardius zonarius* | Australian Ringneck | ✓ | | | ✓ | ✓ | | ✓ |
| *Psephotus varius* | Mulga Parrot | ✓ | | ✓ | | | | |
| *Neopsephotus bourkii* | Bourke's Parrot | ✓ | | | | | | ✓ |
| *Pezoporus occidentalis* | Night Parrot | ✓ | | | | | | |
| *Melopsittacus undulatus* | Budgerigar | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| CENTROPIDAE | | | | | | | | |
| *Centropus phasianus* | Pheasant Coucal | | | | | ✓ | | ✓ |
| CUCULIDAE | | | | | | | | |
| *Chalcites basalis* | Horsfield's Bronze Cuckoo | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| *Cuculus pallidus* | Pallid Cuckoo | ✓ | | | ✓ | ✓ | | ✓ |
| STRIGIDAE | | | | | | | | |
| *Ninox novaeseelandiae* | Southern Boobook | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| TYTONIDAE | | | | | | | | |
| *Tyto alba* | Barn Owl | ✓ | | | | ✓ | | |
| PODARGIDAE | | | | | | | | |
| *Podargus strigoides* | Tawny Frogmouth[a] | | | | | | | ✓ |
| CAPRIMULGIDAE | | | | | | | | |
| *Eurostopodus argus* | Spotted Nightjar | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| AEGOTHELIDAE | | | | | | | | |
| *Aegotheles cristatus* | Australian Owlet-Nightjar | | ✓ | | ✓ | ✓ | | ✓ |
| HALCYONIDAE | | | | | | | | |
| *Dacelo leachii* | Blue-winged Kookaburra | | | | | ✓ | | ✓ |
| *Todirhamphus pyrrhopygia* | Red-backed Kingfisher | ✓ | | | ✓ | ✓ | | ✓ |
| *Todirhamphus sanctus* | Sacred Kingfisher | ✓ | | | | | | ✓ |
| MEROPIDAE | | | | | | | | |
| *Merops ornatus* | Rainbow Bee-eater | ✓ | | | | ✓ | | ✓ |
| NEOSITTIDAE | | | | | | | | |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Daphoenositta chrysoptera* | Varied Sitella | ✓ | | ✓ | | | | |
| CLIMATERIDAE | | | | | | | | |
| *Climacteris melanura* | Black-tailed Treecreeper | ✓ | | ✓ | | | | ✓ |
| MALURIDAE | | | | | | | | |
| *Amytornis striatus* | Striated Grasswren | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Malurus lamberti* | Variegated Fairy-wren | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Malurus leucopterus* | White-winged Fairy-wren | ✓ | | ✓ | | ✓ | | ✓ |
| *Stipiturus ruficeps* | Rufous-crowned Emu-wren[a] | | | | | | | ✓ |
| PARDALOTIDAE | | | | | | | | |
| *Pardalotus rubricatus* | Red-browed Pardalote | ✓ | | ✓ | | ✓ | | ✓ |
| *Pardalotus striatus* | Striated Pardalote | ✓ | | ✓ | ✓ | ✓ | | |
| *Smicrornis brevirostris* | Weebill | ✓ | ✓ | | | ✓ | | ✓ |
| *Gerygone fusca* | Western Gerygone | ✓ | | ✓ | | ✓ | | |
| *Acanthiza apicalis* | Inland Thornbill | ✓ | | | | ✓ | | |
| *Acanthiza chrysorrhoa* | Yellow-rumped Thornbill | ✓ | | ✓ | | | | ✓ |
| *Acanthiza robustirostris* | Slaty-backed Thornbill[a] | | | | | | | ✓ |
| *Acanthiza uropygialis* | Chestnut-rumped Thornbill | ✓ | ✓ | ✓ | | | | ✓ |
| MELIPHAGIDAE | | | | | | | | |
| *Acanthagenys rufogularis* | Spiny-cheeked Honeyeater | ✓ | ✓ | | | ✓ | | ✓ |
| *Manorina flavigula* | Yellow-throated Miner | ✓ | ✓ | | | ✓ | | ✓ |
| *Lichenostomus keartlandi* | Grey-headed Honeyeater | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| *Lichenostomus virescens* | Singing Honeyeater | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Lichenostomus penicillatus* | White-plumed Honeyeater | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| *Lichenostomus plumulus* | Grey-fronted Honeyeater | | ✓ | | | | | |
| *Melithreptus gularis* | Black-chinned Honeyeater | ✓ | | | | ✓ | | |
| *Lichmera indistincta* | Brown Honeyeater | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| *Phylidonyris albifrons* | White-fronted Honeyeater | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| *Epthianura aurifrons* | Orange Chat | ✓ | | | | | | |
| *Epthianura tricolor* | Crimson Chat | ✓ | | ✓ | ✓ | | | ✓ |
| *Certhionyx niger* | Black Honeyeater | | | | ✓ | | | ✓ |
| *Certhionyx variegatus* | Pied Honeyeater | | | | ✓ | | | ✓ |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Conopophila whitei* | Grey Honeyeater | ✓ | | ✓ | | | | |
| PETROICIDAE | | | | | | | | |
| *Melanodryas cucullata* | Hooded Robin | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Petroica goodenovii* | Red-capped Robin | ✓ | ✓ | | | | | ✓ |
| CINCLOSOMATIDAE | | | | | | | | |
| *Cinclosoma castaneothorax* | Chestnut-breasted Quail-thrush | ✓ | | ✓ | | | | |
| POMATOSTOMIDAE | | | | | | | | |
| *Pomatostomus temporalis* | Grey-crowned Babbler | ✓ | | ✓ | | ✓ | | ✓ |
| *Pomatostomus superciliosus* | White-browed Babbler | ✓ | | | | | | |
| PACHYCEPHALIDAE | | | | | | | | |
| *Oreoica gutturalis* | Crested Bellbird | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Pachycephala rufiventris* | Rufous Whistler | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| *Colluricincla harmonica* | Grey Shrike-thrush | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| DICRURIDAE | | | | | | | | |
| *Grallina cyanoleuca* | Magpie-lark | ✓ | | | | ✓ | | ✓ |
| *Rhipidura albiscapa* | Grey Fantail | ✓ | | | | | | |
| *Rhipidura leucophrys* | Willie Wagtail | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| CAMPEPHAGIDAE | | | | | | | | |
| *Coracina novaehollandiae* | Black-faced Cuckoo-shrike | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Coracina maxima* | Ground Cuckoo-shrike | | | | | ✓ | | ✓ |
| *Lalage sueurii* | White-winged Triller | ✓ | | | ✓ | ✓ | | ✓ |
| ARTAMIDAE | | | | | | | | |
| *Artamus personatus* | Masked Woodswallow | ✓ | | | | | | |
| *Artamus cinereus* | Black-faced Woodswallow | ✓ | ✓ | | | ✓ | | ✓ |
| *Artamus minor* | Little Woodswallow | ✓ | ✓ | | ✓ | ✓ | | |
| *Cracticus torquatus* | Grey Butcherbird | ✓ | ✓ | | | | | ✓ |
| *Cracticus nigrogularis* | Pied Butcherbird | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| CORVIDAE | | | | | | | | |
| *Gymnorhina tibicen* | Australian Magpie | ✓ | ✓ | | | ✓ | | |
| *Corvus bennetti* | Little Crow[a] | | | | | | | ✓ |
| *Corvus orru* | Torresian Crow | ✓ | ✓ | | | ✓ | | ✓ |

| FAMILY & species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| PTILONORHYNCHIDAE | | | | | | | | |
| *Chlamydera guttata* | Western Bowerbird | ✓ | | | | ✓ | | ✓ |
| MOTACILLIDAE | | | | | | | | |
| *Anthus novaeseelandiae* | Australian Pipit | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| ESTRILDIDAE | | | | | | | | |
| *Emblema pictum* | Painted Finch | | | | ✓ | ✓ | | ✓ |
| *Taeniopygia guttata* | Zebra Finch | ✓ | ✓ | | ✓ | ✓ | | ✓ |
| DICAEIDAE | | | | | | | | |
| *Dicaeum hirundinaceum* | Mistletoebird | ✓ | | | ✓ | ✓ | | ✓ |
| HIRUNDINIDAE | | | | | | | | |
| *Cheramoeca leucosternus* | White-backed Swallow | | ✓ | | | ✓ | | ✓ |
| *Hirundo neoxena* | Welcome Swallow | ✓ | | | | | | |
| ALAUDIDAE | | | | | | | | |
| *Cinclorhamphus mathewsi* | Rufous Songlark | ✓ | | | | | | ✓ |
| *Cinclorhamphus cruralis* | Brown Songlark | ✓ | | | | | | |
| *Eremiornis carteri* | Spinifexbird | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| *Megalurus gramineus* | Little Grassbird | ✓ | | | | | | |
| *Mirafra javanica* | Singing Bushlark[a] | | | | | | | ✓ |

116 Expected species
81 Previously observed by *ecologia*
85 Species observed in this survey
9 Species not previously recorded

**Appendix A3 Mammal species previously observed or expected in the Hashimoto Project area. [a] denotes species not previously recorded.**

| FAMILY & Species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| TACHYGLOSSIDAE | | | | | | | | |
| *Tachyglossus aculeatus* | Echidna | | | ✓ | ✓ | | | |
| DASYURIDAE | | | | | | | | |
| *Dasycercus cristicauda* | Mulgara | ✓ | | | | | | |
| *Dasykaluta rosamondae* | Kaluta | | ✓ | ✓ | | ✓ | | ✓ |
| *Dasyurus hallucatus* | Northern quoll | | | | | | | |
| *Ningaui ridei* | Wongai Ningaui | ✓ | | | | | | |
| *Ningaui timealeyi* | Pilbara Ningaui | ✓ | | ✓ | ✓ | | | ✓ |
| *Planigale* sp. | | ✓ | | | ✓ | ✓ | | |
| *Pseudantechinus macdonnellensis* | Fat-tailed Antechinus | | ✓ | | | | | |
| *Pseudantechinus woolleyae* | Woolley's Pseudantechinus | ✓ | | | | | | |
| *Sminthopsis crassicaudata* (EHA002) | Fat-tailed Dunnart | | | | | | | ✓ |
| *Sminthopsis longicaudata* | Long-tailed Dunnart | ✓ | | | | | | |
| *Sminthopsis macroura* | Stripe-faced Dunnart | ✓ | | ✓ | | | | ✓ |
| *Sminthopsis ooldea* | Ooldea Dunnart | ✓ | | ✓ | | | | |
| *Sminthopsis youngsoni* | Lesser Hairy-footed Dunnart | ✓ | | | | | | |
| EMBALLONURIDAE | | | | | | | | |
| *Saccolaimus flaviventris* | Yellow-bellied Sheath-tail Bat | ✓ | | ✓ | | ✓ | | ✓ |
| *Taphozous georgianus* | Common Sheath-tail Bat | ✓ | | ✓ | | ✓ | | ✓ |
| *Taphozous hilli* | Hill's Sheath-tail Bat | ✓ | | ✓ | | | | |
| HIPPOSIDERIDAE | | | | | | | | |
| *Rhinonicteris aurantius* | Orange (Pilbara) Leaf-nosed Bat[a] | | | | | | | ✓ |
| FELIDAE | | | | | | | | |
| **Felis catus* | Cat | | ✓ | | | | | |
| LEPORIDAE | | | | | | | | |
| **Oryctolagus cuniculus* | Rabbit | ✓ | ✓ | | ✓ | | | |
| MACROPODIDAE | | | | | | | | |
| *Lagorchestes conspicillatus leichardti* | Spectacled Hare-wallaby | ✓ | | | | | | |
| *Macropus robustus erubescens* | Euro | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |

| FAMILY & Species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| *Macropus rufus* | Red Kangaroo | ✓ | | ✓ | | | | ✓ |
| *Petrogale lateralis* | Black-footed Rock-wallaby | ✓ | | | | | | |
| *Petrogale rothschildi* | Rothschild's Rock-wallaby | ✓ | | | ✓ | | | |
| *Petrogale* sp. | Rock-wallaby Species | | | | | ✓ | | |
| MEGADERMATIDAE | | | | | | | | |
| *Macroderma gigas* | Ghost Bat | ✓ | | ✓ | | | | ✓ |
| MOLOSSIDAE | | | | | | | | |
| *Chaerophon jobensis* | Northern Mastiff-bat | ✓ | | ✓ | | | | |
| *Mormopterus beccarii* | Beccari's Freetail-bat | ✓ | | ✓ | | | | ✓ |
| *Tadarida australis* | White-striped Mastiff-bat | ✓ | | ✓ | | ✓ | | |
| MURIDAE | | | | | | | | |
| **Mus musculus* | House Mouse | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Notomys alexis* | Spinifex Hopping-mouse | ✓ | | | | ✓ | | ✓ |
| *Pseudomys chapmani* | Western Pebble-mound Mouse | ✓ | ✓ | ✓ | ✓ | | | |
| *Pseudomys desertor* | Desert Mouse | ✓ | | ✓ | | ✓ | | ✓ |
| *Pseudomys hermannsburgensis* | Sandy Inland Mouse | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| *Zyzomys argurus* | Common Rock-rat | ✓ | ✓ | ✓ | ✓ | | | ✓ |
| THYLACOMYIDAE | | | | | | | | |
| *Macrotis lagotis* | Bilby | ✓ | | ✓ | | | | |
| VESPERTILIONIDAE | | | | | | | | |
| *Chalinolobus gouldii* | Gould's Wattled Bat | ✓ | | ✓ | | ✓ | | ✓ |
| *Chalinolobus morio* | Chocolate Wattle Bat | | | | | | | |
| *Nyctophilus bifax daedalus* | Eastern Long-eared Bat | | | ✓ | | | | |
| *Nyctophilus geoffroyi* | Lesser Long-eared Bat | ✓ | | ✓ | | | | ✓ |
| *Scotorepens greyii* | Little Broad-nosed Bat | ✓ | | ✓ | | ✓ | | ✓ |
| *Vespadelus finlaysoni* | Western Cave Eptesicus | ✓ | | ✓ | | ✓ | | ✓ |
| CANIDAE | | | | | | | | |
| *Canis familiaris dingo* | Dingo | ✓ | ✓ | | | ✓ | | ✓ |
| *Vulpes vulpes* | Fox | ✓ | | | | | | |

| FAMILY & Species | Common Name | WAM | Endersby 1994 | *ecologia* 1998 | *ecologia* 1995b | *ecologia* 2004a | *ecologia* 2004b | Present Study |
|---|---|---|---|---|---|---|---|---|
| EQUIDAE | | | | | | | | |
| *Equus asinus* | Donkey[a] | | | | | | | ✓ |
| *Equus caballus* | Horse | ✓ | | | | | | |
| BOVIDAE | | | | | | | | |
| *Bos taurus* | Cow | ✓ | | | | | | ✓ |

43 Species expected
30 Species previously recorded by *ecologia*
23 Species observed in this survey
2 Species not previously recorded

# Appendix B

# Fauna recorded during the current survey.

**Appendix B1 Herpetofauna recorded during the Hashimoto Survey. P1 = Phase 1 (spring) survey; P2 = Phase 2 (summer) survey**
**[a] Taxa recorded in the spring survey but not the summer survey.**
**[b] Taxa recorded in the summer survey but not the spring survey.**

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| **AMPHIBIA** | | | | | | | | | | | | | | | |
| HYLIDAE | | | | | | | | | | | | | | | |
| *Cyclorana maini* | Main's Frog[b] | | 43 | | 24 | | 33 | | 28 | | 10 | | 16 | | 1 |
| *Cyclorana platycephala* | Water-Holding Frog | | 1 | | 2 | | | | | | | | | 1 | 1 |
| *Litoria rubella* | Desert Tree Frog | | 3 | | 3 | | 11 | | 1 | | | | | 2 | |
| MYOBATRACHIDAE | | | | | | | | | | | | | | | |
| *Limnodynastes spenceri* | Spencer's Frog | | 92 | | 280 | 5 | 44 | | 28 | | | | 2 | | |
| *Uperoleia russelli* | Russell's Toadlet | | 12 | 22 | 45 | 1 | 25 | | | | | | | 31 | |
| | | | | | | | | | | | | | | | |
| **REPTILIA** | | | | | | | | | | | | | | | |
| AGAMIDAE | | | | | | | | | | | | | | | |
| *Ctenophorus caudicinctus* | Rock Ring-tailed Dragon | | 6 | | 1 | | | 1 | 10 | | 3 | | 1 | 5 | 2 |
| *Ctenophorus nuchalis* | Central Netted Dragon[b] | | | | | | 3 | | | | | | | | 2 |
| *Lophognathus longirostris* | Long-nosed Water Dragon | | | 1 | 6 | 2 | 4 | | 1 | | | | 2 | 20 | |
| *Pogona minor* | Western Bearded Dragon | 1 | | | | | | | | 1 | | 2 | | 3 | 2 |
| BOIDAE | | | | | | | | | | | | | | | |
| *Antaresia perthensis* | Pygmy Python[a] | | | 1 | | | | | | | | | | 1 | |
| *Aspidites melanocephalus* | Black-headed Python[b] | | | | | | | | | | | | | | 1 |
| CHELUIDAE | | | | | | | | | | | | | | | |
| *Chelodina steindachneri* | Steindachner's turtle | | | | 2 | | 1 | | | | | | | 2 | |
| ELAPIDAE | | | | | | | | | | | | | | | |
| *Demansia psammophis* | Yellow-faced Whipsnake[b] | | | | | | | | | | 1 | | 1 | | |
| *Pseudechis australis* | Mulga Snake | | | | | | | | | | 1 | 1 | | | |
| *Pseudonaja modesta* | Ringed Brown Snake[b] | | | | | | | | 1 | | | | | | |
| *Pseudonaja nuchalis* | Western Brown Snake / Gwardar[b] | | | | | | | | | | 1 | | | | |
| GEKKONIDAE | | | | | | | | | | | | | | | |
| *Diplodactylus conspicillatus* | Fat-tailed Gecko[b] | | | 1 | | | | | | | | | 2 | | 1 |

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| *Diplodactylus stenodactylus* | Pale-snouted Ground Gecko | | | | | | | | | 1 | 2 | | 2 | | |
| *Diplodactylus wombeyi* | | 1 | 4 | | | | | | | | | | | | |
| *Gehyra punctata* | Spotted Dtella | | 2 | 1 | 5 | | | 1 | 9 | | | | | 43 | |
| *Gehyra purpurascens* | A gecko[b] | | | | | | | | | | | | | | 1 |
| *Gehyra variegata* | Tree Dtella | 1 | 1 | 1 | | | 3 | | | | | | 7 | 11 | |
| *Heteronotia binoei* | Bynoe's Gecko | | | 2 | | 2 | 1 | | 1 | | | | 1 | 2 | |
| *Heteronotia spelea* | Desert Cave Gecko[b] | | 1 | | | | | | | | | | | | |
| *Rhynchoedura ornata* | Beaked Gecko | | | | | | | | | 1 | 1 | 3 | 7 | | 3 |
| *Strophurus wellingtonae* | | | | | | | | | 1 | | 1 | 3 | 1 | | |
| PYGOPODIDAE | | | | | | | | | | | | | | | |
| *Delma elegans* | A legless lizard[a] | | | 1 | | | | | | | | | | | |
| *Delma haroldi* | A legless lizard[b] | | | | | | | | | | 1 | | | | |
| *Delma pax* | A legless lizard | | | | 1 | 1 | 1 | | | | | 1 | | | |
| *Lialis burtonis* | Burton's Snake Lizard | | | | | | | | | | 1 | | | 1 | |
| *Pygopus nigriceps* | Western Hooded Scaly-foot[b] | | 1 | | | | | | | | | | 1 | | |
| SCINCIDAE | | | | | | | | | | | | | | | |
| *Carlia munda* | | | | | 1 | | | | | | | | | 1 | |
| *Ctenotus duricola* | | | 2 | 1 | 1 | | | 2 | 3 | | | 1 | 6 | | |
| *Ctenotus grandis grandis* | A skink[b] | | | | | | | | | | 11 | | | | |
| *Ctenotus helenae* | A skink[b] | | | | | | | | | | 1 | | | | |
| *Ctenotus pantherinus* | Leopard Skink[a] | | | | | | | | | | | | | 1 | |
| *Ctenotus rutilans* | | 1 | 2 | | | | | | | | | | | | |
| *Ctenotus saxatilis* | | 5 | 7 | 6 | 4 | | 1 | | 2 | | | | 1 | 2 | |
| *Ctenotus schomburgkii* | | | | | | | | | | | | 7 | 6 | | |
| *Ctenotus uber* | A skink[a] | | | | | | | | | | | 3 | | 1 | |
| *Cyclodomorphus melanops* | Spinifex Slender Blue-tongue[b] | | 1 | | | | | | 1 | | | | | | |
| *Egernia depressa* | Pygmy Spiny-tailed Skink[a] | | | | | | | | | | | | | 2 | |
| *Eremiascincus richardsonii* | Banded Skink | | | | | | 1 | | | | | | | 1 | |
| *Lerista bipes* | | | | | | | | | | 4 | 1 | | | | |
| *Lerista muelleri* | | 4 | 1 | 8 | 1 | 1 | | | | 5 | | 6 | 2 | 1 | |
| *Lerista neander* | A skink[a] | | | | | | | | | | | 1 | | 8 | |

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| *Lerista zietzi* | A skink[a] | 1 | | | | | | | | | | | | | |
| *Menetia greyii* | Common Dwarf Skink | | 1 | | | | | | | 2 | 1 | 3 | 1 | 1 | |
| *Morethia ruficauda* | Three-striped Fire-tail | | 2 | 4 | | 1 | | | | | | | | 1 | |
| *Tiliqua multifasciata* | Central Blue-tongue Lizard | | | | | | | | | | 1 | | 1 | 1 | |
| TYPHLOPIDAE | | | | | | | | | | | | | | | |
| *Ramphotyphlops grypus* | A blind-snake | 2 | 1 | | | | 1 | 1 | | | | | | | |
| *Ramphotyphlops hamatus* | A blind-snake | | | | | | 1 | | | 1 | | 1 | | | |
| VARANIDAE | | | | | | | | | | | | | | | |
| Var*anus acanthurus* | Ridge-tailed Monitor | 2 | 3 | 1 | | | | 1 | 4 | | | | | 1 | |
| Var*anus giganteus* | Perentie | | | | | | | | | | | | | 1 | 1 |
| Var*anus gouldii* | Gould's Monitor[b] | | | | | | 1 | | | | 2 | | | | |
| Var*anus panoptes* | Yellow-spotted Monitor[b] | | | | | | | | | | | 2 | | | |
| Var*anus tristis* | Black-headed Monitor | | | | 1 | 1 | | | | | 1 | | | 2 | |

**Appendix B2** **Birds recorded during the Hashimoto Survey. P1 = Phase 1 (spring) survey; P2 = Phase 2 (summer) survey.**
**[a] Taxa recorded in the spring survey but not the summer survey.**
**[b] Taxa recorded in the summer survey but not the spring survey.**

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| PHASIANIDAE | | | | | | | | | | | | | | | |
| *Coturnix ypsilophora* | Brown Quail[b] | | | | | | 1 | | | | | | | | |
| TURNICIDAE | | | | | | | | | | | | | | | |
| *Turnix velox* | Little Button-quail | | | | | | | | 1 | | 3 | | 1 | 2 | 5 |
| PHALACROCORIDAE | | | | | | | | | | | | | | | |
| *Phalacrocorax sulcirostris* | Little Black Cormorant[b] | | | | 1 | | | | | | | | | | |
| ANATIDAE | | | | | | | | | | | | | | | |
| *Chenonetta jubata* | Australian Wood Duck[b] | | | | 1 | | | | | | | | | | |
| *Tadorna tadornoides* | Australian Shelduck[a] | | | | | | | | | | | | | 3 | |
| OTIDIDAE | | | | | | | | | | | | | | | |
| *Ardeotis australis* | Australian Bustard[b] | | | | | | | | 1 | | | | | | 2 |
| RALLIDAE | | | | | | | | | | | | | | | |
| *Gallinula ventralis* | Black-tailed Native-hen[a] | | | 1 | | | | | | | | | | 4 | |
| ARDEIDAE | | | | | | | | | | | | | | | |
| *Ardea pacifica* | White-necked Heron[a] | | | | | | | | | | | | | 1 | |
| *Egretta novaehollandiae* | White-faced Heron[b] | | | | 1 | | | | | | | | | | |
| ACCIPITRIDAE | | | | | | | | | | | | | | | |
| *Accipiter fasciatus* | Brown Goshawk[b] | | | | 1 | | | | | | | | | | 1 |
| *Circus assimilis* | Spotted Harrier[a] | | | | | | | | | | | | | 1 | |
| *Hamirostra melanosternon* | Black-breasted Buzzard[a] | | | | | 3 | | | | | | | | 1 | |
| *Haliastur sphenurus* | Whistling Kite | 1 | | 2 | 1 | 1 | | | | | | | 1 | 4 | 1 |
| *Aquila audax* | Wedge-tailed Eagle | | | | | | | | 1 | | 1 | | | 2 | |
| *Hieraaetus morphnoides* | Little Eagle[a] | | | | | | | | | | | | | 2 | |
| FALCONIDAE | | | | | | | | | | | | | | | |
| *Falco berigora* | Brown Falcon | 1 | | | 1 | | | | 1 | | 1 | 1 | | 3 | |
| *Falco longipennis* | Australian Hobby | | | 2 | | | | | | | | | | 2 | 1 |
| *Falco cenchroides* | Australian Kestrel | | 1 | | | 2 | 1 | | 1 | | | | | 2 | |

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| CHARADRIIDAE | | | | | | | | | | | | | | | |
| *Elseyornis melanops* | Black-fronted Dotterel | | | | 2 | | | | | | | | | 6 | 1 |
| COLUMBIDAE | | | | | | | | | | | | | | | |
| *Phaps chalcoptera* | Common Bronzewing | | | 2 | | | 1 | | 1 | 1 | 2 | | | 3 | 2 |
| *Ocyphaps lophotes* | Crested Pigeon | 1 | | | 1 | | 1 | 1 | | 1 | 3 | 2 | 7 | 1 | 4 |
| *Geophaps plumifera* | Spinifex Pigeon | 1 | 3 | | | 3 | 2 | 2 | 10 | | | | | | |
| *Geopelia cuneata* | Diamond Dove | 1 | 3 | 5 | 11 | 1 | 16 | | 91 | | 7 | | 7 | 1 | 3 |
| *Geopelia placida* | Peaceful Dove[b] | | | | | | | | | | | | | | 1 |
| CACATUIDAE | | | | | | | | | | | | | | | |
| *Cacatua roseicapilla* | Galah | | | 5 | 1 | 13 | 15 | 2 | | 1 | 6 | | | 4 | 1 |
| *Cacatua sanguinea* | Little Corella | | 2 | 6 | 3 | 2 | | | | | | | | 10 | 1 |
| PSITTACIDAE | | | | | | | | | | | | | | | |
| *Barnardius zonarius* | Australian Ringneck | | | 3 | 5 | 5 | 8 | | | | 1 | | 1 | | |
| *Neopsephotus bourkii* | Bourke's Parrot[a] | | | | | 2 | | | | | | | | | |
| *Nymphicus hollandicus* | Cockatiel[b] | | | | 2 | | 2 | | 12 | | | | 9 | | 9 |
| *Melopsittacus undulatus* | Budgerigar | | 3 | 3 | 9 | 33 | 38 | | | 2 | 1 | | 2 | 1 | 12 |
| CUCULIDAE | | | | | | | | | | | | | | | |
| *Chalcites basalis* | Horsfield's Bronze Cuckoo | 2 | 2 | 1 | 3 | 3 | | | | 6 | 1 | 5 | 2 | 1 | |
| *Chalcites osculans* | Black-eared Cuckoo | | | | | 1 | | | | | 1 | | 6 | | |
| *Cuculus pallidus* | Pallid Cuckoo | 5 | 1 | 3 | 1 | 7 | 6 | | 1 | 3 | 6 | 3 | 5 | | |
| CENTROPIDAE | | | | | | | | | | | | | | | |
| *Centropus phasianinus* | Pheasant Coucal[b] | | | | 1 | | | | | | | | | | |
| STRIGIDAE | | | | | | | | | | | | | | | |
| *Ninox novaeseelandiae* | Southern Boobook | | | | 2 | | 1 | | | | | | | 2 | 1 |
| PODARGIDAE | | | | | | | | | | | | | | | |
| *Podargus strigoides* | Tawny Frogmouth | | | | | | | | | | 1 | | | 1 | |
| CAPRIMULGIDAE | | | | | | | | | | | | | | | |
| *Eurostopodus argus* | Spotted Nightjar | | | | | | | | | | | | | 1 | 1 |
| AEGOTHELIDAE | | | | | | | | | | | | | | | |
| *Aegotheles cristatus* | Australian Owlet-Nightjar | | | | | | | | | 1 | 2 | | | | |
| HALCYONIDAE | | | | | | | | | | | | | | | |

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| *Dacelo leachii* | Blue-winged Kookaburra | | 2 | | 1 | 4 | 5 | | | | | | | | |
| *Todirhamphus pyrrhopygia* | Red-backed Kingfisher | | 1 | | 5 | 5 | | | | | | | | | |
| *Todirhamphus sanctus* | Sacred Kingfisher | | | | | | 10 | | | | | | | 1 | |
| MEROPIDAE | | | | | | | | | | | | | | | |
| *Merops ornatus* | Rainbow Bee-eater | | 1 | | 7 | 25 | 20 | | | | | | | 5 | |
| CLIMATERIDAE | | | | | | | | | | | | | | | |
| *Climacteris melanura* | Black-tailed Treecreeper[a] | | | | | | | | | | | | | 1 | |
| MALURIDAE | | | | | | | | | | | | | | | |
| *Amytornis striatus* | Striated Grasswren | | 7 | | 1 | 2 | | | | 5 | 5 | 3 | | 1 | |
| *Malurus lamberti* | Variegated Fairy-wren | 34 | 10 | 14 | 6 | 2 | | | | 21 | 1 | 21 | 20 | 3 | |
| *Malurus leucopterus* | White-winged Fairy-wren[a] | | | | | | | | | | | | | 3 | |
| *Stipiturus ruficeps* | Rufous-crowned Emu-wren | | | | | | | 1 | | | | 3 | 7 | | |
| PARDALOTIDAE | | | | | | | | | | | | | | | |
| *Pardalotus rubricatus* | Red-browed Pardalote | 4 | 1 | 3 | 3 | 12 | 7 | | | | | | | 1 | |
| *Smicrornis brevirostris* | Weebill | | 3 | 3 | 10 | | 4 | | | | | | | 1 | |
| *Acanthiza chrysorrhoa* | Yellow-rumped Thornbill[a] | | | | | | | | | | | | | 1 | |
| *Acanthiza robustirostris* | Slaty-backed Thornbill[a] | | | | | | | | | | | | | 3 | |
| *Acanthiza uropygialis* | Chestnut-rumped Thornbill | 23 | 4 | | 5 | | | | | | | | 4 | 1 | 1 |
| MELIPHAGIDAE | | | | | | | | | | | | | | | |
| *Acanthagenys rufogularis* | Spiny-cheeked Honeyeater | 30 | 9 | 5 | 4 | 18 | 2 | | | 17 | 16 | 23 | 23 | 2 | 5 |
| *Certhionyx niger* | Black Honeyeater[b] | | 2 | | | | | | | | | | | | |
| *Manorina flavigula* | Yellow-throated Miner | | | 2 | 2 | 1 | 8 | | | 13 | 5 | 5 | 17 | 3 | 3 |
| *Lichenostomus virescens* | Singing Honeyeater | 13 | 14 | | 3 | 4 | | 1 | 3 | 54 | 35 | 44 | 62 | 3 | |
| *Lichenostomus penicillatus* | White-plumed Honeyeater | | | 12 | 17 | 56 | 56 | | | 1 | | 1 | | | |
| *Lichmera indistincta* | Brown Honeyeater | 25 | 23 | 20 | 43 | 18 | 24 | | | 36 | 16 | 6 | 6 | 1 | 3 |
| *Epthianura tricolor* | Crimson Chat | | 7 | | | | | | | 8 | | | | 1 | 6 |
| *Certhionyx variegatus* | Pied Honeyeater | | | | | | | | | | 25 | 8 | 2 | | |
| PETROICIDAE | | | | | | | | | | | | | | | |
| *Melanodryas cucullata* | Hooded Robin[a] | | | | | | | | | 3 | | | | | |
| *Petroica goodenovii* | Red-capped Robin[a] | | | | | | | | | | | | | 3 | |
| POMATOSTOMIDAE | | | | | | | | | | | | | | | |

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| *Pomatostomus temporalis* | Grey-crowned Babbler | 7 | 2 | 7 | 1 | 5 | 21 | | | 7 | | | | 3 | |
| PACHYCEPHALIDAE | | | | | | | | | | | | | | | |
| *Oreoica gutturalis* | Crested Bellbird | 3 | 7 | 1 | 2 | | 2 | | | 12 | 7 | 12 | 12 | 5 | |
| *Pachycephala rufiventris* | Rufous Whistler | 13 | 8 | 8 | 7 | 7 | 18 | | | 7 | 4 | 13 | 10 | 5 | |
| *Colluricincla harmonica* | Grey Shrike-thrush | | 3 | 7 | 2 | | 3 | | | 2 | 1 | | | 1 | |
| DICRURIDAE | | | | | | | | | | | | | | | |
| *Grallina cyanoleuca* | Magpie-lark | 3 | | 3 | 8 | 8 | 11 | | | | | | | 1 | 1 |
| *Rhipidura leucophrys* | Willie Wagtail | 8 | 7 | 8 | | 11 | 6 | | | 5 | 1 | 2 | 10 | 3 | |
| CAMPEPHAGIDAE | | | | | | | | | | | | | | | |
| *Coracina novaehollandiae* | Black-faced Cuckoo-shrike | 3 | | 3 | 4 | 10 | 8 | | | 6 | 1 | 2 | 1 | 1 | |
| *Coracina maxima* | Ground Cuckoo-shrike[a] | | | | | | | | | | | | | 6 | |
| *Lalage sueurii* | White-winged Triller | | 11 | | 6 | 9 | 7 | | 1 | 1 | 3 | | 9 | 1 | 4 |
| ARTAMIDAE | | | | | | | | | | | | | | | |
| *Artamus cinereus* | Black-faced Woodswallow | 3 | 4 | 3 | | 5 | 1 | | 3 | 9 | 4 | 5 | 5 | 3 | 2 |
| *Artamus minor* | Little Woodswallow | | | | | | 2 | | | | | | | 1 | |
| *Cracticus nigrogularis* | Pied Butcherbird | 17 | 11 | 7 | 17 | 9 | 8 | 3 | | 8 | | 6 | 12 | 1 | 1 |
| *Cracticus torquatus* | Grey Butcherbird[b] | | 1 | | 1 | | | | | | 4 | | 5 | | 4 |
| CORVIDAE | | | | | | | | | | | | | | | |
| *Corvus bennetti* | Little Crow[a] | | | | | 1 | | | | 5 | | 9 | | 2 | |
| *Corvus orru* | Torresian Crow | 4 | | | | | | | 3 | | 1 | | 3 | 3 | |
| PTILONORHYNCHIDAE | | | | | | | | | | | | | | | |
| *Chlamydera guttata* | Western Bowerbird | | 1 | | | | | | | 3 | | 6 | 4 | 1 | |
| MOTACILLIDAE | | | | | | | | | | | | | | | |
| *Anthus novaeseelandiae* | Australian Pipit | | 1 | | | | | 4 | 20 | | 3 | | | | 6 |
| ESTRILDIDAE | | | | | | | | | | | | | | | |
| *Emblema pictum* | Painted Finch[b] | | 3 | | 4 | | | | | | | | | | |
| *Taeniopygia guttata* | Zebra Finch | | 8 | 20 | 7 | 70 | 6 | 1 | 3 | 40 | 4 | | 6 | 2 | 4 |
| DICAEIDAE | | | | | | | | | | | | | | | |
| *Dicaeum hirundinaceum* | Mistletoebird | | 11 | | 11 | | 1 | | | | | | | | |
| HIRUNDINIDAE | | | | | | | | | | | | | | | |
| *Cheramoeca leucosternus* | White-backed Swallow | | | 2 | | 3 | 6 | | | | | | | 1 | |

| FAMILY & species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| ALAUDIDAE | | | | | | | | | | | | | | | |
| *Cinclorhamphus mathewsi* | Rufous Songlark | | | 1 | 3 | 33 | 32 | 1 | | | | | 2 | | 3 |
| *Mirafra javanica* | Singing Bushlark | | | | | | | 2 | 1 | | | | | | |

**Appendix B3** **Mammal species recorded during the Hashimoto survey. Bat data are presence absence; * indicates a roost site. P1 = Phase 1 (spring) survey; P2 = Phase 2 (summer) survey.**
**[a] Taxa recorded in the spring survey but not the summer survey.**
**[b] Taxa recorded in the summer survey but not the spring survey.**

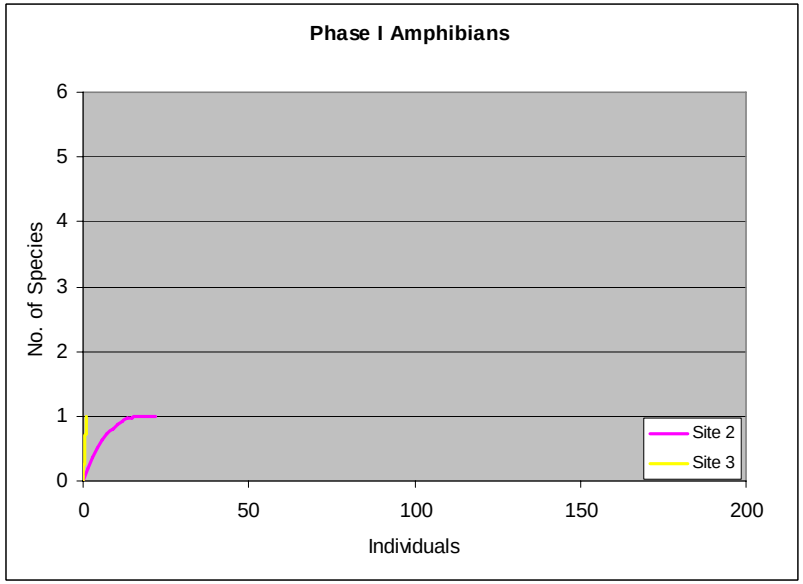
| FAMILY & Species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| DASYURIDAE | | | | | | | | | | | | | | | |
| *Dasykaluta rosamondae* | Kaluta | | | | | | | 1 | | | | | | 1 | |
| *Ningaui timealeyi* | Pilbara Ningaui | | | 2 | | | | | | 1 | | | | | |
| *Sminthopsis macroura* | Stripe-faced Dunnart | | | | | | | | | | 1 | | | | |
| *Sminthopsis crassicaudata* | Fat-tailed Dunnart | | | | | | | | | 1 | | 3 | | | |
| EMBALLONURIDAE | | | | | | | | | | | | | | | |
| *Saccolaimus flaviventris* | Yellow-bellied Sheath-tail Bat | | | | | | | | | | | | | ✓ | |
| *Taphozous georgianus* | Common Sheath-tail Bat | | | | | | | | | | | | | ✓ | |
| HIPPOSIDERIDAE | | | | | | | | | | | | | | | |
| *Rhinonicteris aurantius* | Orange (Pilbara) Leaf-nosed Bat | | | | | | | | | | | | | ✓ | |
| MACROPODIDAE | | | | | | | | | | | | | | | |
| *Macropus robustus* | Euro[a] | | | | | | | | | | | | | 14 | |
| *Macropus rufus* | Red Kangaroo | | | | | | | | 1 | | | | 1 | 2 | |
| MEGADERMATIDAE | | | | | | | | | | | | | | | |
| *Macroderma gigas* | Ghost Bat | | | | | | | | 1 | | | | | ✓ | |
| MOLOSSIDAE | | | | | | | | | | | | | | | |
| *Mormopterus beccarii* | Beccari's Freetail-bat | | | | | | | | | | | | | ✓ | |
| MURIDAE | | | | | | | | | | | | | | | |
| **Mus musculus* | House Mouse | | | 1 | | | 2 | | | 1 | | | 5 | | |
| *Notomys alexis* | Spinifex Hopping-mouse | | | | | | 1 | | | 16 | | 4 | 3 | | |
| *Pseudomys (desertor) EHA006* | Desert Mouse | | | | | 1 | | | | | | | | | |
| *Pseudomys hermannsburgensis* | Sandy Inland Mouse | | | | | | | | | | | 1 | | | |
| *Zyzomys argurus* | Common Rock Rat[b] | | | | | | | | 2 | | | | | | |
| VESPERTILIONIDAE | | | | | | | | | | | | | | | |
| *Chalinolobus gouldii* | Gould's Wattled Bat | | | | | | | | | | | | | ✓ | |
| *Nyctophilus geoffroyi* | Lesser Long-eared Bat | | | | | | | | | | | | | ✓ | |
| *Scotorepens greyii* | Little Broad-nosed Bat | | | | | | | | | | | | | ✓ | |
| *Vespadelus finlaysoni* | Western Cave Eptesicus | | | | | | | | | | | | | ✓ | |

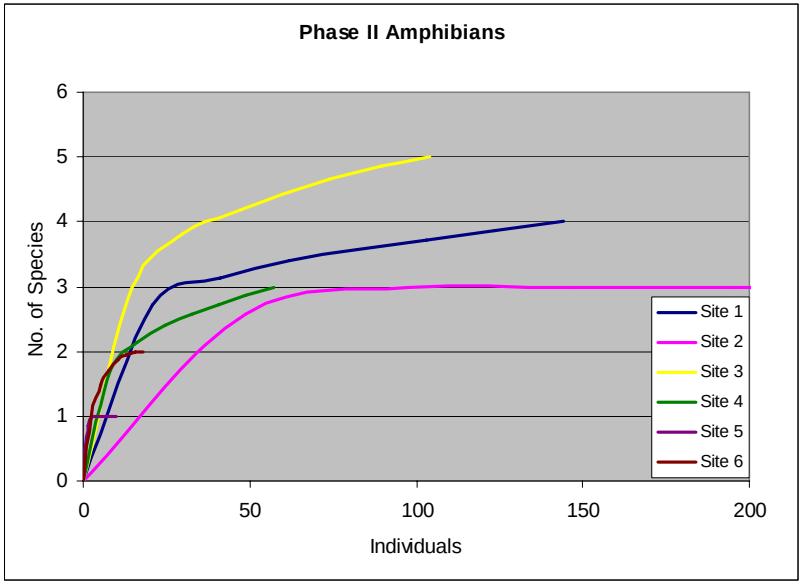
| FAMILY & Species | Common Name | Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | | Site 6 | | Opp | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 | P1 | P2 |
| CANIDAE | | | | | | | | | | | | | | | |
| **Canis familiaris dingo* | Dingo | | | | | | | | | | | | | 7 | 1 |
| EQUIDAE | | | | | | | | | | | | | | | |
| **Equus asinus* | Donkey | | | | | | | | | | | | | 1 | |
| FELIDAE | | | | | | | | | | | | | | | |
| **Felis catus* | Cat[b] | | | | | | | | | | 1 | | | | 1 |
| BOVIDAE | | | | | | | | | | | | | | | |
| **Bos taurus* | European Cattle | | | | | | | | | | | | | 1 | |

# Appendix C

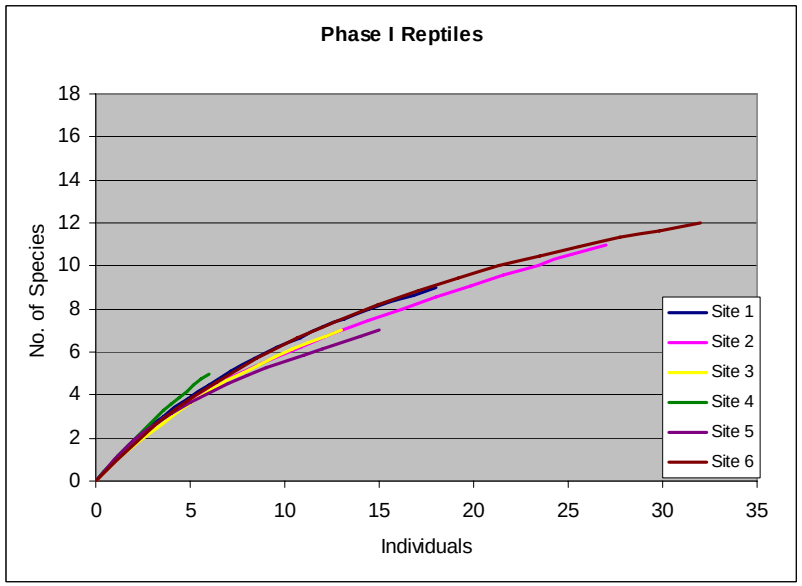
# Species accumulation curves

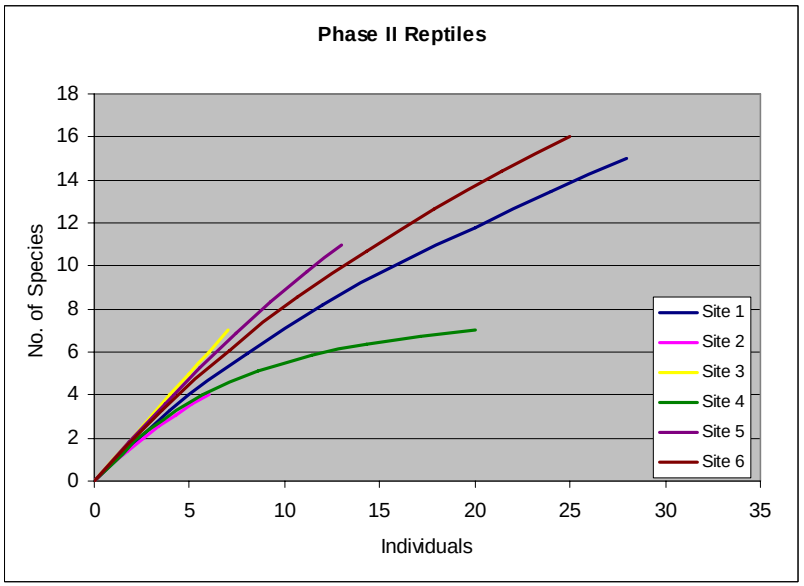
**G-A**


Phase I Amphibians
No. of Species
Individuals
0
1
2
3
4
5
6
0
50
100
150
200
Site 2
Site 3

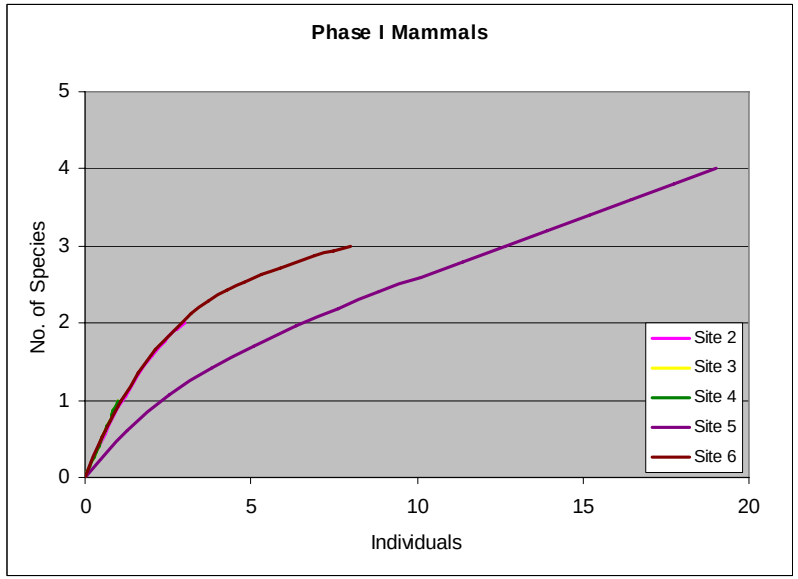

Phase II Amphibians
No. of Species
Individuals
0
1
2
3
4
5
6
0
50
100
150
200
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6

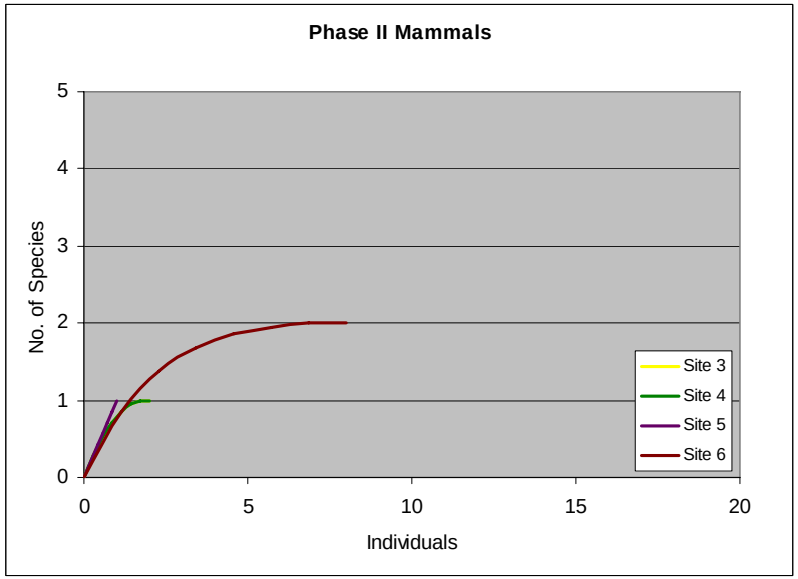
**G-B**


Phase I Reptiles
No. of Species
Individuals
0
2
4
6
8
10
12
14
16
18
0
5
10
15
20
25
30
35
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6

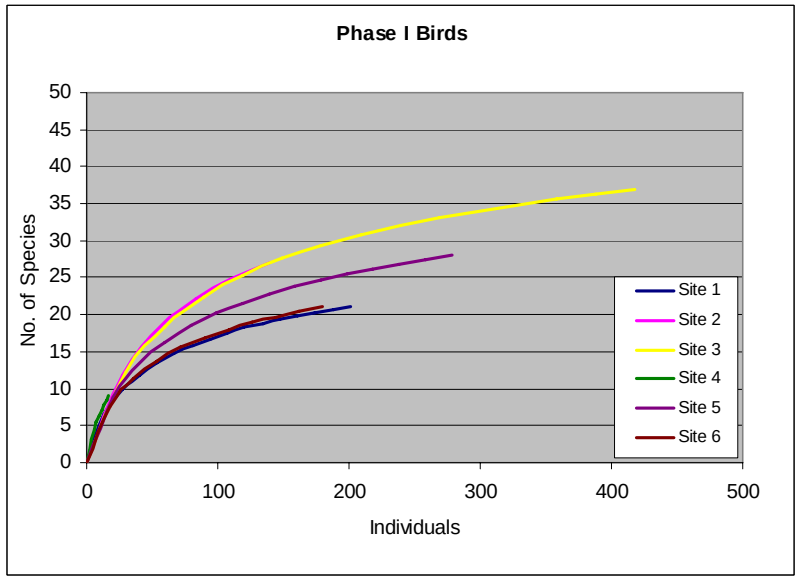

Phase II Reptiles
No. of Species
Individuals
0
2
4
6
8
10
12
14
16
18
0
5
10
15
20
25
30
35
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6

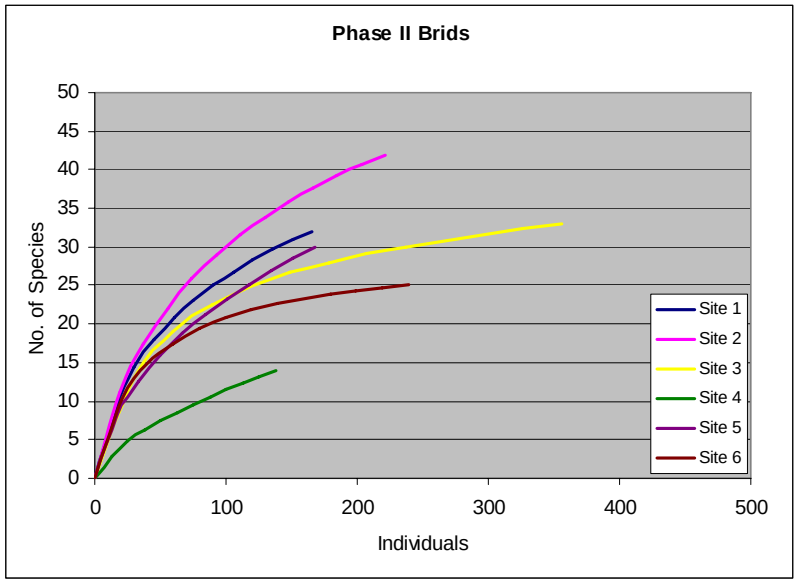
**G-C**


Phase I Mammals
No. of Species
Individuals
0
1
2
3
4
5
0
5
10
15
20
Site 2
Site 3
Site 4
Site 5
Site 6


Phase II Mammals
No. of Species
Individuals
0
1
2
3
4
5
0
5
10
15
20
Site 3
Site 4
Site 5
Site 6

**G-D**


Phase I Birds
No. of Species
Individuals
0
5
10
15
20
25
30
35
40
45
50
0
100
200
300
400
500
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6


Phase II Brids
No. of Species
Individuals
0
5
10
15
20
25
30
35
40
45
50
0
100
200
300
400
500
Site 1
Site 2
Site 3
Site 4
Site 5
Site 6

# Appendix D

# Specimens lodged with the Western Australian Museum

**Appendix D** **Specimens captured during the survey that were lodged with the Western Australian Museum.**

| WAM I.D. | Class | Confirmed ID | Site # | Field Code |
|---|---|---|---|---|
| M62101 | Mammal | *Notomys alexis* | 4 | EHA001 |
| M62105 | Mammal | *Sminthopsis crassicaudata* | 6 | EHA002 |
| M62104 | Mammal | *Ningaui timealeyi* | 2 | EHA004 |
| M62103 | Mammal | *Pseudomys desertor* | 3 | EHA006 |
| M62103 | Mammal | *Pseudomys hermannsburgensis* | 6 | EHA007 |
| | Amphibian | *Uperoleia russelli* | 2 | EHA005 |
| R156774 | Reptile | *Ctenotus uber uber* | 6 | EHA008 |

# Appendix E

# Explanation of fauna conservation codes

## Commonwealth EPBC Act

Schedule 1 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Extinct, Extinct in the wild and Conservation Dependent.

**Table E.1 Explanation of codes for fauna uder the Commonwealth EPBC Act**

| Conservation Category | Definition |
|---|---|
| **Critically Endangered** | The species is facing an extremely high risk of extinction in the wild in the immediate future. |
| **Endangered** | The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction. |
| **Vulnerable** | Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate. |
| **Extinct** | A species is presumed extinct if it has not been located in the last 5 years, or it has not been located in the last 100years despite thorough searching. |
| **Extinct in the wild** | The species is only known to survive in cultivation, in captivity or as a naturalised population well outside its past range or 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 timeframe appropriate to its life cycle and form. |
| **Conservation Dependent** | The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years. |

## WA Wildlife Conservation Act 1950 (Specially Protected Fauna) Notice

Classification of rare and endangered fauna under the WA *Wildlife Conservation (Specially Protected Fauna) Notice 2003*, recognises four distinct schedules.

**Table E.2 Explanation of codes under the WA Wildlife Conservation Act 1950**

| Code | Definition |
|---|---|
| **Schedule 1** | "fauna which are Rare or likely to become extinct, are declared to be fauna that is in need of special protection" |
| **Schedule 2** | "fauna which are presumed to be extinct, are declared to be fauna that is in need of special protection" |
| **Schedule 3** | "birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of 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)." |

## CALM Priority Fauna

Species on the CALM Priority Fauna List (CALM, 2005) include those removed from the Scheduled Fauna List and other species known from only a few populations or in need of monitoring. Five Priority Codes are recognised.

**Table E.3 Explanation of CALM Priority Fauna Categories.**

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

# Appendix F

# Fauna impact risk assessment

# Biological Environmental Impact Risk Assessment

*Project: BHPBIO Hashimoto Baseline Fauna Survey* | *Location: Hashimoto* | *Date:* 13 July 2006

| | | | Inherent Risk | | | | | Residual Risk | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Risk Issue** | **Aspect (Event)** | **Impact** | **Likelihood** | **Consequence** | **Risk Level** | **Significance** | **Controls** | **Likelihood** | **Consequence** | **Risk Level** | **Significance** |
| **Exploration Lease** | | | | | | | | | | | |
| Vegetation clearing | Removal of fauna habitat | Loss of local vertebrate fauna communities | 5 | 2 | 10 | Med | Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical. | 5 | 2 | 10 | Med |
| Vegetation clearing | Removal of fauna habitat | Adverse impact to ecological function | 5 | 2 | 10 | Med | Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Cleared areas should be rehabilitated as soon as is practical. | 5 | 2 | 10 | Med |
| Vegetation clearing | Removal of fauna habitat | Habitat fragmentation | 5 | 1 | 5 | Low | Clearing should be restricted to that which is necessary. Clearing boundaries should be defined in the field. Utilise existing access tracks where possible. Do not create unnecessary additional tracks. | 5 | 1 | 5 | Low |
| Vegetation clearing | Removal of fauna habitat | Loss of biodiversity | 3 | 3 | 9 | Med | Clearing should be restricted to that which is necessary. Clearing should be concentrated on ridges and hills. Use existing access tracks where possible. Avoid impacting Jimblebar Creek and other creeklines. | 5 | 1 | 5 | Low |
| Spread of weeds | Inadequate weed hygiene management | Damage to vegetation resulting in loss of fauna habitat | 3 | 1 | 3 | Low | Weed hygiene measures should be implemented | 1 | 1 | 1 | Low |
| Increased feral fauna | Increased access to fauna habitats. | Increased predation pressure on native fauna. | 1 | 3 | 3 | Low | Clearing should be restricted to that which is necessary. Main access tracks should not be supplemented with secondary tracks and cross-tracks. Cleared areas should be rehabilitated as soon as is practical. | 1 | 3 | 3 | Low |
| Noise pollution | Noise from drilling | Disruption of local fauna populations | 5 | 1 | 5 | Low | Noise controls should be implemented. | 3 | 1 | 3 | Low |
| Noise pollution | Noise and vibration from drilling | Reduction in Rare fauna populations | 4 | 5 | 20 | High | Do not drill within 500m of Orange Leaf-nosed Bat colony. Dr Kyle Armstrong should visit site to determine appropriate drilling exclusion zone. Develop OLNB Management Plan. | 2 | 5 | 10 | Med |
| Human disturbance | Human disturbance of Orange Leaf-nosed Bat and Ghost Bat colony | Reduction in Priority fauna populations | 3 | 5 | 15 | High | Restrict access to the Orange Leaf-nosed Bat colony to authorised personnel only. Physical access barriers, such as padlocked gates, should be installed. Warning signs should be posted. | 1 | 5 | 5 | Low |
| Dust | Dust emissions arising from exploration activities | Damage to vegetation resulting in loss of fauna habitat | 4 | 1 | 4 | Low | Dust supression measures should be implemented, including management of road speed on unsealed roads. | 2 | 1 | 2 | Low |
| Vehicle Strikes | Vehicle movements during construction and operation phases. | Fauna mortality | 3 | 1 | 3 | Low | Enforce speed limits and avoid driving during dusk and dawn. | 2 | 1 | 2 | Low |
| Fire | Wildfire arising as a result of exploration activities | Degradation of fauna habitat and populations | 2 | 2 | 4 | Low | A fire prevention strategy should be implemented. All cars should be fitted with fire extinguishers & all personnel trained in their use. | 1 | 1 | 1 | Low |

**Appendix F: Risk matrix: Likelihood and Consequences**

| Likelihood: | | |
|---|---|---|
| **Value** | **Description** | **Criteria** |
| 5 | Almost Certain | Environmental issue will occur, is currently a problem or is expected to occur in most circumstances. |
| 4 | Likely | Environmental issue has been a common problem in the past and there is a high probability that it will occur in most circumstances. |
| 3 | Possible | Environmental issue may have arisen in the past and there is a high probability that it could occur at some time. |
| 2 | Unlikely | Environmental issue may have occurred in the past and there is a moderate probability that it could occur at some time but not expected. |
| 1 | Rare | Environmental issue has not occurred in the past and there is a very low probability that it may occur in exceptional circumstances. |

| Consequence: | | |
|---|---|---|
| **Value** | **Description** | **Criteria** |
| 5 | Catastrophic | Significant impact to fauna species of conservation significance or regional biodiversity |
| 4 | Major | Impact to fauna species of conservation significance in project area. |
| 3 | Moderate | Loss of fauna biodiversity in project area. |
| 2 | Minor | Short term or localised impact to fauna biodiversity. |
| 1 | Insignificant | No impact to fauna of conservation significance or biodiversity. |

## Appendix F: Risk Assessment Matrix

**Risk Matrix:**

| Risk Assessment Rating | | LIKELIHOOD | | | | |
|---|---|---|---|---|---|---|
| | | 5<br>ALMOST CERTAIN<br>Is expected to occur in most circumstance | 4<br>LIKELY<br>Will probably occur in most circumstance | 3<br>POSSIBLE<br>Could occur | 2<br>UNLIKELY<br>Could occur but not expected | 1<br>RARE<br>Occurs in exceptional circumstances |
| CONSEQUENCES | 5 - CATASTROPHIC<br>Significant impact to fauna species of conservation significance or regional biodiversity | 25 | 20 | 15 | 10 | 5 |
| | 4 - MAJOR<br>Impact to fauna species of conservation significance in project area. | 20 | 16 | 12 | 8 | 4 |
| | 3 - MODERATE<br>Loss of fauna biodiversity in project area. | 15 | 12 | 9 | 6 | 3 |
| | 2 - MINOR<br>Short term or localised impact to fauna biodiversity. | 10 | 8 | 6 | 4 | 2 |
| | 1 - INSIGNIFICANT<br>No impact to fauna of conservation significance or biodiversity. | 5 | 4 | 3 | 2 | 1 |

| | |
|---|---|
| 11-25 | High risk, site/issue specific management programmes required, advice/approval from regulators required. |
| 6 – 10 | Medium risk, specific management and procedures must be specified. |
| 1 – 5 | Low risk, managed by routine procedures. |